Introduction to CS111

Part 2: Big Ideas

CS111 Computer Programming

Department of Computer Science
Wellesley College

What is Computer Science?

- It's not really about computers.
- It's not really a science.
- It's about imperative ("how to") knowledge as opposed to declarative ("what is") knowledge.
- Imperative knowledge is expressed via algorithms: computational recipes.
- "A computer language … is a novel formal medium for expressing ideas about methodology, not just a way to get a computer to perform operations. Programs are written for people to read, and only incidentally for machines to execute."

  -- Harold Abelson and Gerald J. Sussman

Five big ideas

- Five important concepts are at the core of this course:
  1. Abstraction
  2. Modularity
  3. Problem Solving Strategies
  4. Models
  5. Interdependence
- These interrelated ideas are important in almost every discipline, but they're at the core of CS.
- We will illustrate these ideas in several ways.
- Our goal is to help you think about problem solving in new ways.

Big 

#1: Abstraction

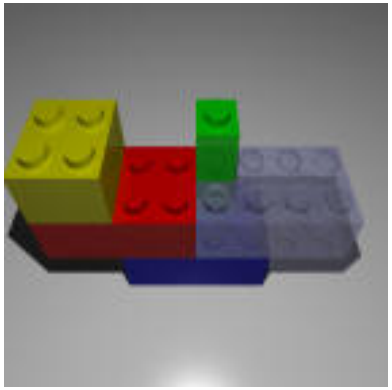
Google

Google Search I'm Feeling Lucky

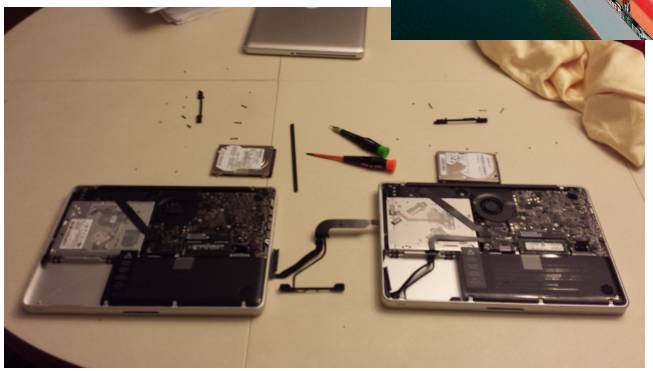
The essence of abstraction is taking complex things, hiding unimportant details, and presenting essential features to users in a simple contract.

Big 

#2: Modularity



- Large systems are built from components called modules.
- The interfaces between modules are designed so they can be put together in a mix-and-match way.
- In computer programming, the goal is to design packages for maximum reusability.



Big  #3: Problem Solving Strategies

Example: Divide/Solve/Combine

Divide

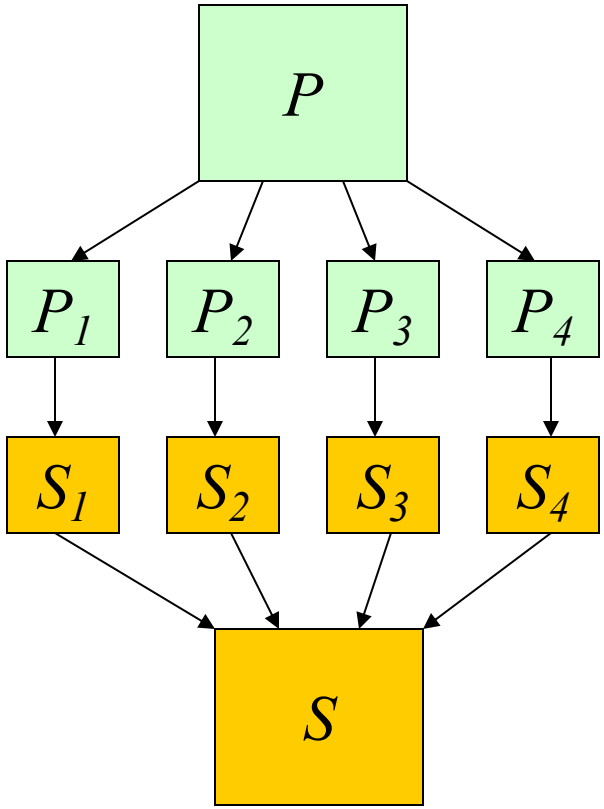
problem P into subproblems.

Solve

each of the subproblems.

Combine

the solutions to the subproblems into a solution S for P.

