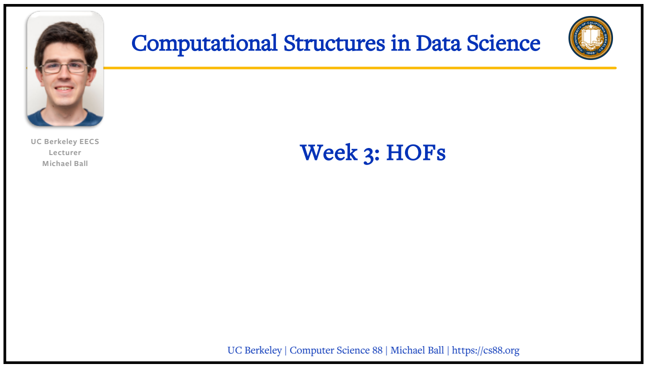
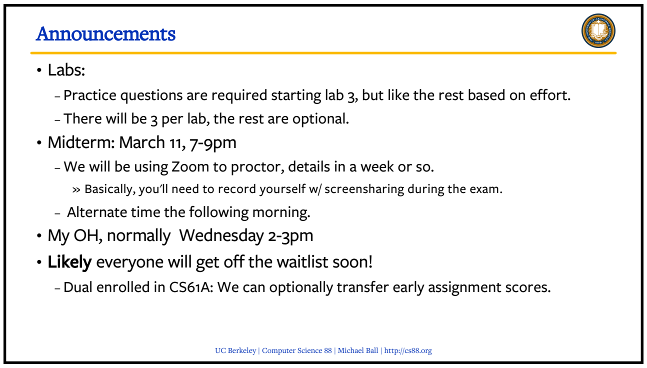


Computational Structures in Data Science

UC Berkeley EECS
Lecturer
Michael Ball

Week 3: HOFs

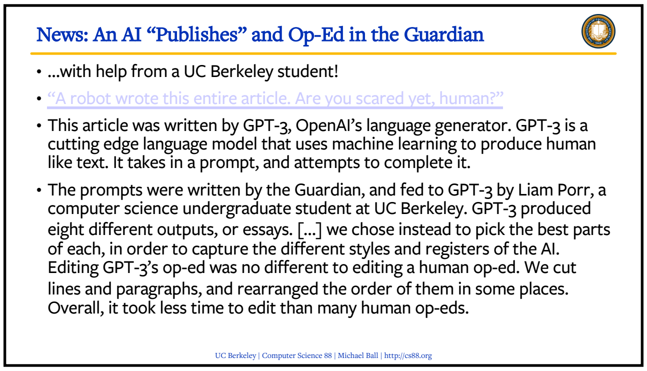
1



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.

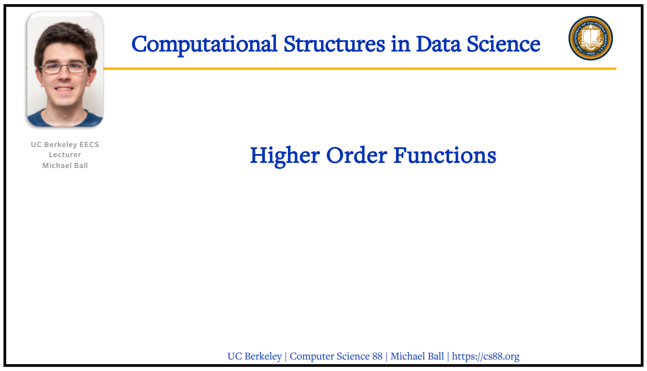
2



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.

3



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Higher Order Functions

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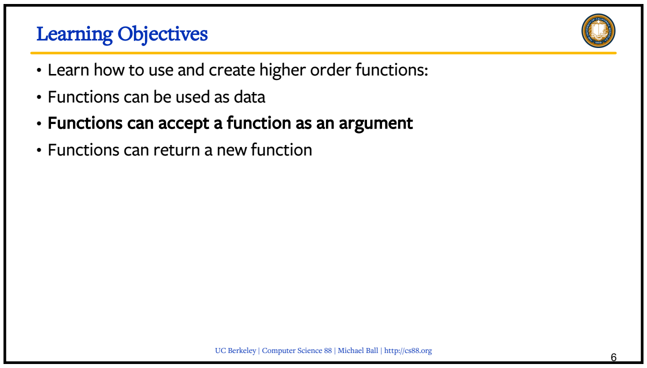
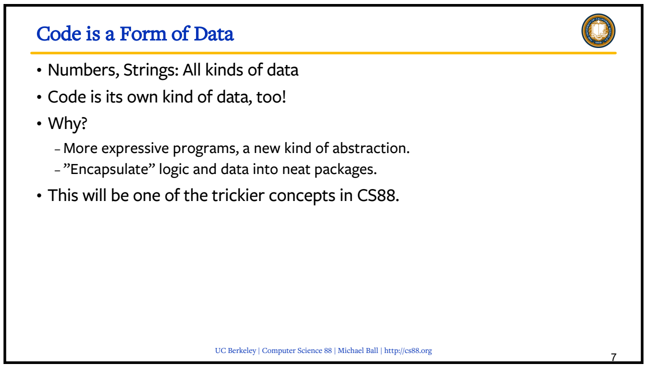


