Introduction to Python and programming

Ruth Anderson

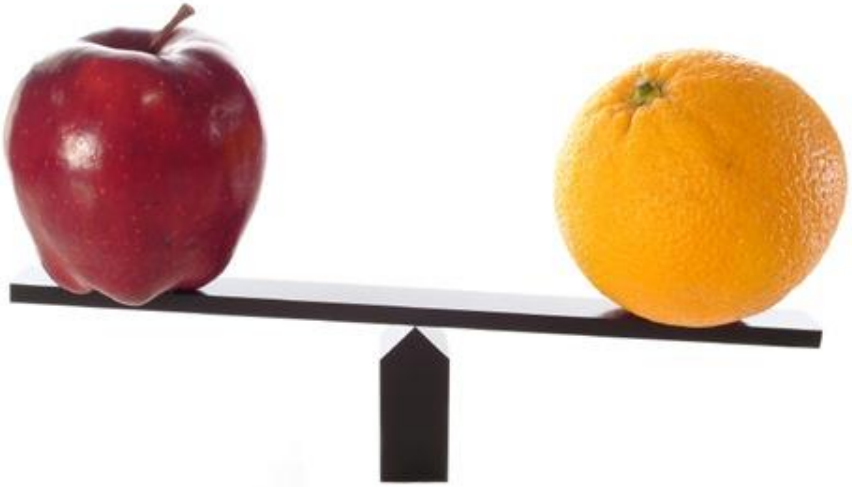
UW CSE 160

Winter 2017

1. Python is a calculator

2. A variable is a container

3. Different types cannot be compared



4. A program is a recipe

0. Don’t panic!

- CSE 160 is for beginners to programming
  - (If you know how to program, you don’t belong)
- You can learn to program in 10 weeks
  - You will work hard
  - We will work hard to help you
- Ask questions!
  - This is the best way to learn

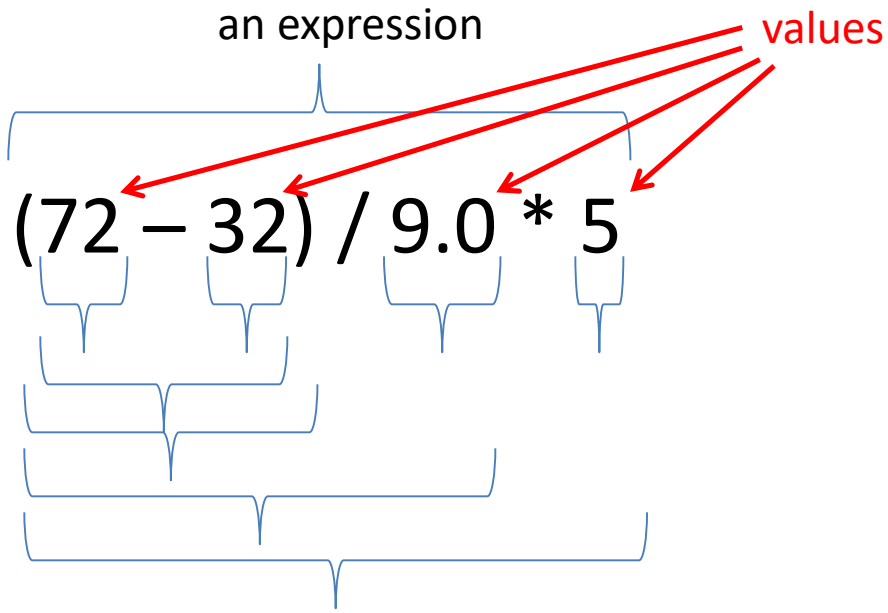
1. Python is a calculator

You type *expressions*. Python computes their *values*.

- 5
- 3 + 4
- 44 / 2
- 2 ** 3
- 3 * 4 + 5 * 6
  - If precedence is unclear, use parentheses
- (72 – 32) / 9 * 5

An expression is evaluated from the inside out

- How many expressions are in this Python code?



