AUTOMORPHISMS OF THE LATTICE OF RECURSIVELY ENUMERABLE SETS pdf

1: Soare : Automorphisms of the lattice of recursively enumerable sets

This chapter discusses the automorphisms of the lattice of recursively enumerable (r.e.) sets and hyperhypersimple (hh-simple) sets. While Maass proved a sufficient criterion for hh-simple sets to be automorphic, in Herrman, those properties of these sets has been analyzed; and it can be concluded when such sets are not automorphic even if their r.e. superset structures are isomorphic.

Many-one reducibility This is essentially one-one reducibility without the constraint that f be injective. A is many-one reducible or m-reducible to B if there is a total computable function f such that each n is in A if and only if f n is in B. Truth-table reducibility A is truth-table reducible to B if A is Turing reducible to B via an oracle Turing machine that computes a total function regardless of the oracle it is given. Many variants of truth-table reducibility have also been studied. Further reducibilities positive, disjunctive, conjunctive, linear and their weak and bounded versions are discussed in the article Reduction recursion theory. The major research on strong reducibilities has been to compare their theories, both for the class of all recursively enumerable sets as well as for the class of all subsets of the natural numbers. Furthermore, the relations between the reducibilities has been studied. For example, it is known that every Turing degree is either a truth-table degree or is the union of infinitely many truth-table degrees. Reducibilities weaker than Turing reducibility that is, reducibilities that are implied by Turing reducibility have also been studied. The most well known are arithmetical reducibility and hyperarithmetical reducibility. These reducibilities are closely connected to definability over the standard model of arithmetic. But, many of these index sets are even more complicated than the halting problem. These type of sets can be classified using the arithmetical hierarchy. The index sets given here are even complete for their levels, that is, all the sets in these levels can be many-one reduced to the given index sets. Reverse mathematics The program of reverse mathematics asks which set-existence axioms are necessary to prove particular theorems of mathematics in subsystems of second-order arithmetic. This study was initiated by Harvey Friedman and was studied in detail by Stephen Simpson and others; Simpson gives a detailed discussion of the program. The set-existence axioms in question correspond informally to axioms saying that the powerset of the natural numbers is closed under various reducibility notions. The weakest such axiom studied in reverse mathematics is recursive comprehension, which states that the powerset of the naturals is closed under Turing reducibility. Numberings[edit] A numbering is an enumeration of functions; it has two parameters, e and x and outputs the value of the e-th function in the numbering on the input x. Numberings can be partial-recursive although some of its members are total recursive, that is, computable functions. Admissible numberings are those into which all others can be translated. A Friedberg numbering named after its discoverer is a one-one numbering of all partial-recursive functions; it is necessarily not an admissible numbering. Later research dealt also with numberings of other classes like classes of recursively enumerable sets. Goncharov discovered for example a class of recursively enumerable sets for which the numberings fall into exactly two classes with respect to recursive isomorphisms. This method is primarily used to construct recursively enumerable sets with particular properties. To use this method, the desired properties of the set to be constructed are broken up into an infinite list of goals, known as requirements, so that satisfying all the requirements will cause the set constructed to have the desired properties. Each requirement is assigned to a natural number representing the priority of the requirement; so 0 is assigned to the most important priority, 1 to the second most important, and so on. The set is then constructed in stages, each stage attempting to satisfy one of more of the requirements by either adding numbers to the set or banning numbers from the set so that the final set will satisfy the requirement. It may happen that satisfying one requirement will cause another to become unsatisfied; the priority order is used to decide what to do in such an event. Priority arguments have been employed to solve many problems in recursion theory, and have been classified into a hierarchy based on their complexity Soare Because complex priority arguments can be technical and difficult to follow, it has traditionally been considered desirable to prove results without priority arguments, or to see if results proved with priority arguments can also be proved without them. For example, Kummer published a paper on a proof for the existence of Friedberg numberings without using the priority method. The lattice of recursively enumerable sets[edit] When Post defined the notion of a simple set as an r. This lattice became a well-studied structure. Recursive sets can be defined in this structure by the basic result that a set is recursive if and only if the set and its complement are both recursively enumerable. Post introduced already hypersimple and hyperhypersimple sets; later maximal sets were constructed which are r. Post did not find such a property and the solution to his problem applied priority methods instead; Harrington and Soare found eventually such a property. Automorphism problems[edit] Another important question is the existence of automorphisms in recursion-theoretic structures. Maximal sets as defined in the previous paragraph have the property that they cannot be automorphic to non-maximal sets, that is, if there is an automorphism of the recursive enumerable sets under the structure just mentioned, then every maximal set is mapped to another maximal set. Soare showed that also the converse holds, that is, every two maximal sets are automorphic. So the maximal sets form an orbit, that is, every automorphism preserves maximality and any two maximal sets are transformed into each other by some automorphism. Harrington gave a further example of an automorphic property: Besides the lattice of recursively enumerable sets, automorphisms are also studied for the structure of the Turing degrees of all sets as well as for the structure of the Turing degrees of r. In both cases, Cooper claims to have constructed nontrivial automorphisms which map some degrees to other degrees; this construction has, however, not been verified and some colleagues believe that the construction contains errors and that the question of whether there is a nontrivial automorphism of the Turing degrees is still one of the main unsolved questions in this area Slaman and Woodin , Ambos-Spies and Fejer The main idea is to consider a universal Turing machine U and to measure the complexity of a number or string x as the length of the shortest input p such that U p outputs x. This approach revolutionized earlier ways to determine when an infinite sequence equivalently, characteristic function of a subset of the natural numbers is random or not by invoking a notion of randomness for finite objects. Kolmogorov complexity became not only a subject of independent study but is also applied to other subjects as a tool for obtaining proofs. There are still many open problems in this area. For that reason, a recent research conference in this area was held in January [4] and a list of open problems [5] is maintained by Joseph Miller and Andre Nies. Frequency computation[edit] This branch of recursion theory analyzed the following question: There are uncountably many of these sets and also some recursively enumerable but noncomputable sets of this type. Inductive inference[edit] This is the recursion-theoretic branch of learning theory. The general scenario is the following: Given a class S of computable functions, is there a learner that is, recursive functional which outputs for any input of the form f 0 ,f 1 , A learner M learns a function f if almost all hypotheses are the same index e of f with respect to a previously agreed on acceptable numbering of all computable functions; M learns S if M learns every f in S. Basic results are that all recursively enumerable classes of functions are learnable while the class REC of all computable functions is not learnable. These generalized notions include reducibilities that cannot be executed by Turing machines but are nevertheless natural generalizations of Turing reducibility. These studies include approaches to investigate the analytical hierarchy which differs from the arithmetical hierarchy by permitting quantification over sets of natural numbers in addition to quantification over individual numbers. Both Turing reducibility and hyperarithmetical reducibility are important in the field of effective descriptive set theory. The even more general notion of degrees of constructibility is studied in set theory. Continuous computability theory[edit] Computability theory for digital computation is well developed. Computability theory is less well developed for analog computation that occurs in analog computers , analog signal processing , analog electronics , neural networks and continuous-time control theory , modelled by differential equations and continuous dynamical systems Orponen ; Moore Relationships between definability, proof and computability[edit] There are close relationships between the Turing degree of a set of natural numbers and the difficulty in terms of the arithmetical hierarchy of defining that set using a first-order formula. Recursion theory is also linked to second order arithmetic , a formal theory of natural numbers and sets of natural numbers. The fact that certain sets are computable or relatively computable often implies that these sets can be defined in weak subsystems of second order arithmetic. The program of reverse mathematics uses these subsystems to measure the noncomputability inherent in well known mathematical theorems. The field of proof theory includes the study of second-order arithmetic and Peano arithmetic , as well as formal theories of the natural numbers weaker than Peano arithmetic. One method of classifying the strength of these weak systems is by characterizing which computable functions the system can prove to be total see Fairtlough and Wainer For example, in primitive recursive arithmetic any computable function that is provably total is actually primitive recursive , while Peano arithmetic proves that functions like the Ackermann function , which are not primitive recursive, are total. Name[edit] The field of mathematical logic dealing with computability and its generalizations has been called "recursion theory" since its early days. Soare , a prominent researcher in the field, has proposed Soare that the field should be called "computability theory" instead. Many contemporary researchers have begun to use this alternate terminology. Not all researchers have been convinced, however, as explained by Fortnow [7] and Simpson. The idea is that a computable bijection merely renames numbers in a set, rather than indicating any structure in the set, much as a rotation of the Euclidean plane does not change any geometric aspect of lines drawn on it. Since any two infinite computable sets are linked by a computable bijection, this proposal identifies all the infinite computable sets the finite computable sets are viewed as trivial. According to Rogers, the sets of interest in recursion theory are the noncomputable sets, partitioned into equivalence classes by computable bijections of the natural numbers. Professional organizations[edit] The main professional organization for recursion theory is the Association for Symbolic Logic , which holds several research conferences each year. The interdisciplinary research Association Computability in Europe CiE also organizes a series of annual conferences.