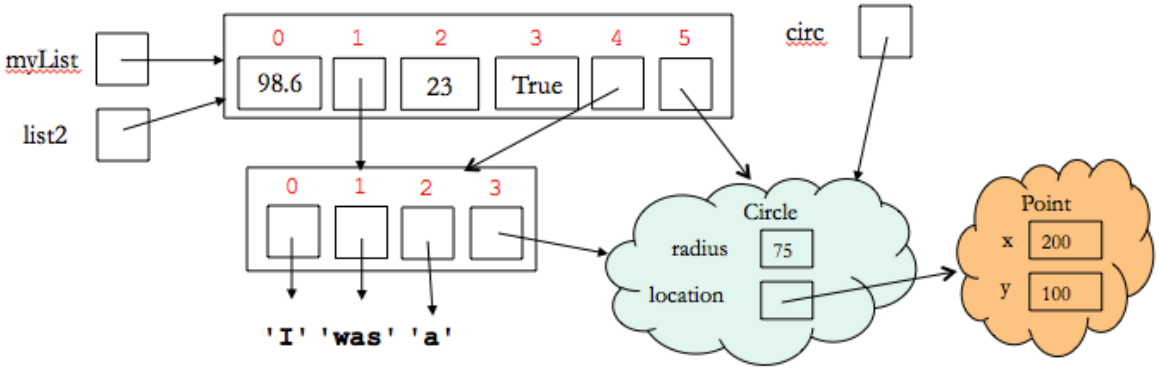


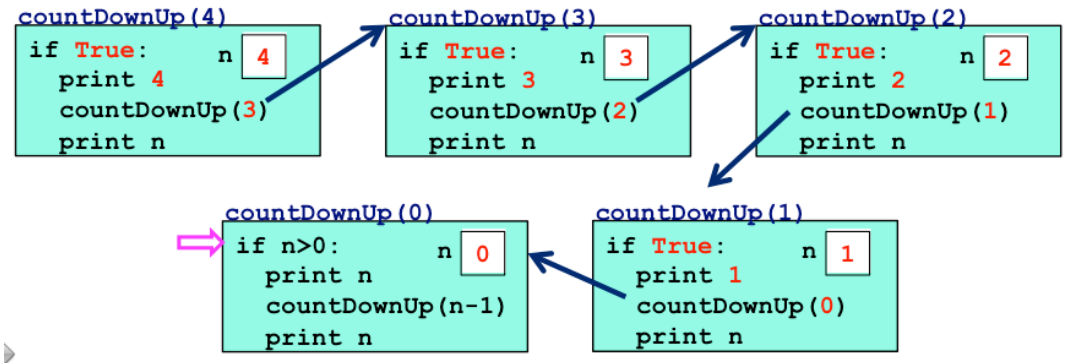
Other Strategies/Skills

- Incremental/iterative development
- Testing & Debugging

Big  # 4: Models

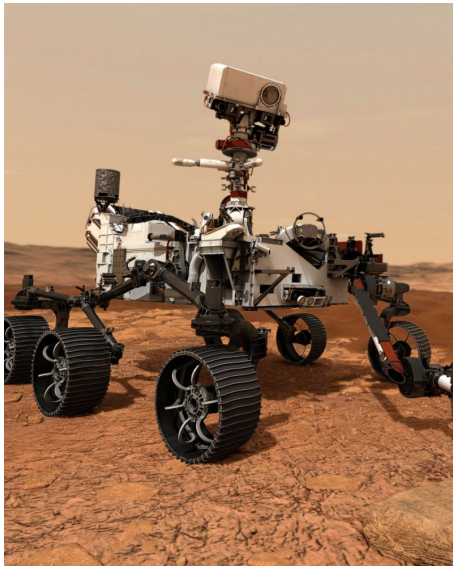
- Need simple models to understand complex artifacts and behaviors.
- We'll draw lots of diagrams to predict what programs will do.

