Programming Languages

Course Motivation
(or, why we are spending so much time on a language that few people have heard of)

Adapted from
Dan Grossman's PL class, U. Washington

Course Motivation
(Did you think I forgot? ☺)

- Why learn languages that are quite different from Python or C++?
- Why learn the fundamental concepts that appear in all (most?) languages?
- Why focus on functional programming?

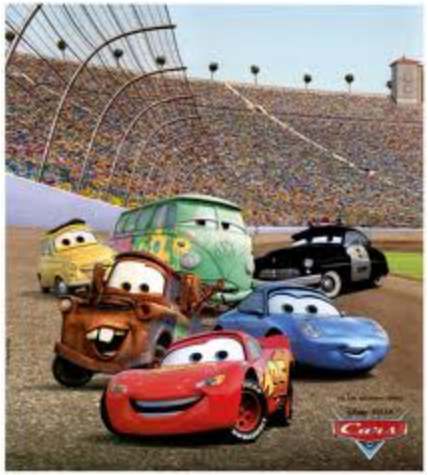
What is the best kind of car?

What is the best kind of shoes?

Cars / Shoes

Cars are used for rather different things:

- Winning the Indy 500
- Taking kids to soccer practice
- Off-roading
- Hauling a mattress
- Getting the wind in your hair
- Staying dry in the rain



Shoes:

- Playing basketball
- Going to a dance
- Going to the beach

More on cars

- A good mechanic might have a specialty, but also understands how “cars” (not 2004 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

All cars are the same

- To make it easier to rent cars, it's great that they all have steering wheels, brakes, windows, headlights, etc.
  - Yet it's still uncomfortable to learn a new one
- And maybe PLs are more like cars, trucks, boats, and bikes
- So are all PLs really the same…

Are all languages the same?

Yes:

- Any input-output behavior implementable in language X is implementable in language Y [Church-Turing thesis]
- Python, C++, Racket, and a language with one loop and three infinitely-large integers are "the same"
- Beware "the Turing tarpit"

Yes:

- Same fundamentals reappear: variables, abstraction, recursive definitions, …

No:

- The primitive/default in one language is awkward in another

A note on reality

Reasonable questions when deciding to use/learn a language:

- What libraries are available for reuse?
- What can get me a summer internship?
- What does my boss tell me to do?
- What is the de facto industry standard?
- What do I already know?

CS 360 by design does not deal with these questions

  - You have the rest of your life for that
  - And technology *leaders* affect the answers

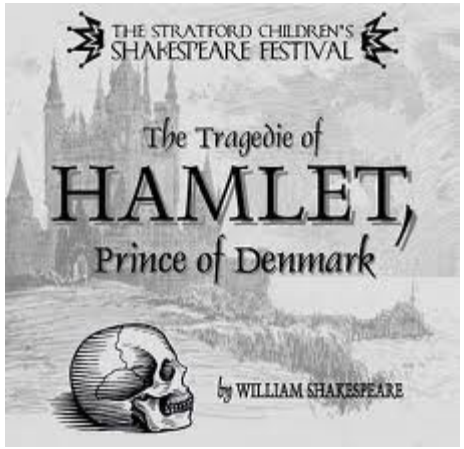
Why semantics and idioms

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 feel 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 Java in a clearer light even if I never show you Java

Hamlet



The play *Hamlet*:

- Is a beautiful work of art
- Teaches deep, eternal truths
- Is the source of some well-known sayings
- Makes you a better person

Continues to be studied (even in college) centuries later even though:

- The syntax is really annoying to many (yet rhythmic)
- There are more popular movies with some of the same lessons (just not done as well)
- Reading *Hamlet* will not get you a summer internship

Functional Programming

Okay, so why do we spend so much time with *functional languages*, i.e., languages where:

- Mutation is unavailable or discouraged
- Recursion expresses all forms of looping and iteration
- Higher-order functions are very convenient

Because:

1. These features are invaluable for correct, elegant, efficient software (great way to think about computation)
2. Functional languages have always been ahead of their time
3. Functional languages well-suited to where computing is going

Most of course is on (1), so a few minutes on (2) and (3) …

Ahead of their time

All of these were dismissed as “beautiful, worthless, slow things PL professors make you learn in school”

- Garbage collection (now used in Python, Java, …)
- Collections (i.e., lists) that can hold multiple data types at once (Python, Java through generics, C++ through templates)
- XML for universal data representation (like Racket/Scheme/LISP)
- Higher-order functions (Python, Ruby, JavaScript, more recent versions of C++, …)
- Recursion (a big fight in 1960 about this – I’m told ☺)

Somehow nobody notices the PL people were right all along.

Recent Surge

- Microsoft: F#, C# 3.0
- Scala (Twitter, LinkedIn, FourSquare)
- Java 8 (sometime soon?), C++ (now)
- MapReduce / Hadoop (everybody)
  - Avoiding side-effects essential for fault-tolerance here
- Haskell (dozens of small companies/teams)
- Erlang (distributed systems, Facebook chat)

Why a surge?

My best guesses:

- Concise, elegant, productive programming
- JavaScript, Python, Ruby helped break the Java/C/C++ hegemony
  - And these functional languages do some things better
- Avoiding mutation is *the* easiest way to make concurrent and parallel programming easier
- Sure, functional programming is still a small niche, but there is so much software in the world today even niches have room

Is this real programming?

- The way we're using Racket in this class can make the language seem almost “silly” precisely because lecture and homework focus on interesting language constructs

- “Real” programming needs file I/O, string operations, floating-point, graphics, project managers, testing frameworks, threads, build systems, …
  - Functional languages have all that and more
  - If we used C++ or Python the same way, those languages would seem “silly” too

Summary

- 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 C++ and Python.