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# EDITORIAL



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Volume 9 includes the papers 'Construction and Schemata in Mathematics' by Klaus Frovin Jørgensen and 'Towards a Theory of Convention' by Pelle Guldborg Hansen, information about the *Masses of Formal Philosophy* project, announcements of upcoming conferences, new publications, initiatives, programs and announcements from AiML – Advances in Modal Logic, ASL – Association for Symbolic Logic, FoLLI – Foundation of Logic, Language and Information, TARK – Theoretical Aspects of Reasoning about Knowledge.

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April, 2006
Vincent F. Hendricks
Pelle Guldborg Hansen
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Editors

# CONSTRUCTION AND SCHEMATA IN MATHEMATICS

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Recently I read Patrick Suppes claiming that "the most important open scandal in philosophy is the problem of free will" [17, p. 205]. I very much agree with Suppes that the problem of the free will is a major puzzle, which we should try to get a better understanding of by examining the deeper issues connected with the free will. This essay, however, does not treat the problem of the free will. It concerns the problems of the ontology and epistemology of mathematics. In general, the problems of the philosophy of mathematics are just as old and—if it makes sense to talk about solvability of such problems—perhaps just as unsolved as the problem of the free will.

Mathematics is a very important ingredient of knowledge. In its most simple form mathematics plays a necessary role in our understanding of the surrounding world and is necessary for solving simple problems of ordinary life. At the other end of the simplicity-scale we find the mathematics as used in science. Also here mathematics has a necessary role in our descriptions of nature and the way in which we are involved with it and each other. It truly amazes me that there seems to be very little consensus with respect to the ontology and epistemology of mathematics.

There can be no doubt that the natural numbers exit; I mean, we use them all the time. The question is only: In which sense? This question I have treated this question elsewhere [13], thus I will here be more interested in the existence of mathematical objects whose nature seems more abstract.

Platonism is an important part of the philosophy of mathematics. The upshot of Platonism is its simplicity with respect to existence and truth: Mathematical objects are existing non-temporally and non-spatially in a universe which we can access only by rational thinking. They exist eternally and independently of human beings and are perfectly real. Mathematical statements are therefore objectively true or false and their truth-value is also independent from humans.[1] Within Platonism one introduces in this way a dualism[2] and from which it follows that all kinds of constructivism are incompatible with Platonism. As Plato himself expresses it:

[1] Kurt Gödel, for instance, expressed views in this directions [8].
[2] It is well-known what the general problem of dualisms is: How are the dual worlds connected?

> [...] no one who has even a slight acquaintance with geometry will deny that the nature of this science is in flat contradiction with the absurd language used by mathematicians, for want of better terms. They constantly talk of "operations" like "squaring", "applying", "adding", and so on, as if the object were to *do* something, whereas the true purpose of the whole subject is knowledge – knowledge, moreover, of what eternally exists, not of anything that comes to be this or that at some time and ceases to be. (Republic 527a)

I find this element of Platonism rather problematic and in the following I would like to outline a philosophy of mathematics which on the one hand takes the language used by mathematicians as serious as possible: When mathematicians talk, for instance, about constructing the real numbers what can they possibly mean? On the other hand I have no intensions towards 'taking the fists from the boxer'. On the contrary, I think to much energy has been put into producing normative philosophy of mathematics in discussing what is 'good' or what is 'bad' mathematics.

I want to do a certain kind of naturalized philosophy of mathematics. We see mathematics is being done in a great many aspects of the human life. I would like to know *what* is going on—the interest is not in the direction of what should be going on.

## Equivalence classes and quotient structures

Mathematicians often talk about constructions in connection with quotient structures.

Let $X$ be some set and suppose $\sim$ is an equivalence relation on $X$.[3] Given any element $x$ of $X$ we now construct another object $[x]$ which is the collection of all elements which are equivalent to $x$, i.e.,

$$[x] = \{y \in X \mid x \sim y\}.$$

$[x]$ is called the equivalence class generated by $x$ under $\sim$ and the question now is, in which sense the equivalence class is *constructed* and in which sense it *exists*. Given such an $X$ and $\sim$ we quite often collect all the equivalence classes and form a new set $X/\!\sim$ consisting of all the equivalence classes, in other words:

$$a \in X/\!\sim \quad \text{if and only if,} \quad \begin{array}{l} a \text{ is an equivalence class generated} \\ \text{by some element of } X \text{ under } \sim. \end{array}$$

By extensionality of sets we can lift the equivalence relation $\sim$ on $X$ to an identity relation on $X/\!\sim$.

$$[x] = [y] \text{ if and only if } x \sim y.$$

[3] That $\sim$ is an equivalence relation on $X$ means that tree conditions obtain for $\sim$ with respect to elements of $X$. Firstly, any element $x$ is related to itself, i.e., $x \sim x$; secondly, $x \sim y$ implies $y \sim x$; and thirdly, $x \sim y$ and $y \sim z$ implies $x \sim z$.

For at very simple example let $X$ be the set of all cars. If $x \sim y$ obtains just in case $x$ has the same color as does $y$, then $\sim$ is an equivalence relation.[4] We can then form $X/\sim$ which consists of all car-colors, so to speak. Philosophers would tend to think of $X/\sim$ as a collection of concepts, whereas mathematicians would think of it as a collection of new objects.

We can also construct $\mathbb{Q}$ as the collection of equivalence classes of ordered pairs of whole numbers $(a, b)$, with $b \neq 0$. The equivalence relation is defined by

$$(a, b) \sim (c, d) \text{ if and only if } ad = bc.$$

The equivalence class $[(a, b)]$ is then understood as the rational number $a/b$.

More generally, we can construct equivalence classes in the following way. Let $f$ be a function form $X$ to $Y$. Then $f$ defines an equivalence relation on $X$ by

$$x \sim y \text{ if and only if } f(x) = f(y).$$

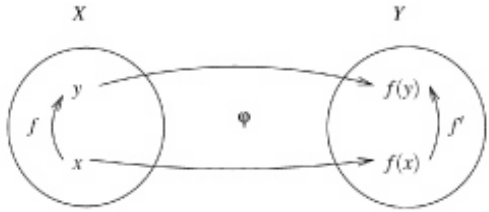
Here $[x]$ is the set of all elements $y$, which are mapped to $f(x)$. The equivalence relation is the kernel of $f$:

$$\ker f = \{(x, y) \in X \times X \mid f(x) = f(y)\}.$$

Now suppose that we are given even more. Let us look at the case where we are given a *homomorphism* $\varphi : X \to Y$ where $X$ and $Y$ are structures, e.g., groups or rings, of the same type.[5] Now, a homomorphism $\varphi : X \to Y$ is a certain mapping which preservers the structure of $X$ to $Y$, in the sense that within $Y$ there is a sub-structure which in a certain sense imitates $X$. If for instance there is a relation $R$ belonging to $X$ then $(x, y) \in R$ implies that in $Y$ there is an $R'$ such that $(\varphi(x), \varphi(y)) \in R'$. Also, mappings are preserved in the sense that if a function $f$ in $X$ maps $x$ to $y$, then there is a function $f'$ in $Y$ such that $f'(\varphi(x)) = \varphi(y)$. In the remaining part of this essay I tacitly assume that if $\varphi$ is a homomorphism from one structure to another, then the two structures are of the same type.

[4] Leaving the problem of Sorites aside for a moment.

[5] That $X$ and $Y$ are structures of the same type means that we can pair relations from $X$ with relations from $Y$ such that the arity of the two relations in each pair is the same. Likewise for functions. Constants are understood as 0-ary functions.

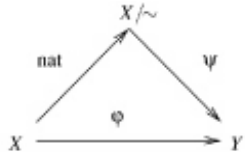



An injective homomorphism $\varphi$ is called a monomorphism and a surjective homomorphism is called an epimorphism. If $\varphi$ is bijective it is an isomorphism. Moreover, suppose we have a structure $X$, then a *congruence relation* $\sim$ on $X$ is an equivalence relation on $X$ which respects the relations and functions of $X$. That means, for instance, if $(x, y) \in R$ and $x \sim x'$ and $y \sim y'$ then $(x', y') \in R$. Thus, given a structure $X$ and a congruence relation we can naturally construct the *quotient structure* $X/\sim$ by letting the domain of $X/\sim$ be the collection of all equivalence classes and if $R$ is a relation on $X$ we define $R_{/\sim}$ by

$$([x], [y]) \in R_{/\sim} \text{ if and only if } (x, y) \in R.$$

Given a congruence relation $\sim$ on a set $X$ we call the epimorphism nat from $X$ to $X/\sim$ defined $x \mapsto [x]$ the *natural epimorphism.*

**Theorem**. Suppose $\varphi : X \to Y$ is a homomorphism from a structure $X$ to a structure $Y$. Then there is a monomorphism $\psi : X/\sim \to Y$ such that $\varphi = \psi \circ \text{nat}$. This simply means that the following diagram commutes:




Let me give a very simple example. Let $\mathbb{Z}$ be the structure of whole numbers with the ordinary operations for plus and times, i.e., $\mathbb{Z} = (Z, +, \cdot)$, where $Z$ is the set of whole numbers. Moreover,

$$\mathbb{Z}_2 = (Z_2, \oplus, \odot)$$

with $Z_2 = \{0, 1\}$ and $\oplus$ and $\odot$ defined as:

| $\oplus$ | 0 | 1 |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 1 | 0 |

| $\odot$ | 0 | 1 |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |

Now define $\varphi : Z \to Z_2$ in the following way:

$$\varphi(n) = \begin{cases} 0, & \text{if } n \text{ is even,} \\ 1, & \text{otherwise.} \end{cases} \tag{2.1}$$

Now it is easily seen that $\varphi(n+m) = \varphi(n) \oplus \varphi(m)$ and $\varphi(n \cdot m) = \varphi(n) \odot \varphi(m)$. Therefore, $\varphi$ respects the functions and $\varphi$ is an epimorphism. The equivalence relation $\sim_\varphi$ defined by $\varphi$ gives rise to two equivalence classes [0] and [1] containing the even whole numbers and the uneven whole numbers, resp. And in fact, as the monomorphism from 2 to $\mathbb{Z}_2$, given by the theorem, is surjective the two simple structures 2 and $\mathbb{Z}_2$ are isomorphic.

We have now seen different ways to construct new structures, namely quotient structures. There are many other ways of constructing new structures such as product structures and ultra-product structures. I will not, however, analyze those more advanced methods for constructing new objects here. Now I think it is important to think philosophically about what is going on when we form equivalence classes and quotient structures.

## Kant on the construction of objects

I propose that generalizing Immanuel Kant's notion of schemata is a very fruitful approach to the epistemology of mathematical objects and concepts. Now, it is very well-known that Kant had a rather antiquated view on mathematics and the so-called a priori. He claims to prove that the Euclidean space is the one and only structure that the empirical space can have and he also claims that finger counting validates the laws of arithmetic and he talks about drawing figures in thought or on paper and proving theorems on the basis of these figures. In the "Transcendental Aesthetics" in the first *Critique* he says that space is infinite whereas in the "Dialectics" he says it is neither finite nor infinite. I must be acknowledged that it is from time to time difficult to make sense out of his, sometimes, rather confusing writings. Nevertheless, I claim that his theory of knowledge can be used for something reasonable. I very much agree with Clark Glymore:

> Kant's three works on epistemology are filled with arguments. Unfortunately, the major arguments appear either invalid or too obscure to assess with confidence [...] Unlike Descartes and Hume, Kant's importance does not rest with his arguments themselves. Instead, the value of Kant's work for the theory of knowledge rests in the *kind* of argument he thought he could give for his theory, and in the general picture of knowledge presented in that theory. [7]

In particular I will here examine Kant's theory of schemata.

In general schemata are a mediating "third thing" (A138/B177) which makes it possible that objects can be subsumed under concepts. The latter is something purely

intellectual and therefore non-sensible, the former on the other hand is something sensible. There must therefore be something which mediates between the senses and the intellectual. In fact, any concept is useless without a schema. As there are basically three different types of concepts—empirical, pure sensible, transcendental—there are also three different types of schemata:

1. Empirical schemata,
2. Geometrical schemata,
3. Transcendental schemata.

By way of example, let us take a look at Kant's own example of empirical schemata. An empirical concept to Kant is a concept which we have derived from experience. Take the concept of dog, for instance. Typically we would tend to think of a dog as an animal which has four feet (and is inclined towards barking). But we are not able to *refer* to anything, unless the concept is used *together* with its schema. When this is the case, then:

> The concept of a dog [together with its schema] signifies a rule in accordance with which my imagination can specify the shape of a four-footed animal in general, without being restricted to any single particular shape that experience offers me of any possible image that I can exhibit *in concreto*. (A141/B180)

The schema of dog is a rule-governed procedure by which the imagination can produce a *paradigmatic mental* image, which functions as a prototype or a representative example giving me a *figurative representation* of a typical dog.[6] By using this I can think of a dog (as such) even though no dogs are present, and when there is a dog present I can subsume this animal under my concept dog, since I find the characteristics to be present in the dog, because of essential similarities between the dog and my mental image of a dog in general. I can compare dogs, and I can count collection of dogs.

On the face of it, the empirical schemata may all seem unproblematic and straightforward. But there is more to it. The problem is that empirical concepts are dynamical, since "**empirical** concepts cannot be defined at all but only explicated", where "**to define** properly means just to exhibit originally [*ursprünglich*] the exhaustive concept of a thing with its boundaries" (A727/B755). Therefore, to give a definition of the concept "dog", would be to give a priori (*originally*) the necessary and sufficient characteristics for objects to be subsumed under dog. But empirical concepts are derived from experience and thus different persons may understand different things under the concept.

In general, one of the the essential properties of a schema is that it enables *uni-*

[6] Thus Kant's theory of schemata are a clear predecessor of a contemporary theory of prototypes found in cognitive psychology as given by Rosch.

*versal* reasoning. From the concept and the construction of a paradigmatic we should be able to reason due to the schema generally about the concept. This is problematic in the case of empirical concepts as these—according to Kant—are not definable. Be that as it may, in the case of mathematical concepts we are en a better position, as these indeed are definable.

There is no doubt that Kant has a special interest in geometry. And in connection with the theory of schemata this is particularly clear. I think there are three reasons for this.

*The first reason: The challenge from mathematics.* Kant understands mathematics and mathematical knowledge as based on constructions taking place in time. Therefore mathematics is synthetic. Moreover, the propositions of mathematics are necessary, therefore a priori. Simultaneously, Kant aims at giving a general account of human knowledge and here the sciences play a central role. So Kant's theory intends at being a framework for understanding the human activity of science. Mathematics is a special kind of science: The objects are in a certain sense non-empirical; nevertheless mathematical knowledge is synthetic. Thus, Kant wants to develop a theory in which we are 'guaranteed' that there really *are* meaningful mathematical objects, fulfilling the criteria concerning constructibility and necessity. The theory of schemata is a basic pillar in explaining this.

*The second reason: The possibility of abstract concepts.* Kant's more general problem is to explore the possibility of subsuming objects under concepts. If Kant can explain how geometrical concepts, such as triangle, 'function' then, perhaps, he can lift this to a *general* theory of the relation between concepts and objects? In fact, I think this is Kant's strategy

*The third reason: The source of schematism.* As a Kantian unification of the two foregoing I find it most likely that Kant got the idea about schematism from his studies of Euclid. Lisa Shabel sharpens this claims by saying that Euclidean reasoning through diagrams "provides an interpretive model for the function of a transcendental schema" ([16], 109).

Here we are especially interested in the schematism of mathematical concepts, thus we should take a look at Kant's theory of geometrical schemata. This has, as point of departure, Euclid's geometry.

## Geometrical schematism

Euclid's *Elements* comprises 13 books with content ranging from basic plane geometry, over arithmetic and incommensurables to solid geometry. A list of definitions, postulates and common notions open Book I. Whereas the postulates and common notions remain the same throughout the 13 books, each of the subsequent books add new definitions to this list. The first book concerns basic geometry and Kant often mentions or refers to the first book in the *Critique*, either the propositions or the

postulates[7] or paraphrasings hereof.[8]

Kant was more than inspired by Euclid. He wants to give an epistemological foundation of the *constructive* reasoning style that he sees in Euclid. Let us therefore look at one example from Euclid's first book [5]:

PROPOSITION 32.

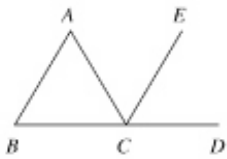
*In any triangle, if one of the sides be produced, the exterior angle is equal to the two interior and opposite angles, and the three interior angles of the triangle are equal to two right angles.*

Let $ABC$ be a triangle, and let one side of it $BC$ be produced to D;

I say that the exterior angle $ACD$ is equal to the two interior and opposite angles $CAB$, $ABC$, and the three interior angles of the triangle $ABC$, $BCA$, $CAB$ are equal to two right angles.

For let $CE$ be drawn through the point $C$ parallel to the straight line $AB$.

[I. 31]




Then, since $AB$ is parallel to $CE$, and $AC$ has fallen upon them, the alternate angles $BAC$, $ACE$ are equal to one another. [I. 29]

Again, since $AB$ is parallel to $CE$, and the straight line $BD$ has fallen upon them, the exterior angle $ECD$ is equal to the interior and opposite angle $ABC$.

But the angle $ACE$ was also proved equal to the angle $BAC$;

therefore the whole angle angle $ACD$ is equal to the two interior and opposite angles $BAC$, $ABC$.

Let the angle $ACB$ be added to each;

therefore the angles $ACD$, $ACB$ are equal to the three angles $ABC$, $BCA$, $CAB$.

But the angles $ACD$, $ACB$ are equal to two right angles; [I. 13]

therefore the angles $ABC$, $BCA$, $CAB$ are also equal to two right angles.

[7] But note, in case of the postulates he only mentions the first three(!)

[8] See (A24/B39; B154; A163/B204; A234/B287; A239/B299; A261/B317; A300/B356; A511/B539; A716/B744).

Therefore etc.

The use of diagrams is central in Euclid's reasoning. Here this is already seen in the very formulation of the proposition. The angles are classified as either interior or exterior. These terms cannot be understood unless one uses the diagram—"exterior" and "interior" are only defined implicitly through diagrams. Now, the diagram of I.32 depicts what we are given: a triangle $ABC$. But more is shown in the diagram. Out of the given triangle we construct line $BD$ (by postulate 2). The extremity of any line is a point, thus $D$ is constructed and exists. Furthermore (due to proposition 31) a line $CE$ can be drawn parallel to $AB$.[9]

The diagram used in the proof of proposition 32 shows properties about line $CE$ which can *only* be inferred by use of the diagram: From the text we do not know the *direction* in which the construction of $CE$ goes. But from the diagram we see that it is drawn upwards and thus splits $ACD$ in two angles $ACE$ and $ECD$. Euclid's fifth common notion states that "[t]he whole is greater than the part"—but it is through the diagram we learn what the whole is ($ACD$) and what the parts are ($ACE$ and $ECD$).

Now that we have determined relations between the lines and we know what is interior and exterior we see (due to proposition 29) that $BAC$ and $ACE$ are equal (in size). In fact this is the only non-obvious part of the proof.[10] The rest of the proof of proposition 32 is more or less trivial.

This type of reasoning is very paradigmatic to Kant and therefore he wants to give this account because he takes it to be the most important mathematical discipline.[11]

### Constructibility and schemata

It is "schemata that ground our pure sensible concepts" (A140/B180). This grounding is deeply connected with the so-called "**construction** of concepts". What it means to "**construct** a concept" is expressed by Kant on pages A713–4/B741–2. Here we learn that to construct a concept means to construct in accordance with rules a non-empirical intuition, which should represent the concept universally. The production of the intuition—which is Kant's epistemological pendant to Euclidean diagrams—can be done either purely by the imagination or it can be a figure drawn on paper. In the latter case the empirical intuition functions as a symbol which refers by analogy to the pure intuition. The *universality* of the image arises when the particular image is taken *together* with the procedure generating the image. Such a procedure is deeply

[9] Proposition 31 is, in turn, proved by appealing to postulate 1 and 2 and propositions 23 and 27, and the construction taking place in this proof is also visualized by a diagram (as all the proofs in *Elements* generally are).

[10] Proposition 29 is proved—through a diagram—by appealing essentially to postulate 5 and proposition 15 (which relies proposition 13 and postulate 4).

[11] Moreover, the Euclidean model of construction provides a general model for Kant's notion of *constructibility*.

connected with the Euclidean style of reasoning:

> Give a philosopher the concept of a triangle, and let him try to find out in his way how the sum of its angles might be related to a right angle. He has nothing but the concept of a figure enclosed by three straight lines, and in it the concept of equally many angles. Now he may reflect on this concept as long as he wants, yet he will never produce anything new. He can analyze and make distinct the concept of a straight line, or of an angle, or of the number three, but he will not come upon any other properties that do not already lie in these concepts. But now let the geometer take up this question. He begins at once to construct a triangle. Since he knows that two right angles together are exactly equal to all of the adjacent angles that can be drawn at one point on a straight line, he extends one side of his triangle, and obtains two adjacent angles that together are equal to two right ones. Now he divides the external one of these angles by drawing a line parallel to the opposite side of the triangle, and sees that here there arises an external adjacent angle which is equal to an internal one, etc. In such a way, through a chain of inferences that is always guided by intuition, he arrives at a fully illuminating and a the same time general solution of the question. (A716–7/B744–5)

Geometrical knowledge evolves in precisely the manner that we have seen the production of mathematical knowledge as given in the case of proposition 32. And here Kant in fact explicitly refers to the proof that proposition. The geometer *constructs* a triangle. But he already knows something in advance, namely (a generalization of) proposition 13. *Therefore* he constructs—in accordance with postulate 2—an extension of one of the lines. Then he divides (a construction validated by proposition 31) the external angle, and *so on*. But it "is always guided by intuition" by the construction of an image (purely mental or empirical with symbolic reference to the pure image) in accordance with some basic postulates, definitions and common notions; after wards discoveries are realized through the constructed image.[12] Then a 'general solution' can be found. I will treat the problem concerning universality in section 2.3.2. Here I concentrate on what precisely the schemata are.

It is a central thesis of that any meaningful concept has a schema. For instance, "[t]he schema of the triangle [...] signifies a rule of the synthesis of the imagination with regard to pure shapes in space" (A141/B180). So the natural question is: What does this rule consist of? The schema for the concept "triangle" must be a rule by which we can construct any (image of a) triangle. Kant writes: "Thus we think of a triangle as an object by being conscious of the composition of three straight lines in

[12] Thus my interpretation differs from Friedman's [6, p. 90], where it is rejected that intuition "enable us to "read off" the side-sum property [in the case of proposition I.32]". Of course the 'reading of'-procedure is not just a simple visual inspection, as Kant also rejects in the case of Euclid's proposition 5 as referred to on page Bxi-xii.

accordance with a rule according to which such an intuition can always be exhibited" (A105). And later in the *Critique*;

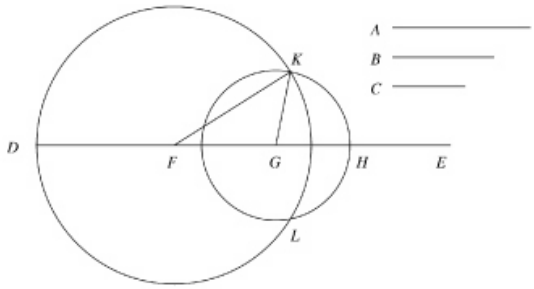
> "three lines, two of which taken together are greater than the third, a triangle can be drawn," then I have here the mere function of the productive imagination, which draws the lines greater or smaller, thus allowing them to abut at any arbitrary angle. (A164/B205)

These two quotations show that the "function of the productive imagination" which Kant is referring to is the function defined in the proof of Euclid's proposition 22:

PROPOSITION 22.

> *Out of three straight lines, which are equal to three given straight lines, to construct a triangle: thus it is necessary that two of the straight lines taken together in any manner should be greater than the remaining one.* [I.20]

The proof is of course given by *constructing* a triangle out of the three given lines $A$, $B$ and $C$, which fulfill the requirement that any two are greater than the remaining one. The requirement was proved in proposition 20 to be a property of the collection of the three sides of any triangle. On a line $DE$ constructed to be long enough (postulate 2) we construct $DF$ to be equal (in length) to $A$; we construct $FG$ to be equal (in length) to $B$ and construct $GH$ equal (in length) to $C$. This can be done by the procedure given in the proof of proposition 3. Now describe two circles with center $F$ and diameter $FD$ and center $G$ and diameter $GH$, respectively (postulate 3). The circles intersect (as seen from the diagram) and thus they meet in $K$. Connect $K$ with $F$ and $G$ (postulate 1) and the triangle is constructed.




Now, the schema for the concept "triangle" is, according to Kant, a rule-governed

operation which "draws the lines greater or smaller, thus allowing them to abut at any arbitrary angle" (A164/B205) (postulate 2). Out of these three lines a triangle is constructed.[13] The rule-governed operation producing all triangles must, however, also conform to the insight expressed in the *assumption* given in the formulation of proposition 22: That any two of the lines are greater than the third.

Let us understand the concept "triangle" as similar to a definition. In modern terms this will sound like the following:

$$x \text{ is a triangle,} \quad \text{iff,} \quad \begin{array}{l} x \text{ is a polygon with three vertices} \\ \text{and three sides which are straight lines.} \end{array}$$

Now, the concept is like a (Peircean) type, whereas the individually constructed images are the tokens falling under the type. The schema corresponding to the concept is, following this line of thought, a *complete* method which exhaust the relation between a type and the tokens falling under that type. By the schema we can construct all triangles, but we can also decide whether a given figure is a triangle or not, by examining whether it can it be constructed by the schema. Thus the concept itself is something passive, whereas the schema amounts to certain active construction procedures.

**Schemata and universality**

Central to the schematism is that the schematic rules are universal: "[T]his representation of a general procedure of the imagination for providing a concept with its image is what I call the schema for this concept" (A140/B180–1). In the case of geometrical schemata the problem is specifically the problem of drawing a universal conclusion based on a singular instance.

My understanding of Kant is that when we argue for a universal statement from a singular instance we use schemata in the following way. We want to prove that some property belongs generally to a mathematical concept:

1. We recognize a particular constructed figure—presented as a mental image or a figure drawn on paper—as a token of a type. We use schema or schemata for recognizing this.
2. Then we prove that the property we are after holds for this particular token.
3. We recognize that in this proof we have not used anything about that particular token which would not hold for any other token of that type. We use the schema in recognizing this.
4. Therefore, the type has the property, i.e., any token of that type has the property.

[13] This construction is with respect to postulates ultimately founded on the basic postulates. Thus the schema and the meaning of a concept as understood by Hilbert (c.f. the classic discussion between Hilbert and Frege on how concepts are defined in (formal) mathematical theories are strikingly close.

This is precisely what happens in the proof of I.32; "we have taken account only of the action of constructing the concept", and therefore we have not used properties such as "the magnitude of the sides and the angles" and since "we have abstracted from these differences" the figure represents the concept universally.[14] Now this is of course nothing but a very typical way of proving universal statements in mathematics. We prove that some property $A$ holds for $a$, then we recognize that none of our assumptions concerns $a$, except that $a$ is of a certain type, say, the natural numbers; therefore we can conclude that every $x$ of that type must have property $A$. Precisely this way of reasoning is codified by the natural deduction rule:

$$\frac{\begin{array}{c}\vdots\\ A(a)\end{array}}{\forall x A(x)}$$

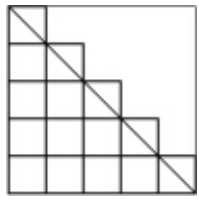
Let me give a simple example, where I assume that the concept of a natural number can be schematised (see my [12] for a detailed analysis of the schematism of the natural numbers).

**Simple example.** The equation

$$1 + 2 + \ldots + n = \frac{n(n+1)}{2}$$

holds for all natural numbers $n$.

*Proof.* We argue for the case where $n = 5$:



The diagram shows $1 + \cdots + 5$ placed in a square with area $5 \cdot 5$. To get $1 + \cdots + 5$ we divide the area of the square by 2 and add half of the elements on the diagonal. Therefore:

$$1 + 2 + \ldots + 5 = \frac{5 \cdot 5}{2} + \frac{5}{2} = \frac{5(5+1)}{2}.$$

The schematic justification of this proof—where there are at least two types of universality around— is the following. First we realize by the 'schema of number' that an empirical intuition, a square, really represents the concept of a particular

[14] All quotes are from (A713–4/B741–2).

number universally. Secondly, the property we prove about the particular token, is really—it is seen by geometrical schemata—about any token square. Finally, again by the 'schema of number' we realize that the property about any square can be transfered to the number any such square represents universally.[15]

**Schemata and abstract concepts**

One of the reasons why geometrical schemata can be successful in the way just described is that geometrical concepts are well-defined. As already mentioned this is in contrast with empirical concepts. According to Kant (A727/B755) we can give necessary and sufficient criteria for, say, triangles. Therefore, we can *decide*, in a finite amount of time, whether an intuition is an instance or not of some concept due to the schema.

The distinction between image and schema is a way of making abstract concepts possible, and thus the distinction can be seen as a refutation of a crude (skeptic and) empiricist claim that mathematical concepts, as simple generalizations, are illusionary. It is in this way that schemata ground or found mathematical concepts, as claimed for instance on A141/B180, and described on A234/B287.

Generally Kant views schemata as the mediating element "which must stand in homogeneity with the category on the one hand and the appearance on the other" (A138/B177). This applies as well to empirical concepts. The schema of dog is mediating between the empirical dog and the concept of dog in that it produces a mental image which as an representation mediates between the empirical and the intellectual.

The situation is different in the case of geometrical and mathematical concepts: The objects are not empirical objects, but pure intuitions. This leads Shabel [15, p. 24] to conclude that "[i]n the case of mathematical concepts then, schemata are strictly redundant: no "third thing" is needed to mediate between a mathematical concept and the objects that instantiate it since mathematical concepts come equipped with determinate conditions on and procedures for their construction".[16] I think this is a somewhat peculiar view. Though certainly, as Shabel notes, mathematical concepts are well-defined. Thus we can define precisely what it means to be a triangle. But a definition does not necessarily include a description of the schema. As Kant writes on A716/B744 "[g]ive a philosopher the concept of a triangle"—from the concept alone, the philosopher can learn nothing about the sum of the interior angles. And, although the certain relation between a right angle and the sum of the interior angles

[15] The example is found, for instance, in [3, 64]. Interestingly, Brown writes "The simple moral I want to draw from this example is just this: We can in special cases correctly infer theories from pictures, that is, from visualizable situations. An intuition is at work and from this intuition we can grasp the truth of the theorem." This sounds very much like Kant at A713/B742. Note, however, that Brown sees his own position as 'full-blooded Platonism'; a term which can hardly be said to characterize Kant's position.

[16] In this respect she follows Guyer [9, p. 159].

is discoverable only by the schema, the relation itself belongs to concept, not to the schema. I therefore find it reasonable to view a geometrical concept as a (passive) type, images (or intuitions) as tokens, and the schema of the type as the constructive (i.e., active) *relation* between the type and its tokens. Such a constructive relation is to be understood, on the one hand, as our cognitive capacity for recognizing in finite time something as a token of a type; on the other hand it gives rise to a rule for constructing a paradigmatic and pure instantiation of that concept. The schema is therefore a *decidable and constructive* procedure in the sense that we can decide in finite time the type to which a token belongs, but also that we can 'go from type to token' through construction.

To sum up: The schema is the "mediating third" which connects the conceptual with the spatial. Take the example of the concept triangle; due to the schema of triangle, we can: recognize triangles as triangles; construct triangles and reason in a universal way about the full type, that is, all kinds of triangles. The ingredient is the beginning of a theory of diagrammatic reasoning, which I will no discuss here, however.

To pin it out with the help of mathematics: Let $T$ be a concept and suppose $\overline{T}$ is the (Fregean) extension of $T$, i.e.,

$$\overline{T} = \{x \mid T(x)\}.$$

The schema of $T$ has (at least) four different functions: $\chi$, Eq, $f$ and $\Phi$.

1. Recognition: For all $x$, $\chi(x) = 1$ iff $x \in \overline{T}$.

2. Representational equality: If two representations of a concept are equal, then the schema recognizes this; for all $x, y \in \overline{T}$:

$$x = y \text{ iff } \mathrm{Eq}(x, y) = 1.$$

3. Construction. For any $x \in \overline{T}$, there exists a finite amount of time, such that, $f(t) = x$.

4. Universal reasoning: Given any property $P$ there is $t$ and $x$ such that $f(t) = x$ and
$\Phi(P, x) = 1$ iff for every $y \in \overline{T} : P(y)$.

All functions $\chi$, Eq, $f$ and $\Phi$ should decide in a finite amount of time. Furthermore, the functions are rule-governed and thus Kant's notion of schema actually anticipates the notion of algorithm.

I therefore interpret Kant's theory of schemata in the following way. An objective concept needs to be founded by a schema. Without such a schema a concept cannot be objective. A concept can be fully schematised by an agent, when the agent possesses some rule-governed procedure which in a finite amount of time recognizes and

produces instances of the concept and allows for universal reasoning.[17] Let us return to the examples with the quotient sets and structures as given in the beginning of this essay.

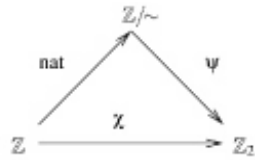
## Equivalence classes and schemata

Let us return to our example with the even and uneven whole numbers. The question now is, are these concepts schematisable in the strong Kantian sense? Given that the general concept a natural number can be schematised it is straight forward to realize that the whole numbers can be constructed—and thus schematised—from the natural numbers.

Let $=$ be equality between whole numbers,[18] and define the evenness of numbers as $n$ is even if and only if there exists $|m| \leq |n|$ such that $n = 2m$.

$$\chi(n) = \begin{cases} 1, & \text{if } n \text{ is even,} \\ 0, & \text{otherwise.} \end{cases} \tag{2.2}$$

Then we take $n \sim m$ iff $\chi(n) = \chi(m)$. Clearly, there is an algorithm which deciding this. Thus the concepts of even and uneven numbers can be schematised relatively to the whole numbers. Obviously we have:




The extension of the concept 'even-whole-number' is [0] and the extension of the concept 'uneven-whole-number' is [1]. Given that the natural numbers can be schematised in the strong Kantian sense, the concepts even and uneven which are concepts having $\mathbb{Z}/\sim$ as interpretation are schematisable.

The rational numbers $\mathbb{Q}$ can be treated in the same way. Suppose we are given $\mathbb{Z}$, then product of the whole numbers is constructable. Now the rational numbers can be constructed as equivalence classes of $\mathbb{Z} \times \mathbb{Z}$. Suppose $b \neq 0$, then

$$(a, b) \sim (c, d) \quad \text{iff} \quad ad = bc.$$

Now, $[(a, b)]$ is understood as the rational number $a/b$. Thus the rational numbers can be schematised given that the naturals can.

[17] Thus the schema takes care of the justificational role of knowledge as found in the traditional view of knowledge as true, justified belief.

[18] This is assumed to be part of the schema of the general concept of a whole number.

