Constructive Knowledge - 4: Abstracts

Sergei Kovalyov (ICS RAS)
Title: Knowledge Management for Digital Design of Novel Materials

Abstract: Principles of knowledge management in the digital design cycle of novel materials based on contemporary computer technologies are considered. An overview of methods of computer analysis of materials is provided, including geometric analysis, multiphysical analysis by means of finite element method as well as meshfree methods, statistical approach, homogenization, and neural network analysis. Multivariate approach to joint use of diverse methods based on integrated corpus of digitized knowledge about the materials is proposed.

Stepan Kuznetzov (MI RAS)
Title: Iteration in residuated structures

Abstract: We present a system with infinite derivations axiomatising the elementary theory of *-continuous Kleene algebras with divisions (residuated Kleene algebras) and show that its circular fragment axiomatises the elementary theory of arbitrary residuated Kleene algebras. In contrast with the non-residuated case, where these theories coincide (as shown by Kozen), here the infinitary one happens to be not recursively enumerable, and therefore properly includes the circular one.

Tudor Protopopescu (HSE)
Title: Intuitionistic Epistemic Logic

Abstract: Intuitionistic Epistemic Logic is the logic of constructive knowledge based on the Brouwer-Heyting-Kolmogorov (BHK) semantics for intuitionistic logic. Constructive knowledge is understood as the product of verification which is not necessarily strict proof. In contrast to classical logics of knowledge intuitionistically co-reflection, $A \to KA$, is valid and reflection, $KA \to A$, is not. The former expresses the constructivity of truth; the latter claims

verifications yield strict proofs and is too strong as an expression of the truth condition for knowledge. We will consider the motivations for such an approach to knowledge and present the resulting system of Intuitionistic Epistemic Logic, IEL, as well as its Kripke models. We will also look at how IEL gives natural intuitionistic responses to the Knowability Paradox.

Andrei Rodin (IP RAS)
Title: Justification Procedures in Knowledge Representation

Abstract: The existing theory and practice of the computer-assisted Knowledge Representation construe formal justification procedures in terms of computable deductions from atomic sentences playing the role of axioms. Such procedures, generally, remain opaque to users and provide them with no epistemic access to the raw empirical data, which is supposed to justify the relevant parts of knowledge. As a result the justification of the represented knowledge becomes a responsibility of these two parties: (i) field researchers and other field practitioners responsible for collecting raw data "from the ground" and (ii) AI experts and KR-developers who are expected to make sure that the knowledge available to users via KR-technology is well-grounded on the data. Within this scheme the user plays no rôle in the justification of knowledge he or she is using. This is all too bad for several (non-independent) reasons. Firstly, in such a setting the justification does not directly support the user's individual beliefs and thus blurs the distinction between one's true belief and one's knowledge. Secondly, it endangers the public nature of knowledge. Thirdly, since computer-assisted deductions are not designed to be epistemically traceable, the AI-experts are not in a position either to validate individual deductions in epistemic terms. All these factors make knowledge represented with the KR-technologies much less reliable than one may wish.

I argue that a part of the problem is a dubious formal model of reasoning adopted in the AI design back in the early 1960-ies, which is based on the contemporary mainstream conceptualisation of logic in the Analytic philosophical tradition. Finally, I suggest a possible remedy that draws upon an alternative view on logic that makes better justice to the concept of justification and to some other important epistemic concepts.

Danya Rogozin (MSU)
Title: Modal type theory based on the intuitionistic epistemic logic.

Abstract: Modal intuitionistic epistemic logic IEL^- was proposed by S.Artemov and T. Protopopescu as the formal foundation for the intuitionistic theory

of knowledge. We construct a modal simply typed lambda-calculus which is Curry-Howard isomorphic to IEL^- as the formal theory of calculations with applicative functors in functional programming languages like Haskell or Idris. We prove that this typed lambda-calculus has the strong normalization and Church-Rosser properties. Also we consider the categorical model for this type theory based on the cartesian closed category with strong lax monoidal endofunctor.

Title:: **Konstantin Shishov (MSU)** Representation of algebraic structures of QMV-algebra and qMV-algebra in relational semantics.

Abstract: It is known that QMV-algebras (quantum many-valued algebras) and qMV-algebras (quasi-many-valued algebras) are semantic structures for the class of quantum logics. It is possible to construct Kripkean-style semantics that are isomorphic to them. In my report, I'll talk about my version of building such relational structures, based on relational semantics for the algebra of effects.

Vladimir Vasyukov (IP RAS) Title: Behaviorality as Contextuality: Does Non-classicality Matter?

Abstract: The motivation for our use of the term "behavioral" emerges from computer science. The data should naturally be split into two categories: visible data which can be directly accessed, and hidden data that can only be accessed indirectly by analyzing the meaning (output) of programs with visible output, called experiments. Since one cannot access the hidden data, it is not possible to reason directly about the equality of two hidden values. Two values are said to behaviorally equivalent if they cannot be distinguished by the set of available experiment.

The characteristic example is the behavioral algebraization of the paraconsistent logic C_1 of da Costa. Since C_1 can be seen as an extension of CPL by a paraconsistent negation, then the key idea will be to leave paraconsistent negation out of the chosen subsignature, while still including the classical negation. But there is also known the case of the so-called da Costa algebras proposed by da Costa himself for C_1 together with the bivaluation semantics. The question arises: what is the genuine context for C_1? Is it behavioral or another one?

Trying to answer the question it worth to pay attention such an obstacle that da Costa algebra serves also as the foundations of paraconsistent set theory. Maybe such non-classicality us the source of confusion.