2: Computability theory - Wikipedia

[So2] R. I. SOARS, "Recursively Enumerable Sets and Degrees," Springer-Verlag, Berlin/ Heidelberg/New York/Tokyo, [St] M. STOB, Invariance of properties under automorphisms of the lattice of recursively enumerable sets, Pacific J. Math. (),

3: Maximal set - Wikipedia

This work explores the connection between the lattice of recursively enumerable (r.e.) sets and the r.e. Turing degrees. Cholak presents a degree-theoretic technique for constructing both automorphisms of the lattice of r.e. sets and isomorphisms between various substructures of the lattice.

4: CiteSeerX â€” Citation Query Automorphisms of the lattice of recursively enumerable sets

Automorphism, recursively enumerable, promptly simple. This research was conducted while the first author was a student associate and the other authors were members of the Mathematical Sciences Research Institute (MSRI).

5: Recursively enumerable set - Wikipedia

Invariance of properties under automorphisms of the lattice of recursively enumerable sets. Stob, Michael, Pacific Journal of Mathematics, Maximal Vector Spaces Under Automorphisms of the Lattice of Recursively Enumerable Vector Spaces Kalantari, Iraj and Retzlaff, Allen, Journal of Symbolic Logic,

6: Automorphisms of the Lattice of Recursively Enumerable Sets

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A set X of nonnegative integers is computably enumerable (c.e.), also called recursively enumerable (r.e.), if there is a computable method to list its elements. Let E denote the structure of the computably enumerable sets under inclusion, E = (fW e g e2! ; `).

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