## Kantian schemata and Tait's thesis

It is certainly not trivial to see that even the natural numbers are schematisable in the strong Kantian sense, which includes that the schema enables finitary reasoning in the sense of the four functions $\chi$, Eq, $f$ and $\Phi$ as given on page 18. Already in the case of the natural numbers the aspect of universal reasoning can be questioned. The property 'any even number is the sum of two prime numbers' is not decided at the moment. Is it reasonable to assume that this is decidable in the strong sense, that we can produce a paradigmatic even natural number which is the sum of two prime numbers in such a way that we can produce a proof that enables generalization to all even natural numbers? And what are the functions which are schematisable? Let us assume for a moment that the finitary functions are the functions which are schematisable in the strong Kantian sense. Tait's thesis now is, that the finitary functions are precisely the primitive recursive functions [18, 19, 20]:

A function $f$ is finitary, if and only if, $f$ is primitive recursive.

The class of primitive recursive functions is the smallest class of functions:[19]

1. containing initial functions for zero, successor and projection.
2. closed under composition and under primitive recursion: Given primitive recursive $g$, $h$ we have

$$f(x,0) = g(x)$$
$$f(x,y+1) = h(x,y,f(x,y))$$

Let us evaluate critically Tait's thesis.

The first problem we face is how to understand the expression 'the function $f$ is finitary'. There are at least two possibilities:

1. 'The function $f$ is finitary' means that given any $x$ the operation $f$ applied to $x$ is epistemically unproblematic.
2. 'The function $f$ is finitary' means that we have a *concept* $f$ of a function. This concept has a corresponding schema which allows us to decide whether a given representation is an instance of $f$ and to use this function, i.e., to compute it in the sense of 1.

I understand Tait as promoting the former understanding.[20] In fact, the former can be derived from the latter in most cases. Suppose we have a definition of a primitive recursive function $f$. This is given as a *finite* piece of text which is generated

[19] See [14, 22] for details.

[20] "So how can the finitist understand $f : A \to B$ [...] he can understand it as recording the fact that he has given a specific procedure for *defining a B from an arbitrary A* or, we shall say, of *constructing* a $B$ from an arbitrary $A$. [20, 24].

according to the rules given in the definition above. We can understand this as an intensional definition of $f$ which works simultaneously as a proto type for our concept of $f$; any other (definition of a) primitive recursive function $g$ is the same if it is defined in precisely the same way. Thus intentional equality between primitive recursive functions is reduced to equality between literal definitions of primitive recursive functions. As the latter equality is completely unproblematic, 2 reduces in the intensional case to 1. The extensional case is more complex and I will treat it below in the case of general recursive functions.

It seems, however, that Hilbert and Bernays perhaps had the intensional understanding of a finitary function in mind:

> A [finitary] function, for us, is an intuitive [*anschauliche*] instruction [*Anweisung*] which on the basis of a numeral, or a pair of numerals, or a triple of numerals, ..., assigns another numeral. [10, 26]

If $f$ is primitive recursive, then computing $f(x)$ is unproblematic with respect to 'complete surveyability in all parts', 'immediacy' and 'intuitivity':

**Tait's "if"**

Given a primitive recursive function $f$ and any number $x$ computing $f(x)$ is completely unproblematic. The only 'complicated' element in a definition of a primitive recursive function can be the two operations: substitution and iteration. Say that $g$ is given and that we define $f$ by $f(0) = a_0$ and $f(x+1) = g(x, f(x))$. Suppose we want to compute $f(x)$. If $x$ is 0 then $a_0$ is given. If $x$ is not 0, then $x = 1$ or $x > 1$. In the first case we have $f(1) = g(1, a_0)$ which by assumption is finitarily computable—say the result is $a_1$. If $x > 1$ then $x = 2$ or $x > 2$. In the first case finitary reasoning gives us $a_2$. This process goes on until we reach $x$. The process is guaranteed to terminate as $g$ is finitary and $x$ is a (finitary) natural number.[21]

**Tait's "only if"**

Let us define a function $\varphi$ in the following way. Suppose $\varphi_1(a, b) = a+b$ and $\varphi_2(a, b) = a \cdot b$ and that $\varphi_3(a, b) = a^b$. Furthermore, let $\varphi_4(a, b)$ be the $b$-th element of the sequence

$$a, \quad a^a, \quad a^{(a^a)}, \quad a^{(a^{(a^a)})}, \ldots$$

Continue an unfolding definition of $\varphi_n$ in this way. That is, $\varphi_{n+1}(a, b)$ is an iteration of $\varphi_n(a, a)$ $b$ times.

[21] The logician could make a counter argument here by asking: "How do we know that the given number $x$ is not a non-standard number being infinitely large". This is actually a skeptic counter-argument. Well, we are not working with non-standard numbers. Our objects are not formal objects—the are contentual or semantic objects. Thus our numbers are not interpreted in some kind of model. They are numbers and not reducible to or interpretable in anything. But the problem becomes a real problem once we allow for ideal elements in the sense of Hilbert.

The Ackermann function $\varphi : \mathbf{N} \to \mathbf{N}$ is defined as $\varphi_n(n, n)$. It grows *really* fast:

$$\varphi(1) = 2, \qquad \varphi(2) = 4, \qquad \varphi(3) = 9, \qquad \varphi(4) = 4^{4294967296}.$$

The function is not a primitive recursive function as it majorizes any function which is primitive recursive. This was observed by Ackermann [2]. It is a relevant question, however, whether Hilbert considered (or should have considered) it to be finitary?

The Ackermann function is defined as a recursive function using nested recursion. This gives rise to a rule which allows that we can compute the values of $\varphi$ from below. In principle we can compute any value of in the sequence $\varphi(1), \varphi(2), \ldots, \varphi(n), \ldots$. Arguments for finitary are:

- It fulfills the 'surveyability', 'immediacy' and 'intuitivity' criteria.
- It is mentioned by Hilbert (1926) in the programmatic article.
- In volume II of *Grundlagen der Mathematik* Hilbert and Bernays write:

  Certain methods of finitistic mathematics which go beyond recursive number theory (in the original sense [i.e., primitive recursive]) have been discussed in §7 [of volume I of *Grundlagen*], namely the introduction of functions by nested recursion [e.g., the Ackermann function] and the more general induction schemata. [11, 354]

- Ackermann [1] uses transfinite induction up to $\omega^{\omega^\omega}$ for showing consistency of a second order version of PRA. In this system $\varphi$ is definable . Moreover, this consistency proof was considered in the Hilbert school to be finitistic.

I find these reasons sufficient as a refutation of Tait's "only if".[22] But let me give another argument also.

Any primitive recursive function is defined by a finite piece of text. We can therefore provide an algorithm which enumerates all primitive recursive functions;

$$f_1, f_2, \ldots, f_n, \ldots$$

Based on this algorithm we can construct a finitary function $U$ which is the universal function taking two arguments $n$ and $x$ and then picks the $n$-th primitive recursive function and applies it to $x$.[23]. In other words $U(n, x) = f_n(x)$. It can be argued that $U$ is a finitary function. Thus also $U(n, n) + 1$ is finitary. It is, however, not primitive recursive. Assume it is. Then there would exists an $m$ such that

$$f_m(n) = U(n, n) + 1. \tag{2.3}$$

On the other hand, because $U$ is the universal function we have $f_m(m) = U(m, m)$, which, however, contradicts (2.3) if we substitute $m$ for $n$. Therefore, there are more finitary functions than primitive recursive functions.

[22] A more detailed analysis is given by Richard Zach in his dissertation [21].
[23] For simplicity I have assumed that the primitive recursive functions are 1-ary.

I therefore propose that the functions $\chi$, Eq, $f$ and $\Phi$ are not required to be primitive recursive functions, but *partial* recursive functions.

## A modern theory of schemata and quasi-schemata

Partial recursive functions are functions from numbers to numbers. They can be computed mechanically, step by step. It is a very robust class of functions and they can be characterized in many different ways using Turing machines, Register machines, lambda calculus, domain theory and Kleene schemata. All these different formulations of the effective functions have turned out to be equivalent and this have led to the so-called Church-Turing thesis: The partial recursive functions characterize effective computability. In the following $x$ can denote a sequence $x_1, \ldots, x_n$ of variables.

**Definition.** The class of partial recursive functions is the smallest class of functions:[24]

1. Containing initial functions for zero, successor and projection.
2. Closed under composition and also under primitive recursion which is: Given $\psi$, $\gamma$ we have

$$\begin{aligned} \varphi(x, 0) &\simeq \psi(x) \\ \varphi(x, y+1) &\simeq \gamma(x, y, \varphi(x, y)) \end{aligned}$$

3. Closed under unrestricted $\mu$-recursion, i.e., given $\psi$ we have

$$\varphi(x) \simeq \mu y\big(\forall z \leq y(\psi(x, z) \downarrow) \wedge \psi(x, y) \simeq 0\big).$$

The partial recursive functions are very well-behaved. They can be given on a certain normal form, and as any partial recursive function is defined by a finite piece of text, they can be enumerated. This is the Enumeration theorem: There is a sequence, $\varphi_0, \varphi_1, \ldots, \varphi_n, \ldots$ of partial recursive functions, such that any partial recursive function is within that enumeration. Let $\langle x \rangle$ be the primitive recursive encoding of the sequence $x$. Then there exists a universal partial recursive function $\varphi(e, x)$ such that for any partial recursive function $\psi$ of $n$ variables there is $e$ such that

$$\psi(x) \simeq \varphi(e, \langle x \rangle).$$

As discussed above we could understand these finitary functions either intensionally of extensionally. The intensional understanding is simple and unproblematic, but what about the extensional notion.

[24] Here I use Kleene's symbol $\varphi \simeq \psi$ which is to be understood as "either $\varphi$ and $\psi$ are both undefined, or they are both defined with the same value".

Say that $\varphi_n$ and $\varphi_m$ are extensionally equal, in symbols,

$$\varphi_n \approx \varphi_m, \text{ if and only if, for every } x, \ \varphi_n(x) \simeq \varphi_m(x).$$

Then any definition of a partial recursive function $\varphi_n$ generates an equivalence class $[\varphi_n]$. The question now is, is such a concept schematisable? It is not trivially so. If we consider $[\varphi_n]$ as a type, then membership of that type is not recursively decidable.[25]

We could also provide some basic schematic rules for *set theory*. We have a determinate concept of a set $A$ in case we have a schema, say a partial recursive function, which constructs a representation of $A$ and the schema also recognizes representations of the concept. Given that two sets $A$ and $B$ are determinate objects, then also $A \cup B$ and $A \cap B$ and $(A, B)$ are determinate objects.

But there are also *quasi-schemata*. These are 'rules for constructing' more abstract objects, such as the first infinite number $\omega$ or a converging sequence of rational numbers taken as a completed object. Characteristic for these quasi-schemata is that we allow constructions to run in an infinite amount of time. This is in contrast with the real schemata which are rules running only in a finite amount of time, if they give output. Examples of quasi-schemata are:

1. Given a set $A$ and a equivalence relation $\sim$ on $A$ form the quotient set $A/\sim$.
2. Zorn's Lemma or any of its equivalents: The axiom of choice, the maximal chain principle or the well-ordering principle.
3. Extensionality of functions and functionals.
4. Taking limits.
5. Power set construction.

Sometimes these principles are ideal, sometimes they are not. The axiom of choice is in an intensional context with intuitionistic logic fully schematisable, whereas in a set-theoretic context we have that extensionality and the axiom of choice imply full classical logic, as shown in [4]. Power set constructions can be un-limited or limited, as they can for instance be restricted to finite subsets or only the first-order definable subsets.

A simple example of an ideal concept (in the sense of Hilbert) with schema could be the symbol $\omega$ which can be seen as denoting the object

$$\{n \mid n \text{ is a natural number.}\}$$

The schema for constructing this set is the quasi-schema: "Take the limit".

The notion of schema and quasi-schema give rise to *a relativised notion of construction* in mathematics. Here there are at least two different notions of constructions.

[25] The question of extensionality of functions is an interesting question that I have looked at in [13].

**Definition.** Suppose $X$ is an already constructed object, whether ideal (in the sense of Hilbert) or not. Then we say that $Y$ *is (quasi)-schematisable relatively to* $X$ in case one of the following situations obtains, either

- $Y$ can be constructed using a (quasi) schema on $X$, or
- $Y$ is obtained by adding some already constructed (ideal) elements to $X$.

Thus there are basically two different types of ideal elements. Some simple examples are

1. $\mathbb{Z}$ is schematisable relatively to $\mathbb{N}$,
2. $\mathbb{Q}$ is schematisable relatively to $\mathbb{Z}$,
3. $\mathbb{R}$ is quasi-schematisable relatively to $\mathbb{Q}$,
4. $\mathbb{C}$ is schematisable relatively to $\mathbb{R}$,
5. Projective geometry is schematisable relatively to Euclidean geometry.

This notion of ideal elements is open towards some dynamical aspects of ideal elements. Our constructions and construction-procedures are not fixed once and for all. Thus it took historically a considerable amount of time to provide an interpretation of the (imaginary) complex numbers, which reduces a complex number to a point in the real plane. Also projective geometry arose by supplying Euclidean geometry with points at infinity. Later on it was discover that we can in fact give a a model of projective geometry within Euclidean geometry by moving up in dimension. There seems to be, however, a very fundamental border between that which can be finitely schematised and that which cannot. I find it very hard to believe that we can eliminate the ideal element when we construct the reals out of the rationals.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# MASSES OF FORMAL PHILOSOPHY



A sequel to *Formal Philosophy* is being prepared entitled

*Masses of Formal Philosophy*
`www.formalphilosophy.com/Masses`

a follow-up where everybody may answer the 5 questions posed to interviewees of the first *Formal Philosophy*. The answers will be collected, compiled and published as a book by Automatic Press / VIP; edited by Vincent F. Hendricks and John Symons. If you would like to participate and give your view on formal philosophy, please follow the instruction set immediately below. Deadline for your contribution is September 15, 2006. *Masses of Formal Philosophy* will be available in December 2006. Below you will find the 5 questions and some guidelines as to the structure and intended content.

## The 5 Questions

1. Why were you initially drawn to formal methods?
2. What example(s) from your work (or the work of others) illustrates the role formal methods can play in philosophy?
3. What is the proper role of philosophy in relation to other disciplines?
4. What do you consider the most neglected topics and/or contributions in late 20th century philosophy?
5. What are the most important open problems in philosophy and what are the prospects for progress?

## Instructions

(a) The interview should not exceed ten letter-size pages, i.e. approximately 4000 words in total. Needless to say that if your interview is a bit longer or shorter, and rather an essay than answers to the questionnaire that is of course acceptable. Word (the questionnaire is available here in Word format) or LaTeX (including

all relevant packages) is preferred. Send your answers electronically to Vincent F. Hendricks, vincent@ruc.dk, no later than September 15, 2006.

(b)Remember to state: Name (to appear in publication); Position (to appear in publication); Affiliation (to appear in publication)

(c)The 5 questions are rather broad in nature, especially the latter two questions. The structural idea behind the questions is to provide a framework in which both a biographical sketch, a description of your work and your views on contemporary philosophy may be expressed. Question (1) leaves room for the biographical dimension, question (2) is designed so that you may describe some of your work which you find illustrative of the application of formal methods. Once question (2) is answered question (3) may set the stage for viewing your work (or that of others you admire or deem particularly pertinent) in light of philosophy and its broader intellectual environment, while question (4) virtually does the same retrospectively. The final question may hopefully provide a venue for expressing your opinion as to the direction of philosophy for the future.

The above items are suggestions for a way to proceed and we will not interfere with your final decision of how to answer the questions. Bear in mind, as already stated in the questionnaire, that we are aiming at a broad readership and that the interview – as far as possible should be self-contained such that a rather inexperienced reader within reason may still profit.

If you have any additional questions, please do not hesitate to contact either Vincent F. Hendricks (vincent@ruc.dk) or John Symons (jsymons@utep.edu)
Read excerpts from the first *Formal Philosophy* at

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*Formal Philosophy* by Vincent F. Hendricks and John Symons; New York: Automatic Press / VIP (December 2005); $26 (Paperback) / $40 (Hardback) 264 pages ISBN 8799101300 / 8799101319. Formal Philosophy is a collection of short interviews based

on 5 questions presented to some of the most influential and prominent scholars in formal philosophy. We hear their views on formal philosophy, its aim, scope, the future direction of philosophy and how their work fits in these respects.

'This is a fabulous collection. Hendricks and Symons have performed an important service to the entire philosophical community. The interviews are not only rewarding in and of themselves but they will help the reader understand what has been going on and has been achieved in the past fifty years.'
—**Ernie Lepore**, Rutgers

'Why do you do philosophy that way? Do you believe all philosophy could be done that way? Do you think it should be done that way? These are questions one seldom asks, except perhaps at dinner. Yet there is a lot one could learn from the answers, especially when they come from philosophers who do have a distinguished way of doing their job. Formal Philosophy identifies one such way and collects the answers of its eminent practitioners—not the quick answers one might give over an entrecote, but the answers one gives when seriously prompted to reflect upon their daily profession. An enticing, provocative, completely novel way of surveying the landscape of contemporary philosophy.'
—**Achille Varzi**, Columbia University.

# TOWARDS A THEORY OF CONVENTION

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Some thirty years ago Lewis published his *Convention: A Philosophical Study* (Lewis 1969). Besides exciting the logical community by providing the seminal work on common knowledge, it also laid the foundations for the formal approach to the study of social conventions by means of game theory. Like for the study of common knowledge, much has happened in this latter field since then. The theory of convention has been developed and extended so as to include multiple types as well as a basis for the study of social norms. However, classical game theory is currently undergoing severe crisis as a tool for understanding and explaining social phenomena; a crisis emerging from the problem of equilibrium selection around which any theory of convention must revolve. The so-called *evolutionary turn* in game theory marks a transition from the classical assumptions of rationality and common knowledge of such to evolutionary game theoretical frameworks inspired by the models of (Maynard Smith & Price 1973), (Taylor & Jonker 1978) and (Maynard Smith 1982). By providing an account of equilibrium selection these are thought to work as well-defined metaphors of learning processes upon which a revised theory of convention may be erected. In this article I outline one way this might be done, as well as point to some problems and perspectives that the evolutionary turn leaves in its tracks when brought to serve in a theory of convention.

**Social Conventions**

A certain kind of behavioral patterns making up the anatomies of societies may be given an informal description as *social conventions* in the sense that, (i) they result somehow from the interdependency of individual actions, and (ii) comparative analysis may reveal them to be *contingent* relative to some attributed functional description. For instance, the regularity of keeping to the left in the UK is conformed to by drivers as they expect other drivers to keep to the left as well. Yet, on the functional description of avoiding collisions, the purpose of this regularity could also be served by everyone keeping to the right, as done e.g. in the US.

Apart from these two features, social conventions differ from each other in many respects. Some are institutionally engineered, carefully codified and severely enforced, while others are so fundamental that thinking of them as a product of man is intriguingly difficult. Some enable the utilization of potentials for cooperation, yet sometimes cease to exist; while others, though socially ineffective, prove utterly hard to dissolve. Not to mention, that while some are easily agreed upon, others become the objects of political and even violent conflicts. Beyond discussion, though, is that they provide the structure within which social life is led and institutions develop. Thus, a central issue of social philosophy has been that of explaining their nature and dynamics. That is, to explain what causes conventions *to*, and how conventions *do*, emerge, stabilize, and in some cases change or deteriorate.

**Lewis' Theory of Convention**

Perhaps the largest obstacle in answering these questions has been the lack of a rigorous framework for exploring the nature and dynamics of conventions. Since Lewis' *Convention*, however, game theory has been thought to provide one particularly interesting candidate. According to Lewis a regularity $R$ in the behavior of members of a population $P$ when they are agents in a recurrent situation $S$ is a convention if and only if it is true that, and it is common knowledge in $P$ that, in almost any instance of $S$ among members of $P$,

(1) almost everyone conforms to $R$;
(2) almost everyone expects almost everyone else to conform to $R$;
(3) almost everyone has approximately the same preferences regarding all possible combinations of actions;
(4) almost everyone prefers that any one more conform to $R$, on condition that almost everyone conforms to $R$;
(5) almost everyone would prefer that any one more conform to $Rb4$, on condition that almost everyone conform to $Rb4$,

where $Rb4$ is some possible regularity in the behavior of members of $P$ in $S$, such that almost no one in almost any instance of $S$ among members of $P$ could conform both to $Rb4$ and to $R$ (Lewis 1969:78).

This definition not only captures characteristics (i) and (ii) above. If, as done by Lewis, $R$ is described within the framework of classical game theory, it effectually attributes to conventions the nature of behavior convergent to what he calls *proper coordination equilibria*. What Lewis means by this odd notion of equilibrium may be shown by means of a pure-coordination game like that of matrix 1. For the purpose of exposition this game may be interpreted as a two-player game representing any instance $s$ of a recurrent situation $S$ in a population $P$[26]. The game is played

[26] Extending the interpretation of the matrix to an $n$ player game is quite easily done – see

repeatedly between a row player, *player 1* and a column player *player 2*, facing the symmetric and simultaneous strategy choice between $a$ and $b$. The pure-strategy Nash equilibria of the game – marked here in bold – are strict. Now, following Lewis a strategy profile qualifies as a proper coordination equilibrium, if (a) each agent likes this not only *at least as well as*, but *better than* any other strategy profile he could have reached, given the choice of the other player and (b) if more than one such profile exists in the game (Lewis 1969:14-23)[27]. In the game of matrix 1, this makes both of the pure-strategy Nash-equilibria ($a$,$a$) and ($b$,$b$) proper coordination equilibria, while the mixed strategy Nash equilibrium assigning the probability of 0.5 to each strategy for each player does not qualify.

| | | *player 2* | |
|---|---|---|---|
| | | $a$ | $b$ |
| *player 1* | $a$ | $\mathbf{1,1}$ | $0,0$ |
| | $b$ | $0,0$ | $\mathbf{1,1}$ |

Matrix 1: a pure-coordination game

The paradigm example of a regularity taken to qualify as a convention under this definition is that of drivers keeping to one particular side of the road. Further examples, however, readily suggest themselves as conventions of coordination: standing on the right and walking on the left of escalators on subway stations; former regularities for armies going into battle wearing certain standards, colors and uniforms; meeting at certain rendezvous points when lost from each other; prostitutes and potential costumers looking each other up in certain neighborhoods (although neither parts usually live in those neighborhoods); exchanging goods using certain coinage; US railroad tracks having a four feet gauge; urban gentrification; certain types of people going to certain clubs, cafés or restaurants; numbering houses; listing letters in the way of the alphabet; not to mention the phenomenon targeted by Lewis' theory of convention: the semantic rules of natural and artificial languages.

Lewis' definition gives rise to at least two fundamental questions about the dynamics of conventions, though. Why do almost everyone expect almost everyone else to conform to $R$, thereby ensuring *stability*?; and in particular, how do specific behavioral regularities like these *emerge* rather than others, given that alternatives were open prior to their establishment?

Starting with the last question; for most of them, no agreements seem to have ever been made as to their establishment. Also, the social processes in which they emerge and persist are so large and complex that communication rarely seems to be

(Hansen 2005) – and the results stated here carries trivially over to such games.

[27] i.e. in standard game theoretic terminology a proper coordination equilibrium is one out of multiple available *strict* Nash equilibria of a game.

extensible to a degree so as to provide for simultaneous agreement. Not to mention, if the semantic rules of natural languages themselves are taken to be conventions of coordination – as they indeed are by Lewis – then how did they come about, if not by agreement? As Quine recounts in his foreword to Lewis' *Convention*,

> "When I was a child I pictured our language as settled and passed down by a board of syndics, seated in grave convention along a table in the style of Rembrandt. The picture remained for a while undisturbed by the question what language the syndics might have used in their deliberations, or by dread of vicious regress." – Quine in (Lewis 1969:xi)

Whether for practical or theoretical purposes, this makes for the adoption of a *non-cooperative contest* approach to the game-theoretic models utilized in analyzing social conventions; i.e. games are interpreted such that players do not have the possibility of making binding commitments or engage in pre-play communication, cf. (Binmore 1990). Posing the questions of what may account for the positive dynamics of conventions (emergence as well as stability) *within a game theoretic framework*, is then equivalent to posing the question of how strategically rational players may come to coordinate their choices repeatedly on particular out of the multiple available proper coordination equilibria in almost any instance $s$ of $S$, where $S$ is a non-cooperative contest game with multiple proper coordination equilibria.

However, as it turns out classical game theory is inherently and unhelpfully indeterminate in facilitating coordination in such games. Any proper coordination equilibrium in any instance $s$ like those in the game above is by definition always just one out of multiple Nash equilibria in a game. Consequently, the general Nash equilibrium selection problem applies. However, stating that play of any available Nash equilibrium is consistent with the assumptions of strategic rationality not only makes the strategically rational players of classical game theory indeterminate in selecting between the proper coordination equilibria of the game in question. It also leaves them without any reason for disfavoring the mixed-strategy equilibrium of the game relative to the proper coordination equilibria. Within a game theoretical framework this raises the fundamental question of why only proper coordination equilibria arise as conventions, or reversely, why conventions only should be attributed the nature of proper coordination equilibria. These are questions that if unresolved, threatens the whole foundation upon which subsequent theories of convention have been build.

In dealing with the equilibrium selection problem in the context of his theory of convention, Lewis adopted his own version of Thomas Schelling's focal point theory. In *The Strategy of Conflict* (Schelling 1960), Schelling had argued, roughly, that certain psychological or logical associations that agents might have with particular actions or outcomes could make them *salient* or *focal* in a way that would serve to focus

expectations. In order to show this, Schelling had conducted a series of experiments on pure coordination problems in which subjects could not communicate, yet succeeded in coordinating far beyond what chance would prescribe. However, as such details are usually abstracted away in formalizing the deep structures of situations as games or types of a game, an explanation of coordination could only be provided by the addition of an empirically based theory of focal points.

Picking up on Schelling's line of thinking, Lewis argued that salience could be used to explain not only the emergence (including the de-selection of mixed strategy equilibria which Lewis found could hardly become salient), but especially the stability of social conventions[28]. He hypothesized that agents "will tend to pick the salient as the last resort, when they have no stronger grounds for choice", and that this tendency is a matter of common knowledge up to some level (Lewis 1969:35). Lewis then claimed that this might provide a basis for agents to achieve coordination *rationally*; i.e. he claimed that salience and common knowledge of this together could establish a basis from which systems of concordant mutual expectations, that everyone will do his part in pursuing the strategies associated with a salient outcome, could be derived (Lewis 1969:27-33).

If granted the truth of this argument, Lewis theory of convention is able to answer the questions posed above with regard to explaining the positive dynamics of conventions. Conventions may emerge as results of agreement, coincidence, imagination or the like bestowing salience upon a particular combination of actions that make up a proper coordination equilibrium. That is, given a salient proper coordination equilibrium, agents will tend to choose this, whereby a case of precedent from which to project into the future is established[29]. Having coordinated on a regularity once, then, conventions become self-perpetuating due to the combination of salience by precedent, and common knowledge of this — as almost everyone expect almost everyone else to conform to $R$, *stability* is ensured trivially through each agents' rational choice of action.

**Extending the Theory of Convention to Types and Social Norms**

The aftermath of Lewis' *Convention* saw the initiation of two independent programmes in game theory. One was the famous development and formal treatment of the concept of common knowledge receiving what is almost regarded as a canonical

[28] In fact, Lewis was not especially interested in explaining the emergence of conventions or de-selection of mixed-strategy equilibria. His primary aim was to analyse language as based on convention, which led him to consider these issues only peripherally and concentrate on stability instead, see (Cubitt&Sugden 2003).

[29] The step of projection is much more problematic than one is led to believe here. Lewis himself discusses extensively the role of analogy between instances of situations in order to make them instances of a recurrent situation $S$, whereby the establishment of $S$ itself becomes a matter of salience. Here, though, this step will be taken for granted, but it will pop up in a somewhat different shape by the end of the next section.

analysis in (Aumann 1976). The other, and much more fragmented program, sought to develop a more comprehensive theory of social conventions based on game theoretical analysis. In particular, this latter program has tried to extend Lewis' theory of convention so as to embrace and distinguish between several types of conventions as well as well as explore the nature and dynamics of social norms in the context of these.

The first extension of this program has been motivated by the observation that the theory of convention and its underlying ideas extend further than the pure coordination games analyzed by Lewis. Thus, the theory of convention has been extended to distinguish between what amounts to at least three different types of conventional patterns of behavior: *conventions of coordination*, *discriminatory conventions*, and *conventions of cooperation*. Each type is modeled as behavior instantiating proper coordination equilibria in one of the three corresponding game types: *pure-coordination games*, *partial coordination games* (see matrix 2), and *Prisoner's Dilemma games* (matrix 3, comment follows).

| | | | *player 2* |
|---|---|---|---|
| | | $a$ | $b$ |
| *player 1* | $a$ | $0,0$ | $\mathbf{2,1}$ |
| | $b$ | $\mathbf{1,2}$ | $0,0$ |

Matrix 2: a partial coordination game (the so-called BOS game)

| | | | *player 2* |
|---|---|---|---|
| | | $c$ | $d$ |
| *player 1* | $c$ | $3,3$ | $0,4$ |
| | $d$ | $4,0$ | $\mathbf{1,1}$ |

Matrix 3: The standard *Prisoner's Dilemma* game

On this account the nature or *reason d'être* of social conventions stays the same as on Lewis theory of convention. Each type of game models a type of recurrent problem in social interaction to which conformity to associated social conventions and norms are claimed to provide real world solutions.

The second extension origins in subtle hypothesis made by Lewis midway in his *Convention*. Here Lewis argues that conventions, once established, are likely to constitute social norms as they instantiate proper coordination equilibria. Quoting Lewis,

> "Any convention is, by definition, a norm which there is some presumption that one ought to conform to... one is expected to conform, and failure to conform tends to evoke unfavorable responses from others... These are bad consequences, and my interest in avoiding them strengthens my conditional preference for conforming" (Lewis

1969:99).

One way the nature of this 'presumption' has usually been interpreted is that, as conventions instantiate proper coordination equilibria, deviation from conventions tends to evoke unfavorable responses of disapproval from others. This is because it not only inflicts a utility-loss on oneself, but on everyone else following the convention, see e.g. (Ullmann-Margalit 1977) (Pettit 1990) (Sugden 2004). The 'corollaries' of these two extensions have then been taken roughly to be as follows.

For pure coordination games the problem is one of coordinating actions in situations where players' preferences coincide perfectly or almost perfectly, but where multiple proper coordination equilibria exist for coordinating at. Hence, players face a *pure coordination problem* that, as mentioned, may be regarded a sub-species of the general equilibrium selection problem. As seen, pure-coordination games may be used to analyze recurrent problems thought to be solved by conformity to conventions or norms of coordination like those analyzed by (Lewis 1969)—left- and right-side driving, use of some particular coinage, signs and gestures, and of course the conventions of languages. Because interests coincide perfectly or almost perfectly, the approach suggest that few deviations are likely to be observed and the resulting attitudes of disapproval will tend to be 'superficial' and based on charitable attributions of intentions to the deviator.

For partial coordination games the problem is one of equilibrium selection as well. Again the equilibria are proper coordination equilibria, but this time players hold divergent preferences as to which out of these they would like to see materialize[30]. Call it a *partial coordination problem*. This type of game has been utilized to analyze recurrent problems of social interaction thought to be solved by conformity to discriminatory conventions and associated norms such as those of divisions of labor and gender roles (Ullmann-Margalit 1977), but may also be applied as baseline models in the study of the conventions of intersecting traffic and queue-formation, cf. (Hansen 2005). Due to the *partiality* or *discrimination* imposed by the situational structure on any disfavored party conforming to this type of behavioral patterns, the theory of convention suggests that attitudes of approval and disapproval toward deviators should be expected to be somewhat ambivalent. While it follows from the nature of proper coordination equilibria that conformity serves the interests of everyone and deviation inflicts utility loss to all parties conforming to this type of behavioral patterns (thereby provoking disapproval even from the disfavored ones), deviation may lead to a better position of some party if coordinated and for this reason at least give reasons to every party for attributing less than charitable intentions to deviators as well as make it more frequent than is the case for norms of coordination.

[30] Still, behavioral patterns conforming repeatedly to one particular string of equilibria may be regarded as conventional on Lewis definition by choosing a relaxed interpretation of the term 'approximately' in Lewis 3rd requirement.

Finally, for PD-games the problem is not directly one of equilibrium selection. Rather it is one of enforcing collective action or cooperation where the pursuit of individual self-interest threatens to undermine such. That is, players face a collective action or *cooperation problem* because the state of cooperation is not a proper coordination equilibrium, nor even a Nash equilibrium in itself. Instead this type of game has been utilized in analyzing fundamental preconditions of such collective phenomena as tax-payment, gun control, property rights, restricted parking behavior, self-serviced supermarkets; in general, phenomena that seem to rely on normative attitudes or institutions prescribing behavior from which unilateral deviation enables a deviator to enjoy the benefits generated by general or near general conformity without contributing himself. Though the lack of multiple equilibria in fact disqualify analysis of the behavioral patterns in question as *contingent* in a direct sense, thereby threatening their status as conventions, they may still be described as contingent in a *derivative* sense, as while particular kinds of collective action or cooperative efforts has been established in some social systems, this has not happened in others. Needless to say, while infrequent transgressions should be observed for conventions of partiality, and little if any for conventions of coordination, the contrary is to be expected for cooperative conventions. Hence, normative attitudes of approval and disapproval have usually been asserted to perform the essential function of equilibrium enforcement in the case of these. That is, most arguments within the tradition is best read as arguments for the necessary imposition of external sanction systems (here taken to include normative attitudes of approval and disapproval) carrying the function of converting collective action into a unique Nash equilibrium of PD-games and thereafter enforce conformity.

**Two Problems for the Theory of Conventions**

No doubt, the theory of convention yield extremely interesting perspectives for social philosophy. Yet, two problems have posed themselves in the way of turning these theories into a larger programme. The one questions whether salience by precedent or the like may in fact facilitate strategically rational players with reasons for acting in conformity with a convention. The other questions the extent to which phenomena of cooperation, posing the really interesting perspectives in relation to social norms, may be brought into a theory of convention based on coordination rather than conflict.

*(1) Salience.* Lewis assumed that salience in general and salience by precedent in particular provides strategically rational players with reasons for action[31]. He did

[31] In what follows it is taken that what Lewis meant by *common knowledge* in fact was identical with the core idea of Aumann's notion of common knowledge in (Aumann 1976). However, this interpretation is not correct, as Lewis meant something quite different by his notion, cf. (Cubitt&Sugden 2003). Yet, the current interpretation is made, as it follows what has so far been the standard interpretation of Lewis' theory of convention upon which much of the subsequent analyzes of *salience* within the programme has been performed.

not, however, try to incorporate the notion salience into the formal framework of classical game theory. The reason for this might be found in the fact that beginning with Schelling, Lewis and others have believed to some extend that incorporating salience into classical game theory is not possible as it is inherently connected with features extraneous to the strategic structure of games. However, since then works like (Gauthier 1975), (Crawford et al 1990) and (Bacharach 1993) have taken up the endeavour of showing how this in fact might be done.

Common to the attempts of incorporating the notion of salience into classical game theory is that they operate with two key elements, cf. (Janssen 1995): (a) the idea that salience functions by transforming the personal description of pure coordination games so as to make the salient outcome a uniquely pareto-dominant equilibrium; and (b) some kind of principle of coordination according to which strategical rational agents have reason to play their part in such an equilibrium, see also (Gauthier 1975), (Crawford et al 1990), (Bacharach 1993), (Janssen 1995), (Colman 1997) and (Janssen 1998).

