

# Lecture 1: Introduction

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Type Systems and Programming Languages



# General Information

Class code: CS546  
Instructor: Polyvios Pratikakis  
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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/~Ejason/advice/how-to-read-a-paper.html>  
<http://www.eecs.harvard.edu/~Emichaelm/postscripts/ReadPaper.pdf>  
<http://www.cs.columbia.edu/~Ehgs/netbib/efficientReading.pdf>



# Class dependencies

- Required
  - ▶ <http://www.csd.uoc.gr/~hy255>
  - ▶ <http://www.csd.uoc.gr/~hy280>
- Recommended
  - ▶ <http://www.csd.uoc.gr/~hy180>
  - ▶ <http://www.csd.uoc.gr/~hy340>





# Next

- 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!

