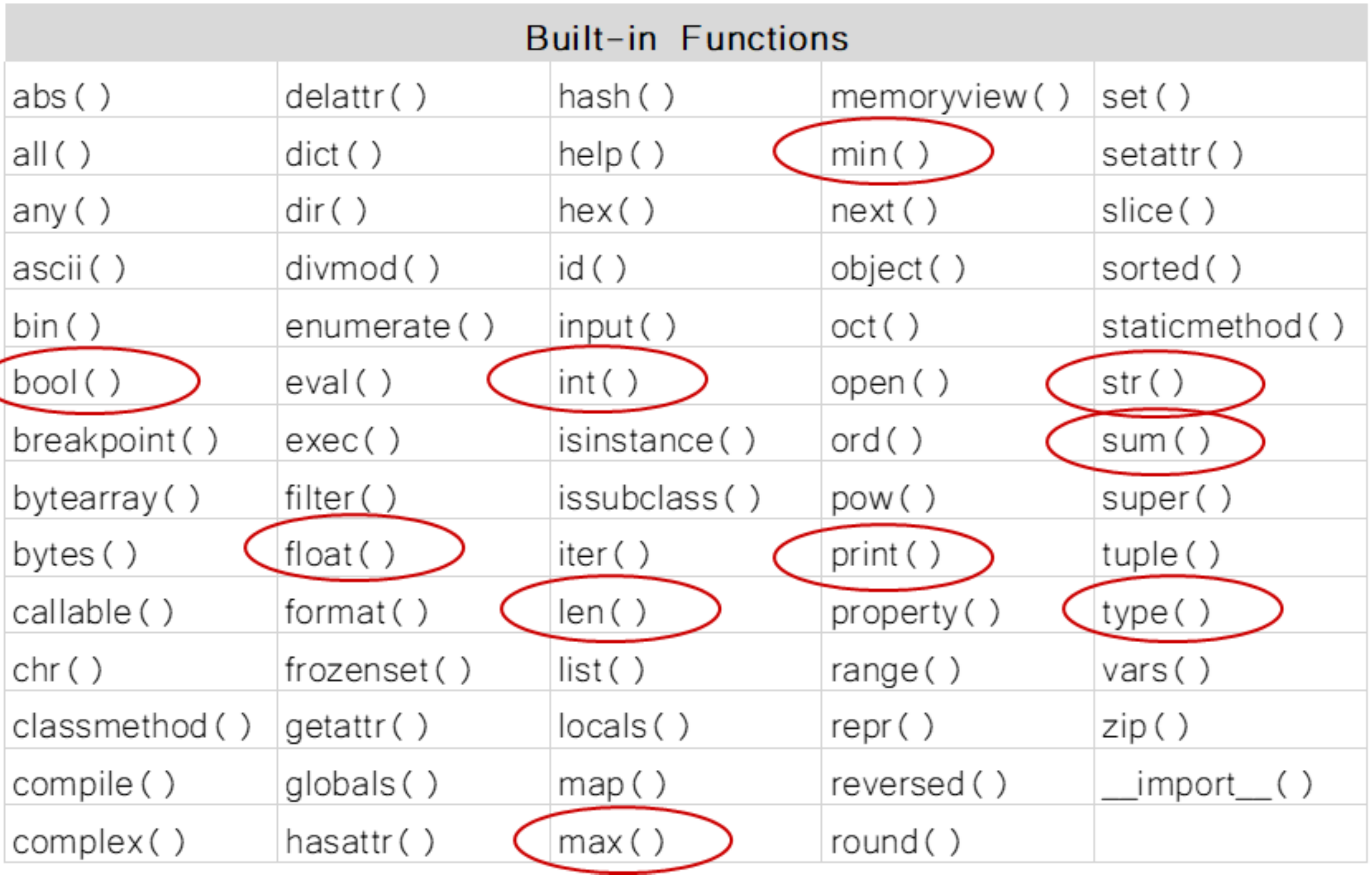
Intro to Scientific Programming to:

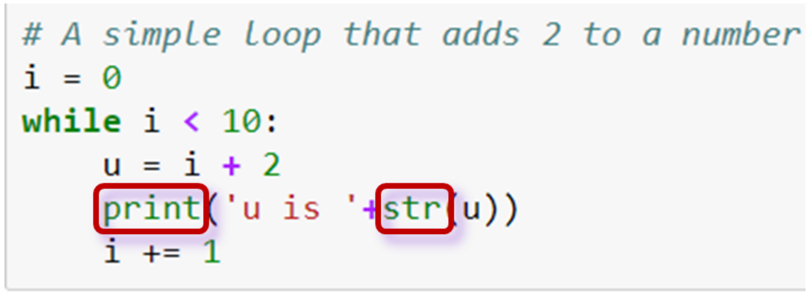
- Lecture 2

Python standard library



Built-in Functions				
abs( )	delattr( )	hash( )	memoryview( )	set( )
all( )	dict( )	help( )	[✓ min( )]	setattr( )
any( )	dir( )	hex( )	next( )	slice( )
ascii( )	divmod( )	id( )	object( )	sorted( )
bin( )	enumerate( )	input( )	oct( )	staticmethod( )
[✓ bool( )]	eval( )	[✓ int( )]	open( )	[✓ str( )]
breakpoint( )	exec( )	isinstance( )	ord( )	[✓ sum( )]
bytearray( )	filter( )	issubclass( )	pow( )	super( )
bytes( )	[✓ float( )]	iter( )	[✓ print( )]	tuple( )
callable( )	format( )	[✓ len( )]	property( )	[✓ type( )]
chr( )	frozenset( )	list( )	range( )	vars( )
classmethod( )	getattr( )	locals( )	repr( )	zip( )
compile( )	globals( )	map( )	reversed( )	__import__( )
complex( )	hasattr( )	[✓ max( )]	round( )	

Example `print()` and `str()`

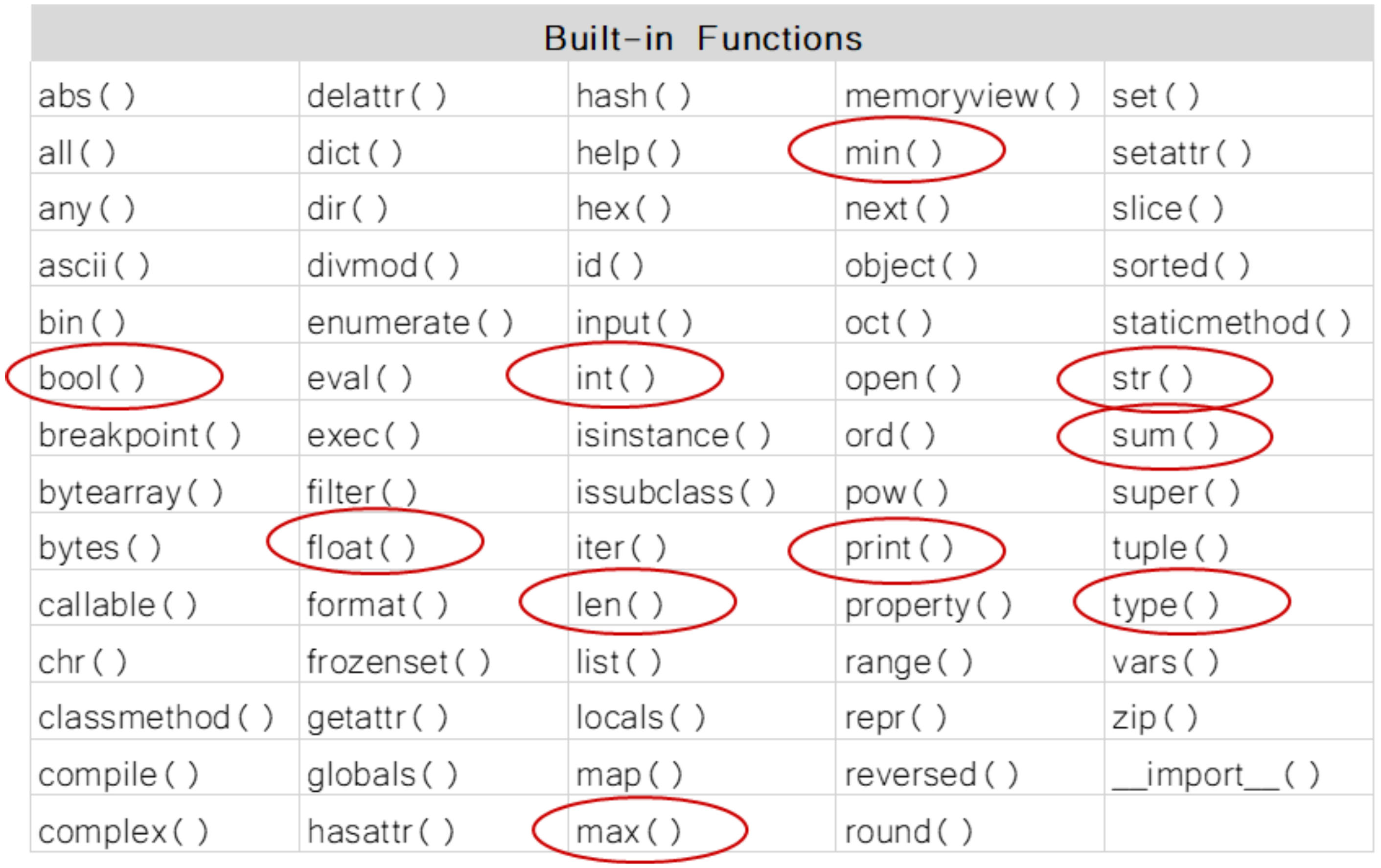


```python
# A simple loop that adds 2 to a number
i = 0
while i < 10:
    u = i + 2
    print('u is '+str(u))
    i += 1
```

```
u is 2
u is 3
u is 4
u is 5
u is 6
u is 7
u is 8
u is 9
u is 10
u is 11
```