*(a1) Transformation 1: Explaining Salience by 'Availability of Clues'*

For instance, recent work such as (Bacharach 1993) and (Janssen 1995) have concentrated on explaining the nature of salience for observations like that of Schelling's experiments on focal points and more controlled experimental replications and developments of this like those of (Metha et al 1994a) and (Metha et al 1994b). Common to their explanations is a reliance on the notion of the *availability* of clues of salience due to certain physical, logical or other universally shared features associated with the strategies or outcomes. To be specific, each player is assumed to observe a certain number of features of strategies corresponding to some kind of primary salience. Each of these features are then ascribed with a commonly known probability stipulating its availability. From this a personal description of a pure coordination game may be constructed on the basis of the expected utility associated with each strategy, where the probabilities of availability are regarded as common knowledge. Given that choosing according to one salient feature is associated with a higher expected utility than any other, rational agents are then asserted to choose this from a principle of coordination.

To illustrate, two subjects may be presented with four cubes — three yellow and one red. Given the problem of coordinating their choices on one and the same cube, where successful coordination yields an utility of 1 and failure yields 0, the theories of (Bacharach 1993) and (Janssen 1995) model salience as transforming the existential game of matrix 4 to the (shared) personal game of matrix 5. In this game each player faces three strategies: $i$, ignoring colors as clues of salience and randomize over all cubes; $y'$ choose some yellow cube at random; and, $r$, choose a red cube. From this the expected utilities may be calculated as those given in matrix 5.

| | | *player 2* | | | |
|---|---|---|---|---|---|
| | | $y^1$ | $y^2$ | $y^3$ | $r$ |
| *player 1* | $y^1$ | $\mathbf{1,1}$ | $0,0$ | $0,0$ | $0,0$ |
| | $y^2$ | $0,0$ | $\mathbf{1,1}$ | $0,0$ | $0,0$ |
| | $y^3$ | $0,0$ | $0,0$ | $\mathbf{1,1}$ | $0,0$ |
| | $r$ | $0,0$ | $0,0$ | $0,0$ | $\mathbf{1,1}$ |

Matrix 4: *existential cube game*

| | | *player 2* | | |
|---|---|---|---|---|
| | | $i$ | $y'$ | $r$ |
| *player 1* | $i$ | $\mathbf{\frac{1}{4},\frac{1}{4}}$ | $\frac{1}{4},\frac{1}{4}$ | $\frac{1}{4},\frac{1}{4}$ |
| | $y'$ | $\frac{1}{4},\frac{1}{4}$ | $\mathbf{\frac{1}{3},\frac{1}{3}}$ | $0,0$ |
| | $r$ | $\frac{1}{4},\frac{1}{4}$ | $0,0$ | $\mathbf{1,1}$ |

Matrix 5: *personal cube game*

Now, according to (Bacharach 1993) and (Janssen 1995) alike it is then credible to assume a principle of coordination that basically says that agents have rational reason to choose the strategies associated with the highest expected utility, thereby reaching the Pareto-dominant equilibrium of the transformed game $(r, r)$—i.e. both choose the red cube.

Before discussing this argument, though, one may notice a limitation of their transformation argument when made in the context of a theory of convention. As conventions are characterized by being contingent relative to a functional description any universal psychological, logical or other cause of salience falls short in a general account of conventions. That is, if conventions were asserted to emerge and stabilize by means of salience derived from *particular* available clues, then this would be inconsistent with the basic feature of the contingency of the kind of equilibrium behavior modelled. This is for instance the case for bidirectional pedestrian flows which under systematic observation and comparative analysis reveal themselves not to be contingent, but always tending to be right-sided due to the consequences of widespread right-handedness (Hansen 2005). Hence, albeit the transformation argument of (Bacharach 1993) and (Janssen 1995) may apply as an explanation of coordination in experiments like those made by (Schelling 1960), (Metha et al1994a), and (Metha et al 1994b), as well as for bidirectional pedestrian flows, it does not provide an incorporation of a kind of salience directly applicable in the context of a general theory of social conventions.

Of course, one could counter that the universal psychological, logical or other recognizable clue providing salience could pertain to some single situation or period in time. Consulting Peter Kincaid's 250 pages monograph on the history and practise

of left- and right-side driving, for instance, reveals that the emergence of these conventions are intimately connected with the types of carts that was driven in different countries, the side from which horses were mounted and the tendency to use the whip with the right hand, see (Kincaid 1986). Obviously carts, horses and whips are not relevant features of present day automobile driving. Instead, having facilitated coordination once, the particular solution provided by these features could be argued to have provided a generalizable and self-reinforcing solution by *precedent*. In fact, this assertion is in direct line with a graphic point made by Lewis:

> 'Conventions are like fires: under favorable conditions, a sufficient concentration of heat spreads and perpetuates itself. The nature of the fire does not depend on the original source of heat. Matches may be our best fire starters, but that is no reason to think of fires started otherwise as any the less fires.' (Lewis 1969:88)

This, however, turns the discussion of salience into one independent of the presently discussed transformation argument based on availability of clues or any other transformation argument relying on some kind of universal cause of salience. Instead the discussion becomes one concerning the notion of precedent alone.

*(a2) Transformation 2: Salience by Precedent*

The seminal account of salience provided by (Gauthier 1975) is perhaps the best to illustrate how salience by precedent may function on this approach. His argument may be reworked by assuming salience of $(a, a)$ in a pure-coordination game like that of matrix 1. It is then Gauthier's claim that salience transforms the personal description of this game for each of the players to that of matrix 6. In this game each player faces two options: 'seeking salience' and 'ignoring salience'; or in the case of precedent: 'seeking precedent' and 'ignoring precedent'. The former leads to the realization of $(a, a)$ in the existential game of matrix 1, while the latter is likely to lead each agent to randomize over $a$ and $b$. In the transformed game two Nash equilibria exist – one proper coordination equilibrium, and one non-strict Nash equilibrium – but according to the principle of coordination invoked by Gauthier, similar to that of Bacharach and Janssen, rational players now have reasons for choosing their 'seeking salience' strategy as this leads to a pareto-dominant outcome. Thereby successful coordination in the existential game is explained in consistency with the assumption that the regularities regarded as conventions represent contingent equilibrium behavior.

| | | *player 2* | |
|---|---|---|---|
| | | '*seeking salience*' | '*ignoring salience*' |
| *player 1* | '*seeking salience*' | **1,1** | 0.5,0.5 |
| | '*ignoring salience*' | 0.5,0.5 | **0.5,0.5** |

Matrix: 6: *Gauthier transformation of the game in matrix 1*

Against this argument of transformation, though, (Gilbert 1989) has argued quite convincingly that Gauthier does not seem to have a good reason to restrict the options of the transformed game to two. In particular, sticking to the two-strategy case utilized here as well as in (Gauthier 1975), there seems to be at least one other alternative, namely that of seeking the 'non-salient' — *in casu* the 'non-precedent'. Allowing for this third possibility ultimately destroys Gauthier's account. This is revealed by the Gilbert-based correction of the transformed game of matrix 6 to matrix 7. In this game no unique pareto-dominant equilibrium exists. Hence Gauthier's Principle of Coordination cannot operate successfully.

| | '*seeking salience*' | '*ignoring salience*' | '*s. the non-salient*' |
|---|---|---|---|
| '*seeking salience*' | $\mathbf{1,1}$ | $0.5, 0.5$ | $0, 0$ |
| '*ignoring salience*' | $0.5, 0.5$ | $0.5, 0.5$ | $0.5, 0.5$ |
| '*s. the non-salient*' | $0, 0$ | $0.5, 0.5$ | $\mathbf{1,1}$ |

Matrix: 7: *Gilbert-correction of Gauthier's transformation*

Now, one could retort that this argument does not apply when more than two strategies are available, as done by (Janssen 1995). This makes for asking, though, whether it is plausible that only one strategy salient by precedent exists — in particular, in the case of the hyperrational agency that must be invoked to make the calculations needed when many strategies exist.

One may begin to answer this question by noticing that a hyperrational player who is capable of making the calculations needed to ensure a transformation like that of Gauthier's in situations where multiple strategies exist, would also be capable of recognizing all possible patterns that precedent could be taken to follow. Following (Sugden 2004:190), imagine a player who has played a pure coordination game 1.000 times, and on every repetition has met players choosing strategy $a$. It may seem obvious that the rational inference for him to draw is that the next player he encounters will very probably choose $a$ as well. But although this inference is obvious in the perspective of common-sense, it is not accessible to perfectly rational players. For real world individuals, the fact that all 1.000 encounters fit the pattern 'always $a$' is a remarkable fact, which call for some explanation beyond pure chance. But, from the perspective of a hyperrational player, such reasoning is merely a betrayal of the lack of imagination. For him, every sequence of 1.000 instances of '$a$' and '$b$' has some

pattern that can be projected into the future. Consequently, within the framework of classical game theory, transformations like that of Gauthier's are infeasible whether only two or more strategies are available.

*(b) The Principle of Coordination*

However, one may still entertain the idea that some Principle of Coordination may facilitate coordination in existential games like that of matrix 8, where multiple proper coordination equilibria exist, but where one of these pareto-dominates all others without transformation — if only to exhaust any transformation argument along the lines of the two above. This raises the general question whether pareto-dominance somehow provides strategically rational players with reasons to pursue such an equilibrium if unique. According to (Heal 1978) this intuitively must be case[32]. Choosing a salient strategy, *in casu* one salient by being the unique pareto-dominant equilibrium, seems intuitively the rational thing to do. The players "know that they can coordinate their choices if they can single out one [strategy] from the rest". They also know that "by choosing a [strategy] which does stand out for both of them, and *only* by doing this, can they hope to coordinate. This provides a reason for each to make the choice of the outstanding [strategy], which is reinforced by knowledge that the other also has that reason.", (Heal 1978:129).

| | | *player 2* | |
|---|---|---|---|
| | | *a* | *b* |
| *player 1* | *a* | **2, 2** | 0, 0 |
| | *b* | 0, 0 | **1, 1** |

Matrix 8: a pure-coordination game

Against this (Gilbert 1989), (Sugden 1991) and (Colman 1999) have pointed out that arguments along this line fail. It does not explain why it is rational for a strategically reasoning player to choose a salient strategy without any reason for assuming that other players will also choose the salient strategy, aside from the knowledge that the other agents confront the same pure-coordination problem. The fact that choosing a salient strategy has powerful intuitive appeal does not, in itself, constitute a rational reason for choosing it. The point is that although it is obviously true that the players succeed in coordinating if they both choose the same salient strategy, and although it is true by definition that successful coordination is a good outcome for them, that does not provide them with any rational grounds for behaving in that way. As Gilbert puts it, "the fact that a good outcome would be reached if *both* did something cannot by itself be a reason for either one individually why he should do it. For his doing

[32] Heal does not make her argument with special regard to pareto-dominant equilibria, but to salient equilibria in general, see (Heal 1978).

it cannot ensure that the other does it.", (Gilbert 1989:72). Thus, "if human beings are – happily – guided by salience, it appears that this is not a consequence of their rationality.", (Gilbert 1989:61). Consequently, any principle of coordination assuming that agents will automatically play their part of a pareto-dominant equilibrium cannot be derived from premises of rationality and common knowledge.

Ultimately, what this argument amounts to is the claim that salience, whether by precedent or any other means, may not facilitate strategically rational players with reasons for acting in conformity with conventions. An account of the dynamics of conventions of coordination and partiality is seemingly unavailable within the framework of classical game theory, as strategic rationality is purely forward looking making it indeterminate in games with multiple Nash equilibria, whether proper coordination equilibria or not. This poses one fundamental problem to the theory of convention.

*(2) Cooperation.* In addition, the further fact that only non-cooperative behavior is consistent with strategic rationality in PD-games seemingly renders classical game theory unable to explain how cooperative behavior came about in the first place — cooperative behavior is not a Nash equilibrium. To remedy this problem the standard claim within the programme has called on the necessary imposition of sanction systems external to the situation of interaction in order to make cooperative behavior a strictly dominant strategy (see matrix 9). To be specific, the claim is that such systems change the individually perceived utilities or payoffs and hence transform the preference structure of this type of games so as to make cooperative behavior strategically rational, cf. (Kavka 1983), (Ostrom 1990), (Heap&Varoufakis 2004). The aforementioned imposition of normative attitudes of approval and disapproval serves much the same function and may be regarded as external in so far as they are not motivated internally by the structure of the game.

| | | *player 2* | |
|---|---|---|---|
| | | $c$ | $d$ |
| *player 1* | $c$ | $\mathbf{3,3}$ | $0,2$ |
| | $d$ | $2,0$ | $-1,-1$ |

Matrix 9: *Coercion in the Prisoner's Dilemma game of matrix 1.3, with sanctioning power of -2*

This strategy finds a notable precedent in (Hobbes 1651) who interpreted the state as a *Leviathan* based on contract: i.e. an absolute sovereign established by everyone agreeing to confer all of their powers and rights to this common power, which thereby becomes strong enough to "tie them by fear of punishment to the performance of their covenants" (Hobbes 1651:Ch.17). However, besides raising the question of how sanction systems or norms of disapproval themselves emerge in a pre-institutional or pre-normative state, and how they are kept stable, it may be argued that this

strategy overlooks a crucial feature of institutional reality: no possible or existing sanction system can mount the power necessary to bind its 'subjects' by *fear of punishment* to the performance of some of the most fundamental kinds of cooperative behavior. This may be illustrated by observing what individuals actually do when such systems exist, but when they at the same time expect almost nobody to conform to their prescriptions. For instance, during the Los Angeles Riots in 1992, chaos broke out and crowds looted supermarkets, violated traffic rules, disregarded gun-control, property-rights and law and order in general[33]. Situations like these show that formal sanction systems are powerless against the overwhelming force deposited in any population. Thus, the effect of sanction systems appears to be *conditional* on the individual expectation of general or near general conformity. Hence, invoking their imposition does not suffice to account for how collective action or cooperation problems are solved. This argument applies to normative attitudes as well as sanction institutions.

What this means is that the standard interpretation of the effect of sanction systems (modeled in matrix 9) has by and large been wrong. In particular, the type of PD-games may be challenged as the appropriate analogy for exploring behavioral patterns of cooperation and associated attitudes. Instead the appropriate type of game model may be argued to be that which (Sen 1967) has called *assurance games*. Thus, (Hansen 2005) argues that this game is both the appropriate one if sanction systems exist (by annulling the effects of sanctions in the strategy profile of mutual deviation, as in matrix 10); or, if such systems is taken not to exist, by iterating the PD-game indefinitely in the *shadow of the future*, yielding a structurally much similar game like that of matrix 11 under suitable assumptions[34], see also (Jiborn 1999).

| | | *player 2* | |
|---|---|---|---|
| | | $c$ | $d$ |
| *player 1* | $c$ | $\mathbf{3,3}$ | $0,2$ |
| | $d$ | $2,0$ | $\mathbf{1,1}$ |

Matrix 10: *The Stag Hunt Game resulting from by annulling the effects of sanctions in the strategy profile of mutual deviation*

[33] Another good example is the mutiny of the French army under the Nivelle offensive in WWI. Here more than 20.000 soldiers refused to attack enemy lines, leaving the officers in recognition of the impossibility of punishing entire divisions or implement harsh measures.

[34] Matrix 11 is taken from (Hansen 2005:90), who reaches this game from the standard PD-game of matrix 3 by setting the shadow of the future at $\frac{1}{3}$ and following Skyrm's strategy of (Skyrm 2004:5) of categorizing the infinitude of available strategies in the the game under one of two ideal-types of '*trigger*' or '*reciprocal*' and '*all d*'. Thus, if matrix 11 is to be read precise strategy $c$ refers to all strategies approximating so-called trigger or reciprocal strategies of the indefinitely repeated PD of matrix 3, while strategy $d$ refer to all strategies of this game approximating the so-called 'all d' strategy.

| | | *player 2* | |
|---|---|---|---|
| | | *c* | *d* |
| *player 1* | *c* | **6, 6** | 1, 5 |
| | *d* | 5, 1 | **2, 2** |

Matrix 11: *The Stag Hunt Game resulting from iterating the PD-game indefinitely in the shadow of the future*

This type of games is perhaps better known as the *Stag Hunt* (Heap & Varoufakis 2004:67-69) and (Skyrms 2004), and is a sub-type of the general class of coordination games. Special to it is that although players in these games agree on their preference for one particular equilibrium to others, alternatives are less risky. Coordination on cooperation is thus a matter of confidence in other players' intention to cooperate, which again turns on their confidence in one's own intention for the same. This reinterpretation makes the basic problem of cooperative behavior a particular type of coordination problem—call it the *stag hunt problem*. By comprising multiple equilibria it reveals the surprising fact that cooperation may ultimately be a matter of *contingency* in a *non-derivative* sense. If this is true, exploring cooperative behavior by a theory of convention may turn out to have profound implications for the understanding of the nature and dynamics of such behavior. A serious obstacle remains, though: like for the other game types utilized in exploring social conventions, the equilibrium selection problem threatens to undermine any account based on classical game theory for cooperation in the stag hunt. That ism ultimately, the two problems facing a theory of convention turns out to hinge, to some extend, on one and the same problem.

**The Evolutionary Turn and the Theory of Convention**

In the 70s and 80s evolutionary game theory arose as a result of applying game theory to problems of evolutionary biology. Where classical game theory approaches social phenomena as aggregate products of interactive choice involving individuals possessing a modicum of rationality, evolutionary biologist John Maynard Smith and others demonstrated that it also provided a powerful framework for explaining various aspects of animal behavior and evolution, see (Maynard Smith & Price 1973), (Maynard Smith 1982).

Their application of game theory, however, was not just carbon copied. They adjusted and developed it in important ways. Instead of assuming agents to be fully informed and hyperrational, the players of evolutionary game theory came to be understood as biologically or socially "preprogrammed" (conditioned) for certain strategies. Also, where the baseline models of classical game theory are games played exactly once, the baseline models of evolutionary game theory came to be games played over and over again by agents randomly drawn from large populations on which

some evolutionary selection process operates over time on the population distribution of strategies.

Besides providing insight into problems of evolutionary biology the development of evolutionary game theory has also provided a novel theoretical framework for dealing with the traditional problems of classical game theory. The first large achievement came by its provision of the concept of *evolutionary stability* revealing hitherto neglected stability features of strategy profiles figuring as Nash equilibria on the classical approach, see (Maynard Smith & Price 1973). The second came by its success in providing a framework for developing dynamic solution concepts such as the *replicator dynamics* of (Taylor & Jonker 1978) capable of describing how behavior may come to converge to strategy profiles which on the classical approach figure as particular Nash equilibria out of multiple available in a game. These results necessarily spurs the idea that evolutionary game theory might be able to provide an appropriate framework within which the theory of convention may reconstructed so as to avoid the problems pinned out in the previous section. In order to follow this of thought deeper some basics of evolutionary game theory may be in its place.

*Some basics of Evolutionary Game Theory*

In pursuit of this idea it should first be noticed that the evolutionary framework may be given two very different, though not opposing interpretations. The literal interpretation focus on evolutionary selection processes modeled as real ones working on the level of *genetics*. Recently a wave of such studies has emerged so as to help revive the notion of sociobiology. The metaphorical interpretation, on the other hand, focus on the evolutionary selections processes as metaphors of social learning processes. As an interpretation in terms of genetics would preclude the approach to the behavioral patterns in question as contingent, the prospects for an appropriate theory of convention lies on this latter path.

Having said this much, an *evolutionary stable strategy* (ESS) may be defined in a symmetric two-player game, as any mixed or pure strategy, $x^*$, for which all $x \in \Delta$,

(1) $u(x^*, x^*) > u(x, x^*)$

or,

(2) $u(x^*, x^*) = u(x, x^*)$ and $u(x^*, x) > u(x, x)$,

where $\Delta$ is the set of all possible combinations of mixed strategies, some times called the *mixed strategy space* of the game $G$, and $x^* \neq x$. When speaking of a *symmetric* two-player game one assumes that there are precisely two player 'positions', that each position has the same number of pure strategies (in the sense that they are identical), and that the utility to any strategy is independent of which player position it is played in.

From this definition it follows that a population in an evolutionary stable state – i.e. a state where all agents play the same ESS - has converged to what amounts to

a Nash equilibrium of the game on the approach of classical game theory. That is, an ESS is always a Nash equilibrium by definition. However, the opposite does not hold. The definition of a Nash equilibrium does not exclude the possibility of such to rely on a weakly dominated strategy. In cases like this the weakly dominated strategy may do just as good against the weakly dominant strategy, but better against itself than the weakly dominant strategy does against itself. Consequently, the behavior of the population may exhibit a phenomenon called *drift*. Here individual changes in strategy by error, creativity or experimentation does not inflict a utility loss to the 'deviator' and when meeting other 'deviators' these may do better against each other than the 'conformists' does against each other. Given that a social learning dynamics portrayable as an evolutionary dynamics is operating, then, this new strategy spreads so as to take over the population in the long run. What this reveals is that the set of evolutionary stable states identifies a subset of the set of Nash equilibria in a game—in this way the ESS criterion refines the Nash equilibrium concept in an evolutionary setting.

At least three features of the ESS concept are, however, important to notice. First of all, the ESS concept refers implicitly to a close connection between the utilities in a game and the spreading of a strategy in a population. This presupposes that the utils in a game are supposed somehow to represent a gain in social reproductive fitness of a strategy from the interaction in question. Second, the ESS concept only applies when the population is large and the 'mutation-rate' or 'experimentation' is low, cf. (Weibull 1995:33-35). Although credible within biology, this assumption may raise some questions when transferred to social phenomena. However, third, and perhaps most important, as with the Nash equilibrium concept, the ESS concept does not explain *how* and *how likely* a population arrives at an associated evolutionary stable state. Instead it asks whether, once reached, such a state is robust to evolutionary pressures. Hence, it provides a refinement of the Nash equilibrium concept in an evolutionary setting, rather than a real alternative to this.

This alternative is provided, however, by the particular population dynamics first formulated by (Taylor & Jonker 1978), later to be dubbed the *replicator dynamics*. Other dynamics has been developed since, but this is the most widespread one. While the criterion of evolutionary stability highlights the role of mutations, the replicator dynamics highlights the role of selection. It does this by providing a model of such a selection dynamics capable of describing how the distributions of different strategies evolve over continuous time. Cutting to the bone the replicator dynamics may be defined by the differential equation

$$\dot{x}_i = [u(e^i, x) - u(x, x)]x_i$$

where $u(e^i, x)$ is the expected payoff to any pure strategy $i$ at a random match, when the population is in state $x \in \Delta$; $u(x, x)$ is the expected payoff to any mixed

or pure strategy $x$ mirroring the population distribution of strategies when played against itself; $x_i$ is the population share playing strategy $i$ at time $t$; and $\dot{x}_i$ is the population share playing strategy $i$ at time $t+1$. Consequently the *growth rate* $\dot{x}_i / x_i$ of the population share using strategy $i$ equals the difference between the strategy's current payoff and the current average payoff in the population.

Features of dynamic processes specified for games by equations like this may be described in the following terminology, cf. (Binmore 1992). An *initial point* of a dynamic process is the point from which it begins at $t = 0$. A process such as the replicator dynamic then describes a *trajectory*. A trajectory may do various things. In particular, it may converge or diverge. Except for pathological cases, a convergent trajectory converges to a *fix point*. Such are defined by being initial points from which the dynamic process never moves. The *basin of attraction* of a fix point is the set of initial points from which the dynamic process converges to this. If a fix point's basin of attraction consists of every possible initial point, then the fix point is a *global attractor*. A *local attractor* is a fix point that lies in the interior of its basin of attraction. I henceforth refer to attractors as evolutionary stable states. Finally, some fix points are not evolutionary stable at all. Their basin of attraction is a singleton. Hence, no-one would ever want to be found predicting that the long-run outcome of a dynamic process will be such a non-stable state. Even if the process started at such a point, any small perturbation could push it into a trajectory in the basin of attraction of a locally or globally stable state making the prediction wildly wrong.

As it turns out, fix points that are global and local stable states always correspond to some Nash equilibrium of the game on the approach of classical game theory. However, as in the case of the ESS concept the reverse does not hold, cf. (Weibull 1995). On this background it is now possible to see how evolutionary game theory might provide a framework for solving what amounts to the equilibrium selection problem on the classical game theoretic approach. Given an evolutionary dynamics such as the replicator dynamics, plus some slight mutation rate (notice the replicator dynamics is deterministic and hence does not incorporate mutation by itself) it may be explained how a population converges to one particular out of multiple available evolutionary stable states. Granted some initial point high-performing strategies may be observed to increase, whereas low-performing strategies decrease and eventually disappear all depending on which basin of attraction the initial population state is located in. This introduces a novel important factor into the analysis of games. The particular initial point of the process determines which stable state, if any, the process converges to.

Having become acquainted with these basics of evolutionary game theory, the details of how the theory of convention might be reconstructed may now be outlined.

*Conventions of Coordination*

Beginning with conventions of coordination, it was earlier seen how conformity to

these were asserted to solve pure-coordination problems in recurrent situations modeled as pure-coordination games. Yet, it was impossible to explain the ability of individuals to establish and conform to such conventions within the framework of noncooperative classical game theory. However, granted that evolutionary game theory is taken to provide a rigid way of thinking about and modeling the dynamics of social learning processes, it turns out that this provides some interesting suggestions for how to answer the questions concerning the positive dynamics of conventions of coordination.

First, it may be noticed that in the game of matrix 1 if played repeatedly within a single population by pairs of randomly matched players, only the two Nash equilibria in pure strategies, but not the one in mixed strategies, correspond to evolutionary stable states. Consequently, an evolutionary dynamics such as the replicator dynamics drives the population to one of the population states where everyone plays either strategy $a$ or strategy $b$. In particular, this is also the case if we start the population in a state corresponding to the mixed strategy equilibrium and invoke slight perturbations. Sooner or later one player will switch strategy by error, choice or whatever, whereby the average payoffs of all strategies in the game changes so as to favor the strategy that the 'switching' player adopted. That is, the population is pushed into a basin of attraction belonging to one of the evolutionary stable states. Given a low perturbation rate and the positive feedback loop between payoffs and play of particular strategies stipulated by the replicator dynamics, more and more players will then adopt the strategy in question whereby the incentive for others to do so as well is raised even more.

Ultimately, what the shift to an evolutionary framework shows us is that any social learning dynamics for which the evolutionary dynamics may function as a metaphor will drive a population playing a pure-coordination game towards an evolutionary stable state instantiating one of the pure-strategy Nash equilibria on the classical approach. In particular, it shows that such coordination may be achieved in the absence of strategic rationality. Further, the evolutionary reconstruction lends substance to Lewis' claim that we should not expect to see behavioral patterns corresponding to the mixed strategy equilibrium materialize; or alternatively, why we should not attribute to behavioral patterns the nature of mixed strategy equilibria in this type of games. Thus, one of the fundamental assumptions of the theory of convention is saved. Finally, as it turns out one may also use the evolutionary framework to think about the nature and dynamics of certain types of salience. That is, given that social learning dynamics are taken to operate, evolutionary game theory shows not only how an evolutionary pressure may operate upon each players tendency to choose an action, but also upon each players background beliefs about other peoples tendency to pick certain actions when no other grounds for choice are given[35]. In a screwed sense, then,

[35] These types of salience is what (Metha et al 1994b) in another context refers to as *primary* and *secondary salience*, respectively.

the theory of convention may be brought to explain certain types of salience—i.e. in contrast to what is the case for classical game theory, certain types of salience may be incorporated into the evolutionary game theory. The dynamics and detailed features of such processes have been explored further by (Sugden 2004), though it should be mentioned that he is somewhat divided on his view on the extend to which evolutionary game theory is useful for explaining salience. Despite this, he shows how evolutionary dynamics may push for certain focal points given small initial perturbations or mistakes, and why other points that on the classical approach could not be disregarded as candidates of focal points, may be disfavored by such a dynamic. Still, much in this field is unresolved, and even worse, little experimental data exists to inform discussion.

*Discriminatory Conventions*

Things, however, are not that simple when trying to extend the evolutionary framework to discriminatory conventions. When applying this to partial coordination games like that of matrix 2, it turns out that the population converges to playing what amounts to the mixed strategy Nash equilibrium of the game, cf. (Sugden 2004) and (Hansen 2005). That is, for the game of matrix 2 the sole evolutionary stable population state is the one assigning a probability of $\frac{2}{3}$ to the play of strategy $a$ and $\frac{1}{3}$ to the play of strategy $b$ in the population. A part from appearing utterly disappointing in the context of the theory of convention, this result is consistent with experimental findings such as (Cooper et al 1989).

However, bringing further experimental studies into the construction chamber may provide some insight into why the present approach fails. An experimental study of (Heap & Varoufakis 2002) shows that if attributing some kind of arbitrary but distinguishing feature to groups of experimental subjects playing a repeated game somewhat similar to that of matrix 2, the aggregate behavior gradually converges to either of the states corresponding to the pure strategy equilibria. This is good news. Whereas there is no room for such features to effect coordination by salience within the framework of classical game theory, there is no reason why one should preclude the possibility that players may condition strategies on such features within an evolutionary framework.

However, to model this requires a developed approach. In analyzing conventions of coordination it was assumed that the pure coordination games were games of symmetric pairwise *random* matching between players drawn from a *single* population. However, one way to incorporate distinguishing features into an evolutionary framework is by modeling this as dividing the population into corresponding sub-populations, cf. (Sugden 2004) (Hansen 2005). That is, if a group of members in a single population playing the game of matrix 2 is given some distinguishable feature, it may be argued that players may condition their actions on this, thereby affecting a division of the population into two sub-populations—e.g. 'you' v.s. 'I', men v.s. women, 'them' v.s.

'us', colored v.s. white, taller v.s. smaller, newcomers v.s. old inhabitants, row- v.s. column players, and so on.

This leads the exploration into the field of evolutionary selection in multi-population models—a field on the cutting edge of contemporary modeling techniques.[36] In multi-population models it is assumed that large (technically infinite) populations of agents interact, one such population for each player position of the game. Repeatedly individuals are randomly drawn – one for each population – to play the game. Formally, a population state is then identical with a pure- or mixed strategy for a player position. It is these population states that are modeled as interacting. Taken together such states – one for each population – constitute a pure- or mixed strategy profile of the game. However, besides these basics, little may be said in general about multi-populational modeling. For instance, there appears to be no strict consensus as to how the criterion of evolutionary stability should be extended to multi-population interactions; and even further, multiple extension of the replicator dynamics exist, cf. (Weibull 1995:165).

Still, some interesting conclusions may be drawn from these basics. For instance, when some fraction of a population state change strategy by creativity or error, this fraction will never meet members of itself, for the simple reason that each agent in any of the interacting populations is always matched with agents from the other population(s). Thus, where such strategies may have done poorly against themselves in single population models, this is not an issue in a multi-population model. They may survive and invade their population due to them doing quite well against the strategies of another population. Consequently, a non strict Nash equilibrium like the mixed strategy equilibrium of matrix 2 is vulnerable to invasions. On this background, the different available criteria for multi-populational evolutionary stability are formulated so that they are met *only* by strict Nash equilibria (Weibull 1995:163). In conclusion, for partial coordination games such as that of matrix 2, the mixed strategy Nash equilibrium on the classical approach now turns out to be unstable in multi-population models on the evolutionary approach, while only the pure strategy equilibria facilitate stability as they corresponds to strict Nash equilibria.

This gives way to an even more interesting conclusion. Using the 'standard' $n$-population replicator dynamics formulated by (Weibull 1995:171-181) gives a dynamics for the game of matrix 2 like that shown in *figure 2* below.

[36] For a good introduction to multipopulational modeling see (Weibull 1995:Ch.5).

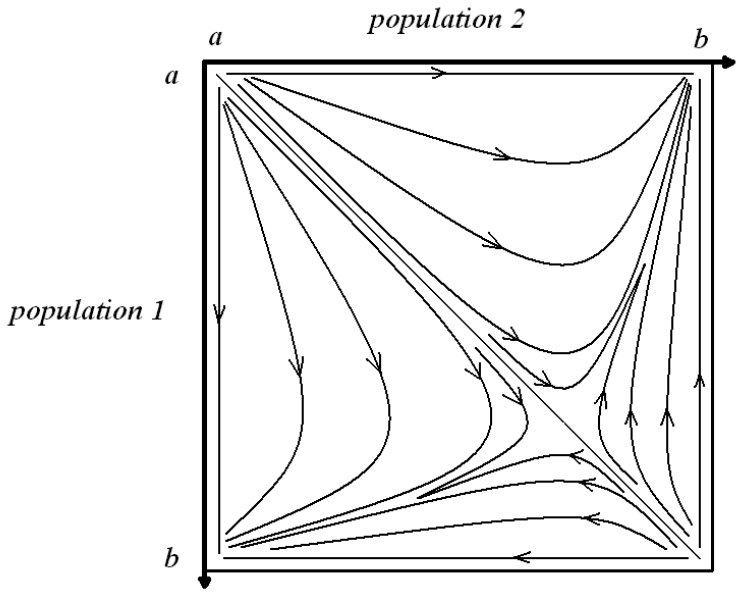



Figure 2: *two-populational replicator dynamic solution orbits in the game of matrix 2*

The vertical axis gives the frequency distribution of strategies $a$ and $b$, respectively, within population 1. Likewise, the horizontal axis gives the frequency distribution of strategies $a$ and $b$, respectively, within population 2. Where the mixed strategy equilibrium profile was seen to correspond to a globally attractive population state for the replicator dynamics in the single population model, the portrayed trajectories of *figure 2* show that population states corresponding to pure strategy Nash equilibria constitutes evolutionary stable states in the two-population replicator dynamics of the game of matrix 2, while the state corresponding to the mixed strategy Nash equilibrium has disappeared as a stable state. The reason for this stark qualitative contrast between the single- and two-population models is that when interaction takes place between two distinct populations, there arises the possibility of *polarization* in behaviors. The slightest deviation from identical population distributions corresponding to the mixed Nash equilibria may lead the player populations toward specialization in *different* pure strategies (Weibull 1995:183). In the game of matrix 2 this means that one population distinguishable by some arbitrary feature will specialize in – i.e. be carried by the dynamics towards – the state corresponding to the Nash equilibrium in which they are favored, while the other population will move towards the state corresponding to the Nash equilibrium in which they are disfavored. Which of the two possible evolutionary stable states will emerge depends on the initial population

states.

What has been established here by means of the replicator dynamics in a multi-population model is what amounts to a basis for an internally consistent prototype account of the nature and dynamics of discriminatory conventions. On this account, the *reason d'être* of behavioral patterns qualifying as such conventions is that of providing a solution to recurrent partial coordination problems in social interaction. In order to do this, however, arbitrary features must be available for pre-programmed agents to condition their actions on; or, in the terminology of a learning theoretic interpretation, by providing a basis for agents to fix their expectations regarding other people's behavior. If such features are not available, discriminatory conventions will not emerge. Instead behavior corresponding to the mixed strategy Nash equilibria of the game in question should be observed. If, on the other hand, one or more distinguishing features are available, discriminatory conventions are expected to emerge spontaneously and be self-reinforcing.

Further, it may be conjectured that the availability of arbitrary features may determine *which* conventions will emerge. In particular, it may be argued that the more unambiguous and recognizable some arbitrary feature is, the better it serves as a basis for discriminatory conventions (Sugden 2004:187-190). This claim fits quite well with the fact that large-scale discriminatory conventions may be observed to attach to natural features difficult to manipulate, such as color, gender, age, order of arrival and the like. Unfortunately, no experimental studies exploring this further seem to be available.

