Python Fundamentals

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DATPREP

Based on “A Whirlwind Tour of Python” by Jake VanderPlas (O’Reilly)

Goal

- Understand what Python is
- Review basic Python syntax
  - Variables
  - Operations
  - Useful Built-ins
  - Control Flows
  - Functions
- Tasks

What is Python?

- High-level programming language
- Interpreted – not compiled
- Object oriented
- Dynamic typing

- Why choose Python?
  - Easy to read and write
  - Main target for many popular data science libraries
  - Widely used

Disadvantages with Python

- More difficult to create large applications
- No compiler – will not find obvious type mismatches before execution
- Interpreted language – often slower than compiled languages

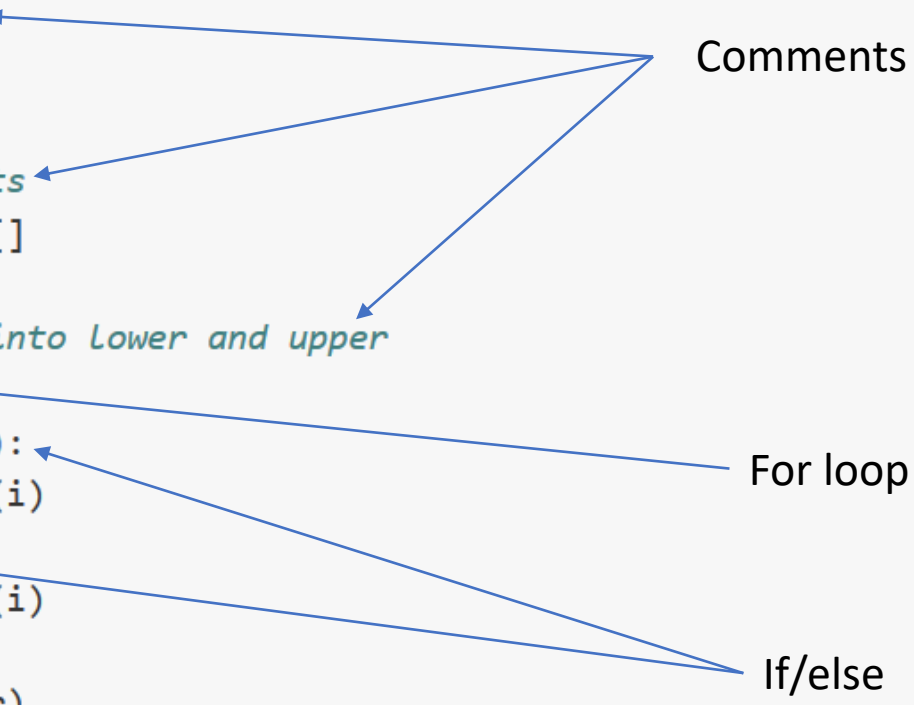
Basic Syntax Example

```
# set the midpoint
midpoint = 5

# make two empty lists
lower = []; upper = []

# split the numbers into lower and upper
for i in range(10):
    if (i < midpoint):
        lower.append(i)
    else:
        upper.append(i)

print("lower:", lower)
print("upper:", upper)
```




```
lower: [0, 1, 2, 3, 4]
upper: [5, 6, 7, 8, 9]
```

Note: No; at the end of each line, indentation determines block, not { and }

Variables

- Assigning Variables

```
x = 1          # x is an integer
x = 'hello'    # now x is a string
x = [1, 2, 3] # now x is a list
```

- Everything is an object

```
x = 4
type(x)
```

```
int
```

```
x = 'hello'
type(x)
```

```
str
```

```
x = 3.14159
type(x)
```

```
float
```

Variables

- Most types have inbuilt functions

```
L = [1, 2, 3]
L.append(100)
print(L)
```

```
[1, 2, 3, 100]
```

- Be careful when assigning variables to other variables

```
x = [1, 2, 3]
y = x
```

```
print(y)
```

```
[1, 2, 3]
```

```
x.append(4) # append 4 to the list pointed to by x
print(y) # y's list is modified as well!
```

```
[1, 2, 3, 4]
```

```
x = 'something else'
print(y)  # y is unchanged
```

```
[1, 2, 3, 4]
```

Operations - Arithmetic

Operator	Name	Description
`a + b`	Addition	Sum of `a` and `b`
`a - b`	Subtraction	Difference of `a` and `b`
`a * b`	Multiplication	Product of `a` and `b`
`a / b`	True division	Quotient of `a` and `b`
`a // b`	Floor division	Quotient of `a` and `b`, removing fractional parts
`a % b`	Modulus	Integer remainder after division of `a` by `b`
`a ** b`	Exponentiation	`a` raised to the power of `b`
`-a`	Negation	The negative of `a`
`+a`	Unary plus	`a` unchanged (rarely used)

```
# addition, subtraction, multiplication
(4 + 8) * (6.5 - 3)
```

```
42.0
```