(**72** – **32**) / **9.0** * **5**

(**40**) / **9.0** * **5**

40 / **9.0** * **5**

4.44 * **5**

22.2

Another evaluation example

(72 – 32) / (9.0 * 5)

(40) / (9.0 * 5)

40 / (9.0 * 5)

40 / (45.0)

40 / 45.0

.888

2. A variable is a container

Variables hold values

- Recall variables from algebra:
  - Let x = 2 …
  - Let y = x …
- In Python assign a variable: "*varname* = *expression*"

```
pi = 3.14
pi
avogadro = 6 * 10 ** 23
avogadro
22 = x                    # Error!
```

No output from an assignment statement

- Not all variable names are permitted

Changing existing variables ("re-binding" or "re-assigning")

```
x = 2
x
y = x
y
x = 5
x
y
```

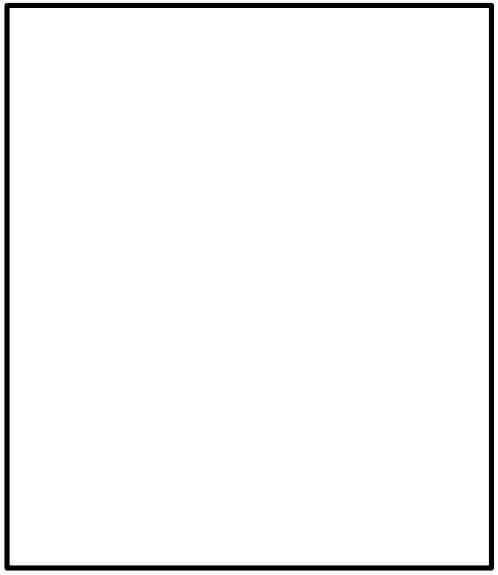
- "=" in an assignment is not a promise of eternal equality
  - This is different than the mathematical meaning of "="
- Evaluating an expression gives a new (copy of a) number, rather than changing an existing one

How an assignment is executed

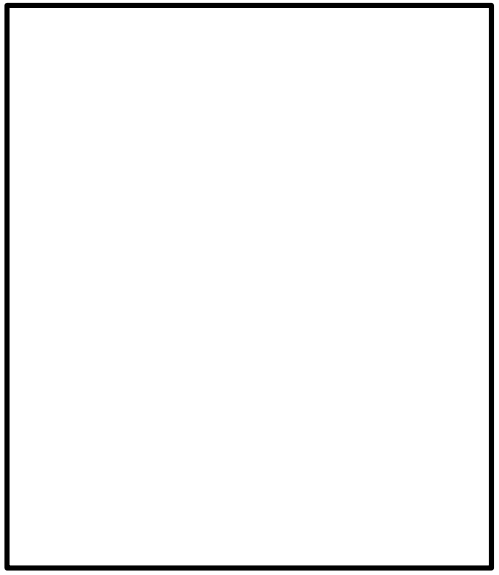
1. Evaluate the right-hand side to a value
2. Store that value in the variable

```
x = 2
print x
y = x
print y
z = x + 1
print z
x = 5
print x
print y
print z
```

State of the computer:



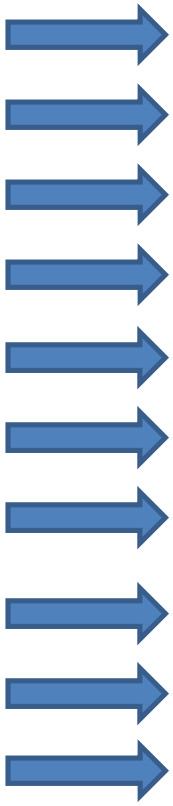
Printed output:



To visualize a program's execution:
http://pythontutor.com Link to this code here

How an assignment is executed

1. Evaluate the right-hand side to a value
2. Store that value in the variable



```
x = 2
print x
y = x
print y
z = x + 1
print z
x = 5
print x
print y
print z
```

State of the computer:

x: ~~2~~ 5

y: 2

z: 3

Printed output:

2
2
3
5
2
3

To visualize a program's execution:
http://pythontutor.com Link to this code here

More expressions: Conditionals (value is `True` or `False`)

```
22 > 4
22 < 4
22 == 4
x = 100
22 = 4
x >= 5
x >= 100
x >= 200
not True
not (x >= 200)
3<4 and 5<6
4<3 or 5<6
temp = 72
water_is_liquid = temp > 32 and temp < 212
```

See in python tutor or here

Assignment, *not* conditional!