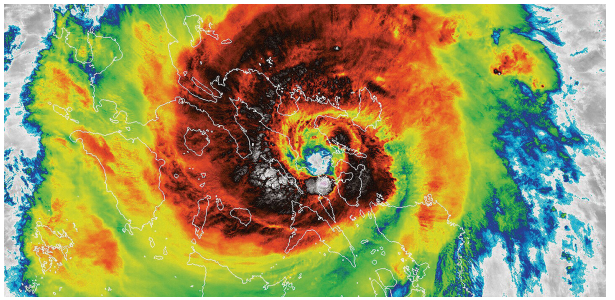




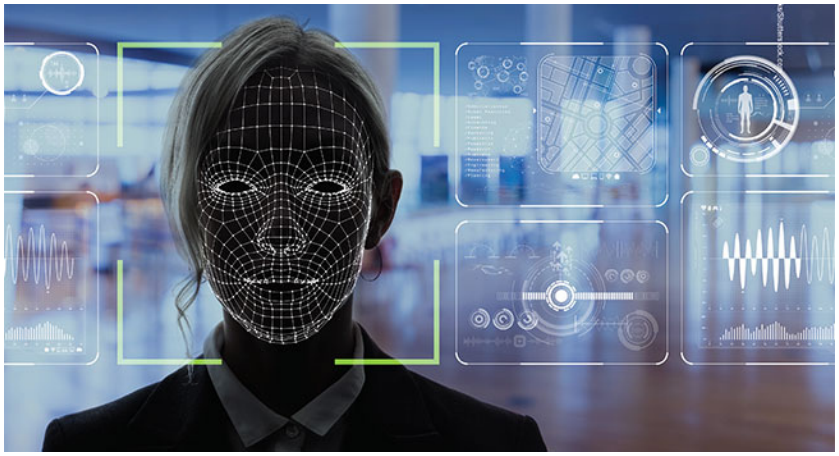
Big 

#5: Interdependence





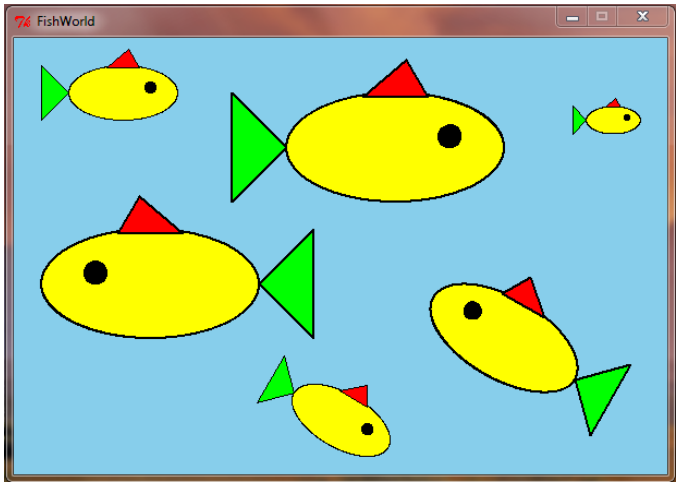
- Most of our social, economic, industrial, scientific, cultural activities are mediated via computational technologies. They have improved our quality of life.
- At the same time, companies that build these technologies are asserting too much power in our lives, and authoritarian regimes use them for surveillance and oppression.
- A liberal arts education helps you ask the right questions about computational technology.

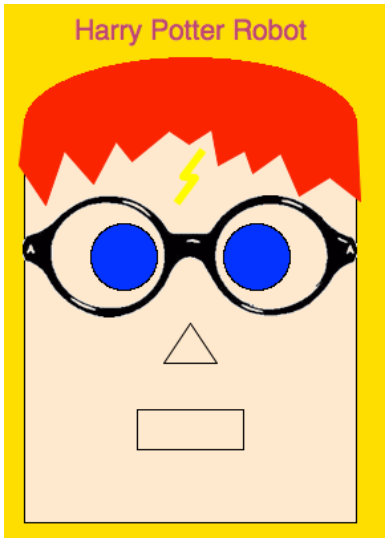


What will you build with these ideas?

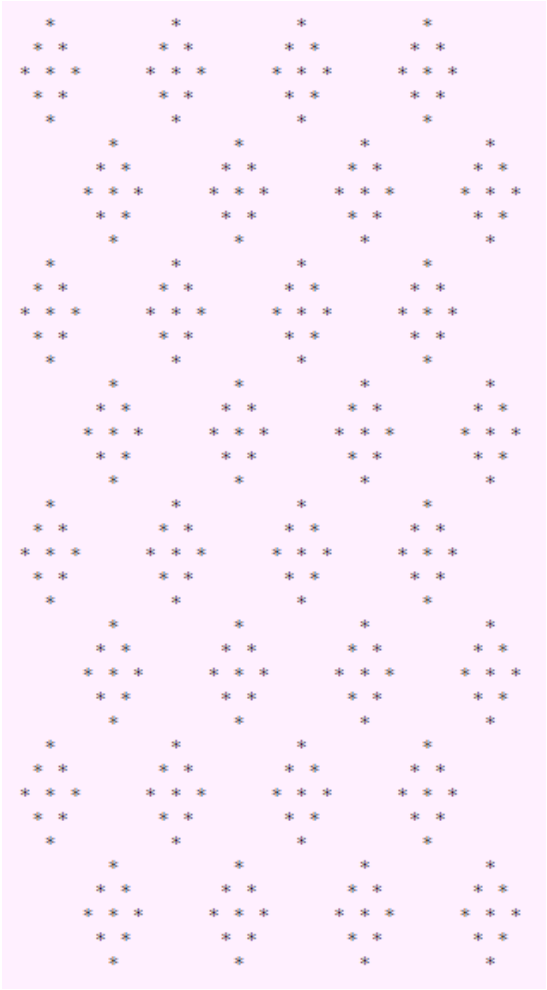
We'll start with numerical calculations and graphics