Operations – Bitwise

Operator	Name	Description
`a & b`	Bitwise AND	Bits defined in both `a` and `b`
`a | b`	Bitwise OR	Bits defined in `a` or `b` or both
`a ^ b`	Bitwise XOR	Bits defined in `a` or `b` but not both
`a << b`	Bit shift left	Shift bits of `a` left by `b` units
`a >> b`	Bit shift right	Shift bits of `a` right by `b` units
`~a`	Bitwise NOT	Bitwise negation of `a`

Operations – Assignment Shorthand

- One for each operation covered

```
a += b   a -= b a *= b   a /= b
a //= b a %= b a **= b a &= b
a |= b   a ^= b a <<= b a >>= b
```

Operations – Comparison

Operation	Description	Operation	Description
`a == b`	`a` equal to `b`	`a != b`	`a` not equal to `b`
`a < b`	`a` less than `b`	`a > b`	`a` greater than `b`
`a <= b`	`a` less than or equal to `b`	`a >= b`	`a` greater than or equal to `b`

```
# 25 is odd
25 % 2 == 1
```

```
True
```

```
# 66 is odd
66 % 2 == 1
```

```
False
```

Operations – Boolean

- Combining and negating comparisons

```
x = 4
(x < 6) and (x > 2)
```

```
True
```

```
(x > 10) or (x % 2 == 0)
```

```
True
```

```
not (x < 6)
```

```
False
```

Operations – Identity and Membership

Operator	Description
`a is b`	True if `a` and `b` are identical objects
`a is not b`	True if `a` and `b` are not identical objects
`a in b`	True if `a` is a member of `b`
`a not in b`	True if `a` is not a member of `b`

```
1 in [1, 2, 3]
```

```
True
```

```
2 not in [1, 2, 3]
```

```
False
```

Useful Built-ins – Simple Types

Type	Example	Description
`int`	`x = 1`	integers (i.e., whole numbers)
`float`	`x = 1.0`	floating-point numbers (i.e., real numbers)
`complex`	`x = 1 + 2j`	Complex numbers (i.e., numbers with real and imaginary part)
`bool`	`x = True`	Boolean: True/False values
`str`	`x = 'abc'`	String: characters or text
`NoneType`	`x = None`	Special object indicating nulls

Useful Built-ins – Data Structures

Type Name	Example	Description
`list`	`[1, 2, 3]`	Ordered collection
`tuple`	`(1, 2, 3)`	Immutable ordered collection
`dict`	`{'a':1, 'b':2, 'c':3}`	Unordered (key,value) mapping
`set`	`{1, 2, 3}`	Unordered collection of unique values

Useful Built-ins – Lists

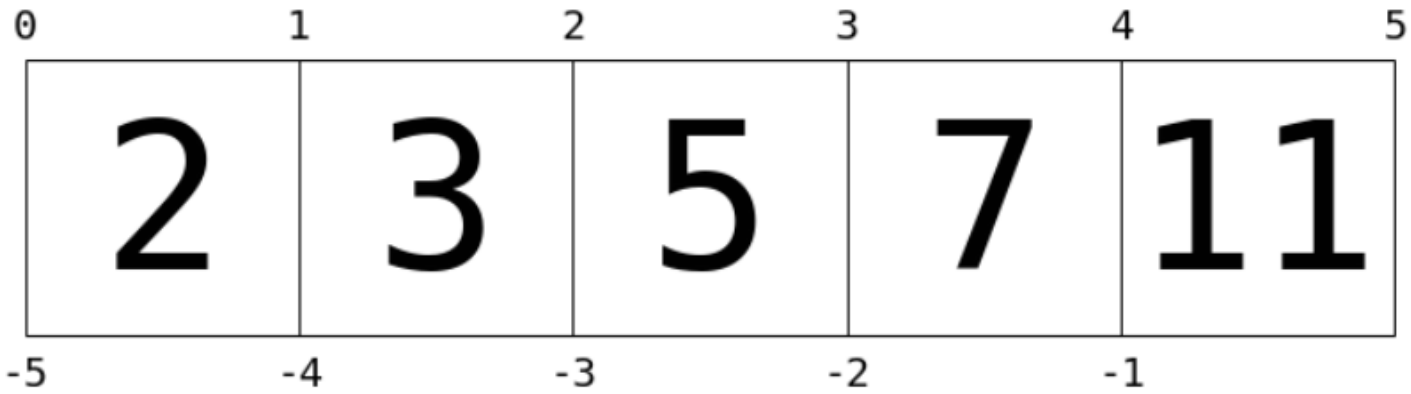
```
L = [2, 3, 5, 7, 11]
```

```
L[0]
```

```
2
```

```
L[-1]
```

```
11
```



Useful Built-ins – List Slicing

```
L = [2, 3, 5, 7, 11]
```

```
L[:3]
```

```
[2, 3, 5]
```

```
L[-3:]
```

```
[5, 7, 11]
```

```
L[0] = 100
print(L)
```

```
[100, 3, 5, 7, 11]
```

```
L[1:3] = [55, 56]
print(L)
```

```
[100, 55, 56, 7, 11]
```

Useful Built-ins – List Slicing Trick

```
L = [2, 3, 5, 7, 11]
```

```
L[::2]  # equivalent to L[0:len(L):2]
```

```
[2, 5, 11]
```

Third value = step

```
L[::-1]
```

```
[11, 7, 5, 3, 2]
```

Reversed list!