Error!

Numeric operators: `+`, `*`, `**`
Mixed operators: `<`, `>=`, `==`
Boolean operators: `not`, `and`, `or`

More expressions: strings

A string represents text

```
'Python'
this_class = "CSE 160"
""
```

Empty string is not the same as an unbound variable

Operations on strings:

- Length:

```
len(this_class)
```

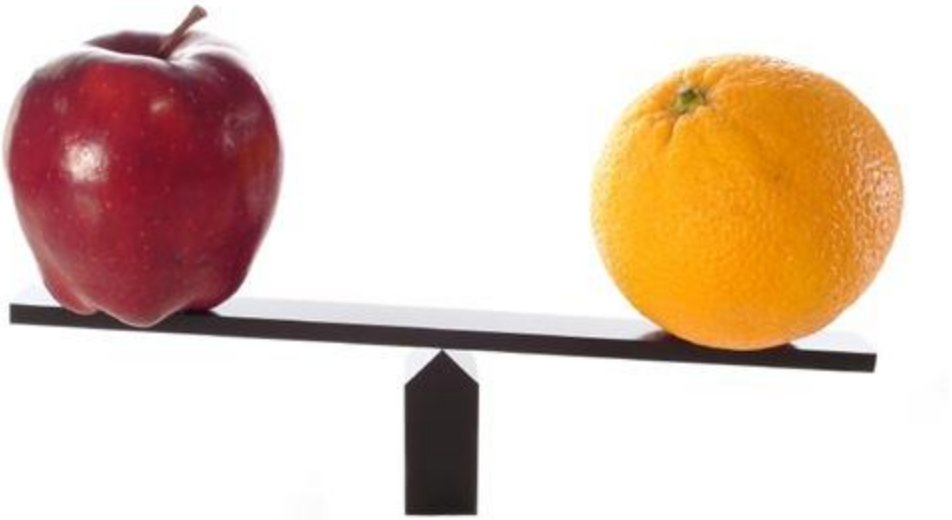
- Concatenation:

```
"Ruth" + 'Anderson'
```

- Containment/searching:

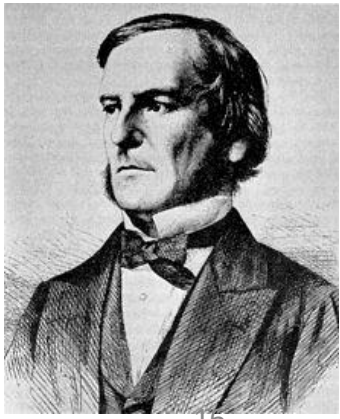
```
'0' in this_class
"O" in this_class
```

3. Different types cannot be compared



Types of values

- Integers (**`int`**): **`-22, 0, 44`**
  - Arithmetic is exact
  - Some funny representations: **`12345678901L`**
- Real numbers (**`float`**, for "floating point"): **`2.718, 3.1415`**
  - Arithmetic is approximate, e.g., **`6.022*10**23`**
  - Some funny representations: **`6.022e+23`**
- Strings (**`str`**): **`"I love Python", ""`**
- Truth values (**`bool`**, for "Boolean"): **`True, False`**



George Boole

Operations behave differently on different types

See in python tutor

```
3.0 + 4.0
3 + 4
3 + 4.0
"3" + "4"
3 + "4"                 # Error
3 + True                # Insanity!  (Don't do this.)
```

Moral: Python *sometimes* tells you when you do something that does not make sense.