However, it is surprising to find that, as long as a recurrent partial coordination problem persists, the replicator dynamics together with the ESS concept suggests that discriminatory conventions are quite *stable*. In fact, as stability is defined by the basins of attraction of the evolutionary stable states that such conventions constitute, it turns out that the dynamics affecting conformity to discriminatory conventions in these states are just as strong as the dynamics involved in stabilizing conventions of coordination. Perturbations have to be just as strong as the perturbations needed to change conventions of coordination, in order to throw a population out of the basin of attraction of an established convention and into its alternative, cf. *figure 2*.

Still, the element of conflict ever present due to the relative divergence of preferences over possible outcomes should be expected to make discriminatory conventions somewhat more fragile than conventions of coordination. If the fragility of discriminatory conventions is to be accommodated within this account, then, it should be found to pertain to some other aspect. This may readily be conjectured to be the arbitrary features that discriminatory conventions attach to. On this conjecture, changes in the availability of distinguishing features may lead to changes to alternatives or even the deterioration of discriminatory conventions. Put bluntly, cut of the light and color based discrimination becomes impossible. Consequently, disfavored and favored parties and agents should be expected to show just as much interest in what arbitrary

features should be treated as significant – i.e. in what should count as sub-populations – as in how to invert inequalities between existing sub-populations. This provides an additional possible cause of the change or deterioration of discriminatory conventions to the standard one of a change in preference structure.

However, no experimental studies investigating this claim seem to be available. Yet, social theories external to game theory have discussed it at length. Most prominently, perhaps, studies like those carried out by Pierre Bourdieu on the significance of distinctions surrounding the use of words, clothes and other seemingly arbitrary features provide for considerations. Also, his theory of social objectification of such arbitrary features to the status of *causal* ones may have much to say on how certain normative attitudes receive their content. These details aside, inquiring into the workings and effects of arbitrary features on discriminatory conventions seems like a promising field of study.

*Conventions of Cooperation*

To be sure, the application of an evolutionary framework reaches the same conclusion with regard to the prospects of cooperation in Prisoner's Dilemma games as that of classical game theory. On this approach a state of general defection in the game of matrix 3 is the only evolutionary stable one, whether modeled as a single or two-population game. Still, it is not the evolution of cooperation in PD-games that is of interest here. In exploring the conditions of spontaneous cooperation *without* sanction systems it is the evolution of reciprocal strategies that is of interest; and in exploring the conditions of cooperation *given* sanction systems it is the evolution of pure strategies in the stag hunt that is of interest. Following the simplifying assumption taken from (Skyrms 2004), however, the former may be done by studying the evolution of the two pure strategies of '*reciprocity*' and 'all d' in the stag hunt—hence these two inquiries become formally identical.

Having said this, it may be observed that on the classical approach to a two person stag hunt game like those given in matrix 10 or 11, three Nash equilibria exist. The two in pure-strategies are easily found in both. One of these, mutual defection, is strictly pareto-inferior to the other, mutual cooperation. The third in mixed strategies may be calculated to be one assigning a probability of $0,5$ to $c$ and $d$, respectively, yielding an expected payoff of $1,5$ in the game of matrix 10 and $3,50$ in the game of matrix 11 to each player; hence this is also pareto-inferior to mutual cooperation in both games.

However, turning to the evolutionary approach it turns out that only the two states corresponding to the pure-strategy Nash equilibria are evolutionary stable. Further, it is the case for any stag hunt game that the population state corresponding to the mixed strategy Nash equilibrium forms under the replicator dynamics an evolutionary non-stable separating point for the basins of attraction belonging to each of the pure strategy equilibria of the game. What this basically means is that if initial populations playing the stag hunt of matrix 10 or 11 are formed at random, half of these will go

to the social state of universal cooperation, while the other half will be carried to the social state of universal defection.

On the one hand this is really good news. What have been provided by the evolutionary approach is rudiments of an account of how contingent equilibrium behavior can emerge and stabilize in the stag hunt game. That is, by analogy the rudiments of an account for how conventions of cooperation may emerge and stabilize both for scenarios incorporating the existence of sanction systems and scenarios where such is absent, but where the shadow of the future is sufficiently large. On the other hand, it is crucial to notice that the basic assumption in the study of cooperation is that the initial social state is one of universal defection. Under this assumption the prospect of cooperation is still extremely poor. The dynamics of the stag hunt game of matrix 10 and 11 alike, for instance, reveals a strong dynamic pressure capturing the population in a state of universal defection: for cooperation to emerge in the first instance, it is required that more than 50% of the population 'mutate' simultaneously by creativity or error from playing $d$ to playing $c$, for a similar result see (Skyrms 2004:11-12).

Until now it has been assumed on the evolutionary approach that a game is played repeatedly between *randomly* correlated pairs of players within a large population. However, this assumption is obviously at odds with the context of most social interaction. Individuals usually interact with certain other individuals with a higher frequency than with other individuals. One reason for this is that individuals are *spatially* located and hence tend to interact only or to a higher degree with those located nearby their location. This leads to the conjecture that some kind of spatial correlation may improve on the prospect for cooperation.

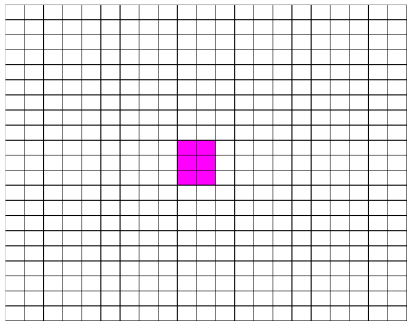
In *The Stag Hunt and the Evolution of Social Structure* (2004) Brian Skyrms discusses the effect of local interaction in the stag hunt at length. Although Skyrms finds local interaction to improve somewhat the prospect for cooperation – a smaller fraction of $c$ players than that prescribed in random correlation is stable or may spread when located next to each other – the threshold problem from above basically remains in his analysis, see (Skyrms 2004:Ch1, Ch3). Skyrms' analysis is carried out in a local interaction model comprising a 100-by-100 square lattice where each square is occupied by a player playing the stag hunt with his *Moore (8) neighborhood* (i.e. with her neighbors to the N, NE, E, SE, S, SW, W, NW) with the payoffs given in matrix 12, see (Skyrms 2004:32). The dynamics he chooses is the simplest case of an imitation dynamics—imitate the best of your neighbors. In this model Skyrms finds that the population is carried to universal cooperation more often than under a best-reply dynamics (the simplest classical dynamics) as well as the replicator dynamics in a population with random correlation. To be specific, with the particular payoffs of the stag hunt chosen by Skyrms the dynamics carries the population to universal stag hunt when the initial population of cooperators are above $\frac{2}{3}$ per cent, as compared to the $\frac{3}{4}$ per cent needed in random correlation under the same payoffs. Skyrms,

then concludes that "... local interaction opens up possibilities of cooperation that do not exist in a more traditional setting, and that imitation dynamics is often more conducive to cooperation than best-response-dynamics".

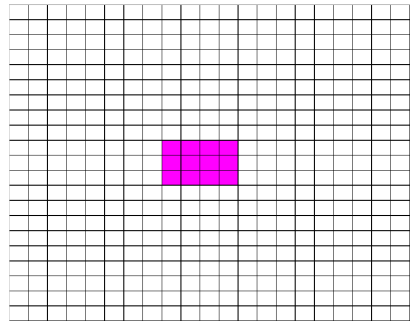
| | | *player 2* | |
|---|---|---|---|
| | | $c$ | $d$ |
| *player 1* | $c$ | $\mathbf{3,3}$ | $0,2$ |
| | $d$ | $2,0$ | $\mathbf{2,2}$ |

Matrix 12: *Skyrms' version of the Stag Hunt*

However, according Skyrms himself the 'imitate the best of your neighbors' dynamics utilized in his model is not the most realistic one. An 'imitate the strategy that performs best on average in your neighborhood' is more realistic. Still, he chooses not to model this alternative. Yet, (Hansen 2005) constructs a local interaction model based on this dynamics with the following two specifications: (1) an agent only imitates the strategy that performs best on average in his neighborhood if this did better in the last round than he himself did[37], and (2) the stag hunt game played has the payoffs of the game in matrix 11. In this, each agent is taken to occupy a cell in a $n \times n$ lattice, where $n$ is large (technically infinite). *Figure 3* reveals the surprising result: given that 6 agents in adjacent cells forming a $2 \times 3$ square mutate so as to play $c$ in the stag hunt, the 'imitate the strategy that performs best on average in your neighborhood' dynamics leads to universal cooperation.



$t = 1$



$t = 2$

[37] In case of a ties it is assumed that the agent keeps his strategy. This assumption turns out so as to slow down the spread of conditional cooperation, why the result does not depend on it.

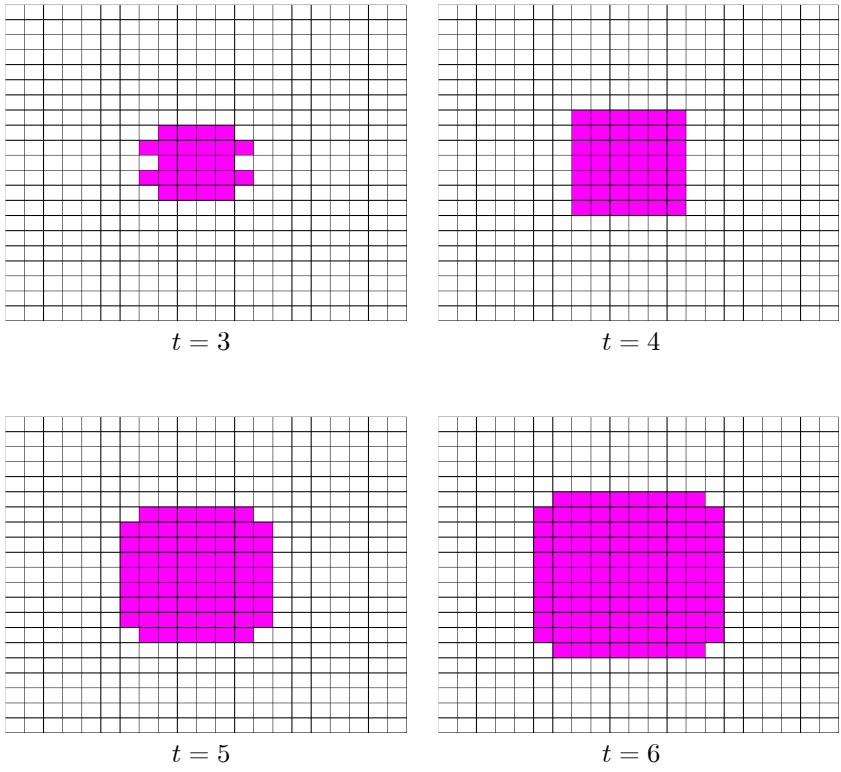



Figure 3: *Cooperative strategies invading a 'defectionist' population state in a local interaction model*

To be sure, this result does not obtain for a similar local interaction model playing a stag hunt with the payoffs chosen by Skyrms, cf. (Skyrms 2004:Ch.3). However, as evolutionary dynamics are payoff sensitive Skyrms' result is likewise. Thus, if enhancing the payoffs resulting from joint stag hunt in Skyrms' version to $4\frac{1}{2}$ and mutating 9 agents in adjacent cells forming a $3 \times 3$ square so as to play $c$ in the stag hunt the same result obtains: stag hunt spreads so as to invade the whole of the population. One might, of course, question the credibility of such models by asking what the possibilities are for the necessary initial configurations of cooperative agents appearing in the model. Answering this is not as difficult as it may seem. If the lattice is technically infinite and game repeated indefinitely with a low mutation rate, it may be argued that it is quite likely that *at some point* these configurations will appear. How often this will happen, of course, depends on the mutation rate chosen.

Now, results like this latter one obviously opens up for a host of interesting possibilities for exploring the normative attitudes associated with conventions of cooperation. At this point of inquiry, however, it may prove more useful to turn the discussion in the direction of a brief evaluation of the prospects for the theory of convention in becoming a comprehensive research programme within the social sciences.

One may begin by noticing the striking theoretical success that a reconstruction of the theory of convention within the evolutionary framework has. As it has been shown here, evolutionary game theory is capable of accommodating explanations for the positive dynamics of all three paradigm types of conventions. But not only that. Evolutionary game theory succeeds in doing this by the introduction of various modeling techniques offering new perspectives in the study of social conventions and associated phenomena. This is, for instance, the case for the introduction of multi-population models in the study of discriminatory conventions which drew attention to the significance and function of arbitrary features for discriminatory conventions. Likewise, this is the case where a reconstruction within the evolutionary framework makes possible an exploration of features relevant for understanding the prospects for cooperative conventions emerging, stabilizing as well as deteriorating. In this way, the evolutionary turn in game theory singles out a path along which a theory of convention may avoid classical problems and open up new perspectives.

Still, as (Sugden 2001) correctly has pointed out, the evolutionary turn in general is mainly a response to theoretical problems in what essentially has been an a priori research programme. The use of classical as well as evolutionary game theory within the development of the theory of conventions suffers from a lack of empirical underpinnings. This is also seen from the fact that the introduction and development of the evolutionary models above mostly is driven by common sense considerations within the evolutionary framework—a weakness which applies in general to the literature on the theory of convention. The consequences of this appear several places. Take, for instance, the replicator dynamics. In its biological application it is obvious that this dynamic is taken to model the replication of genes through reproduction. However, as a metaphor of learning, it is far from obvious what is supposed to get replicated and how. If the replicator dynamics is taken as a metaphor of social imitation – the perhaps most common interpretation – it is assumed to capture a process where people copy the behavior of others, especially behavior that is popular or appears to yield high payoffs. This interpretation is quite consistent with the adaptive learning situations in which the dynamics of social conventions most likely plays out. Yet, in order for this interpretation to make sense it must be the case that individual payoffs must be observable and unambiguous to the players as well as the modeler. When this is not the case, as it might often be, the results of the two processes are most likely to diverge. For instance, the players appearing most popular to others may not necessarily be the most successful in terms of the payoffs attributed by the modeler. Yet,

they will be the ones imitated by others, whereby the dynamics prescribed for the observed system becomes inadequate.

If, on the other hand, the replicator dynamics is taken as a metaphor of reinforcement learning, it is assumed to capture the process emerging when people tend to adopt actions that yielded a high payoff in the past, and to avoid actions that yielded a low payoff. This simple model is the standard learning model in behavioral psychology. Yet, in relation to evolutionary game theory in general, and the theory of convention in particular, evidence is too limited to draw general conclusions about the empirical validity of the model of reinforcement learning in itself, let alone the extend to which dynamics such as the replicator dynamics captures important aspects of this or fails to do so.

In order to remedy such problems a theory of convention has to recognize a weakness in the framework similar to that made by (Binmore 1987) in relation to classical game theory—the need to model the *actual* reasoning and learning processes of individuals explicitly within this. If this may be successfully done, it is not so much a turn away from the evolutionary framework as an explication of the ways in which this works as a successful metaphor. As long as this is not done a theory of convention reconstructed within an evolutionary framework can make no claims whatsoever to speak of social reality. However, even if this obstacle is overcome, an even more daunting assignment awaits the theory of convention. Until now references to real world social conventions have been anecdotal, illustrative and highly *ad hoc*. Few studies, mostly within linguistics, have tried to take the theory seriously and utilize it in profound social research. Even fewer has tried to come up with deep analyzes of social conventions and their purported relations to such phenomena as social norms. So far it has been possible to defend such problems by reference to the pertinence of the fundamental analytical obstacles posed. However, such an excuse is no longer credible. If a theory of convention erected within the framework of evolutionary game theory or the like wants to acquire a rightful claim to the candidacy of a comprehensive theory of social phenomena, it will have to go into the field. Fortunately, the trend seems to be moving in the right direction. Empirical studies of bargaining and fairness norms formulated within the framework of game theory are spreading like fire. Though, these phenomena are not cases of conventions on the account presented here, the first signs of this movement spreading to the theory of convention are slowly starting to appear.

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# RETURN TO SELF-REFERENCE



The anthology from the conference on Self-Reference in Copenhagen in 2002 is finally here. *Self-Reference* is edited by Thomas Bolander, Vincent F. Hendricks, Stig Andur Pedersen; Center for the Study of Language and Informat (June 2006); $27.50, 200 pages; ISBN 1575865157 (hardback), ISBN 1575865165 (paperback).

This book is an antology on self-reference with original, previously unpublished, contributions by some of the most outstanding scholars in the area. The book contains the invited articles presented at the conference 'Self-Reference' held at the Carlsberg Academy in Copenhagen, Denmark, October 31–November 2, 2002 by ΦLOG – The Network for Philosophical Logic and Its Applications. The aim of the conference was to bring together researchers in philosophy, mathematics, and computer science to present theories of – and related to – self-reference. Particular attention was paid to theories intended to explain and resolve the semantic and set-theoretic paradoxes. In addition to the contributing articles the book contains an introductory chapter which gives a thorough introduction to the subject of self-reference intended for a broad audience. The chapter also gives an accessible introduction to each of the articles, and it is shown how and where these articles fit into the general area of self-reference.

> This is a book that every logician will want to read. The well-worn topics of self-reference and the paradoxes have been given new life in these papers by a distinguished group of logicians.
> —**Elliot Mendelson**

> For over 2000 years, self-reference, in the form of the Liar's Paradox, was considered a philosophical oddity. In 1902, self-referential set-theoretic paradoxes triggered a foundational crisis in mathematics. Since then, self-reference has continued to play a key role in philosophical and mathematical logic, as well as, more recently, in theoretical computer science. This thought-provoking volume contains a collection of cutting-edge articles on this important topic.
> —**Moshe Y. Vardi**

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# ANNOUNCEMENTS



## CONFERENCES

*Fourth Workshop on Learning with Logics and Logics for Learning,* June 5 (Monday) or 6 (Tuesday), 2006, Tower Hall Funabori, Edogawa, Tokyo Japan, (LLLL, L4):

`http://www.i.kyoto-u.ac.jp/~akihiro/LLLL2006.html`

SCOPE OF THE WORKSHOP: Logic is a fundamental and useful representation method in Artificial Intelligence. In the area of Machine Learning, various types of computational logic, such as logic programs, first-order logic, description logic, higher-order logic, have been used for representing knowledge obtained with various types of learning mechanisms including identification in the limit, PAC learning, on-line learning, EXACT learning, machine discovery, and learning based on Bayesian networks. On the other hand, machine learning procedures are used in giving semantics to logic and foundations of some procedures in mathematics. This workshop is proposed to bring together researchers who are interested in both of the areas of machine learning and computational logic, and to have intensive discussions on various relations between the two with making their interchange more active. Potential (but not exclusive) topics include:

- Learning and knowledge discovery using logics,
- Algorithmic aspects of learning based on logics,
- Logics for machine learning and knowledge discovery,
- Logics using machine learning,
- Machine learning as a foundation of mathematics/mathematical, procedures,
- Amalgamation of logic-based learning and statistical/information theoretical learning,
- Learning and knowledge discovery from relational data,
- Learning and knowledge discovery from structured/semi-structured data,
- Learning and knowledge discovery from real-valued data.

The working note (proceedings) will be published by JSAI for the workshop, and some outstanding papers will be published in a post proceedings book as a volume in Lecture Notes in Artificial Intelligence from Springer, with such papers from other collocated workshops.

WORKSHOP ORGANIZERS: Akihiro Yamamoto (Kyoto University), Kouichi Hirata (Kyushu Institute of Technology), Ken Satoh (National Institute of Informatics). Program Committee: Yoji Akama (Tohoku University, Japan), Marta Arias (Columbia University, USA), Hiroki Arimura (Hokkaido University, Japan), Kouichi Hirata (Kyushu Institute of Technology, Japan), Eiju Hirowatari (The University of Kitakyushu, Japan), Tamas Horvath (Fraunhofer Institute, Germany), Katsumi Inoue (National Institute of Informatics, Japan), Roni Khardon (Tufts University, USA), Eric Martin (University of New South Wales, Australia), Shin-ichi Minato (Hokkaido University, Japan), Tetsuhiro Miyahara (Hiroshima City University, Japan), Luc de Raedt (University of Freiburg, Germany), M.R.K. Krishna Rao (King Fahd University of Petroleum and Minerals, Saudi Arabia), Ken Satoh (National Institute of Informatics, Japan), Joe Suzuki (Osaka University, Japan), Gyorgy Turan (University of Illinois at Chicago, USA), Hiroaki Watanabe (Imperial College London, UK), Akihiro Yamamoto (Kyoto University, Japan).

CONTACT: Postal addess : Akihiro Yamamoto, Graduate School of Informatics, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto, 606-8501 Japan, Email : akihiro@i.kyoto-u.ac.jp, Tel: +81 75 753 5995, Fax: +81 75 753 5628.

*Computing and Philosophy.* E-CAP 2006@NTNU Norway, Norwegian University for Science and Technology, Dragvoll Campus, Trondheim, Norway, June 22-24, 2006. Conference Co-Chairs: Charles Ess (Drury University / NTNU): cmess@drury.edu; May Thorseth (NTNU): may.thorseth@hf.ntnu.no.

`http://ntnu.no/events/ecap06`

E-CAP is the European conference on Computing and Philosophy, the European affiliate of the International Association for Computing and Philosophy (IACAP, www.iacap.org). E-CAP is organized in cooperation with the Association of Computing Machinery's Special Interest Group on Artificial Intelligence (SIGART).

E-CAP is the premier European venue for current research, reflection, and lively discussion of all aspects of the "computational turn" that has emerged over the past several decades, and continues to expand and develop as a result of the multiple interactions between philosophy and computing. The "culture" of E-CAP, like its sister CAP conferences in North America and Asia-Pacific, discourages paper reading—and

stresses instead the presentation of ideas and lively discussion, along with informal networking.

On behalf of the Program Committee and presenting authors, we invite your participation in ECAP'06.

IMPORTANT DATES

Early registration deadline.....May 5, 2006
Conference.....June 22-24, 2006

The Program (see www.eu-cap.org/?page=program includes:

KEYNOTE SPEAKERS. A leading figure in the computational turn will open each day of the conference: Dr. Raymond Turner, Dept. of Computer Science, University of Essex, UK Dr. Lucas Introna, Centre for the Study of Technology & Organisation, Lancaster University, UK Dr. Vincent Hendricks, Dept. of Philosophy and Science Studies, Roskilde University, Denmark

PROGRAM TRACKS. Papers selected for presentation are organized as follows:

- Information and Computing Ethics: Chair - Philip Brey (University of Twente)
- Ontology (Distributed Processing, Emergent Properties, Formal Ontology, Network Structures, etc): Chair - Luciano Floridi (Oxford University)
- Philosophy of Computer Science: Chairs - Amnon Eden and Raymond Turner (University of Essex)
- Philosophy of Information and Information Technology: Chair - Lars-Göran Johansson (University of Uppsala)
- Ethical and Political Dimensions of ICTs in Globalization: Chairs - May Thorseth and Charles Ess
- Interdisciplinary Approaches to the Problem of Consciousness: Chair - Susan Stuart (University of Glasgow)
- "Intersections" (between logic, epistemology, philosophy of science and ICT / Computing, such as Philosophy of AI): Chair: Chris Dobbyn (Open University)
- Computer-based Learning and Teaching Strategies and Resources & The Impact of Distance Learning on the Teaching of Philosophy and Computing: Chair - Teresa Numerico (University of Salerno)
- IT and Gender Research, Feminist Technoscience Studies: Chair - Alison Adam (University of Salford)

- Biological Information, Artificial Life, Biocomputation: Chair - Colin Allen (Indiana University)

Additional program details may be found on the conference website.

REGISTRATION FEES: before / after 6 May 2006; Standard: EURO 200 / 250 (all the activities of the Conference, Reception included) Phd Students: EURO 100 / 150; Students: Free. Secure registration is available on conference web site.

ACCOMMODATION: To book accommodation, please visit the conference web site.

VENUE: The NTNU campus at Dragvoll offers excellent conference facilities as well a beautiful physical setting as it overlooks Trondheim and the Trondheim fjord. The city of Trondheim (Norway's ancient capital and home to the Nidaros Cathedral, the largest Gothic cathedral north of the Rhine) is easily accessible by air and rail, and is itself more than worth the visit.

*Logic and Mathematics 2006,* June 9-11, 2006, Department of Mathematics, University of Illinois at Urbana-Champaign. 'Logic and Mathematics 2006' will be held at the Mathematics Department, University of Illinois at Urbana-Champaign, June 9-11, 2006. The organizers are C. Ward Henson and Slawomir Solecki. The focus of the meeting will be on descriptive set theory and its connections (with algebra, topology, measure theory, topological dynamics, combinatorics, etc). In part, the meeting is organized to honor Alexander S. Kechris of CalTech on the occasion of his 60th birthday. There will be two invited lectures on Friday (the 9th) starting at 3 p.m., five on Saturday, and three on Sunday; the meeting will end at 1 p.m. on the 11th. Confirmed invited speakers include: Scot Adams (University of Minnesota), Howard Becker (University of South Carolina), Greg Hjorth (UCLA), Alain Louveau (University of Paris), Russell Lyons (Indiana University), Yiannis Moschovakis (UCLA), Sorin Popa (UCLA), Simon Thomas (Rutgers University), Stevo Todorcevic (University of Toronto/University of Paris), W. Hugh Woodin (University of California, Berkeley). Financial support for this meeting is provided by a grant from the US National Science Foundation.

*Logica 2006* Hejnice, Czech Republic, June 19–23, 2006. This event, organized by the Institute of Philosophy of the Academy of Sciences of the Czech Republic, is the twentieth in a series of international symposia devoted to logic. Invited speakers include: M. Cresswell, G. Hellman, A. Koslow, and P. Stekeler-Weithofer. The Co-chairs of the Organizing Committee are T. Childers and V. Svoboda. For further information, visit the website below.

http://www.flu.cas.cz/Logica/Aconf/log2006.html

The 20th event in the series of annual international symposia organized by The Institute of Philosophy, Academy of Sciences of the Czech Republic, will be held at Hejnice Monastery, 19th - 23th June, 2006. Since 1987 the LOGICA Symposia have become an interdisciplinary platform for discussion on all aspects of logic among both internationally renowned scholars and young researchers. The official language of the symposium is English.

There is a registration fee for the symposium covering full board and lodging at Hejnice Monastery during the symposium, conference coach from Prague to Hejnice and back, and a copy of the volume containing contributions to the symposium. The fee amounts to 320 EUR for participants or 230 EUR for accompanying persons (volume not included).

If you are interested in reading a paper at the symposium, please send us a two-page abstract accompanied by a separate sheet with your name, contact address and affiliation by 28 February 2006. Submissions should be in one of the standard formats, i.e., MS Word, postscript or pdf. The subject line of email submissions should contain "Logica 2006" to assure that the mail will not be deleted as spam.

Scholars from countries with severely underfunded academic institutions are invited to apply for a reduction of the conference fee. In exceptional cases the organizing committee may cover the entire fee. Those who wish to apply for the reduction should explicitly state this when submitting their abstract, which should be extended to four pages.

Selected contributions to LOGICA are published by the Academy of Sciences. Recent volumes include, among others, papers from Nuel Belnap, Johan van Benthem, Rom Harré, Jaakko Hintikka, David Lewis, Jeff Paris, Barbara Partee, Jaroslav Peregrin, Graham Priest, Wlodek Rabinowicz, Michael Resnik, Mark Sainsbury, Gabriel Sandu, Stewart Shapiro, Pirmin Stekeler-Weithofer, and Göran Sundholm.

For up-to-date information as well as information about previous events in the series visit: http://www.flu.cas.cz/Logica/Aconf/Aconf.html. For information about the conference site see http://www.mcdo.cz/. All correspondence concerning the symposium should be directed to logica@mbox.cesnet.cz or to:

Timothy Childers & Vladimír Svoboda
Co-chairs of the Organizing Committee
logica@mbox.cesnet.cz
Institute of Philosophy, ASCR

Jilská 1, 110 00 Prague 1, Czech Republic
fax: +420-2/22220138

*Eighth International Workshop on Deontic Logic in Computer Science (DEON-06)* Utrecht, The Netherlands, July 12–14, 2006. This biennial event focuses on research linking the formal-logical study of normative concepts and systems with computer science, artificial intelligence, philosophy, organization theory, and law. There also will be a special focus this year on artificial normative systems. The invited speakers are: J. Carmo, F. Dignum, and P. Petta. The Program Co-chairs are L. Goble and J.-J. Ch. Meyer. For further information, visit the website below.

`http://www.cs.uu.nl/deon2006/`

*Model-based Reasoning in Science and Medicine*, The Second International Conference of Philosophy and Cognitive Science, MBR'06_CHINA, Guangzhou (Canton), China, July 3-5, 2006. Chairs: Ping Li and Lorenzo Magnani.

`http://www.unipv.it/webphilos_lab/mbr06.php`

MBR in Engineering and Robotic Systems:
http://www.unipv.it/webphilos_lab/mbr06.php

MBR COMMUNITY WEB SITE: http://www.unipv.it/webphilos_lab/cpl2/

GENERAL INFORMATION: From Monday 3 to Wednesday 5 July 2006 (three days) the International Conference "Model-Based Reasoning in Science and Medicine" will be held at Sun Yat-Sen University in the city of Guangzhou. The conference derives from a research cooperation between the Department of Philosophy of Sun Yat-Sen University and the Department of Philosophy of the University of Pavia and continues the themes both of the Conferences "Model-Based Reasoning in Scientific Discovery" MBR'98, "Model-Based Reasoning: Scientific Discovery, Technological Innovation, and Values" MBR'01, and "Model-Based Reasoning in Science and Engineering: Abduction, Visualization, and Simulation" MBR'04, and of "the First International Conference of Philosophy and Cognitive Science: Science, Cognition, and Consciousness", 2004.

The previous volumes derived from those conferences are: L. Magnani and N. J. Nersessian (eds.) (2002), *Model-Based Reasoning. Science, Technology, Values*, Kluwer Academic/Plenum Publishers, New York (http://www.wkap.nl/prod/b/0-306-47244-9). L. Magnani, N. J. Nersessian, and C. Pizzi (eds.) (2002), *Logical and Computational Aspects of Model-Based Reasoning*, Kluwer Academic, Dordrecht (http://www.wkap.nl/prod/b/1-4020-0791-4). L. Magnani, N. J. Nersessian, and P.

Thagard (eds.) (1999), *Model-Based Reasoning in Scientific Discovery*, Kluwer Academic/Plenum Publishers, New York (http://www.wkap.nl/prod/b/0-306-46292-3) (Chinese edition, translated and edited by Q. and T. Wang, China Science and Technology Press, Beijing, 2000). Ping Li, Xiang. Chen, Zhilin Zhang, and Huaxia Zhang (eds.)(2004), *Science, Cognition, and Consciousness*, JiangXi People's Press, Nanchang, China.

PROGRAM: The conference will deal with the logical, epistemological, and cognitive aspects of modeling practices employed in science and medicine, including computational models of such practices. We solicit papers that examine the role of abduction, visualization, and simulation in model-based reasoning from philosophical, historical, sociological, psychological, or computational perspectives.

RELEVANT RESEARCH AREAS: We call for papers that cover topics pertaining to model-based reasoning in science and medicine from the following list:

- model-based reasoning in scientific discovery and conceptual changes
- the role of models in scientific and technological thinking
- model-based reasoning in scientific explanation
- model-based medical diagnosis
- model-based reasoning and traditional Chinese medicine
- model-based reasoning in engineering and robotics
- model-based reasoning and technological artefacts
- abduction
- visual, spatial, imagistic modeling and reasoning
- simulative modeling
- the role of diagrammatic representations
- computational models of visual and simulative reasoning
- causal and counterfactual reasoning in model construction
- visual analogy
- thought experimenting
- logical analyses related to model-based reasoning
- manipulative reasoning

- distributed model-based reasoning
- embodiment in model-based reasoning

SUBMISSIONS OF PAPERS AND SYMPOSIA PROPOSALS: All submitted papers will be carefully refereed. The precise format of the conference will be fixed after we have an idea of the number of accepted papers. We expect approximately 40 contributed presentations some of 40 and others of 20 minutes. There will be several invited papers of 1 hour. A selected subset will be invited for inclusion (subject to additional refereeing) in a book which will constitute an advanced handbook for researchers in this area. The book will be published by an international publishing house. Moreover another selected subset will be invited for inclusion (subject to additional refereeing) in special issues of suitable international journals. Authors must submit an electronic version – formatted in Microsoft Word or RTF, or PDF (in this last case please include source — DOC, TEX, etc., file) – of an extended abstract (total word count aproximately 1000-1200). The file must also contain a 300 WORD abstract that will be used for the conference web site/booklet. Not later than March 1, 2006, please send electronically the extended abstract to the Prof. Magnani at the address lmagnani@unipv.it (if the previous address does not work please use lmagnaniusa@netscape.net), *and* to Prof. Li at hsslip@zsu.edu.cn (if the previous address does not work please use zsupingli@tom.com).

SYMPOSIA PROPOSALS: Not later than March 15, 2006. Please send electronically a two pages symposium proposal (3-5 presentations) to the Prof. Magnani at the address lmagnani@unipv.it (if the previous address does not work please use lmagnaniusa@netscape.net) *and* to Prof. Li at hsslip@zsu.edu.cn (if the previous address does not work please use zsupingli@tom.com).

REGISTRATION AND FURTHER INFORMATION: Please register by email to hsslip@zsu.edu.cn *and* lmagnani@unipv.it, fax or air mail by sending to the Program Chair Ping Li or Lorenzo Magnani first and last name, function, institution, full address, phone, fax and email.

For information about paper submission and the program that is not available on the web sites,please contact the program chairs.

Registration Fees: Standard: US$ 80.00 (to participate in all the activities of the Conference and free meals during the conference); Phd Students: US$ 30.00; Students (Undergraduates): Free.

METHOD OF PAYMENT: Pay the registration free after arriving.

ACCOMMODATION: To book a reservation, please indicate in the registration email. Hotel price: US$30-50.00.

IMPORTANT DATES

Submission deadline.....1 March 2006
Notification of acceptance..... 19 April 2006
Conference.....3-5 July 2006
Final papers.....due....31 August 2006

PROGRAM CHAIRS

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PROGRAM COMMITTEE: Thomas Addis, Department of Computer Science and Software Engineering, University of Portsmouth, UK; Atocha Aliseda, Instituto de Investigaciones Filosoficas Universidad, Nacional Autonoma de Mexico (UNAM), Mexico City, Mexico; Walter Carnielli, CLE - Centre for Logic, Epistemology and the History of Science, State University of Campinas - UNICAMP, Campinas, SP, Brazil; Dideril Batens, Center for Logic and Philosophy of Science, Universiteit Gent, Belgium; David Brown, Institute of Industrial Research University of Portsmouth, Portsmouth, UK; Xiang Chen, Department of Philosophy, California Lutheran University, USA; Roberto Cordeschi, Department of Communication Sciences, University of Salerno, Salerno, Italy; Dov Gabbay, Department of Computer Science, King's

College, London, UK; Shenchun Gao, College of Philosophy and Sociology, Jilin University, Changchun, China; Michael E. Gorman, School of Engineering and Applied Science, University of Virginia, Charlottesville, VA, USA; David Gooding, Science Studies Centre, Department of Psychology, University of Bath, Bath, UK; Sundari Krishnamurthy, Stella Maris College (Autonomous), University of Madras, India; Michael Leyton, DIMACS, Busch Campus, Rutgers University, New Brunswick, NJ, USA; Ping Li, Department of Philosophy, Sun Yat-Sen University, Guangzhou, China; Xingmin Li, Graduate School, the Chinese Academy of Sciences, Beijing, China; Xiaoli Liu, Department of Philosophy, Beijing Normal University, Beijing, China; Honghai Liu, Department of Computing Science, University of Aberdeen, Aberdeen, UK; Shangmin Luan, Institute of Software, Chinese Academy of Sciences, China; Lorenzo Magnani, Department of Philosophy, University of Pavia, Pavia, Italy; Joke Meheus, Center for Logic and Philosophy of Science, Universiteit Gent, Belgium; Claudio Pizzi, Department of Philosophy and Social Sciences, University of Siena, Siena, Italy; Colin Schmidt, Le Mans University, Laval, France; Paul Thagard, Department of Philosophy, University of Waterloo, Canada; Barbara Tversky, Stanford University, Stanford, CA; Riccardo Viale, Lascomes (Laboratory of Cognitive, Methodological and Socio-Economic Sciences), Fondazione Rosselli, Torino, Italy; John Woods, Department of Philosophy, University of British Columbia, Vancouver and Department of Computer Science, King's College, London, UK; Zhilin Zhang, Department of Philosophy, Sun Yat-Sen University, Guangzhou, China; Changle Zhou, Department of Computer Science, Xiamen University, P.R.China.

