رواد مصر الرقمية

وزارة الاتصـــــالات
وتكنولوجيا المعلومات

Data Science with Python

17/04/2024

Course Overview

The Data Science with Python course provides a comprehensive overview of Python's tools and techniques for data analytics. Learning Python is a vital skill for numerous data science roles, and you can cultivate it through this course.

Benefits of Enrolling in a Course:

- Gain an in-depth understanding of Data Science processes, data wrangling, data exploration,data visualization, hypothesis building, and testing. You will also learn the basics of statistics.
- Install the required Python environment and other auxiliary tools and libraries.
- Understand the essential concepts of Python programming such as data types, tuples, lists,dicts, basic operators and functions.
- Perform high-level mathematical computing using the NumPy, Panda's package and its vast library of mathematical functions.
- Perform scientific and technical computing using the SciPy package and its sub-packages such asIntegrate, Optimize, Statistics, IO, and Weave.
- Perform data analysis and manipulation using data structures and tools provided in the Pandaspackage.
- Gain expertise in Machine Learning using the Scikit-Learn package.

Python Basics

Data Types

Name	Type	Description	Example
Integers	Int	Whole numbers	3 300 200 -2
Floats	Float	Numbers with decimal point	2.3 4.0 -5.3
Strings	Str	**Ordered** sequence of characters	“hello” ‘Eman’ “2000”
Lists	List	**Ordered** sequence of objects	[10,”omar”,2.33]
Dictionaries	dict	**Unordered** Key:Value pairs	{“key1”:”value1”, “key2”:”value2”}
Tuples	Tup	**Ordered** immutable sequence of objects	(“hello”,4.4,200)
Sets	Set	**Unordered** collection of unique objects	{“a”,3000}
Booleans	bool	Logical vale indicating True or False	True False

Arithmetic Operators

+	(Addition)
-	(Subtraction)
*	(Multiplication)
/	(Division)
//	(Floor division)
%	(Modulus)
**	(Exponentiation)

Variable declaration

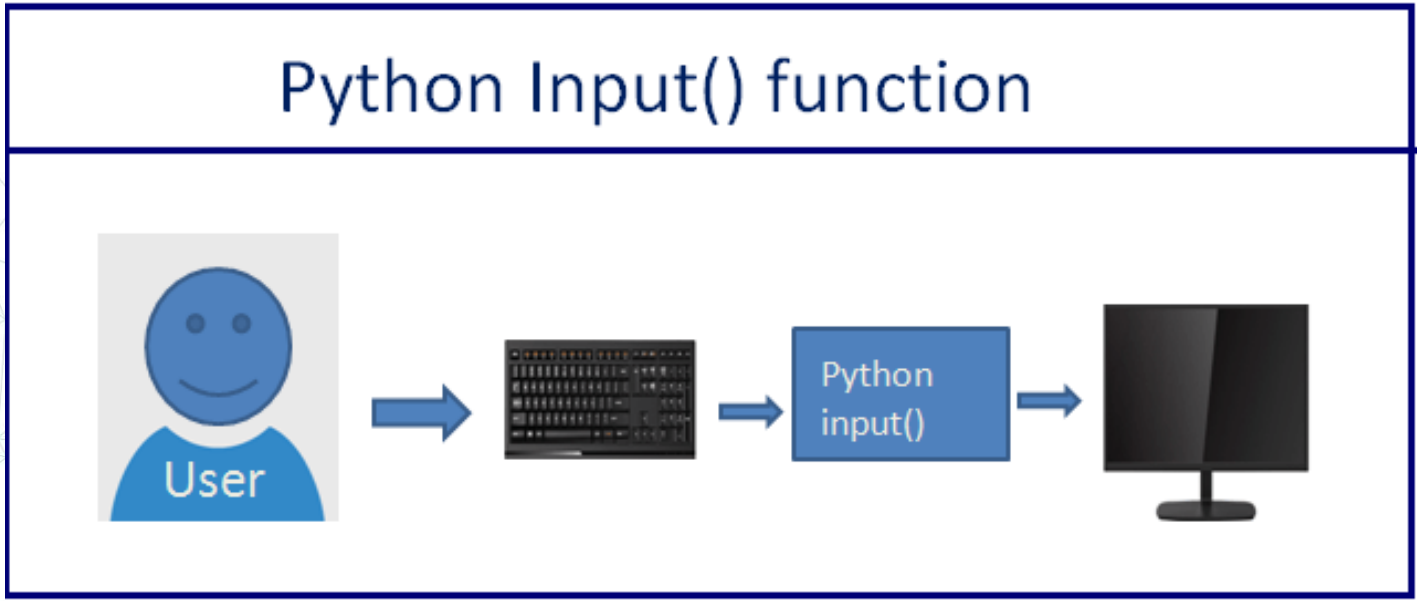
Rules for variable names

- names can not start with a number
- names can not contain spaces, use _ instead
- names can not contain any of these symbols:
  :'",<>/?|\!@#%^&*~-+
- avoid using Python built-in keywords like `list` and `str`
- avoid using the single characters `l` (lowercase letter el), `O` (uppercase letter oh) and `I` (uppercase letter eye) as they can be confused with `1` and `0`.

Assignment operators

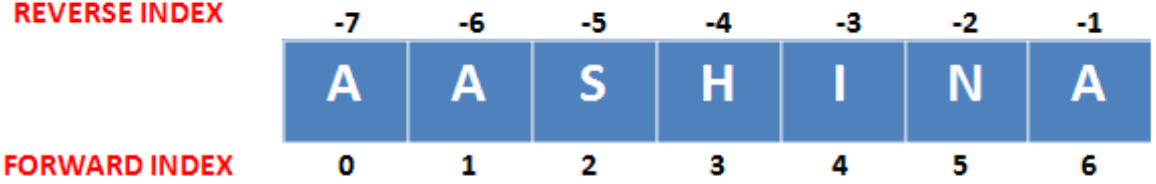
Operator	Meaning	Equivalent
= (Assign)	a=5 Assign 5 to variable a	**a = 5**
+= (Add and assign)	a+=5 Add 5 to a and assign it as a new value to a	**a = a+5**
-= (Subtract and assign)	a-=5 Subtract 5 from variable a and assign it as a new value to a	**a = a-5**
*= (Multiply and assign)	a*=5 Multiply variable a by 5 and assign it as a new value to a	**a = a*5**
/= (Divide and assign)	a/=5 Divide variable a by 5 and assign a new value to a	**a = a/5**
%= (Modulus and assign)	a%=5 Performs modulus on two values and assigns it as a new value to a	**a = a%5**
**= (Exponentiation and assign)	a**=5 Multiply a five times and assigns the result to a	**a = a**5**
//= (Floor-divide and assign)	a//=5 Floor-divide a by 5 and assigns the result to a	**a = a//5**

Input



Strings

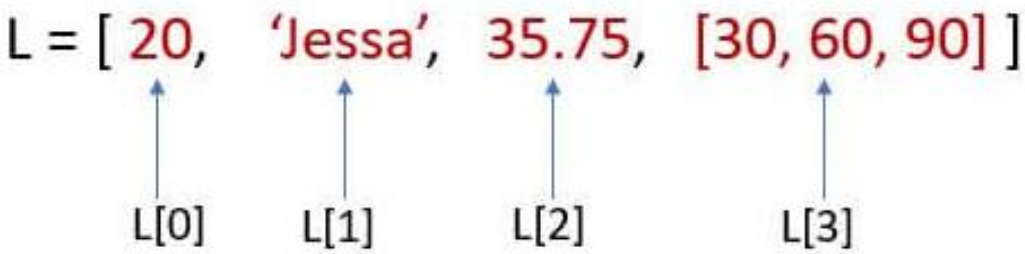
STRING = “AASHINA”



STRING[0] = ‘A’
STRING[1] = ‘A’
STRING[2] = ‘S’
STRING[3] = ‘H’
STRING[4] = ‘I’
STRING[5] = ‘N’
STRING[6] = ‘A’

STRING[-7] = ‘A’
STRING[-6] = ‘A’
STRING[-5] = ‘S’
STRING[-4] = ‘H’
STRING[-3] = ‘I’
STRING[-2] = ‘N’
STRING[-1] = ‘A

Lists



- ✓ **Ordered**: Maintain the order of the data insertion.
- ✓ **Changeable**: List is mutable and we can modify items.
- ✓ **Heterogeneous**: List can contain data of different types
- ✓ **Contains duplicate**: Allows duplicates data

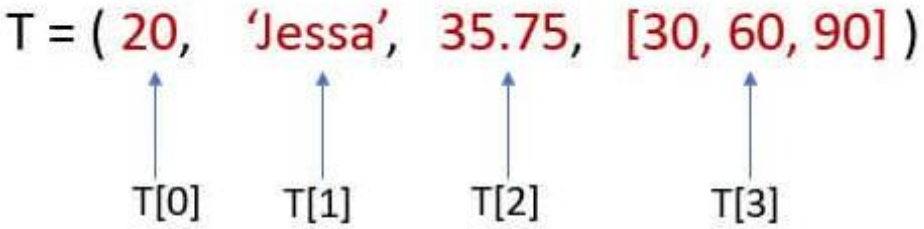
List Operations

Operation	Description
x in l1	Check if the list l1 contains item x.
x not in l2	Check if list l1 does not contain item x.
l1 + l2	Concatenate the lists l1 and l2. Creates a new list containing the items from l1 and l2.
l1 * 5	Repeat the list l1 5 times.
l1[i]	Get the item at index i.
l1[i:j]	List slicing. Get the items from index i up to index j (excluding j) as a List.
l1[i:j:k]	List slicing with step. Returns a List with the items from index i up to index j taking every k-th item.
len(l1)	Returns a count of total items in a list.
l2.count(60)	Returns the number of times a particular item (60) appears in a list..

List Operations

Operation	Description
l1.index(30)	Returns the index number of a particular item (30) in a list.
l1.index(30, 2, 5)	Returns the index number of a particular item (30) in a list. But search Returns the item with maximum value from a list.
min(l1)	Returns the item with a minimum value from a list.
max(l1)	Returns the item with maximum value from a list.
l1.append(100)	Add item at the end of the list
l1.append([2, 5, 7])	Append the nested list at the end
l1[2] = 40	Modify the item present at index 2
l1.remove(40)	Removes the first occurrence of item 40 from the list.
pop(2)	Removes and returns the item at index 2 from the list.
l1.clear()	Make list empty
l3= l1.copy()	Copy l1 into l2

Tuples



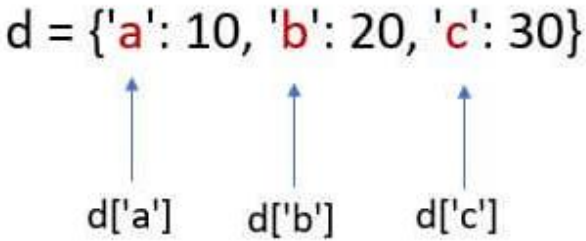
- ✓ **Ordered**: Maintain the order of the data insertion.
- ✓ **Unchangeable**: Tuples are immutable and we can't modify items.
- ✓ **Heterogeneous**: Tuples can contains data of types
- ✓ **Contains duplicate**: Allows duplicates data

Tuples operations

Operation	Description
x in t1	Check if the tuple t1 contains the item x.
x not in t2	Check if the tuple t1 does not contain the item x.
t1 + t2	Concatenate the tuples t1 and t2. Creates a new tuple containing the items from t1 and t2.
t1 * 5	Repeat the tuple t1 5 times.
t1[i]	Get the item at the index i.
t1[i:j]	Tuple slicing. Get the items from index i up to index j (excluding j) as a tuple.
t1[i:j:k]	Tuple slicing with step. Return a tuple with the items from index i up to index j taking every k-th item.
len(t1)	Returns a count of total items in a tuple
t2.count(60)	Returns the number of times a particular item (60) appears in a tuple.
t1.index(30)	Returns the index number of a particular item(30) in a tuple.
t1.index(40, 2, 5)	Returns the index number of a particular item(30) in a tuple. But search only from index number 2 to 5.
min(t1)	Returns the item with a minimum value from a tuple
max(t1)	Returns the item with maximum value from a tuple

Dictionary

Unordered collections of unique values stored in (Key-Value) pairs.



