Advanced Computability Theory

Course definition:

What is a Computation?

- *Is there a unique approach to express a computation?*
- *Is there a finite manner to state the rules for a computation?*
- *Is there termination condition for a computation?*

What is the power of Computation?

- *Can we write a program that its output is a copy of itself?*
- *Can we write a program to decide when a program halts on a specific input?*
- *Can we write a program to determine beautifulness of a building?*

Computability theory is the mathematical modeling and studying of computation. This theory provides computer science in terms of concepts and models for thinking about the power of computation. By using computability theory we able to classify the problems (or functions, or sets, or languages) to some classes and find a measuring tool for comparing problems in terms of limits and power of computation.

We start this course by a simple language contains three instructions, *Increment*, *Decrement* and *Conditional Branch* (or *jump*). Based on this language we define the computation and computable functions. In the next step we define primitive recursive functions and PRC classes and some other operators to enhance the power of computation. By using these basic concepts we study *The Halting Problem, Universality, Recursively Enumerable Sets, The Parameter Theorem, Diagonalization and Reducibility, Rice's Theorem and The Recursion Theorem*. Finally we investigate the relation among different models of computations. Especially we study *Turing machine* and show that the Turing machine equals to the simple proposed language.

Note that in this course we **don't study the complexity theory**. We **don't study the class of P and NP**. We **don't study Logic**. We just focus on the computability theory.

Text Book:

***Computability, Complexity and Languages**, Fundamentals of Theoretical Computer Science, by* Martin D. Davis, Ron Sigal, Elaine J. Weyuker, Second edition, 1994.

Prerequisites: just Basic Mathematics. However, knowing the automata theory and Turing machine can be helpful.

Lectures: Sunday and Tuesday 9: 30-11: 00

Evaluating:

- 40%   Homework
- 60%   Final exam

For further information about the course visit me in my office or send an email to mdmonfared@iasbs.ac.ir.