LOCAL ORGANIZER

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LOCAL ORGANIZING COMMITTEE: Xuemei Zhu (Department of Philosophy, Sun Yat-Sen University); Ping Li (Department of Philosophy, Sun Yat-Sen University); Zhilin Zhang (Department of Philosophy, Sun Yat-Sen University); Zhikang Wang (Department of Social Science, Sun Yat-Sen University); Fang Yu (Department of Philosophy, Sun Yat-Sen University); Kaitao Wang (Department of Philosophy, Sun Yat-Sen University); Dachao Li (Department of Philosophy, Sun Yat-Sen University); Kunru Yan (Department of Philosophy, Sun Yat-Sen University).

The Conference is sponsored by

- University of Sun Yat-Sen University, China
- University of Pavia, Italy
- MIUR (Ministero dell'Universite della Ricerca Scientifica e Tecnologica), Italy
- CARIPLO (Fondazione Cassa di Risparmio delle Provincie Lombarde), Milan, Italy

*7th Conference on Logic and the Foundations of Game and Decision Theory,* Liverpool, UK, 13 - 15 July, 2006. Deadline for papers: 15 April, 2006.

`http://www.csc.liv.ac.uk/~wiebe/LOFT06`

*Rationality and Knowledge,* August 7-11, 2006. Workshop organized as part of European Summer School on Logic, Language and Information ESSLLI 2006

`http://esslli2006.lcc.uma.es/`

*Rationality and Knowledge — Workshop*, July 31 - August 11, 2006 in Malaga, Spain. Workshop Organizers: Sergei Artemov and Rohit Parikh.

WORKSHOP PURPOSE: The workshop on rationality and knowledge intends to bring together young researchers from a wide variety of fields — including Artificial Intelligence, Cryptography, Distributed Computing, Economics and Game Theory, Linguistics, Logic, Philosophy, and Psychology, in order to further our understanding of interdisciplinary issues involving reasoning about rationality and knowledge.

WORKSHOP TOPICS: Topics of interest include, but are not limited to,

- semantic models for knowledge,
- for belief, and for uncertainty,
- resource-bounded reasoning,
- epistemic logic, logics of knowledge and action,
- formal analysis of games, belief revision, logics of proofs and justification,
- the role of knowledge in general information flow.

SUBMISSION DETAILS: Authors are invited to submit an extended abstract describing original work. Submissions should not exceed 8 pages. The following formats are

accepted: PDF, PS, ASCII text. Please send your submission electronically by RK-Workshop@g.mail.com http://www.cs.nyu.edu/mailman/listinfo/fom by the deadline listed below. The submissions will be reviewed by the workshop's programme committee and additional reviewers. The accepted papers will appear in the workshop proceedings published by ESSLLI. The format for the final versions will be available on the workshop website. A selection of papers might be published in a special issue of a leading Journal in this area.

WORKSHOP FORMAT: The workshop is part of ESSLLI and is open to all ESSLLI participants. It will consist of five 90-minute sessions held over five consecutive days in the second week of ESSLLI. There will be 2 or 3 slots for paper presentation and discussion per session. On the first day the workshop organizers will give an introduction to the topic.

IMPORTANT DATES: Submissions: March 8, 2006. Notification: April 21, 2006. Preliminary programme: April 24, 2006. ESSLLI early registration: May 1, 2006. Final papers for proceedings: May 17, 2006. Final programme: June 21, 2006. Workshop dates: August 7-11, 2006.

INVITED SPEAKERS: TBA.

WORKSHOP PROGRAMME COMMITTEE: Sergei Artemov (New York), Alexandru Baltag (Oxford), Adam Brandenburger (New York), Johan van Benthem (Amsterdam/Stanford), Melvin Fitting (New York), Valentin Goranko (Johannesburg), Joseph Halpern (Ithaca), Vincent Hendricks (Roskilde), Barteld Kooi (Groningen), David Makinson (London), Yoram Moses (Haifa), Larry Moss (Indiana), Elena Nogina (New York), Rohit Parikh (New York), Krister Segerberg (Uppsala), Rineke Verbugge (Groningen), Renata Wasserman (Sao Paulo), Tatiana Yavorskaya (Moscow).

Local Arrangements: All workshop participants including the presenters will be required to register for ESSLLI. The registration fee for authors presenting a paper will correspond to the early student/workshop speaker registration fee. Moreover, a number of additional fee waiver grants will be made available by the OC on a competitive basis and workshop participants are eligible to apply for those. There will be no reimbursement for travel costs and accommodation. Workshop speakers who have difficulty in finding funding should contact the local organizing committee to ask for the possibilities for a grant.

*International Workshop on Hybrid Logic 2006 (HyLo 2006)*, Affiliated with LICS 2006, August 11, 2006, Seattle, USA.

AIMS AND SCOPE: Hybrid logic is a branch of modal logic in which it is possible to directly refer to worlds/times/states or whatever the elements of the (Kripke) model

are meant to represent. Although they date back to the late 1960s, and have been sporadically investigated ever since, it is only in the 1990s that work on them really got into its stride. It is easy to justify interest in hybrid logic on applied grounds, because of the usefulness of the additional expressive power. For example, when reasoning about time one often wants to build up a series of assertions about what happens at a particular instant,and standard modal formalisms do not allow this. What is less obvious is that the route hybrid logic takes to overcome this problem (the basic mechanism being to add nominals – atomic symbols true at a unique point – together with extra modalities to exploit them) often actually improves the behavior of the underlying modal formalism. For example, it becomes far simpler to formulate modal tableau, resolution, and natural deduction in hybrid logic, and completeness and interpolation results can be proved of a generality that is not available in orthodox modal logic. Hybrid logic is now a mature field, therefore a theme of special interest at this HyLo workshop will be the combination of hybrid logic with other logics, the basic methodological question being "what is the best way of hybridizing a given logic?" However, submissions in all areas of hybrid logic are welcome. The workshop HyLo 2006 is likely to be relevant to a wide range of people, including those interested in description logic, feature logic, applied modal logics, temporal logic, and labelled deduction. The workshop continues a series of previous workshops on hybrid logic, for example the LICS-affiliated HyLo 2002 (http://floc02.diku.dk/HYLO) which was held as part of FLoC 2002, Copenhagen, Denmark. If you are unsure whether your work is of relevance to the workshop, please do not hesitate to contact the workshop organizers for more information. Contact details are given below. For more general background on hybrid logic, and many of the key papers, see the Hybrid Logics homepage (http://hylo.loria.fr/).

PROGRAMME COMMITTEE: Carlos Areces (INRIA Lorraine, France), Patrick Blackburn (INRIA Lorraine, France), Thomas Bolander (Technical University of Denmark), Torben Braüner (Roskilde University, Denmark) (Chair), Valeria de Paiva (PARC, USA), Melvin Fitting (Lehman College, New York, USA), Balder ten Cate (University of Amsterdam, The Netherlands), Jørgen Villadsen (Roskilde University, Denmark).

SUBMISSIONS: We invite the contribution of papers reporting new work from researchers interested in hybrid logic. Details about the submission procedure will be announced in the second call for papers (note that the dates below are tentative). The workshop proceedings have been accepted for publication in ENTCS (http://www.elsevier.com/locate/entcs/). A preliminary version of the proceedings will also be distributed at the workshop. One author for each accepted paper must attend the workshop in order to present the paper.

IMPORTANT DATES (tentative): Deadline for submissions: May 26, 2006. Notifi-

cation of acceptance: June 23, 2006. Deadline for final versions: July 21, 2006.

CONTACT DETAILS: See the workshop homepage

`http://hylomol.ruc.dk/HyLo2006`

for further information. Please send all correspondence regarding the workshop to the organizers:

Patrick Blackburn: `http://www.loria.fr/~blackbur/`

Thomas Bolander: `http://www.imm.dtu.dk/~tb/`

Torben Braüner — Chair: `http://www.ruc.dk/~torben/`

Valeria de Paiva: `http://www.cs.bham.ac.uk/~vdp/`

Jørgen Villadsen: `http://www.ruc.dk/~jv/`

*Abduction and Induction in AI and Scientific Modelling*, ECAI'06 Workshop, Riva Del Garda, August 29, 2006

`http://www.doc.ic.ac.uk/~or/AIAI06/`

BACKGROUND: Abduction and induction are forms of logical reasoning with incomplete information that have many applications in AI. Abduction reasons from effects to possible causes and has been used in tasks such as planning and diagnosis. Induction learns general rules for observed data and is typically used for classification and knowledge acquisition. As our understanding of abduction and induction continues to grow and our computational methods improve, it is becoming apparent that there are potentially significant benefits to be gained by integrating them both in an incremental cycle of knowledge development. By providing a means of extending prior knowledge in the light of new experience, such techniques could be useful in scientific and other AI modelling applications. Indeed, some promising results are beginning to emerge from the very first tentative applications of such hybrid systems.

FOCUS: The purpose of this Workshop is to identify novel techniques for the integration of abduction and induction, and to explore the practical utility of such methods in scientific and other modelling domains. The primary aims of the Workshop are: *To better understand the role of abduction and induction in theory formation and revision; and to explore methods for combining them both within an incremental cycle of knowledge development; *To identify different conceptual models for integrating abduction and induction and to investigate how this integration can be done in a computationally viable way; *To determine the benefits that could result from the

combination of abduction and induction and to characterise the classes of problems that can be usefully solved with such techniques; *To examine possible application areas (such as systems biology) and to assess in more detail the utility of such integrated frameworks. The Workshop will also aim to examine the relations to other approaches (philosophical or cognitive) for modelling scientific and other domains.

SUBMISSIONS: To promote a genuine workshop atmosphere, short papers (of 2-5 pages in length) are preferred over full conference style technical papers. These should be written for this Workshop and should address at least one of its general focus points. Position papers, system descriptions and original applications are especially welcome. An effort should be made to cover both abductive and inductive reasoning, as opposed to focusing mainly on one of the two. Papers should be prepared in Latex using the ECAI 2006 guidelines and style files (available on the web page cited at the top of this mail). Please send the pdf via email to "or@doc.ic.ac.uk" with the subject "aiai06submission". Submissions should be sent by the 5th of April. Papers will be reviewed by a Program Committee, who will be assessing their relevance, quality and/or potential impact. Authors of selected papers will be invited to present their research at the Workshop. Authors will be notified of acceptance/rejection by the 5th of May.

IMPORTANT DATES: Jan 10th, 2006 — Call for papers. Apr 5th, 2006 — Paper submission deadline. May 5th, 2006 — Notification of acceptance. May 18th, 2006 — Early registration deadline. May 20th, 2006 — Camera ready copy deadline. Aug 29th, 2006 — Date of the Workshop.

PROGRAM COMMITTEE: Peter Flach (University of Bristol, UK); Katsumi Inoue (National Institute of Informatics, Japan) Antonis Kakas (University of Cyprus, Cyprus) Lorenzo Magnani (University of Pavia, Italy) Stephen Muggleton (Imperial College London, UK); Oliver Ray (Imperial College London, UK) Alessandra Russo (Imperial College London, UK), Chiaki Sakama (Wakayama University, Japan).

ORGANIZING COMMITTEE: Peter Flach, Department of Computer Science, University of Bristol, UK, email: Peter.Flach@cs.bris.ac.uk; Antonis Kakas, Department of Computer Science, University of Cyprus, Cyprus, email: antonis@cs.ucy.ac.cy; Lorenzo Magnani, Department of Philosophy, University of Pavia, Italy, email: lmagnani@unipv.it; Oliver Ray (primary contact), Department of Computing, Imperial College London, UK, email: or@doc.ic.ac.uk.

*Uncertainty: Reasoning about probability and vagueness*, Prague International Colloquium 2006, September 5 to 8, Prague. Uncertainty is a ubiquitous phenomenon in everyday life, but it is also a topic of fundamental significance to many scientific

disciplines. Uncertainty taken here in a broad sense, has many facets - among them probability and vagueness, including possibility, confidence, fuzziness etc. These are captured by different theories which often seem to be conceptually and technically incompatible. Therefore there is no universally accepted theory covering all this area and there are many reasons why we shall neither expect nor want to have one. On the other hand there have been attempts to cross the borders - there are theories trying to bridge gaps between rival approaches and looking for their common background. The aim of the conference is to provide a platform for an open discussion between proponents of the main theories of uncertainty and vagueness on the market. Special attention shall be paid to the comparison of theories, analyzing differences and similarities of the respective concepts of uncertainty. Of particular interest are logical aspects and formal models of reasoning about vague information. The scope of interest contains, but is not limited to the following topics:

- reasoning under uncertainity
- theories of vagueness
- supervaluationism
- foundations of fuzzy logic
- concepts of probability
- possibility and trust
- epistemic and pragmatic aspects of uncertainty

The invited speakers of the colloquium: Patrick Greenough (St. Andrews), Rosanna Keefe (Sheffield), Peter Milne (Edinburgh), Richard Zach (Calgary).

The colloquium uses an abstract processing service kindly provided by Atlas Conferences Inc.(http://atlas-conferences.com). If you are interested in presenting a paper, please submit an abstract at http://atlas-conferences.com / cgi-bin / abstract / submit / casu-01. Your submission will be confirmed automatically on the e-mail address you provide. The accepted abstracts will be available on-line after the final decision of the program committee. If you have any problems to submit an abstract, please contact us at colloquium@flu.cas.cz.

The deadline for contributions is 6 June 2006, the notification of acceptance/rejection will be sent until 30 June 2006.

Programme committee: Didier Dubois, Christian Fermueller, Ondrej Majer, Peter Milne, Richard Zach.

The conference fee is EUR 150, it covers conference materials, coffee breaks and the banquet at Villa Lanna. Participants unable to pay the conference fee are encouraged to apply for a reduction. Those who wish to apply for the reduction should explicitly state this when submitting their abstract, which should be extended to 2-4 pages. The official language of the symposium is English. The authors will be offered to submit the papers presented at the colloquium to a special issue of Studia Logica on vagueness and uncertainty (their publication will be subject to the journal's regular refereeing process). Details on the special issue will be distributed at a later point by its editors. The workshop starts one day after the *Studia Logica International Conference Towards Mathematical Philosophy* in Torun (http://www.logika.uni.torun.pl/TrendsIV.html); the participants can consider taking part in both conferences (the journey to Prague from Torun takes less than one day). The Prague International Colloquium continues the series of annual International meetings on topics in logic, epistemology and analytic philosophy organized in Prague by the Department of Logic of the Institute of Philosophy (see previous colloquia at http://www.flu.cas.cz/Logica/konf/konf.html). The official web page of the colloquium is

`http://www.flu.cas.cz/Logica/konf/col2006.html.`

All correspondence should be directed to colloquium@flu.cas.cz .

Organising Committee: Ondrej Majer, Libor B Hounek, Petr Cintula

*Rationality and Knowledge,* Workshop, August 7-11, 2006

`www.cs.gc.cuny.edu/~sartemov/rkw`

Workshop organized as part of European Summer School on Logic, Language and Information ESSLLI 2006 (http://esslli2006.lcc.uma.es/), July 31 - August 11, 2006 in Malaga, Spain.

Workshop Organizers: Sergei Artemov and Rohit Parikh

Workshop Purpose: The workshop on rationality and knowledge intends to bring together young researchers from a wide variety of fields – including Artificial Intelligence, Cryptography, Distributed Computing, Economics and Game Theory, Linguistics, Logic, Philosophy, and Psychology – in order to further our understanding of interdisciplinary issues involving reasoning about rationality and knowledge.

Workshop Topics: Topics of interest include, but are not limited to

- semantic models for knowledge, for belief, and for uncertainty
- epistemic logic
- logics of knowledge and action
- formal analysis of games
- belief revision
- logics of proofs and justification
- the role of knowledge in general information flow
- voting and social choice
- social software
- fair division.

Submission details: Authors are invited to submit an extended abstract describing original work. Submissions should not exceed 8 pages. The following formats are accepted: PDF, PS, ASCII text. Please send your submission electronically by RK-workshop@gmail.com by the deadline listed below. The submissions will be reviewed by the workshop's programme committee and additional reviewers. The accepted papers will appear in the workshop proceedings published by ESSLLI. The format for the final versions will be available on the workshop website. A selection of papers will be published in a special issue of a leading Journal in this area.

Workshop format: The workshop is part of ESSLLI and is open to all ESSLLI participants. It will consist of five 90-minute sessions held over five consecutive days in the second week of ESSLLI. There will be 2 or 3 slots for paper presentation and discussion per session. On the first day the workshop organizers will give an introduction to the topic.

Important Dates:

Submissions.....March 8, 2006
Notification.....April 21, 2006
Preliminary programme.....April 24, 2006
ESSLLI early registration.....May 1, 2006
Final papers for proceedings..... May 17, 2006
Final programme.....June 21, 2006
Workshop dates.....August 7-11, 2006

Invited Speakers:

- Johan van Benthem (Amsterdam/Stanford)
- Remzi Sanver (Istanbul Bilgi University)

Workshop Programme Committee: Sergei Artemov (New York); Alexandru Baltag (Oxford); Steven Brams (New York); Adam Brandenburger (New York); Melvin Fitting (New York); Valentin Goranko (Johannesburg); Joseph Halpern (Ithaca); Vincent F. Hendricks (Roskilde); Barteld Kooi (Groningen); David Makinson (London); Yoram Moses (Haifa); Larry Moss (Indiana); Elena Nogina (New York); Rohit Parikh (New York); Krister Segerberg (Uppsala); Rineke Vergbugge (Groningen); Renata Wasserman (Sao Paulo); Tatiana Yavorskaya (Moscow).

Local Arrangements: All workshop participants including the presenters will be required to register for ESSLLI. The registration fee for authors presenting a paper will correspond to the early student/workshop speaker registration fee. Moreover, a number of additional fee waiver grants will be made available by the OC on a competitive basis and workshop participants are eligible to apply for those. There will be no reimbursement for travel costs and accommodation. Workshop speakers who have difficulty in finding funding should contact the local organizing committee to ask for the possibilities for a grant.

*Relations and Kleene Algebra in Computer Science*, Joint 9th International Conference on Relational Methods in Computer Science and 4th International Workshop on Applications of Kleene Algebra, (RelMiCS/AKA 2006), 29 August - 2 September 2006, Manchester, UK

`www.cs.man.ac.uk/relmics06/`

GENERAL INFORMATION: The RelMiCS Conference is the main forum for the relational calculus as a conceptual and methodological tool. The AKA Workshop is a forum on topics related to Kleene algebras. As in previous years, the two events are co-organised; they have a joint programme committee and joint proceedings. RelMiCS/AKA 2006 will be held from 30 August to 2 September 2006 in Manchester.

TOPICS: We invite submissions on the general topics of relations and Kleene algebra in computer science. Special focus will be on formal methods for software engineering, logics of programs and links with neighbouring disciplines. Particular topics of the conference cover, but are not limited to the theory of

- relation algebras and Kleene algebras,
- related formalisms such as process algebras, fixed point,

- calculi, idempotent semirings, quantales, allegories, dynamic, algebras, cylindric algebras, and their applications in areas such as,
- verification, analysis and development of programs and algorithms,
- algebraic approaches to logics of programs, modal and dynamic logics, interval and temporal logics,
- relational formal methods such as B or Z, tabular methods,
- algebraic semantics of programming languages,
- graph theory and combinatorial optimisation,
- games, automata and language theory,
- mechanised and automated reasoning, decision procedures,
- spatio-temporal reasoning, knowledge acquisition, preference and scaling methods,
- information systems.

INVITED SPEAKERS: *Ernie Cohen, Microsoft, USA, *Roger D. Maddux, Iowa State University, USA, *Jeff Sanders, Oxford University, UK.

IMPORTANT DATES: A paper title and a short abstract of about 100 words must be submitted before the paper. All submissions will be electronic from the conference website.

ABSTRACT SUBMISSIONS: 27 February 2006. Paper Submission: 6 March 2006. Author Notification: 2 May 2006. Camera-ready papers: 2 June 2006. PhD Programme: 29 August 2006. RelMiCS/AKA 2006: 30 August - 2 September 2006.

SUBMISSION INSTRUCTIONS: Submissions must be in English, in postscript or pdf format and provide sufficient information to judge their merits. They must be unpublished and not submitted for publication elsewhere. They may not exceed 15 pages in Springer LNCS style and must be produced with LaTeX. Additional material may be provided by a clearly marked appendix or a reference to a manuscript on a website. This may be considered at the discretion of the PC. Deviation from these requirements may cause immediate rejection. One author of each accepted paper is expected to present the paper at the conference. Detailed instructions for electronic submission can be found at the conference website. Formatting instructions and the LNCS style files can be obtained via http://www.springer.de/comp/lncs/authors.html.

PUBLICATION DETAILS: The proceedings of the conference will be published in the Springer LNCS series. They will be available at the conference.

STUDENT PROGRAMME: A PhD training programme will be co-organised with the conference. Details will be published in a special call and on the conference website.

COMMITTEES: Renate Schmidt, Manchester, UK, schmidt@cs.man.ac.uk (General Chair), Georg Struth, Sheffield, UK, g.struth@dcs.shef.ac.uk (Programme Chair).

PROGRAMME COMMITTEE: Roland Backhouse, Nottingham, UK, Brandon Bennett, Leeds, UK, Rudolf Berghammer, Kiel, Germany, Stephane Demri, Cachan, France, Jules Desharnais, Laval, Canada, Zoltan Esik, Szeged, Hungary & Tarragona, Spain, Marcello Frias, Buenos Aires, Argentina, Hitoshi Furusawa, AIST, Japan, Stephane Gaubert, INRIA, France, Steven Givant, Mills College, USA, Valentin Goranko, Witwatersrand, South Africa, Martin Henson, Essex, UK, Ali Jaoua, Quatar, Peter Jipsen, Chapman University, USA, Wolfram Kahl, McMaster, Canada, Yasuo Kawahara, Kyushu, Japan, Zhiming Liu, UNU-IIST Macao, China, Bernhard Moeller, Augsburg, Germany, Damian Niwinski, Warsaw, Poland, Ewa Orlowska, Warsaw, Poland, Alban Ponse, Amsterdam, The Netherlands, Ingrid Rewitzky, Stellenbosch, South Africa, Ildiko Sain, Hungarian Academy of Sciences, Holger Schlingloff, Berlin, Germany, Gunther Schmidt, Muenchen, Germany, Renate Schmidt, Manchester, UK, Giuseppe Scollo, Catania, Italy, Harrie de Swart, Tilburg, The Netherlands, Michael Winter, St.Catharines, Canada. Local Organisation: Renate Schmidt, Manchester, UK, schmidt@cs.man.ac.uk, Zhen Li, Manchester, UK, David Robinson, Manchester, UK, Iain Hart & ACSO, Manchester, UK.

*PhD Training Programme*, Joint 9th International Conference on *Relations and Kleene Algebra in Computer Science* and 4th International Workshop on *Applications of Kleene Algebra*, (RelMiCS/AKA 2006), 29 August - 2 September 2006, Manchester, UK

`www.cs.man.ac.uk/relmics06/`

BACKGROUND: The RelMiCS Conference is the main forum for the relational calculus as a conceptual and methodological tool. The AKA Workshop is a forum on topics related to Kleene algebras. As in previous years, the two events are co-organised; they have joint programme committee and joint proceedings. Special focus will be on formal methods for software engineering, logics of programs and links with neighbouring disciplines. For detailed topics please consult the conference website.

THE PHD TRAINING PROGRAMME: This year, for the first time, the RelMiCS / AKA conference includes a PhD Training Programme that comprises two tutorials, a student session and attendance of the conference and co-located workshops. If you

are currently doing a PhD in the general area of the conference or are interested in learning more about relations or Kleene algebra, then we would like to invite you to apply for participation. The tutorials will teach you the theoretical background and an exemplary application of relational methods to a formal software engineering task. The student session will allow you to present your ongoing work and to establish contacts with other students. The conference and workshops will provide you with an overview of work in your area of research and allow you to discuss it with leading international experts. Overall, the programme will provide a solid background on mathematical foundations in combination with interesting applications.

TUTORIALS:

- Foundations of Relations and Kleene Algebra, Peter Jipsen, Chapman University, USA
- Relational Methods for Program Refinement, John Derrick, Sheffield, UK. RelMiCS/AKA

INVITED SPEAKERS: * Ernie Cohen, Microsoft, USA; * Roger D. Maddux, Iowa State University, USA; * Jeff Sanders, Oxford University, UK.

IMPORTANT DATES: Application Submission: 30.05.2006; Notification: 30.06.2006; Camera-ready papers: 31.07.2006; Student session and tutorials: 29.08.2006; RelMiCS/AKA 2006: 30.08.-02.09.2006.

APPLICATION INSTRUCTIONS: Applications must be in English, in postscript or pdf format and contain, * an extended abstract of at most 5 pages, LNCS-style, describing original, completed or ongoing, PhD work, * a short CV, * a letter of support by your PhD-supervisor or head of department. Abstracts should provide sufficient information to judge their relevance to the programme. Participants will be selected by the organisers and members of the conference programme committee. This includes rewiewing of the extended abstracts submitted. Accepted students are expected to present their work at the student session. Their extended abstracts will be published within a research report at the University of Manchester and at the conference website. Papers submitted by PhD-students to the RelMiCS/AKA conference can also be considered for the programme. All applications should be sent to Georg Struth (g.struth@dcs.shef.ac.uk).

PROGRAMME FEES: Grant support for students is currently being negotiated. Reduced RelMiCS/AKA conference fees will be available for all participants. Further information will be published at the conference website.

ORGANIZATION: Chair: Renate Schmidt, Manchester, UK, schmidt@cs.man.ac.uk. PhD Programme Chair: Georg Struth, Sheffield, UK, g.struth@dcs.shef.ac.uk. Local Organisation: Renate Schmidt, Manchester, UK, schmidt@cs.man.ac.uk, Zhen Li, Manchester, UK, David Robinson, Manchester, UK, Iain Hart & ACSO, Manchester, UK.

*Studia Logica International Conference, Trends in Logic IV, Current philosophical issues in mathematical logic*, Toruń, Poland, September 1 – 4, 2006

`http://www.ifispan.waw.pl/StudiaLogica/TrendsIV.html`

CONFERENCE GOALS: The leading idea of Lvov-Warsaw School of Logic, philosophy and mathematics was to investigate the philosophical problems by means of rigorous methods of mathematics. Since its very first issue Studia Logica has been joining forces of mathematicians and philosophers in carrying out logical investigations. There are many of elaborate mathematical theories that find their origin in philosophy and had a big impact on both philosophy and mathematics. For a couple of decades we have been witnessing the fruitful application of strictly mathematical methods to handling more and more philosophical problems. The main goal of the conference if to present current trends in applying mathematical methods to philosophical problems.

CALL FOR PAPERS: We invite the contributions concerning applications of mathematical methods to philosophical problems. Especially, but not exclusively, we invite contributions on:

- The theory of consequence operations.
- Logical systems within artificial intelligence.
- Many-valued logics, fuzzy logic and its applications to computer science.
- Logical structure of natural languages, categorial grammar and substructural logics.
- Theories of truth.
- Modal logics.
- Paraconsistent logics.
- Logical systems of quantum mechanics.
- Formal epistemology applying logical, probabilistic, game-theoretic, and other mathematical methods to epistemology.

- Logical systems of cognitive science, especially those utilizing methods and systems of belief revision, non-monotonic logic, dynamic epistemic logic.
- Contemporary deontic logic broadly understood utilizing formal methods of mathematics.

Honorary Chairman of the Conference: Ryszard Wójcicki.

INVITED SPEAKERS: Wojciech Buszkowski (Poznań), Janusz Czelakowski (Opole), Branden Fitelson (Berkeley), Melvin Fitting (New York), Rob Goldblatt (Wellington), Vincent Hendricks (Roskilde), Hannes Leitgeb (Bristol), David Makinson (London/Paris), Daniele Mundici (Firenze), Hiroakira Ono (Tatsunokuchi), Hans Rott (Regensburg), Peter Schroeder-Heister (Tübingen), Gerhard Schurz (Erfurt), Neil Tennant (Columbus), Johan van Bemthem (Amsterdam), Martin van Hees (Groningen), Heinrich Wansing (Dresden). Some invited speakers don't confirm his participation yet.

ORGANIZING COMMITTEE: Jacek Malinowski (Chairman), Andrzej Pietruszczak, Rafał Gruszczyński, Tomasz Jarmużek, Jolanta Monikowska-Zygierewicz (Conference Secretary). Marek Nasieniewski, Maciej Nowicki, Rafał Palczewski. Program Committee: Heinrich Wansing (Chairman), Melvin Fitting, Rob Goldblatt, Hiroakira Ono, Andrzej Pietruszczak.

ORGANIZERS: Studia Logica, Institute of Philosophy and Sociology Polish Academy of Sciences and Nicolas Copernicus University in Toruń.

DEADLINE: Please send an abstract not exceeding 2 pages (in format of Latex or MS Word to Heinrich.Wansing@tu-dresden.de not later than May 15, 2006. The authors will be notified about the acceptance within 4 weeks after submission.

CONFERENCE FEE: Euro 320. It covers hotel (4 nights), breakfast and lunches during the conference, garden party on Saturday, a guided tour in Toruń old town on Sunday and conference materials. The fee for an accompanying person is Euro 200. Scholars who are not able to get sufficient support from their home sources are encouraged to apply for reduced conference fee by writing to the organizers.

HOT TO PAY: By transfer to the bank account of Institute Philosophy and Sociology PAN, 00-330 Warszawa, Nowy Swiat 72, number IBAN: PL 45 1060 0076 0000 4010 5000 1029, SWIFT CODE BPHKPLPK, with the note "Trends IV conference fee". Do not pay before your participation is confirmed by the organizers.

CONFERENCE FRAMEWORK AND SOCIAL EVENTS: We expect that the participants arrive to Toruń on Thursday afternoon. On Friday at 10 am the opening conference is planned. Morning session will be devoted to the history of Studia Logica. It will open with Ryszard Wójcicki's lecture Late afternoon we plan a guided tour in Toruń old town. On Saturday night the participants are invited to garden party in Piwnice (Astronomical Observatory of Nicolas Copernicus University near to Toruń). On Monday about noon closing conference is planned.

CONTACT: Contact please Ms Jola Monikowska-Zygierewicz jolamz@interia.pl on all the organizational matters.

*10th European Conference on Logics in Artificial Intelligence*, JELIA06, Liverpool, UK, 13-15 September 2006 Deadline for submissions: 01/05/06.

`http://www.csc.liv.ac.uk/~jelia06`

*Second International Congress on Tools for Teaching Logic*, 26-30 September 2006, Salamanca, Spain. Submission of Papers: May 15, 2006, Notification of Acceptance: June 15, 2006 Final Camera-Ready Submission Due: July 3, 2006

`http://logicae.usal.es/SICTTL`

AIMS AND SCOPE: Most of us share the feeling that the teaching of an interdisciplinary field spanning logic, linguistics and computer science should be available in such a way that will facilitate further interdisciplinary research. Nevertheless, we are aware that the needs are different in those fields of study which have already been stablished. The overall concern is in the teaching of logic, but with special regard in addressing innovations and the systematization of educational activity. We believe that the role of logic in the shaping of the epistemology of this XXI creature should be crucial; Information technology is rapidly changing the world we live in, and logic is helping us to produce, distribute and process information, as well as to understand how coded information can modify people's state of knowlege. At the University of Salamanca the First International Congress on Tools for Teaching Logic took place in June 2000. A number of logicians from different countries in Europe, the US and South America gathered there to focus on education on the interfaces between philosophy, linguistics, mathematics, computer science and related disciplines. The organizing committee invites you to take part in the Second International Congress on Tools for Teaching Logic, which will be held in Salamanca on September 26-30, 2006. There will be lectures, discussion sessions, round tables and software demonstrations. You are kindly invited to take active part in these sessions and to exhibit your teaching or professional software. We invite submission of papers on all aspects of teaching logics, including the following main topics:

- Issues, Means and Objectives in Teaching Logic.
- Teaching the Role of Logic in Science and Humanities.
- Teaching Logic Research in a Postgraduate Programme.
- Software for Teaching Logic and Reasoning.
- e-Learning Logic: Resources and Challenges.

PROGRAM:; We have already arrange the following plenary sessions:

- Johan van Benthem: What Should Every Student Know About Logic? Rethinking the Core Curriculum. University of Amsterdam. Holland
- Wilfrid Hodges: Mathematical Writing. Quen Mary College. U.K.
- Patrick Blackburn. Representation and Inference for Natural Language, INRIA Lorraine, France.
- Hans van Ditmarsch. 10 Years of "logic software and logic education", University of Otago. New Zealand

Dick de Jongh, Carlos Martín Vide, Felip Manya, Raymundo Morado, Angel Nepomuceno, Huberto Marraud, Diógenes Rosales, Concepción Martínez, Enrique Caorsi, Francisco Salguero, Carlos Oller, Tulio Olmos, Antonia Huertas, Enrique Alonso, Carmen Cadena and others are also planing to give talks.

ADVISING COMMITTEE: Carlos Areces (Loria, Nancy, France), Carlos Enrique Caorsi (Facultad de Humanidades y Ciencias de la Educación, Uruguay), Hans van Ditmarsch (University of Otago, New Zeeland), Begoña Carrascal (Universidad del Pais Vasco. Donostia, Spain), Lucila González Pazos (Departamento de Lógica. Universidad Complutense de Madrid, Spain), Antonia Huertas (OUC, Barcelona, Spain), Concepción Martínez, (Departamento de Lóxica e Filosofia Moral, Universidad de Santiago de Compostela.), Huberto Marraud (Universidad Autónoma de Madrid, Spain), Angel Nepomuceno (ULLI, Universidad de Sevilla, Spain), Francisco José Salguero (Universidad de Sevilla, Spain), Carlos Oller (Universidad de la Plata, Argentina), Tulio Olmos (Universidad Central de Venezuela, Venezuela), Gladys Palau (Universidad de Buenos Aires, Argentina), Ruy de Queiroz (Universidade Federal de Pernambuco, Brazil), Diógenes Rosales (Universidad Pontificia, Lima)

ORGANIZING COMMITTEE: Enrique Alonso, (Universidad Autónoma de Madrid, Spain), enr.alonso@gmail.com; Dick de Jongh, (ILLC, Universiteit van Amsterdam,

Holland), dickdj@science.uva.nl; María Manzano, Universidad de Salamanca; Felip Manya (IIIA, CSIC, Bellaterra, Spain), felip@eps.udl.es; Raymundo Morado, (IIF. Universidad Nacional Autónoma de México, México).