- ✓ **Unordered**: The items in dict are stored without any index value
- ✓ **Unique**: Keys in dictionaries should be Unique
- ✓ **Mutable**: We can add/Modify/Remove key-value after the creation

Dictionary Operations

Operations	Description
dict({'a': 10, 'b': 20})	Create a dictionary using a dict() constructor.
d2 = {}	Create an empty dictionary.
d1.get('a')	Retrieve value using the key name a.
d1.keys()	Returns a list of keys present in the dictionary.
d1.values()	Returns a list with all the values in the dictionary.
d1.items()	Returns a list of all the items in the dictionary with each key-value pair inside a tuple.
len(d1)	Returns number of items in a dictionary.
d1['d'] = 40	Update dictionary by adding a new key.
d1.update({'e': 50, 'f': 60})	Add multiple keys to the dictionary.
d1.setdefault('g', 70)	Set the default value if a key doesn't exist.
d1['b'] = 100	Modify the values of the existing key.
d1.pop('b')	Remove the key b from the dictionary.
d1.popitem()	Remove any random item from a dictionary.
d1.clear()	Removes all items from the dictionary.
'key' in d1.keys()	Check if a key exists in a dictionary.
d1.update(d2)	Add all items of dictionary d2 into d1.
d3= {**d1, **d2}	Join two dictionaries.
d2 = d1.copy()	Copy dictionary d1 into d2.
max(d1)	Returns the key with the maximum value in the dictionary d1
min(d1)	Returns the key with the minimum value in the dictionary d1

Set

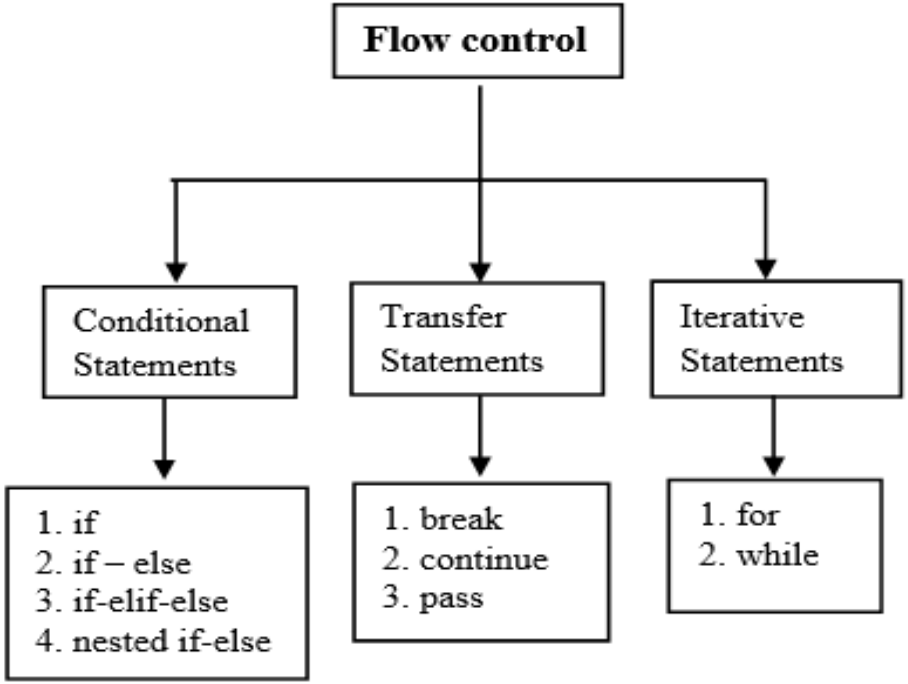
S = { 20, 'Jessa', 35.75}

- ✓ **Unordered**: Set doesn't maintain the order of the data insertion.
- ✓ **Unchangeable**: Set are immutable and we can't modify items.
- ✓ **Heterogeneous**: Set can contains data of all types
- ✓ **Unique**: Set doesn't allows duplicates items

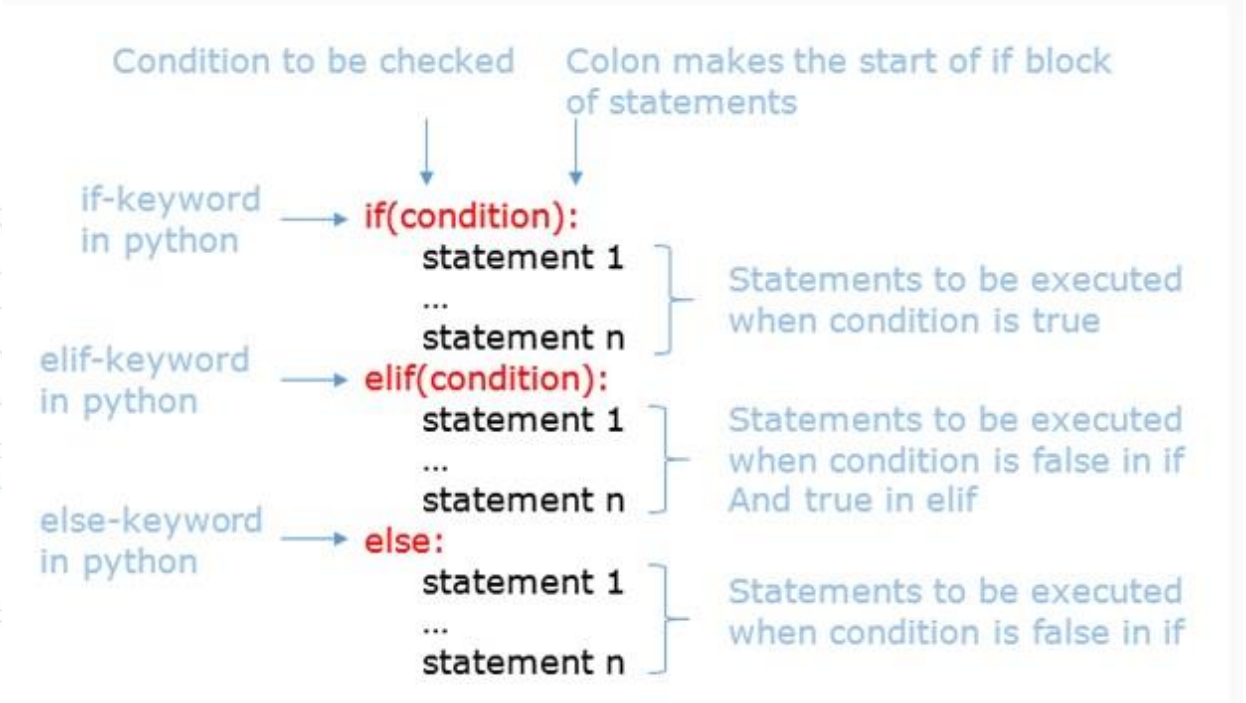
Set Operations

Operation	Equivalent	Result
`len(s)`		number of elements in set *s* (cardinality)
`x in s`		test *x* for membership in *s*
`x not in s`		test *x* for non-membership in *s*
`s.issubset(t)`	`s <= t`	test whether every element in *s* is in *t*
`s.issuperset(t)`	`s >= t`	test whether every element in *t* is in *s*
`s.union(t)`	`s | t`	new set with elements from both *s* and *t*
`s.intersection(t)`	`s & t`	new set with elements common to *s* and *t*
`s.difference(t)`	`s - t`	new set with elements in *s* but not in *t*
`s.symmetric_difference(t)`	`s ^ t`	new set with elements in either *s* or *t* but not both
`s.copy()`		new set with a shallow copy of *s*

Flow Control



if, elif, and else Statements



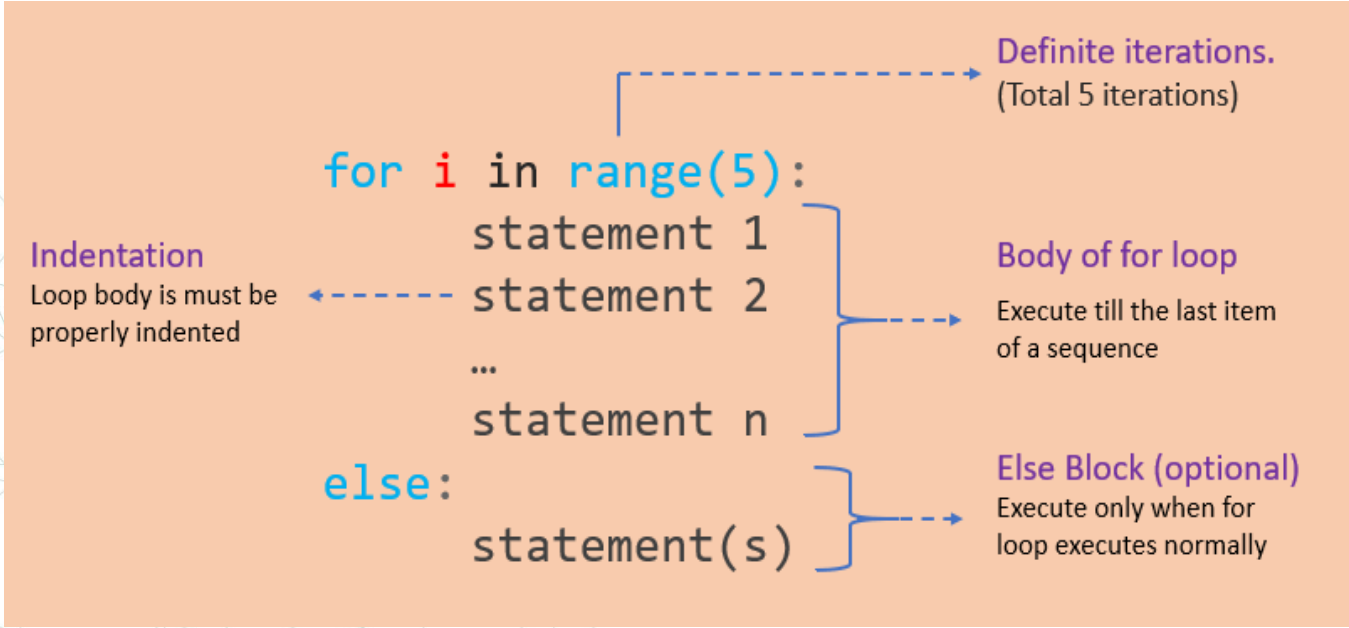
Relational (comparison) operators

Operator	Description	Example
> (Greater than)	It returns True if the left operand is greater than the right	x > y result is True
< (Less than)	It returns True if the left operand is less than the right	x < y result is False
== (Equal to)	It returns True if both operands are equal	x == y result is False
!= (Not equal to)	It returns True if both operands are equal	x != y result is True
>= (Greater than or equal to)	It returns True if the left operand is greater than or equal to the right	x >= y result is True
<= (Less than or equal to)	It returns True if the left operand is less than or equal to the right	x <= y result is False

