CS 360
Programming Languages
Victory Lap

Swift

JavaScript

Dart

CAR/CDR Pronunciation Guide

Function	Pronunciation	Alternate Name
CAR	*kar*	FIRST
CDR	*cou-der*	REST
CAAR	*ka-ar*	
CADR	*kae-der*	SECOND
CDAR	*cou-dar*	
CDDR	*cou-dih-der*	
CAAAR	*ka-a-ar*	
CAADR	*ka-ae-der*	
CADAR	*ka-dar*	
CADDR	*ka-dih-der*	THIRD
CDAAR	*cou-da-ar*	
CDADR	*cou-dae-der*	
CDDAR	*cou-dih-dar*	
CDDDR	*cou-did-dih-der*	
CADDDR	*ka-dih-dih-der*	FOURTH

and so on

Final Exam

- Monday, May 1, 5:30PM.
- Material will be split somewhat evenly between pre-midterm and post-midterm. (Possible slight emphasis on post-midterm).
  - Including topics on projects and not on projects.
- You will need to write code (Java, Racket) and English.

Final Exam

Topics will be a subset of the following:

- All the stuff from the midterm (Racket in general, box-and-pointer, closures, recursion/tail-recursion, no mutation, lexical/dynamic scoping)
- Delayed evaluation, thunks
- Streams
- Memoization
- Threading
- Mini-Racket interpreter (and interpreters in general)

Keys to the game:
Know what a topic is, what it's good for, what it's bad for, how to use it, how it relates to other topics, and how to code it.

Victory Lap

A victory lap is an extra trip around the track

- By the exhausted victors (us) ☺

Review course goals

- See if we met them.

Some big themes and perspectives

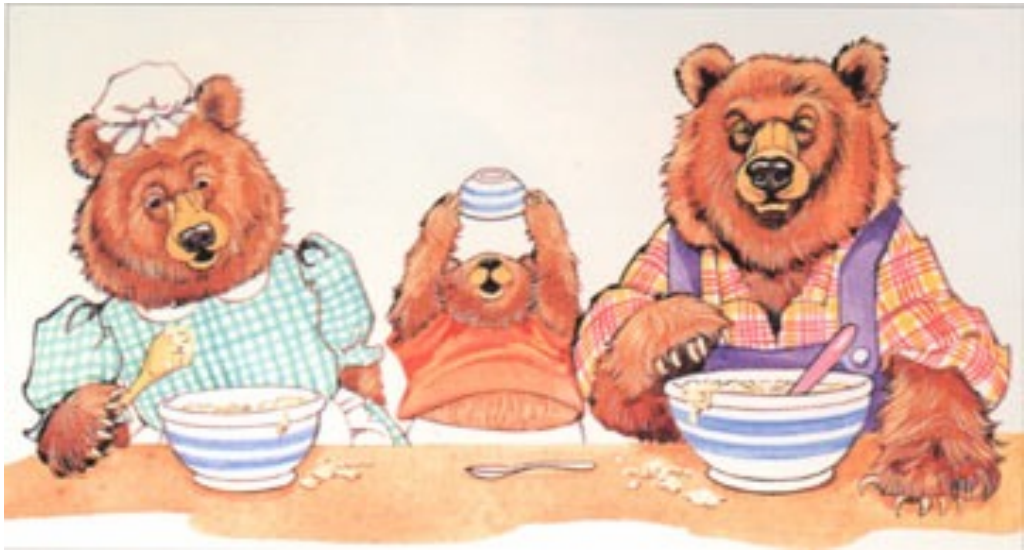
- Stuff for five years from now more than for the final.

Thank you!

- You all made this a great class!
  - Great attitude about a very different view of programming.
  - Good class attendance and questions.
  - Occasionally laughed at stuff ☺.

Thank you!

- My fourth time teaching this course; not my area of expertise. (But I had a great time!)
- Feedback is appreciated on projects, tests, and their respective difficulty (too hard, too easy, just right?)



[From Lecture 1]

We have 14 weeks to learn *the fundamental concepts* of programming languages.

With hard work, patience, and an open mind, this course makes you a much better programmer.