LOCAL ORGANIZERS: María Manzano (mara@usal.es), Belén Pérez Lancho (lancho@usal.es), Gustavo Santos García (santos@usal.es), Ana Gil (abg@usal.es).

*Effective content of ineffective proofs*, workshop March-May 2007, Announcement of Logic Activity at the Max Planck Institute for Mathematics (Bonn). In the last twenty years advances in proof theory made it possible to shift the emphasis from purely foundational studies to applications in core areas of mathematics. G.Kreisel's idea of "unwinding proofs" has led to new results in combinatorics, number theory, algebra, and analysis. To make these results accessible to a wider audience of mathematicians, we intend to hold a 3 months long workshop (March-May 2007): "Effective content of ineffective proofs" at the Max-Planck-Institut fuer Mathematik in Bonn. The workshop will culminate in a research conference scheduled for the first week of June 2007. More details will become available in the near future on the homepage of the institute

`http://www.mpim-bonn.mpg.de`

The organizers (U. Kohlenbach - Darmstadt, B. Moroz - MPIM Bonn, G. Mints - Stanford).

*Announcement from Open Access Publications.* Logic and Philosophy of Logic, Open Access Publications. Dear Professors, I'm the editor in chief of Polimetrica Publisher

`http://www.polimetrica.com`

an international publishing house that works in the field of scientific publications. We're developing a new editorial policy, through which intend to produce and distribute knowledge that is accessible to anyone in the world who might be interested, without obstacles concerning economic disadvantages. In order to achieve this goal, we distribute freely the electronic edition of the published volumes and establish reasonable prices on the printed edition (see the web-site for more information). An example of open access publication is the following: Topics in General and Formal Ontology, edited by Paolo Valore (University of Milan),

http://www.polimetrica.com/polimetrica/209/.

And now to the purpose of this letter, which is to ask you if you could kindly be interested in submitting your next works (monographs, collections, proceedings) for

an open access publication with Polimetrica Publisher. I'm working to create a strong open access catalog, composed by high quality works written by researchers coming from universities located in the different countries of the world, who should help us in the development of this innovative publishing line. For each proposed book we need to receive a document containing the following information: 1. Title; 2. Short description; 3. A sample chapter; 4. Biografic profile of the authors;> Then we will evaluate the work and, in case of interest, we propose a publication agreement. I hope you could accept my invitation. It would mean a great deal to us, and I am sure that it would help a good cause. Please feel free to contact me by phone or by e-mail for any kind of question. I'm really looking forward to your answer. Many thanks. Yours sincerely, Giandomenico , Editor-in-chief Polimetrica Publisher, Corso Milano 26, 20052 Monza MI Italy, p. +39.039.2301829, f. +39.039.2301822 mail:g.sica@polimetrica.org.

# NEW PUBLICATIONS

*Abductive Reasoning: Logical Investigations into Discovery and Explanation (Synthese Library)* by Atocha Aliseda; Springer; 1 edition (March 2006); $139.00 (Hardcover) 225 pages; ISBN: 1402039069. Abductive Reasoning: Logical Investigations into Discovery and Explanation is a much awaited original contribution to the study of abductive reasoning, providing logical foundations and a rich sample of pertinent applications. Divided into three parts on the conceptual framework, the logical foundations, and the applications, this monograph takes the reader for a comprehensive and erudite tour through the taxonomy of abductive reasoning, via the logical workings of abductive inference ending with applications pertinent to scientific explanation, empirical progress, pragmatism and belief revision.

*Automata Theory with Modern Applications* by James Anderson; Cambridge University Press; 1st edition (July 31, 2006); $45.00 (Paperback) 252 pages; ISBN: 0521613248. Recent applications to biomolecular science and DNA computing have created a new audience for automata theory and formal languages. This is the only introductory book to cover such applications. It begins with a clear and readily understood exposition of the fundamentals that assumes only a background in discrete mathematics. The first five chapters give a gentle but rigorous coverage of basic ideas as well as topics not found in other texts at this level, including codes, retracts and semiretracts. Chapter 6 introduces combinatorics on words and uses it to describe a visually inspired approach to languages. The final chapter explains recently-developed language theory coming from developments in bioscience and DNA computing. With over 350 exercises (for which solutions are available), many examples and illustrations, this text will make an ideal contemporary introduction for students; others,

new to the field, will welcome it for self-learning.

*Fundamentals of Switching Theory and Logic Design: A Hands on Approach* by Jaakko Astola, Radomir S. Stankovic; Springer; 1 edition (March 7, 2006); $109.00 (Hardcover) 342 pages; ISBN: 0387285938. Switching theory and logic design provide mathematical foundations and tools for digital system design that is an essential part in the research and development in almost all areas of modern technology. The vast complexity of modern digital systems implies that they can only be handled by computer aided design tools that are built on sophisticated mathematical models. Fundamentals of Switching Theory and Logic Design is aimed at providing an accessible introduction to these mathematical techniques that underlie the design tools and that are necessary for understanding their capabilities and limitations. As is typical to many disciplines a high level of abstraction enables a unified treatment of many methodologies and techniques as well as provides a deep understanding of the subject in general. The drawback is that without a hands-on touch on the details it is difficult to develop an intuitive understanding of the techniques. We try to combine these views by providing hands-on examples on the techniques while binding these to the more general theory that is developed in parallel. For instance, the use of vector spaces and group theory unifies the spectral (Fourier-like) interpretation of polynomial, and graphic (decision diagrams) representations of logic functions, as well as provides new methods for optimization of logic functions. Consequently, Fundamentals of Switching Theory and Logic Design discusses the fundamentals of switching theory and logic design from a slightly alternative point of view and also presents links between switching theory and related areas of signal processing and system theory. It also covers the core topics recommended in IEEE/ACM curricula for teaching and study in this area. Further, it contains several elective sections discussing topics for further research work in this area.

*Category Theory (Oxford Logic Guides)* by Steve Awodey; Oxford University Press, USA (June 30, 2006); $134.50 (Hardcover) 272 pages; ISBN: 0198568614. This text and reference book on Category Theory, a branch of abstract algebra, is aimed not only at students of Mathematics, but also researchers and students of Computer Science, Logic, Linguistics, Cognitive Science, Philosophy, and any of the other fields that now make use of it. Containing clear definitions of the essential concepts, illuminated with numerous accessible examples, and providing full proofs of all important propositions and theorems, this book aims to make the basic ideas, theorems, and methods of Category Theory understandable to this broad readership. Although it assumes few mathematical pre-requisites, the standard of mathematical rigour is not compromised. The material covered includes the standard core of categories; functors; natural transformations; equivalence; limits and colimits; functor categories; representables; Yoneda's lemma; adjoints; monads. An extra topic of cartesian closed categories and the lambda-calculus is also provided.

*Deflating Existential Consequence: A Case for Nominalism* by Jody Azzouni; Oxford University Press, USA (April 13, 2006); $25.00 (Paperback) 256 pages; ISBN: 0195308670. If we must take mathematical statements to be true, must we also believe in the existence of abstracta eternal invisible mathematical objects accessible only by the power of pure thought? Jody Azzouni says no, and he claims that the way to escape such commitments is to accept (as an essential part of scientific doctrine) true statements which are about objects that don't exist in any sense at all. Azzouni illustrates what the metaphysical landscape looks like once we avoid a militant Realism which forces our commitment to anything that our theories quantify. Escaping metaphysical straitjackets (such as the correspondence theory of truth), while retaining the insight that some truths are about objects that do exist, Azzouni says that we can sort scientifically-given objects into two categories: ones which exist, and to which we forge instrumental access in order to learn their properties, and ones which do not, that is, which are made up in exactly the same sense that fictional objects are. He offers as a case study a small portion of Newtonian physics, and one result of his classification of its ontological commitments, is that it does not commit us to absolute space and time.

*Intuitionistic Fuzzy Measures: Theory And Applications* by Adrian I. Ban; Nova Science Publishers (April 2006); $129.00 (Hardcover); ISBN: 1594549117.

*Logical Pluralism* by J. C. Beall, Greg Restall; Oxford University Press, USA (February 2, 2006); $29.95 (Paperback) 152 pages; ISBN: 0199288410. Consequence is at the heart of logic; an account of consequence, of what follows from what, offers a vital tool in the evaluation of arguments. Since philosophy itself proceeds by way of argument and inference, a clear view of what logical consequence amounts to is of central importance to the whole discipline. In this book JC Beall and Greg Restall present and defend what thay call logical pluralism, the view that there is more than one genuine deductive consequence relation, a position which has profound implications for many linguists as well as for philosophers. We should not search for one true logic, since there are many.

*Deflationism and Paradox* by J. C. Beall, Bradley Armour-Garb; Oxford University Press, USA (January 5, 2006); $74.00 (Hardcover) 288 pages; ISBN: 0199287112. Deflationist accounts of truth are widely held in contemporary philosophy: they seek to show that truth is a dispensable concept with no metaphysical depth. However, logical paradoxes present problems for deflationists that their work has struggled to overcome. In this volume of fourteen original essays, a distinguished team of contributors explore the extent to which, if at all, deflationism can accommodate paradox. The volume will be of interest to philosophers of logic, philosophers of language, and anyone working on truth. Contributors include Bradley Armour-Garb, Jody Azzouni, JC

Beall, Hartry Field, Christopher Gauker, Michael Glanzberg, Dorothy Grover, Anil Gupta, Volker Halbach, Leon Horsten, Paul Horwich, Graham Priest, Greg Restall, and Alan Weir.

*Gottlob Frege: Critical Assessments of Leading Philosophers, 4 Volume Set (Critical Assessments of Leading Philosphers)* by Mike Beaney (Editor), Erich Reck (Editor); Routledge; 1 edition (January 2006); $830.00 (Library Binding) 1600 pages; ISBN: 0415306019. This collection brings together recent scholarship on Frege, including new translations of German material, made available to Anglophone scholars for the first time. Gottlob Frege (1848-1925) has come to be recognized as someone who, in demonstrating the affinity of logic with mathematics, laid the foundations for modern philosophy of language and modern logic. Frege regarded logic as the foundation for philosophy. In so doing he instigated a radical change in the stance of the majority of Western philosophers whose main pre-occupation had been with the nature of logic rather than logic. His influence can be seen in the work of the logical positivists of the early twentieth century and in much of Ludwig Wittgenstein's philosophy.

*Nonmonotonic Reasoning: A Unifying Framework* by Dritan Berzati (Editor); Nova Science Publishers (June 2006); $89.00 (Hardcover); ISBN: 1594545626.

*Fuzzy Logic and Applications: 6th International Workshop, WILF 2005, Crema, Italy, September 15-17, 2005, Revised Selected Papers (Lecture Notes in Computer ... / Lecture Notes in Artificial Intelligence)* by Isabelle Bloch (Editor), Alfredo Petrosino (Editor), Andrea G.B. Tettamanzi (Editor); Springer; 1 edition (April 2006); $84.00 (Paperback) 438 pages; ISBN: 3540325298. This volume constitutes the thoroughly refereed post-workshop proceedings of the 6th International Workshop on Fuzzy Logic and Applications held in Crema, Italy in September 2005. The 50 revised full papers and 32 short papers presented together with 3 invited papers were carefully reviewed and selected from 86 submissions. The papers are organized in topical sections on neuro-fuzzy systems, fuzzy logic and possibility theory, pattern recognition, evolutionary algorithms, control, bioinformatics, image processing, knowledge management, and miscellaneous applications.

*Continuity, Quantum, Continuum, And Dialectic: The Foundational Logics of Western Historical Thinking* by Mark E. Blum; Peter Lang Publishing (February 24, 2006); $93.95 (Hardcover) 497 pages; ISBN: 0820463981.Continuity, quantum, continuum, and dialectic are foundational logics of Western historical thought. The historiographical method to discern them is a critique of historical reason. Through 'stylistics' Mark E. Blum demonstrates how the inner temporal experience of the person shapes both judgment and historical action. Blum's work augments the epistemology of Immanuel Kant, Wilhelm Dilthey, and Edmund Husserl. Studies of significant persons from Shakespeare through the Framers of the American Constitution, as well as

contemporary adolescents, illustrate the intergenerational presence of these historical logics. Courses in historical method, phenomenological philosophy, cognitive psychology, linguistics, and literary theory can benefit from Blum's findings and approach.

*Self-Reference* by Thomas Bolander, Vincent F. Hendricks, Stig Andur Pedersen; Center for the Study of Language and Informat (June 2006); $27.50 (Paperback) 200 pages; ISBN: 1575865165.

*Automata and Logics for Communicating Systems (Texts in Theoretical Computer Science. an Eatcs)* by Benedikt Bollig; Springer; 1 edition (May 2006); (Hardcover) ISBN: 3540329226. This book studies the relationship between automata and monadic second-order logic, focusing on classes of automata that describe the concurrent behavior of distributed systems. It provides a unifying theory of communicating automata and their logical properties. Based on Hanf's Theorem and Thomas's graph acceptors, it develops a result that allows us to characterize many popular models of distributed computation in terms of the existential fragment of monadic second-order logic. In particular, the book covers finite automata, asynchronous (cellular) automata, communicating finite-state machines, and lossy channel systems. Model behavior is described using graphs and partial orders, leading to the notions of Mazurkiewicz traces, message sequence charts, and live sequence charts. This book is suitable for senior undergraduate and graduate courses on advanced automata theory, concurrency and communication issues. It can also be used as a reference by researchers concerned with the formal modeling of concurrent systems. Some knowledge of automata theory is a prerequisite. Numerous exercises, chapter summaries, and suggested reading allow for self-study, while the book is supported with a website containing course material and solutions.

*Universal Logic (Center for the Study of Language and Information - Lecture Notes)* by Ross Brady; Center for the Study of Language and Inf; New Ed edition (January 15, 2006); $35.00 (Paperback) 360 pages; ISBN: 1575862565. The classical logic of Frege and Russell has dominated formal logic in the 20th century. But a new type of weak relevant logic may prove itself to be better equipped to present new solutions to persisting paradoxes. Universal Logic conceptualizes a new weak quantified relevant logic where the main inference connective is understood as 'meaning containment.' This logic is intended to analyze naive set/class theories. The volume begins with an overview of classical logic and relevant logic, and discusses the limitations of both types of logic in analyzing certain paradoxes. A summary on the history of logic segues into the author's introduction of his new logic modeled on the properties of set-theoretic containment. This book is the first to demonstrate how the main set-theoretic and semantic paradoxes can be solved in a systematic way, which is conceptualized independently of the paradoxes themselves.

*Techniques of Constructive Analysis (Universitext)* by Douglas S. Bridges, Luminita Simona Vita; Springer; 1 edition (June 2006); $49.95 (Paperback) 250 pages; ISBN: 038733646X. This book is an introduction to constructive mathematics with an emphasis on techniques and results that have been obtained in the last twenty years. The text covers fundamental theory of the real line and metric spaces, focusing on locatedness in normed spaces and with associated results about operators and their adjoints on a Hilbert space. Some of the other areas that are discussed in this book are the Ishihara's tricks, Separation theorems, and Locally convex spaces. There are two appendices to the book. The first gathers together some basic notions about sets and orders, the second gives the axioms for intuitionistic logic. The intended readership of the book consists of postgraduate or senior undergraduate students, and professional research mathematicians. No background in intuitionistic logic or constructive analysis is needed in order to read the book, but some familiarity with the classical theories of metric, normed and Hilbert spaces is recommended.

*Methods of Legal Reasoning (Law and Philosophy Library)* by Bartosz Brozek, Jerzy Stelmach; Springer; 1 edition (August 2006); $134.95 (Hardcover) 230 pages; ISBN: 1402049366. The book attempts to describe and criticize four methods used in legal practice, legal dogmatics and legal theory: logic, analysis, argumentation and hermeneutics. Apart from a presentation of basic ideas connected with the above mentioned methods, the essays contained in this book seek to answer questions concerning the assumptions standing behind these methods, the limits of using them and their usefulness in the practice and theory of law. A specific feature of the book is that in one study four different, sometimes competing concepts of legal method are discussed. The panorama, sketched like this, allows one to reflect deeply on the questions concerning the methodological conditioning of legal science and the existence of a unique, specific legal method. The authors argue that there exists no such method. They claim that the methodologies presented in the book may serve as a basis for constructing a coherent and useful conception of legal thinking. Any such conception, however, must recognize its own assumptions and limitations, resulting from adopting a specific philosophical stance.

*Logic Colloquium '02: Proceedings of the Annual European Summer Meeting of the Association for Symbolic Logic and the Colloquium Logicum, He (Lecture Notes in Logic)* by Zoe Maria Chatzidakis (Other Contributor); AK Peters, Ltd. (June 2006); (Paperback); ISBN: 1568813015.

*The Algebra of Logic (Phoenix Edition)* by Louis Couturat; Dover Publications (January 3, 2006); $23.63 (Hardcover) 112 pages; ISBN: 0486446387. In an admirably succinct form, this volume offers a historical view of the development of the calculus of logic, illustrating its beauty, symmetry, and simplicity from an algebraic perspective. Topics include the principles of identity and the syllogism, the principles of

simplification and composition; the laws of tautology and of absorption; the distributive law and the laws of duality, double negation, and contraposition; the formulas of De Morgan and Poretsky; Schröder's theorem; sums and products of functions; solution of equations involving one and several unknown quantities; the problem of Boole; Venn diagrams; tables of consequences and causes; and formulas peculiar to the calculus of propositions. 1914 ed.

*Ideals, Varieties, and Algorithms : An Introduction to Computational Algebraic Geometry and Commutative Algebra (Undergraduate Texts in Mathematics)* by David Cox, John Little, Donal O'Shea; Springer; 2 edition (April 2006); $48.31 (Hardcover) 556 pages; ISBN: 0387946802. Algebraic Geometry is the study of systems of polynomial equations in one or more variables, asking such questions as: Does the system have finitely many solutions, and if so how can one find them? And if there are infinitely many solutions, how can they be described and manipulated? The solutions of a system of polynomial equations form a geometric object called a variety; the corresponding algebraic object is an ideal. There is a close relationship between ideals and varieties which reveals the intimate link between algebra and geometry. Written at a level appropriate to undergraduates, this book covers such topics as the Hilbert Basis Theorem, the Nullstellensatz, invariant theory, projective geometry, and dimension theory. The algorithms to answer questions such as those posed above are an important part of algebraic geometry. This book bases its discussion of algorithms on a generalization of the division algorithm for polynomials in one variable that was only discovered in the 1960's. Although the algorithmic roots of algebraic geometry are old, the computational aspects were neglected earlier in this century. This has changed in recent years, and new algorithms, coupled with the power of fast computers, have let to some interesting applications, for example in robotics and in geometric theorem proving. In preparing a new edition of Ideals, Varieties and Algorithms the authors present an improved proof of the Buchberger Criterion as well as a proof of Bezout's Theorem. Appendix C contains a new section on Axiom and an update about Maple , Mathematica and REDUCE.

*Nonstandard Methods and Applications in Mathematics* (Lecture Notes in Logic) by Nigel J. Cutland (Editor), Mauro Di Nasso (Editor), David A. Ross (Editor); A K Peters, Ltd. (February 28, 2006); $35.00 (Paperback) 264 pages; ISBN: 1568812922. A conference on Nonstandard Methods and Applications in Mathematics (NS2002) was held in Pisa, Italy from June 12-16, 2002. Nonstandard analysis is one of the great achievements of modern applied mathematical logic. In addition to the important philosophical achievement of providing a sound mathematical basis for using infinitesimals in analysis, the methodology is now well established as a tool for both research and teaching, and has become a fruitful field of investigation in its own right. This book is a collection of peer-reviewed papers solicited from some of the participants of this conference with the aim of providing something more timely than a

textbook, but less ephemeral than a conventional proceedings. It contains both survey papers and research articles with special consideration for one, "Nonstandard analysis at pre-university level: naive magnitude analysis" in which the author discusses his experience teaching calculus through an infinitesimal approach.

*A Roadmap for Formal Property Verification* by Pallab Dasgupta; Springer; 1 edition (May 2006); $89.95 (Hardcover) 200 pages; ISBN: 1402047576. Integrating formal property verification (FPV) into an existing design process raises several interesting questions. Have I written enough properties? Have I written a consistent set of properties? What should I do when the FPV tool runs into capacity issues? This book develops the answers to these questions and fits them into a roadmap for formal property verification – a roadmap that shows how to glue FPV technology into the traditional validation flow. A Roadmap for Formal Property Verification explores the key issues in this powerful technology through simple examples – you do not need any background on formal methods to read most parts of this book.

*Classic Works on the Dempster-Shafer Theory of Belief Functions (Studies in Fuzziness and Soft Computing)* by Arthur P. Dempster (Editor), Ronald Yager (Editor), Liping Liu (Editor); Springer; 1 edition (April 2006); $199.00 (Hardcover) 680 pages; ISBN: 3540253815. This book brings together a collection of classic research papers on the Dempster-Shafer theory of belief functions. This book will serve as the authoritative reference in the field of evidential reasoning and an important archival reference in a wide range of areas including uncertainty reasoning in artificial intelligence and decision making in economics, engineering, and management. The carefully selected contributions are grouped into seven sections, including conceptual foundations, theoretical perspectives, theoretical extensions, alternative interpretations, and applications to artificial intelligence, decision-making, and statistical inferences. The book also includes a foreword by Dempster and Shafer reflecting the development of the theory in the last forty years, and an introduction describing the basic elements of the theory and how each paper contributes to the field.

*Logic and Declaritive Languages* by Michael Downward; CRC Press (January 2006); $39.95 (Paperback); ISBN: 1857286537.

*Logic in Tehran: Proceedings of the Workshop And Conference on Logic, Algebra, And... (Lecture Notes in Logic, 26)* by Ali Enayat, Mojtaba Moniri, Iraj Kalantari; Association for Symbolic Logic (April 30, 2006); $40.00 (Paperback) 361 pages; ISBN: 1568812965.

*Classical Mathematical Logic: The Semantic Foundations of Logic* by Richard L. Epstein; Publisher: Princeton University Press (April 11, 2006); $79.50 (Hardcover) 544 pages; ISBN: 0691123004.

*David Hilbert's Lectures on the Foundations of Arithmetic and Logic, 1894-1917* by William Ewald (Editor), Michael Hallett (Editor), Wilfried Sieg (Editor), Ulrich Majer (Editor); Springer; 1 edition (May 2007); $99.00 (Hardcover); ISBN: 3540206051. This volume focuses on notes for lectures on the foundations of the mathematical sciences held by Hilbert in the period 1894-1917. They document Hilbert's first engagement with 'impossibility' proofs; his early attempts to formulate and address the problem of consistency, first dealt with in his work on geometry in the 1890s; his engagement with foundational problems raised by the work of Cantor and Dedekind; his early investigations into the relationship between arithmetic, set theory, and logic; his advocation of the use of the axiomatic method generally; his first engagement with the logical and semantical paradoxes; and the first formal attempts to develop a logical calculus. The Volume also contains Hilbert's address from 1895 which formed the preliminary version of his famous Zahlbericht (1897).

*David Hilbert's Lectures on the Foundations of Arithmetic and Logic, 1917-1933* by William Ewald (Editor), Wilfried Sieg (Editor), Ulrich Majer (Editor); Springer; 1 edition (May 2006); (Hardcover) ISBN: 3540205780. The bulk of this volume consists of six sets of notes for lectures Hilbert gave (often in collaboration with Bernays) on the foundations of mathematics between 1917 and the early 1930s. The notes detail the increasing dominance of the metamathematical perspective in Hilbert's treatment, i.e., the development of modern mathematical logic, the evolution of proof theory, and the parallel emergence of Hilbert's finitist standpoint. The notes are mostly very polished expositions; e.g., the 1917-18 lectures are in effect a first draft of Hilbert and Ackermann's Grundzüge der theoretischen Logik (1928), reprinted in this Volume. They are thus essential for understanding the development of modern mathematical logic leading up to Hilbert and Bernays's Grundlagen der Mathematik (1934, 1938). Also included is a complete version of Bernay's Habilitationschrift of 1918, only partially published in 1926.

*Parameterized Complexity Theory (Texts in Theoretical Computer Science. An EATCS Series)* by J. Flum, M. Grohe; Springer; 1 edition (March 16, 2006); $89.95 (Hardcover) 493 pages; ISBN: 3540299521. Parameterized complexity theory is a recent branch of computational complexity theory that provides a framework for a refined analysis of hard algorithmic problems. The central notion of the theory, fixed-parameter tractability, has led to the development of various new algorithmic techniques and a whole new theory of intractability. This book is a state-of-the-art introduction into both algorithmic techniques for fixed-parameter tractability and the structural theory of parameterized complexity classes, and it presents detailed proofs of recent advanced results that have not appeared in book form before. Several chapters each are devoted to intractability, algorithmic techniques for designing fixed-parameter tractable algorithms, and bounded fixed-parameter tractability and

subexponential time complexity. The treatment is comprehensive, and the reader is supported with exercises, notes, a detailed index, and some background on complexity theory and logic. The book will be of interest to computer scientists, mathematicians and graduate students engaged with algorithms and problem complexity.

*Attitude Problems: An Essay in Linguistic Intensionality* by Graeme Forbes; Oxford University Press, USA (August 31, 2006); $45.00 (Hardcover) 200 pages; ISBN: 0199274940.

*Modern Formal Methods and Applications* by Hossam A. Gabbar (Editor); Springer; 1 edition (February 10, 2006); $129.00 (Hardcover) 197 pages; ISBN: 1402042221. Formal methods are a robust approach for problem solving. It is based on logic and algebraic methods where problems can be formulated in a way that can help to find an appropriate solution. This book shows the basic concepts of formal methods and highlights modern modifications and enhancements to provide a more robust and efficient problem solving tool. Applications are presented from different disciplines such as engineering where the operation of chemical plants is synthesized using formal methods. Computational biology becomes easier and systematic using formal methods. Also, hardware compilation and systems can be managed using formal methods. This book will be helpful for both beginners and experts to get insights and experience on modern formal methods by viewing real applications from different domains.

*Cambridge and Vienna: Frank P. Ramsey and the Vienna Circle (Vienna Circle Institute Yearbook)* by Maria Carla Galavotti (Editor); Springer; 1 edition (April 2006); $179.00 (Hardcover) 257 pages; ISBN: 1402041004. The Institute Vienna Circle held a conference in Vienna in 2003, Cambridge and Vienna – Frank P. Ramsey and the Vienna Circle, to commemorate the philosophical and scientific work of Frank Plumpton Ramsey (1903–1930). This Ramsey conference provided not only historical and biographical perspectives on one of the most gifted thinkers of the Twentieth Century, but also new impulses for further research on at least some of the topics pioneered by Ramsey, whose interest and potential are greater than ever. Ramsey did pioneering work in several fields, practitioners of which rarely know of his important work in other fields: philosophy of logic and theory of language, foundations of mathematics, mathematics, probability theory, methodology of science, philosophy of psychology, and economics. There was a focus on the one topic which was of strongest mutual concern to Ramsey and the Vienna Circle, namely the question of foundations of mathematics, in particular the status of logicism. Although the major scientific connection linking Ramsey with Austria is his work on logic, to which the Vienna Circle dedicated several meetings, certainly the connection which is of greater general interest concerns Ramsey's visits and discussions with Wittgenstein. Ramsey was the only important thinker to actually visit Wittgenstein during his school-teaching ca-

reer in Puchberg and Ottertal in the 1920s, in Lower Austria; and later, Ramsey was instrumental in getting Wittgenstein positions at Cambridge.

*Modal Logic for Philosophers* by James Garson; Cambridge University Press (July 31, 2006); $27.99 (Paperback) 450 pages; ISBN: 0521682290. Designed for use by philosophy students, this book provides an accessible, yet technically sound treatment of modal logic and its philosophical applications. Every effort has been made to simplify the presentation by using diagrams in place of more complex mathematical apparatus. These and other innovations provide philosophers with easy access to a rich variety of topics in modal logic, including a full coverage of quantified modal logic, non-rigid designators, definite descriptions, and the de-re de-dictio distinction. Discussion of philosophical issues concerning the development of modal logic is woven into the text. The book uses natural deduction systems and also includes a diagram technique that extends the method of truth trees to modal logic. This feature provides a foundation for a novel method for showing completeness, one that is easy to extend to systems that include quantifiers.

*Historical Dictionary of Logic (Historical Dictionaries of Religions, Philosophies, and Movements)* by Harry J. Gensler; Scarecrow Press (March 28, 2006); $70.00 (Hardcover) 352 pages; ISBN: 0810855313.

*Fuzzy Logic and Applications : 5th International Workshop, WILF 2003, Naples, Italy, October 9-11, 2003, Revised Selected Papers (Lecture Notes in Computer ... / Lecture Notes in Artificial Intelligence)* by Vito Di Gesù (Editor), Francesco Masulli (Editor), Alfredo Petrosino (Editor); Springer; 1 edition (March 16, 2006); $67.00 (Paperback) 342 pages; ISBN: 3540310193. This volume constitutes the thoroughly refereed post-workshop proceedings of the 5th International Workshop on Fuzzy Logic and Applications held in Naples, Italy, in October 2003. The 40 revised full papers presented have gone through two rounds of reviewing and revision. All current issues of theoretical, experimental and applied fuzzy logic and related techniques are addressed with special attention to rough set theory, neural networks, genetic algorithms and soft computing. The papers are organized in topical section on fuzzy sets and systems, fuzzy control, neuro-fuzzy systems, fuzzy decision theory and application, and soft computing in image processing.

*Topoi: The Categorial Analysis of Logic* by Robert Goldblatt; Dover Publications (May 22, 2006); $18.87 (Paperback) 576 pages; ISBN: 0486450260. A classic exposition of the branch of mathematical logic known as category theory, this text is suitable for advanced undergraduates and graduate students and accessible to both philosophically and mathematically oriented readers. Beginning with a survey of set theory and its role in mathematics, it proceeds to definitions and examples of categories and explains the use of arrows in the place of epsilon. Subsequent topics include

topos logic, algebra of subobjects, institutionism and its logic, functors, set concepts and validity, and elementary truth. Explorations of categorial set theory, local truth, and adjointness and quantifiers conclude with a study of logical geometry. 1983 ed.

*Incompleteness: The Proof and Paradox of Kurt Godel (Great Discoveries)* by Rebecca Goldstein; W. W. Norton; Reprint edition (February 6, 2006); $11.16; (Paperback) 224 pages; ISBN: 0393327604.

*Empiricism and Experience* by Anil Gupta; Oxford University Press, USA (August 18, 2006); $55.00 (Hardcover) 288 pages; ISBN: 0195189582. This book offers a novel account of the relationship of experience to knowledge. The account builds on the intuitive idea that our ordinary perceptual judgments are not autonomous, that an interdependence obtains between our view of the world and our perceptual judgments. Anil Gupta shows in this important study that this interdependence is the key to a satisfactory account of experience. He uses tools from logic and the philosophy of language to argue that his account of experience makes available an attractive and feasible empiricism.

*Logic Synthesis and Verification Algorithms* by Gary D. Hachtel, Fabio Somenzi; Springer; 1 edition (February 10, 2006); $69.95 (Paperback) 600 pages; ISBN: 03-873-1004-5. Logic Synthesis and Verification Algorithms blends mathematical foundations and algorithmic developments with circuit design issues. Each new technique is presented in the context of its application to design. Through the study of optimal two-level and multilevel combinational circuit design, the reader is introduced to basic concepts, such as Boolean algebras, local search, and algebraic factorization. Similarly, through the study of optimal sequential circuit design, the reader is introduced to graph algorithms, finite state systems, and language theory. Throughout the book, recurrent themes such as branch and bound, dynamic programming, and symbolic implicit enumeration are used to establish optimal design principles. Circuit designers and CAD tool developers alike will find Logic Synthesis and Verification Algorithms useful as an introductory and reference text. The rich collection of examples and solved problems make this book ideal for self study. Because of its careful balance of theory and application, Logic Synthesis and Verification Algorithms will serve well as a textbook for upper division and first year graduate students in electrical and computer engineering.

*The Philosophy of Jaakko Hintikka (Library of Living Philosophers)* by Lewis Edwin Hahn (Editor), Randall E. Auxier (Editor); Open Court (May 28, 2006); $37.77 (Hardcover) 736 pages; ISBN: 0812694627. One of the world's most influential logicians, Jaakko Hintikka is a leading figure on the international philosophical scene. Here, he responds to his critics. The 27 critical and descriptive essays in this book,

written by important scholars from a variety of fields, challenge Hintikka's innovations in philosophy, logic, and linguistics. His replies, and the essays themselves, all previously unpublished, form a lively, provocative exchange of ideas. Also included is an intellectual autobiography and a complete bibliography of Hintikka's writings.

*A Textbook of Belief Dynamics: Solutions to Exercises (Applied Logic Series, V. 11)* by Sven Ove Hansson; Kluwer Academic Pub (February 28, 2006); (Hardcover); ISBN: 0792353269.

*500 CC: Computer Citations* by Vincent F. Hendricks; London: King's College Publications (September 1, 2005): $14 (Paperback) 192 Pages; ISBN: 1904987095. "hAS aNYONE sEEN MY cAPSLOCK kEY?" 500CC is a compilation of more than 500 citations on the experiences we have as computer users, abusers and Internet-cruisers - from rage and anger via joy, laughter and appreciation to despair and frustration. This volume completes Vincent F. Hendricks' trilogy of quotations including, besides *500CC: Computer Citations*, *Feisty Fragments: For Philosophy*, and *Logical Lyrics: From Philosophy to Poetics*.

'*500CC* contains an amazing assortment of computer related quotes. It's the sort of book you put down and then simply must pick up again 5 minutes later. If you only ever buy two books about Computing, then buy this one twice and give one copy to a friend.' Kevin Warwick, University of Reading.

*Mainstream and Formal Epistemology* by Vincent F. Hendricks; New York: Cambridge University Press (December 31, 2005); $70.00 (Hardback) 224 Pages; ISBN: 0521857899. *Mainstream and Formal Epistemology* provides the first easily accessible yet erudite and original analysis of the meeting point between mainstream and formal theories of knowledge. These two strands of thinking have traditionally proceeded in isolation from one another but in this book Vincent F. Hendricks brings them together for a systematic comparative treatment. He demonstrates how mainstream and formal epistemology may significantly benefit from one another, paving the way for a new unifying program of 'plethoric' epistemology. His book will both define and further the debate between philosophers from two very different sides of the epistemological spectrum.

'Mainstream and Formal Epistemology is a very timely tour de force, bringing together mainstream epistemology and the modern logic-computational tradition in knowledge, learning, and agency. Using the unifying concept of 'forcing,' it presents a clear and impassioned analysis of both static and dynamic aspects of cognition. ... '[T]he author shows us a highway for new contacts between philosophy and its broader intellectual environment.' Johan van Benthem, University of Amsterdam and Stanford University.

'... Vincent Hendricks has done the philosophical community a major service by

bringing several such important lines of thought together and by trying to synthesize them.' Jaakko Hintikka, Boston University.

