Objectives

- Continuing fundamentals of programming in Python
- Software development practices
  - Testing
  - Debugging
  - Iteration
- Numeric Operations

Review

- What are Python's primitive data types and what do they represent?

Recap of Programming Fundamentals

- Most important data types (for us, for now): `int, float, str, bool`
  - Use these types to represent various information
- Variables have identifiers, (implicit) types
  - Should have "good" names
  - Names: start with lowercase letter; can have numbers, underscores
- Assignments
  - `x = y` means "x gets value y" or "x is assigned value of y"
  - Only variable on LHS of statement changes

Review: Assignment statements

- Assignment statements are NOT math equations!

```
count = count + 1
```

- These are commands!

```
x = 2
y = x
x = x + 3
```

  - What's the value of y?

What are the values?

- After executing the following statements, what are the values of each variable?

```
a = 5
y = a + -1 * a
z = a + y / 2
a = a + 3
y = (7+x)*z
x = z*2
```


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```

Runtime error:
x doesn't have a value yet!
- We say "x was not initialized"
- Can't use a variable on RHS until seen on LHS!*

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

NOT Math Class

- Need to write out all operations explicitly
  - In math class, a (b+1) meant a * (b+1)

Write this way in Python

Math Practice

```
5+3*2
2 * 3 ** 2
-3 ** 2
2 ** 3 ** 3
```

- How should we verify our answers?

Two Types of Division

- Float Division: Result is a `float`
  - 3.0/6.0 → 0.5
  - 6.0/3.0 → 2.0
  - ***At least*** one of numerator and denominator must have a decimal, i.e., have type `float`
- Integer Division: Result is an `int`
  - 3/6 → 0
  - 6/3 → 2
  - x/y, if both x and y are `int`s
  - If both numerator and denominator are `int`s, result is `int`

Not always obvious

Division Practice (NOT Math class)

What is the result? What is the **type** of the LHS variable?

- `x = 6/4`
- `y = 4 / 6 * 5.0`
- `a = 6/12.0`
- `b = 6.0/12`
- `z = .3`

```
z = x / y
z = x / 3
```


Parts of an Algorithm

- Input, Output
- Primitive operations
  - What data you have, what you can do to the data
- Naming
  - Identify things we're using
- Sequence of operations
- Conditionals
  - Handle special cases
- Repetition/Loops
- Subroutines
  - Call, reuse similar techniques

Printing Output

- **print** is a special command
  - Displays the result of expression(s) to the terminal
- `print "Hello, class"`
  - string literal
  - **print** automatically adds a '\n' (carriage return) after it's printed
- `print "Your answer is", 4*4`
  - Displays same as:
    - `print "Your answer is",`
    - `print 4*4`
  - **Syntax**: commas **Semantics**: print multiple "things" in one line

Interactive Programs

- Often, meaningful programs need input from users
- Demo: `input_demo.py`

Getting Input From User

- **input** and **raw_input** are ***functions***
  - **Function**: A command to do something
  - Prompts user for input, gets the user's input
  - **input**: to read in *numbers*
  - **raw_input**: to read in strings/*text*
- Syntax:
  - `input(<string_prompt>)`
  - `raw_input(<string_prompt>)`

Getting Input From User

- Typically used in assignments
- Examples:
  - Prompt displayed to user
  - `width = input("Enter the width: ")`
    - **width** is assigned the number the user enters
    - Use **input** because expect a number from user
  - `name=raw_input("What is your name?")`
    - **name** is assigned the string the user enters
    - Use **raw_input** because expect a string from user

What do you think the code looks like for `input_demo.py`?

Getting Input from User

```
color = raw_input("What is your favorite color? ")
```

Terminal:

Grabs every character up to the user presses "enter"

```
> python input_demo.py
What is your favorite color? blue
Cool!  My favorite color is _light_ blue !
```

Assigns variable **color** the user's input

Documenting Your Code

- Use English to describe what your program is doing in ***comments***
  - Everything after a **#** is a comment
    - Color-coded in IDLE, jEdit
  - Python does not execute comments
- Does not affect the correctness of your program
- Improves program's ***readability***
  - Easier for someone else to read and update your code

When to Use Comments

- Document the author, high-level description of the program at the top of the program
- Provide an outline of an algorithm
  - Separates the steps of the algorithm
- Describe difficult-to-understand code

Identify the Pieces of a Program

```
# Demonstrate numeric and string input
# by Sara Sprenkle for CS111
#

color = raw_input("What is your favorite color? ")
print "Cool!  My favorite color is _light_", color, "!"

scale = input("On a scale of 1 to 10, how much do you
like Matt Damon? ")
print "Cool!  I like him", scale*1.8, "much!"
```

Identify the comments, variables, functions, expressions, assignments, literals

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                           expression
```

Identify the comments, variables, functions, expressions, assignments, literals

Putting it all together

- Find the area of a rectangle (which has a width and height)
  - What is the algorithm for solving this problem?

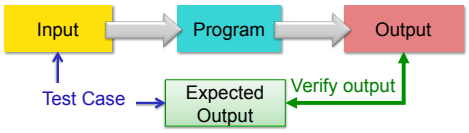
Putting it all together

- Find the area of a rectangle (which has a width and height)
- Algorithm:
  - Optional: get the width and height from user
    - Alternative: "hard-code" width and height
  - Calculate area
  - Print area

Errors/Bugs

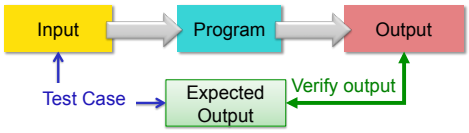
- Sometimes the program doesn't work
- Types of programming errors:
  - Syntax error
    - Interpreter shows where the problem is
  - Logic/semantic error
    - answer = 2+3
    - No, answer should be *2*3*
  - Exceptions/Runtime errors
    - answer = 2/0
    - Undefined variable name
- Expose errors when **Testing**

Testing Process



- Test case: **input** used to test the program, **expected output** given that input
- Verify if output is what you expected

Testing Process



- Need ***good*** **test cases** to help determine if program is correct
  - Tester plays devil's advocate
  - Want to expose **all** bugs!
  - Find before customer/professor!

Practice: Test Cases

- Test cases for finding the area of a rectangle

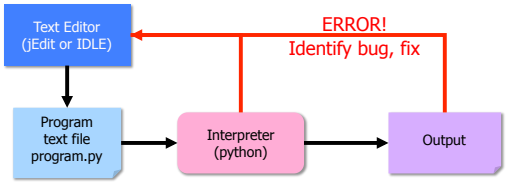
Input	Expected Output

Practice: Test Cases

- Test cases for finding the area of a rectangle
  - Test both integers
  - Test with at least one float for width, height
  - Test numbers less than or equal to 0
    - Shouldn't compute area for those

Debugging

- Edit the program, re-execute/test until everything works
- The error is often called a "bug"
- Diagnosing and fixing it is called ***debugging***



Good Development Practices

- Design the algorithm
  - Break into pieces
- **Implement** *and* **Test** each piece *separately*
  - Identify the best pieces to make progress
  - Iterate over each step to improve it
- Write comments FIRST for each step
  - Elaborate on what you're doing in comments when necessary

This Week

- Tuesday: Lab 1
  - Starts at 3
  - Due Friday
- For Friday, read up to "Jake's Communities" of Four Puzzles from Cyberspace