Recitation 2: Programming

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Logistics

- Please do the survey if you haven't yet.
- Questions for me?
- Please interrupt me more if you don't understand!

On Datacamp

Intro to R:

- You learnt basic data structures, including factors, lists, data frames

Intermediate R:

- You learnt conditionals, loops, functions, apply, regexp and datetimes

ggplot2 intro, aesthetics, geometries

- you learnt about how to plot stuff for EDA.

Datacamp Check-in

- What did you like/what was something that surprised you?
- What did you find frustrating?
- Favorite restaurant in NYC

Syntax and Error

- Syntax – code is structured for the computer
  - Very common error – type in code, with slight syntax problem
  - Professional programmers make that sort of "error" all the time
  - Fortunately, very easy to fix . . . don't worry about it
- Not a reflection of some flaw in the programmer
  - Just the nature of typing ideas into the mechanical computer language
  - Beginners can be derailed by syntax step, thinking they are making some big error
- Try to make a bunch of typical syntax errors and fix them
- Fixing these little errors is a small, normal step

(source: Stanford CS101)

Apart from syntax, some of my takeaways

- It's really hard to be precise
- Data structures matter a lot
  - They determine how data is stored
  - What you can do next with the variable depends on the data type
- Manipulating specific types of data is hard
  - regexp is like a whole new language
  - dates and times are surprisingly tricky
- Plotting seems relatively straightforward, but very different somehow.

This week

- Quick summary of last week
- Abstraction once more
- Pseudocode
- Pseudocode breakout exercise
- Recursion
- big pseudocode-recursion exercise

Summary of last week

- A computer just does two things
  - perform calculation
  - remember results
- A process is a *precise* sequence of steps
- Computer = Powerful + Stupid
  - Let computers do the repetitive work for you!
  - We can endow computers with some decision making power using logicals
  - But you have to be precise in doing so
- Abstraction and Recursion