Note!
Here we format everything to a string before printing it

Python standard library



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In [ ]:

```
width  = 5
height = 3.6
snps   = ['rs123', 'rs5487']
snp    = 'rs2546'
active = True
nums   = [2,4,6,8,4,5,2]

float(width)
```

More on operations

Operation	Result
x + y	sum of x and y
x − y	difference between x and y
x ** y	x to the power y
....	....
pow(x, y)	x to the power y
float(x)	x converted to float
int(x)	x converted to int!
len(z)	length of z if list
max(z)	maximum in list of z
min(z)	minimum in list of z

In [ ]:
```
x = 4
y = 3
z = [2, 3, 6, 3, 9, 23]
pow(x, y)
```

Comparison operators

Operation	Meaning
<	less than
<=	less than or equal
>	greater than
>=	greater than or equal
==	equal
!=	not equal

Can be used on int, float, str, and bool. Outputs a boolean.

In [ ]:
```
x = 5
y = 3

y > x
```

Logical operators

Operation	Meaning
and	connects two statements, both conditions having to be fulfilled
or	connects two statements, either conditions having to be fulfilled
not	reverses and/or

Membership operators

Operation	Meaning
in	value in object
not in	value not in object

```
In [ ]:
```

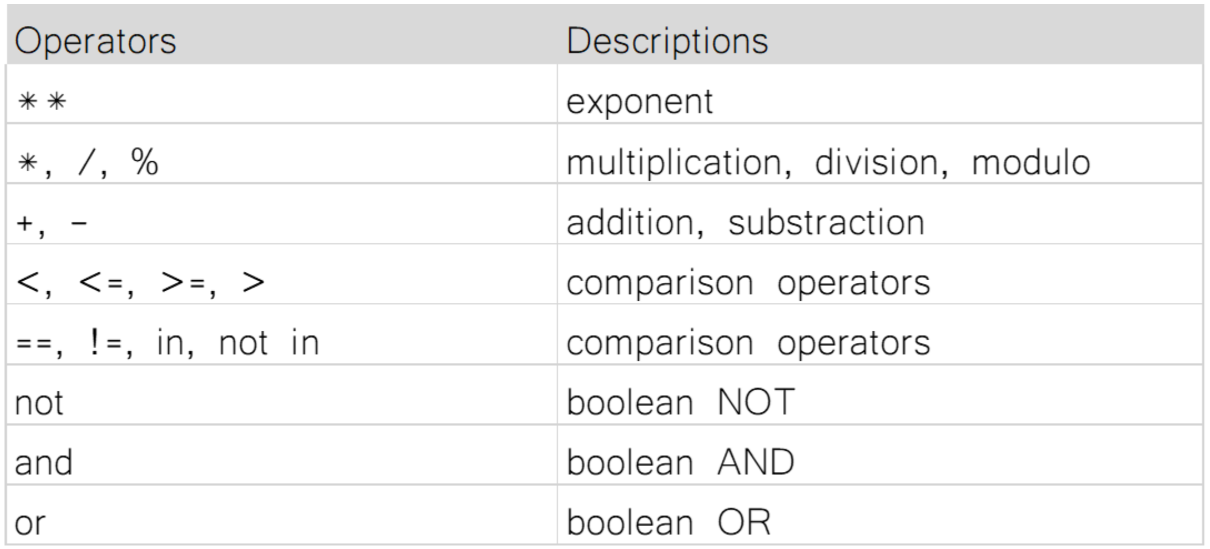
```
x = 2
y = 3

x == 2 and y == 5

#x = [2,4,7,3,5,9]
#y = ['a','b','c']

#2 in x
#4 in x and 'd' in y
```

```python
# A simple loop that adds 2 to a number and checks if the number is even
i    = 0
even = [2,4,6,8,10]
while i < 10:
    u = i + 2
    print('u is '+str(u)+'. Is this number even? '+str(u in even))
    i += 1
```

```python
# A simple loop that adds 2 to a number, check if number is even and below 5
i    = 0
even = [2,4,6,8,10]
while i < 10:
    u = i + 2
    print('u is '+str(u)+'. Is this number even and below 5? '+\
          str(u in even and u < 5))
    i += 1
```

