COMPUTATIONAL FORMALISM: ABSTRACT COMBINATORY VIEW-POINT AND RELATED FIRST ORDER LOGICAL FRAMEWORK

Vincenzo Manca 3-18

Abstract. A natural notion of computational formalism is here characterized by elaborating on the algebraic approach with Uniformly Reflexive Structures. Namely by dealing with the undefined within a first-order theory admitting partial functions. Here, quite generally, we obtain several limitative theorems about the computational formalisms.

Keywords: Computational formalisms, uniformly reflexive structures, idealized theories, limitative theorems.

MULTIPLE REGULARITY AND BINARY ETOL-SYSTEMS

Ryszard Danecki 19-34

Abstract. Closure properties of binary ETOL-languages are investigated by means of multiple tree automata. Decidability of the equivalence problem of deterministic binary ETOL-systems is proved.

Keywords: ETOL-system, multiple tree automata, deterministic ETOL-system.

ON THE SEMANTICS OF PARALLEL PROGRAMS

Tomasz Müldner 35-81

Abstract. The paper deals with the semantics of parallel programs. It is shown that there exist other semantics besides the well-known one, which reflects multiplexing and is defined as an interleaving of elementary actions. Those semantics are not necessarily equivalent with respect to the input (out-put) relation; moreover, they permit the investigation of the internal behaviour of a computation. A formalized language of parallel programs is defined. Definitions of computational semantics and of a tree of acceptable computations are given. As an example of computational semantics the semantics MULT (for multiplexing) is defined, Next a scheme of computational semantics is introduced. Given the scheme, one can define various computational semantics by means of several strategies.
The most natural scheme of computational semantics is then given, followed by examples defined by it. Connections between different classes of computational semantics are examined.

Keywords: Semantics of parallel program, acceptable computation.

LATTICE THEORETIC ORDERING PROPERTIES FOR NP-COMPLETE OPTIMIZATION PROBLEMS

Giorgio Ausiello, Alessandro d'Atri, Marco Protasi 83-94

Abstract. The ordering among classes of isomorphic NP-complete optimization problems is studied from a lattice theoretic point of view. It is shown that the set of such classes has the structure of an upper semilattice; while a top element can found be it is proved that no bottom element can exist.

Keywords: Computational complexity, lattice, NP-complete problems, optimization problems.

ON THE SYNCHRONIZING TOOLS FOR PARALLEL PROGRAMS

Tomasz Müldner 95-134

Abstract. The paper contains precise and structured definitions of the following synchronizing tools: Mutually Excluding Regions, Elementary Critical Regions and Critical Regions. Some applications of these tools are shown on the following examples: the Kung algorithm of finding a zero of a function, ticket booking system, and synchronous and asynchronous Jacobi algorithms of solving a system of linear equations.

Next, the implementations of the above synchronizing tools in the formal languages of parallel programming are given. The semantics of these languages are defined on the ground of the present author's earlier paper "On the Semantics of Parallel Programs". The implementations are proved to be correct.

The implementation of a critical region is actually an implementation of Dijkstra P and V operations on binary semaphores.

Keywords: Synchronizing tool, critical region, mutual exclusion, accessibility, passive waiting, monotonicity.

ON SUB REGULAR *OL* FORMS

J. Albert, H. A. Maurer, Th.Ottmann 135-149

Abstract. We present necessary and sufficient conditions for an OL form F to generate regular languages only. The conditions at issue can be effectively checked, whence the "regularity problem for OL forms" is proven decidable.

Keywords: OL forms, regional languages, decision procedure.

A LOGICALLY JUSTIFIED MODEL OF COMPUTATION I

Pierangelo Miglioli, Mario Ornaghi 151-172

Abstract. The aim of this paper is to provide a general explanation of the "algorithmic content" of proofs, according to a point of view adequate to computer science. Differently from the more usual attitude of program synthesis, where the "algorithmic content" is captured by translating proofs into standard algorithmic languages, here we propose a "direct" interpretation of "proofs as programs". To do this, a clear explanation is needed of what is to be meant by "proof-execution", a concept which must generalize the usual "program-execution".

