## Objectives

- Refining our development process
- Passing parameters
- BI: Google Search

## Review

- What is the syntax for creating a function?
- What is the special keyword that means “this is the output for the function”?
  - Why do we typically not just print the result from a function?
- What does a variable’s “scope” mean?
- What are options for how we organize our program (with respect to functions)?

## Practice: Trace through the Program's Execution

- What is the output of this program?
  - Example: user enters 4

```python
def main():
    num = eval(input("Enter a number to be squared: "))
    squared = square(num)
    print("The square is", squared)

def square(n):
    return n * n

main()
```

practice1.py

## Practice

- What is the output of this program?
  - Example: user enters 4

```python
def main():
    num = eval(input("Enter a number to be squared: "))
    squared = square(num)
    print("The square is", squared)
    print("The original num was", n)

def square(n):
    return n * n

main()
```

practice2.py

## Practice

- What is the output of this program?
  - Example: user enters 4

```
def main():
    num = eval(input("Enter a number to be squared: "))
    squared = square(num)
    print("The square is", squared)
    print("The original num was", n)

def square(n):
    return n * n

main()
```

Error! n does not have a value in function main()

## Variable Scope

- Know "lifetime" of variable
  - Only during execution of function
  - Related to idea of "scope"
- Consider: how many functions probably use a variable like x or i? What would the impact be on our programs if all variables had global scope?
- In general, our only *global* variables will be constants because we don't want them to change value
  - e.g., EIEIO

## Review

- How can we test functions easily?
  - What do we need to test functions?
- What are benefits of functions?

## Example: Testing sumEvens

```
import test
…
def testSumEvens():
    actual = sumEvens( 10 )
    expected = 20
    test.testEqual( actual, expected )

def sumEvens(limit):
    total = 0
    for x in range(0, limit, 2):
        total += x
    return total
```

This is the actual result from our function

This is what we expect the result to be

What are other good test cases?

testSumEvens.py

## Design Patterns

- Former general design pattern:
  1. Optionally, get user input
  2. Do some computation
  3. Display results
- Now general design pattern:
  1. Optionally, get user input
  2. Do some computation in **functions**, get results
  3. Display results

Another development approach

## REFACTORING

## Refactoring

- After you've written some code and it passes all your test cases, the code is probably still not perfect
- ***Refactoring*** is the process of improving your code *without* changing its functionality
  - Organization
  - Abstraction
    - Example: Easier to read, change
  - Easier to test
- Part of iterative design/development process
- Where to refactor with functions
  - Duplicated code
    - "Code smell"
  - Reusable code
  - Multiple lines of code for one purpose

## Example: PB & J

1. Gather materials (bread, PB, J, knives, plate)
2. Open bread
3. Put 2 pieces of bread on plate
4. Spread PB on one side of one slice
5. Spread Jelly on one side of other slice
6. Place PB-side facedown on Jelly-side of bread
7. Close bread
8. Clean knife
9. Put away materials

- Which of these are the "core" part of making a PB & J sandwich?
- How would you describe the rest of the parts?

## Example: PB & J

1. Gather materials (bread, PB, J, knives, plate)
2. Open bread
3. Put 2 pieces of bread on plate
4. Spread PB on one side of one slice
5. Spread Jelly on one side of other slice
6. Place PB-side facedown on Jelly-side of bread
7. Close bread
8. Clean knife
9. Put away materials

## Example: PB & J as Functions

1. Gather materials (bread, PB, J, knives, plate)
2. Open bread
3. Put 2 pieces of bread on plate
4. Spread PB on one side of one slice
5. Spread Jelly on one side of other slice
6. Place PB-side facedown on Jelly-side of bread
7. Close bread
8. Clean knife
9. Put away materials

```
def main():
    prepare()
    makePBJSandwich()
    cleanUpSupplies()
main()
```

## Refactoring: Converting Functionality into Functions

1. Identify functionality that should be put into a function
   - What should the function do?
   - What is the function's input?
   - What is the function's output (i.e., what is returned)?
2. Define the function
   - Write comments
3. Test the function programmatically
4. Call the function where appropriate
5. Create a `main` function that contains the "driver" for your program
   - Put at top of program
6. Call `main` at bottom of program

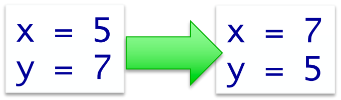
## Our First Problem

- Create three variables (i, j, and result) to calculate and display result = $i^2 + 3j - 5$ for the case where i=7 and j=2. Your code will not look exactly like this formula. Display the result and verify that it is correct. Consider if you were the user of the program and make the program display appropriate output.

`arithmetic.py`

## Passing Parameters

- Only **copies** of the actual parameters are given to the function
  - For **immutable** data types (which are what we've talked about so far)
- The *actual* parameters in the calling code do not change
- **Swap example:**
  - Swap two values in script
  - Then, put into a function



swap.py

## Exam Next Friday

- **Do not panic**
- In-class, on paper
  - Emphasis on critical thinking
- Exam Preparation Document is on course web page
- Similar problems to class and lab
  - Review questions
  - Worksheets
  - Problems
- Content: up through Tuesday's lab 4
  - Practicing what we learned Wed – Mon
- No broader issue next week

## Broader Issue: Google Search

| | | | | |
|---|---|---|---|---|
| Callie | Danny | Cat | Alice | Dan |
| Charlotte | Laurie | Ellis | Andrew | Hayden |
| Danielle | Matt | Jake | August | James |
| Giovanni | Natalie | Jenna | Bobby | Mike |
| Karel | Nate | Kassi | Melissa | |

## Broader Issue: Google Search

- Why is Google search a “broader issue”?
- How does Google search work?
  - Which are the most important pieces?
- What are some ways you think searches could be improved?
  - How do you measure “improved search”?
- Will you use Google differently, now that you know how it works (kind of)?

## Broader Issue: Google Search

- What power do search engines have?
- Is Google search biased?

## Looking Ahead

- PreLab 4 due Tuesday
- Lab 4 next week – practice with functions
- No Broader Issue
- Exam on Friday
  - Look at Exam Prep Document