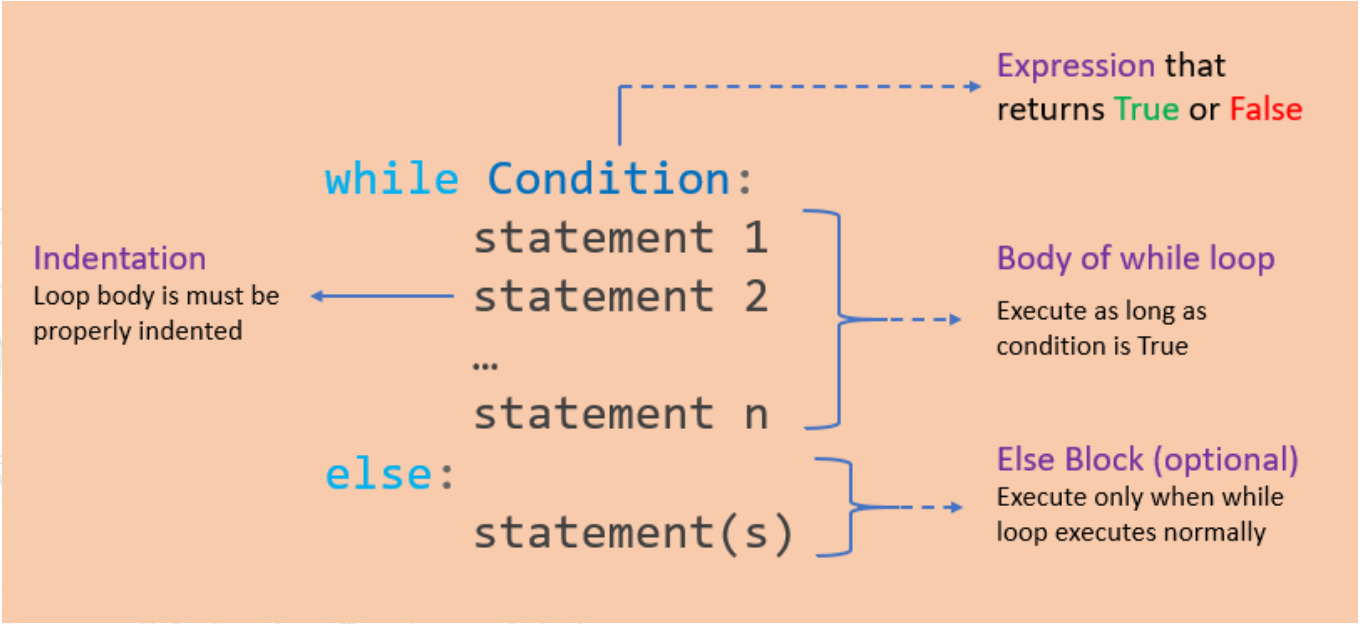
Logical operators

Operator	Description	Example
and (Logical and)	True if both the operands are True	a and b
or (Logical or)	True if either of the operands is True	a or b
not (Logical not)	True if the operand is False	not a

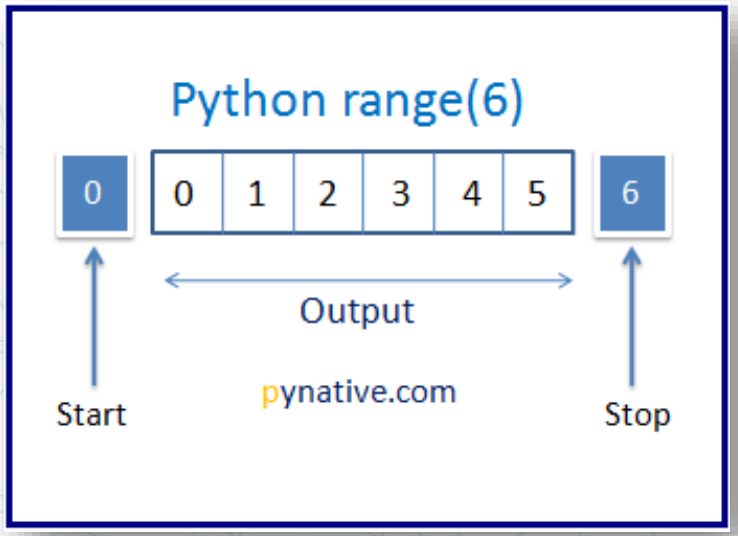
For Loops


Definite iterations.
(Total 5 iterations)
for i in range(5):
statement 1
statement 2
...
statement n
else:
statement(s)
Indentation
Loop body is must be properly indented
Body of for loop
Execute till the last item of a sequence
Else Block (optional)
Execute only when for loop executes normally

While Loops


Expression that returns True or False
while Condition:
statement 1
statement 2
…
statement n
else:
statement(s)
Indentation
Loop body is must be properly indented
Body of while loop
Execute as long as condition is True
Else Block (optional)
Execute only when while loop executes normally

Range Function



How to use Python range(start, stop, step)

range() returns the immutable sequence of numbers starting from the given **start integer to the stop-step**. Each number is incremented by adding step value to its preceding number

range(0, 6, 1) → 0 1 2 3 4 5

Step. (Optional) Specify the increment. Default is **1**

Stop. **(Required)** specifying at which position to stop. Not part of the result

Start. (Optional) Start number of sequence. Default is **0**

```
for i in range(6):
    print(i)
```

It returns a range object not list
type(range(6)) -> class 'range'

Reverse range/ Decrementing

1. range(5, -1, -1) → 5 4 3 2 1 0
2. reversed(range(6))

List from range x = **list**(range(6)) → 0 1 2 3 4 5

range(-1, -11, -1)	Negative range from -1 to -10
range(start, stop+step, step)	Generate an inclusive range
range(0, 10)[5]	Access 5th number of a range()
range(10)[3:8]	Slice a range to from index 3 to 8
range(5).start, range(5).stop	Access range() attributes

Range Function

```
>>> # One parameter
>>> for i in range(5):
...     print(i)
...
0
1
2
3
4
```

```
>>> # Two parameters
>>> for i in range(3, 6):
...     print(i)
...
3
4
5
```

```
>>> # Three parameters
>>> for i in range(4, 10, 2):
...     print(i)
...
4
6
8
```

```
>>> # Going backwards
>>> for i in range(0, -10, -2):
...     print(i)
...
0
-2
-4
-6
-8
```

Break, Continue, and Pass

Statement	Description
break	Terminate the current loop. Use the break statement to come out of the loop instantly.
continue	Skip the current iteration of a loop and move to the next iteration
pass	Do nothing. Ignore the condition in which it occurred and proceed to run the program as usual

break

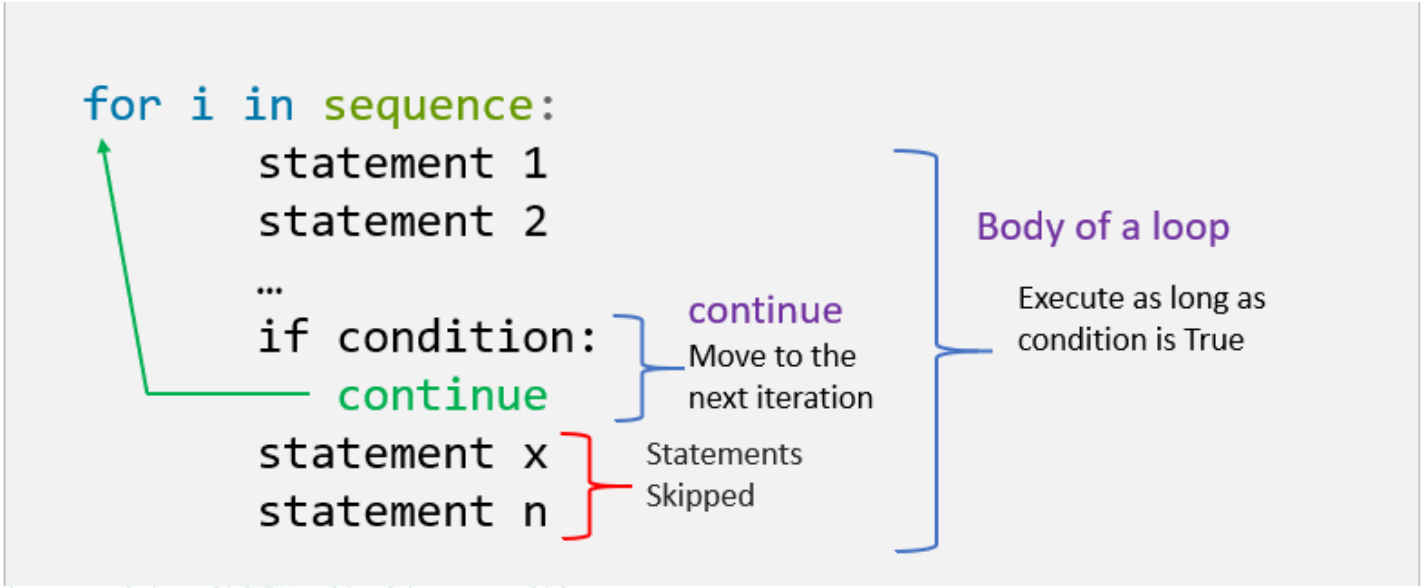
```
for i in sequence:
        statement 1
        statement 2
        …
        if condition:
            break
        statement x
        statement n

#Next statement after loop
```

Break Statement
Terminate loop immediately

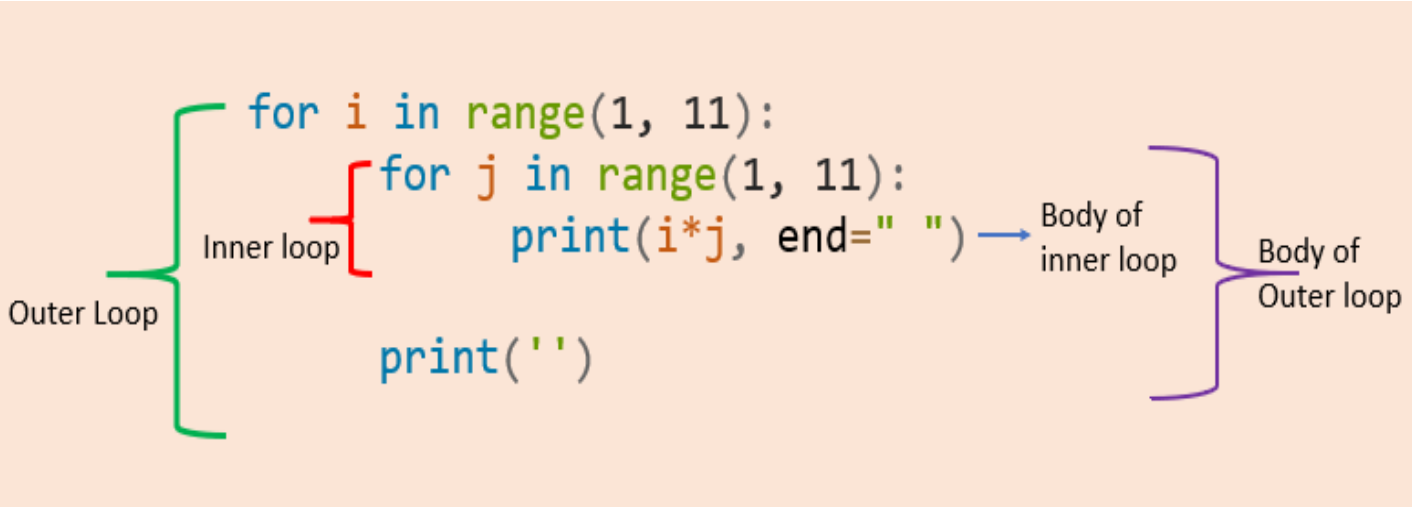
Remaining body of loop

Body of a loop
Execute as long as condition is True

continue


for i in sequence:
statement 1
statement 2
…
if condition:
continue
statement x
statement n
continue
Move to the next iteration
Statements Skipped
Body of a loop
Execute as long as condition is True

Nested Loop


for i in range(1, 11):
for j in range(1, 11):
print(i*j, end=" ")
print('')
Outer Loop
Inner loop
Body of inner loop
Body of Outer loop

Python Program to Find the Factorial of a Number

Python program to print the duplicate elements of an array

Python program to find $\sum_{1}^{n} n!$

Python program to print the elements of an array in reverse order

Python program to print the largest element in an array

Python program to sort the elements of an array in ascending order

Python Program to Remove Punctuation from a String

Python program to find the frequency of each element in the array

Q&A

Questions and answers

Reading and Writing to text files in Python

Opening a File

```
File_object = open(r"File_Name","Access_Mode")
```

```
# Open function to open the file "MyFile1.txt"
# (same directory) in append mode and
file1 = open("MyFile.txt","a")

# store its reference in the variable file1
# and "MyFile2.txt" in D:\Text in file2
file2 = open(r"D:\Text\MyFile2.txt","w+")
```

File Access Modes

1. **Read Only (‘r’) :** Open text file for reading. The handle is positioned at the beginning of the file. If the file does not exists, raises I/O error. This is also the default mode in which file is opened.
2. **Read and Write (‘r+’) :** Open the file for reading and writing. The handle is positioned at the beginning of the file. Raises I/O error if the file does not exists.
3. **Write Only (‘w’) :** Open the file for writing. For existing file, the data is truncated and over-written. The handle is positioned at the beginning of the file. Creates the file if the file does not exists.
4. **Write and Read (‘w+’)** : Open the file for reading and writing. For existing file, data is truncated and over-written. The handle is positioned at the beginning of the file.
5. **Append Only (‘a’)** : Open the file for writing. The file is created if it does not exist. The handle is positioned at the end of the file. The data being written will be inserted at the end, after the existing data.
6. **Append and Read (‘a+’) :** Open the file for reading and writing. The file is created if it does not exist. The handle is positioned at the end of the file. The data being written will be inserted at the end, after the existing data.