In the first part of the paper we discuss the general conditions to be satisfied by the executions of proofs and consider, as a first example of proof-execution, Prawitz's normalization. According to our analysis, simple normalization is not fully adequate to the goals of the theory of programs: so, in the second section we present an execution-procedure based on ideas more oriented to computer science than Prawitz's. We provide a soundness theorem which states that our executions satisfy an appropriate adequacy condition, and discuss the sense according to which our "proof-algorithms" inherently involve parallelism and non determinism.

The Properties of our computation model are analyzed and also a completeness theorem involving a notion of "uniform evaluation" of open formulas is stated. Finally, an "algorithmic completeness" theorem is given, which essentially states that every flow-chart program proved to be totally correct can be simulated by an appropriate "purely logical proof".

Keywords: Proof-executions, pseudo-truth-sets, uniform evaluations, algorithmic completeness of proofs.

ON UNIVERSAL BINARY SEARCH TREES

Thomas R.M. Fischer   *173-184*

Abstract. The paper deals with the problem of constructing binary search trees that are available in the case of unknown or time varying access probabilities.

ON ELIMINATING THE λ-RULES FROM SIMPLE MATRIX GRAMMARS

Georghe Paun   *185-196*

Abstract. It is proved that the λ-rules increase the generative capacity of context-free simple matrix grammars but can be eliminated from right-linear simple matrix grammars and from linear simple matrix grammars without diminishing their generative capacity.

A COPYING THEOREM FOR ETOL LANGUAGES WITH RANK

Grzegorz Rozenberg   *197-205*

Abstract. An infinite hierarchy within the class of ETOL languages is proved in such a way that it is spanned on an infinite sequence of ETOL languages with increasing rank where each of the languages has a length set containing the range of a strictly growing polynomial of degree 1.

ON THE COMPILATION OF PARALLEL PROGRAMS

Tomasz Müldner

Abstract. The paper examines the properties of a compilation of sequential and parallel programs with respect to computational semantics, defined in the earlier paper of the present author "On the Semantics of Parallel Programs".

A compilation of sequential programs is defined and proved to be stable, i.e. the sets of results of an arbitrary program and the corresponding compiled program coincide. Next, a natural compilation of parallel programs is defined and shown not to be stable with respect to natural semantics: The compiled program may give the results which are not results of the source program.

Other semantics are defined and it is proved that in those semantics the given compilation is stable. The main corollary states that for parallel programs with synchronizing tools, a compilation is stable in natural semantics.

Keywords: Parallel programs, compilation, stable compilation.

GLOBAL SYNTAX AND SEMANTICS FOR RECURSIVELY ENUMERABLE LANGUAGES

Cristian Calude, Gheorghe Păun

Abstract. According to (Benson, 1970), a syntax is a category of strings and derivations (modulo similarity) between them. In this paper the semantic domain is an elementary topes. Thus, an interpretation of a syntax is a cofunctor taking strigs to products and derivations to morphisms. It is proved the existence of a free x - category $\mathscr{U}$ such that every syntax is a full subcategory of $\mathscr{U}$, which can be determined recursively. Every interpretation of a syntax is the restriction of the interpretation of $\mathscr{U}$.

IMPLEMENTATION AND PROPERTIES OF CERTAIN TOOLS FOR PARALLEL COMPUTATIONS

Tomasz Müldner

Abstract. The paper is a continuation of the papers of the present author in which the semantics of parallel programs and several synchronizing tools (e.g. critical regions) for parallel programs were defined.

Now, a universal synchronizing tool - a monitor, with delay, continue and delcont instructions, is defined.

Then, an implementation of a monitor in the LOGLAN 77 programming language is given and proved to be correct. The implementation is given by means of a LOGLAN type Parallel in such a way that in order to use monitors in the user's program it is sufficient to prefix that program by the Parallel.

Keywords: Parallel programs, synchronizing tool, monitor.

A LOGICALLY JUSTIFIED MODEL OF COMPUTATION II

APC: THE ALGORITHMIC PREDICATE CALCULUS

Abstract. The paper presents a logic which is an algorithmic extension of the classical predicate calculus and is based on the ideas given by F. Kröger.
The programs and the effects of their execution are the formulas of this logic which are considered at any time scale. There are many interesting properties of the logic which are connected with the notion of time scale. These properties are examined in the paper.
Moreover the problem of the formulas normalization is presented.
Our logic is compared with the algorithmic logic introduced by A. Salwicki. Next, the usefulness of a new logic in the theory of programs is shown.

Keywords: Thickness of formulas, algorithmic logic, algorithmic properties.