'... a highly recommendable meta-epistemological study, presenting a unifying perspective on approaches like mainstream epistemology, epistemic logic, and computational theories of knowledge.' Heinrich Wansing, Dresden University of Technology.

'... This is a genuinely interesting and challenging work of philosophy, one that will both define and substantially further the debate between philosophers from these two very different sides of the epistemic spectrum for many years to come.' Duncan Pritchard, University of Stirling.

'This interesting and original book connects a diverse range of approaches to the theory of knowledge that are rarely considered together ... Whether or not he succeeds in his ambitious aim of defeating the skeptic, [Vincent Hendricks] illuminates the issues by finding some unifying themes, and by showing that these contrasting projects have something to say to each other.' Robert Stalnaker, Massachusetts Institute of Technology.

*8 Bridges between Formal and Mainstream Epistemology (Volume 128, Number 1, special issue of Philosophical Studies*) by Vincent F. Hendricks (editor); Springer Netherlands (March 2006); ISSN: 0031-8116. Contributers: Vincent F. Hendricks, Horacio Arló Costa, Johan van Benthem, Luc Bovens and Stephan Hartmann, Sven Ove Hansson, Matthias Hild, John Symons, Robert Stalnaker, and Heinrich Wansing.

*Axiom of Choice (Lecture Notes in Mathematics)* by Horst Herrlich; Springer; 1 edition (May 2006); $59.95 (Paperback) 200 pages; ISBN: 3540309896. AC, the axiom of choice, because of its non-constructive character, is the most controversial mathematical axiom, shunned by some, used indiscriminately by others. This treatise shows paradigmatically that: - Disasters happen without AC: Many fundamental mathematical results fail (being equivalent in ZF to AC or to some weak form of AC). - Disasters happen with AC: Many undesirable mathematical monsters are being created (e.g., non measurable sets and undeterminate games). - Some beautiful mathematical theorems hold only if AC is replaced by some alternative axiom, contradicting AC (e.g., by AD, the axiom of determinateness). Illuminating examples are drawn from diverse areas of mathematics, particularly from general topology, but also from algebra, order theory, elementary analysis, measure theory, game theory, and graph theory.

*Arguing on the Toulmin Model: New Essays in Argument Analysis and Evaluation (Argumentation Library)* by David Hitchcock (Editor), Bart Verheij (Editor); Springer; 1 edition (August 2006); $134,95 (Hardcover) 353 pages; ISBN: 1402049374. In The Uses of Argument, first published in 1958, Stephen Toulmin proposed a new model for the layout of arguments, with six components: claim, data, warrant, qualifier, rebuttal, backing. Toulmin's model has been appropriated, adapted and extended

by researchers in the fields of speech communications, philosophy and artificial intelligence. The present volume aims to bring together the best contemporary reflection in these fields on the Toulmin model and its current appropriation. The volume includes 24 articles by 27 scholars from 10 countries. All the essays are newly written, have been selected from among those received in response to a call for papers, and have been revised extensively in response to referees' comments. They are not exegetical but substantive, extending or challenging Toulmin's ideas in ways that make fresh contributions to the theory of analysing and evaluating arguments. Collectively, they represent the only comprehensive book-length study of the Toulmin model. They point the way to new developments in the theory of argument, including a typology of warrants, a comprehensive theory of defeaters, a rapprochement with formal logic, and a turn from propositions to speech acts as the constituents of argument.

*Building Models by Games* by Wilfrid Hodges; Dover Publications (April 14, 2006); $12.89 (Paperback) 336 pages; ISBN: 0486450171. This volume presents research by algebraists and model theorists in accessible form for advanced undergraduates or beginning graduate students studying algebra, logic, or model theory. It introduces a general method for building infinite mathematical structures and surveys applications in algebra and model theory. Starting with an overview of basic model theory, the text examines a variety of algebraic applications, including completeness for Magidor-Malitz quantifiers, Shelah's recent and sophisticated omitting types theorem for L(Q), and applications to Boolean algebras and models of arithmetic. More than 160 exercises range from elementary drills to research-related items. 1985 ed.

*Uncertainty, Rationality, and Agency* by Wiebe van der Hoek (Editor); Springer; 1 edition (April 2006); $49.95 (Paperback) 350 pages; ISBN: 1402046308. This book is about Rational Agents, which can be humans, players in a game, software programs or institutions. Typically, such agents are uncertain about the state of affairs or the state of other agents, and under this partial information they have to decide on which action to take next. This book collects chapters that give formal accounts not only of Uncertainty, Rationality and Agency, but also of their interaction: what are rational criteria to accept certain beliefs, or to modify them; how can degrees of beliefs guide an agent in making decisions; why distinguish between practical and epistemic rationality when agents try to coordinate; what must be common beliefs between agents about each other's rationality in order to act rationally themselves; can an agent assign probabilities to planned actions; how to formalise assumptions about a rational speaker in a conversation obeying Gricean maxims; how should a rational agent best represent the states, consequences, and acts that constitute the agent's rational decision problem? This volume should appeal to researchers addressing issues in artificial systems that have to gather information in order to obtain Knowledge, reason about it and then make a Rational decision about which Action to take next.

*Wittgenstein and the End of Philosophy: Neither Theory nor Therapy* by Daniel D. Hutto; Palgrave Macmillan (March 3, 2006); $28.95 (Paperback) 280 pages; ISBN: 1403989869. What is the true worth of Wittgenstein's contribution to philosophy? Answers to this question are strongly divided. However, most assessments rest on certain popular misreadings of his purpose. This book challenges both "theoretical" and "therapeutic" interpretations. In their place, it seeks to establish that, from beginning to end, Wittgenstein regarded clarification as the true end of philosophy. It argues that, properly understood, his approach exemplifies rather than betrays critical philosophy and provides a viable alternative to other contemporary offerings.

*Companion to Philosophical Logic* by Dale Jacquette; publisher not announced (October 30, 2006); $39.95 (Paperback) 832 pages; ISBN: 1405145757. This collection of newly commissioned essays by international contributors offers a representative overview of the most important developments in contemporary philosophical logic. Written by experts from a variety of different logical and philosophical perspectives, the volume presents controversies in philosophical implications and applications of formal symbolic logic. Each section features contributors currently active in research who explain the central ideas of their special field and take a philosophical stand on recent issues in the intersection of logic and analytic philosophy. Taken together the essays survey major trends and offer original insights to advance research and philosophical discussion. A Companion to Philosophical Logic provides a comprehensive state-of-the-art handbook for students and professional researchers in philosophical logic.

*Set Theory* by Thomas Jech; Springer; 3 edition (April 2006); $134.34 (Hardcover) 772 pages; ISBN: 3540440852. Set Theory has experienced a rapid development in recent years, with major advances in forcing, inner models, large cardinals and descriptive set theory. The present book covers each of these areas, giving the reader an understanding of the ideas involved. It can be used for introductory students and is broad and deep enough to bring the reader near the boundaries of current research. Students and researchers in the field will find the book invaluable both as a study material and as a desktop reference.

*Formal Logic: Its Scope And Limits* by Richard Jeffrey, John P. Burgess (Editor); Hackett Publishing Company; 4th edition (March 30, 2006); $32.50 (Hardcover) 172 pages; ISBN: 0872208133. The first beginning logic text to employ the tree method—a complete formal system of first-order logic that is remarkably easy to understand and use—this text allows students to take control of the nuts and bolts of formal logic quickly, and to move on to more complex and abstract problems. The tree method is elaborated in manageable steps over five chapters, in each of which its adequacy is reviewed; soundness and completeness proofs are extended at each step, and the

decidability proof is extended at the step from truth functions to the logic of nonoverlapping quantifiers with a single variable, after which undecidability is demonstrated by example. The first three chapters are bilingual, with arguments presented twice, in logical notation and in English. The last three chapters consider the discoveries defining the scope and limits of formal methods that marked logic's coming of age in the 20th century: Godel's completeness and incompleteness theorems for first and second-order logic, and the Church-Turing theorem on the undecidability of first-order logic. This new edition provides additional problems, solutions to selected problems, and two new Supplements: "Truth-Functional Equivalence" reinstates material on that topic from the second edition that was omitted in the third, and "Variant Methods," in which John Burgess provides a proof regarding the possibility of modifying the tree method so that it will always find a finite model when there is one, and another, which shows that a different modification—once contemplated by Jeffrey—can result in a dramatic speed-up of certain proofs.

*Logical Self-Defense (Key Titles in Rhetoric, Argumentation, and Debates)* by Ralph H. Johnson, J. Anthony Blair; International Debate Education Association (February 1, 2006); $15.72 (Paperback) 313 pages; ISBN: 1932716181. Logical Self-Defense offers step-by-step guidelines for identifying and analyzing arguments. It outlines a theory of good argument to use for purposes of evaluating and constructing arguments. It contains guidelines for constructing arguments and for preparing and writing essays or briefs. Special methods for interpreting and assessing longer arguments are provided. It gives guidelines to help filter out the more reliable information from newspapers and television news.

*A Logic Book: Fundamentals of Reasoning* by Robert M. Johnson; Wadsworth Publishing; 5 edition (April 21, 2006); $76.95 (Paperback) 360 pages; ISBN: 0495006726. Unwavering in its fundamental commitment to today's students and their typical inexperience in rigorous logical analysis, Robert Johnson's A LOGIC BOOK is unparalleled in its ability to make logic simple, if not entertaining. After two chapters on basic concepts?argument, deductive validity, inductive strength, truth of premises?the text presents two different deductive systems, Categorical Logic and Truth-Functional Logic. A chapter on Formal Deduction is then followed by chapters on Inductive Logic and Informal Fallacies. The book culminates in a clear presentation of a strategy for evaluating lengthy arguments. Filled with timely examples and exercises drawn from popular culture, this book is an invitation to logic for even the most apprehensive students.

*Lukasiewicz's Logics And Prime Numbers* by Alexander S. Karpenko; Luniver Press (January 30, 2006); $10.26 (Paperback) 168 pages; ISBN: 0955117038. Is there any link between the doctrine of logical fatalism and prime numbers? What do logic

and prime numbers have in common? The book adopts truth-functional approach to examine functional properties of finite-valued Lukasiewicz logics Ln+1. Prime numbers are defined in algebraic-logical terms (Finn's theorem) and represented as rooted trees. The author designs an algorithm which for every prime number n constructs a rooted tree where nodes are natural numbers and n is a root. Finite-valued logics Kn+1 are specified that they have tautologies if and only if n is a prime number. It is discovered that Kn+1 have the same functional properties as Ln+1 whenever n is a prime number. Thus, Kn+1 are 'logics' of prime numbers. Amazingly, combination of logics of prime numbers led to uncovering a law of generation of classes of prime numbers. Along with characterization of prime numbers author also gives characterization, in terms of Lukasiewicz logical matrices, of powers of primes, odd numbers, and even numbers.

*The Limits of Logical Empiricism: Selected Papers of Arthur Pap (Synthese Library)* by Alfons Keupink (Editor), Sanford Shieh (Editor); Springer; 1 edition (April 2006); $229.00 (Hardcover) 394 pages; ISBN: 1402042981. This volume brings together a selection of the most philosophically significant papers of Arthur Pap. As Sanford Shieh explains in the Introduction to this volume, Pap's work played an important role in the development of the analytic tradition. This role goes beyond the merely historical fact that Pap's views of dispositional and modal concepts were influential. As a sympathetic critic of logical empiricism, Pap, like Quine, saw a deep tension in logical empiricism at its very best in the work of Carnap. But Pap's critique of Carnap is quite different from Quine's, and represents the discovery of limits beyond which empiricism cannot go, where there lies nothing other than intuitive knowledge of logic itself. Pap's arguments for this intuitive knowledge anticipate Etchemendy's recent critique of the model-theoretic account of logical consequence. Pap's work also anticipates prominent developments in the contemporary neo-Fregean philosophy of mathematics championed by Wright and Hale. Finally, Pap's major philosophical preoccupation, the concepts of necessity and possibility, provides distinctive solutions and perspectives on issues of contemporary concern in the metaphysics of modality. In particular, Pap's account of modality allows us to see the significance of Kripke's well-known arguments on necessity and apriority in a new light. This volume will be of interest to all researchers in the philosophical history of the analytic tradition, in philosophy of logic, philosophy of mathematics, and contemporary analytic metaphysics.

*Problems and Theorems in Classical Set Theory (Problem Books in Mathematics)* by Peter Komjath, Vilmos Totik; Springer; 1 edition (May 5, 2006); $59.95 (Hardcover) 527 pages; ISBN: 038730293X.This volume contains a variety of problems from classical set theory. Many of these problems are also related to other fields of mathematics, including algebra, combinatorics, topology and real analysis. The problems vary in

difficulty, and are organized in such a way that earlier problems help in the solution of later ones. For many of the problems, the authors also trace the history of the problems and then provide proper reference at the end of the solution.

*The Structure of Nonstandard Models of Arithmetic (Oxford Logic Guides)* by Roman Kossak, Jim Schmerl; Oxford University Press, USA (July 31, 2006); $99.50 (Hardcover) 304 pages; ISBN: 0198568274. Aimed at research logicians and mathematicians, this much-awaited monograph covers over forty years of work on relative classification theory for non-standard models of arithmetic. With graded exercises at the end of each chapter, the book covers basic isomorphism invariants: families of types realized in a model, lattices of elementary substructures and automorphism groups. Many results involve applications of the powerful technique of minimal types due to Haim Gaifman, and some of the results are classical but have never been published in a book form before.

*Modelling and Reasoning with Vague Concepts (Studies in Computational Intelligence)* by Jonathan Lawry; Springer; 1 edition (January 11, 2006); $119.00 (Hardcover) 300 pages; ISBN: 0387290567. Vagueness is central to the flexibility and robustness of natural language descriptions. Vague concepts are robust to the imprecision of our perceptions, while still allowing us to convey useful, and sometimes vital, information. The study of vagueness in Artificial Intelligence (AI) is therefore motivated by the desire to incorporate this robustness and flexibility into intelligent computer systems. Such a goal, however, requires a formal model of vague concepts that will allow us to quantify and manipulate the uncertainty resulting from their use as a means of passing information between autonomous agents. This volume outlines a formal representation framework for modelling and reasoning with vague concepts in Artificial Intelligence. The new calculus has many applications, especially in automated reasoning, learning, data analysis and information fusion. This book gives a rigorous introduction to label semantics theory, illustrated with many examples, and suggests clear operational interpretations of the proposed measures. It also provides a detailed description of how the theory can be applied in data analysis and information fusion based on a range of benchmark problems.

*The Oxford Handbook of Philosophy of Language (Oxford Handbooks in Philosophy S.)* by Ernest Lepore (Editor), Barry C. Smith (Editor); Oxford University Press (September 7, 2006); (Hardcover); ISBN: 0199259410.

*Decisions and Revisions* by Isaac Levi; Cambridge University Press; 1st edition (April 30, 2006); $43.00 (Paperback); ISBN: 0521027624. This is a collection of Isaac Levi's philosophical papers. Over the period represented by the work here, Professor Levi has developed an interrelated set of views, in the tradition of Peirce and Dewey,

on epistemology and the philosophy of science and social science. This focus has been on the problem of induction and the growth of knowledge, the foundations of probability and the theory of rational decision making. His most important essays in these areas are assembled here, with an introduction setting out their main themes and connections. Part I considers how the aims of scientific inquiry should constrain its practice, employing the crucial notion of 'epistemic utility'. The essays in Part II explain Professor Levi's conception of human knowledge; those in Part III consider objective or statistical probability and evaluate the notion of potential surprise; while Part IV extends his views to central questions of individual and collective decision making. As a whole the volume presents a coherent, elaborated position which will be of great interest to a range of philosophers, decision theorists, welfare and social choice theorists and cognitive scientists.

*Integration of Fuzzy Logic and Chaos Theory (Studies in Fuzziness and Soft Computing)* by Zhong Li (Editor), Wolfgang A. Halang (Editor), Guanrong Chen (Editor); Springer; 1 edition (February 28, 2006); $129.00 (Hardcover) 625 pages; ISBN: 3540268995. This book attempts to present some current research progress and results on the interplay of fuzzy logic and chaos theory. More specifically, this book includes a collections of some state-of-the-art surveys, tutorials, and application examples written by some experts working in the interdisciplinary fields overlapping fuzzy logic and chaos theory. The content of the book covers fuzzy definition of chaos, fuzzy modeling and control of chaotic systems using both Mamdani and Takagi-Sugeno models, fuzzy model identification using genetic algorithms and neural network schemes, bifurcation phenomena and self-referencing in fuzzy systems, complex fuzzy systems and their collective behaviours, as well as some applications of combining fuzzy logic and chaotic dynamics, such as fuzzy-chaos hybrid controllers for nonlinear dynamic systems, and fuzzy-model-based chaotic cryptosystems. This book can serve as a handy reference for researchers working in the interdisciplines related, among others, to both fuzzy logic and chaos theory.

*Wittgenstein, Austrian Economics, and the Logic of Action; Praxeological Investigations (Routledge Studies in Twentieth-Century Philosophy)* by Roderick Long; Routledge; 1 edition (June 2006); $96.95 (Hardcover) 224 pages; ISBN: 0415329485. This book shows how the methodology of Austrian economics can be justified and strengthened by grounding it in the philosophy of Wittgenstein. Frege and Wittgenstein argued that whatever counts as thought must embody logical principles. Their arguments also support the conclusion that whatever counts as action must embody economic principles. The author shows that this confirms the claims of Austrian economists such as Mises and Hayek that the laws of economics are a priori rather than empirical.

*Real Conditionals* by William G. Lycan; Oxford University Press, USA; New Ed

edition (February 9, 2006); $29.95 (Paperback) 240 pages; ISBN: 0199285519. William G. Lycan offers a fresh approach to the long-running debate among philosophers and logicians about the best way to analyze and understand conditional sentences. Lycan attends not just to the semantics of such sentences, but equally to their syntax, making use of insights from linguistic theory. Real Conditionals is the definitive presentation of Lycan's view, written in his characteristically lively style.

*Model Theory of Fields, Second Edition (Lecture Notes in Logic)* by Dave Marker, Margit Messmer, Anand Pillay; A K Peters, Ltd.; 2nd edition (January 8, 2006); $26.00 (Paperback) 175 pages; ISBN: 1568812825. The model theory of fields is a fascinating subject stretching from Tarski's work on the decidability of the theories of the real and complex fields to Hrushovksi's recent proof of the Mordell-Lang conjecture for function fields. This volume provides an insightful introduction to this active area, concentrating on connections to stability theory.

*Plural Predication* by Thomas McKay; Oxford University Press, USA (July 31, 2006); $55.00 (Hardcover) 208 pages; ISBN: 0199278148. Plural predication is a pervasive part of ordinary language. We can say that some people are fifty in number, are surrounding a building, come from many countries, and are classmates. These predicates can be true of some people without being true of any one of them; they are non-distributive predications. However, the apparatus of modern logic does not allow a place for them. Thomas McKay here explores the enrichment of logic with non-distributive plural predication and quantification. His book will be of great interest to philosophers of language, linguists, metaphysicians, and logicians.

*Gentzens Problem: Mathematische Logik im nationalsozialistischen Deutschland* by Eckart Menzler-Trott, J.v. Plato (Contributor); Birkhauser; 1 edition (April 30, 2006); $37.78 (Hardcover) 411 pages; ISBN: 3764365749. Gerhard Gentzen (1909-1945) ist der Begründer der modernen mathematischen Beweistheorie. Die nachhaltige Bedeutung der von ihm entwickelten Methoden, Regeln und Strukturen zeigt sich heute in wichtigen Teilgebieten der Informatik, in der Verifikation von Programmen. Die Arbeiten Gentzens über das natürliche Schliessen, der Sequenzenkalkül und die Ordinal-Beweistheorie beeindrucken noch heute durch ihre Einsicht und Eleganz. Der Autor dokumentiert in dieser ersten umfassenden Biografie Leben und Werk Gerhard Gentzens, seinen tragischen Lebensweg, Festnahme 1945 in Prag, Gefangenschaft und Tod. Die Bedingungen wissenschaftlicher Forschung, in diesem Fall der mathematischen Logik, im nationalsozialistischen Deutschland, den ideologischen Kampf um eine "Deutsche Logik" und deren Protagonisten ist ein weiterer Schwerpunkt des Buches. Zahlreiche, bislang unveröffentlichte Quellen, Fotos und Dokumente aus Korrespondenzen und Nachlass sowie der Abdruck dreier Vorträge von Gerhard Gentzen machen dieses Buch zu einer erstrangigen Informationsquelle über diesen bedeuten-

den Mathematiker und seine Zeit. Der Band wird ergänzt durch ein Essay von Jan von Plato über Gentzens Beweistheorie und deren Entwicklung bis zur Gegenwart.

*Commonsense Reasoning, First Edition* by Erik T. Mueller; Morgan Kaufmann (January 19, 2006); $49.95 (Hardcover) 432 pages; ISBN: 0123693888. To endow computers with common sense is one of the major long-term goals of Artificial Intelligence research. One approach to this problem is to formalize commonsense reasoning using mathematical logic. Commonsense Reasoning is a detailed, high-level reference on logic-based commonsense reasoning. It uses the event calculus, a highly powerful and usable tool for commonsense reasoning, which Erik T. Mueller demonstrates as the most effective tool for the broadest range of applications. He provides an up-to-date work promoting the use of the event calculus for commonsense reasoning, and bringing into one place information scattered across many books and papers. Mueller shares the knowledge gained in using the event calculus and extends the literature with detailed event calculus solutions to problems that span many areas of the commonsense world. *Covers key areas of commonsense reasoning including action, change, defaults, space, and mental states. *The first full book on commonsense reasoning to use the event calculus. *Contextualizes the event calculus within the framework of commonsense reasoning, introducing the event calculus as the best method overall. *Focuses on how to use the event calculus formalism to perform commonsense reasoning, while existing papers and books examine the formalisms themselves. *Includes fully worked out proofs and circumscriptions for every example. *Describes software tools that can be downloaded and used for automated commonsense reasoning, and real-world applications that have been built using the event calculus.

*Paradox and Platitude in Wittgenstein's Philosophy* by David Pears; Oxford University Press, USA (August 31, 2006); $34.95 (Hardcover) 150 pages; ISBN: 0199247706.

*Quantifiers in Language and Logic* by Stanley Peters, Dag Westerstahl; Oxford University Press, USA (June 30, 2006); $99.00 (Hardcover) 500 pages; ISBN: 019929125X. Quantification is a topic which brings together linguistics, logic, and philosophy. Quantifiers are the essential tools with which, in language or logic, we refer to quantity of things or amount of stuff. In English they include such expressions as no, some, all, both, and many. Peters and Westerstahl present the definitive interdisciplinary exploration of how they work–their syntax, semantics, and inferential role.

*Signs of Logic: Peircean Themes on the Philosophy of Language, Games, and Communication (Synthese Library)* by Ahti-Veikko Pietarinen; Springer; 1 edition (March 2006); $229.00 (Hardcover) 496 pages; ISBN: 1402037287. Charles Sanders Peirce (1839-1914), the principal subject of this book, was one of the most profound and prolific thinkers and scientists to have come out of the United States. His pragmatic

logic and scientific methodology largely represent the application of interactive and intercommunicative triadic processes, best viewed as strategic and dialogic conceptualisations of logical aspects of thought, reasoning and action. These viewpoints also involve pragmatic issues in communicating linguistic signs, and are unified in his diagrammatic logic of existential graphs. The various game-theoretic approaches to the semantics and pragmatics of signs and language, to the theory of communication, and to the evolutionary emergence of signs, provide a contemporary toolkit, the relevance of which Peirce envisioned to a wondrous extent. This work sheds considerable new light on these and other aspects of Peirce's philosophy and his pragmatic theory of meaning. Many of his most significant writings in this context reflect his later thinking, covering roughly the last 15-20 years of his life, and they are still unpublished. Drawing comprehensively from his unpublished manuscripts, the book offers a fresh and rich picture of this remarkable man's original involvement with logical aspects of thought in action.

*How to Win Every Argument: The Use and Abuse of Logic* by Madsen Pirie; Continuum International Publishing Group (June 2, 2006); $13.57 (Hardcover) 182 pages; ISBN: 0826490069. In this witty and infectious book Madsen Pirie provides a complete guide to using - and indeed abusing - logic in order to win arguments. He identifies with devastating examples all the most common fallacies popularly used in argument. We all like to think of ourselves as clear-headed and logical - but all readers will find in this book fallacies of which they themselves are guilty. The author shows you how to simultaneously strengthen your own thinking and identify the weaknesses in other people arguments. And, more mischievously, Pirie also shows how to be deliberately illogical - and get away with it. This book will make you maddeningly smart: your family, friends and opponents will all wish that you had never read it.

*Thinking about Acting: Logical Foundations for Rational Decision Making* by John L. Pollock; Oxford University Press, USA (June 16, 2006); $55.00 (Hardcover) 288 pages; ISBN: 0195304810. John Pollock aims to construct a theory of rational decision making for real agents–not ideal agents. Real agents have limited cognitive powers, but traditional theories of rationality have applied only to idealized agents that lack such constraints. Pollock argues that theories of ideal rationality are largely irrelevant to the decision making of real agents. We need a theory of "real rationality" in its place. Thinking about Acting aims to do just that. The most contentious conclusions of the book are: (1) For purely computational reasons, the primitive evaluative database that real agents employ in evaluating outcomes cannot be preference ranking. An agent's evaluative database must instead assign real numbers to outcomes. It is argued that, contrary to initial appearances, this is psychologically plausible. (2) Subjective probability makes no sense when we are talking about real (resource

bounded) agents. Rational decision making must instead be based on a species of objective probability, and it is discussed how this can be done. (3) Classical decision theory is based on the optimality principle, according to which rationality dictates choosing actions that constitute optimal solutions to practical problems. It is argued that the optimality prescription is wrong, for a number of reasons: (a) actions cannot be chosen in isolation–they must be chosen as parts of plans; (b) we cannot expect real agents to find optimal plans, because there are infinitely many alternatives to survey; (c) plans cannot be evaluated in terms of their expected values anyway, because different plans can be of different scopes. Pollock constructs an alternative theory that accommodates these difficulties. This theory is intended not only to solve the philosophical problems, but also to provide the basis for an implemented system of decision-theoretic planning in artificial intelligence.

*Natural Deduction: A Proof-Theoretical Study* by Dag Prawitz; Dover Publications (February 24, 2006); $9.95 (Paperback) 128 pages; ISBN: 0486446557.

*In Contradiction* by Graham Priest; Oxford University Press, USA; 2 edition (March 31, 2006); $35.00 (Paperback) 350 pages; ISBN: 0199263302. In Contradiction advocates and defends the view that there are true contradictions (dialetheism), a view that flies in the face of orthodoxy in Western philosophy since Aristotle. The book has been at the center of the controversies surrounding dialetheism ever since its first publication in 1987. This second edition of the book substantially expands upon the original in various ways, and also contains the author's reflections on developments over the last two decades. Further aspects of dialetheism are discussed in the companion volume, Doubt Truth to be a Liar, also published by Oxford University Press in 2006.

*Philosophy of Logic: 2nd Edition* by W. V. Quine; Harvard University Press; 2nd edition (January 31, 2006); $17.95 (Paperback) 128 pages; ISBN: 0674665635. With his customary incisiveness, W. V. Quine presents logic as the product of two factors, truth and grammar–but argues against the doctrine that the logical truths are true because of grammar or language. Rather, in presenting a general theory of grammar and discussing the boundaries and possible extensions of logic, Quine argues that logic is not a mere matter of words.

*A Concise Introduction to Mathematical Logic (Universitext)* by Wolfgang Rautenberg; Springer; 2 edition (March 29, 2006); $49.95 (Paperback) 260 pages; ISBN: 0387302948. Traditional logic as a part of philosophy is one of the oldest scientific disciplines. Mathematical logic, however, is a relatively young discipline and arose from the endeavors of Peano, Frege, Russell and others to create a logistic foundation for mathematics. It steadily developed during the 20th century into a broad discipline with several sub-areas and numerous applications in mathematics, informatics,

linguistics and philosophy. While there are already several well-known textbooks on mathematical logic, this book is unique in that it is much more concise than most others, and the material is treated in a streamlined fashion which allows the professor to cover many important topics in a one semester course. Although the book is intended for use as a graduate text, the first three chapters could be understood by undergraduates interested in mathematical logic. These initial chapters cover just the material for an introductory course on mathematical logic combined with the necessary material from set theory. This material is of a descriptive nature, providing a view towards decision problems, automated theorem proving, non-standard models and other subjects. The remaining chapters contain material on logic programming for computer scientists, model theory, recursion theory, Godel's Incompleteness Theorems, and applications of mathematical logic. Philosophical and foundational problems of mathematics are discussed throughout the text. The author has provided exercises for each chapter, as well as hints to selected exercises.

*Decision Theory and Multi-Agent Planning (CISM International Centre for Mechanical Sciences)* by Giacomo Della Riccia (Editor), Didier Dubois (Editor), Rudolf Kruse (Editor), Hans-Joachim Lenz (Editor); Springer; 1 edition (April 2006); $74.95 (Paperback) 198 pages; ISBN: 3211317872. The work presents a modern, unified view on decision support and planning by considering its basics like preferences, belief, possibility and probability as well as utilities. These features together are immanent for software agents to believe the user that the agents are "intelligent".

*Cambridge Companion to Logical Empiricism* by Alan Richardson; Cambridge Univ Pr (Sd) (January 20, 2007); (Paperback); ISBN: 0521796288.

*Symmetry and the Monster: The Story of One of the Greatest Quests of Mathematics* by Mark Ronan; Oxford University Press, USA (May 31, 2006); $16.38 (Hardcover) 224 pages; ISBN: 0192807226. Mathematics is driven forward by the quest to solve a small number of major problems–the four most famous challenges being Fermat's Last Theorem, the Riemann Hypothesis, Poincare's Conjecture, and the quest for the "Monster" of Symmetry. Now, in an exciting, fast-paced historical narrative ranging across two centuries, Mark Ronan takes us on an exhilarating tour of this final mathematical quest. Ronan describes how the quest to understand symmetry really began with the tragic young genius Evariste Galois, who died at the age of 20 in a duel. Galois, who spent the night before he died frantically scribbling his unpublished discoveries, used symmetry to understand algebraic equations, and he discovered that there were building blocks or "atoms of symmetry." Most of these building blocks fit into a table, rather like the periodic table of elements, but mathematicians have found 26 exceptions. The biggest of these was dubbed "the Monster"–a giant snowflake in 196,884 dimensions. Ronan, who personally knows the individuals now working on

this problem, reveals how the Monster was only dimly seen at first. As more and more mathematicians became involved, the Monster became clearer, and it was found to be not monstrous but a beautiful form that pointed out deep connections between symmetry, string theory, and the very fabric and form of the universe. This story of discovery involves extraordinary characters, and Mark Ronan brings these people to life, vividly recreating the growing excitement of what became the biggest joint project ever in the field of mathematics. Vibrantly written, Symmetry and the Monster is a must-read for all fans of popular science–and especially readers of such books as Fermat's Last Theorem.

*Metaphysics, Mathematics, and Meaning: Philosophical Papers (Philosophical Papers)* by Nathan Salmon; Oxford University Press, USA (February 2, 2006); $39.95 (Paperback) 448 pages; ISBN: 0199284717. Metaphysics, Mathematics, and Meaning brings together Nathan Salmon's influential papers on topics in the metaphysics of existence, non-existence, and fiction; modality and its logic; strict identity, including personal identity; numbers and numerical quantifiers; the philosophical significance of Godel's Incompleteness theorems; and semantic content and designation. Including a previously unpublished essay and a helpful new introduction to orient the reader, the volume offers rich and varied sustenance for philosophers and logicians.

*Bringing Out the Algebraic Character of Arithmetic: From Children's Ideas to Classroom Practice (Studies in Mathematical Thinking and Learning)* by Analucia Dias Schliemann, David William Carraher, Barbara M. Brizuela; Lawrence Erlbaum Associates (March 30, 2006); $19.95 (Paperback) 209 pages; ISBN: 0805858733.

*Computational Logic and Set Theory (Texts in Computer Science)* by Jacob Schwartz, Eugenio Omodeo, Domenico Cantone; Springer; 1 edition (April 2006); $69.95 (Hardcover) 368 pages; ISBN: 0387407626. An advanced, graduate-level text, surveying computational logic and set theory and its application to proof verification techniques. Book develops all needed theory and provides a CD-ROM with a proof-verifier program to demonstrate concepts. Advanced CS students and researches will find the book an essential presentation of the theoretical concepts of proof verification (i.e., proof checker) systems for large-scale software systems. Topics and features: *Describes in-depth how a specific first-order theory can be exploited to model and carry out reasoning in branches of computer science and mathematics *Provides a verifier aimed at tackling large-scale proof scenarios *Integrates important proof-engineering issues, reflecting the goals of large-scale verifiers.

*Vagueness in Context* by Stewart Shapiro; Oxford University Press, USA (February 23, 2006); $55.00 (Hardcover) 240 pages; ISBN: 0199280398. Stewart Shapiro's ambition in Vagueness in Context is to develop a comprehensive account of the meaning, function, and logic of vague terms in an idealized version of a natural language

like English. It is a commonplace that the extensions of vague terms vary according to their context: a person can be tall with respect to male accountants and not tall (even short) with respect to professional basketball players. The key feature of Shapiro's account is that the extensions of vague terms also vary in the course of conversations and that, in some cases, a competent speaker can go either way without sinning against the meaning of the words or the non-linguistic facts. As Shapiro sees it, vagueness is a linguistic phenomenon, due to the kinds of languages that humans speak; but vagueness is also due to the world we find ourselves in, as we try to communicate features of it to each other.

*Fields and Models: From Sturm to Tarski and Robinson* by Hourya Benis Sinaceur; Birkhauser; 1 edition (December 2006); $99.00 (Hardcover) 446 pages; ISBN: 0-8176-4114-9. The first English translation of the well-received French text "Corps et Modèles," Fields and Models: from Sturm to Tarski and Robinson traces the intertwined development of logic and algebra, particularly Tarski's model theory and Artin's and Schrier's algebra of real-closed fields. A number of pivotal results are woven in to this collaboration across disciplines: Sturm's theorem on the location of roots of real polynomials, which is the unifying theme, as well as Artin's solution to Hilbert's 17th problem, Tarski's decision procedure for the field of real numbers, and research into quadratic forms. Drawing extensively on original sources, Hourya Sinaceur discusses not only the evolution of new mathematical ideas, but also their epistemological foundations and the ways in which mathematical subdisciplines influence one another. A wide audience of students and researchers in both the sciences and humanities will benefit from this fascinating chapter of intellectual history.

*Logical Number Theory II (Universitext)* by Craig Smorynski; Springer; 1 edition (October 2006); (Paperback) 450 pages; ISBN: 3540522352.

*Logic Colloquium '03: Proceedings of the Annual European Summer (Lecture Notes in Logic)* by Viggo Stoltenberg-Hansen (Editor), Jouko Vaananen (Editor); Association for Symbolic Logic (February 28, 2006); $35.00 (Paperback) 422 pages; ISBN: 1568812949. A compilation of papers presented at the 2003 European Summer Meeting of the Association for Symbolic Logic, Logic Colloquium '03 includes tutorials and research articles from some of the world's preeminent logicians. One article is a tutorial on finite model theory and query languages that lie between first order and second order logic. The other articles cover current research topics in all areas of mathematical logic, including Proof Theory, Set Theory, Model Theory, and Computability Theory, and Philosophy.

