UC Berkeley EECS
Lecturer
Michael Ball

Computational Structures in Data Science

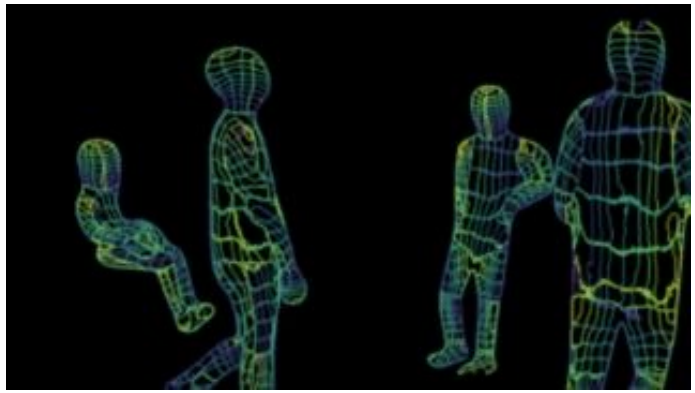
Lecture 2:
Abstraction and Functions

Computing In The News

Wi-Fi Routers Can Detect Human Locations, Poses Within a Room

Tom's Hardware
Mark Tyson
January 18, 2023

Carnegie Mellon University scientists have been testing a system that uses Wi-Fi signals to detect the positions and poses of people in a room. The researchers positioned TP-Link Archer A7 AC1750 Wi-Fi routers at either end of the room, while algorithms generated wireframe models of people in the room by analyzing the signal interference the people caused. The researchers based the perception system on Wi-Fi signal channel-state-information, or the ratio between transmitted and received signal waves.



A computer vision-capable neural network architecture processes this data to execute dense pose estimation; the researchers deconstructed the human form into 24 segments to accelerate wireframe representation. They claim the wireframes' position and pose estimates are as good as those generated by certain "image-based approaches."

Announcements

- Join the EECS 101 and DATA 001 Ed Discussions!
  - https://eecs.link/join-ed
  - https://eecs.link/data-ed
- Hopefully not needed! *Please,* report any concerns about class / campus climate to the department. *You* are welcome here!
- https://eecs.link/climate

Announcements – Waitlist and Exams

- We are working to expand the course.
  - Usually 10-15% people get off the waitlist.
  - This year it keeps growing. ☹
  - **Keep up with the class!**
- Section Signups Released This Week
  - Expect a Friday section, maybe 2
  - Please sign up and attend a regular section
- Exams:
  - Midterm March 21, 7-9pm
  - Final Exam: May 9th, 11:30am
  - Both will have alternates available

Links

- Q&A Thread: https://go.c88c.org/qa2
- Self-Check: https://go.c88c.org/2
- Chat!!: https://go.c88c.org/chat

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Abstraction

Abstraction

- Detail removal

  "The act of leaving out of consideration one or more properties of a complex object so as to attend to others."

- Generalization

  "The process of formulating general concepts by abstracting common properties of instances"

- Technical terms: Compression, Quantization, Clustering, Unsupervized Learning

Henri Matisse *"Naked Blue IV"*

Experiment


Standard Time Zones of the World
WHERE ARE YOU FROM?
CANADA
U.S.
UNITED STATES
MEXICO
BRAZIL
ARGENTINA
CHILE
BOLIVIA
PARAGUAY
PERU
COLOMBIA
VENEZUELA
RUSSIA
CHINA
INDIA
MONGOLIA
KAZAKHSTAN
JAPAN
PHILIPPINES
INDONESIA
AUSTRALIA
NEW ZEALAND
ALGERIA
LIBYA
EGYPT
SUDAN
NIGERIA
ETHIOPIA
SOMALIA
ZAIRE
KENYA
TANZANIA
ANGOLA
ZAMBIA
MADAGASCAR
SOUTH AFRICA
MOROCCO
MAURITANIA
MALI
NIGER
CHAD
TURKEY
IRAN
IRAQ
SAUDI ARABIA
PAKISTAN
North Atlantic Ocean
South Atlantic Ocean
North Pacific Ocean
South Pacific Ocean
Indian Ocean
Coordinated Universal Time (U.T.C.) formerly Greenwich Mean Time
International Date Line

Where are you from?

Possible Answers:

- Planet Earth
- Europe
- California
- The Bay Area
- San Mateo
- 1947 Center Street, Berkeley, CA
- 37.8693° N, 122.2696° W

All correct but different levels of abstraction!

Detail Removal (in Data Science)

- You'll want to look at only the interesting data, leave out the details, zoom in/out…
- Abstraction is the idea that you focus on the essence, the cleanest way to map the messy real world to one you can build
- Experts are often brought in to know what to remove and what to keep!

The London Underground 1928 Map & the 1933 map by Harry Beck.

The Power of Abstraction, Everywhere!

- Examples:
  - Math Functions (e.g., sin x)
  - Hiring contractors
  - Application Programming Interfaces (APIs)
  - Technology (e.g., cars)

- Amazing things are built when these layer
  - And the abstraction layers are getting deeper by the day!