ON A VARIANT OF A METHOD OF BERSTEL'S AND NIELSEN'S

Abstract. An analogy to a result of J. Berstel's and M. Nielsen's, showing how equality of co-efficient sets of certain N-rational sequences (DOL growth sequences) manifests itself by forcing equal periodical subsequences, is obtained for sequences of words. As applications, certain decid-ability problems for $\mathscr{L}$ languages are reduced to the equivalence problem for HDOL sequences.

Keywords: Developmental systems, decidability.

ON THE AMOUNT OF NONDETERMINISM IN PUSHDOWN AUTOMATA

ALGORITHMIC ASPECTS OF THE ATTRIBUTE SET MINIMIZATION PROBLEM

Abstract. Algorithmic aspects of the problem of minimizing the set of attributes in an information system are considered. Two simplifications of this problem are proved to be NP-complete. A simple heuristic algorithm is presented and analyzed.

Keywords: Information system, attribute, combinatorial problems, NP-completeness, heuristic algorithms.

ON PARTIAL LANGUAGES

Abstract. The paper studies the behavior of control structures of algorithms designed for (partly) parallel execution. A generalization of Peterson's computation sequence set, the partial language, is discussed, which reflects the concurrency of events. In particular, the families of partial languages definable by Petri nets and by safe Petri nets are investigated with respect to closedness under certain operations. Trace languages (Mazurkiewicz) and path expressions (Campbell and Habermann) are included in the considerations.

Keywords: Computation sequence set, partial word, partial language, concurrent processes, Petri net, path expression, trace language.

GENERALIZED INVERSE OF A FINITE GRAPH

Marian Mrożek *499-510*

Abstract. We define the optimal generalized inverse of the directed graph, give its construction and prove that the graph has an inverse graph iff its optimal generalized inverse is its inverse. The construction of the optimal generalized inverse may be used in the preparation of the PERT networks by the computer.

Keywords: Directed graph, dual graph, inverse graph, line graph, PERT networks.

A REMARK OF THE SYNTACTIC PARTITION

Piotr Rudnicki, Andrzej Trybulec *511-516*

Abstract. An analytic investigation of formal languages is of practical value, apart from their description by means of generative grammars. This paper deals with the problem of grouping into classes the vocabulary elements of similar syntactic properties. The introduction of types for variables in programming languages is an example of such a grouping. In [3] a notion of syntactic partition onto sets of words has been defined. We prove below that there is continuum of such partitions.

Keywords: Formal languages, syntactic partition, classes of lexical tokens.

THE ARBITER: AN ACTIVE SYSTEM COMPONENT FOR IMPLEMENTING SYN-CHRONIZING PRIMITIVES

Henk J. M. Goeman *517-530d*

Abstract. An active system component, the arbiter, is proposed as a system structuring concept for the implementation of synchronizing primitives.
The concept is illustrated by showing a new and very simple implementation of the critical section with a busy form of waiting. This implementation will be refined in such a way that it does not need the commonly stated postulate of atomicity, according to which assignments to and inspections of common store locations are indivisible, non interfering, atomic actions. Thus we refute the well-known and widely believed "paradox of the critical region".
The use of the arbiter is further illustrated by showing an implementation of the semaphore operations. These operations are implemented "on top of" the proposed implementation for the critical section, i.e. using the same busy form of waiting to ensure the mutual exclusion of concurrently issued individual semaphore operations. Nevertheless, the proposed implementation explicitly allows a nonbusy form of waiting to result from one of the semaphore operations by means of an interrupt mechanism.

Keywords: Active system component, arbiter, synchronizing primitives, critical section, semaphore.

A CLASSIFICATION AND CLOSURE PROPERTIES OF LANGUAGES FOR DESCRIBING CONCURRENT SYSTEM BEHAVIOURS

Miklós Szijártó *531-549*

Abstract. The correspondence between sequential program schemes and formal languages is well known (Blikle and Mazurkiewicz (1972), Engelfriet (1974)). The situation is more complicated in the case of parallel program schemes, and trace languages (Mazurkiewicz (1977)) have been introduced to describe them.

We introduce the concept of the closure of a language on a so called independence relation on the alphabet of the language, and formulate several theorems about them and the trace languages. We investigate the closedness properties of Chomsky classes under closure on independence relations, and as a special case we derive a new necessary and sufficient condition for the regularity of the commutative closure of a language.