Closing a file

```
# Opening and Closing a file "MyFile.txt"
# for object name file1.
file1 = open("MyFile.txt","a")
file1.close()
```

Reading from a file

There are three ways to read data from a text file.

1.read() : Returns the read bytes in form of a string. Reads n bytes, if no n specified, reads the **entire file**.

File_object.read([n])

2.readline() : Reads a line of the file and returns in form of a string. For specified n, reads at most n bytes.

However, does not reads more than **one line**, even if n exceeds the length of the line.

File_object.readline([n])

3.readlines() : Reads **all the lines** and return them as each line a string element in a **list**.

File_object.readlines()

Writing to a file

There are two ways to write in a file.

1. write() : Inserts the string str1 in a single line in the text file.

File_object.write(str1)

2. writelines() : For a list of string elements, each string is inserted in the text file. Used to insert multiple strings at a single time.

File_object.writelines(L) for L = [str1, str2, str3]

Using write along with the with() function

Example

```
# Python code to illustrate split() function
with open("file.txt", "r") as file:
        data = file.readlines()
        for line in data:
                word = line.split()
                print (word)
```

Copy contents of one file to another file

```
# open both files
with open('first.txt','r') as firstfile, open('second.txt','a') as secondfile:

    # read content from first file
    for line in firstfile:

        # append content to second file
        secondfile.write(line)
```

Copy all the content of one file to another file in uppercase

```
# To open the first file in read mode
f1 = open("sample file 1.txt", "r")

# To open the second file in write mode
f2 = open("sample file 2.txt", "w")

# For loop to traverse through the file
for line in f1:

        # Writing the content of the first
        # file to the second file

        # Using upper() function to
        # capitalize the letters
        f2.write(line.upper())
```

Copy odd lines of one file to other

```
# open file in read mode
fn = open('bcd.txt', 'r')
# open other file in write mode
fn1 = open('nfile.txt', 'w')
# read the content of the file line by line
cont = fn.readlines()
type(cont)
for i in range(0, len(cont)):
        if(i % 2 ! = 0):
                fn1.write(cont[i])
        else:
                pass
```

Count number of lines in a text file in Python

```
file = open("gfg.txt","r")
Counter = 0

# Reading from file
Content = file.read()
CoList = Content.split("\n")

for i in CoList:
        if i:
                Counter += 1
print("This is the number of lines in the file")
print(Counter)
```

Exercise

- Get number of characters, words, spaces and lines in a file

- Read lines from this file and split line on last delimiter in Python and save it to another file

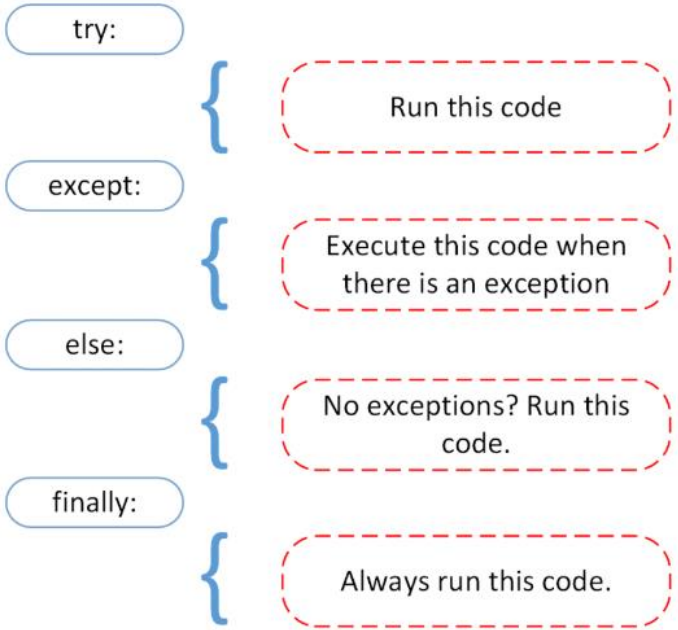
first_name1:last_name1:mail1@mail.com:address1
first_name2:last_name2:mail2@mail.com:address2
first_name3:last_name3:mail3@mail.com:address3
first_name4:last_name5:mail4@mail.com:address4
first_name5:last_name6:mail5@mail.com:address5
first_name6:last_name7:mail6@mail.com:address6
first_name7:last_name8:mail7@mail.com:address7

Errors Types

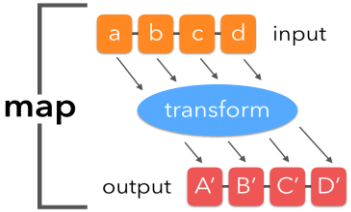
1.Syntax errors

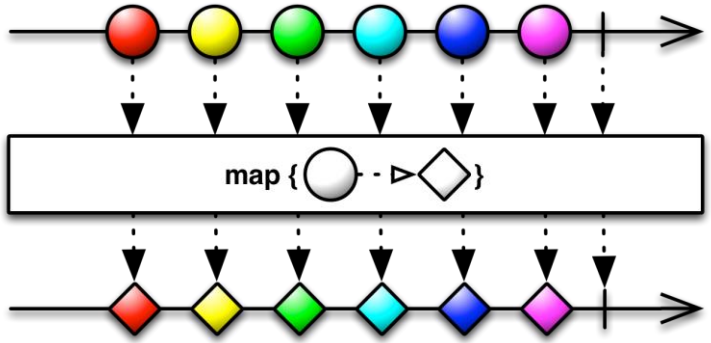
2.Logical errors (Exceptions)

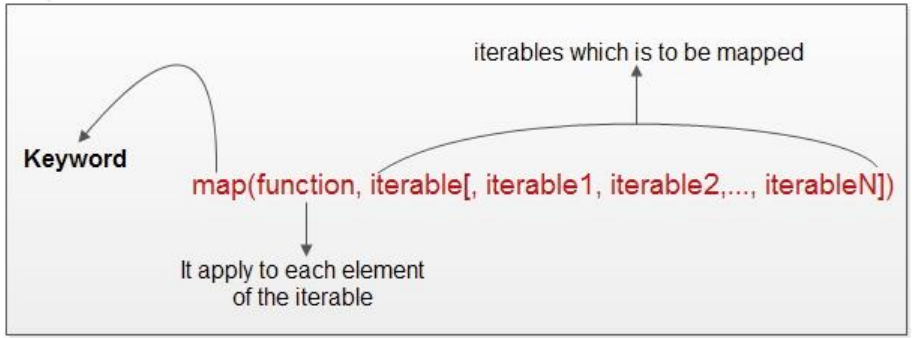
Errors and Exception Handling



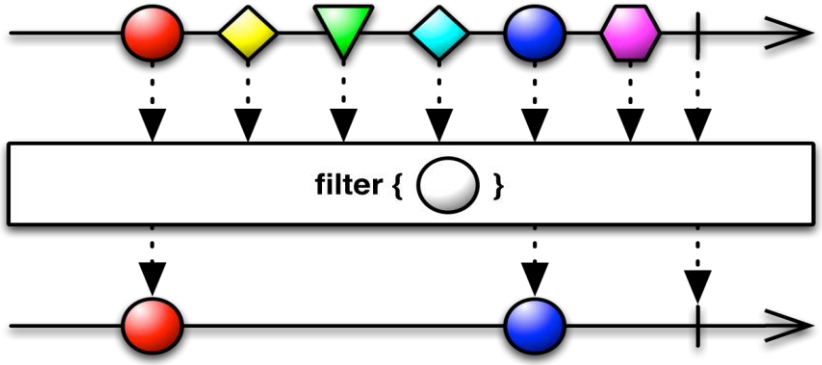
map


map
a
b
c
d
input
transform
output
A′
B′
C′
D′


map {


iterables which is to be mapped
Keyword
map(function, iterable[, iterable1, iterable2,..., iterableN])
It apply to each element
of the iterable

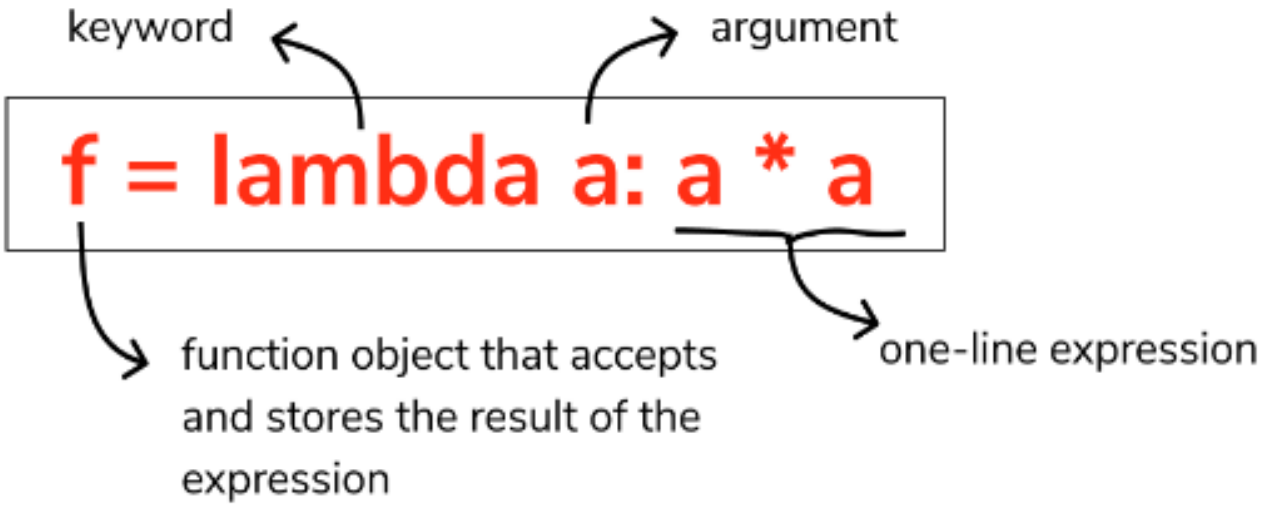
filter



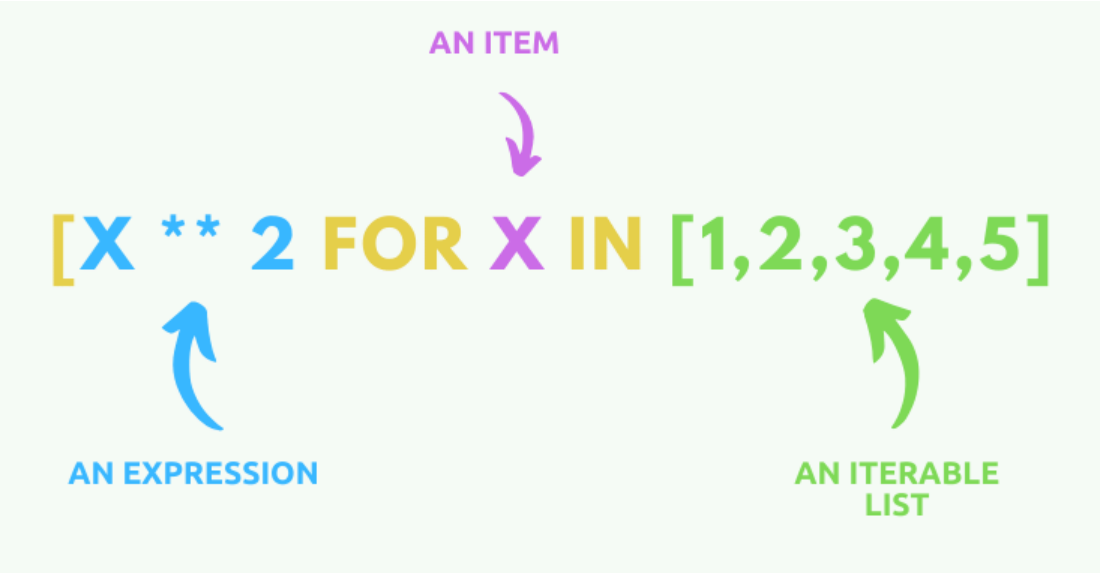

```
filter(function, iterable)
```

Returns a sequence from those elements of iterable for which the function returns true.

