LABORATORY OF DATA SCIENCE

Python recap

Data Science & Business Informatics Degree

Python

Python is a

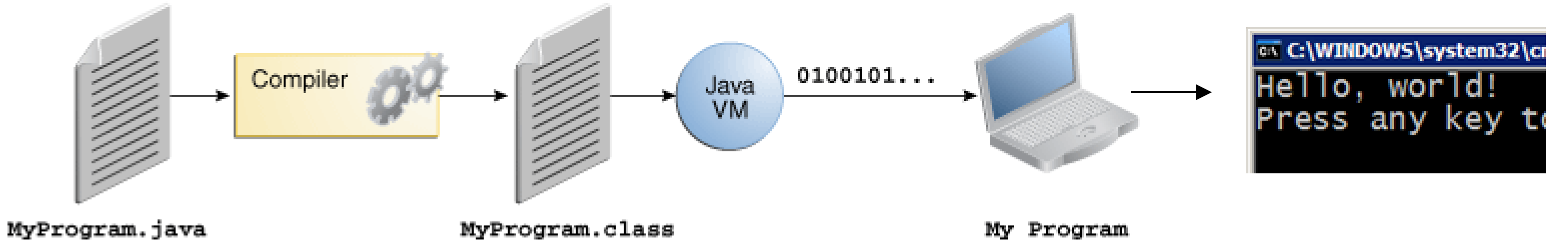
- High-level
- Interpreted (Interpreters for many OS)
- Dynamically Typed
  - Verification of the type safety of a program at runtime
- Object oriented
- Cross-Platform
- Multi-purpose (WEB, GUI, Scripting)

computer programming language

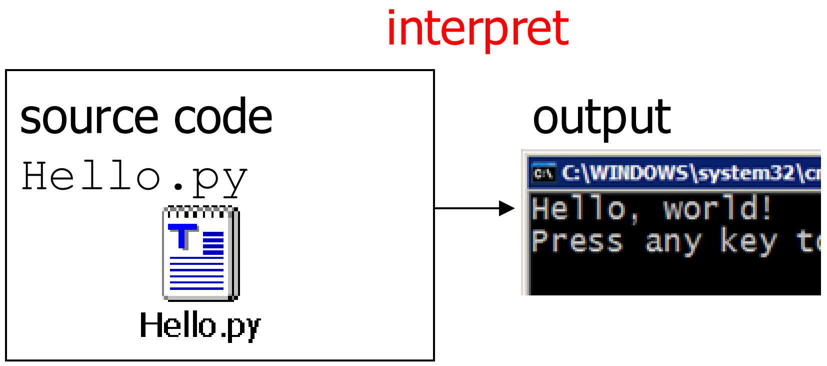
https://www.python.org/

Compiling and interpreting

- Many languages require you to *compile* (translate) your program into a form that the machine understands.



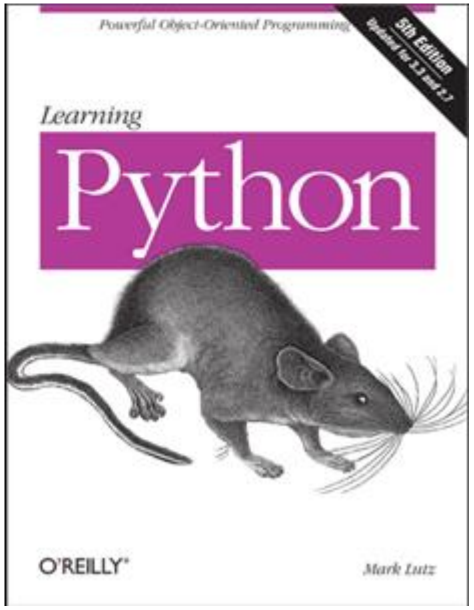
```
Hello, world!
Press any key to
```



```
Hello, world!
Press any key to
```

- Python is instead directly *interpreted* into machine instructions.

Python language: books



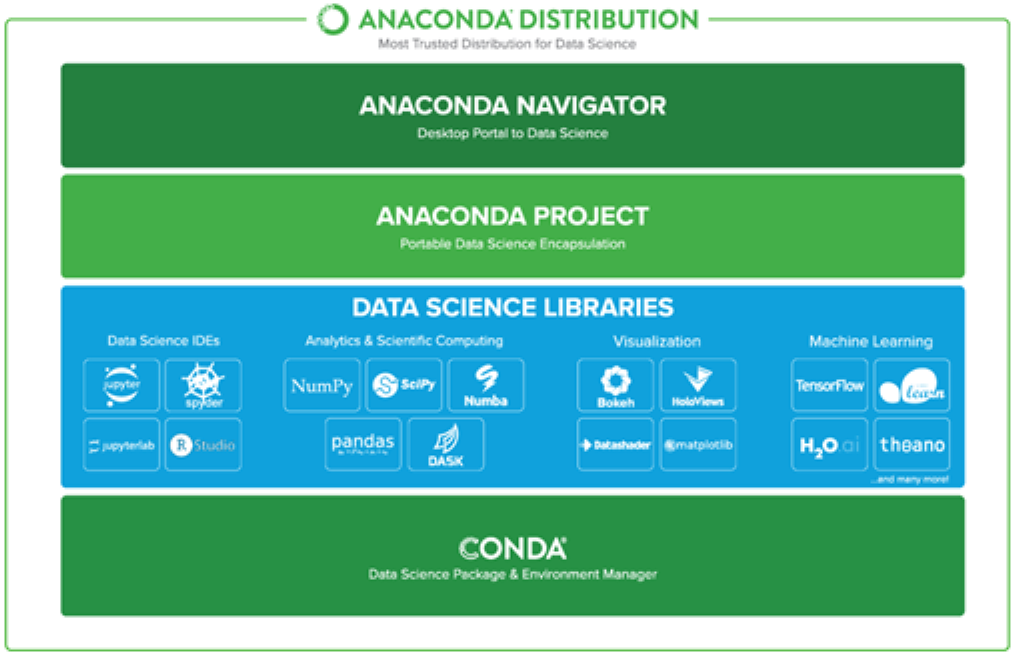
BignumWorks Software LLP
Python Data Structures and Algorithms
Implement Classic Data Structures and Algorithms Using Python
Packt

Frank Kane
Hands-On Data Science and Python Machine Learning
Perform data mining and machine learning efficiently using Python and Spark
Packt

http://www.spronck.net/pythonbook/

Anaconda - www.anaconda.com

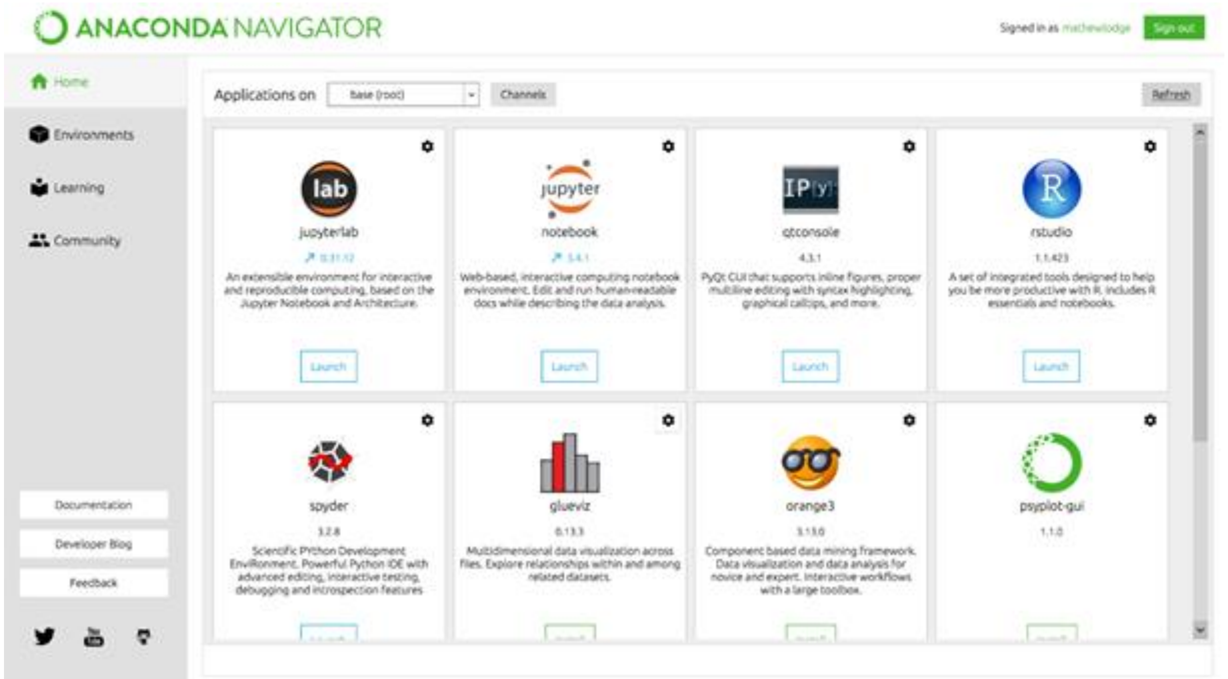
- Manage your DS packages, **dependencies**, and environments
- Develop DS projects using Jupyter, JupyterLab, Spyder…



