Objective

- Using functions
- Using modules
- Animation

Review

- What is a function?

Functions

- Syntax:
  - `func_name(arg0, arg1, …, argn)`

Argument list (input)

- Depending on the function, arguments may or may not be required
  - [ ] indicate an optional argument
- Semantics: depend on the function

Built-in Functions

- Python provides some built-in functions for common tasks

Known as function's ***signature***

Template for how to "**call**" function

Optional argument

- `input([prompt])`
  - If prompt is given as an argument, prints the prompt without a newline/carriage return
  - If no prompt, just waits for user's input
  - **Returns** user's input (up to "enter") as a **string**

Description of `print`

- `print(value, …, sep=' ', end='\n', file=sys.stdout)` Important later

  Meaning: default values for `sep` and `end` are `' '` and `'\n'`, respectively

  - Print *object*(s) to the stream *`file`*, separated by *`sep`* and followed by *`end`*.
  - Both *`sep`* and *`end`* must be strings; they can also be `None`, which means to use the default values. If no *object* is given, *`print`*() will just write *`end`*.

`http://docs.python.org/py3k/library/functions.html#print`

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- Examples

```
print("Hi", "there", "class", sep='; ')
print("Put on same", end='')
print("line")
```

Output:

```
Hi; there; class
Put on sameline
```

`print_examples.py`

More Examples of Built-in Functions

Function Signature	Description
round(x[,n])	Return the float x rounded to n digits after the decimal point If no n, round to nearest int
abs(x)	Returns the absolute value of x
type(x)	Return the type of x
pow(x, y)	Returns x^y

Interpreter

Using Functions

- Example use: Alternative to exponentiation
  - Objective: compute -3^2
  - Python alternatives:
    - pow(-3, 2)
    - (-3) ** 2
- We often use functions in assignment statements
  - Function does something
  - Save the output of function (what is ***returned*** in a variable

```
roundedX = round(x)
```

Python Libraries

- Beyond built-in functions, Python has a rich **library** of functions and definitions available
  - The library is broken into **modules**
  - A ***module*** is a file containing Python definitions and statements
- Example modules
  - `math` — math functions
  - `random` – functions for generating random numbers
  - `os` — operating system functions
  - `network` — networking functions

`math` Module

- Defines constants (variables) for `pi` (i.e., π) and `e`
  - These values never change, i.e., are ***constants***
  - Recall: ***we*** name constants with all caps
- Defines functions such as

Function	What it Does
`ceil(x)`	Return the ceiling of x as a float
`exp(x)`	Return e raised to the power of x
`sqrt(x)`	Return the square root of x

Using Python Libraries

- To use the definitions in a module, you must first `import` the module
  - Example: to use the `math` module's definitions, use the the import statement: `import math`
  - Typically import statements are at ***top*** of program
- To find out what a module contains, use the `help` function
  - Example within Python interpreter

```
import math
help(math)
```


Using Definitions from Modules

- Prepend constant or function with `modulename`.
  - Examples for constants:
    - `math.pi`
    - `math.e`
  - Examples for functions:
    - `math.sqrt`
- Practice
  - How would we write the expression $e^{i\pi} + 1$ in Python?

Alternative Import Statements

```
from <module> import <defn_name>
```

- Examples:
  - `from math import pi`
    - Means "import pi from the math module"
  - `from math import *`
    - Means "import *everything* from the math module"
- With this `import` statement, don't need to prepend module name before using functions
  - Example: `e**(1j*pi) + 1`

Benefits of Using Python Libraries/Modules

- Don't need to rewrite code
- If it's in a module, it is very *efficient* (in terms of computation speed and memory usage)

Finding Modules To Use

- How do I know if functionality that I want already exists?
  - Python Library Reference: `http://docs.python.org/py3k/library/`
- For the most part, in the beginning you will write most of your code from scratch

RANDOM MODULE

random module

- Python provides the random module to generate pseudo-random numbers

- Why "pseudo-random"?
  - Generates a list of random numbers and grabs the next one off the list
  - A "seed" is used to initialize the random number generator, which decides which list to use
    - By default, the current time is used as the seed

List of Lists of Random Numbers

Seed	List of Random Numbers				
1	0.1343642441	0.8474337369	0.763774619	0.2550690257	…
2	0.9560342719	0.9478274871	0.0565513677	0.0848719952	…
3	0.2379646271	0.5442292253	0.3699551665	0.6039200386	…
4	0.2360480897	0.1031660342	0.3960582426	0.1549722708	…
…	…				…

Some `random` Functions

- `random()`
  - Returns the next random floating point number in the range [0.0, 1.0)
- `randint(a, b)`
  - Return a random integer N such that a ≤ N ≤ b

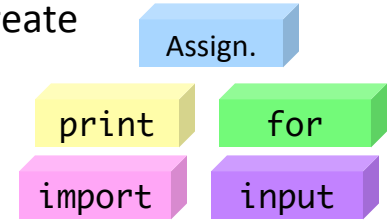
```
import random

#random.seed(1)      # module.function()

for x in range(10):
    print(random.random())
```


VA Lottery: Pick 4

- To play: pick 4 numbers between 0 and 9, inclusive
- To win: select the numbers that are selected by the magic ping-pong ball machine
- Your job: Simulate the magic ping-pong ball machines
  - Display the number on one line

Programming Building Blocks

- Adding to your tool set
- We can combine them to create more complex programs
  - Solutions to problems



ANIMATION

Problem: Circle Shift

- Move a circle to the position clicked by the user
  - Repeat five times

Animation

- Use combinations of the method **`move`** and the function **`sleep`**
  - Need to **sleep** so that humans can see the graphics moving
  - Computer would process the **move**s too fast!
- **`sleep`** is part of the **`time`** module
  - takes a `float` parameter representing *seconds* and pauses for that amount of time

animate.py

Problem: Animate Moving to User Click

- In X steps, move from the circle's current location to the location clicked by user

`circleShiftAnim.py`

Looking Ahead

- Pre Lab 3 - tomorrow
- Lab 3 – due Friday
- BI – due Friday