Computing Science Course Outlines 2020 Spring

CMPT 409 - D100 Special Topics in Theoretical Computing Science

Instructor(s): Eugenia Ternovska

Calendar Objective/Description:
Current topics in theoretical computing science depending on faculty and student interest.

Instructor's Objectives:
Cross-listed with CMPT 701

This course is on theoretical foundations of Computer Science. It provides insights into the nature and limitations of computation and logical reasoning.

The first part deals with fundamental theoretical results in logic. It includes first-order logic (syntax and semantics), the completeness theorem for first-order logic, undecidability of first-order logic, Peano Arithmetic, compactness, and Lowenheim-Skolem theorems. We will take a pick into how complexity classes can be characterized in logic, on the example of Fagin's theorem for NP.

The second part starts with Register machines as a model of computation and proceeds to the theory of primitive recursive, and then recursive, functions and relations. We use the technique of diagonalization several times in the course, in particular to show the existence of non-enumerable sets. We study the existence of algorithms (effective computational procedures) for solving decision problems. In particular, we learn about the halting problem, for which we prove that no algorithm can solve it. We show that non-computability of many problems follows from a single result, Rice's theorem. We consider Universal functions, Decidability theorem and several result illustrating incompleteness phenomena in mathematics and theory of computation including Tarski's theorem and Godel's Incompleteness Theorems.

There is no required textbook. A list of recommended references will be provided. As the main reference, we will use the lecture notes of Stephen A. Cook which will be posted on the course website.

Prerequisites:
CMPT 307.

Topics:
- Syntax and semantics of propositional and predicate calculus
- Completeness of Gentzen proof systems
- Formal theories, nonstandard models
- Recursive and primitive recursive functions, Computability
- Church-Turing thesis
- Computationally unsolvable problems
- Recursively enumerable sets
- Godel Incompleteness Theorems

Grading:
To be announced in the first week of classes.
Reference Books:

Academic Honesty Statement::
Academic honesty plays a key role in our efforts to maintain a high standard of academic excellence and integrity. Students are advised that ALL acts of intellectual dishonesty will be handled in accordance with the SFU Academic Honesty and Student Conduct Policies (http://www.sfu.ca/policies/gazette/student.html).