MATH 6010: Computability Theory

MWF 12:00-12:50 pm, ECCR 110

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Office hours: Monday 3 – 4 pm, Tuesday 10 – 11 am, Wednesday 3 – 4 pm

Course description. Computability theory is a part of mathematical logic and of computer science. Informally it is the study of what can be calculated by a modern computer. Historically the question of computability actually goes back to before the existence of computers. For example, in 1900 David Hilbert asked for an algorithm that decides whether a given polynomial with integer coefficients has a root in the integers. He probably would have been surprised to see that in 1970 Yuri Matiyasevich showed that no such algorithm exists, that is, Hilbert's Tenth Problem is not solvable.

In this course we study the basics of computability theory and give some applications following this outline:

(1) Finite automata, Turing machines (models of computation and language recognition)
(2) Partial recursive functions, recursively enumerable sets
(3) Halting problem, unsolvable problems in algebra (word problem)
(4) Oracles and relativization (Turing degrees, jump operator)
(5) Arithmetical hierarchy
(6) Post's problem and the finite injury priority method

Assignments. Each week I will hand out homework problems. Please send in solutions in pdf. Please use "Math 6010 - assignment n" as title for the mail for the n-th assignment. Additionally I will ask you to give short presentations in class.

References. There is no required text for this course. The following are suggested references:

(1) Hopcroft, John; Motwani, Rajeev; Ullman, Jeffrey. Introduction to automata theory, languages, and computation. Pearson, 3rd edition, 2006.
(2) Odifreddi, Piergiorgio. Classical recursion theory. North-Holland Publishing Co., Amsterdam, 1989.
(3) Sipser, Michael. Introduction to the theory of computation. Thomson Course Technology, Boston, 2nd edition, 2006.
(4) Soare, Robert I. Recursively enumerable sets and degrees. Springer-Verlag, Berlin, 1987.

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