INFORMATION RETRIEVAL SYSTEMS, AN ALGEBRAIC APPROACH I

Zbigniew Raś

Abstract. This paper is the first of the three parts of work on the information retrieval systems proposed by Salton (see [24]). The system is defined by the notions of a partially ordered set of requests $(A, \leq O)$, the set of objects X and a monotonic retrieval function $U : A \to 2^X$. Different conditions imposed on the set A and a function U make it possible to obtain various classes of information retrieval systems. We will investigate systems in which $(A, \leq)$ is a partially ordered set, a lattice, a pseudo-Boolean algebra and Boolean algebra. In my paper these systems are called partially ordered information retrieval systems (po-systems) lattice information retrieval systems (l-systems); pseudo-Boolean information retrieval systems (pB-systems) and Boolean information retrieval systems (B-systems). The first part concerns po-systems and 1-systems. The second part deals with pB-systems and B-systems. In the third part, systems with a partial access are investigated.

The present part discusses the method for construction of a set of attributes. Problems connected with the selectivity and minimalization of a set of attributes are investigated. The characterization and the properties of a set of attributes are given.

A CRITERION OF UNDECIDABILITY OF ALGORITHMIC THEORIES

Wiktor Dańko

Abstract. In this paper a criterion of undecidability of theories based on algorithmic logic [1,8] is formulated. By the application of this criterion we are able to assert undecidability of algorithmic theory finite fields, theories of date structures e.g. dictionaries, storage management system and others theories of structures with finite universes. It is also proved that every decidable algorithmic theory admits elimination of iteration quantifiers and examples of decidable algorithmic theories are given.

LOGIC OF EFFECTIVE DEFINITIONS

Jerzy Tiuryn

Abstract. A new logic to deal with properties of algorithmic processes in an abstract structure is proposed. This logic is based on the class of (deterministic) effective definitional schemes.

A complete (infinitary) proof system is given. The paper contains among the other results, a "computation" of Hanf number of the above-mentioned logic, which turns out to he unexpectedly high.

Keywords: Logic, program schemes, axiomatization.

IMPLICIT DEFINABILITY OF ALGEBRAIC STRUCTURES BY MEANS OF PROGRAM PROPERTIES

Jan Bergstra, Jerzy Tiuryn *661-674*

Abstract. The following problem is investigated in the paper: what structures can be uniquely defined by algorithmic properties? The algorithmic properties are represented in this paper as open formulae of the logic of effective definitions. This approach can be viewed as an alternative way of defining abstract data types.

Keywords: Logic of programs, computation in abstract structures, algorithmic properties, abstract data types.

P A L - PROPOSITIONAL ALGORITHMIC LOGIC

Grażyna Mirkowska *675-760*

Abstract. The aim of propositional algorithmic logic is to investigate the properties of program connectives. Complete axiomatic systems for deterministic as well as for nondeterministic interpretations of program variables are presented. They constitute basic sets of tools useful in the practice of proving the properties of program schemes. Propositional theories of data structures, e.g. the arithmetic of natural numbers and stacks, are constructed.This shows that in many aspects PAL is close to first-order algorithmic logic. Tautologies of PAL become tautologies of algorithmic logic after replacing program variables by programs and propositional variables by formulas. Another corollary to the completeness theorem asserts that it is possible to eliminate nondeterministic program variables and replace them by schemes with deterministic atoms.

Keywords: Logic of programs, algorithmic logic, nondeterminism, completeness.

A SURVEY OF NORMAL FORM COVERS FOR REGULAR GRAMMARS

Anton Nijholt 761-776

Abstract. An overview is given of cover results for normal forms of regular grammars. Due to the special form of regular grammars and due to the results which are obtained it is sufficient to consider covering grammars in Greibach normal form. Among other things it is proved that any left-regular grammar can be left covered with a context-free grammar in Greibach normal form. All the cover results concerning the left- and right-regular grammars are listed, with respect to several types of covers, in a cover table.

Keywords: Regular grammars, covers, Greibach normal form, parsing.

