Department of Mathematics of the George Washington University

Math 6270-10 (CRN 95062): Topics in Logic

Algorithmic Learning. Set Theory

Fall 2011

Tu 3:45–6:15p.m.

Monroe Hall (2115 G Street), Room 267

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We will focus on two topics: algorithmic learning theory and set theory.

Algorithmic Learning Theory. By exploiting the concepts and methods of computability theory, we present a mathematical framework for the study of learning. We adopt E.M. Gold's learning paradigm, known as identification in the limit. It is intended as a model of language acquisition by children. We present explanatory learning and behaviorally correct learning. We study learning from all data, that is, learning from an informant, and learning from positive data only, that is, learning from text, as well as the intermediate concepts of learning. In particular, we investigate the learnability of classes of substructures of certain algebraic structures.

Set Theory. Cantor proved that there are infinitely many infinities. He showed that, while there are as many rational numbers as natural numbers, there are more real numbers than natural numbers. Is there an intermediate infinity? A negative answer to this question is known as the continuum hypothesis. In 1963, Paul Cohen obtained a dramatic result, which was "rather unsatisfactory to an average mathematician," by establishing that the continuum hypothesis is independent, that is, neither provable nor refutable from the ordinary set theoretic axioms. Another mathematical principle which the ordinary set theoretic axioms fail to settle is the axiom of choice. The independence results use the forcing technique for which Cohen won the Fields Medal.

Required Background

Mathematical maturity and familiarity with the notion of an algorithm. Math 272 can be taken for credit repeatedly. Advanced undergraduate students may also take this course for credit.

Course Material

All reading material will be provided in class. Here are some references:

Systems That Learn, D. Osherson, M. Stob, and S. Weinstein, MIT Press, 1986.

Systems That Learn, 2nd Edition, S. Jain, D. Osherson, J.S. Royer, and A. Sharma, MIT Press, 1999.

Induction, Algorithmic Learning Theory, and Philosophy, M. Friend, N.B. Goethe, V. Harizanov, Springer, 2007.

Set Theory, K. Kunen, Elsevier, 1995.

Learning Outcomes

As a result of completing this course students should be able to:

1. Identify computably enumerable languages inferable from text, from an informant, and from switching type of information;
2. Compare and contrast different convergence criteria such as explanatory learning and behaviorally correct learning;
3. Apply axioms of Zermelo-Frankel set theory to derive familiar mathematical results;
4. Design and analyze various set theoretic models satisfying certain axioms and principles.

Grading

Based on class participation and in-class presentation (30%), take-home assignments (50%), and final take-home exam (20%).