- Automatically manages all packages, including cross-language **dependencies**
- Works across all platforms: Linux, macOS, Windows

Anaconda Navigator

- Desktop Portal to Data Science
- Install and launch applications and editors including Jupyter, RStudio, Visual Studio Code, Spyder…
- Manage your local environments and data science projects from a graphical interface



jupyterlab
0.31.12
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.

notebook
5.4.1
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.

qtconsole
4.3.1
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.

rstudio
1.1.423
A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.

spyder
3.2.8
Scientific PYthon Development EnviRonment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features

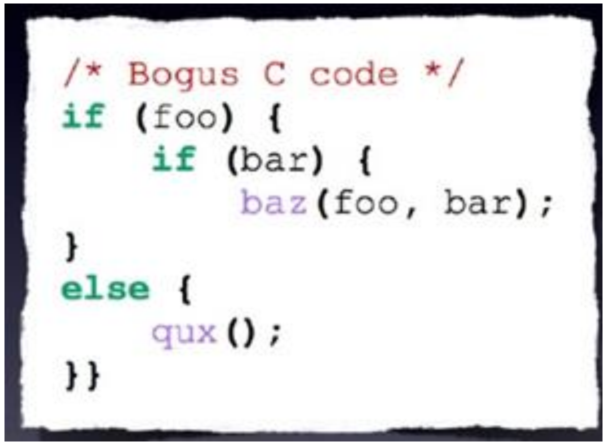
glueviz
0.13.3
Multidimensional data visualization across files. Explore relationships within and among related datasets.

orange3
3.13.0
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.

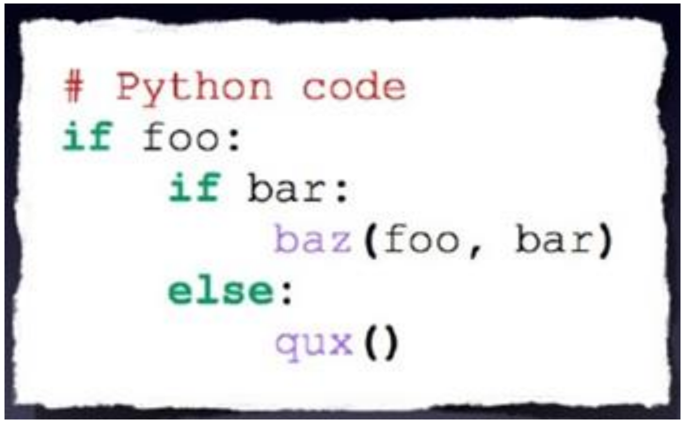
psyplot-gui
1.1.0

Python Recap

Indentation

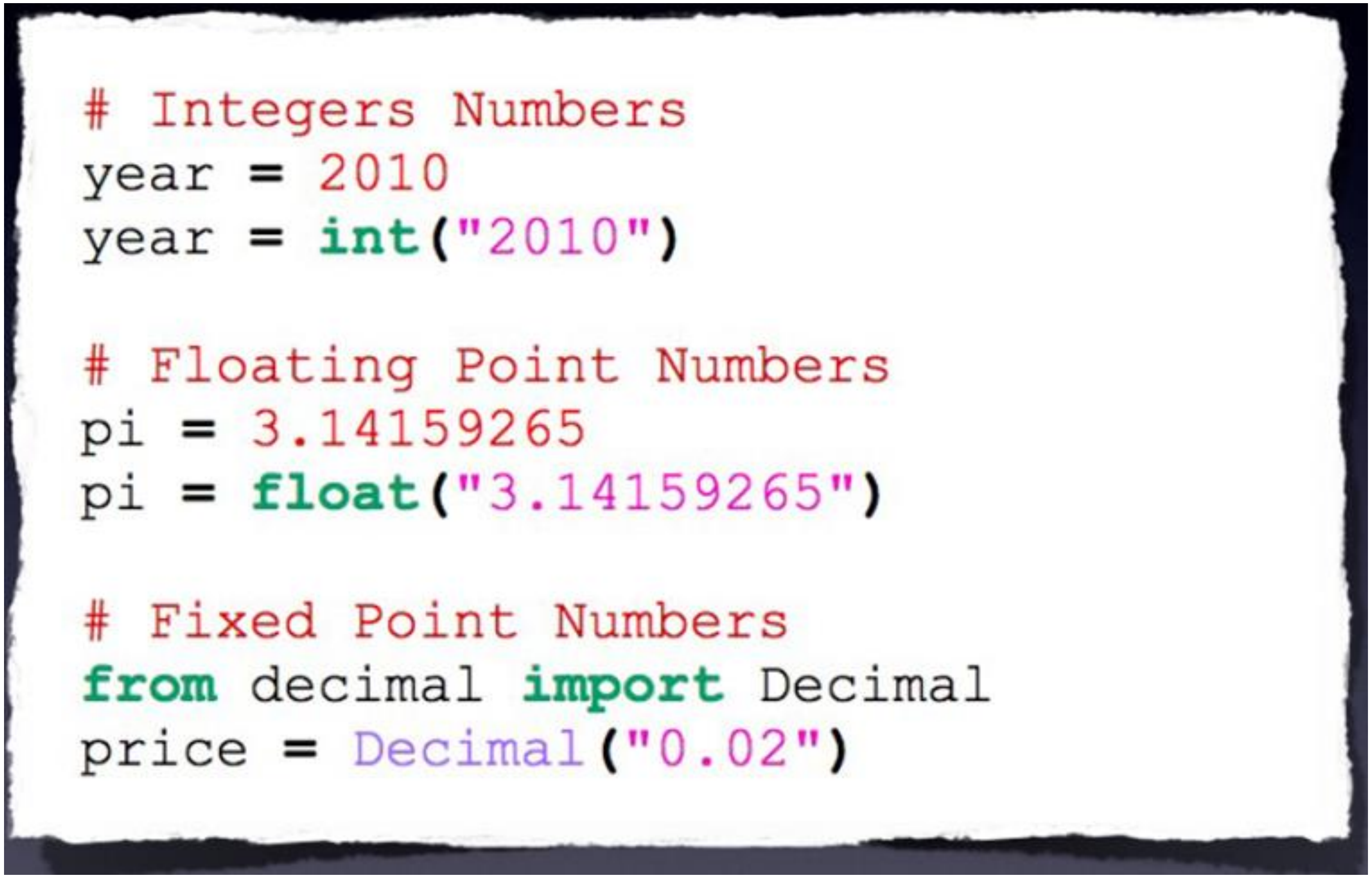


```
/* Bogus C code */
if (foo) {
     if (bar) {
          baz(foo, bar);
}
else {
     qux();
}}
```



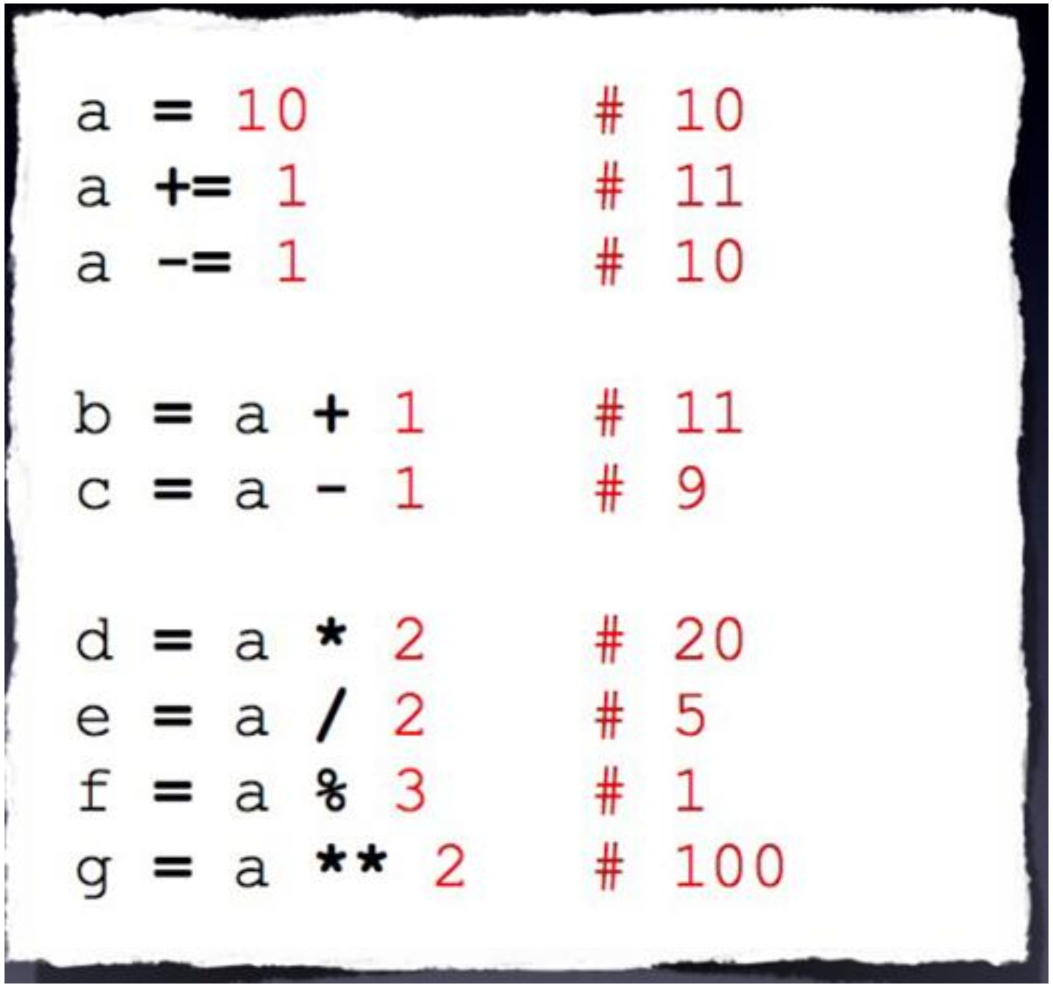
```
# Python code
if foo:
    if bar:
        baz(foo, bar)
    else:
        qux()
```