- Even in languages we won't use.
- Learn the core ideas around which *every* language is built, despite countless surface-level differences and variations.
- *Poor* course summary: "We learned Racket and Java."

[From Lecture 1]

- Focus on the essential concepts relevant in any programming language.
  - See how these pieces fit together.
- Use Racket and Java (possibly others) because:
  - They let many of the concepts "shine."
  - Using multiple languages shows how the same concept can "look different" or actually be slightly different in another language.
- A big focus on *functional programming*
  - No *mutation* (assignment statements) (!)
  - No loops! Only recursion!
  - Using *first-class functions* (can't explain that yet).

[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.

[From motivation lecture]

- A good mechanic might have a specialty, but also understands how “cars” (not 2014 Honda Civics) work.
  - And that the syntax---I mean upholstery color---isn’t essential.

- A good mechanical engineer really knows how cars work, how to get the most out of them, and how to design better ones.

- To learn how cars work, it may make sense to start with a classic design rather than the latest model.
  - A popular car may not be a good car for learning how cars work.

[From motivation lecture]

This course focuses as much as it can on semantics and idioms.

- Correct reasoning about programs, interfaces, and interpreters or compilers *requires* a precise knowledge of semantics.
  - Not "I ***think*** that conditional expressions might work like this."
  - Not "I like curly braces more than parentheses."
  - Much of software development is designing precise interfaces; what a PL means is a *really* good example.

- Idioms make you a better programmer.
  - Best to see in multiple settings, including where they shine.
  - See future languages in a clearer light.

[From motivation lecture]

- No such thing as a “best” PL.
- There are good general design principles for PLs.
- A good language is a relevant, crisp interface for writing software.
- Software leaders should know PL semantics and idioms.
- Learning PLs is not about syntactic tricks for small programs.
- Functional languages have been on the leading edge for decades.
  - Ideas get absorbed by the mainstream, but very slowly.
  - Meanwhile, use the ideas to be a better programmer in Java and Python.

Benefits of No Mutation

- Can freely alias or copy values/objects.

- No need to make local copies of data.

Allowing mutation is appropriate when you are modeling a phenomenon that is inherently state-based (meaning there are variables that hold the "state" of the system and will need to change.)

  - Performing an accumulation over a collection (e.g., summing a list) isn't!

Some other highlights

- Function closures are *really* powerful and convenient…
  - … and implementing them is not magic.

- Static typing (and static checking) prevents certain errors…
  - … but makes some types of code more complicated.

- Multi-threading can make really neat programs…
  - … but introduces a lot of sticky situations (synch, wait/notifyAll)
  - … partially addressed by event-driven programming.

From the syllabus

[Caveat: I wrote the goals, so not surprising I hope we met them.]

Successful course participants will:

- obtain 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 a number of popular programming languages, and,
- become more proficient in languages they already know

From the "so-called experts" ☺

- Once a decade or so, ACM/IEEE updates a "standard CS curriculum"
  - A specification of what every CS undergraduate degree should teach its students

- Last updated in 2013!
  - Let's take a look at a draft and see how well we did.
  - (Note that not everything in the PL section of the draft will be taught in a single course.)

