Objectives

- Review
- Lab 2
  - Programming practice

Feedback on Lab 1

- Overall good
- Notes
  - Saved output from each program
    - With user input, try several different good test cases
  - Want *good* output
    - think about what the user wants to see
  - High-level comments
    - Describes what the program does
      - Helps for quick overview when reviewing
  - Electronic submission
    - In directory – looked good!

"Good" Output

- Depends on context
- Not necessarily showing how computation was performed

50 vs When i = 7 and j = 2, i^2+3*j-5 = 50

```
Rickey Henderson's Stealing %: 80.75818495117748
Lou Brock's Stealing %: 75.34136546184739
Henderson was 5.416819489330095 % more successful at stealing than Brock.
```


Review

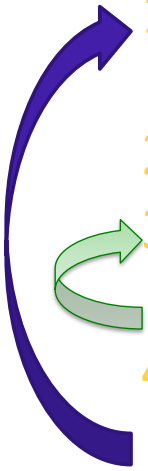
- What program do we use to develop programs?
  - What is the command you execute to start it?
- What are the expectations for your programs?
- What is our *process* for developing programs?
  - In general and for lab (e.g., what do you need to submit for your programs?)
- How can we make our program interactive with a user?

IDLE Review

- Run using `idle &`

You can install Python/IDLE on your own computers to practice between labs.

Formalizing Process of Developing Computational Solutions



1. Create a sketch of how to solve the problem (the algorithm)
2. Fill in the details in Python
3. Execute the program ***with good, varied test cases*** *to try to* ***reveal errors***
4. If output doesn't match your expectation, debug the program
   - (Where is the problem? How do I fix it?)

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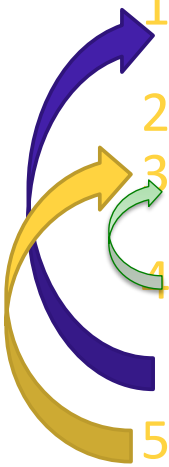

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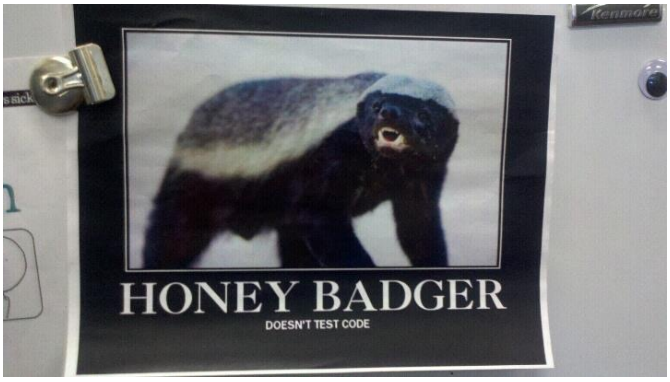
4. If output doesn't match your expectation, debug the program
   - (Where is the problem? How do I fix it?)
5. Iterate to improve your program
   - Better variable names, better input, more efficient, …

Testing



Honey Badger gets bad grade in CSCI111

Calculating the Average of Two Numbers

Suggested Approach to Development

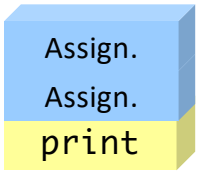
- Input is going to become fairly routine.
- Wait to get user input until you have figured out the rest of the program/algorithm.
- Develop/test without getting input first
  - Hardcode values
  - Speeds up process
- Then, add user input

Design Patterns

- General, repeatable solution to a commonly occurring problem in software design
  - Template for solution

Design Patterns

- General, repeatable solution to a commonly occurring problem in software design
  - Template for solution
- Example (Standard Algorithm)
  - Get input from user
  - Do some computation
  - Display output




```
x = input("…")
ans = …
print(ans)
```

Review: Linux Commands

- What is the command to…
  - Determine which directory you're in?
  - View the contents of a directory?
  - Create a directory?
  - Copy a file?
  - Delete a file?
- How do you refer to … your home directory? The current directory? The parent directory?

Linux Command: `mv`

- Used to *move* or *rename* a file
- `mv <sourcefile> <destination>`
- Example usage:
  - Renames `file.py` to `newfilename.py`

```
mv file.py newfile.py
```

  - Moves `~/cs111/file.py` to *current* directory with a new name

```
mv ~/cs111/file.py newfilename.py
```

  - If `<destination>` is a *directory*, keeps the original source file's name

```
mv ~/cs111/file.py ~/cs111/lab1/
```

directory

    - File `file.py` will now be in `cs111/lab1` directory instead of `cs111/`

Linux Command: rm

- Used to *delete* or *remove* a file
- `rm <filename>`
- Example usage:
  - Deletes `file.py` in the current directory

```
rm file.py
```

  - Deletes `~/cs111/lab1/file.py`

```
rm ~/cs111/lab1/file.py
```


Review

- What are the two types of division?
- How can we find the remainder of a division?