Numbers



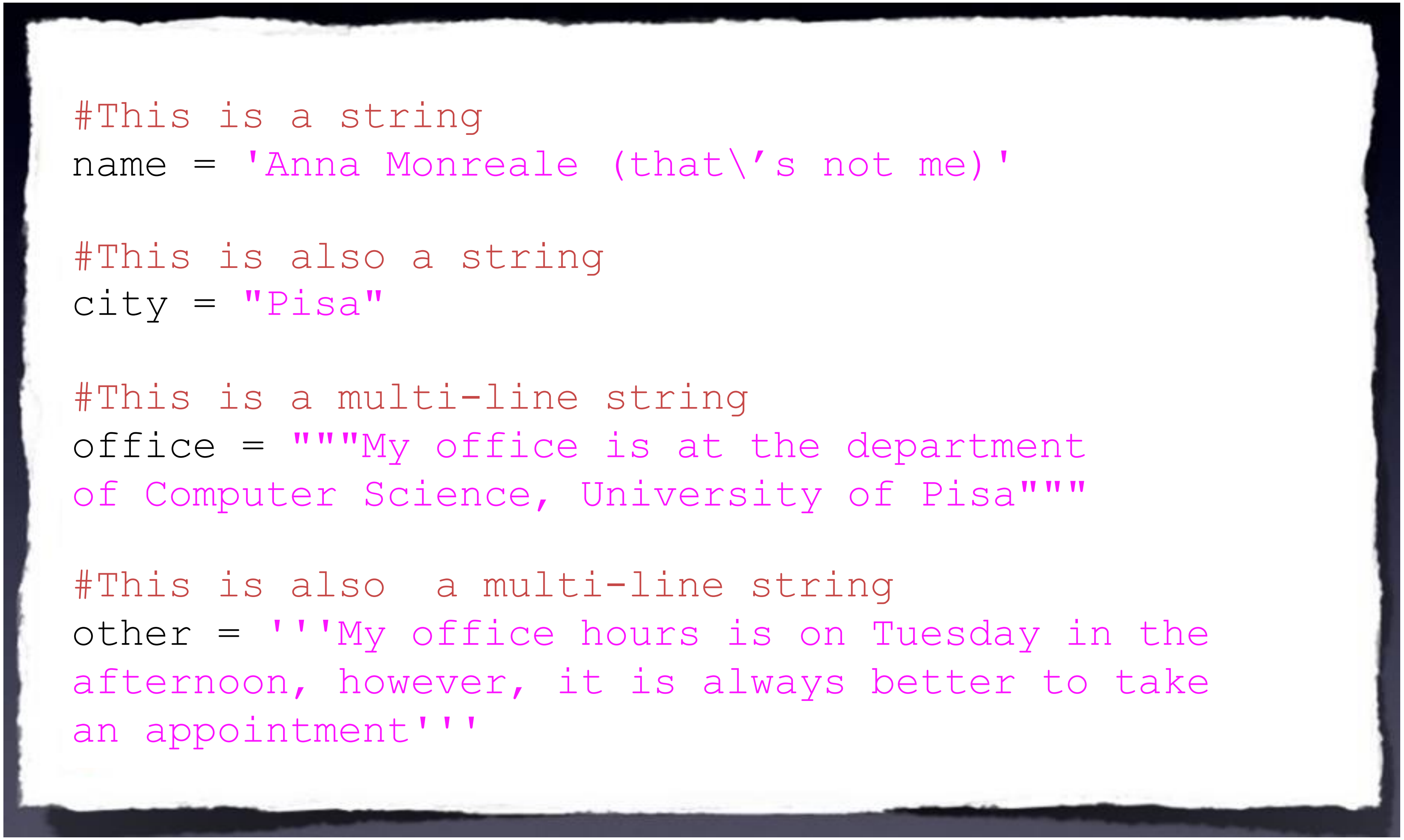
```
# Integers Numbers
year = 2010
year = int("2010")

# Floating Point Numbers
pi = 3.14159265
pi = float("3.14159265")

# Fixed Point Numbers
from decimal import Decimal
price = Decimal("0.02")
```

Arithmetic



```
a = 10          # 10
a += 1          # 11
a -= 1          # 10

b = a + 1       # 11
c = a - 1       # 9

d = a * 2       # 20
e = a / 2       # 5
f = a % 3       # 1
g = a ** 2      # 100
```

Strings

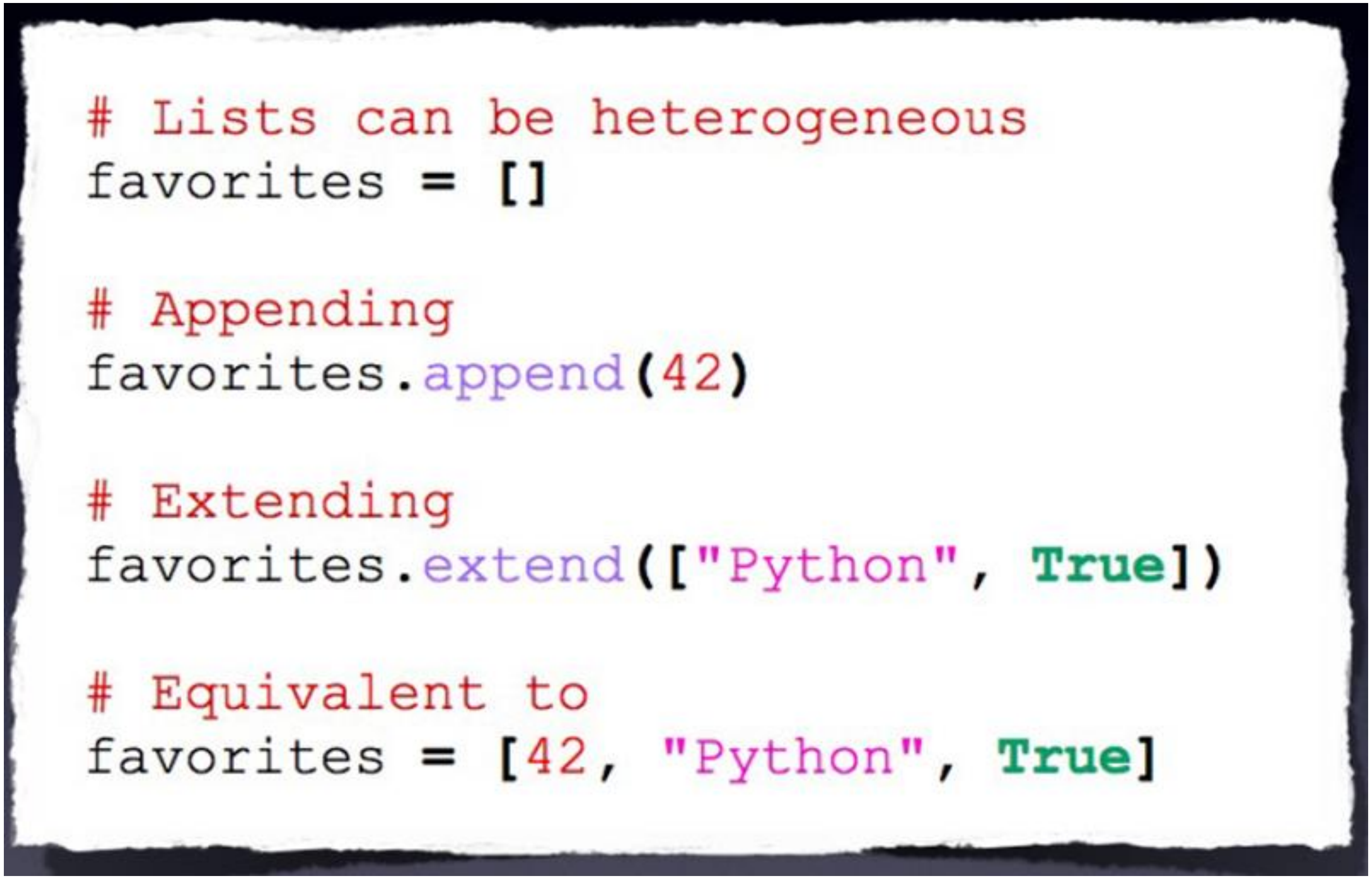


```
#This is a string
name = 'Anna Monreale (that\'s not me)'

#This is also a string
city = "Pisa"

#This is a multi-line string
office = """My office is at the department
of Computer Science, University of Pisa"""

#This is also  a multi-line string
other = '''My office hours is on Tuesday in the
afternoon, however, it is always better to take
an appointment'''
```