What is the role of a programmer

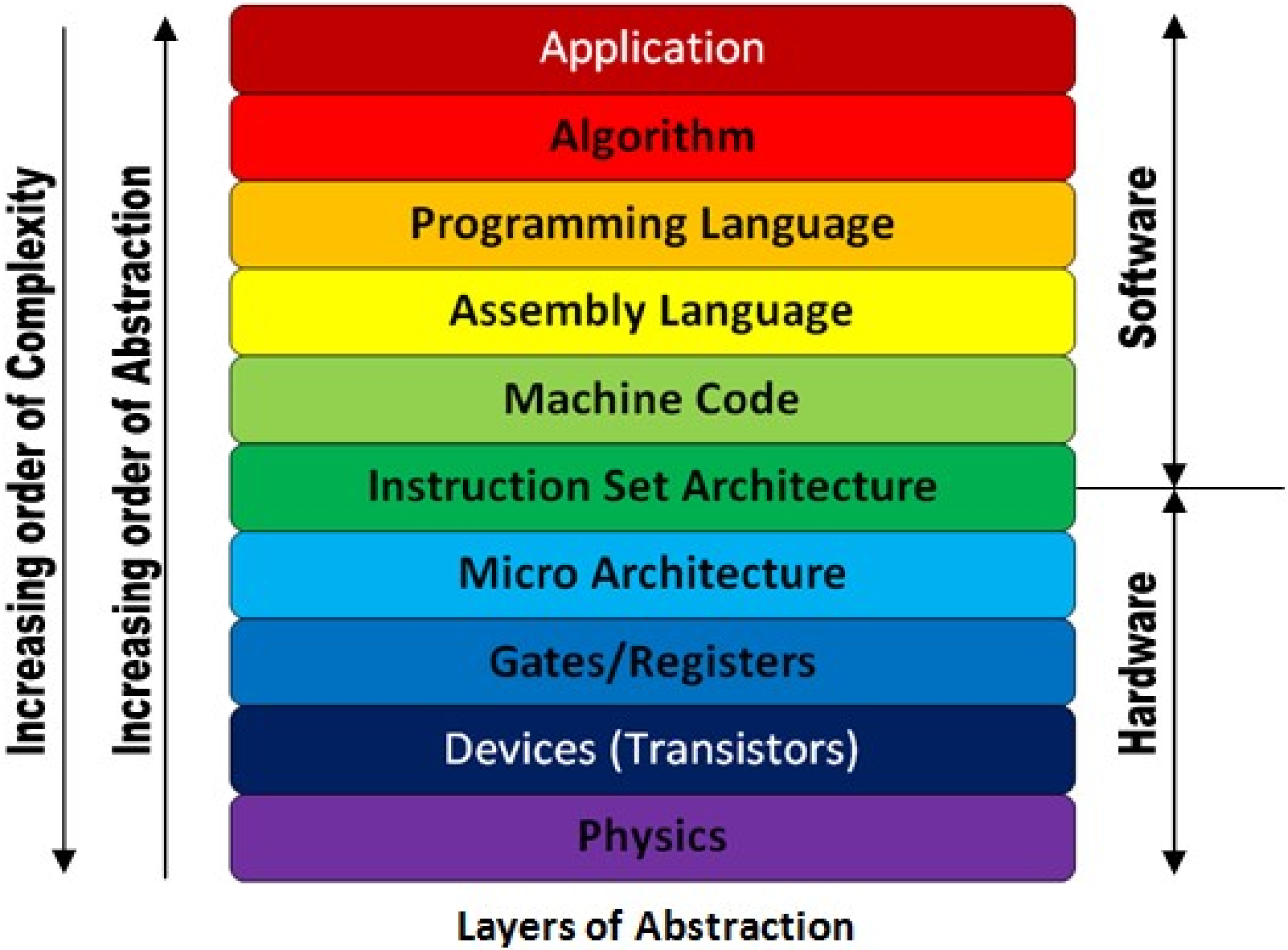
- Programmers harness the power of a computer!
- The programmer thinks up a useful feature
  - Requires creativity, insight about human needs, and knowledge of computers
- Programmers break down the steps, writing code for the computer
  - Dumbs it down for the computer!
- Best features of both sides:
  - inexpensive/fast processing of computer + creative insight of the programmer

(source: Stanford CS101)

Abstraction Definition

Abstraction is 'the process of removing physical, spatial, or temporal details, or attributes in the study of objects of systems to focus attention on details of greater importance.

Abstraction Diagram



Programming Languages in translation

Abstraction in practice as a high-level programmer

- You use variables for parameters to abstract away from doing things on a case-by-case basis
- You use functions (e.g. regress(), download_file()) to abstract away from the details
- Often we use libraries (other people's functions and processes) to simplify our work.
  - Open source software
    - Richard Stallman (1985) believed users should have the right to see and edit source code.
    - Here is great software and you are free to use and change it
    - If you add a great feature, contribute it back so others may use it

Open Source

- Software has many layers where you want something to work reliably
- Open source provides
  - free
  - widely used, high quality
  - maintained collectively
  - provides no advantage vs. competitors Conclusion: for many niches, free + high-quality is an appealing tradeoff
  - Proprietary software is not dead, but open source dominates many areas
  - Ultimately we all benefit: avoid work duplication
  - That's how your computer systems work today!

Source: CS101 Stanford

Increasing Abstraction

- Linear regression gives you the best fit line between an independent x and dependent variable y
- . . . that minimizes sum of squared error between predicted values and the actual dependent variables
- . . . that is derived using optimization
- . . . which is choosing the best value of the parameter β subject to certain criteria
- . . . the criteria is. . . .

Building Algorithms - Pseudocode

Pseudocode is the plain language description of the steps in an algorithm or another system.

- Intended for human reading!
- You write pseudocode trying to anticipate what you'll need to do code wise to implement the algorithm in a process.

Pseudocode Example

Determine whether an integer is a palindrome? Return true or false as needed.

