UC Berkeley EECS
Lecturer
Michael Ball

Computational Structures in Data Science

Week 3: HOFs

Announcements

- Labs:
  - Practice questions are required starting lab 3, but like the rest based on effort.
  - There will be 3 per lab, the rest are optional.
- Midterm: March 11, 7-9pm
  - We will be using Zoom to proctor, details in a week or so.
    - » Basically, you'll need to record yourself w/ screensharing during the exam.
  - Alternate time the following morning.
- My OH, normally Wednesday 2-3pm
- **Likely** everyone will get off the waitlist soon!
  - Dual enrolled in CS61A: We can optionally transfer early assignment scores.

News: An AI "Publishes" and Op-Ed in the Guardian

- ...with help from a UC Berkeley student!
- "A robot wrote this entire article. Are you scared yet, human?"
- This article was written by GPT-3, OpenAI's language generator. GPT-3 is a cutting edge language model that uses machine learning to produce human like text. It takes in a prompt, and attempts to complete it.
- The prompts were written by the Guardian, and fed to GPT-3 by Liam Porr, a computer science undergraduate student at UC Berkeley. GPT-3 produced eight different outputs, or essays. [...] we chose instead to pick the best parts of each, in order to capture the different styles and registers of the AI. Editing GPT-3's op-ed was no different to editing a human op-ed. We cut lines and paragraphs, and rearranged the order of them in some places. Overall, it took less time to edit than many human op-eds.

UC Berkeley EECS
Lecturer
Michael Ball

Computational Structures in Data Science

Higher Order Functions

Learning Objectives

- Learn how to use and create higher order functions:
- Functions can be used as data
- **Functions can accept a function as an argument**
- Functions can return a new function

Code is a Form of Data

- Numbers, Strings: All kinds of data
- Code is its own kind of data, too!
- Why?
  - More expressive programs, a new kind of abstraction.
  - ”Encapsulate” logic and data into neat packages.
- This will be one of the trickier concepts in CS88.

What is a Higher Order Function?

- A function that takes in another function as an argument
- OR
- A function that returns a function as a result.

An Interesting Example

$$\sum_{k=1}^{5} k = 1 + 2 + 3 + 4 + 5 = 15$$

$$\sum_{k=1}^{5} k^3 = 1^3 + 2^3 + 3^3 + 4^3 + 5^3 = 225$$

$$\sum_{k=1}^{5} \frac{8}{(4k-3)\cdot(4k-1)} = \frac{8}{3} + \frac{8}{35} + \frac{8}{99} + \frac{8}{195} + \frac{8}{323} = 3.04$$

UC Berkeley EECS
Lecturer
Michael Ball

Computational Structures in Data Science

Higher Order Functions

Learning Objectives

- Learn how to use and create higher order functions:
- Functions can be used as data
- Functions can accept a function as an argument
- **Functions can return a new function**

What is a Higher Order Function?

- A function that takes in another function as an argument
- OR
- A function that returns a function as a result.

UC Berkeley EECS
Lecturer
Michael Ball

Computational Structures in Data Science

Environments & Higher Order Functions

Learning Objectives

- Learn how to use and create higher order functions:
- Functions can be used as data
- **Functions can accept a function as an argument**
- **Functions can return a new function**

Example: compose

- Python Tutor:
  http://pythontutor.com/composingprograms.html#code=def%20square%28x%29%3A%0A%20%20%20%20return%20x%20*%20x%0A%20%20%20%20%0As%20%3D%20square%0Ax%20%3D%20s%283%29%0A%0Adef%20make_adder%28n%29%3A%0A%20%20%20%20def%20adder%28k%29%3A%0A%20%20%20%20%20%20%20%20%2

Environment Diagrams

- Organizational tools that help you understand code
- **Terminology:**
  - **Frame:** keeps track of variable-to-value bindings, each function call has a frame
  - **Global Frame:** global for short, the starting frame of all python programs, doesn't correspond to a specific function
  - **Parent Frame:** The frame of where a function is defined (default parent frame is global)
  - **Frame number:** What we use to keep track of frames, f1, f2, f3, etc
  - **Variable** vs **Value**: x = 1. x is the **variable**, 1 is the **value**

Environment Diagrams Steps

1. Draw the global frame
2. When evaluating assignments (lines with single equal), always evaluate right side first
3. When you call a function MAKE A NEW FRAME!
4. When assigning a primitive expression (number, boolean, string) write the value in the box
5. When assigning anything else, draw an arrow to the value
6. When calling a function, name the frame with the intrinsic name – the name of the function that variable points to
7. The parent frame of a function is the frame in which it was defined in (default parent frame is global)
8. If the value isn't in the current frame, search in the parent frame

Environment Diagram Tips / Links

- NEVER EVER EVER draw an arrow from one variable to another.
- Source:
- http://markmiyashita.com/cs61a/environment_diagrams/rules_of_environment_diagrams/
- http://albertwu.org/cs61a/notes/environments.html