DD2457 Program Semantics and Analysis 6.0 credits

Programsemantik och programanalys

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

The official course syllabus is valid from the spring semester 2022 in accordance with Head of School decision: J-2021-2306.Decision date: 14/10/2021

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Computer Science and Engineering

Specific prerequisites

Single course students:

DD1337 Programming, DD1338 Algorithms and Data Structures, SF1630 Discrete Mathematics, DD1350 Logic for Computer Scienceor corresponding courses.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The overall aim of the course is to study the main semantic styles used for capturing the meaning of programs in a formal way, namely operational semantics, denotational semantics and axiomatic semantics, compare their strengths and weaknesses, and use these semantics for program analysis, optimisation and verification, both in theory and as a basis for software tools.

The successful student will be able to perform constructions such as:

* Construct the state space of a program as a basis for program behaviour analysis through state space exploration.

* Translate programs to abstract machine code, and execute the latter.

* Compute the denotation of a program.

* As above, but in abstract domains.

* Extend a programming language with new language features, and extend its semantics and abstract machine implementations accordingly.

* Suggest and justify program transformations supported by a suitable program analysis.

* Specify and verify programs in Hoare logic.

* Generate verification conditions from a program with annotated while loops.

as well as be able to formally establish results such as:

* Relate different semantic styles.

* Prove language properties such as determinism and termination.

* Show correctness of a given program transformation by proving equivalence of the original and the transformed program.

* Show properties of a given semantics.

For passing the course, a student has to demonstrate proficiency with problems of the first type; for the highest grade he/she has to be equally proficient at the remaining types of problems.

Course contents

* Part I. Operational Semantics and Language Implementation: natural semantics, structural operational semantics, abstract machines, correctness of language implementation.

* Part II. Denotational Semantics and Program Analysis: denotational semantics, fixed-point theory, program analysis and transformation.

* Part III. Axiomatic Semantics and Program Verification: axiomatic semantics, program specification and verification, weakest pre-conditions, verification condition generation.

Examination

- HEM1 - Exercises, 2.0 credits, grading scale: P, F
- TEN1 - Examination, 2.0 credits, grading scale: A, B, C, D, E, FX, F
- LAB1 - Laboratory Work, 2.0 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

* LAB1 - Laboratory work, 2,0 hp, grade: Pass/fail

* HEM1 - Exercises, 2,0 hp, grade: Pass/fail

* TEN1 - Examination, 2,0 hp, grade: A, B, C, D, E, FX, F

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.