Useful Built-ins – Dictionaries

```
numbers = {'one':1, 'two':2, 'three':3}
```

```
# Access a value via the key
numbers['two']
```

```
2
```

```
# Set a new key:value pair
numbers['ninety'] = 90
print(numbers)
```

```
{'three': 3, 'ninety': 90, 'two': 2, 'one': 1}
```

Control Flows – if, elif, else

```
x = -15

if x == 0:
    print(x, "is zero")
elif x > 0:
    print(x, "is positive")
elif x < 0:
    print(x, "is negative")
else:
    print(x, "is unlike anything I've ever seen...")
```

```
-15 is negative
```

Control Flows – for Loops

```
for i in range(10):
    print(i, end=' ')
```

```
0 1 2 3 4 5 6 7 8 9
```

```
# range from 5 to 10
list(range(5, 10))
```

```
[5, 6, 7, 8, 9]
```

```
# range from 0 to 10 by 2
list(range(0, 10, 2))
```

```
[0, 2, 4, 6, 8]
```

Control Flows – while Loops

- Less often used than for loops

```
i = 0
while i < 10:
    print(i, end=' ')
    i += 1
```

```
0 1 2 3 4 5 6 7 8 9
```

Control Flows – break and continue

```
for n in range(20):
    # if the remainder of n / 2 is 0, skip the rest of the loop
    if n % 2 == 0:
        continue
    print(n, end=' ')
```

Continues to next iteration if n is even

```
1 3 5 7 9 11 13 15 17 19
```

```
a, b = 0, 1
amax = 100
L = []

while True:
    (a, b) = (b, a + b)
    if a > amax:
        break
    L.append(a)

print(L)
```

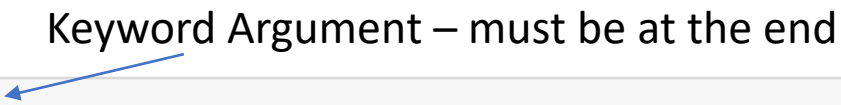
Exits the loop if a > 100

```
[1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89]
```

Calling Functions


```
print(1, 2, 3)
```

```
1 2 3
```




```
print(1, 2, 3, sep='--')
```

```
1--2--3
```

Defining Functions

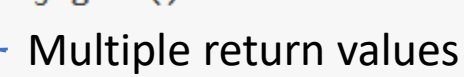
```
def fibonacci(N):
    L = []
    a, b = 0, 1
    while len(L) < N:
        a, b = b, a + b
        L.append(a)
    return L
```

```
fibonacci(10)
```

```
[1, 1, 2, 3, 5, 8, 13, 21, 34, 55]
```

```
def real_imag_conj(val):
    return val.real, val.imag, val.conjugate()

r, i, c = real_imag_conj(3 + 4j)
print(r, i, c)
```




```
3.0 4.0 (3-4j)
```

Defining Functions – Default Values

```
def fibonacci(N, a=0, b=1):
    L = []
    while len(L) < N:
        a, b = b, a + b
        L.append(a)
    return L
```

```
fibonacci(10)
```

```
[1, 1, 2, 3, 5, 8, 13, 21, 34, 55]
```

```
fibonacci(10, 0, 2)
```

```
[2, 2, 4, 6, 10, 16, 26, 42, 68, 110]
```

```
fibonacci(10, b=3, a=1)
```

```
[3, 4, 7, 11, 18, 29, 47, 76, 123, 199]
```

Defining Functions – Flexible Arguments

```
def catch_all(*args, **kwargs):
    print("args =", args)
    print("kwargs = ", kwargs)
```

```
catch_all(1, 2, 3, a=4, b=5)
```

```
args = (1, 2, 3)
kwargs =  {'a': 4, 'b': 5}
```

```
catch_all('a', keyword=2)
```

```
args = ('a',)
kwargs =  {'keyword': 2}
```

```
inputs = (1, 2, 3)
keywords = {'pi': 3.14}

catch_all(*inputs, **keywords)
```

```
args = (1, 2, 3)
kwargs =  {'pi': 3.14}
```

Tasks!

You will continue developing the concepts we have gone through