Lecture 1: Introduction

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Type Systems and Programming Languages
General Information

Class code: CS546
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Content

- An introduction into the research field of programming languages
- Formal systems for describing and understanding programming languages
- Programming language features and semantics
- Static analysis: techniques for automatically reasoning about programs
- Functional programming
- Programming languages research papers
Goals

1. Learn functional programming in OCaml
2. Study lambda calculus
3. Use it to describe functional and imperative features of programming languages
4. Study language semantics as a way to describe the meaning of programs
5. Study static analysis techniques,
   - Type systems
   - Data flow analysis
   - Alias analysis
6. Learn program verification
   - Hoare logic
What you need to do

- Two lectures per week
- Five homework assignments during the first half of the semester
  - Small programs in Ocaml
  - Improve understanding of material
  - Personal work (no teams)
  - Expected to take about 4–8 hours per assignment
  - Homeworks will be graded automatically
    - No partial credit for code that does not compile or work
- One mid-term exam
  - Exam material is everything covered in lectures until the mid-term
- One term project
  - Learn and use LLVM (C++)
  - Implement a static code analysis and transformation
  - Grade based on (i) implementation, (ii) project presentation, (iii) report
- Final exam
  - Exam material is everything taught during the term
Grading

- Grade consists of:
  - Homeworks: 3 points
  - Project & presentation: 3 points
  - Mid-term exam: 3 points
  - Final exam: 3 points

- Requirement for passing grade is 50% on the final exam

- There are two bonus points (max grade is 12/10)
  - Scores over 10 will be truncated to 10
Books and other reading material

- Types and Programming Languages, B. Pierce
  - http://www.cis.upenn.edu/~bcpierce/tapl/
- Logic in Computer Science: Modeling and Reasoning about Systems, Huth and Ryan
- Principles of Program Analysis, Nielson, Nielson, and Hankin
- Ocaml Resources
  - Main page: http://caml.inria.fr/
  - Tutorial: http://www.ocaml-tutorial.org/
- Other online PL texts
  http://www.cs.uu.nl/wiki/Techno/ProgrammingLanguageTheoryTextsOnline
- Papers:
  http://www.cs.jhu.edu/%7Ejason/advice/how-to-read-a-paper.html
  http://www.eecs.harvard.edu/%7Emichaelm/postscripts/ReadPaper.pdf
Class dependencies

- **Required**
  - http://www.csd.uoc.gr/~hy255
  - http://www.csd.uoc.gr/~hy280

- **Recommended**
  - http://www.csd.uoc.gr/~hy180
Introduction to OCaml

- A functional language in the family of ML
- Object oriented
- Supports imperative code
  - Not in this class
- Good for scripting, quick development
- Usually, if it compiles, it works
  - The benefit of type systems!