Lambda

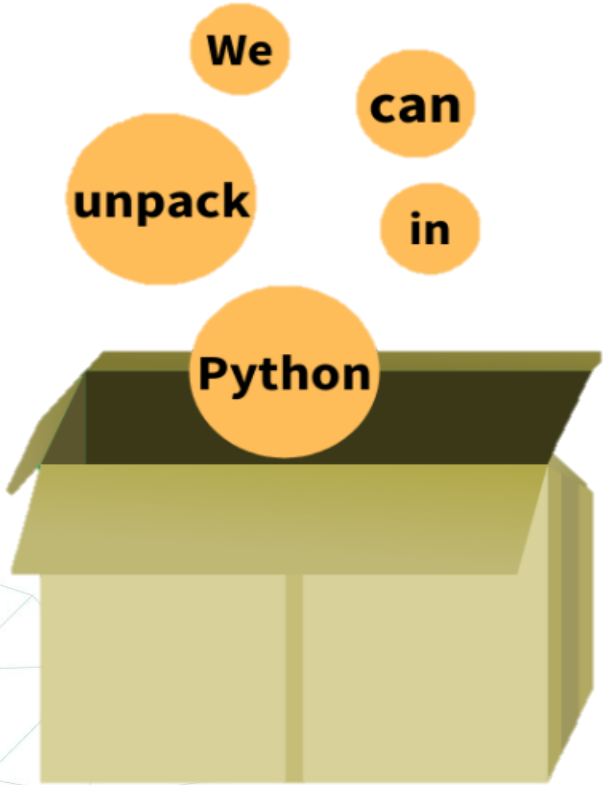

keyword
argument
f = lambda a: a * a
function object that accepts and stores the result of the expression
one-line expression

List comprehension



Do this	For this collection	In this situation
`[x**2`	`for x in range(0, 50)`	`if x % 3 == 0]`

Unpacking



*args and **Kwargs

Function definition

def fun_name(*args) → Packing arguments
statement(s)

Function call

fun_name(a,b,c,d) → Actual arguments

- Parameter 1
- Parameter 2
- Parameter 3
- . . . . . .

*args means passing an arbitrary number of arguments

**kwargs means passing an arbitrary number of arguments with keywords

- Parameter 1
- Parameter 2
- Parameter 3
- Parameter 4
- . . . . . .

Function definition

def fun_name(**kwargs) → Packing keyword arguments
statement(s)

Function call

fun_name(a=1,b=2,c=3) → keyword arguments

Using map() function and lambda and count() function create a list which consists of the number of occurence of letter: a.

Using map() function and lambda and count() function create a list consisted of the number of occurence of both letters: A and a.

Using filter() function filter the list so that only negative numbers are left.

Using map() and filter() functions add 2000 to the values below 8000.

Write a program that reads the sentence and gives the output as the length of each word in a sentence in the form of a list.

Using map() function and lambda and count() function create a list which consists of the number of occurence of letter: a.

```
lst2 = list(map(lambda x: x.count("a"), lst1))
```

Using map() function and lambda and count() function create a list consisted of the number of occurence of both letters: A and a.

```
lst2 = list(map(lambda x: x.lower().count("a"), lst1))
```

Using filter() function filter the list so that only negative numbers are left.

```
lst2 = list(filter(lambda x: x<0, lst1))
print(lst2)
```

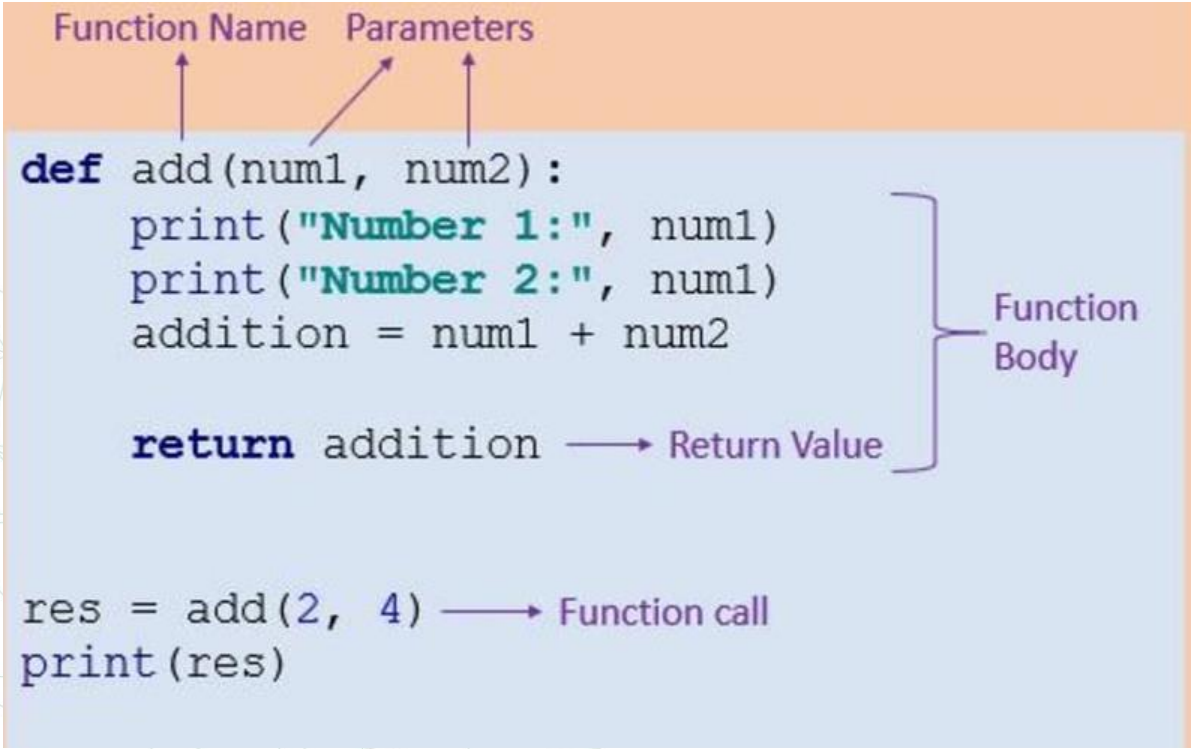
Using map() and filter() functions add 2000 to the values below 8000.

```
lst2 = list(map(lambda x: x+2000, filter(lambda x: x<8000, lst1)))
```

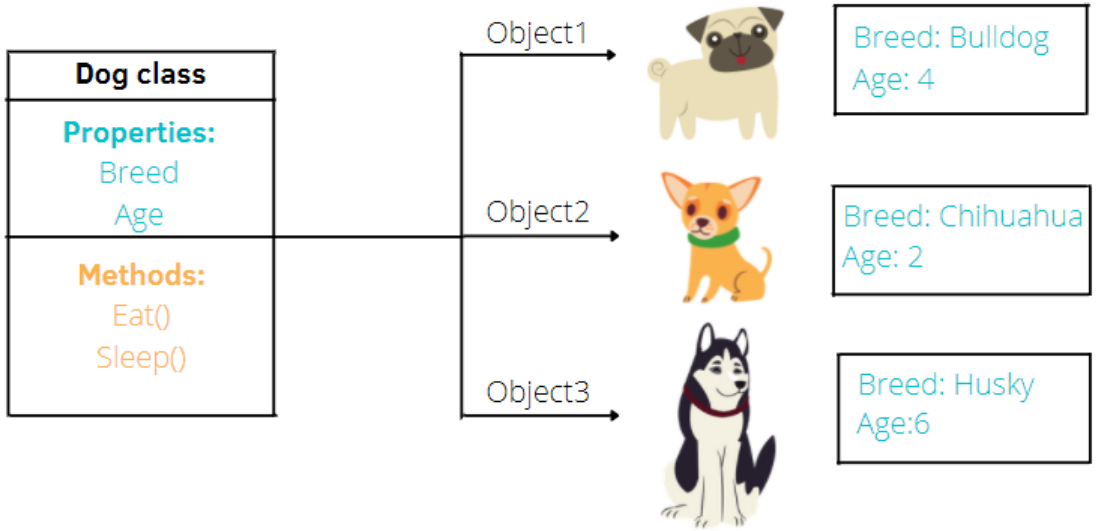
Write a program that reads the sentence and gives the output as the length of each word in a sentence in the form of a list.

```
sentence = 'I am learning Python programming with CSEstack'
words = sentence.split()
lengths = map(lambda word: len(word), words)
```

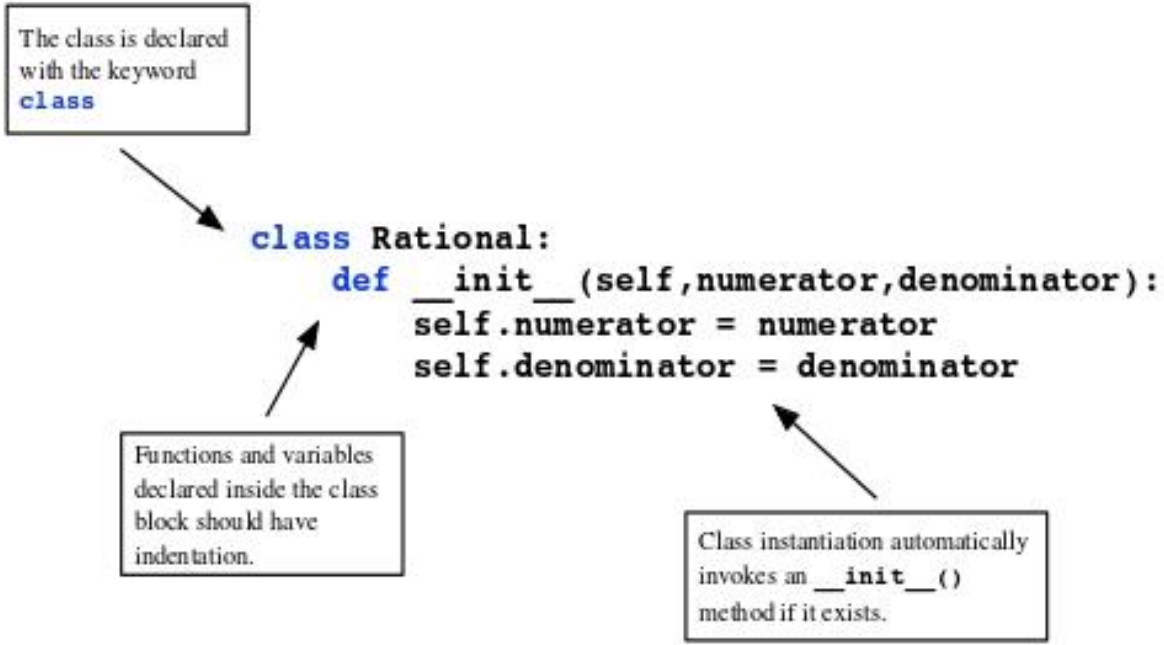
Functions


Function Name
Parameters
def add(num1, num2):
print("Number 1:", num1)
print("Number 2:", num1)
addition = num1 + num2
return addition
Return Value
Function Body
res = add(2, 4)
Function call
print(res)

Classes


Dog class
Properties:
Breed
Age
Methods:
Eat()
Sleep()
Object1
Object2
Object3
Breed: Bulldog
Age: 4
Breed: Chihuahua
Age: 2
Breed: Husky
Age:6

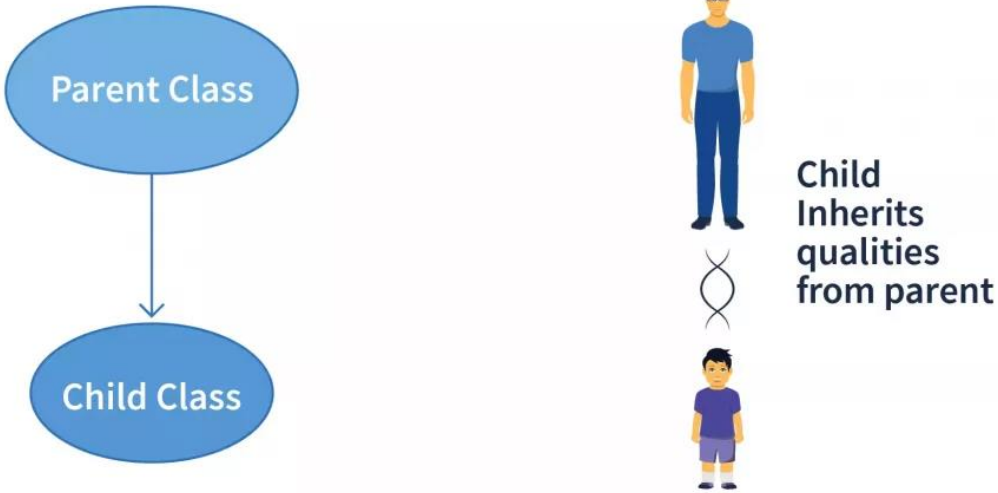
Classes


The class is declared with the keyword class
class Rational:
def __init__(self,numerator,denominator):
self.numerator = numerator
self.denominator = denominator
Functions and variables declared inside the class block should have indentation.
Class instantiation automatically invokes an __init__() method if it exists.