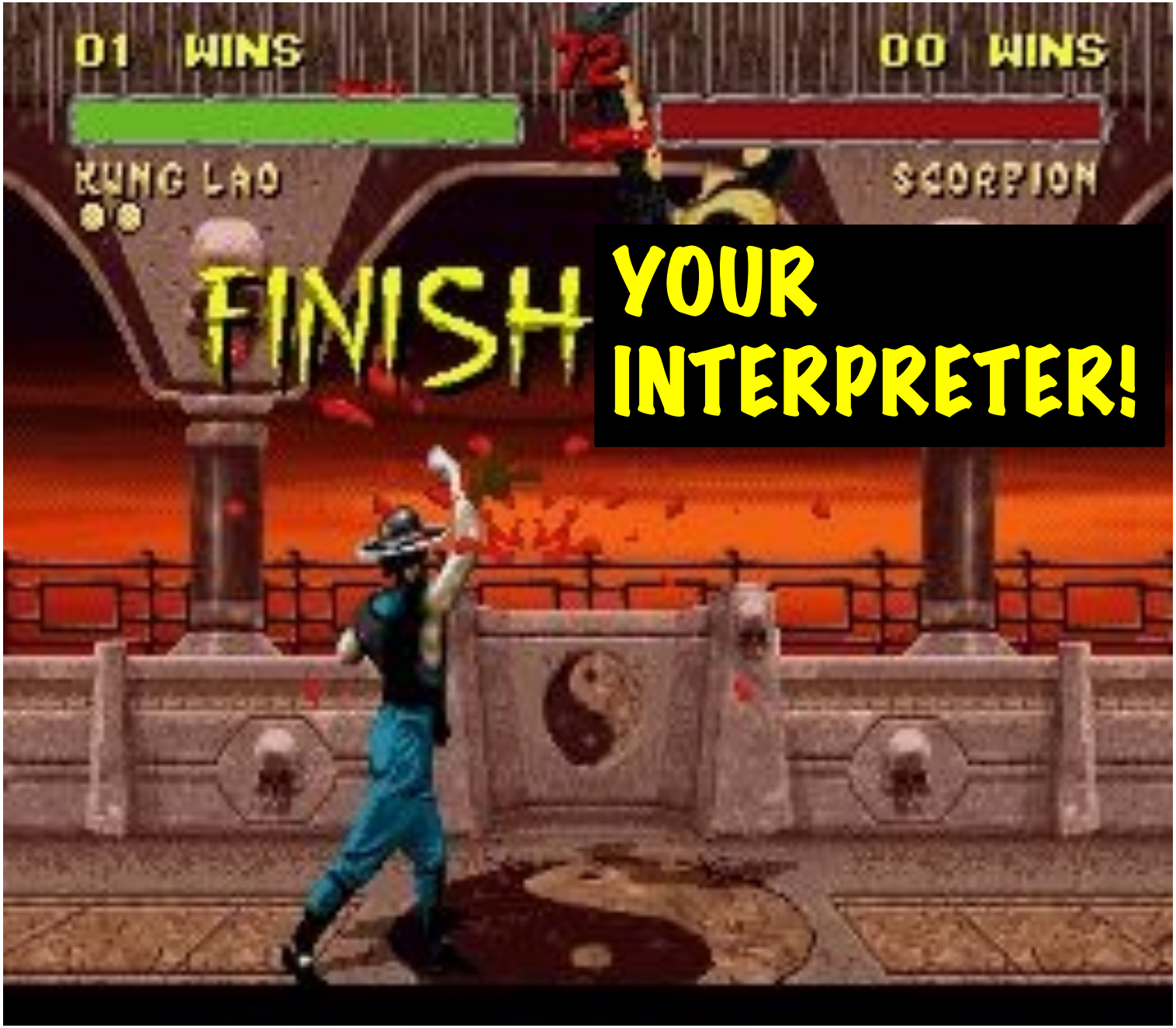
PL. Programming Languages (8 Core-Tier1 hours, 20 Core-Tier2 hours)

	Core-Tier1 hours	Core-Tier2 hours	Includes Electives
PL/Object-Oriented Programming	4	6	N
PL/Functional Programming	3	4	N
PL/Event-Driven and Reactive Programming		2	N
PL/Basic Type Systems	1	4	N
PL/Program Representation		1	N
PL/Language Translation and Execution		3	N
PL/Syntax Analysis			Y
PL/Compiler Semantic Analysis			Y
PL/Code Generation			Y
PL/Runtime Systems			Y
PL/Static Analysis			Y
PL/Advanced Programming Constructs			Y
PL/Concurrency and Parallelism			Y
PL/Type Systems			Y
PL/Formal Semantics			Y
PL/Language Pragmatics			Y
PL/Logic Programming			Y

What next?

- Take these ideas and use them in practice!
  - (But only where it makes sense.)
- Be confident when reading documentation, unfamiliar code, learning a {new PL, new PL library, new programming paradigm}.

- Stay in touch
  - Tell me when this class helps you out with something cool (seriously).
  - Ask me cool PL questions (may not always know the answer, but I can tell you where to find it).
  - Don't be a stranger: let me know how the rest of your time at Rhodes (and beyond!) goes… I really do like to know.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SCORPION
FINISH
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INTERPRETER!