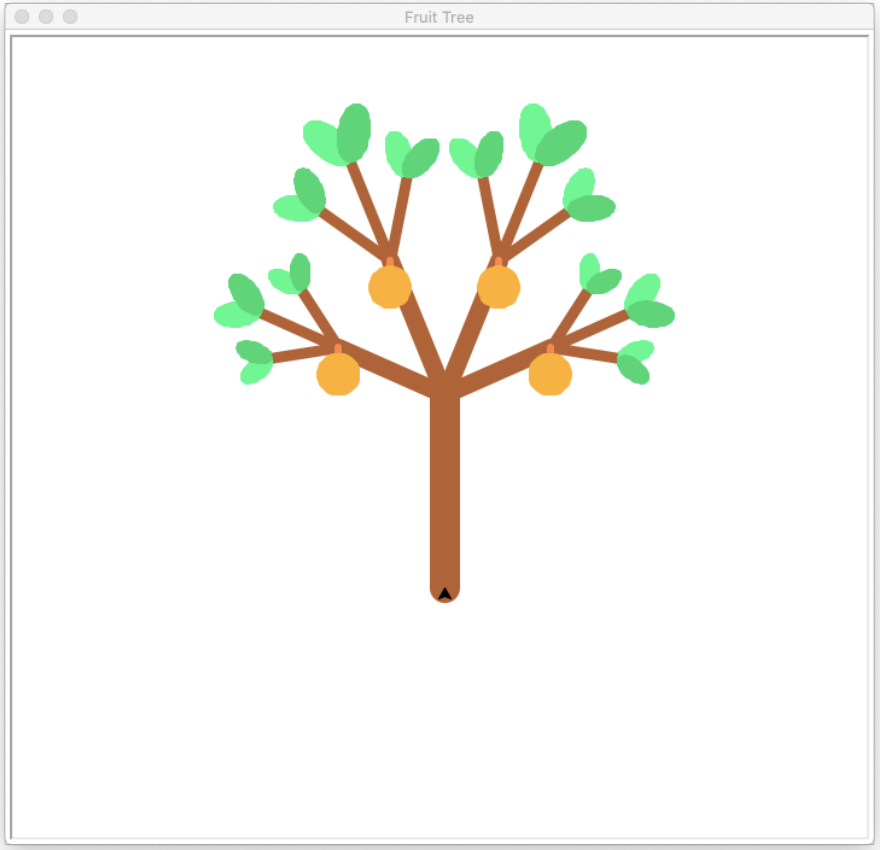
```
What is your name? Valentina

How many classes are you taking this semester? 5

What is the average time in class per week this semester? 2.5

How many hours per week do you spend on extracurricular activities (including jobs)? 15

How many hours per day do you sleep on average? 8

Weekly time profile for Valentina:
          37.5 class hours: CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
15.0 extracurricular hours: XXXXXXXXXXXXXXX
           59.5 free hours: FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
          56.0 sleep hours: SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
```