Classes

```python
class Books:
  def __init__(self, title, cost):
    self.title = title
    self.cost = cost
  def gettitle(self):
      print("Title of the book is: "+self.title)

python_book = Books("Learn and Practice Python Programming", 136)
print(python_book.title)
print(python_book.cost)
python_book.gettitle()
```

Inheritance



Inheritance

```
class ParentClass:

    def feature_1(self):
        print('feature_1 from ParentClass is running...')

    def feature_2(self):
        print('feature_2 from ParentClass is running...')


class ChildClass(ParentClass):

    def feature_3(self):
        print('feature_3 from ChildClass is running...')

obj = ChildClass()
obj.feature_1()
obj.feature_2()
obj.feature_3()
```

Define a class called Songs, it will show the lyrics of a song. Its `__init__()` method should have two arguments:`self`anf `lyrics`.`lyrics`is a list. Inside your class create a method called `sing_me_a_song`that prints each element of `lyrics`on his own line. Define a varible:

`happy_bday = Song(["May god bless you, ", "Have a sunshine on you,", "Happy Birthday to you !"])`

Call the `sing_me_song`mehod on this variable.

```
>>> class Song(object):
... def __init__(self, lyrics):
          self.lyrics=lyrics
... def sing_me_a_song(self):
          for line in self.lyrics:
              print line


happy_bday = Song(["May god bless you, ", ... "Have a sunshine on you,", ... "Happy Birthday to you !"])
print happy_bday.sing_me_a_song()
```

Python Modules

```
def add(a, b):
    return a + b

def sub(a, b):
    return a - b

def mul(a, b):
    return a * b

def div(a, b):
    return a / b
```

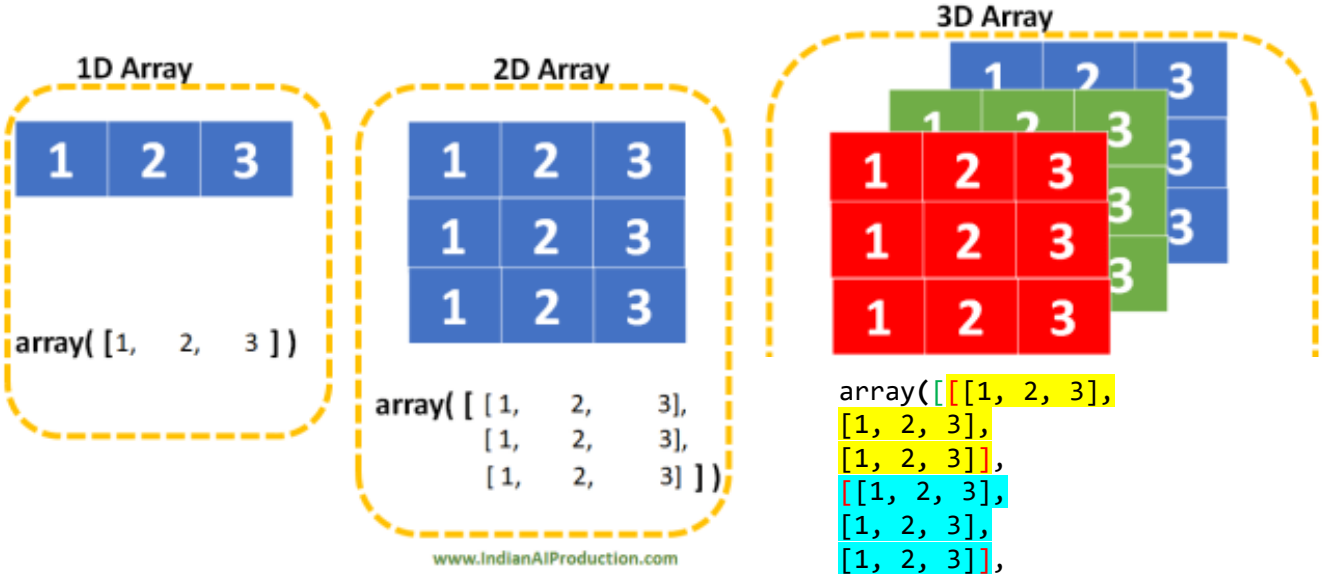
```
import Calci

print(Calci.add(10, 5))
print(Calci.sub(10, 5))
print(Calci.mul(10, 5))
print(Calci.div(10, 5))
```

NumPy Basics

NumPy Agenda

- NumPy Intro
- Creating Arrays
- NumPy Array Indexing
- NumPy Array Slicing
- NumPy Data Types
- NumPy Copy vs View
- NumPy Array Shape
- NumPy Array Reshape
- NumPy Array Filter

Creating NumPy Arrays



Creating NumPy Array

```
np.array([1,2,3])
```

1
2
3

```
np.arange(1, n+1)
```

n=5

1	2	3	4	5

```
np.ones(3)
```

1
1
1

```
np.zeros(3)
```

0
0
0

```
np.random.random(3)
```

0.5967
0.0606
0.2223

```
np.ones((3,2))
```

3

1	1
1	1
1	1

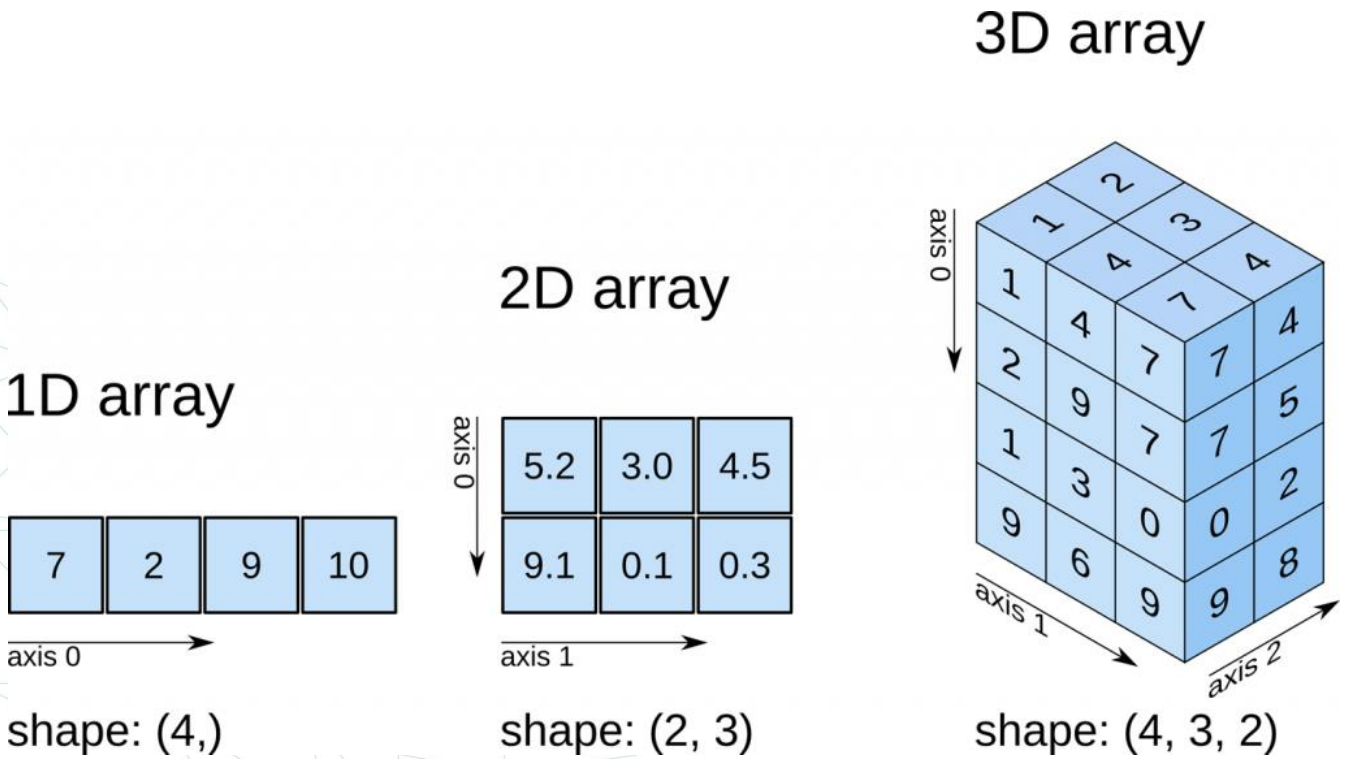
```
np.zeros((3,2))
```

0	0
0	0
0	0

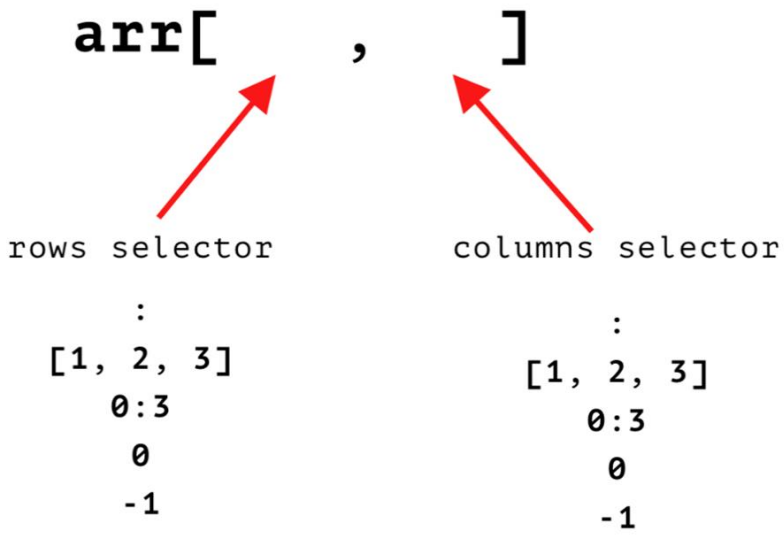
```
np.random.random((3,2))
```

0.37	0.88
0.75	0.79
0.63	0.16

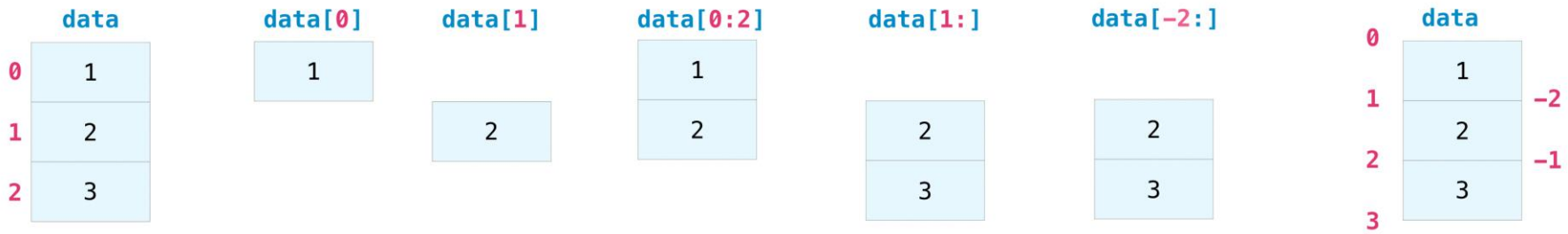
NumPy Arrays Shape



NumPy Array Indexing



NumPy Array Indexing



NumPy Array Indexing

```
np.array([[1,2],[3,4],[5,6]])
```

1	2
3	4
5	6

data

	0	1
0	1	2
1	3	4
2	5	6

data[0,1]