Learning Objectives

- 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

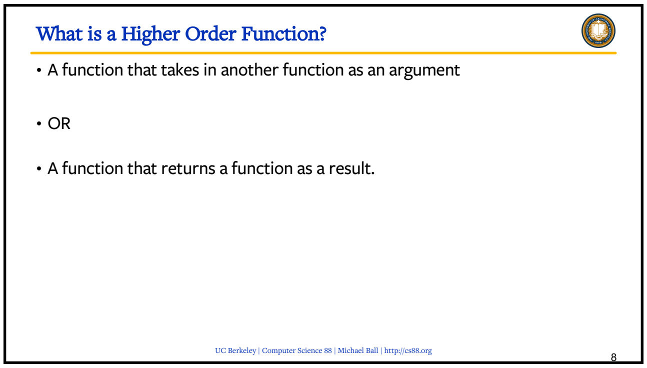
6



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.

7



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.

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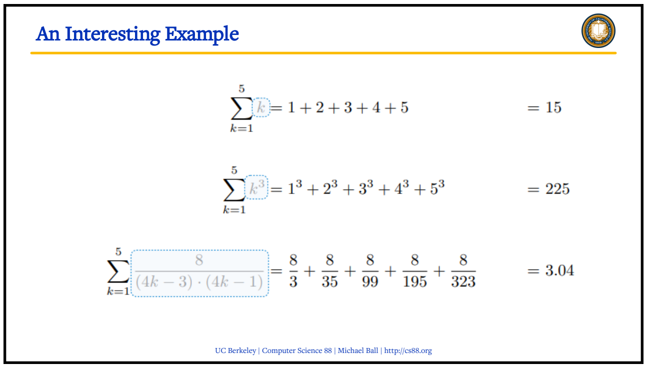

An Interesting Example

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

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

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

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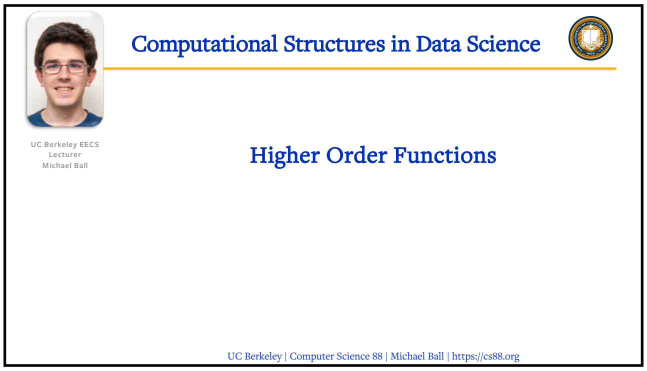

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Higher Order Functions

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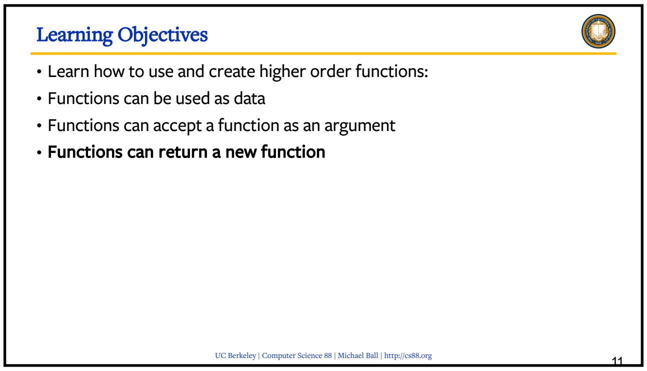

Learning Objectives

- 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**

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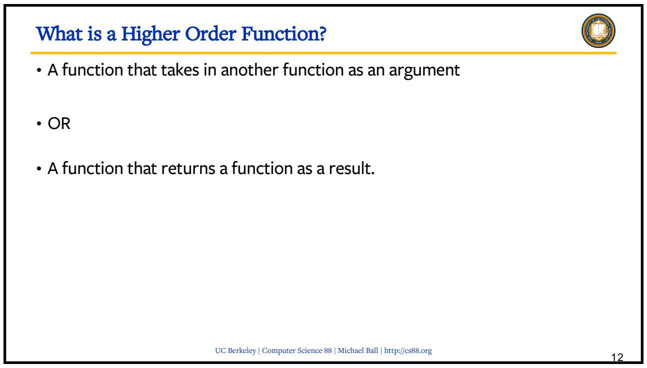

What is a Higher Order Function?