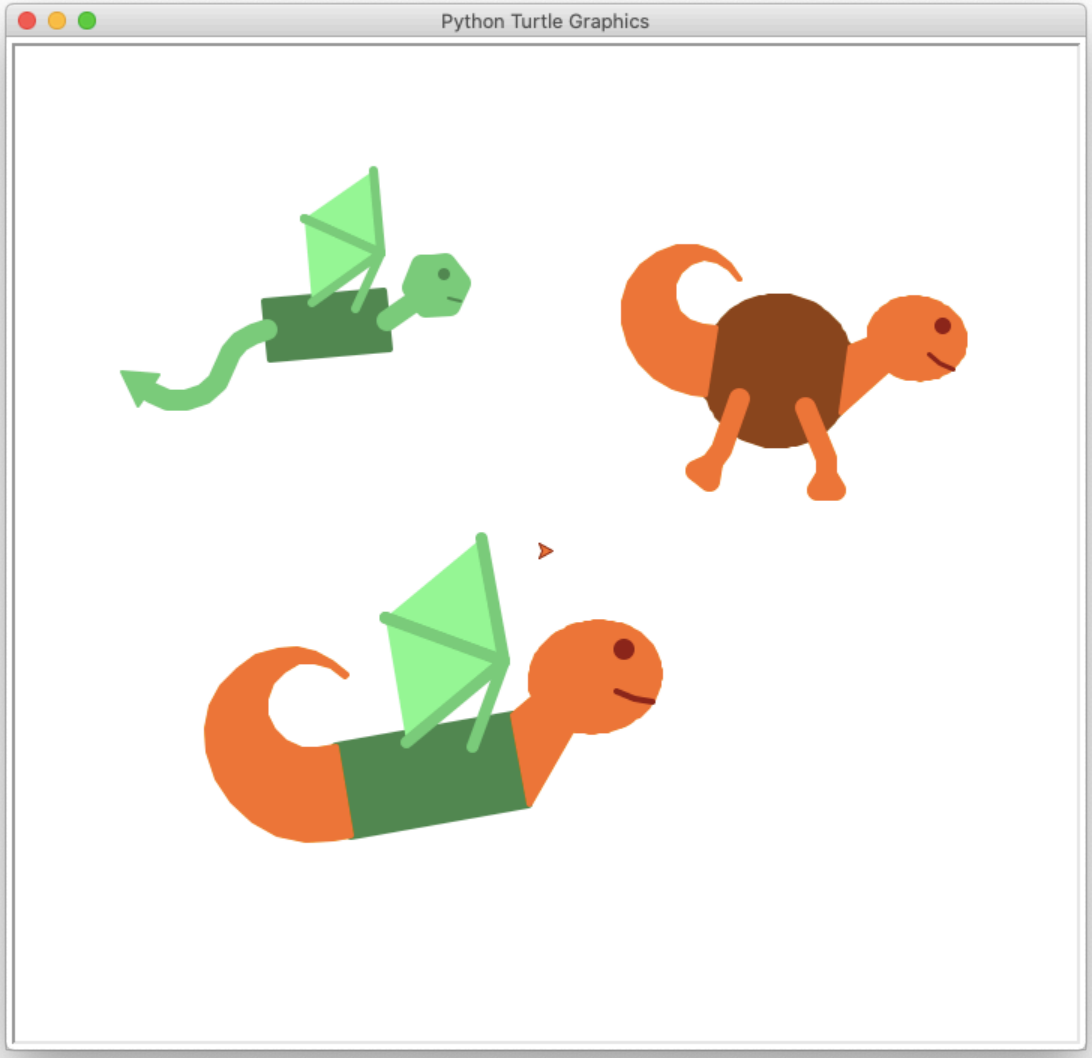


Define functions to capture common patterns



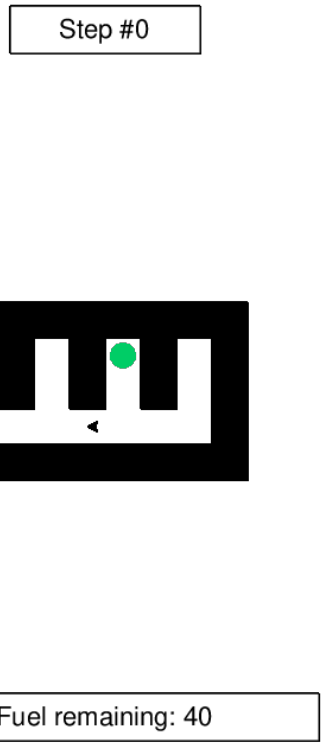


Apply different problem solving strategies

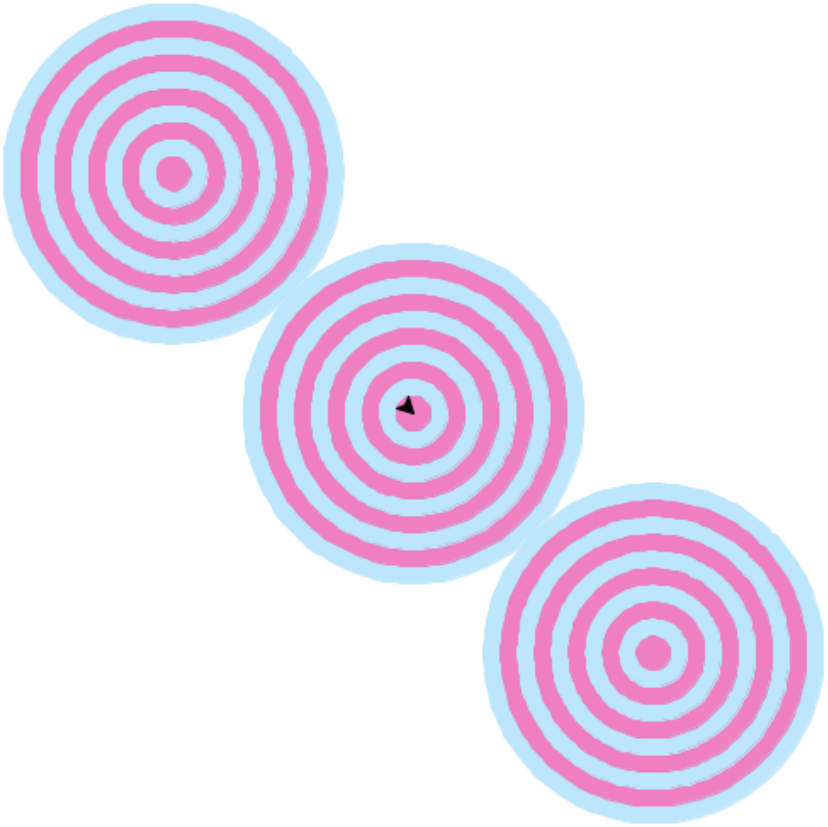


Build games and solve mazes with conditionals

```
Playing rock-paper-scissors (to 3 wins)
Each round, pick a gesture from 'rock', 'paper', or 'scissors'.
---
Round 1 (0 wins, 0 losses, and 0 ties)
What gesture will you use? rock
Computer chooses scissors
You win!
---
Round 2 (1 win, 0 losses, and 0 ties)
What gesture will you use? rock
Computer chooses paper
Opponent wins!
---
Round 3 (1 win, 1 loss, and 0 ties)
What gesture will you use? paper
Computer chooses rock
You win!
---
```