We only need to worry about the interface, or specification, or contract NOT how (or by whom) it's built

Above the abstraction line

Abstraction Barrier (Interface)
(the interface, or specification, or contract)

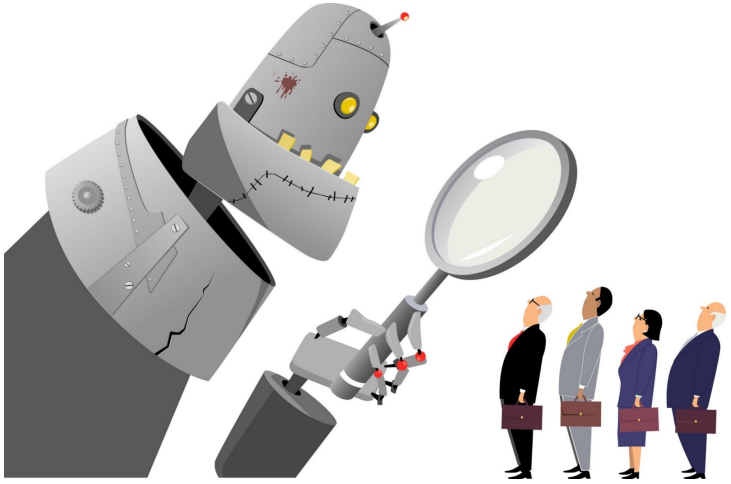
Below the abstraction line

This is where / how / when / by whom it is actually built, which is done according to the interface, specification, or contract.

Abstraction: Pitfalls

- Abstraction is not universal without loss of information (mathematically provable). This means, in the end, the complexity can only be "moved around"

- Abstraction makes us forget how things actually work and can therefore hide bias. Example: AI and hiring decisions.



- Abstractions can formalize a design or pattern. When something doesn't follow that pattern–perhaps a new use case emerges–it can be a burden to adapt.

Data or Code? Abstraction→ Take CS61C

Human-readable code
(programming language)

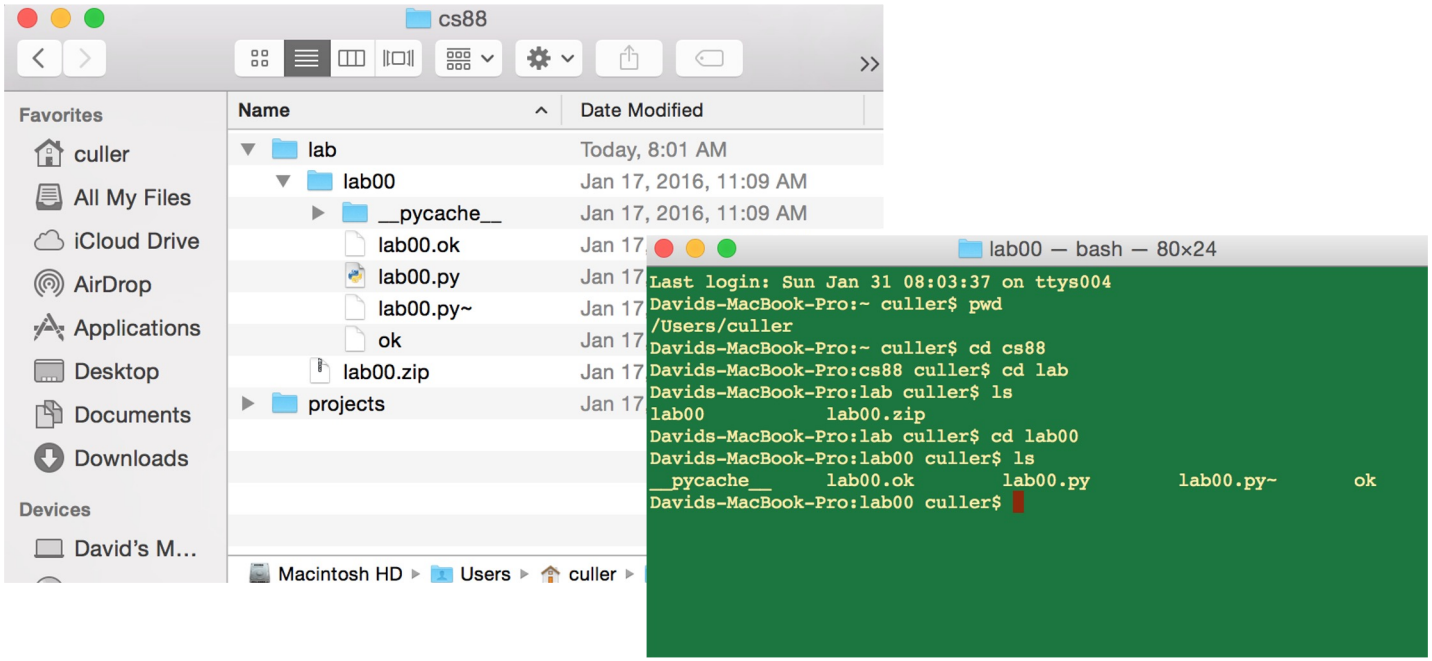
```
def add5(x):
   return x+5

def dotwrite(ast):
   nodename = getNodename()
   label=symbol.sym_name.get(int(ast[0]),ast[0])
   print ' %s [label="%s' % (nodename, label),
   if isinstance(ast[1], str):
      if ast[1].strip():
         print '= %s"];' % ast[1]
      else:
         print '"]'
   else:
      print '"];'
      children = []
      for n, child in enumerate(ast[1:]):
         children.append(dotwrite(child))
      print ' %s -> {' % nodename,
      for name in children:
         print '%s' % name,
```

Machine-executable
instructions (byte code)

Compiler or Interpreter

Here: Python

Code or GUI: More Abstraction!



