

CS 320: Principles of Programming Languages

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Introduction, Class Structure, Logistics, and Objectives

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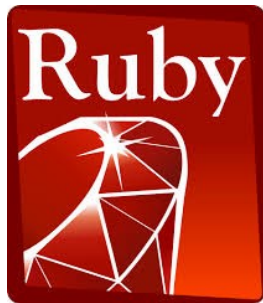
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(Fall 2019)

(Spring 2020)

What is your favorite language?



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Why is it your favorite?

WHY?

- Easy to program?
- Good debugging environment?
- Large amount of standard libraries?
- Syntax?
- Language you know the most?
- Performance (or other runtime characteristics)?
- Validation mechanisms (type checking, verification)?
- Garbage collection?

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What do we study in Programming Languages?

PL

➤ Language Design

- Programming Constructs, Abstractions

➤ Formal mechanisms to reason about and specify programs / languages

- Type Systems, Verification

➤ Compiler Design

- Optimizations, Program Analysis, JIT

➤ Language Runtime Design

- Virtual Machines, Garbage Collection, JIT, Interpreters

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Why studying Programming Languages?



➤ Learn how to learn

- Understanding the different design choices involved in the design of a programming language will help you learn more easily different programming languages.

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➤ Improve your programming skills

- Learning how a programming language is designed will help you to think at a different level of abstraction.

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➤ Writing better code

- Understanding how your programs are transformed and executed by compilers and interpreters will help you design programs that are more reliable, secure and efficient.



What will we look at?

- We will study the functional programming paradigm
- We will study the different features and constructs of programming languages,
- We will look at more formal ways to compare different languages design choices,
- We will experiment with building our own language.

Topics Covered (tentative)

- Functional Programming
- Language Design and Evolution
- Syntax and Semantics
- Names, Bindings, and Scopes
- Data Types
- Expressions and Assignment Statements
- Control Structures
- Subprograms and their Implementation
- Exceptions and Event Handling (tentative)

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Piazza Etiquette

- Form questions in a general manner
- Do not out / paste your code
 - *Try to “distill” your question*
- You can post anonymously
 - *Only teaching staff will know your identity*

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I have a question!

- Ask on Piazza
- If you send an email use [CS320] in the subject line <https://powcoder.com>
- Come to office hours [Add WeChat powcoder](#)

Labs

- Attendance will be graded (participation)
- 30 Minutes of Presentation
- 20 Minutes of Q/A

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Programming Language we will use



www.ocaml.org

Assignment and Homework submissions

- Submission via *Gradescope*
 - More details to come
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Structure of classes

- Functional Programming in OCaml (first few weeks)
- Concepts of Programming languages

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What is a Functional Language

A functional language:

- defines programs in a way similar to the one we use to define mathematical functions,
- avoids the use of mutable states (states that can change) in describing what a program should do.

In a functional language, the information is maintained by the computation.

Thinking Functionally

In imperative languages like Java or C, you get most work done by **changing the state of the memory**, via variables or data structures

```
temp  = pair.x;  
pair.x = pair.y;  
pair.y = temp;
```

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Commands **modify** or **change** the state – in this case an existing data structure (pair)

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In functional languages you get most work done by **producing something new**


```
let  
  (x,y) = pair  
in  
  (y,x)
```

Commands **analyze** an existing data (pair) and produce a new data (y,x)

Why study functional programming?

1. Learning a different style of programming teach you that programming transcends programming in a language
2. Functional languages predict the future
<https://powcoder.com>
3. Functional languages are more and more used in industry
4. Functional languages help writing correct code

Learning a different style of programming teach you that programming transcends programming in a language

- It is similar to human languages.
- Speaking a language allows one to communicate but in different situation one may need very different languages
 - Learning another language helps understanding your native language better
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- Language** 言語 (Gothic script), Linguaggio (Italian), Язык (Russian), Γλώσσα (Greek), Język (Polish), မာၤစီၤစီၤ (Burmese), بولی (Urdu), لسان (Persian), Lenguaje (Spanish), ভাষা (Bengali), 言語 (Japanese), Ngôn ngữ (Vietnamese), اللغة (Arabic), Wika (Hawaiian), ଶାସନ (Odia), 𑌕𑌃𑌔𑌰 (Georgian), 언어 (Korean), Linguagem (Portuguese), 语言 (Chinese), 𐌆𐌿𐌸𐌸𐌹 (Old Norse), Bahasa (Malay), Sprache (German).
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Alan J. Perlis

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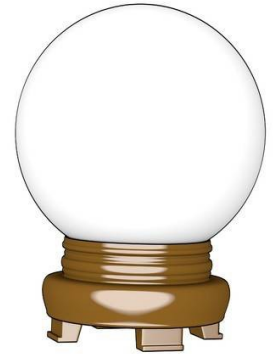
1922-1990

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“A language that doesn't affect the way you think about programming is not worth knowing.”