String manipulation

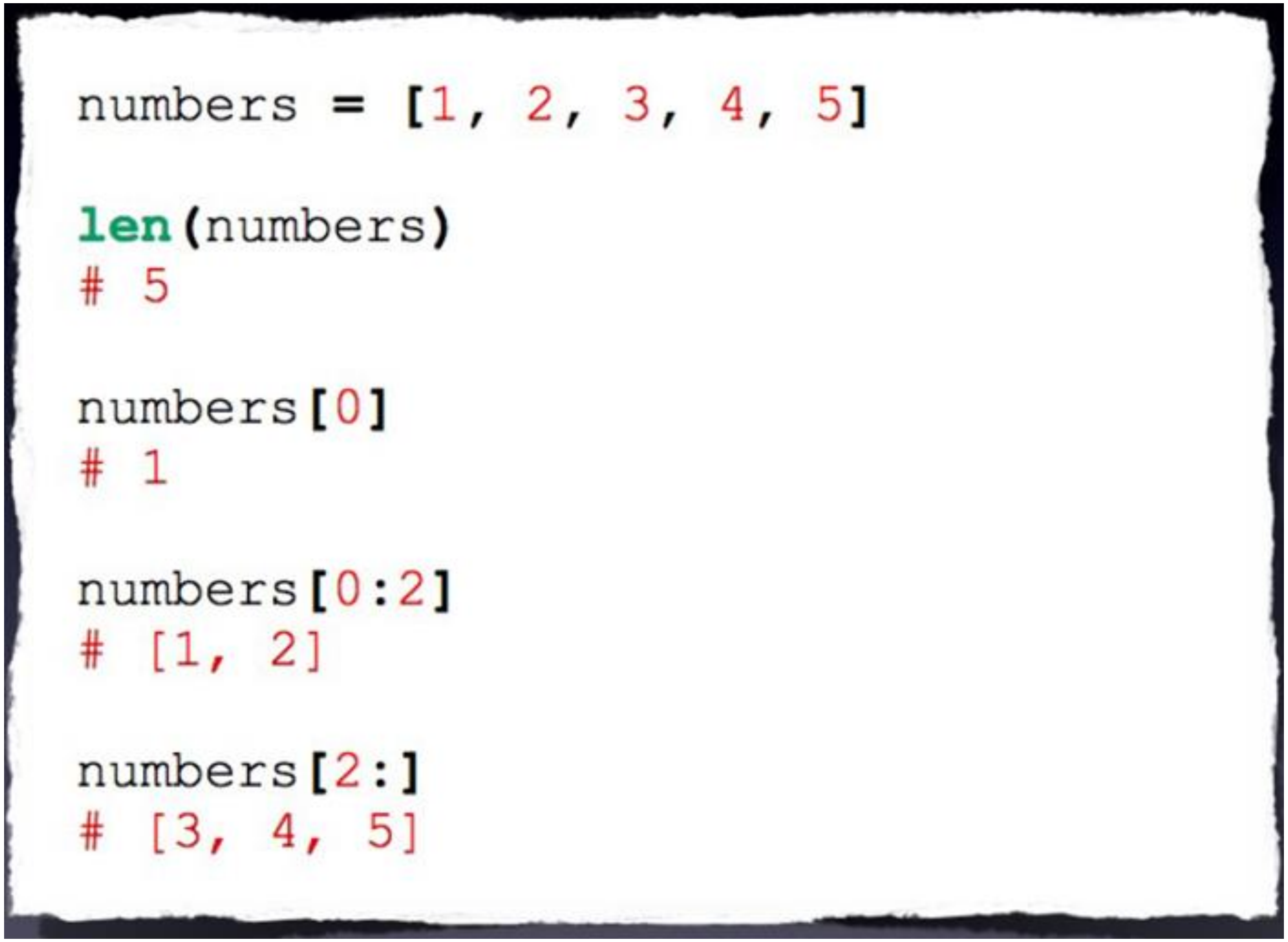
```
animals = "Cats, " + "Dogs, "
animals += "Rabbits"
# Cats, Dogs, Rabbits

fruits = ', '.join(['Apples', 'Bananas', 'Oranges'])
# Apples, Bananas, Oranges

end_of_the_world = "%s %d %d" % ('Dec', 21, 2012)
# Dec 21 2012

#This is also  a multi-line string
other = f"On {end_of_the_world} I ate {fruits}"
# On Dec 21 2012 I ate some apples, bananas, oranges
```

Lists



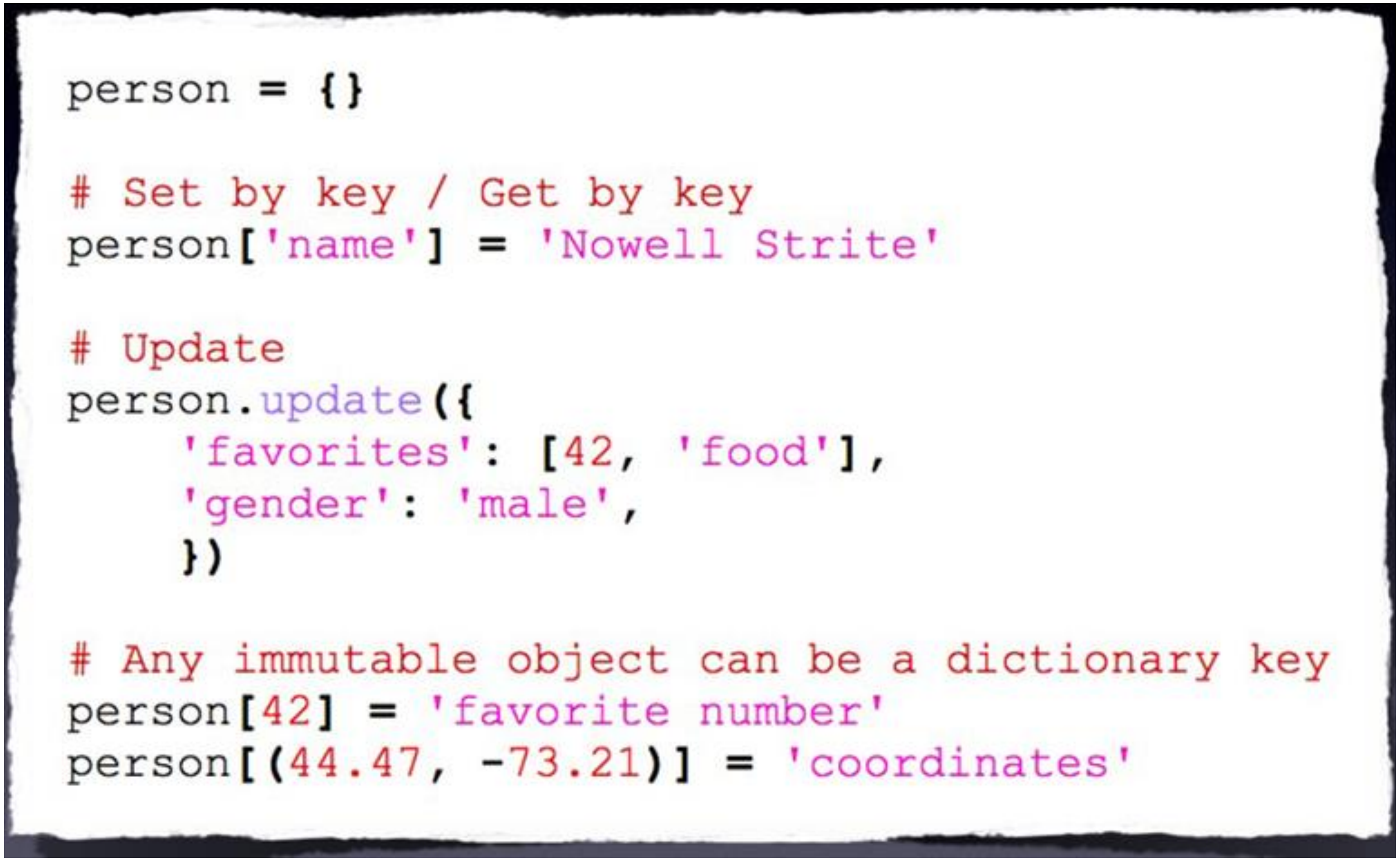
```
# Lists can be heterogeneous
favorites = []

# Appending
favorites.append(42)

# Extending
favorites.extend(["Python", True])

# Equivalent to
favorites = [42, "Python", True]
```

