Introduction to Python and programming

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UW CSE 140

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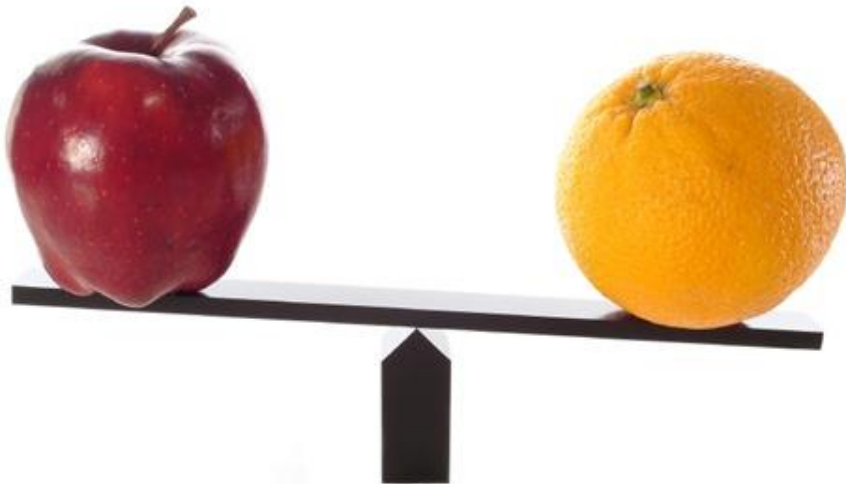
1. Python is a calculator

2. A variable is a container

3. Different types cannot be compared

4. A program is a recipe

0. Don't panic!

- CSE 140 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!
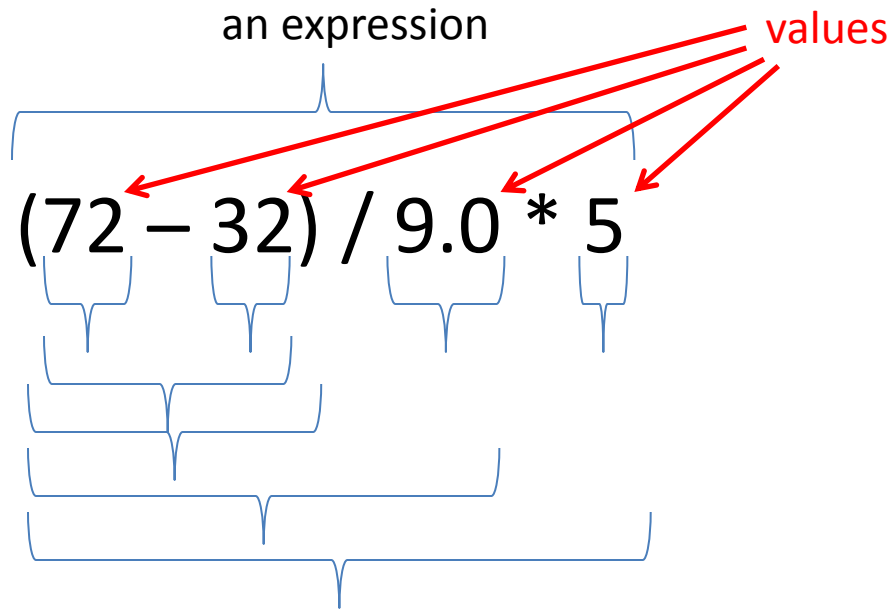 - This is the best way to learn

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?

an expression   values

$(72 - 32) / 9.0 * 5$

$(72 - 32) / 9.0 * 5$

$(40) / 9.0 * 5$

$40 / 9.0 * 5$

$4.44 * 5$

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 …
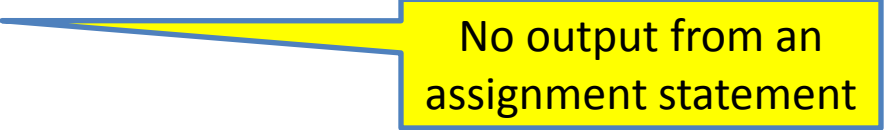- To assign a variable, use "*varname = expression*"

```
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 = 2
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:

x: 2

y: 2

z: 3

Printed output:

2
2
3
5
2
3

To visualize a program's execution:
http://pythontutor.com

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