First recipient of the Turing Award

for his “influence in the area of advanced programming techniques and compiler construction”

Functional languages predict the future



- Garbage collection Java [1995], LISP [1958]
- Generics Java 5 [2004], ML [1990]
- Higher-order functions
C#3.0 [2007], Java 8 [2014], LISP [1958]
- Type inference
C++11 [2011], Java 7 [2011] and ML [1990]
- What's next?

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Functional languages are more and more used in industry

- Java 8 
- F#, C# 3.0, LINQ   **Assignment Project Exam Help**
- Scala    <https://powcoder.com>
- Haskell    **Add WeChat powcoder**
- Erlang   
- OCaml   
<https://ocaml.org/learn/companies.html>  **Jane Street**

Functional languages help writing correct code

Abstraction:

Functional languages - mathematical functions

Imperative languages - mutable state

Imperative languages <https://powcoder.com>

Machines are good at complex manipulations of states, humans are not good at reason about them.

Functional languages

Variable never change values and functions have no side-effect, this makes it easier to reason about them.



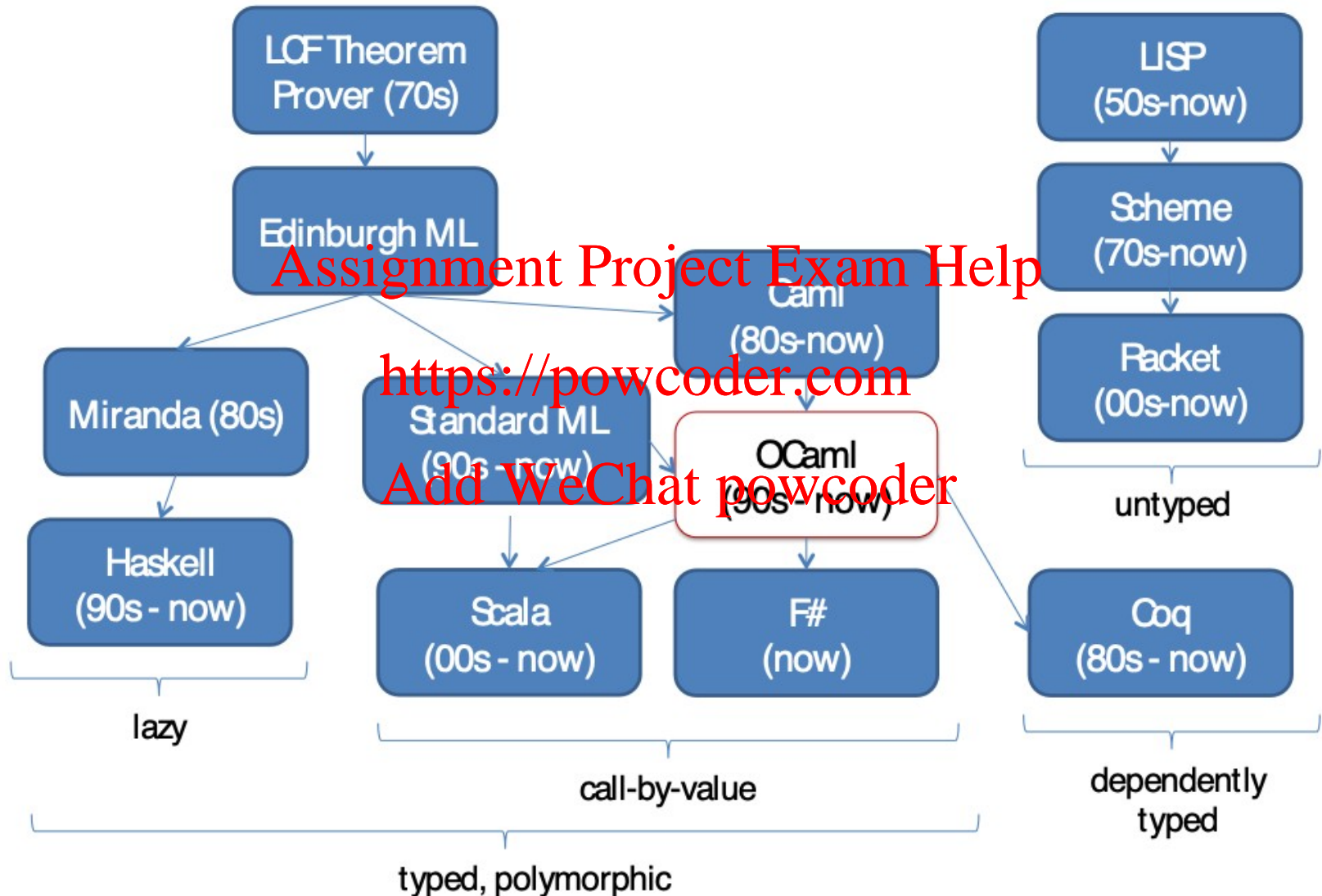
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A good functional language part of the ML family.

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- Small core language,
- Supports first-class higher order functions,
- Lexically scoped
- Statically strongly typed
- Type inference
- It has a good community: ocaml.org

Vastly Abbreviated FP Genealogy



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Questions?

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