Use the power of iteration to generate pictures or music and analyze poetry



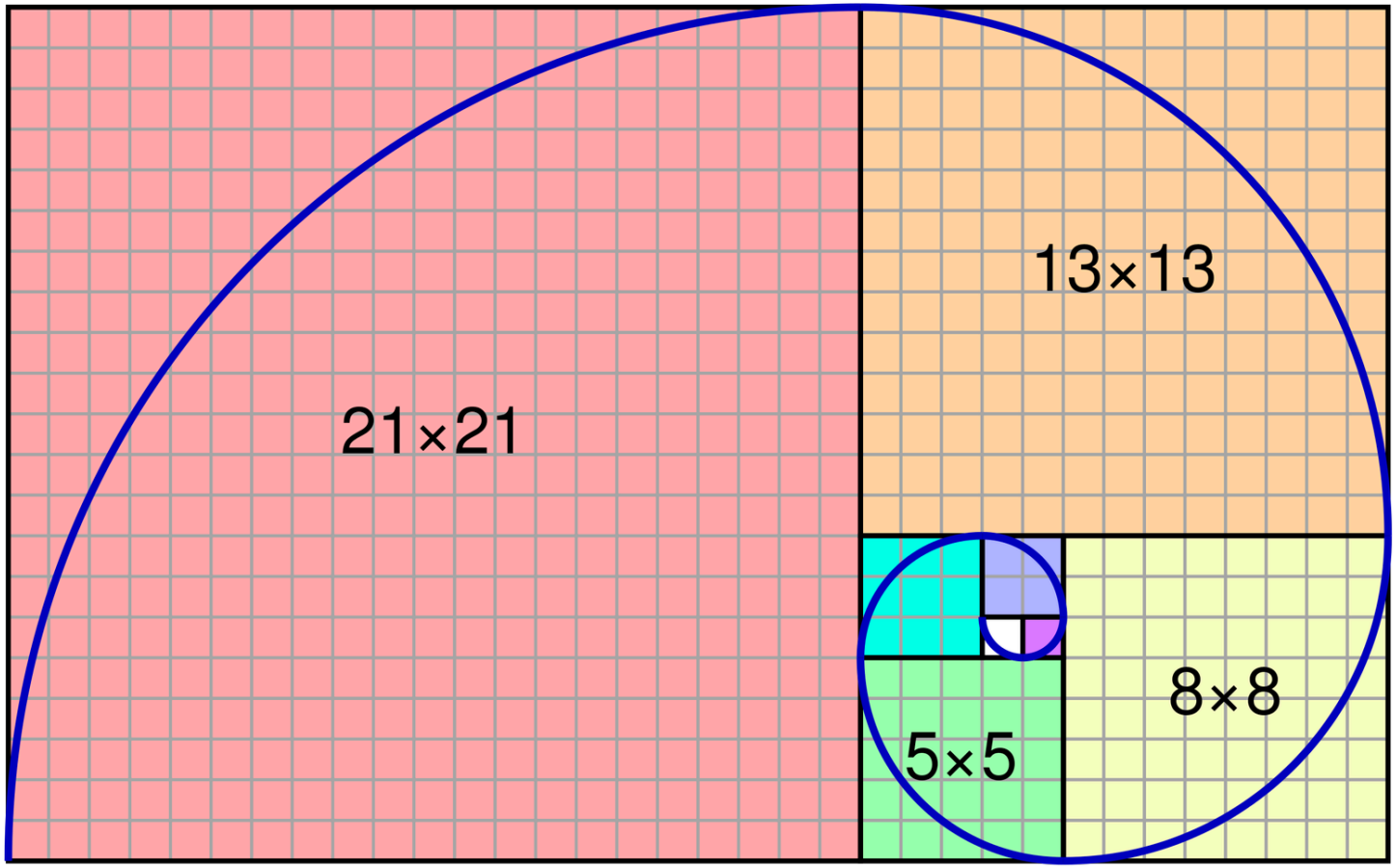
in summer rains
the crane's legs
become short

4-4-3

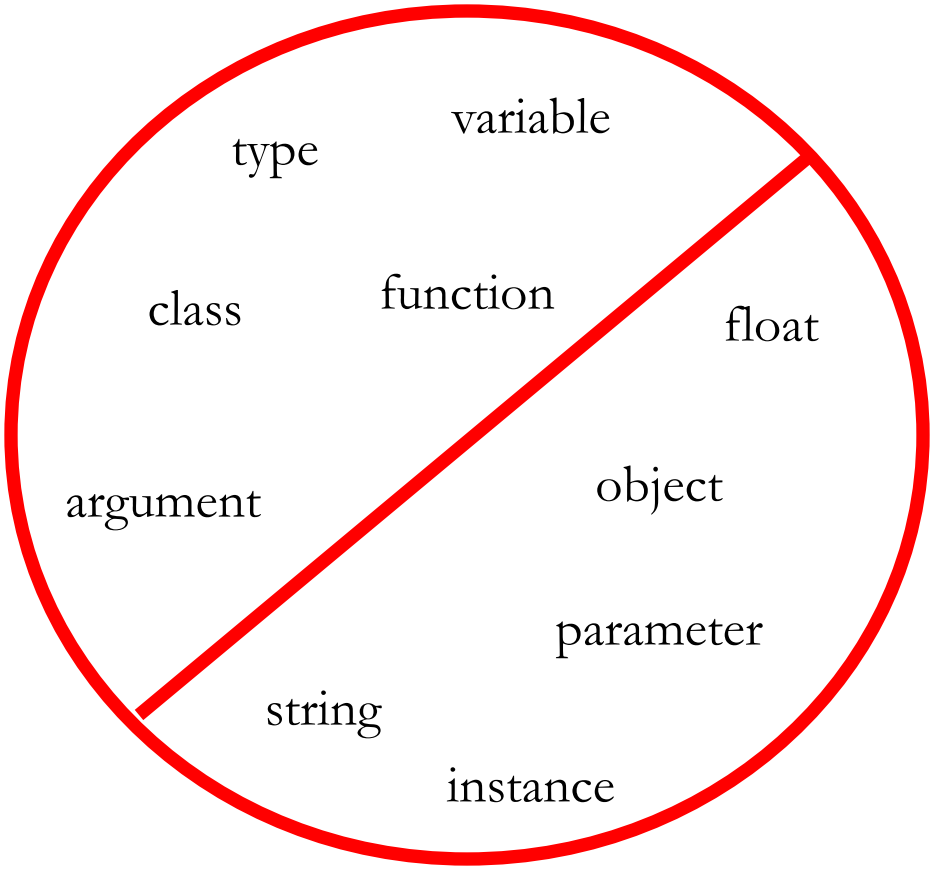
Learn Data Structures: Lists and Dictionaries

```
miniDict = {
"PMH4oUa-bWELKogdtkWewg": {'state': 'ON', 'address': '100
City Centre Dr', 'review_count': 16, 'stars': 2.0,
'name': 'GoodLife Fitness', 'city': 'Mississauga',
'categories': ['Fitness & Instruction', 'Sports Clubs',
'Gyms', 'Trainers', 'Active Life']},
"XguKrY0dAuaK1W6HUlUQ1Q": {'state': 'OH', 'address': '547
Sackett Ave', 'review_count': 29, 'stars': 3.5, 'name':
"Retz's Laconi's II", 'city': 'Cuyahoga Falls',
'categories': ['Italian', 'Restaurants', 'Pizza']},
"Wpt0sFHcPtV5MO9He7yMKQ": {'state': 'NV', 'address':
'3020 E Desert Inn Rd', 'review_count': 20, 'stars': 2.0,
'name': "McDonald's", 'city': 'Las Vegas', 'categories':
['Restaurants', 'Fast Food', 'Burgers']},
```