*Mathematical Reasoning Writing and Proof (2nd Edition)* by Ted Sundstrom; Prentice Hall; 2 edition (March 13, 2006); $100.00 (Hardcover) 544 pages; ISBN: 0131877186.

Focusing on the formal development of mathematics, this book shows readers how to read, understand, write, and construct mathematical proofs. Uses elementary number theory and congruence arithmetic throughout. Focuses on writing in mathematics. Reviews prior mathematical work with "Preview Activities" at the start of each section. Includes "Activities" throughout that relate to the material contained in each section. Focuses on Congruence Notation and Elementary Number Theorythroughout. For professionals in the sciences or engineering who need to brush up on their advanced mathematics skills.

*Logic for Programming, Artificial Intelligence, and Reasoning: 12th International Conference, LPAR 2005, Montego Bay, Jamaica, December 2-6, 2005, Proceedings ... / Lecture Notes in Artificial Intelligence)* by Geoff Sutcliffe (Editor), Andrei Voronkov (Editor); Springer; 1 edition (January 9, 2006); $117.00 (Paperback) 744 pages; ISBN: 354030553X. This book constitutes the refereed proceedings of the 12th International Conference on Logic for Programming, Artificial Intelligence, and Reasoning, LPAR 2005, held in Montego Bay, Jamaica in December 2005. The 46 revised full papers presented together with abstracts of 3 invited talks were carefully reviewed and selected from 108 full paper submissions. The papers address all current issues in logic programming, logic-based program manipulation, formal method, automated reasoning, and various kinds of AI logics.

*Models, Truth, and Realism* by Barry Taylor; Oxford University Press, USA (July 31, 2006); $55.00 (Hardcover) 200 pages; ISBN: 0199286698.

*Computational Logic in Multi-Agent Systems : 6th International Workshop, CLIMA VI, London, UK, June 27-29, 2005, Revised Selected and Invited Papers (Lecture ... / Lecture Notes in Artificial Intelligence)* by Francesca Toni (Editor), Paolo Torroni (Editor); Springer; 1 edition (May 2006); $78.00 (Hardcover) 427 pages; ISBN: 3540339965. This book constitutes the strictly refereed post-proceedings of the 6th International Workshop on Computational Logic for Multi-Agent Systems, CLIMA VI, held in London, UK, in June 2005. The series of workshops presents current work on application of general and declarative theories grounded on computational logic to multi-agent systems specification, semantics and procedures, and confronts ideas such as autonomy, deliberation, knowledge, commitment, openness, trust, with the computational logic paradigms. This research has encouraged the use of formal approaches to multi-agent systems research, and it has dealt with disparate issues such as implementations, environments, tools, and verification of computational systems. The 14 revised full technical papers, 4 contest papers, and 7 invited papers presented together with 1 invited article were carefully selected from 30 submissions and went through two rounds of reviewing and improvement. The papers of this state-of-the-art survey are devoted to techniques from computational logic for representing, programming,

and reasoning about multi-agent systems. They are organized in topical sections on foundational aspects of agency, agent programming, agent interaction and normative systems, the first CLIMA contest, and on the project report of the SOCS project.

*How to Prove It : A Structured Approach* by Daniel J. Velleman; Cambridge University Press; 2 edition (January 16, 2006); $29.99 (Paperback) 398 pages; ISBN: 0521675995. Geared to preparing students to make the transition from solving problems to proving theorems, this text teachs them the techniques needed to read and write proofs. The book begins with the basic concepts of logic and set theory, to familiarize students with the language of mathematics and how it is interpreted. These concepts are used as the basis for a step-by-step breakdown of the most important techniques used in constructing proofs. To help students construct their own proofs, this new edition contains over 200 new exercises, selected solutions, and an introduction to Proof Designer software. No background beyond standard high school mathematics is assumed.

*A Theory of Argument* by Mark Vorobej; Cambridge University Press (March 6, 2006); $29.99 (Paperback) 336 pages; ISBN: 052167025X. Mark Vorobej develops a novel approach to argument interpretation and evaluation that synthesizes subjective concerns about the personal points of view of individual arguers, with objective concerns about the structural properties of arguments. One of the key themes of the book is that we cannot succeed in distinguishing good arguments from bad arguments until we learn to listen carefully to others. Part I develops a relativistic account of argument cogency that allows for rational disagreement. Part II offers a comprehensive and rigorous account of argument diagramming.

*The Seventeen Provers of the World: Foreword by Dana S. Scott (Lecture Notes in Computer Science / Lecture Notes in Artificial Intelligence)* by Freek Wiedijk (Editor); Springer; 1 edition (March 16, 2006); $39.95 (Paperback) 159 pages; ISBN: 3540307044. Commemorating the 50th anniversary of the first time a mathematical theorem was proven by a computer system, Freek Wiedijk initiated the present book in 2004 by inviting formalizations of a proof of the irrationality of the square root of two from scientists using various theorem proving systems. The 17 systems included in this volume are among the most relevant ones for the formalization of mathematics. The systems are showcased by presentation of the formalized proof and a description in the form of answers to a standard questionnaire. The 17 systems presented are HOL, Mizar, PVS, Coq, Otter/Ivy, Isabelle/Isar, Alfa/Agda, ACL2, PhoX, IMPS, Metamath, Theorema, Leog, Nuprl, Omega, B method, and Minlog.

*Notebooks, 1914-1916* by Ludwig Wittgenstein; publisher not announced (December 30, 2006); $27.95 (Paperback) 240 pages; ISBN: 0631124993.

*Essays on the Foundations of Mathematics and Logic (vol. 1)* edited by Giandomenico Sica, 35 Euro, http://www.polimetrica.com/polimetrica/117/, Publisher: Polimetrica International Scientific Publisher. Contributions and authors: 'Is there still a Sense in which Mathematics can have Foundations?' by Jody Azzouni; 'Logic and Ideologized Science Phenomenon (Case of the USSR)' by Valentin A. Bazhanov; 'A.N. Kolmorogoff and the Relevance of the Double Negation Law in Science' by Antonino Drago; 'Structures, Points and Levels of Reality' by Costas A. Drossos; 'Logical Form' by Marie Duzi and Pavel Materna; 'Wings, not Foundations!' by Reuben Hersh; 'Exogenous Semantics Approach to Enriching Logics' by Paulo Mateus, Amílcar Sernadas and Cristina Sernadas; 'Incompleteness and Paradox' by Timothy McCarthy; 'Property is Prior to Set: Fichte and Weyl' by Stephen Pollard; 'Tarski's Intuitive Notion of Set' by Francisco Rodríguez-Consuegra; 'Aspects of Informal Mathematics' by Bart Van Kerkhove.

*Essays on the Foundations of Mathematics and Logic (vol. 2)* edited by Giandomenico Sica, 20 Euro, http://www.polimetrica.com/polimetrica/139/, Publisher: Polimetrica International Scientific Publisher. Contributions and authors: 'Constructivity, Computability, and the Continuum' by Michael Beeson; 'Logical Monism: The Global Identity of Applicable Logic' by Michael Heather and Nick Rossiter; 'On a Problem of da Costa' by João Marcos; 'Some arguments against Field on the Indispensability Thesis' by Gianluigi Oliveri; 'Conditions on the Use of the One-dimensional Heat Equation' by Christopher Pincock; 'The Use of Symbols in Mathematics and Logic' by Sundar Sarukkai.

# AiML – ADVANCES IN MODAL LOGIC


**AiML** —*Advances in Modal Logic* is the main international forum at which research on all aspects of modal logic is presented. The Advances in Modal Logic Initiative was founded in 1995 and the first AiML Conference was held in 1996 in Berlin, Germany. Since then the AiML Conference has been organised on a bi-annual basis with previous meetings being held in 1998 in Uppsala, Sweden, in 2000 in Leipzig, Germany (jointly with ICTL-2000), in 2002 in Toulouse, France, and in 2004 in Manchester, UK.

**AiML-2006**
Advances in Modal Logic
25-28 September 2006, Noosa (Queensland, Australia)
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**Topics**

We invite submission on all aspects of modal logics, including the following:

- applications of modal logic
- computational aspects of modal logics
  - complexity and decidability of modal and temporal logics
  - modal and temporal logic programming
  - model checking
  - theorem proving for modal logics
- history of modal logic
- philosophy of modal logic
- specific instances of modal logic
  - description logics
  - dynamic logics and other process logics

  - epistemic and deontic logics
  - modal logics for agent-based systems
  - modal logic and game theory
  - modal logic and grammar formalisms
  - provability and interpretability logics
  - spatial and temporal logics
- theoretical aspects of modal logic
  - algebraic and coalgebraic perspective on modal logic
  - completeness and canonicity
  - correspondence and duality theory
  - many-dimensional modal logics
  - modal fixed point logics
  - model theory of modal logic
  - proof theory of modal logic
- variations of modal logic
  - hybrid logic
  - intuitionistic logic
  - monotonic modal logic
  - substructural logic

Papers on related subjects will also be considered.

**Invited Speakers**

- Renate Schmidt (Manchester, UK)
- Valentin Shehtman (Moscow, Russia)
- Igor Walukiewicz (Bordeaux, France)
- Alberto Zanardo (Padua, Italy)

**Paper Submission**

The Proceedings of AiML 2006 will be published by College Publications

`www.dcs.kcl.ac.uk/kcl-publications`

In a change from previous AiMLs, the proceedings will be made available at the meeting. Authors are invited to submit a full paper (not just an abstract) of at most 15 pages plus optionally a technical appendix of up to 5 pages, together with a plain-text abstract of say 100-200 words. To be considered, submissions must be received no later than 27 March 2006. Papers must be submitted as .ps or .pdf files. The first page should include title, names of authors, the co-ordinates of the corresponding author, and some keywords describing the topic of the paper. More precise details will be available at

`www.itee.uq.edu.au/~aiml06`

To appear in the proceedings, papers must be prepared in LaTeX using the style files to be provided at www.itee.uq.edu.au/~aiml06/. At least one author of each accepted paper must register for and attend the conference to present the paper.

**Programme Committee**

- Alessandro Artale (Free University of Bolzano, Italy)
- Alexandru Baltag (University of Oxford, UK)
- Guram Bezhanishvili (New Mexico State University, USA)
- Julian Bradfield (University of Edinburgh, UK)
- Melvin Fitting (City University of New York, USA)
- Guido Governatori (University of Queensland, Australia)
- Silvio Ghilardi (University of Milano, Italy)
- Rob Goldblatt (Victoria University Wellington, New Zealand)
- Valentin Goranko (University of the Witwatersrand, South Africa)
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- Martin Otto (Technical University of Darmstadt, Germany)
- Graham Priest (University of Melbourne, Australia)
- Mark Reynolds (University of Western Australia, Australia)
- Ildiko Sain (Hungarian Academy of Sciences, Hungary)
- Renate Schmidt (University of Manchester, UK)
- Jerry Seligman (University of Auckland, New Zealand)
- Nobu-Yuki Suzuki (Shizuoka University, Japan)
- Heinrich Wansing (Dresden University of Technology, Germany)
- Frank Wolter (University of Liverpool, UK)
- Michael Zakharyaschev (Birkbeck College, London, UK)

**Programme Co-Chairs**

- Ian Hodkinson, Imperial College London, imh@doc.ic.ac.uk
- Yde Venema, University of Amsterdam, yde@science.uva.nl

**Local Organizers**

- Guido Governatori, School of Information Technology and Electrical Engineering, The University of Queensland, guido@itee.uq.edu.au

**Important Dates**

- Submission deadline: 27 March 2006
- Acceptance notification: 26 May 2006
- Final version for conference due: 30 June 2006
- Conference: 25-28 September 2006

**Conference Location**

Advances in Modal Logic 2006 will be held at Australis Noosa Lakes Conference Centre located at Noosaville, Noosa, Sunshine Coast, Queensland. The Sunshine Coast's white surf beaches stretch for about forty miles, broken only by an occasional headland

or the clear water of a river estuary. Coastal townships like Caloundra, Mooloolaba, Maroochydore, Coolum and Noosa are synonymous with the traditional Australian beach vacation. In the green, subtropical hills behind the Sunshine Coast, among the pineapple and sugar cane farms, are country hamlets. Old pubs serve excellent counter lunches on open verandas that overlook green valleys. Painters, potters and other artisans are drawn here by the tranquillity, the easy pace and the natural beauty. Noosa and Noosa National Park are legendary in Australia. The protected cove beach virtually guarantees perfect surf year round and the stroll around the headland through the National Park rewards you with spectacular seascapes. Hastings Street, the hub of Noosa, is a mecca for designer label shoppers and discerning diners. For more details, see

`http://www.tourismnoosa.com.au`

**Further Information**

Information about AiML-2006 can be obtained at http://www.itee.uq.edu.au/~aiml06/ E-mail enquiries about AiML-2006 should be directed to the local organizers or the program co-chairs. Information about AiML can be obtained at http://www.aiml.net

# ASL – ASSOCIATION FOR SYMBOLIC LOGIC


*2006 ASL Annual Meeting* Montreal, Canada, May 17–21, 2006. The invited speakers include: E. Bouscaren, P. Kremer, C. LaFlamme, A. Montalbán, J. Moore, P. Scott, H. Schwichtenberg, S. Shapiro, P. Speissegger, and B. Spitters. The Seventeenth Annual Gödel Lecture will be given by P. Martin-Löf, and a tutorial on quantum information theory will be offered by P. Selinger. The invited program also includes a symposium to commemorate the centennial of the birth of Gödel, in which J. Avigad, S. Friedman, and A. Kanamori will speak. Special sessions are planned in categorical logic/quantum information theory, effective aspects of measure theory and analysis, model theory, and set theory. The members of the Program Committee are: S. Feferman, S. Kuhlmann, D.A. Martin, P. Panangaden, S. Simpson, and M. Valeriote (Chair). The members of the Local Organizing Committee include: L. Bélair, F. Lepage, M. Marion (Chair), and P. Panangaden. A registration form and program for this meeting are enclosed in the Newsletter mailing to ASL Members. Electronic registration is available at http://www.aslonline.org/meeting_registration.html. For further information, visit the website below.

`http://asl2006.uqam.ca`

*2006 ASL European Summer Meeting (Logic Colloquium '06)* July 27–August 2, 2006 Nijmegen, The Netherlands, July 27–August 2, 2006. An informational brochure about this meeting, including a registration form, is enclosed in the April Newsletter mailing to ASL members. The invited speakers include: S. Abramsky, M. Arslanov, H. Friedman, M. Goldstern, E. Hrushovski, J. Koenigsmann, A. Lewis, A. Montalban, E. Palmgren, W. Pohlers, E. Schimmerling, J. Steel, W. Tait, and F. Wagner. Tutorials will be offered by R. Downey on algorithmic randomness and computability, I. Moerdijk on an introduction to algebraic set theory, and B. Velickovic on forcing axioms. On the occasion of the centennial of the birth of Kurt Gödel, a plenary discussion on Gödel's legacy in logic is planned. Special sessions on computability theory, computer science logic, model theory, proof theory and type theory, and set theory also will be held. The Program Committee includes: B. Cooper, S. Friedman, H. Geuvers, D. Macpherson, G. Mints, A. Pillay, M. Rathjen, R. Schindler, H. Schwichtenberg (Chair), R. Shore, W. Sieg, G. Sundholm, and J. Väänänen. The Local Organizing Committee includes: H. Geuvers (Chair), N. Messink, B. Spitters, and F. Wiedijk. For further information, visit the website below. Abstracts of contributed

talks submitted by ASL members will be published in The Bulletin of Symbolic Logic if they satisfy the Rules for Abstracts (see below). Abstracts—hard copy or email—should be received before the deadline of April 17, 2006 at the official meeting address: Logic Colloquium 2006, ICIS Faculty of Science, Radboud University Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands; email: lc2006@cs.ru.nl.

`http://www.cs.ru.nl/lc2006/`

*2006-07 ASL Winter Meeting* (with Joint Mathematics Meetings) New Orleans, Louisiana, January 7–8, 2007. This meeting will take place in conjunction with the Joint Mathematics Meetings, which will be held January 5–8, 2007. In addition to the ASL program, there will be a joint AMS/ASL/MAA Panel discussion on Hilbert's Second Problem. The members of the Program Committee are T. Carlson, C. Delzell, and M. Groszek (Chair). Abstracts of contributed talks submitted by ASL members will be published in The Bulletin of Symbolic Logic if they satisfy the Rules for Abstracts (see above). Abstracts must be received by the deadline of September 15, 2006, at the ASL Business Office: ASL, Box 742, Vassar College, 124 Raymond Avenue, Poughkeepsie, New York 12604, USA; Fax: 1-845-437-7830; email: asl@vassar.edu.

*2007 ASL Annual Meeting* Gainesville, Florida, March 10–13, 2007. The Program Committee members are: M. Aschenbrenner, M. Dzamonja (Chair), N. Immerman, J. Larson, J. Miller, and J. Tappenden. The members of the Local Organizing Committee include: D. Cenzer, G. Emch, W. Mitchell, G. Ray, M. Sitharam, and J. Zapletal (Chair).

**Sponsored Meetings**

*Computability in Europe 2006 (CiE 2006): Logical Approaches to Computational Barriers* Swansea, Wales, June 30–July 5, 2006. This meeting is being organized within the network "Computability in Europe" (CiE). The particular focus of the event is on aspects of logical approaches to computational barriers. There will be tutorials on Logical Approaches to the P vs. NP problem (S. Buss) and "Quantum Algorithms: Standard Tools and New Models" (J. Kempe). Invited speakers include: J. Bergstra, L. Cardelli, J.W. Dawson, J. Krajicek, E. Mayordomo Cámara, I. Németi, H. Schwichtenberg, and A. Weiermann. Special sessions on Challenges in Complexity, Computable Analysis, Foundations of Programming, Gödel Centenary: His Legacy for Computing, Mathematical Models of Computers and Hypercomputers, and Proofs and Computation also are planned. The Co-chairs of the Program Committee are A. Beckmann and J. Tucker. The Organizers are: A. Beckmann (Chair), U. Berger, B. Cooper, P. Grant, O. Kullmann, B. Löwe, M. Seisenberger, A. Setzer, and J. Tucker. For further information, visit the website below.

http://www.cs.swansea.ac.uk/cie06/

*Thirteenth Workshop on Logic, Language, Information and Computation.* Stanford, California, July 18–21, 2006 *(WoLLIC'2006).* This is the thirteenth in a series of workshops intended to foster interdisciplinary research in pure and applied logic. The Program Committee includes: J. Avigad, J. van Benthem, M. Davis, K. Devlin, E. Hirsch, G. Hjorth, D. Israel, V. Kreinovich, G. Mints, I. Neeman, H. Ono, W. Pohlers, V. Pratt, and T. Scanlon. The members of the Organizing Committee are: A.G. de Oliveira, V. de Paiva, M. Pauly, and R. de Queiroz. For further information, visit the website below.

http://www.cin.ufpe.br/~wollic/wollic2006/

*XIII Simposio Latinoamericano de Lógica Matemática (SLALM)* Oaxaca, Mexico, August 7–12, 2006. The Program Committee members are: C. DiPrisco (Chair), J. Flum, J. Larson, A. Llera, P. Mancosu, R. Matthes, A. Maynes, E. Pimentel, M. Rathjen, J. Truss, and A. Villaveces. The Organizing Committee includes: C. Alcaraz, G. Arena, M. de Castro, J. Cuevas, J. Montano, F. Perea, D. Rebolledo, L. Silva, and J. Valencia. As in previous symposia, a School in Mathematical Logic will precede the symposium on August 1–5, and offer the following short courses: Infinite Combinatorics and Ramsey's Theory (C. DiPrisco), Set Theory and its Applications (J. Larson), Tarski's Work (P. Mancosu), and Model Theory (J. Truss). For further information, visit the website below.

http://slalm.izt.uam.mx/

*Twenty-first Annual IEEE Symposium on Logic in Computer Science (LICS 2006)* Seattle, Washington, August 12–15, 2006. The LICS Symposium is an annual international forum on theoretical and practical topics in computer science that relate to logic in a broad sense. LICS 2006 will be held as part of the Fourth Federated Logic Conference (FLoC'06). The invited speakers include: A. Blass, A. Gordon, and O. Kupferman. There also will be a joint LICS/RTA/SAT plenary lecture given by R. Bryant. The LICS Program Chair is R. Alur, and the LICS General Chair is P. Kolaitis. For further information about LICS, visit the website below; for additional information about FLoC'06, see http://research.microsoft.com/floc06/.

http://www.lfcs.informatics.ed.ac.uk/lics

*2006 Australasian Association for Logic Meeting* Noosa, Queensland, Australia, September 23–24, 2006. This event will take place immediately prior to the Advances in Modal Logic '06 Conference (AiML'06). The program of the meeting includes an invited talk by Y. Venema. The deadline for submission of abstracts of contributed talks

is June 30, 2006; abstracts should conform to the ASL rules for abstracts (see above). For further information contact G. Governatori (email: guido@itee.uq.edu.au) or visit the website below.

`http://www.itee.uq.edu.au/~guido/AAL06`

*Logic, Computability and Randomness 2007* Buenos Aires, Argentina, January 10–13, 2007. The theme of this conference is algorithmic randomness and related topics in logic, computability, and complexity. The program will consist of invited talks, contributed talks, and discussions. The Program Committee includes: V. Becher, R. Downey, and D. Hirschfeldt. The deadline for submission of abstracts of contributed talks is October 1, 2006. For further information, visit the website below.

`http://www.dc.uba.ar/people/logic2007`

# FoLLI – FOUNDATION OF LOGIC, LANGUAGE AND INFORMATION


FoLLI—The Foundation of Logic, Language and Information was founded in 1991 to advance the practising of research and education on the interfaces between logic, linguistics, computer science and cognitive science and related disciplines in Europe. Each year FoLLI organizes the European Summer School on Logic, Language and Information (ESSLLI). FoLLI has its own journal, the *Journal of Logic, Language and Information* (JoLLI), and book series, the *Studies in Logic, Language and Information* (SiLLI).

`http://www.folli.org`

*Eighteenth European Summer School in Logic, Language and Information (ESSLLI-2006)*, Malaga, Spain, July 31–August 11, 2006. The main focus of the European Summer Schools in Logic, Language and Information is on the interface between linguistics, logic and computation. Foundational, introductory and advanced courses together with workshops cover a wide variety of topics within the three areas of interest: Language and Computation, Language and Logic, and Logic and Computation. ESSLLI-2006 is organized under the auspices of the European Association for Logic, Language and Information (FoLLI). For further information about ESSLLI-2006, visit the website below; for further information about FoLLI, see http://www.folli.org.

`http://esslli2006.lcc.uma.es`

# MASTER IN PURE AND APPLIED LOGIC

This **Master** aims to provide a thorough grounding in all aspects of advanced logic, both pure and applied. On completion, students will have the necessary skills to be able to continue with their postgraduate studies, put their knowledge into practice in the job market, or start undertaking research in many of the central areas in the field of logic.

This Master is organized jointly by the **University of Barcelona** (UB) and the **Technical University of Catalonia** (UPC), with the collaboration of the **Artificial Intelligence Research Institute** (IIIA). The following departments and institutes participate in the teaching of this Master:

- Department of Applied Mathematics II (Technical University of Catalonia).
- Department of Logic, History and Philosophy of Science (University of Barcelona).
- Department of Probability, Logic and Statistics (University of Barcelona).
- Artificial Intelligence Research Institute (Spanish Scientific Research Council).
- Software Department (Technical University of Catalonia).

All of the above form part of either the *Faculty of Philosophy* and the *Faculty of Mathematics* at the University of Barcelona, the *Faculty of Mathematics and Statistics* and the *Faculty of Computer Studies* at the Technical University of Catalonia, or the *Faculty of Sciences* at the Universitat Autònoma de Barcelona.

The **Master** courses are taught by Spain's largest group of specialists in the field of Logic and our staff are recognised active researchers in the following areas: Algebraic Logic, Computational Complexity, Computational Linguistics, History of Logic, Logical Foundations of Artificial Intelligence, Model Theory, Non-Classical Logics, Philosophy of Logic and of Mathematics, Proof Theory and Set Theory.

The universities in the Barcelona area offer a wealth of opportunities in related subjects, including Artificial Intelligence, Computer Science, History of Science, Linguistics, Mathematics and Philosophy, for students wishing to further their training on successful completion of this **Master**.

*

Academic coordinators

- General coordinator: Prof. Ramon Jansana
- Coordinator at the University of Barcelona: Prof. Josep Maria Font
- Coordinator at the Technical University of Catalonia: Prof. Rafel Farré

*

Courses

The **Master in Pure and Applied Logic** is organized following the guidelines of the new regulation of postgraduate studies in Spain, as an step towards the *European Higher Education Area* started with the *Bologna Declaration* (1999), and is open to students of any nationality.

The **Master in Pure and Applied Logic** is designed specifically for graduates in mathematics, computer science and philosophy. Graduates in related fields, such as physics or linguistics, may also be considered for admission.

The **Master in Pure and Applied Logic** programme comprises a range of taught courses, seminars, lectures, writing of introductory research papers, and other activities. Normally, the whole programme can be completed in 4 semesters.

*

Compulsory courses:

- Basic Model Theory
- Basic Set Theory
- Computability
- Mathematical Logic
- Non-Classical Logics

*

Optional courses:

- Abstract Algebra
- Abstract Algebraic Logic
- Advanced Model Theory
- Algebraic Logic
- Automated Theorem Proving
- Basic algebra
- Combinatorial Set Theory
- Complexity
- Categorical Logic
- History of Mathematics

- Introduction to Mathematical Logic
- Logics and Artificial Intelligence
- Many-Valued Logics
- Modal Logic
- Models of Set Theory
- Order, Lattices and Boolean Algebras
- Philosophy of Mathematics
- Proof Theory
- Substructural Logics and Computational Linguistics
- The Development of Formal Logic
- Universal Algebra

*

For more information

Please visit the **Master**'s web site: `http://www.ub.edu/masterlogic/`.

# AUTOMATED REASONING, WEB ONTOLOGIES, AND MULTI-AGENT SYSTEMS

**VACANCIES:**

1 Post-Doc Research Associate
1 PhD Research Studentship

**CLOSING DATE:**

31 May 2006

**START DATE:**

Beginning of September 2006

Applications are invited for the position of a research associate (Manchester) and the position of a research student (Liverpool) to work on the EPSRC funded project 'Practical Reasoning Approaches for Web Ontologies and Multi-Agent Systems'. This is a three year collaborative research project between the School of Computer Science at the University of Manchester and the Department of Computer Science at the University of Liverpool.

The positions are part of a research programme which aims to develop a powerful and versatile logic engineering platform which will comprise various tools aimed to support both users and developers of logic theories, formal specification frameworks, and automated reasoning formalisms to carry out logical reasoning. The project will develop, study and implement practical resolution-based approaches for reasoning about expressive web ontology languages and expressive agent logics.

The research at Manchester will focus on reasoning for the semantic web, ontologies, and description logics, while the research at Liverpool will focus on reasoning for multi-agent systems.

**RESEARCH ASSOCIATE POSITION**

Based at Manchester the appointment will be on a fixed term contract for 36 months. The post is available from 1 September 2006, or a later date by negotiation.

Salary: Up to 28,009 Pounds p.a.

Full details:

`http://www.cs.man.ac.uk/~schmidt/womas/`

Informal enquiries:
Dr. Renate Schmidt, email: schmidt@cs.man.ac.uk

**RESEARCH STUDENTSHIP**

Based in Liverpool the funding provided by the EPSRC includes PhD registration fees at the level of EU/UK applicants as well as a stipend towards the cost of living, both for the three year duration of the project. Full details:

`http://www.csc.liv.ac.uk/~ullrich/epsrc_phd_2006.html`

Informal enquiries: Dr Ullrich Hustadt, email: U.Hustadt@csc.liv.ac.uk

# FUNNY FRAGMENTS



**From** *500CC: Computer Citations*. Vincent F. Hendricks. £8 / $15. King's College Publications, September 2005, ISBN 1904987095.

## Bob Dole

▶ *Former US vice-president candidate*

The Internet is a great way to get on the net.

## Sir Arthur Eddington

▶ *English astrophysicist*

We are a bit of stellar matter gone wrong. We are physical machinery—puppets that strut and talk and laugh and die as the hand of time pulls the strings beneath. But there is one elementary inescapable answer. We are that which asks the question.

## Robert Firth

▶ *American computer scientist*

— C++ has it's place in the history of programming languages.
— Just as Caligula has his place in the history of the Roman Empire?

There is a computer disease that anybody who works with computers knows about. It's a very serious disease and it interferes completely with the work. The trouble with computers is that you 'play' with them!

## Paul Gilster

▶ *American free-lance writer*

Your pathway through its passages is determined by your mouse click, making your experience of hypertext a malleable and personalized phenomenon.

## Zachary Good

▶ *American programmer*

I sit looking at this damn computer screen all day long, day in and day out, week after week, and think: Man, if I could just find the 'on' switch ...

## Paul Graham

▶ *American programmer and essayist*

The object-oriented model makes it easy to build up programs by accretion. What this often means, in practice, is that it provides a structured way to write spaghetti code.

## Harold Hambrose

▶ *President of Electronic Ink*

I find sitting at a specially equipped desk in front of some pretty ugly plastics and staring at a little window is a very unnatural event.

## Gene Spafford

▶ *American computer scientist*

**Axiom 1**: The Usenet is not the real world. The Usenet usually does not even resemble the real world.

**Corollary 1**: Attempts to change the real world by altering the structure of the Usenet is an attempt to work sympathetic magic—electronic voodoo.

**Corollary 2**: Arguing about the significance of newsgroup names and their relation to the way people really think is equivalent to arguing whether it is better to read tea leaves or chicken entrails to divine the future.

**Axiom 2**: Ability to type on a computer terminal is no guarantee of sanity, intelligence, or commonsense.

**Corollary 3**: An infinite number of monkeys at an infinite number of keyboards could produce something like Usenet.

**Corollary 4**: They could do a better job of it.

**Axiom 3**: Sturgeon's Law (90% of everything is crap) applies to Usenet.

**Corollary 5**: In an unmoderated newsgroup, no one can agree on what constitutes the 10%.

**Corollary 6**: Nothing guarantees that the 10% isn't crap, too.

## FEISTY FRAGMENTS: FOR PHILOSOPHY

⊢ September 2004

*Feisty Fragments: For Philosophy* is a collection of more than 550 quotations from people from all walks of life expressing their rather critical and often quite humorous takes on both philosophy and philosophers—from Nietzsche to Einstein, from Catherine the Great to John F. Kennedy.

> It is a wonderful collection with a fine presentation. We're all enjoying everything from Quine (of course) and Queen Victoria to Charlie Brown. —Douglas B. Quine

## LOGICAL LYRICS: FROM PHILOSOPHY TO POETICS

⊢ March 2005

*Logical Lyrics: From Philosophy to Poetics* is a collection of citations and aphorisms from all sorts of people – from Napoleon Bonaparte to Human League – expressing their embracing, critical and humorous views on logic and logical matters.

> I found this collection utterly absorbing from beginning to end. It combines some very sagacious ideas with some choice bits that are delightfully funny. —Raymond M. Smullyan

## 500 CC: Computer Citations

⊢ September 2005

'hAS aNYONE sEEN MY cAPSLOCK kEY?' *500 CC* records the experiences we have as computer users, abusers and Internet-cruisers—from rage and anger via joy, laughter and appreciation to despair and frustration.

> 500CC contains an amazing assortment of computer related quotes. It's the sort of book you put down and then simply must pick up again 5 minutes later. If you only ever buy two books about Computing, then buy this one twice and give one copy to a friend. —Kevin Warwick

## The Free Newsletter for Philosophical Logic and Its Applications

ΦNEWS is the freely distributed newsletter associated with ΦLOG and has much the same aims:

- To consolidate philosophical logic as an interdisciplinary activity
- To report on, and hopefully aid the coordination of, the research activities, conference activities and publications in philosophical logic, its applications and neighboring disciplines
- To shape and sharpen the general interest in philosophical logic and communicate important results and break-throughs in the field to a less specialized audience

ΦNEWS is edited by Vincent F. Hendricks, Pelle Guldborg Hansen, Stig Andur Pedersen and Dov M. Gabbay. The newsletter is published by ΦLOG and Springer.

## Submissions

ΦNEWS publishes contributions in terms of

- Extensive expositional papers
- Announcements
- New initiatives

### Extensive Expositional Papers

ΦNEWS invites authors to submit extensive expositional papers (30–50 pages) on philosophical logic (including inductive logic, alethic logic, temporal logic, epistemic logic, deontic logic, conditional logic ... with a special focus on multi-modal logics) and its relations to notably epistemology, methodology, philosophy of science, philosophy of language, philosophy of mind ... and its applications in computer science, information theory, cognitive science, mathematics, linguistics, economics and game

theory ... These lists are not exhaustive. The papers should be expositional in nature rather than detailed technical accounts or analyses. Observe that ΦNEWS only publishes a limited number of papers a volume.

**Announcements**

ΦNEWS publishes announcements of

- upcoming workshops, seminars and conferences
- forthcoming publications

Be sure to provide as detailed information as possible including the title of the event, time and place, contact information, website address and an abstract/description of the event or publication.

**New Initiatives**

ΦNEWS attempts to keep track of new initiatives pertinent to philosophical logic and its applications such as new networks, societies, foundations, bulletin boards, journals etc. To place an add for a new initiative in the newsletter contact the ΦNEWS editors.

ΦNEWS*, volume 10 is scheduled for October 2006. Deadline for submissions is September 1, 2006.*

# Format

ΦNEWS encourages contributors to format their submissions according to the following guidelines: Contributors are asked to state their name, affiliation and contact information on a cover sheet together with information on the nature of the contribution. Contributions should preferably be written in TEX, LATEX or LATEX2$_\varepsilon$ but other word processing packages are accepted provided that the contributions are saved in rich text format (RTF) with a minimum of formatting (remember to state your system platform). If either TEX, LATEX or LATEX2$_\varepsilon$ is used contributors are instructed to include all special packages and macros used to generate the document. In addition to hard-copy printouts of figures, contributors are requested to supply the electronic versions of figures in either Encapsulated PostScript (EPS), TIFF format, GIF format or JPG format.

- References to books should follow the citation format: Glymour, C. (1992). *Thinking Things Through*. Cambridge, MA: The MIT Press
- References to articles should follow the citation format: Lewis, D. (1996). Elusive Knowledge, *The Australasian Journal of Philosophy*, **74**(1996): 549-67

- References to articles in conference proceedings should follow the citation format: Halpern, J.Y. and Vardi, M. Y. (1988). The Complexity of Reasoning about Knowledge and Time, in *Proc. 20th ACM Symp. on Theory of Computing*: 53-65

Submissions should be sent to the ΦNEWS editors either electronically or by regular mail to the address stated on the inner sleeve of this newsletter. The contribution should be accompanied with a cover letter stating full address for correspondence, including telephone and fax number and e-mail address. Proofs will be sent to the corresponding contributor electronically in PS or PDF format. The corresponding contributor is kindly requested to return one corrected hard-copy of the manuscript inside 2 weeks of receipt. Deadline for submissions for ΦNEWS volume 10 is September 1, 2006.

## Free Subscription

Subscription to ΦNEWS is free. Please write the editors to obtain your free subscription to the newsletter. Be sure to include the following information:

- Name
- Position
- Affiliation
- Mailing address
- Email
- A short description of your interest in philosophical logic

# INDEX OF NAMES