DS5010

Intro to programming for Data Science

LECTURE 1

TODAY

- syllabus overview
- house and alias name assignments
- basic python objects
- basic operations
- variables and types
- rules of sum and product
- branching and conditionals

Syllabus

- you can access the full syllabus here:

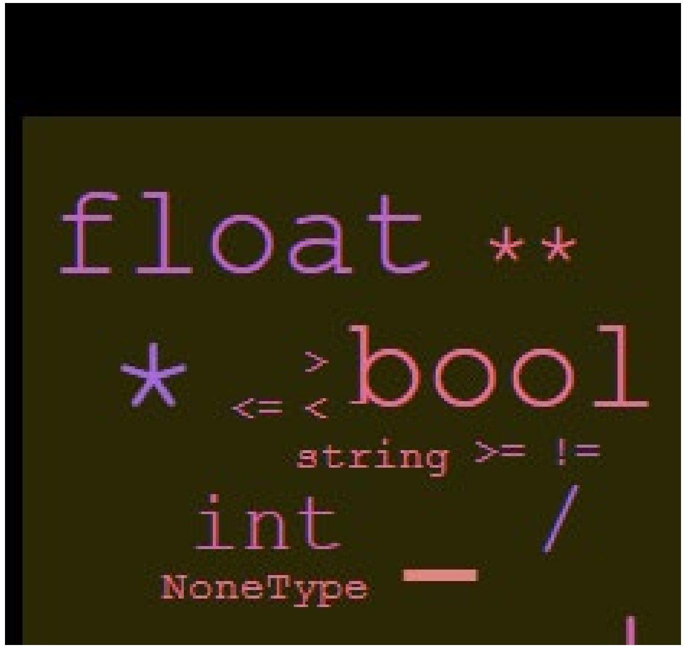
  https://rahiminasab.github.io/DS5010F19/

House and Alias name Assignments

- students in this class will be divided into 5 Houses:
  - Stark
  - Baratheon
  - Lannister
  - Targaryen
  - Martell
- each student will also get an alias name which are chosen from GOT character names.
- students will participate in HackerRank contests with a username derived from their alias names.
- a script written in Python will do the assignments and emails the students their assigned, House, alias name, and username.

Python vs English as a language

- **primitive constructs**
  - English: words.
  - programming language: numbers, strings, simple operators.



Python vs English as a language

- **syntax**
  - English: **”cat dog boy”** → not syntactically valid
    ”cat hugs boy” → syntactically valid
  - programming language: **+"hi"5** → not syntactically valid
    3.2*5 → syntactically valid

Python vs English as a language

- **static semantics** is which syntactically valid strings have meaning
  - English: **"I are hungry"** → syntactically valid but with static semantic error
  - programming language: **3.2*5** → syntactically valid
    3+"hi" → static semantic error

Python vs English as a language

- **semantics** is the meaning associated with a syntactically correct string of symbols with no static semantic errors
  - English: can have many meanings "Flying planes can be dangerous“
  - programming languages: have only one meaning but may not be what programmer intended

WHERE THINGS GO WRONG

- **syntactic errors**
  - common and easily caught
- **static semantic errors**
  - some languages check for these before running program
  - can cause unpredictable behavior
- no semantic errors but **different meaning than what programmer intended**
  - program crashes, stops running
  - program runs forever
  - program gives an answer but different than expected

PYTHON PROGRAMS

- a **program** is a sequence of definitions and commands
  - definitions **evaluated**
  - commands **executed** by Python interpreter in a shell
- **commands**(statements) instruct interpreter to do something
- can be typed directly in a **shell** or stored in a **file** that is read into the shell and evaluated

OBJECTS

- programs manipulate **data objects**
- objects have a **type** that defines the kinds of things programs can do to them
  - A human can walk, and speak English
  - A monkey can walk, but cannot speak English
- objects are
  - scalar (cannot be subdivided)
  - non-scalar (have internal structure that can be accessed)

