



PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

CSE341: Programming Languages

Lecture 26 Course Victory Lap

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Final Exam

As also indicated in class-list email:

- Next **Thursday, 8:30-10:20AM**
- Intention is to focus primarily on material since the midterm
 - Including topics on homeworks and not on homeworks
 - May also have a little ML, just like the course has had
- You will need to write code and English

Victory Lap

A victory lap is an extra trip around the track

- By the exhausted victors (us) 😊

Review course goals

- Slides from Introduction and Course-Motivation

Some big themes and perspectives

- Stuff for five years from now more than for the final

Time for open Q&A

Do your course evaluations!!!



Thank you!

- **Huge** thank-you to your TAs
 - Great team effort
 - Really invested in a successful course

Thank you!

- And a huge thank you to all of **you**
 - Great attitude about a very different view of software
 - Good class attendance and questions
 - Occasionally laughed at stuff 😊
- Computer science ought to be challenging and fun!

[From Lecture 1]

- Many essential concepts relevant in any programming language
 - And how these pieces fit together
- Use ML, Racket, and Ruby languages:
 - They let many of the concepts “shine”
 - Using multiple languages shows how the same concept can “look different” or actually be slightly different
 - In many ways simpler than Java
- Big focus on *functional programming*
 - Not using *mutation* (assignment statements) (!)
 - Using *first-class functions* (can’t explain that yet)
 - But many other topics too

[From Lecture 1]

Learning to think about software in this “PL” way will make you a better programmer even if/when you go back to old ways

It will also give you the mental tools and experience you need for a lifetime of confidently picking up new languages and ideas

[Somewhat in the style of *The Karate Kid* movies (1984, 2010)]



[From Course Motivation]

- No such thing as a “best” PL
- Fundamental concepts easier to teach in some (multiple) PLs
- A good PL is a relevant, elegant interface for writing software
 - There is no substitute for precise understanding of PL semantics
- Functional languages have been on the leading edge for decades
 - Ideas have been absorbed by the mainstream, but very slowly
 - First-class functions and avoiding mutation increasingly essential
 - Meanwhile, use the ideas to be a better C/Java/PHP hacker
- Many great alternatives to ML, Racket, and Ruby, but each was chosen for a reason and for how they complement each other

[From Course Motivation]

SML, Racket, and Ruby are a useful *combination* for us

	dynamically typed	statically typed
functional	Racket	SML
object-oriented	Ruby	Java

ML: polymorphic types, pattern-matching, abstract types & modules

Racket: dynamic typing, “good” macros, minimalist syntax, eval

Ruby: classes but not types, very OOP, mixins

[and much more]

Really wish we had more time:

Haskell: laziness, purity, type classes, monads

Prolog: unification and backtracking

[and much more]

Benefits of No Mutation

[An incomplete list]

1. Can freely alias or copy values/objects: Unit 1
2. More functions/modules are equivalent: Unit 4
3. No need to make local copies of data: Unit 5
4. Depth subtyping is sound: Unit 8

State updates are appropriate when you are modeling a phenomenon that is inherently state-based

- A fold over a collection (e.g., summing a list) is not!

Some other highlights

- Function closures are *really* powerful and convenient...
 - ... and implementing them is not magic
- Datatypes and pattern-matching are really convenient...
 - ... and exactly the opposite of OOP decomposition
- Sound static typing prevents certain errors...
 - ... and is inherently approximate
- Subtyping and generics allow different kinds of code reuse...
 - ... and combine synergistically
- Modularity is really important; languages can help

From the syllabus

Successful course participants will:

- Internalize an accurate understanding of what functional and object-oriented programs mean
- Develop the skills necessary to learn new programming languages quickly
- Master specific language concepts such that they can recognize them in strange guises
- Learn to evaluate the power and elegance of programming languages and their constructs
- Attain reasonable proficiency in the ML, Racket, and Ruby languages and, as a by-product, become more proficient in languages they already know

What now?

- Use what you learned whenever you reason about software!
- CSE 401
- CSE 402

Does PL research (cf. uwplse.org) design new general-purpose languages? *Not really; it does cool stuff with same intellectual tools!*

Some current UW projects

- 3D-printing tools
- Checker framework
- Rosette
- Language for microfluidics
- Verified software written in Coq (which is quite SML-like)

The End

This really is my favorite course and it probably always will be



Don't be a stranger!

Time for ask-me-anything questions?