	0	1
0	1	2
1	3	4
2	5	6

data[1:3]

	0	1
0	1	2
1	3	4
2	5	6

data[0:2,0]

	0	1
0	1	2
1	3	4
2	5	6

Basic array operations

```
data = np.array([1,2])
```

data

1
2

```
ones = np.ones(2)
```

ones

1
1

data + ones =

data

1
2

+

ones

1
1

=

2
3

data

1
2

-

ones

1
1

=

0
1

data

1
2

*

data

1
2

=

1
4

data

1
2

/

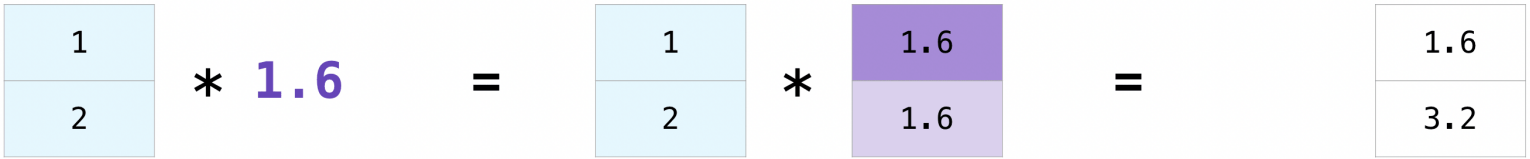
data

1
2

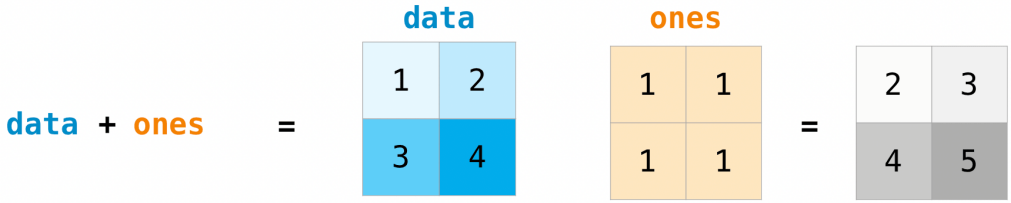
=

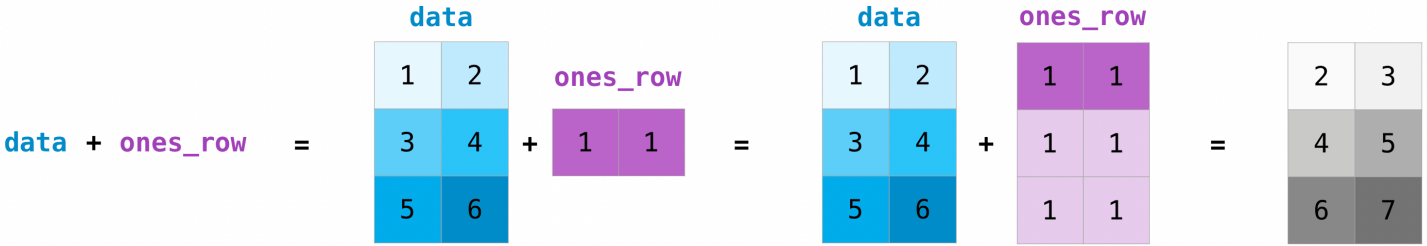
1
1

Broadcasting

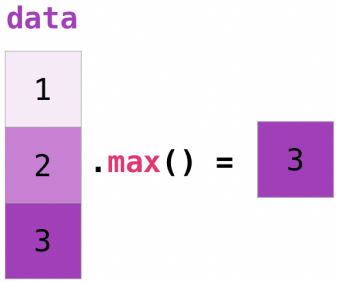


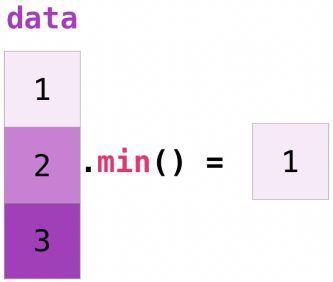
Basic array operations

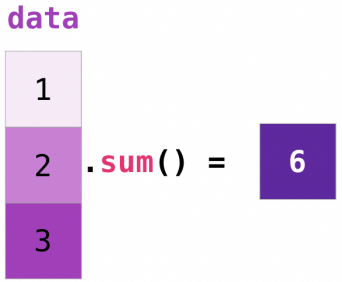


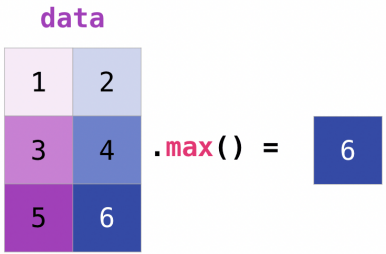


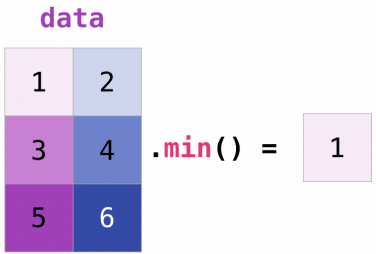
More useful array operations

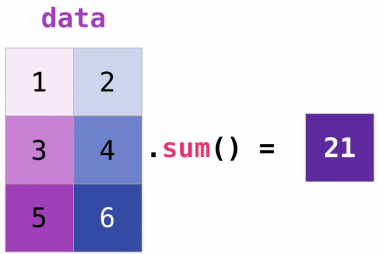




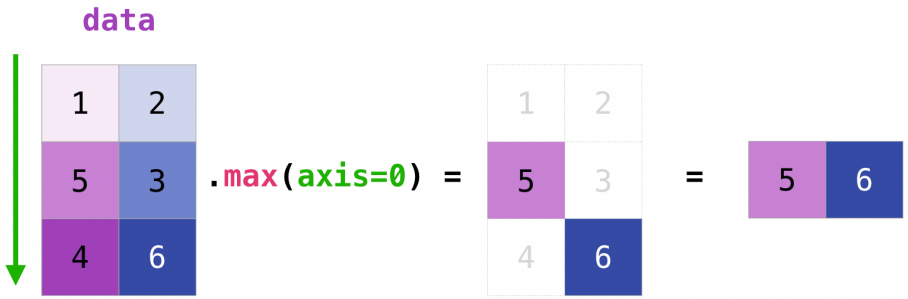


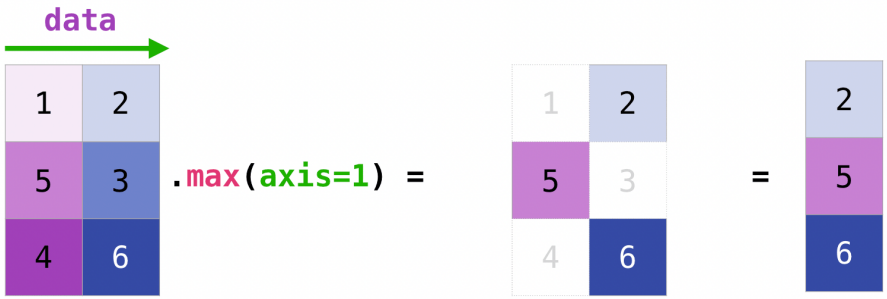






More useful array operations

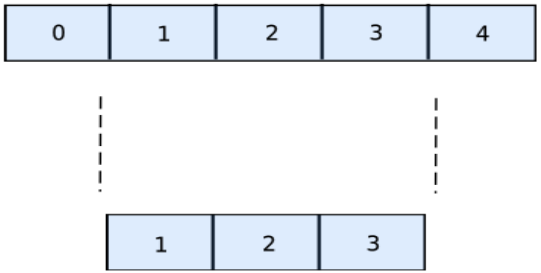




NumPy Copy vs View

View

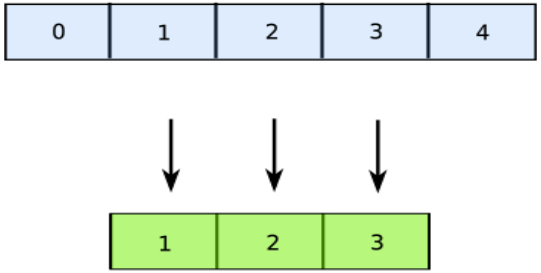
arr[1:4]



Merely offset is changed

Copy

arr[[1,2,3]]



Elements are copied and a new object is created

NumPy Array Reshape

data

1
2
3
4
5
6

data.reshape(2,3)

1	2	3
4	5	6

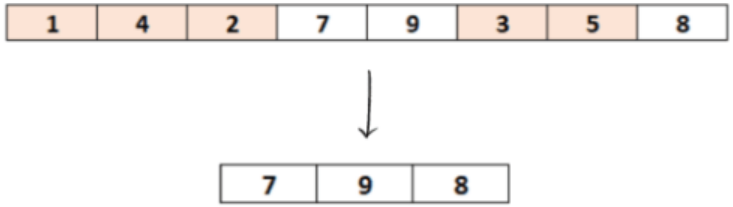
2 (rows) × 3 (columns)

data.reshape(3,2)

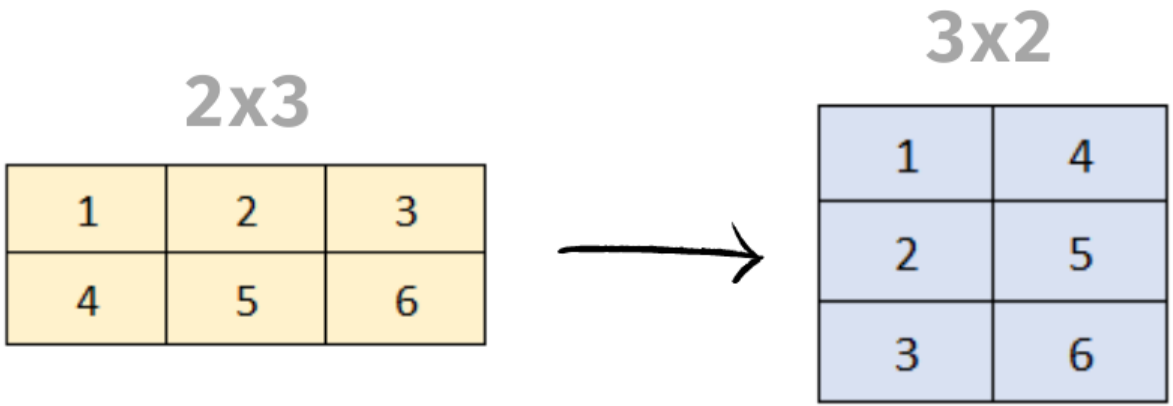
1	2
3	4
5	6

3 (rows) × 2 (columns)