```
22 > 4
22 < 4
22 == 4
x = 100                    # Assignment, not conditional!
22 = 4                     # Error!
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
```

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

More expressions: strings

A string represents text
```
'Python'
myclass = "CSE 140"
""
```
Empty string is not the same as an unbound variable

Operations:
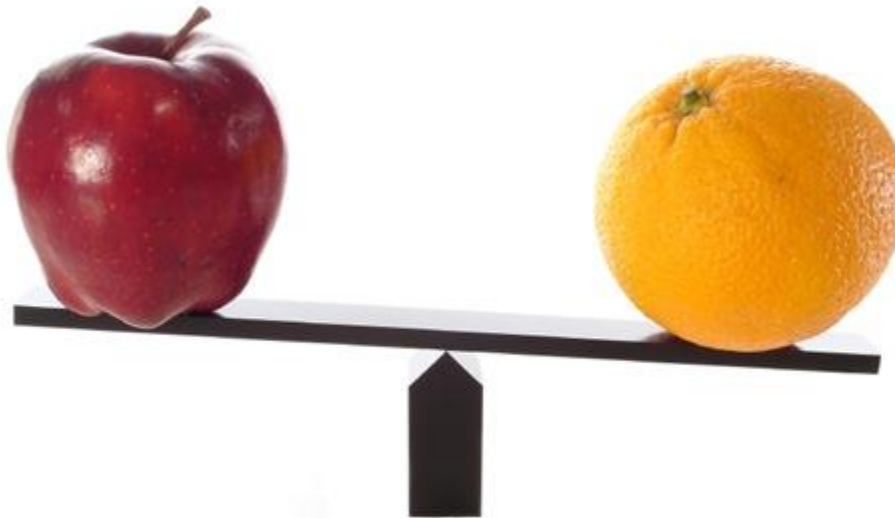- Length:
  ```
  len(myclass)
  ```
- Concatenation:
  ```
  "Ruth" + 'Anderson'
  ```
- Containment/searching:
  ```
  '0' in myclass
  "O" in myclass
  ```

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`
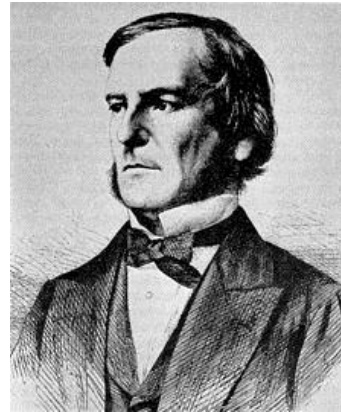
George Boole

Operations behave differently on different types

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

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?

- 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

- 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
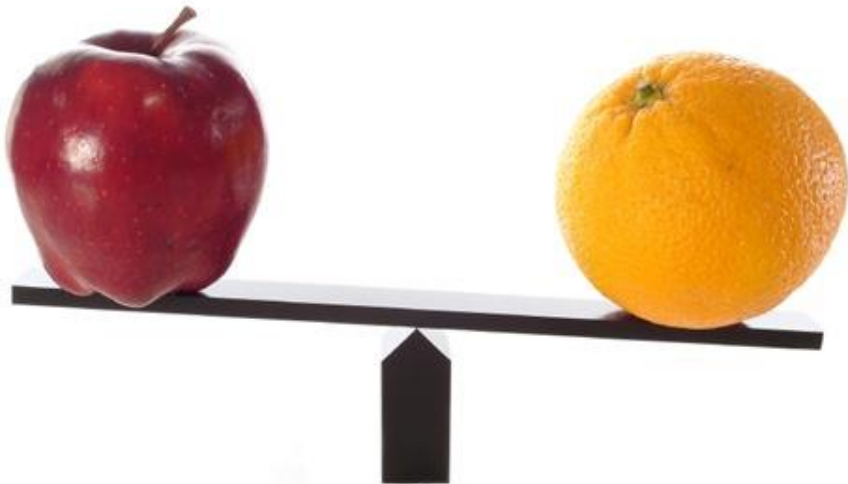 – Just evaluating an expression does not accomplish either goal

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