- A function that takes in another function as an argument
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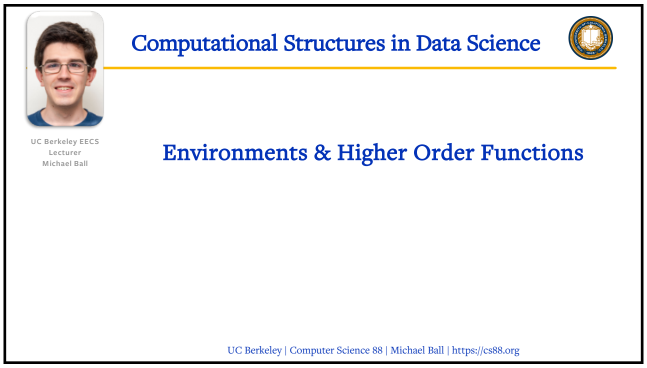

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Computational Structures in Data Science

Environments & Higher Order Functions

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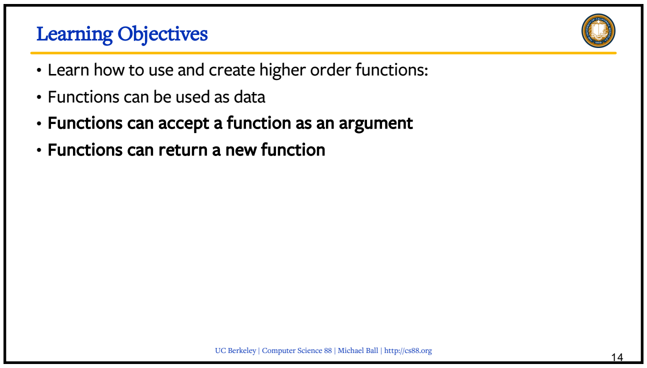

Learning Objectives

- Learn how to use and create higher order functions:
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- **Functions can accept a function as an argument**
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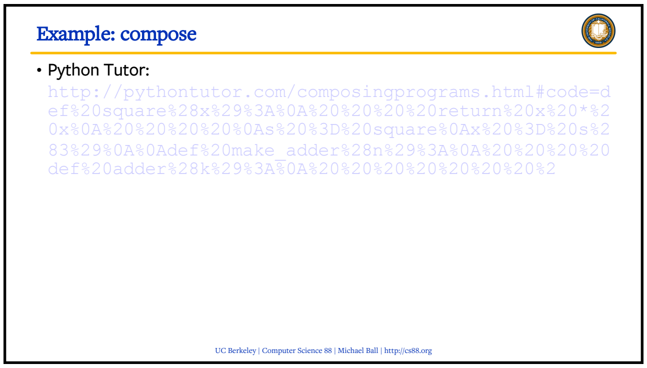
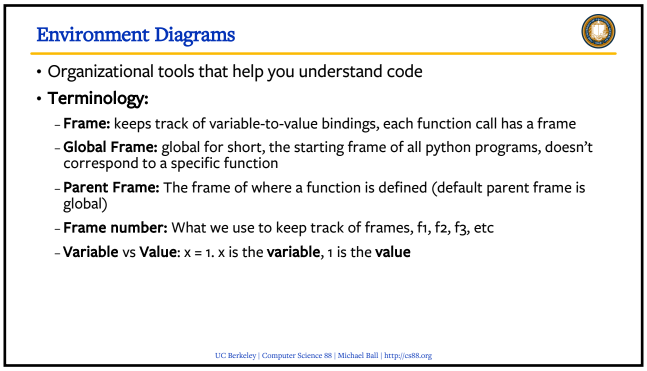
14



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%2

15



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**

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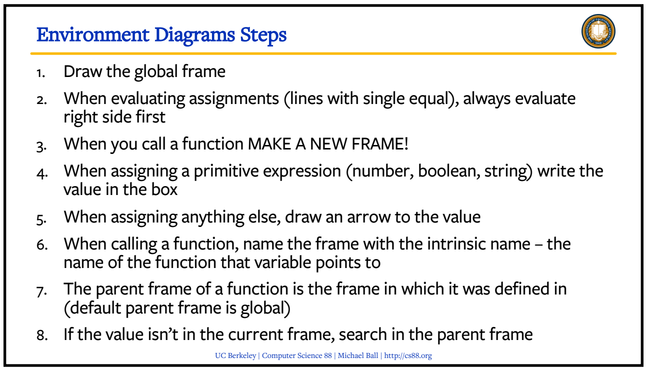

Environment Diagrams Steps

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

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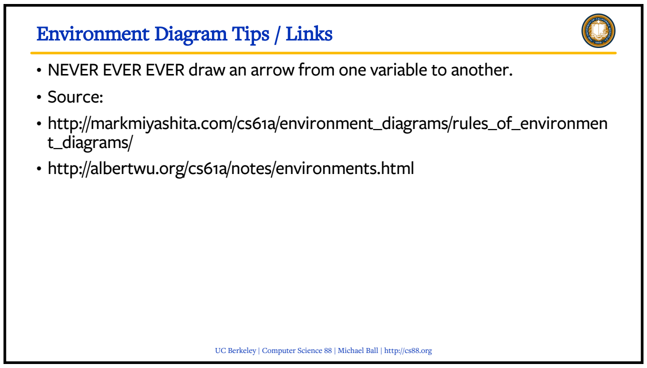

Environment Diagram Tips / Links

- 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

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