Operations behave differently on different types

```
15.0 / 4.0
15 / 4                    # Truncating!
15.0 / 4
15 / 4.0
```

See in python tutor or here

Type conversion:

```
float(15)
int(15.0)
int(15.5)
int("15")
str(15.5)
float(15) / 4
```

4. A program is a recipe

CORNBREAD

Colvin Run Mill Corn Bread

1 cup cornmeal
1 cup flour
½ teaspoon salt
4 teaspoons baking powder
3 tablespoons sugar
1 egg
1 cup milk
¼ cup shortening (soft) or vegetable oil

Mix together the dry ingredients. Beat together the egg, milk and shortening/oil. Add the liquids to the dry ingredients. Mix quickly by hand. Pour into greased 8x8 or 9x9 baking pan. Bake at 425 degrees for 20-25 minutes.

What is a program?

See in python tutor

- A program is a sequence of instructions
- The computer executes one after the other, as if they had been typed to the interpreter
- Saving your work as a program is better than re-typing from scratch

```
x = 1
y = 2
x + y
print x + y
print "The sum of", x, "and", y, "is", x+y
```

Interlude: The `print` statement

See in python tutor

- The **`print`** statement always prints one line
  - The next print statement prints below that one
- Write 0 or more expressions after **`print`**, separated by commas
  - In the output, the values are separated by spaces
- Examples:

```
print 3.1415
print 2.718, 1.618
print
print 20 + 2, 7 * 3, 4 * 5
print "The sum of", x, "and", y, "is", x+y
```

Exercise: Convert temperatures

- Make a temperature conversion chart:
  Fahrenheit to Centrigrade, for -40, 0, 32, 68, 98.6, 212, 293, 451
  Output:

```
-40 -40.0
0 -17.7778
32 0.0
68 20.0
98.6 37.0
212 100.0
293 145.0
451 232.778
```

- You have created a Python program!
- (It doesn't have to be this tedious, and it won't be.)

Expressions, statements, and programs

- An expression evaluates to a value

```
3 + 4
pi * r**2
```

- A statement causes an effect

```
pi = 3.14159
print pi
```

- Expressions appear within other expressions and within statements

```
(fahr - 32) * (5.0 / 9)
print pi * r**2
```

- A statement may *not* appear within an expression

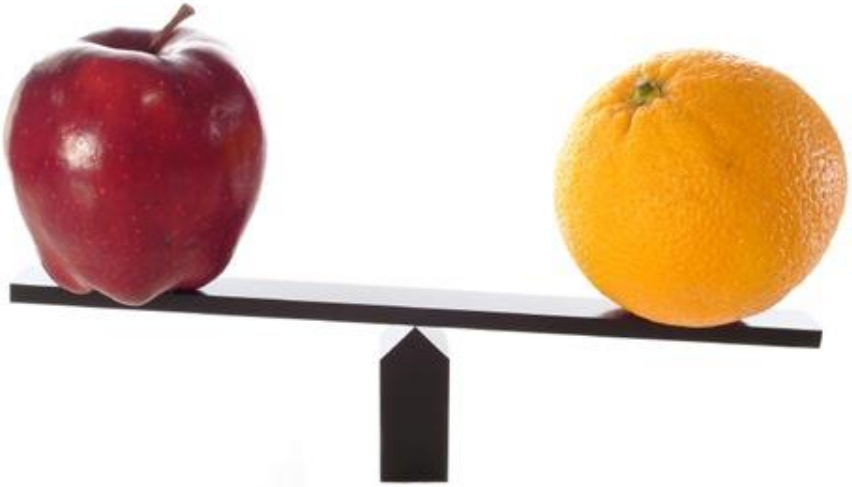
```
3 + print pi              # Error!
```

- A program is made up of statements
  - A program should do something or communicate information
  - Just evaluating an expression does not accomplish either goal

1. Python is a calculator

2. A variable is a container

3. Different types cannot be compared



4. A program is a recipe