

COSE212: Programming Languages

Lecture 0 — Course Overview

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Basic Information

Instructor: Hakjoo Oh

- **Position:** Associate professor in CS, Korea University
- **Expertise:** Software Analysis, Programming Languages
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TAs:

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- **Use blackboard when asking questions**

About This Course

This is not an introductory course on programming.

- You will not learn particular programming languages



- You will not learn how to write programs in those languages

Instead, in this course you will learn

- how programming languages are designed and implemented
- fundamental principles of modern programming languages
- thinking formally and rigorously

To succeed in this course, you must

- have basic programming skills
- be familiar with at least two PLs (e.g., C, Java)
- have taken Theory of Computation, Discrete Math, etc
- be prepared to learn new things

Design and Implementation of Programming Languages

You will learn programming language concepts by designing and implementing our own programming language system.

- We will define a programming language. For example, “factorial” is written in our language as follows:

```
let x = read in
letrec fact(n) =
  if iszero n then 1
  else ((fact (n-1)) * n)
in (fact x)
```

- We will design and implement an interpreter for the language:

Program \rightarrow Interpreter \rightarrow Result

- We will design and implement a type checker for the language:

Program \rightarrow Type Checker \rightarrow Safe/Unsafe

Functional Programming

The secondary goal of this course is to be familiarized with functional programming, which encourages using pure functions rather than making side effects.

- Functional programming is one of the major programming paradigms adopted in modern programming languages such as Python, JavaScript, C++, Java8, Scala, Go, etc.
- In this course, you will learn functional programming with OCaml¹ and use it to implement programming languages.

¹<https://ocaml.org>

Topics

- **Part 1 (Preliminaries):** inductive definition, basics of functional programming, recursive and higher-order programming
- **Part 2 (Basic concepts):** syntax, semantics, naming, binding, scoping, environment, interpreters, states, side-effects, store, reference, mutable variables, parameter passing
- **Part 3 (Advanced concepts):** type system, typing rules, type checking, soundness/completeness, automatic type inference, polymorphic type system, lambda calculus, program synthesis

Course Materials

- Self-contained slides will be provided.
 - ▶ You are required to attend every class (otherwise, it'd be difficult to catch up)
- Hakjoo Oh. Introduction to Principles of Programming Languages. (pdf will be provided)
- (Supplementary) Essentials of Programming Languages (Third Edition) by Daniel P. Friedman and Mitchell Wand. MIT Press.



Grading

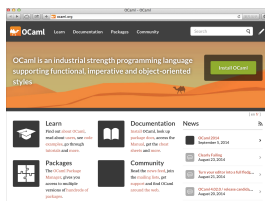
- Homework assignments – 90%
 - ▶ 5–6 programming assignments
 - ▶ No late submissions will be accepted.
- Attendance – 10%

Assignment Policy / Academic Integrity

- **All assignments must be your own work.**
- Discussion with fellow students is encouraged and you can discuss how to approach the problem. However, your code must be your own.
 - ▶ Discussion must be limited to general discussion and must not involve details of how to write code.
 - ▶ You must write your code by yourself and must not look at someone else's code (including ones on the web).
 - ▶ Do not allow other students to copy your code.
 - ▶ Do not post your code on the public web.
- **Cheating (violating above rules) gets you 0 for the entire HW score.**
 - ▶ We use automatic technology for detecting clones

Programming in ML

- ML is a general-purpose programming language, reflecting the core research achievements in the field of programming languages.
 - ▶ higher-order functions
 - ▶ static typing and automatic type inference
 - ▶ parametric polymorphism
 - ▶ algebraic data types and pattern matching
 - ▶ automatic garbage collection
- ML inspired the design of modern programming languages.
 - ▶ C#, F#, Scala, Java, JavaScript, Haskell, Rust, etc
- We use OCaml, a French dialect of ML:



<http://ocaml.org>

Web-based Programming Environment

We will provide a web-based programming environment, where you do and submit homework assignments.

The screenshot shows a web-based programming environment interface. At the top, there is a navigation bar with a hamburger menu icon, the text "Home", the course title "COSE212 - Programming Language", and links for "Sign Up" and "Login". On the left side, there is a sidebar menu with sections: "Assignment Policy", "Homework Select", "Feedback", and "Option". The "Option" section contains three dropdown menus: "Font Size" (set to "18px"), "Theme" (set to "White"), and "Mode" (set to "REPL"). The main area is a code editor with a dark background and light text. The code is in OCaml and defines three functions: `inc_all`, `square_all`, and `map`. The code is as follows:

```
1 let rec inc_all l =
2   match l with
3   | [] -> []
4   | hd::tl -> (hd+1)::(inc_all tl)
5
6 let rec square_all l =
7   match l with
8   | [] -> []
9   | hd::tl -> (hd*hd)::(square_all tl)
10
11 let rec map f l =
12   match l with
13   | [] -> []
14   | hd::tl -> (f hd)::(map f tl)
```

Below the code editor is a "Compile Result Area". At the bottom of the interface, there are two buttons: a green "Run" button and a blue "Save" button.

Questions?