- Big Idea: Layers of Abstraction
  - The GUI look and feel is built out of files, directories, system code, etc.

Review:

- Abstraction:
  - Detail Removal or Generalizations
- Code:
  - Is an abstraction!

Computer Science is the study (and building) of abstractions

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Python: Simple Statements

Learning Objectives

- Evaluate Python Expressions
- Call Functions in Python
- Assign data to Variables

Let's talk Python

- **Expression** `3.1 * 2.6`
- ***Call* expression** `max(0, x)`
- Variables `my_name`
- Assignment Statement `my_name = <expression>`
- **Define Statement:** `def function_name(<arguments>):`
- Control Statements:
  ```
  if …
  for …
  while …
  ```
- Comments `# Text after the # is ignored.`

Boolean Expressions

- **Booleans** are Yes/No values.
  - In Python: `True` and `False`
- `>, <, ==, !=, >=, <=, and, or`
  - Note the the *"double equals"*
- These expressions all return only True or False.
- `3 < 5 # returns True`
  - You can write `3 < 5 == True` – but this is redundant.
- We'll keep practicing over time

Live Coding Demo

- Open Terminal on the Mac
- Type `python3`
  - We are now in the "interpreter" and can type code.
- Python runs each line of code as we type it.
  - After each line, we see a result. This happens *only* in the interpreter.
- It's a very useful calculator.
- We can also run files!
- `python3 -i 02-Functions.py`
  - `-i :` This means open the interpreter after running the file. It's optional
- `python3 ok …`
  - This runs the file "ok" which is included with each lab / homework.

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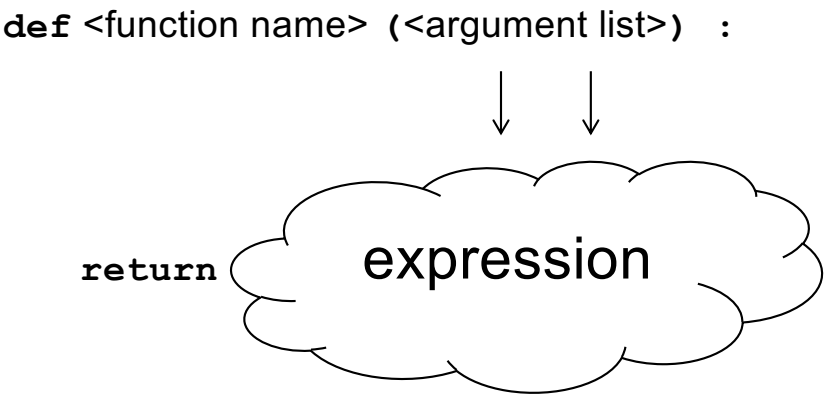
Python: Function Definitions

Learning Objectives

- Create your own functions.
- Use if and else to control the flow of code.

Defining Functions



- Abstracts an expression or set of statements to apply to lots of instances of the problem
- A function should *do one thing well*

Functions in Python

- We "define" them with `def`
- We typically `name_them_using_underscores` ("Snake case")
- The first line ends in a `:`
- The body is indented by 4 spaces
- Arguments (parameters) create 'names' that exist only in our function
- Most functions will return a value, but some do not.

```
def greet(name):
    print("Hello, " + name)
```

Functions: Example

```
>>> y  = 5
>>> x = 3
>>> z = max(3, 5) * 10
>>> z
50
```

```
def max(x, y):
    if x > y:
        return x
    else:
        return y
```

How to Write a Good Function

- Give a descriptive name
  - Function names should be lowercase. If necessary, separate words by underscores to improve readability. Names are extremely suggestive!
- Chose meaningful parameter names
  - Again, names are extremely suggestive.

- Write the docstring to explain *what* it does
  - What does the function return? What are corner cases for parameters?

Python Style Guide "PEP 8"

- Write *doctest* to show what it should do
  - Before you write the implementation.

Functions: Example

Live Coding Demo

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Functions and Environments

Functions: Calling and Returning Results

Python Tutor

```
def max(x, y):
    return x if x > y else y

x = 3
y = 4 + max(17, x + 6) * 0.1
z = x / y
```

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Iteration With While Loops

Learning Objectives

- Write functions that call functions
- Learn How to use while loops.

`while` Statement – Iteration Control

- Repeat a block of statements until a predicate expression is satisfied

```
<initialization statements>
while <predicate expression>:
    <body statements>

<rest of the program>
```