Abstracts presented by title

► ADIB BEN JEBARA, *An idea about time in cosmology*.
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We are postulating that time is not finite because infinitary set theory and cosmology have to meet. For we know since Galileo and Descartes that physics is written mathematically. The counting of time before the Big Bang and beyond the Big Crush (if any Big Crush) can be not well defined because of a new mathematical theory. The new theory is that only CC(2 through m) is true, which is countable axiom of choice for sets of n elements, n from 2 to m. See web page: http://www.math.lsa.umich.edu/~ablass/dpcc.pdf. That the axiom of choice is not true would explain the difficulty to deal with time .... Indeed, time can be counted with $n + n + n + \dots$ and be well defined or it can be counted with $(m+1)+(m+1)+(m+1)+\dots$ or with $1+2+3+4+\dots$ and thus be not well defined. Time can be a pair wise disjoint countable union of well ordered sets of n elements and in such a case be well ordered with an origin or it can be a pair wise disjoint countable union of sets of $m+1$ elements or of increasing integers as numbers of elements and in such a case be not even countable so without origin.

As Mr. Andreas Blass pointed out, the assumptions here are that time is discrete and need not be well ordered.

Time is considered as a continuum but for studying long periods of time we can use the approximation of considering it discrete.

The end of time will be when time equal the empty set by equaling a countable Cartesian products of sets of $m+1$ elements or of sets of increasing integers as numbers of elements.

This idea does not answer many questions but it answers the following: Is the counting of time always well defined? Is there an origin of time? Is there an end of time?

► JOHN CORCORAN, *Meanings of word: type-occurrence-token*.
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The four-letter written-English expression ‘word’, which plays important roles in applications and expositions of logic and philosophy of logic, is ambiguous (multisense, or polysemic) in that it has multiple normal meanings (senses, or definitions). Several of its meanings are vague (imprecise, or indefinite) in that they admit of borderline (marginal, or fringe) cases. This paper juxtaposes, distinguishes, and analyzes several senses of ‘word’ focusing on a constellation of senses analogous to constellations of senses of other expression words such as ‘expression’, ‘symbol’, ‘character’, ‘letter’, ‘term’, ‘phrase’, ‘formula’, ‘sentence’, ‘derivation’, ‘paragraph’, and ‘discourse’. Consider, e.g., the word ‘letter’. In one sense there are exactly twenty-six *letters* (letter-types or ideal letters) in the English alphabet and there are exactly four *letters* in the word-type ‘letter’. In another sense, there are exactly six *letters* (letter-repetitions or letter-occurrences) in the word-type ‘letter’. In yet another sense, every new inscription (act of writing or printing) of ‘letter’ brings into existence six new *letters* (letter-tokens or ink-letters) and one new word that had not previously existed. The number of letter-occurrences (occurrences of a letter-type) in a given word-type is the same as the number of letter-tokens (tokens of a letter-type) in a single token of the given word. Many logicians fail to distinguish ”token” from ”occurrence” and a few actually confuse the two concepts. Epistemological and ontological problems concerning word-types, word-occurrences, and word-tokens are described in philosophically neutral terms. This paper presents a theoretical framework of concepts and principles concerning logicography, including use of English in logic. The framework is applied to analytical exposition and critical evaluation of classic passages in the works of philosophers and logicians including

Boole, Peirce, Frege, Russell, Tarski, Church and Quine. This paper is intended as a philosophical sequel to Corcoran et al. *String Theory*, ***The Journal of Symbolic Logic***, vol. 39 (1974), pp. 625–637.

► LEONA F. FASS, *A logical approach to real system design.*
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There has long been debate as to whether logic-based formal methods could be used to synthesize and verify systems and engineered hardware designs or whether correct designs could be established empirically. Our position is that it would be unlikely to find a complex practical system whose entire behavior could be completely, correctly formally specified and realized effectively. Thus for complex systems and devices an original design could only be an approximation of the behavioral ideal. At best we can establish correctness of these approximate behavioral models, dealing with erroneous or anomalous behaviors as they are observed and, perhaps, revising the approximations. Empirically detecting design defects and behavioral errors is, we believe, a crucial and inevitable phase of establishing correct design.

We describe how model-based design and model checking can combine formal methods and empirical techniques to improve specifications and designs, and to detect defects and flaws in devices and systems. Model-based design formally analyzes a potential behavioral domain to determine necessary components of a realization. Model checking may then formally, automatedly, attempt to verify that a model-based specification is fulfilled. Checkers may mimic potential system/device behavior, e.g., by descriptive formula or finite-state machine. They then compute "all reachable states", searching for results or paths to indicate that specified behavioral properties are satisfied. But in real system design, it is most often the case that these formal behavioral modeling techniques are useful for detecting defects, producing counter-examples, and finding design flaws.

We discuss our own experience utilizing these techniques and some important research of others, using formal methods for design and for empirical error detection. These include applications to factory process modeling, Navy aviation software design, NASA fault-detection systems and system security.