AN ALGEBRAIC APPROACH II

Zbigniew Raś 777-818

Abstract. This paper is the second of the three parts of the work on the information retrieval systems proposed by Salton (see [13]). The system is defined by the notions of a partially ordered set of requests $(A, \leq)$, the set of documents X and a monotonic retrieval function $U : A \to 2^X$. Different conditions imposed on the set A and a function U make it possible to obtain various classes of information retrieval systems. We investigate systems in which $(A, \leq)$ is a partially ordered set, a lattice, a pseudo-Boolean algebra and a Boolean algebra. In my paper these systems are called partially ordered information retrieval systems (po-systems), lattice information retrieval systems (1-systems), pseudo-Boolean information retrieval systems (pB-systems) and Boolean information retrieval systems (B-systems). The first part concerned po-systems and 1-systems. The second part deals with pB-systems and B-systems. In the third part systems with a partial sates ere investigated.

The present part discusses the pB-systems and B-systems. The problems connected with the properties of sets of attributes are investigated. The method of constructing a selective system for a pB-system and a B-system is given. The problem related to the minimalization of systems are investigated.

Keywords: Information retrieval, selectivity, artificial attributes, single systems, pB-systems and B-systems,

ALGORITHMIC TRIVIALITY OF ABSTRACT STRUCTURES

Paweł Urzyczyn 819-849

Abstract. In the present paper we investigate algorithmically trivial structures, that is structures where every recursive function (relation) is definable by a first-order open formula. We prove that algorithmic triviality is equivalent to a property called the unwind property. We also study the notion of effective interpretation of structures and its relation to algorithmic triviality.

Keywords: Algorithmic triviality, unwind property, effective interpretation, effective definitional schema.

ALGORITHMIC DEGREES OF ALGEBRAIC STRUCTURES

Jan Bergstra, Jerzy Tiuryn 851-862

Abstract. We define a reducibility relation $\leq$ between algebraic structures $\mathfrak{A} \leq \mathfrak{B}$ means that $\mathfrak{A}$ can be embeddet in an enrichment of $\mathfrak{B}$ with partial computable operations. This notion is a generalized version of implementability as known in the theory of algebraic data types.

Keywords: Algorithmic degrees, program schemes, programmability in algebraic structures.

FIXED POINTS IN THE POWER SET ALGEBRA OF INFINITE TREES

Jerzy Tiuryn 863-890

Abstract. In this paper we are studying two notions of continuity, both are weaker than the well known and broadly applied notion of ω-continuity. The paper shows that power set algebras of finite/infinite trees provide all possible instances of the above-mentioned continuities, which depend on the signature of trees and on the substitution: OI or IO.

Keywords: Regular algebras, fixed-point equations, ω-continuity infinite trees.

NONHOMOGENEOUS STOCHASTIC AUTOMATA

Sławomir Janicki 891-917

Abstract. In this note we consider a nonhomogeneous Markov chain type stochastic automaton which is a generalization of Bartoszyński's stochastic automaton. The latter is a generalization of the Pawlak's known machine in a stochastic direction. By nonhomogeneous stochastic automaton we mean a system $< T, \alpha\{A^{(n)}, n \geq 1\} >$, where T is a finite nonempty set, α, is an initial distribution on T, and $\{A^{(n)}, n \geq 1\}$ is a matrix sequence whose every element is a stochastic matrix called a transition probability matrix. If $A^{(n)} = A$ for all $n \geq 1$, then we obtain Bartoszyński's automaton. The sequence $(t_{i_0}, t_{i_1}, \ldots)$ $t_{i_j} \in T$, $j = 0, 1, 2, \ldots$ is called a word of automata if $\alpha(t_{i_0}) > 0$ and $A^{(k)}(t_{i_{k-1}}, t_{i_k}) > 0$ for every $k \geq 1$.
The goal of this note is to give necessary and sufficient conditions for the existence of an extension and a shrinkage of the automata under consideration. These problems for T, A were considered for the first time by Bartoszyński.
The shrinkage problem deals with the existence of a stochastic automaton which generates only all sequences of states of T which are simultaneously generated by two given automata while the extension problem treats of the existence of a stochastic automaton which generates all sequences of states of which are generated by at least one of two given automata.
Moreover, we introduce some new notions: attainable state, concordance of automata in a wide and a narrow sense, which help us to solve the problems mentioned above.

Keywords: Nonhomogeneous stochastic automaton, attainable states, concordance of automata in a narrow sense, concordance in a wide sense of automata, extension of automata, shrinkage of automata.