SCALAR OBJECTS

- int – represent **integers**, ex. 5
- float – represent **real numbers**, ex. 3.27
- bool – represent **Boolean** values True and False
- NoneType – **special** and has one value, `None`
- can use type() to see the type of an object

```
>>> type(5)
int
>>> type(3.0)
float
```

what you write into the Python shell

what shows after hitting enter

TYPE CONVERSIONS (CAST)

- can **convert object of one type to another**
- float(3) converts integer 3 to float 3.0
- int(3.9) truncates float 3.9 to integer 3

PRINTING TO CONSOLE

- to show output from code to a user, use print command

```
In [11]: 3+2
Out[11]: 5

In [12]: print(3+2)
5
```

"Out" tells you it's an interaction within the shell only

No "Out" means it is actually shown to a user, apparent when you edit/run files

EXPRESSIONS

- **combine objects and operators** to form expressions
- an expression has a **value**, which has a type
- syntax for a simple expression

```
<object> <operator> <object>
```

OPERATORS ON ints and floats

- `i+j` → the sum
- `i-j` → the difference
- `i*j` → the **product**
- `i/j` → **division**
- `i//j` → **floor division**

if both are ints, result is int
if either or both are floats, result is float

result is float

- `i%j` → the **remainder** when `i` is divided by `j`
- `i**j` → `i` to the **power** of `j`

SIMPLE OPERATIONS

- parentheses used to tell Python to do these operations first
- **operator precedence** without parentheses
  - **
  - *
  - /
  - + and – executed left to right, as appear in expression

BINDING VARIABLES AND VALUES

- equal sign is an **assignment** of a value to a variable name

variable value

```
pi = 3.14159
pi_approx = 22/7
```

- value stored in computer memory
- an assignment binds name to value
- retrieve value associated with name or variable by invoking the name, by typing pi

ABSTRACTING EXPRESSIONS

- why **give names** to values of expressions?
- to **reuse names** instead of values
- easier to change code later

```
pi = 3.14159
radius = 2.2
area = pi*(radius**2)
```

PROGRAMMING vs MATH

- in programming, you do not “solve for x”

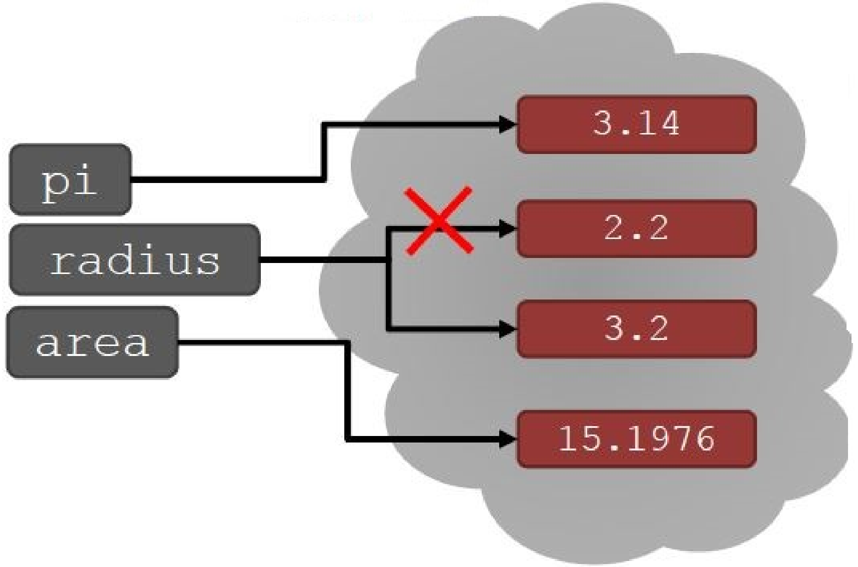
```
pi = 3.14159
radius = 2.2
# area of circle
area = pi*(radius**2)
radius = radius+1
```

an assignment
* expression on the right, evaluated to a value
* variable name on the left
* equivalent expression to `radius = radius + 1`
is `radius += 1`

CHANGING BINDINGS

- can **re-bind** variable names using new assignment statements
- previous value may still stored in memory but lost the handle for it
- value for area does not change until you tell the computer to do the calculation again

```
pi = 3.14
radius = 2.2
area = pi*(radius**2)
radius = radius+1
```



A SIMPLE COUNTING PROBLEM

- You know **4** different roads which you can take to go from NEU to Copley square
- You know **3** different roads which you can take to go from Copley to Downtown.