Lists



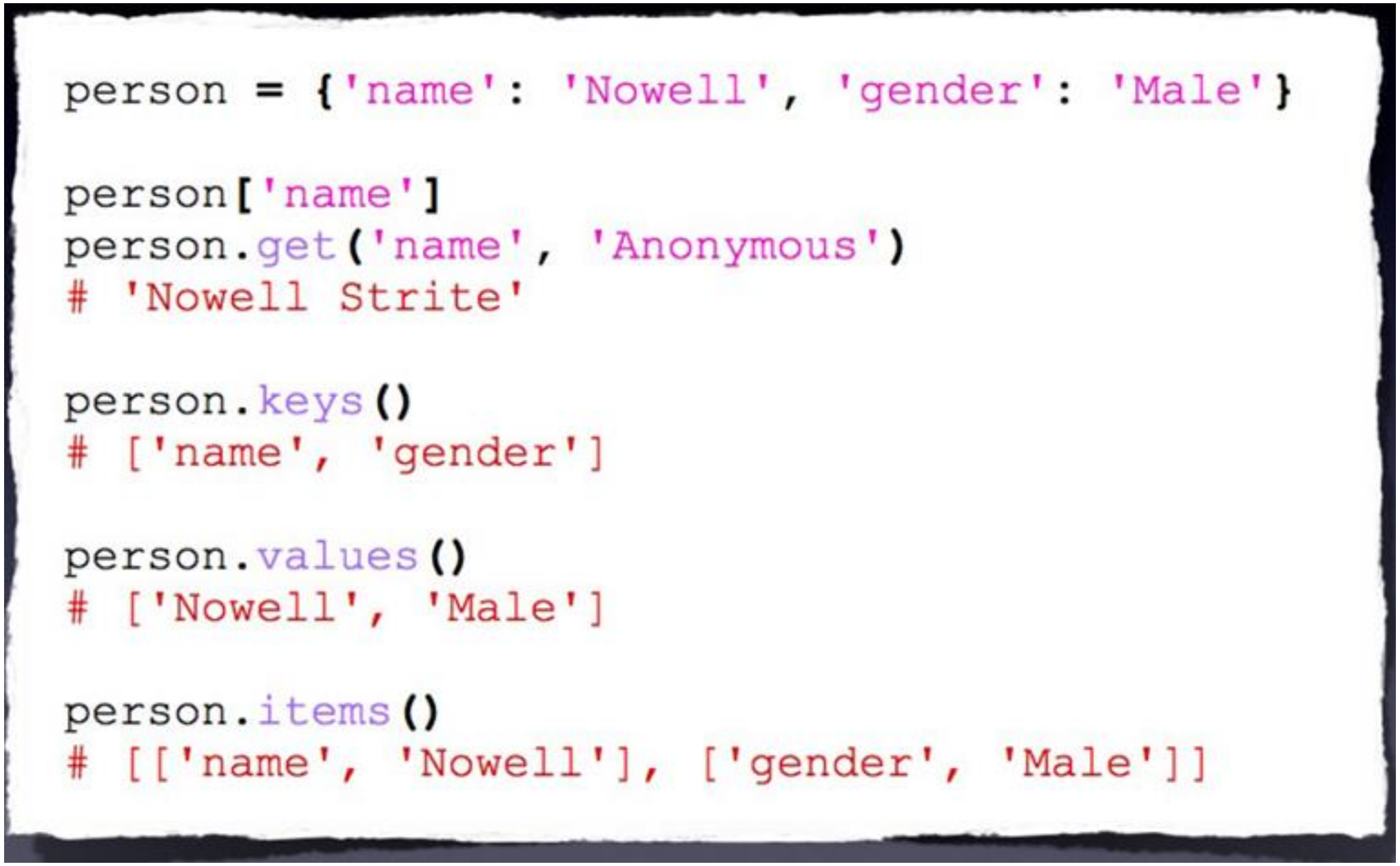
```
numbers = [1, 2, 3, 4, 5]

len(numbers)
# 5

numbers[0]
# 1

numbers[0:2]
# [1, 2]

numbers[2:]
# [3, 4, 5]
```

Dictionary



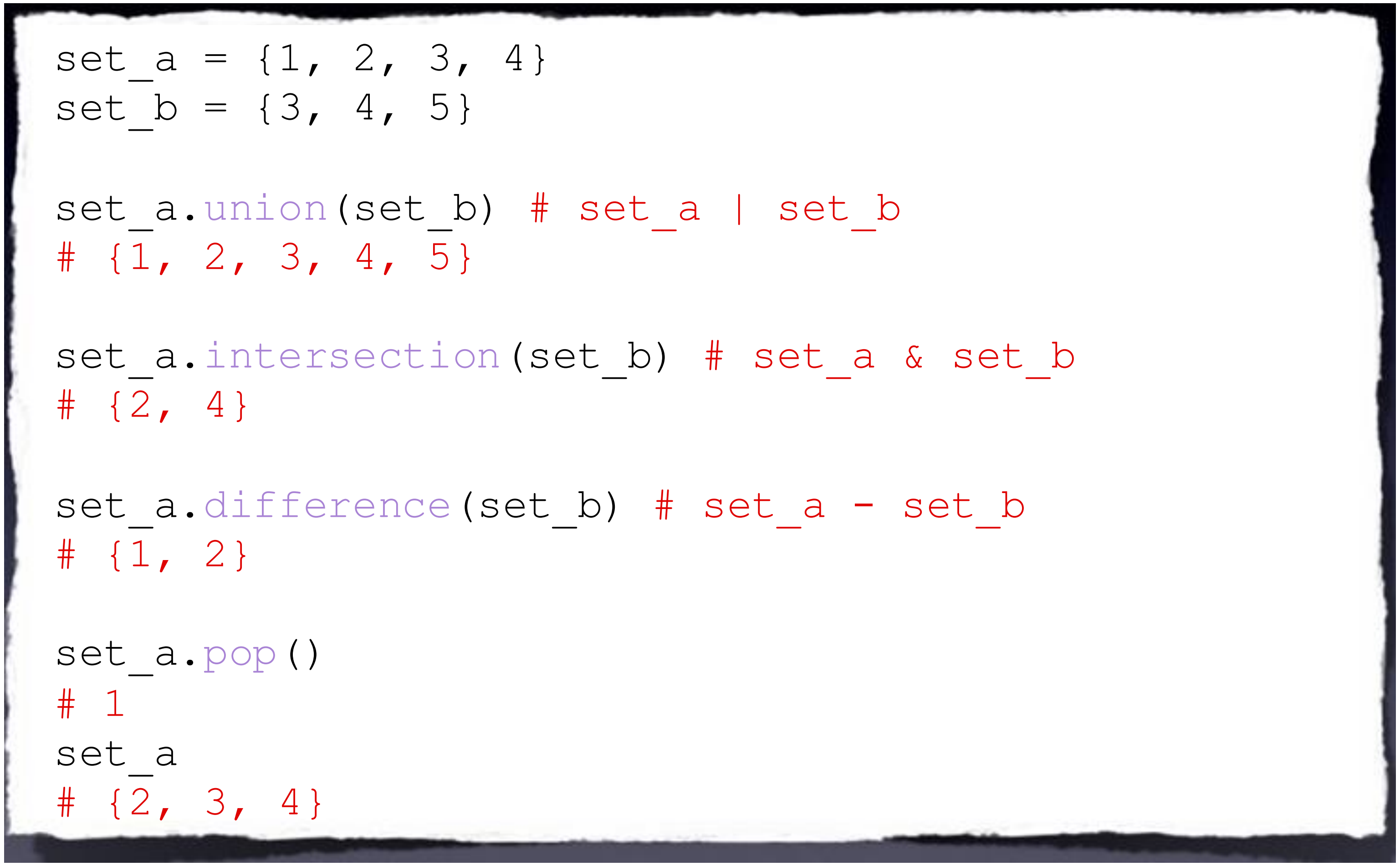
```
person = {}

# Set by key / Get by key
person['name'] = 'Nowell Strite'

# Update
person.update({
    'favorites': [42, 'food'],
    'gender': 'male',
    })

# Any immutable object can be a dictionary key
person[42] = 'favorite number'
person[(44.47, -73.21)] = 'coordinates'
```

Dictionary



```
person = {'name': 'Nowell', 'gender': 'Male'}

person['name']
person.get('name', 'Anonymous')
# 'Nowell Strite'

person.keys()
# ['name', 'gender']

person.values()
# ['Nowell', 'Male']

person.items()
# [['name', 'Nowell'], ['gender', 'Male']]
```