► GRIGORI MINTS AND ARIST KOJEVNIKOV, *Intuitionistic Frege systems are polynomially equivalent.*
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In [1] it is shown that any two classical Frege systems polynomially simulate each other. The same proof does not work for the intuitionistic Frege systems, since they can have non-derivable admissible rules. In Lemma 1 we polynomially simulate one admissible rule. Therefore any two intuitionistic Frege system polynomially simulate each other. We need the following two facts and use notation from [1], [2].

THEOREM 1 ([2]). The set of most general unifiers of a formula is finite.

PROPOSITION 1 ([2]). An inference rule A/B is admissible in Frege system $\mathfrak{F}$ iff every unifier for A is also a unifier for B.

LEMMA 1. *For any Frege system $\mathfrak{F}_1$ and its extension $\mathfrak{F}_2$ with admissible rule $R \cong C/D$ there is a function f and constant c such that for all formulas $A_1, \dots, A_n, B$ and derivations π, if $A_1, \dots, A_n \vdash^{\pi}_{\mathfrak{F}_2} B$, then $A_1, \dots, A_n \vdash^{f(\pi)}_{\mathfrak{F}_1} B$, and $\lambda(f(\pi)) \leqslant c\lambda(\pi), \tau(f(\pi)) \leqslant c\rho(\pi)$.*

PROOF. Assume $\{\Theta_1, \dots, \Theta_s\}$ is a finite (by Theorem 1) complete set of unifiers for the formula C. For each $i = 1, \dots, s$, let π_i be a derivation of $\Theta_i(D)$ in $\mathfrak{F}_1$ (it exists by the Proposition 1). We fix c_1 to be the number of lines in the longest derivation π_i $(i = 1, \dots, s)$

and c_2 to be the maximum of sizes of formulas in all the derivations π_i $(i = 1, \dots, s)$. Now suppose π is a derivation of B from $A_1, \dots, A_n$ in $\mathfrak{F}_2$ and $\sigma C/\sigma D$ an application of the rule R in π. By Theorem 1 there is j such that $\sigma = \tau \circ \Theta_j$. Replace the application of R with derivation $\tau\pi_i$. Let $f(\pi)$ be the result of replacing all applications of R in π. This is an $\mathfrak{F}_1$-derivation. Clearly $\lambda(f(\pi)) \leqslant c_1\lambda(\pi)$. Finally, note that $\tau(f(\pi)) \leqslant c_2\rho(\pi)$. ⊣

[1] STEPHEN A. COOK AND ROBERT A. RECKHOW, *The relative efficiency of propositional proof systems*, ***The Journal of Symbolic Logic***, vol. 44 (1979), no. 1, pp. 36–50.

[2] SILVIO GHILARDI, *Unification in intuitionistic logic*, ***The Journal of Symbolic Logic***, vol. 64 (1999), no. 2, pp. 859–880.

► XUNWEI ZHOU, *Inductive composition v. decomposition are better than induction v. deduction*.
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The author has invented two new methodologies: inductive composition and decomposition which can be depicted by truth tables. Take $\overset{-1}{\leqslant}$ (mutually inverse implication) as an example, its truth table of inductive composition is shown in Table 1, its truth tables of decomposition are shown in Tables 2 and 3.

Table 1

A	B	$A \overset{-1}{\leqslant} B$
F	F	T
F	T	F/T
T	F	F
T	T	T

Table 2

$A \overset{-1}{\leqslant} B$	A	B
F	F	F/T
F	T	F/T
T	F	F/T
T	T	T

Table 3

$A \overset{-1}{\leqslant} B$	B	A
F	F	F/T
F	T	F/T
T	F	F
T	T	F/T

In Tables 1 through 3, A and B are mutually inverse special propositions, $A \overset{-1}{\leqslant} B$ is a mutually inverse general proposition.

Table 1 is from the special to the general, Tables 2 and 3 are from the general to the special. Table 1 is mutually inverse with Tables 2 and 3. F/T in Table 1 means "needn't determine". F/T in Tables 2 and 3 mean "unable to determine". The aim of Table 1 is to establish $A \overset{-1}{\leqslant} B$. The aims of Tables 2 and 3 are to employ the established $A \overset{-1}{\leqslant} B$ to make hypothetical inference. Table 2 depicts modus ponens, Table 3 modus tollens. Inductive composition and decomposition are defined by truth tables, more stringent than the definitions of induction and deduction. Induction was formerly defined as from the particular to the general, deduction as from the general to the particular. But, what is the particular, what is the general cannot be defined. Later, induction is defined as that the conclusion surpasses the premise, deduction as that the conclusion doesn't surpass the premise. But under this definition, complete inductive inference, a pure induction, is classified as deduction. Therefore, the definitions of inductive composition and decomposition are better than those of induction and deduction.