❖ In how many different ways can you go from NEU to Downtown given that you want to stop at Copley in between?

- You know also **5** different roads which you can take to go from NEU to Downtown directly without passing Copley.

❖ In how many different ways can you go from NEU to Downtown now?

DM: RULES OF SUM and PRODUCT

Rule of sum:

- if we have *A* ways of doing something and *B* ways of doing another thing and we can not do both at the same time, then there are *A* + *B* ways to choose one of the actions.

Rule of product:

- if there are **a** ways of doing something and **b** ways of doing another thing, then there are **a** * **b** ways of performing both actions.

STRINGS

- letters, special characters, spaces, digits
- enclose in **quotation marks or single quotes**

```
hi = "hello there"
```

- **concatenate** strings

```
name = "Arya"
greet = hi + name
greeting = hi + " " + name
```

- do some **operations** on a string as defined in Python docs

```
silly = hi + " " + name * 3
```

INPUT/OUTPUT: print

- used to **output** stuff to console
- keyword is `print`

```
x = 1
print(x)
x_str = str(x)
print("my fav num is", x, ".", "x =", x)
print("my fav num is " + x_str + ". " + "x = " + x_str)
```

INPUT/OUTPUT: input("")

- prints whatever is in the quotes
- user types in something and hits enter
- binds that value to a variable

```
text = input("Type anything... ")
print(5*text)
```

- input **gives you a string** so must cast if working with numbers

```
num= int(input("Type a number... "))
print(5*num)
```

STRINGS

- You can access the i’th character in a string using brackets.

```
s = “abcde”

s[0] → ‘a’
s[1] → ‘b’
…
s[4] → ‘e’
```

- use `len` function to get the length of a string, which is the number of characters it has:

```
len(s)→ 5
```

- Negative indexing, makes it easy to access the last elements!

```
s[-1]→ ‘e’
```

STRINGS

- you can get a slice of a string, by telling that from which index it starts and before which one it ends.

```
s = “abcdef”

s[1:4]→ ‘bcd’

s[:3]→ ‘abc’  if we do not write the starting index, it assumes 0

s[3:]→ ‘def’  if we do not write the ending index, it assumes it is len(s)
```

COMPARISON OPERATORS ON int, float, string

- `i` and `j` are variable names
- comparisons below evaluate to a Boolean

`i > j`

`i >= j`

`i < j`

`i <= j`

`i == j` → **`equality`** `test, True if i is the same as j`

`i != j` → **`inequality`** `test, True if i not the same as j`

LOGIC OPERATORS ON bools

- `a` and `b` are variable names (with Boolean values)

not a → `True` if `a` is `False`. `False` if `a` is `True`

a and b → `True` if both are `True`

a or b → `True` if either or both are `True`

A	B	A and B	A or B
True	True	True	True
True	False	False	True
False	True	False	True
False	False	False	False

COMPARISON EXAMPLE

```
pset_time = 15
sleep_time = 8
print(sleep_time > pset_time)
derive = True
drink = False
both = drink and derive
print(both)
```

CONTROL FLOW - BRANCHING

```
if <condition>:
    <expression>
    <expression>
    ...
```

```
if <condition>:
    <expression>
    <expression>
    ...
else:
    <expression>
    <expression>
    ...
```

```
if <condition>:
    <expression>
    <expression>
    ...
elif <condition>:
    <expression>
    <expression>
    ...
else:
    <expression>
    <expression>
    ...
```

- `<condition>` has a value `True` or `False`
- evaluate expressions in that block if `<condition>` is `True`

INDENTATION

- matters in Python
- how you denote blocks of code

```
x = float(input("Enter a number for x: "))

y = float(input("Enter a number for y: "))

if x == y:
    print("x and y are equal")
    if y != 0:
        print("therefore, x / y is", x/y)
elif x < y:
    print("x is smaller")
else:
    print("y is smaller")

print("thanks!")
```