MPhil in Advanced Computer Science
Denotational Semantics

Leader: Marcelo Fiore (course lecturer)
Timing: Michaelmas
Prerequisites: Basic computer science and mathematical background
Structure: 8 lectures + 4 exercise classes

AIMS
This module aims to introduce domain theory and denotational semantics, and to show how they provide a mathematical basis for reasoning about the behaviour of programming languages.

SYLLABUS

• **Introduction.** The denotational approach to the semantics of programming languages. Recursively defined objects as limits of successive approximations.

• **Least fixed points.** Complete partial orders (cpos) and least elements. Continuous functions and least fixed points.

• **Constructions on domains.** Flat domains. Product domains. Function domains.

• **Scott induction.** Chain-closed and admissible subsets of cpos and domains. Scott’s fixed-point induction principle.

• **PCF.** The Scott-Plotkin language PCF. Evaluation. Contextual equivalence.

• **Denotational semantics of PCF.** Denotation of types and terms. Compositionality. Soundness with respect to evaluation.

• **Relating denotational and operational semantics.** Formal approximation relation and its fundamental property. Computational adequacy of the PCF denotational semantics with respect to evaluation. Extensionality properties of contextual equivalence.

• **Full abstraction.** Failure of full abstraction for the domain model. PCF with parallel or.

OBJECTIVES
At the end of the course students should

• be familiar with basic domain theory: cpos, continuous functions, admissible subsets, least fixed points, basic constructions on domains;

• be able to give denotational semantics to simple programming languages with simple types;
• be able to apply denotational semantics; in particular, to understand the use of least fixed points to model recursive programs and be able to reason about least fixed points and simple recursive programs using fixed point induction;

• understand the issues concerning the relation between denotational and operational semantics, adequacy and full abstraction, especially with respect to the language PCF.

COURSEWORK
Exercises will be provided.

PRACTICAL WORK
N/A

ASSESSMENT
The course will be assessed by means of a written test to be set and marked by the course lecturer.

RECOMMENDED READING
Books


Papers


Last updated: July 2010