Set

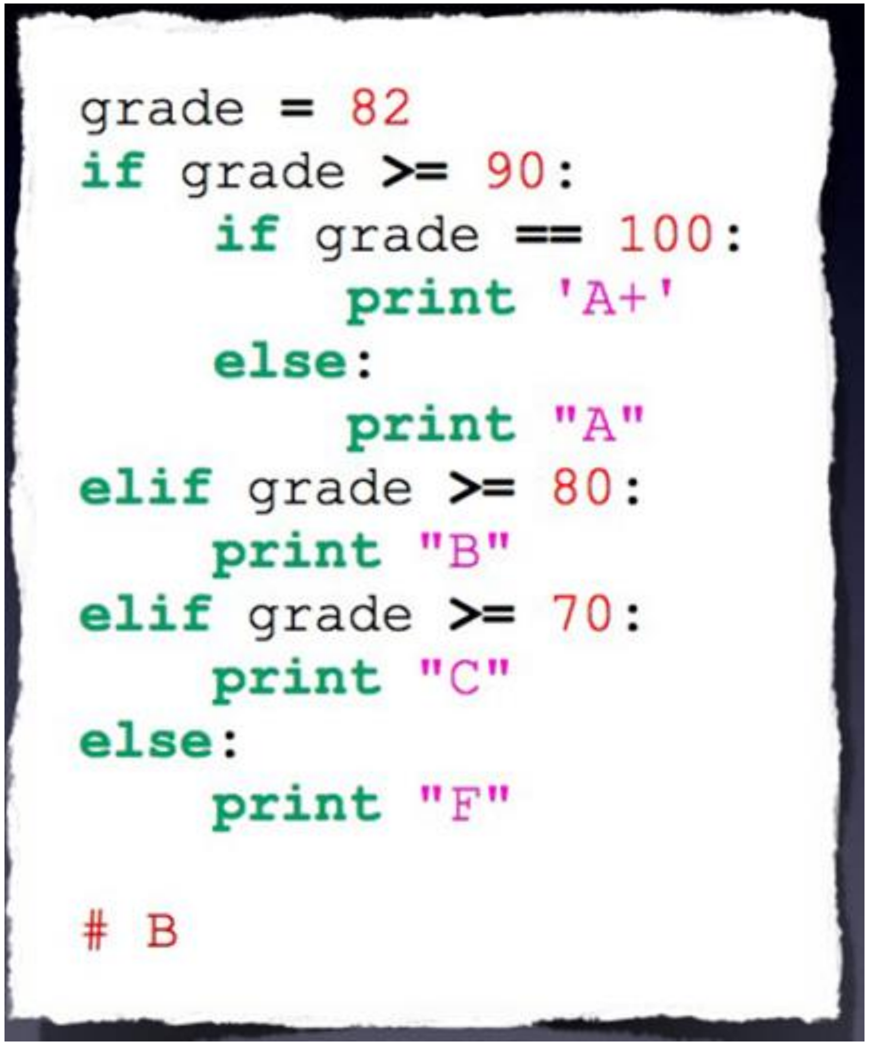


```
set_a = {1, 2, 3, 4}
set_b = {3, 4, 5}

set_a.union(set_b) # set_a | set_b
# {1, 2, 3, 4, 5}

set_a.intersection(set_b) # set_a & set_b
# {2, 4}

set_a.difference(set_b) # set_a - set_b
# {1, 2}

set_a.pop()
# 1
set_a
# {2, 3, 4}
```

Additional built-in Functions

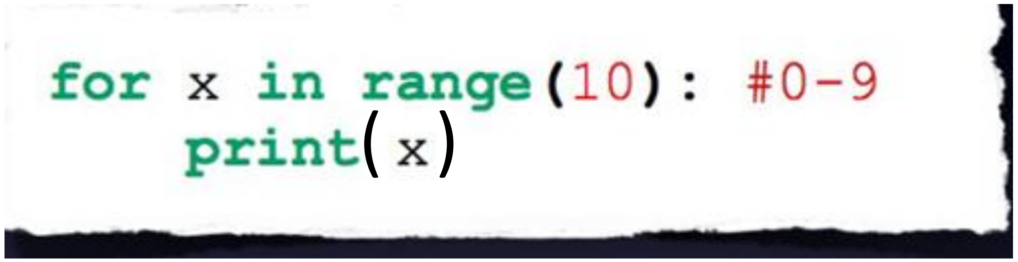
```
a = {4, 3, 2, 1, 0}

sorted(a)
# [0, 1, 2, 3, 4]

min(a)  # max
# 0

len(a)
# 5

sum(a)
# 10


# And more...
```

If-then-else

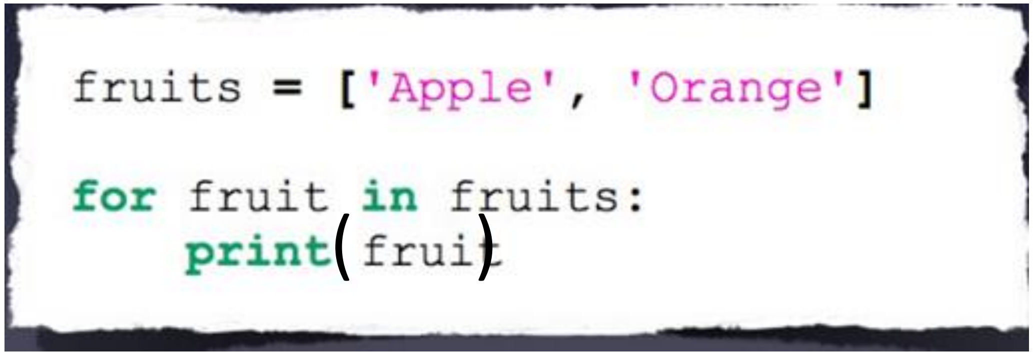


```
grade = 82
if grade >= 90:
    if grade == 100:
        print 'A+'
    else:
        print "A"
elif grade >= 80:
    print "B"
elif grade >= 70:
    print "C"
else:
    print "F"

# B
```

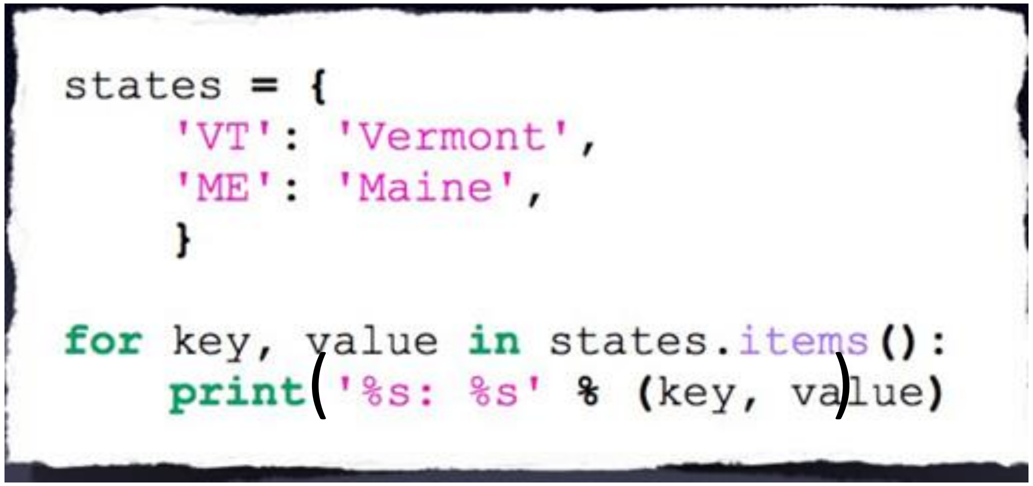
For Loop



```
for x in range(10): #0-9
    print(x)
```