Problem solving with Recursion

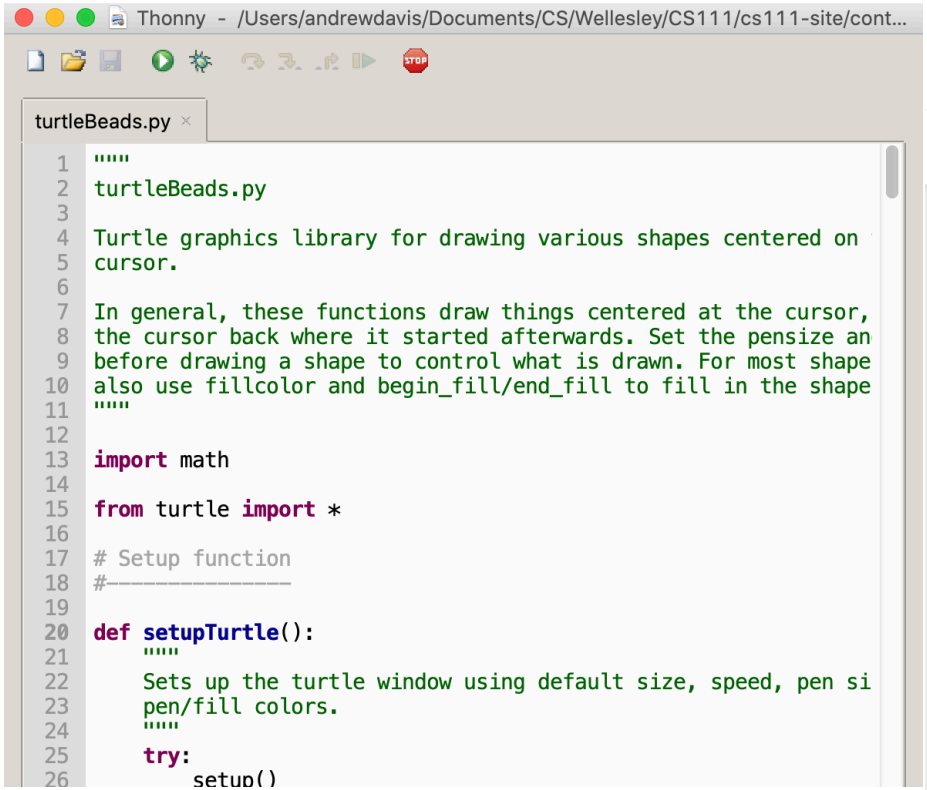


On to Python! Unlearn what you have learned

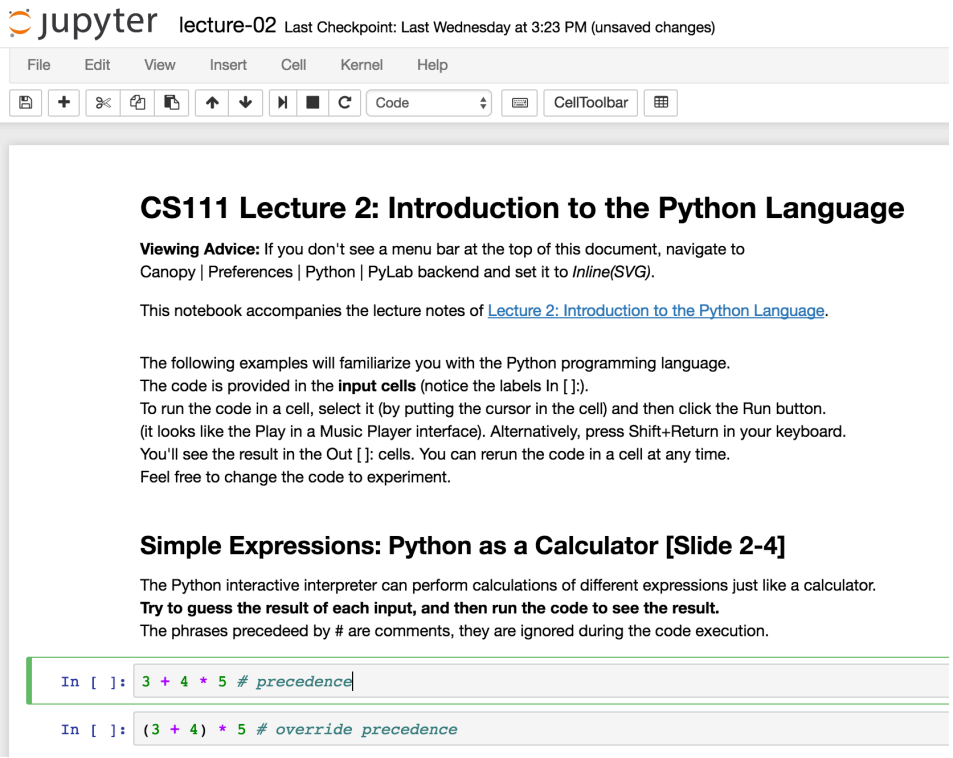


I don't think that word means what you think it means

Thonny to edit and execute Python programs in projects



Jupyter notebooks for hands-on lecture activities and weekly graded drill-like exercises



Python Intro Overview [Continues next lecture]

- **Values**: `10` (integer),
  `3.1415` (decimal number or float),
  `'wellesley'` (text or string)

- **Types**: numbers and text: **`int`**, **`float`**, **`str`**

```
type(10)
type('wellesley')
```

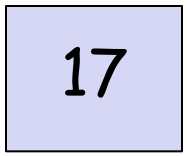
Knowing the **type** of a **value** allows us to choose the right **operator** when creating **expressions**.

- **Operators:** `+ - * / % =`
- **Expressions:** (they always produce a value as a result)

```
len('abc') * 'abc' + 'def'
```

- **Built-in functions**: `max, min, len, int, float, str, round, print, input`

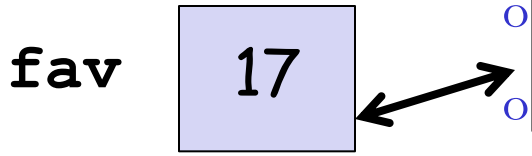
The First Model: Variable as a Box




```
fav = 17   # assign

# lookup and reassign
fav = fav + 3
```

- Variables are names we make up (but, there are rules for creating these names)
- They represent a piece of data and can take on many forms (numbers, words, a data structure containing multiple pieces of data, etc).