Order of precedence

There is an order of precedence for all operators:



Operators	Descriptions
**	exponent
*, /, %	multiplication, division, modulo
+, -	addition, substraction
<, <=, >=, >	comparison operators
==, !=, in, not in	comparison operators
not	boolean NOT
and	boolean AND
or	boolean OR

Word of caution when using operators

In [8]:
```
x = 5
y = 7
z = 2
x == 5 and y < 7 or z > 1

#x > 6 and (y == 7 or z > 1)

# and binds stronger than or
#x > 4 or y == 6 and z > 3
#x > 4 or (y == 6 and z > 3)
#(x > 4 or y == 6) and z > 3
```

Out[8]:
```
True
```

In [11]:
```
# BEWARE!
x = 5
y = 8

#xx == 6 or xxx == 6 or x > 2
x > 42 or (y < 7 and xx > 1000)
```

Out[11]:
```
False
```

Python does short-circuit evaluation of operators

More on sequences (For example strings and lists)

Lists (and strings) are an ORDERED collection of elements where every element can be accessed through an index.

Operators	Descriptions
x in s	True if an item in *s* is equal to *x*
s + t	Concatenates *s* and *t*
s * n	Adds *s* to itself *n* times
s[i]	*i*th item of *s*, origin 0
s[i:j]	slice of *s* from *i to j-1*
s[i:j:k]	slice of *s* from *i to j-1* with step *k*

In [7]:

```python
l = [2,3,4,5,3,7,5,9]
n = [9,8]
s = 'some longrandomstring'
n * 2
#'o' in s
#19 in l
#l + n
#
#l[2]
#s[0:7]
#s[0:8:2]
#s[-2]
#l[0] = 42
#l
#s[0] = 'S'
```

```
Out[7]: [9, 8, 9, 8]
```

Mutable vs Immutable objects

Mutable objects can be altered after creation, while immutable objects can't.

Immutable objects:

- `int`
- `float`
- `bool`
- `str`
- `tuple`

Mutable objects:

- `list`
- `set`
- `dict`

Operations on mutable sequences

Operation	Result
s[i] = x	item *i* of *s* is replaced by *x*
s[i:j] = t	slice of *s from i* to *j-1* is replaced by the contents of the iterable t
del s[i:j]	removes element *i* to *j-1*
s[i:j:k] = t	specified element replaced by *t*
s.append(x)	appends *x* to the end of the sequence
s[i:j:k]	slice of *s* from *i to j-1* with step *k*
s[:] or	creates a copy of *s*
s.copy()	creates a copy of *s*
s.insert(i, x)	inserts *x into s* at the index *i*
s.pop([i])	retrieves the item *i* from *s* and also removes it
s.remove(x)	retrieves the first item from *s* where s[i] == x
s.reverse()	reverses the items of *s* in place

In [8]:
```
s = [0,1,2,3,4,5,6,7,8,9]
#s.insert(5,10)
s.reverse()
s
#s
```

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

Summary

- The python standard library has many built-in functions regularly used
- Operators are used to carry out computations on different values
- Three types of operators; comparison, logical, and membership
- Order of precedence crucial!
- Mutable object can be changed after creation while immutable objects cannot be changed

Loops in Python

```
In [ ]: fruits = ['apple','pear','banana','orange']

        print(fruits[0])
        print(fruits[1])
        print(fruits[2])
        print(fruits[3])
```

```
In [13]: fruits = ['apple','pear','banana','orange']

         for fruit in fruits:
             print(fruit)
             print(" was the last fruit")
         #    print('end')
         print('done')
```

```
apple
 was the last fruit
pear
 was the last fruit
banana
 was the last fruit
orange
 was the last fruit
done
```

Always remember to INDENT your loops!