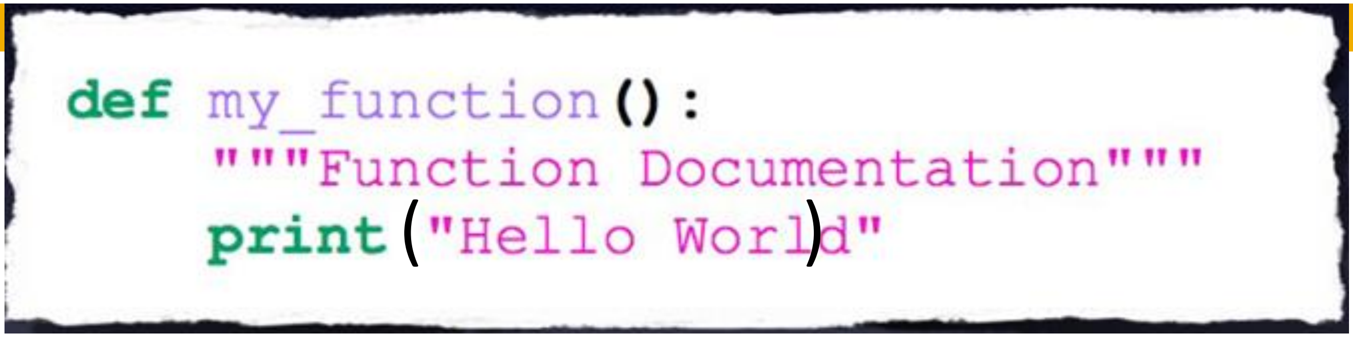


```
fruits = ['Apple', 'Orange']

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

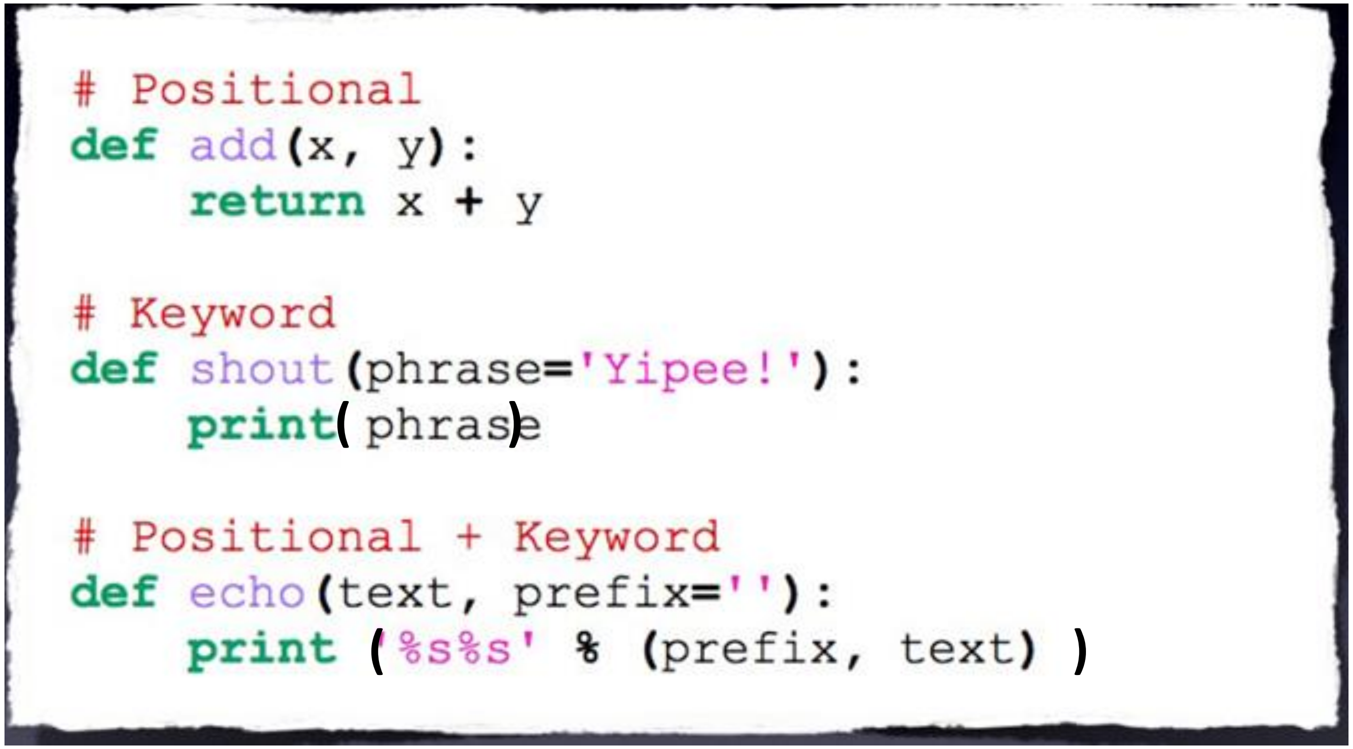


```
states = {
    'VT': 'Vermont',
    'ME': 'Maine',
    }

for key, value in states.items():
    print('%s: %s' % (key, value))
```

Function Definition

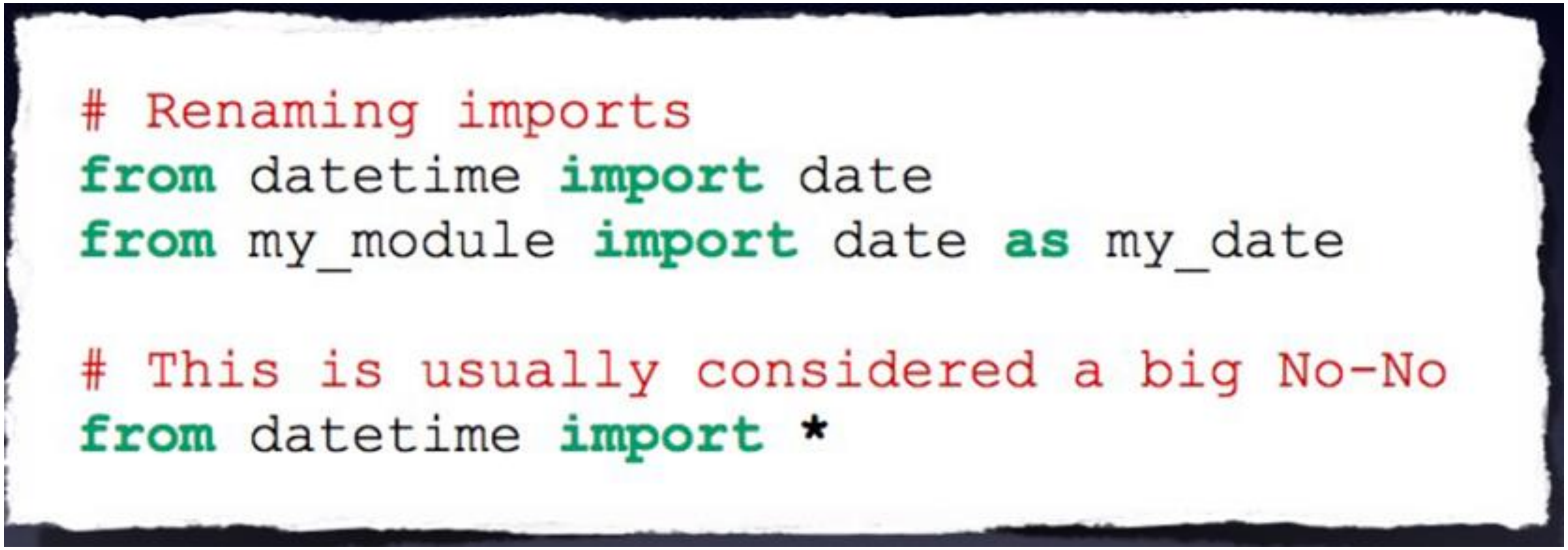


```
def my_function():
    """Function Documentation"""
    print("Hello Worl)d"
```



```
# Positional
def add(x, y):
    return x + y

# Keyword
def shout(phrase='Yipee!'):
    print( phras)e

# Positional + Keyword
def echo(text, prefix=''):
    print (%s%s' % (prefix, text) )
```

Import packages



```
# Renaming imports
from datetime import date
from my_module import date as my_date

# This is usually considered a big No-No
from datetime import *
```

Kinds of Imports

```
└── project
    ├── package1
    │   ├── module1.py
    │   └── module2.py
    └── package2
        ├── __init__.py
        ├── module3.py
        ├── module4.py
        └── subpackage1
            └── module5.py
```

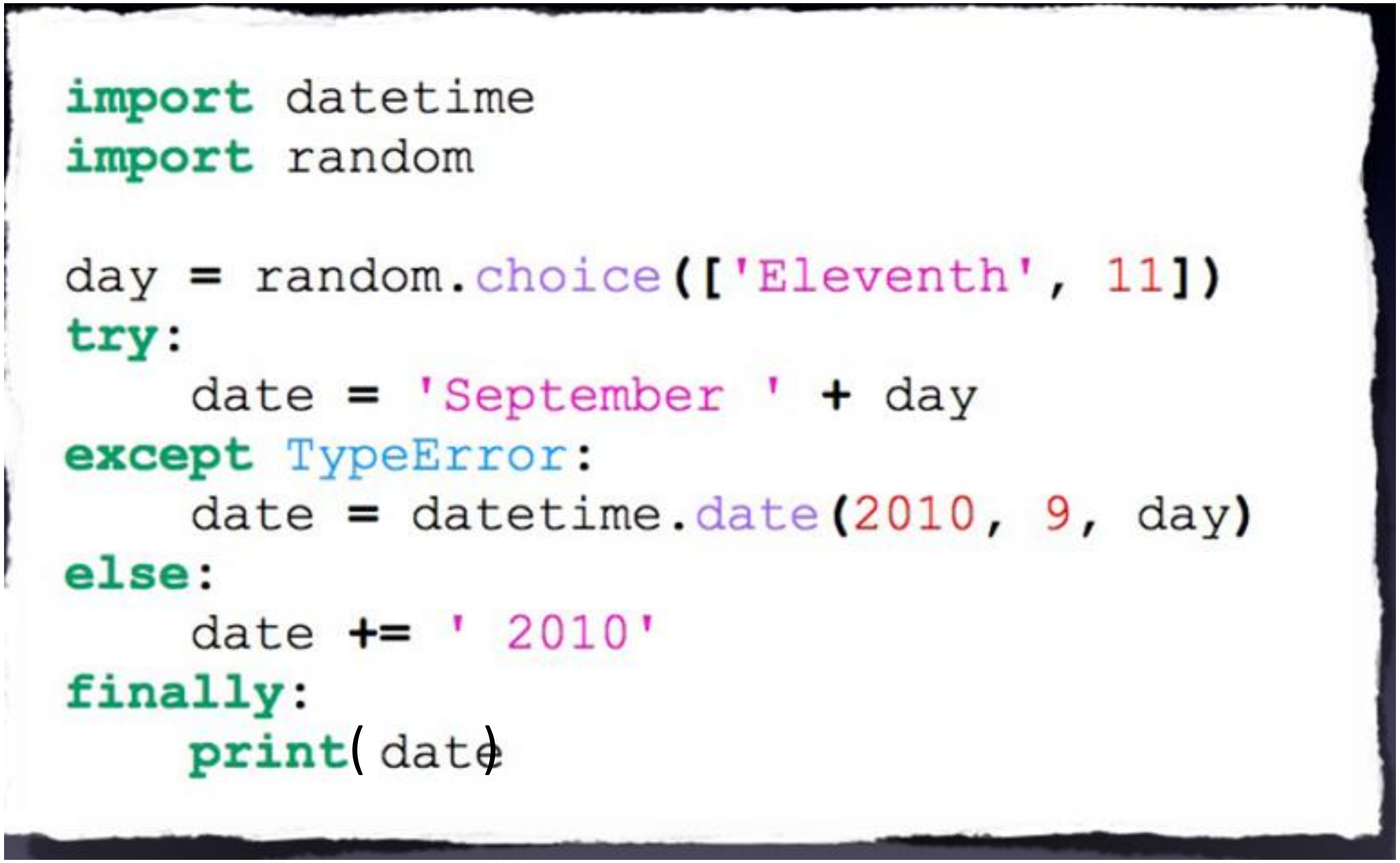
```
from package1 import module1
from package1.module2 import function1
from package2 import class1
from package2.subpackage1.module5 import function2
```

Absolute