Review: Arithmetic Operations

Symbol	Meaning	Associativity
+	Addition	Left
-	Subtraction	Left
*	Multiplication	Left
/	Division	Left
%	Remainder ("mod")	Left
**	Exponentiation (power)	Right

Precedence rules: P E - DM% AS

negation

Associativity matters when you have the same operation multiple times

Review: Two Division Operators

/ Float Division

- Result is a `float`
- Examples:
  - `6/3 → 2.0`
  - `10/3 → 3.3333333333333335`
  - `3.0/6.0 → 0.5`
  - `10/9 → 1.9`

// Integer Division

- Result is an `int`
- Examples:
  - `6//3 → 2`
  - `10//3 → 3`
  - `3.0//6.0 → 0`
  - `10//9 → 1`

Review: Object-Oriented Programming

- What is the term for how we create a new object?
  - What is the syntax for that?
- What is the term for how we give commands to/do operations on objects?
  - What is the syntax for that?
  - What are two types of those operations we talked about?
    - What is the difference? How does that effect how we use them?

Review

- How do we get access to the code in `graphics.py` in our code?
- What is our typical process for drawing an object?
- How can we find out what we can do to an object?
  - How can we make a duplicate of a drawable object using the Graphics API?

Our Graphics Programming Design Pattern

- Import the Graphics Library
- Create the GraphWin
- Repeat:
  - Construct an object
    - Set up its color, width, …
  - Draw the object
- At the end of program
  - Call getMouse to make the window stay open until the user clicks
  - Then, call close on the window

Write out the algorithm then program on paper

Using the Graphics Library

- How do we create an instance of a Rectangle?
- Draw the rectangle?
- Shift the instance of the Rectangle class to the **right** 10 pixels
- What are the x- and y- coordinates of the upper-left corner of the Rectangle now?

Programming with the Graphics Library

- Algorithm for our program
  - Create an instance of a 50x100 Rectangle
  - Draw the rectangle
  - Shift the instance of the Rectangle class to the right 10 pixels
  - Display (print) the x- and y- coordinates of the upper-left corner of the Rectangle
- Now, implement it!
  - Draw on paper to help you think it through
  - Refer back to example program

Post-mortem: Analyzing Problem-Solving Process

- There were gaps in our algorithm
  - We needed a GraphWin
  - We needed to import graphics.py
  - Algorithm didn't say where to put the rectangle
  - Don't forget to wait for the mouse click and then close
- We didn't necessarily work linearly
  - Iteration often involves working backwards or in circles or …

Designing for Change

- Sometimes there are "magic numbers" in our code
  - Example: 200 in board
- Humans have more trouble understanding numbers than understanding words
- Give our magic numbers meaning by assigning them to variables, called ***constants***
  - Example: PI = 3.14159…
  - Name them with all capital letters (and maybe underscores) and put them at the top of programs
  - Makes them easier to find and change; software is ***soft***

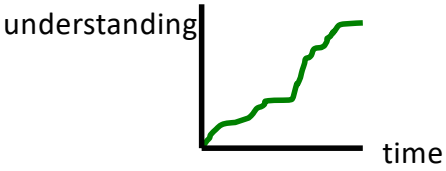
Example: Designing for Change

- First, define the constant: WIDTH=200
- Base later values on constants, e.g.,
  - window = GraphWin(WIDTH, WIDTH*2)
  - upperRightPoint = Point(0, WIDTH)
- Why is this a better design?
  - If want to change the width and keep rest of code working, update the constant (in one place)
- Using all caps is an indication that this is something that won't change during the program's execution

Example: Designing for Change

- Works for any data type
- Consider a *color theme* for your image
  - MAIN_COLOR=rgb_color(135, 206, 235)
  - HIGHLIGHT_COLOR=rgb_color(255, 219, 0)
- Later…
  - rect = Rectangle(…)
  - rect.setFill(MAIN_COLOR)
  - rect.setOutline(HIGHLIGHT_COLOR)

Lessons from Lab



- Look at examples!
  - "We were able to do this in that other program. How did we do that?"
  - On the course schedule page
- Explore!
  - Try things out in interactive mode
  - Then, put the ones that work into a script/program
- Testing!
  - Start with smaller and easy-to-verify tests
  - Test a variety of inputs
- Follow all of the directions!

Lab Overview

- Arithmetic problems
- Graphics API Problems
  - Update web page