Different types of loops

For loop

In [19]:
```
fruits = ['apple','pear','banana','orange']

for fruit in fruits:
    print(fruit)
```

```
apple
pear
banana
orange
```

While loop

In [14]:
```
fruits = ['apple','pear','banana','orange']

i = 0
while i < len(fruits):
    print(fruits[i])
i = i + 1
```

```
apple
pear
banana
orange
```

Different types of loops

`For` loop

Is a control flow statement that performs a fixed operation over a known amount of steps.

`While` loop

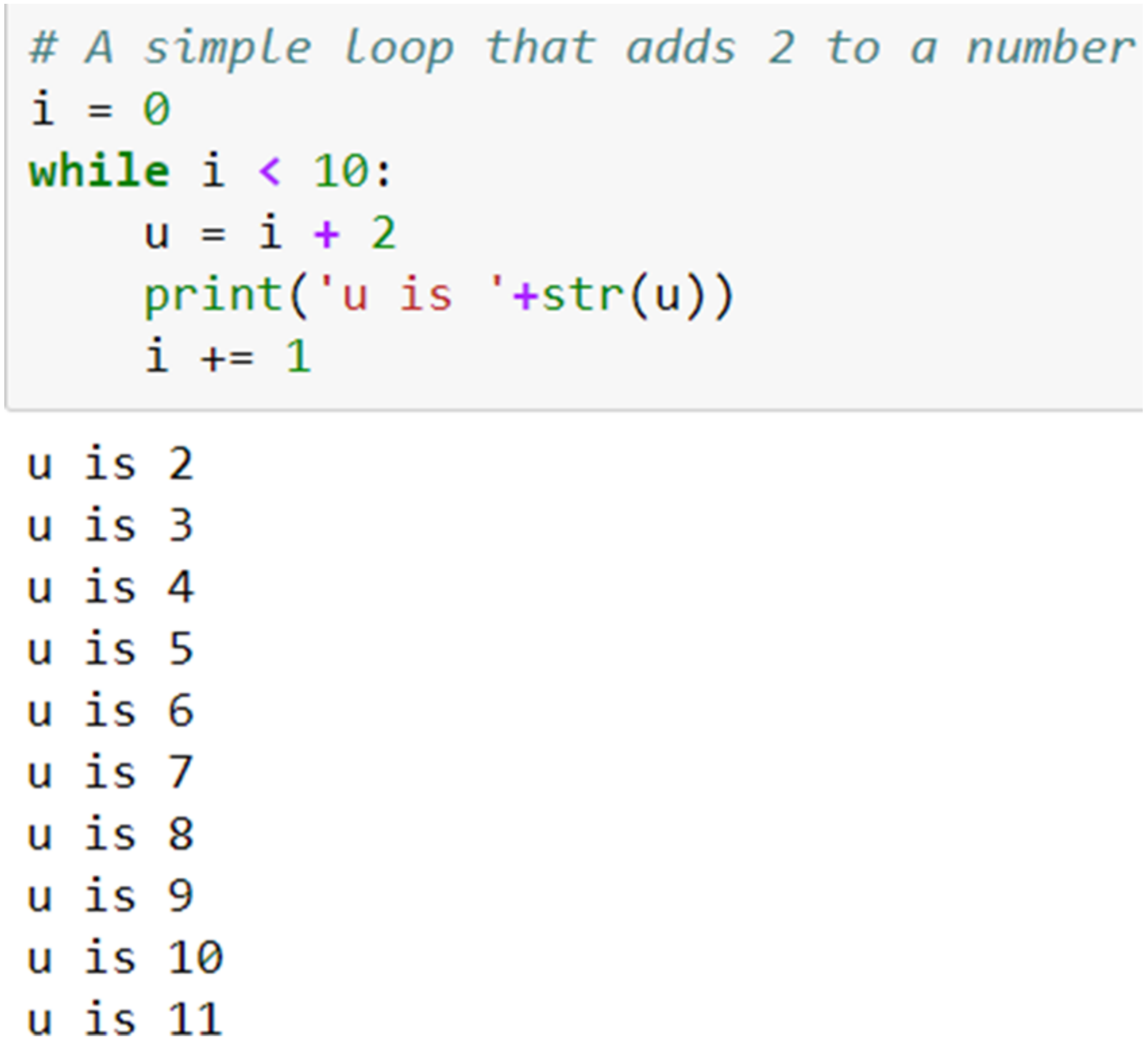
Is a control flow statement that allows code to be executed repeatedly based on a given Boolean condition.