Pseudocode Example

```
# Assume that it's stored in a numeric vector of length 1
# Convert to a character vector
# Store the length of the string in a variable
# If the length is odd
  # Find the middle indices
  # Slice and store the string up to the middle number (exc
  # Slice the store the string from the middle (exclusive)
# If it's even
  # find the middle two numbers
  # Slice and store the string up to the first middle numbe
  # Slice the store the string from the second middle numbe
# Reverse the second stored value
# Check whether they are the same
# If they are it's a palindrome! Return True
# Else Return False
```

From Algorithms to Processes (pseudocode to real code)

```
# Assume that it's stored in a numeric vector of length 1
# Convert to a character vector
is_palindrome<-function(x){
  x <- as.character(x)
  # Store the length of the string in a variable
  len_string <- nchar(x[1])
  # If the length is odd
  if (len_string%%2 >0){
    # Find the middle indices
    middle <- len_string%/%2+1
    # Slice and store the string up to the middle number (
    first_part <- substr(x,1,middle-1)
    # Slice the store the string from the middle (exclusiv
    second_part <- substr(x,middle +1 ,len_string)
  } else {
    # find the middle two numbers
    middle1 <- len_string%/%2
    middle2 <- middle1+1
```

Pseudocode breakout exercise

- If you're watching the recording, pause now and write the pseudocode yourself.
- I want to write a function that takes in a number n as input.
- the function iterates from 1 until that number, printing one item for each number
- the output I want prints fizz if it's divisible by 3, buzz if it's divisible by 5, 'fizzbuzz' if both.:
  1 2 fizz 4 buzz fizz 7 8 fizz buzz 11 fizz 13 14 fizzbuzz 16

Let's save this as a script.

- A script is just a process file
- Convention: name_of_file_that_you_choose.____
  - ____ just tells the computer or programmer what type of file it is.
  - .R is an R Script
  - .Rmd are Rmarkdown files
  - .py is a python script
  - .html is hypertext markup language
  - .zip is a archive file format
  - .tar.gz is a tarball wrapped in a gzip compression scheme
  - portable document format are .pdf
- What type of file it is tells you what program to run the file in.

Recursion

the repeated application of a recursive procedure or definition.

Recursion

the repeated application of a recursive procedure or definition.
It's something that is defined in terms of itself.

Recursion

Which of these is the best definition of ancestor?

- Ancestor $>$ Parent of Ancestor
- Ancestor $>$ Parent, Ancestor $>$ Parent of Ancestor
- Ancestor $>$ Parent, Ancestor $>$ Parent of Parent, Ancestor $>$ Parent of Parent of Ancestor

Recursion (simplest example)

What is n for all n?

```
### Recursive factorial
factorial <- function(n){
    if(n == 0){
      return(1)
    } else {
        return(n*factorial(n-1))
    }
}
```

Recursion (last week's example)

What is the *n*th number of the Fibonacci sequence?

```
fibonacci <- function(n){
  # Base case
  if ((n==1)|(n==2)){
    return(1)
  }
  # Recursive case
  else {
    return(fibonacci(n-1) + fibonacci(n-2))
  }
}
```

Your turn

- Write pseudocode in groups that implements is_palindrome in a recursive manner.
- We won't need to code it up.

Now we've covered a lot of your beginner CS class

- Compare to Computing in Context
  - numpy and mpl $\sim=$ vector + matrix operations, ggplot2
  - pandas $\sim=$ what you'll do this week
- Maybe we've gone a bit deeper than that in understanding CS concepts
  - Abstraction and Recursion which are hard!
- And we've gone much faster
  - We'll practice a lot in the coming weeks!

What we've covered

- Intro, Intermediate R
- ggplot2 basics
- Syntax
- Abstraction (again)
- Pseudocode
- Recursion (again)

This week on Datacamp

- data.table
- Tidyverse
- short chapters on importing data from csvs, excel files