- A variable name should appear for the first time in an **assignment statement**.

The First Model: Variable as a Box



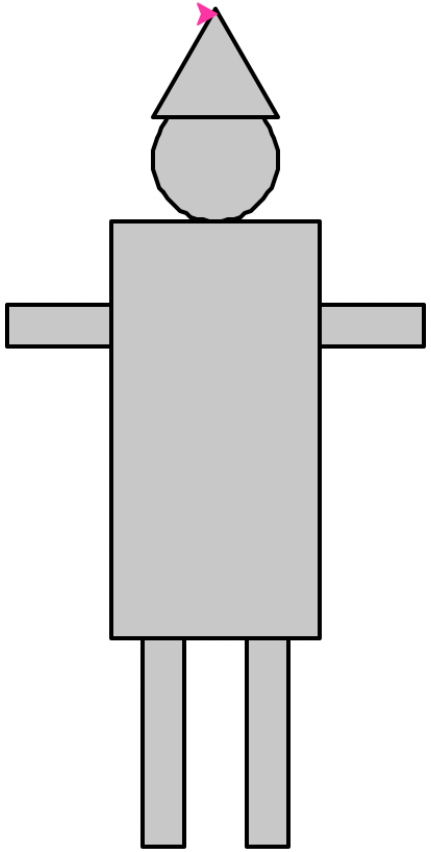
- A value is stored in a "box".
- The variable "labels" the box.
- When a variable is used in expressions, we lookup for the "box" with that name and read its value.
- We can reassign a (new) value to a box.
- If we use a name in an expression without using it in an assignment first, we get a **`NameError`**.

```
fav = 17   # assign

fav + 3    # lookup

# lookup and reassign
fav = fav + 3
```

Example with turtle graphics

`lec_course_intro.ipynb`

If only I had a heart!



turtle – A library for turtle graphics

```
from turtle import *
from turtleBeads import *

setupTurtle()

# the head
teleport(0, 130)
fillcolor('grey')
begin_fill()
drawCircle(30)
end_fill()

# SOME CODE OMITTED

teleport(0, 200)
color('deep pink')
style = ('Courier', 40, 'italic')
write('If only I had a heart!', font=style, align='center')
```

Defines names used in this program and provides support for graphics

Setups up the turtle and screen for drawing

A series of function calls that move the turtle to the right location for drawing, setups the turtle to fill a shape with the color grey, and draws a circle.

Function calls for drawing. Note the third line starting with "style" is a statement that assigns the object on the right to the variable `style`.