Which one to use?

`For` loops better for simple iterations over lists and other iterable objects

`While` loops are more flexible and can iterate an unspecified number of times

Example of a simple Python script



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```

```
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u is 4
u is 5
u is 6
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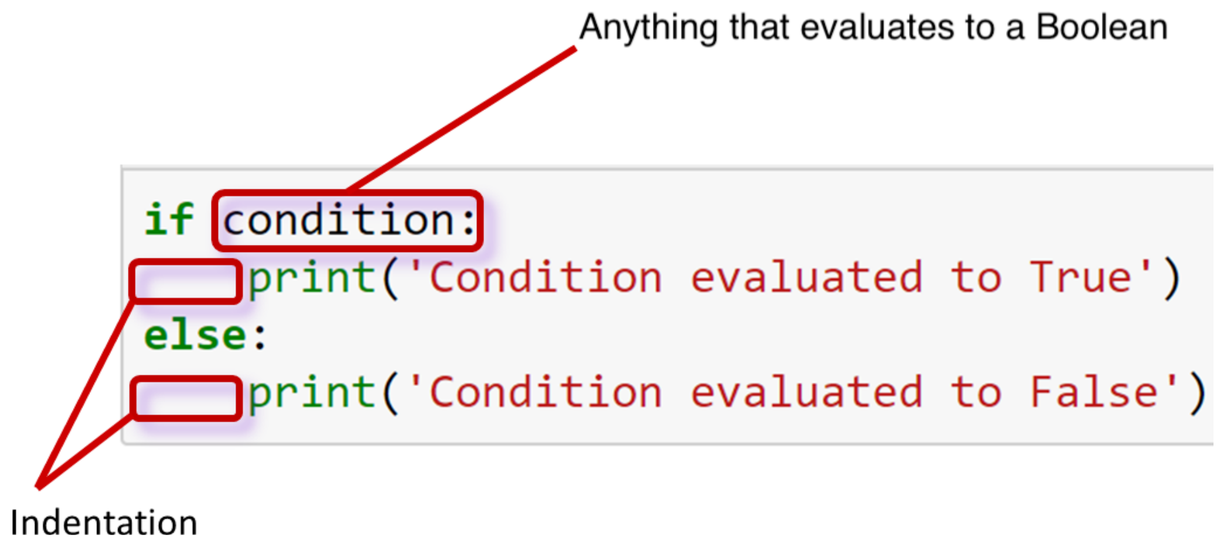
u is 9
u is 10
u is 11
```

Conditional `if/else` statements



```python
if condition:
    print('Condition evaluated to True')
else:
    print('Condition evaluated to False')
```

```python
shopping_list = ['bread', 'egg', 'butter', 'milk']

if len(shopping_list) > 5:
    print('Go shopping!')
else:
    print('Nah! I\'ll do it tomorrow!')
```

In [ ]:

```python
shopping_list = ['bread', 'egg', 'butter', 'milk']
tired         = False

if len(shopping_list) > 5:
    if not tired:
        print('Go shopping!')
    else:
        print('Too tired, I\'ll do it later')
else:
    if not tired:
        print('Better get it over with today anyway')
    else:
        print('Nah! I\'ll do it tomorrow!')
```

This is an example of a nested conditional

Putting everything into a Python script

Any longer pieces of code that have been used and will be re-used SHOULD be saved

Two options:

- Save it as a text file and make it executable
- Save it as a notebook file

Things to remember when working with scripts

- Put *#!/usr/bin/env python* in the beginning of the file
- Make the file executable to run with `./script.py`
- Otherwise run script with `python script.py`

Summary

- Python has two types of loops, `For` loops and `While` loops
- Loops can be used on any iterable types and objects
- `If/Else` statement are used when deciding actions depending on a condition that evaluates to a boolean
- Several `If/Else` statements can be nested
- Save code as notebook or text file to be run using python