A SECOND-ORDER DYNAMIC LOGIC WITH ARRAY ASSIGNMENTS

Petr Hajek and Petr Kůrka 919-933

Abstract. A second-order axiomatization of dynamic logic with array assignments is presented. This axiomatization is shown to be arithmetically complete in the sense of Harel. As an example, a partial correctness assertion concerning a sorting algorithm is proved.

Keywords: Dynamic logic, arithmetical completeness, second-order axiomatization.

ON THE QUANTIFIER-FREE FRAGMENT OF LOGIC OF EFFECTIVE DEFINITIONS

Jan A. Bergstra and John J. Ch. Meyer   935-955

Abstract. In [2] Jerzy Tiuryn has introduced Logic of Effective Definitions (LED) in which properties of effective definitional schemes are expressed. With respect to the quantifier-free part of it, he proved that each open formula is equivalent to one in a special conjunctive normal form. We prove that there is no finite bound to the number of conjuncts required for these normal forms.

Keywords: Algorithmic logic, computability, algebraic structures, functional effective definitional schemes.

WORD PROBLEM IN DISTRIBUTIVE MAGMAS

Jean Marcel Pallo   957-973

Abstract. This paper shows that among the transformations which have words formed with three operators and four variables correspond to words formed with two operators and three variables, distributivity clone verifies some remarkable properties. Indeed, it is a confluent and noetherian relation which satisfies inductive comparison theorem. One can deduce a computer - programmable algorithm which makes it possible to solve the word problem in a set of variables with two associative operators one of which is distributive on the right with respect to the other, i.e to decide whether or not two words composed of variables and operators can be proved equal as a consequence of the identities of associativity and distributivity satisfied by these operators.

Keywords: Word problem, magmas, confluent relation, noetherian relation.

ALGORITHMIC LOGIC WITH RECURSIVE FUNCTIONS

Andrzej Szałas   975-995

Abstract. A language is considered in which the reader can express such properties of block-structured programs with recursive functions as correctness and partial correctness. The semantics of this language is fully described by a set of schemes of axioms and inference rules. The completeness theorem and the soundness theorem for this axiomatization are proved.

Keywords: Algorithmic logic, Boolean algebra, completeness, correctness, filter, lattice, Lindenbaum-Tarski algebra, Q-filter, recursive functions, soundness.

REGULAR EXTENSIONS OF ITERATIVE ALGEBRAS AND METRIC INTERPRETATIONS

Jan Bergstra, and Jerzy Tiuryn   997-1014

Abstract. An algebra is said to be iterative if every nontrivial finite system of fixed-point equations has unique solution.
The paper discusses possibilities of finding topological structure for a given iterative algebra so that the unique solution of every system S can be approximated by a sequence of elements generated from S.

Keywords: Fixed-point semantics, iterative algebras, approximations of unique fixed points.

AUTOMATA IN RANDOM ENVIRONMENTS

Jerren Gould

Abstract. In Gould and Wegman (1977), a model of a system located within an environment was introduced in which the transition function of the system is not only related to the present state and input, but also to the present configuration of the environment.

In this paper we shall consider the case of automata operating within random environments. In contrast to the previous case,where we suppose we can control the environment, we shall assume that the realization of the environment is governed by some probabilistic structure. Hence, the sequence of environment configurations is a stochastic process.

In considering automata in random environments (ARE) there is a dual nature to the randomness, the environment sequence is random and for each value the environment sequence assumes, the probabilistic state transitions are defined. In the ARE case the relative frequency of acceptance of a tape under a fixed random environment sequence estimates the expected acceptance probability. Accordingly, the notion of expected acceptance sets is defined. Finally, a mean equivalent canonical representation for automata in random environments which eliminates the randomness due to the probabilistic state transitions is formulated. That is, for any ARE with finite environment set, deterministic assignment of the initial state, and deterministic transitions which has a state distribution equivalent in the mean.

This formulation of automata in random environments is useful when only certain probabilistic assumptions about the occurrence of any environment configuration can be made or when the environment configuration can only be measured by statistical techniques.

ON SEQUENTS DEFINED BY MEANS OF INFORMATION SYSTEMS

Miroslav Novotný

Abstract. Information (storage and retrieval) systems lead to define sequents of formulas of the propositional calculus. By constructing the so called very simple information systems and their marked valuations, we prove that a formula β s a sequent of a formula α if and only if the formula $\beta \to \alpha$, is a tautology.