```
# package1/module1.py
from .module2 import function1

# package2/module3.py
from . import class1
from .subpackage1.module5 import function2
```

Relative

Error Handling



```
import datetime
import random

day = random.choice(['Eleventh', 11])
try:
    date = 'September ' + day
except TypeError:
    date = datetime.date(2010, 9, day)
else:
    date += ' 2010'
finally:
    print( date)
```

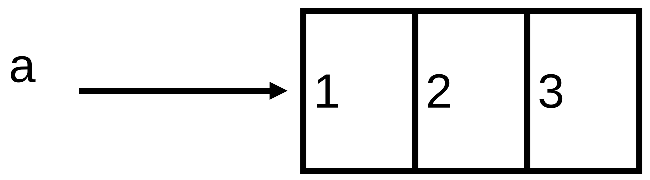
Reference Semantics

- Assignment manipulates references
  - x = y **does not make a copy** of y
  - x = y makes x **reference** the object y references
- Very useful; but beware!
- Example:

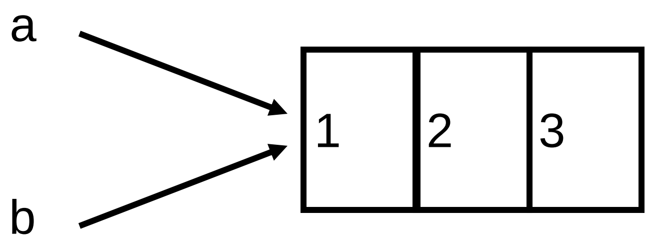
```
>>> a = [1, 2, 3]
>>> b = a
>>> a.append(4)
>>> print b
[1, 2, 3, 4]
```

Changing a Shared List

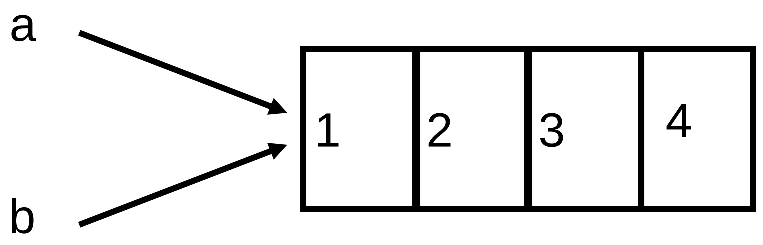
a = [1, 2, 3]



b = a

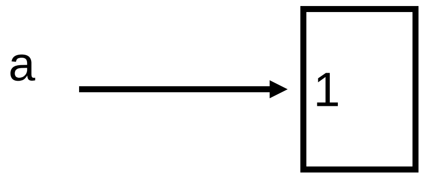


a.append(4)

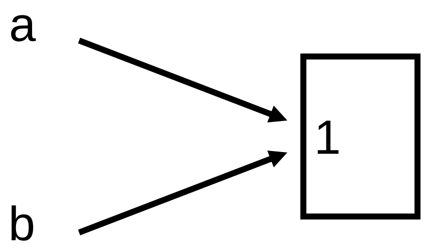


Changing an Integer

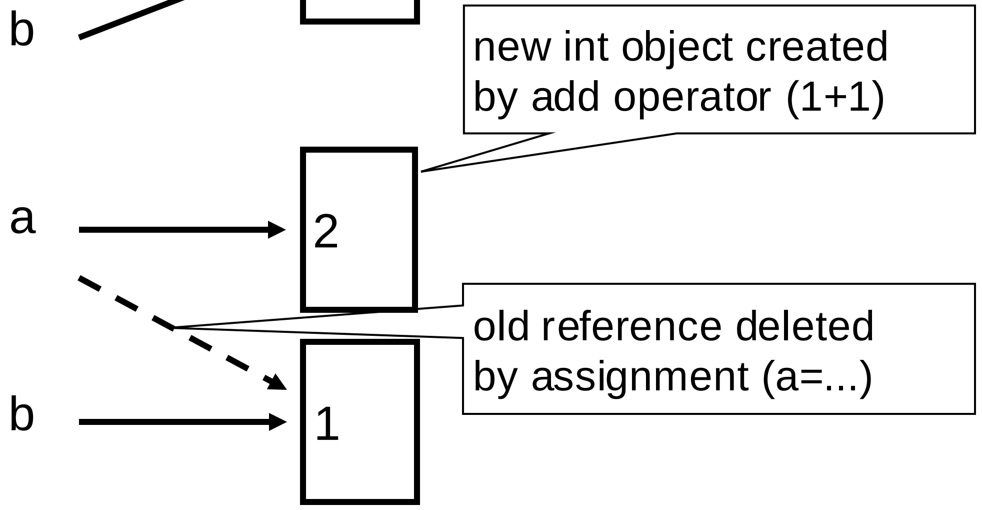
a = 1



b = a



a = a+1


new int object created by add operator (1+1)
a
2
old reference deleted by assignment (a=...)
b
1

Exercise: maximal subsequence

Given an array of integers, e.g.

- a = [-2, 1, -3, 4, -1, 2, 1, -5, 4]

And a function S to compute the sum from h to k,

$$S(a,h,k) = \sum_{i=h}^{k} a[i]$$

Find the values of h and k such that S maximizes ($S(3,6) = 6$)

Variant:

- Use `a = generate_large_array()` (import the function from the provided `supplementary_code.py`) and make the code run in less then 1s

Exercise: lists and dictionaries

- Given the list: l = [12, 3, -4, 6, -5, 9]
- Given the dictionary:
  - d = {'apple': 3, 'orange': 4, 'tomato': -5, 'meat': 6, 'potato': 15, 'strawberry': 9}
- If a value in the dictionary is found in the list, add the corresponding key to a string named ‘to_buy' and print it at the end.
- If a value in the dictionary is not found in the list, chose a random value from the list, that is not present in the dictionary, and assign it to the corresponding key. Print the updated dictionary at the end.

Exercise: lists

- Given 2 lists:

a = [12, 3, 4, 6, 5, 9]

b = [10, 3, 2, 6, 3, 7]

Compute the Pearson's correlation.

Exercise: for loops

- Import and run `generate_order` and `get_menu` from `sushi_rest.py`
  - `Generate_order` return the list of all the plates in a order
  - `Get_menu` return a dictionaty with `<plate_name, price>`

- Answer the following questions:
  - How many plates are in the order?
  - How many unique plates are in the order?
  - For each plate in the menu, find if it is in the order

  - Create a dictionary that counts how often each plate from the menu appears in the order.
  - Add to the previous dictionary all menu plates, even if they don't appear in the order.

Exercise: for loops (with constraints)

- Import and run `generate_order` and `get_menu` from `sushi_rest.py`
  - `Generate_order` return the list of all the plates in a order
  - `Get_menu` return a dictionaty with `<plate_name, price>`

- Answer the following questions:
  - How many plates are in the order? Max 1 line of code
  - How many unique plates are in the order? Max 1 line of code
  - For each plate in the menu, find if it is in the order
    Less then len(menu)*len(order) iterations
  - Create a dictionary that counts how often each plate from the menu appears in the len(order) iterations
  - Add to the previous dictionary all menu plates, even if they don't appear in the order. Use the for loop to add elements to the dictionary ONLY. Max 1 for loop