

CSE 130 : Winter 2016

Programming Languages

Sorin Lerner
UC San Diego



Hi! My name is Sorin



Why study PL ? (discussion)

Why study PL ?

“A different language is a different vision of life”

- Fellini

- Hypothesis:

Programming **language** shapes programming **thought**

- Characteristics of a language affect how ideas can be expressed in the language

Course Goals



“Free your mind”

-Morpheus

You will learn several new

- languages and constructs
- ways to **describe** and **organize** computation

Yes, *you can* do that in Java/Assembly but ...

So what does studying PL buy me?

Enables you to create software that is

- Readable
- Correct
- Extendable
- Modifiable
- Reusable

So what does studying PL buy me?

Will help you learn new languages

- There was no Java (C#) 15 (10) years ago
- Will learn the **anatomy** of a PL
- Fundamental **building blocks** of languages reappear in different guises in different languages and different settings
- Re-learn the languages you already know

So what does studying PL buy me?

Enables you to design new languages
“who, me?”

Buried inside any **extensible** system is a PL

- Emacs: E-Lisp
- Word, Powerpoint: VBScript
- Quake: QuakeC
- Facebook: FBML, FBJS
- SQL, Renderman, LaTeX, XML...

So what does studying PL buy me?

Enables you to design new languages

“who, me?”

Companies develop general purpose PLs/paradigm!

- Google: MapReduce
- Mozilla: Rust
- RedHat: Ceylon
- Nvidia: CUDA

So what does studying PL buy me?

Enables you to better choose the right language

“but isn’t that decided by

- libraries,
- standards,
- and my boss ?”

Yes. Chicken-and-egg.



My goal: educate tomorrow’s tech leaders & bosses

So you’ll make considered, informed choices

So what does studying PL buy me?

Makes you look at things in different ways,
think outside of the box

Knowing language paradigms other than
traditional ones will give you new tools to
approach problems, even if you are
programming in Java

PL Dimensions

- Wide variety of programming languages
- How do they differ?
- along certain dimensions...
- What are these dimensions?

PL Dimensions (discussion)

Dimension: Syntax

- Languages have different syntax
 - But the difference in syntax can be superficial
 - C# and Java have different syntax, but are very similar
- In this class, will look beyond superficial syntax to understand the underlying principles

Dimension: Computation model

- Functional: Lisp, OCaml, ML
- Imperative: Fortran, Pascal, C
- Object oriented: Smalltalk, C++, Java, C#
- Constraint-based: Prolog, CLP(R)

Dimension: Memory model

- Explicit allocation-deallocation: C, C++
- Garbage collection: Smalltalk, Java, C#
- Regions: safe versions of C (e.g. Cyclone)
 - allocate in a region, deallocate entire region at once
 - more efficient than GC, but no dangling ptrs

Dimension: Typing model

- Statically typed: Java, C, C++, C#
- Dynamically typed: Lisp, Scheme, Perl, Smalltalk
- Strongly typed (Java) vs. weakly typed (C, C++)

Dimension: Execution model

- Compiled: C, C++
- Interpreted: Perl, shell scripting PLs
- Hybrid: Java

- Is this really a property of the language?
Or the language implementation?
- Depends...

So many dimensions

- Yikes, there are so many dimensions!
- How to study all this!
- One option: study each dimension in turn
- In this course: explore the various dimensions by looking at a handful of PLs

Course material

Outline:

- | | | |
|----------------|---------|---------|
| 1. Functional, | OCaml, | 4 weeks |
| 2. OO, | Python, | 4 weeks |
| 3. Logic, | Prolog, | 1 weeks |

No recommended Text:

- Online lecture notes
- Resources posted on webpage
- Pay attention to lecture and section!

Course Mechanics

www.cs.ucsd.edu/classes/wi16/cse130-a/

(Google “Sorin Lerner”, follow “Teaching Now”)

Nothing printed, everything on Webpage!

Piazza: [sign-up using link on web page](#)

TAs: [Mario Alvarez](#), [Dimo Bounov](#), [John Sarracino](#)

Tutors: TBD

Requirements and Grading

- Prog. Assignments (6-8): 30%
- Midterm (open book): 35%
- Final (open book): 35%

Weekly Programming Assignments

Schedule up on webpage

Deadline Extension:

- Four “late days”, used as “whole unit”
- 5 mins late = 1 late day
- Plan ahead, **no other extensions**

PA #1 online, due Jan 15th

Academic Integrity

- Programming Assignments done **ALONE**
- We use plagiarism detection software
 - Have code from **all previous classes**
 - Have code from public repos
 - **MOSS** is fantastic, plagiarize **at your own risk**
 - Make your repo private, or you will be found responsible
- **Cases referred to AI office**
- Please see UCSD academic integrity stmt

Weekly Programming Assignments

Unfamiliar languages
+ Unfamiliar environments

Start Early!

Weekly Programming Assignments



Forget Java, C, C++ ...
... other 20th century PLs

Don't complain

... that Ocaml is hard

... that Ocaml is @!#@%

Immerse yourself in new language



Free your mind.

Enough with the small talk



Say hello to OCaml

```
void sort(int arr[], int beg, int end){
  if (end > beg + 1){
    int piv = arr[beg];
    int l = beg + 1;
    int r = end;
    while (l != r-1){
      if(arr[l] <= piv)
        l++;
      else
        swap(&arr[l], &arr[r--]);
    }
    if(arr[l]<=piv && arr[r]<=piv)
      l=r+1;
    else if(arr[l]<=piv && arr[r]>piv)
      {l++; r--;}
    else if (arr[l]>piv && arr[r]<=piv)
      swap(&arr[l++], &arr[r--]);
    else
      r=l-1;
    swap(&arr[r--], &arr[beg]);
    sort(arr, beg, r);
    sort(arr, l, end);
  }
}
```

}

Quicksort in C

```
let rec sort l =
  match l with [] -> []
  | (h::t) ->
    let (l,r) = List.partition ((<=) h) t in
    (sort l)@h::(sort r)
```

Quicksort in Ocaml

Why readability matters...

```
sort=: (($:@ (<# []), (=# []), $:@ (># [])) ({~ ?@#))^: (1:<#)
```

Quicksort in J

Say hello to OCaml

```
let rec sort l =  
  match l with [] -> []  
  | (h::t) ->  
    let (l,r)= List.partition ((<=) h) t in  
    (sort l)@h::(sort r)
```

Quicksort in OCaml

Plan (next 4 weeks)

1. Fast forward

- Rapid introduction to what's in OCaml

2. Rewind

3. Slow motion

- Go over the pieces individually