NumPy Filter Array

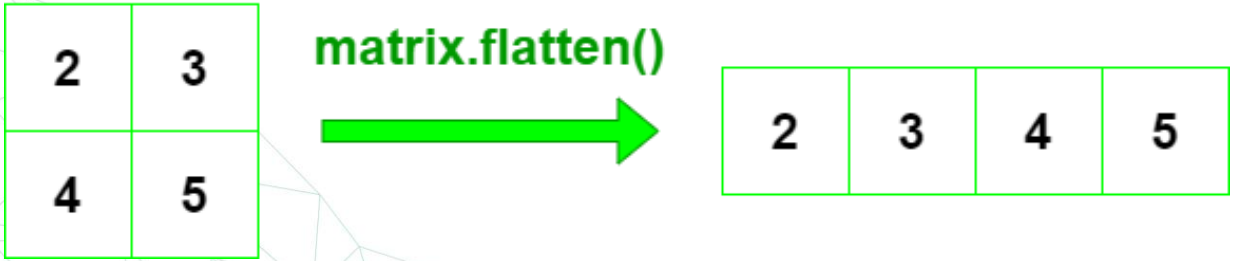


NumPy Arrays Transpose

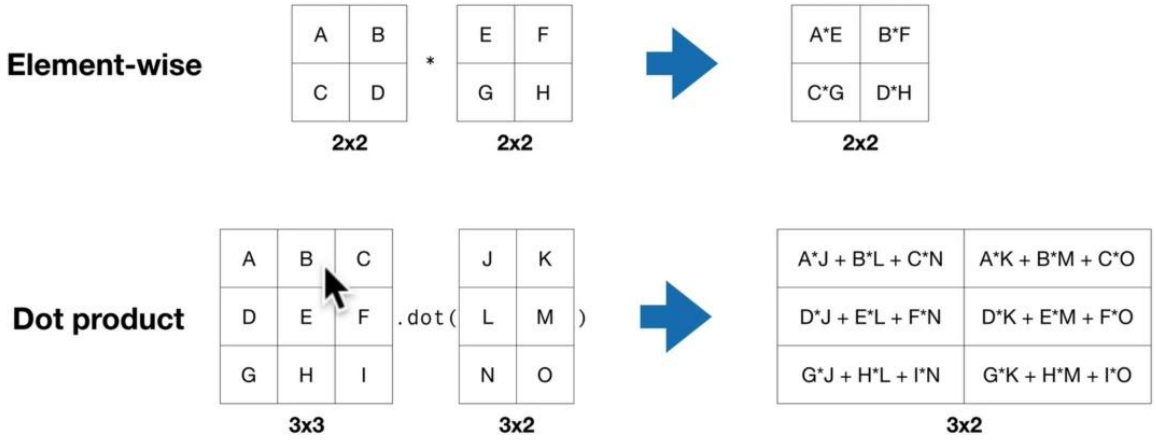


Transpose array

flattening multidimensional arrays



Dot product vs. element-wise



Numpy Functions

- np.sqrt()
- np.max()
- np.log()
- np.sin()
- np.mean()
- np.square()
- np.sum()
- np.sort()
- np.quantile()
- np.percentile
- np.cov
- `np.linalg.norm`

Working with mathematical formulas

$$MeanSquareError = \frac{1}{n}\sum_{i=1}^{n}(Y\_prediction_i - Y_i)^2$$

Working with mathematical formulas

$$MeanSquareError = \frac{1}{n}\sum_{i=1}^{n}(Y\_prediction_i - Y_i)^2$$

```
error = (1/n) * np.sum(np.square(predictions - labels))
```

predictions

1
1
1

labels

1
2
3

```
error = (1/3) * np.sum(np.square(        -        ))
```

Working with mathematical formulas

```
error = (1/3) * np.sum(np.square(
```

0
-1
-2

```
))
```

```
error = (1/3) * np.sum(
```

0
1
4

```
)
```

```
error = (1/3) * 5
```

Calculate Cosine Similarity

```
# import required libraries
import numpy as np
from numpy.linalg import norm

# define two lists or array
A = np.array([2,1,2,3,2,9])
B = np.array([3,4,2,4,5,5])

# compute cosine similarity
cosine = np.dot(A,B)/(norm(A)*norm(B))
print("Cosine Similarity:", cosine)
```

```
from sklearn.metrics.pairwise import cosine_similarity
import numpy as np


array_vec_1 = np.array([[12,41,60,11,21]]) array_vec_2
= np.array([[40,11,04,11,14]])


cosine_similarity(array_vec_1 , array_vec_2)
```

Write a NumPy program to find a matrix or vector norm.

```
import numpy as np
v = np.arange(7)
result = np.linalg.norm(v)
print("Vector norm:")
print(result)
m = np.matrix('1, 2; 3, 4')
result1 = np.linalg.norm(m)
print("Matrix norm:") print(result1)
```

Write a NumPy program to compute the multiplication of two given matrixes.

```
import numpy as np
p = [[1, 0], [0, 1]]
q = [[1, 2], [3, 4]]
print("original matrix:")
print(p)
print(q)
result1 = np.dot(p, q)
print("Result of the said matrix multiplication:")
print(result1)
```

Write a NumPy program to compute the 80th percentile for all elements in a given array

Write a NumPy program to compute IQR for all elements in a given array

Compute the mean, standard deviation, and variance of a given array

Compute the covariance matrix of two given arrays

Q&A

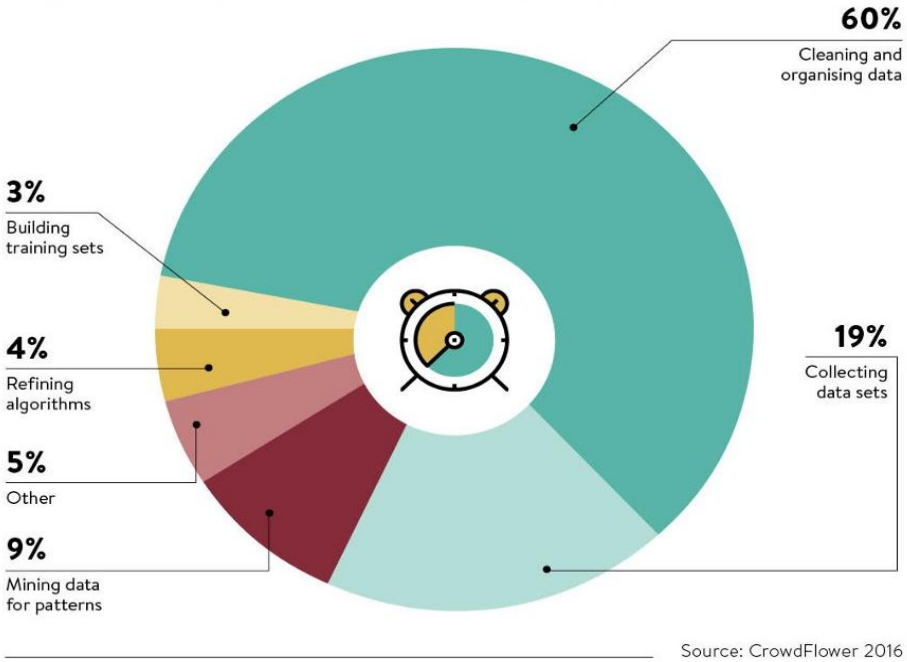
Questions and answers

Data Quality

The future belongs to those who can control their data

Quality =

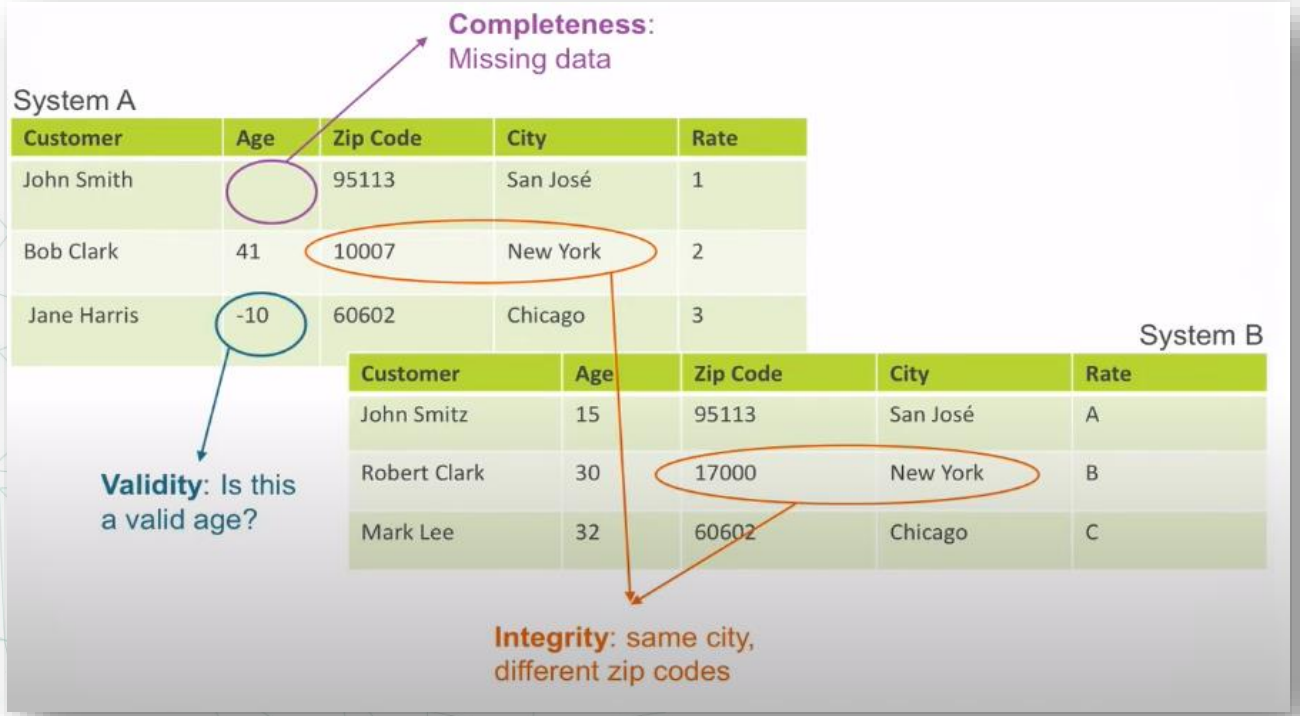
Data Quality



Data Quality

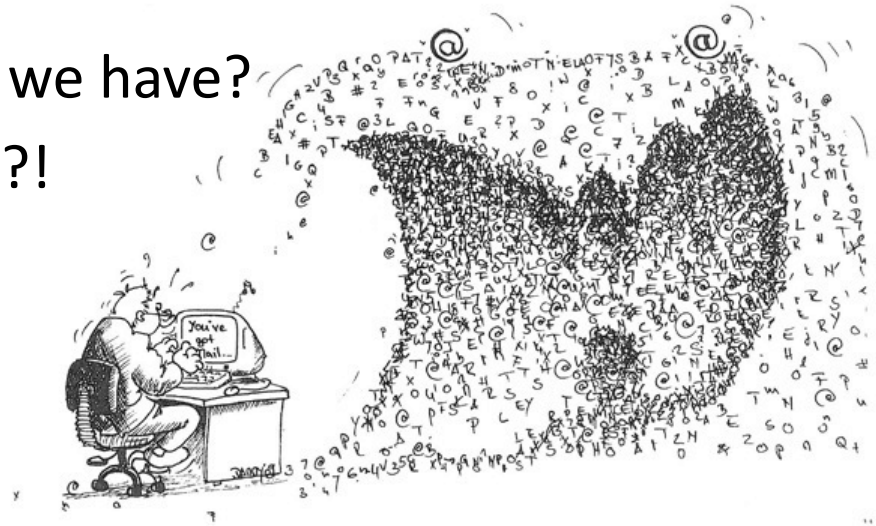
Data Quality

Data Quality



Dealing with Missing Values

- Take a first look at the data.
- How many missing data points do we have?
- Figure out why the data is missing?!



Strategies To Handle Missing Values

PassengerId	Survived	Pclass	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarked
1	0	3	male	22	1	0	A/5 21171	7.25		S
2	1	1	female	38	1	0	PC 17599	71.2833	C85	C
3	1	3	female	26	0	0	STON/O2. 3101282	7.925		S
4	1	1	female	35	1	0	113803	53.1	C123	S
5	0	3	male	35	0	0	373450	8.05		S
6	0	3	male		0	0	330877	8.4583		Q

Strategies To Handle Missing Values

- Remove observation/records that have missing values.
- Imputation.

Deleting Columns & Rows with Missing Values

- Here, we either delete a particular row if it has a null value for a particular feature and a particular column if it has more than 70-75% of missing values.
- This method is advised only when there are enough samples in the data set.
- Removing the data will lead to loss of information which will not give the expected results while predicting the output.

Handling Continuous variables

- This strategy can be applied on a feature which has numeric data like the age of a person.
- We can calculate the **mean**, **median** or **mode** of the feature and replace it with the missing values.
- This is an approximation which can add variance to the data set.
- But the loss of the data can be negated by this method which yields better results compared to removal of rows and columns.

Handling categorical variables

- A categorical feature will have a definite number of possibilities, such as gender, for example.
- Since they have a definite number of classes, we can assign another class for the missing values.

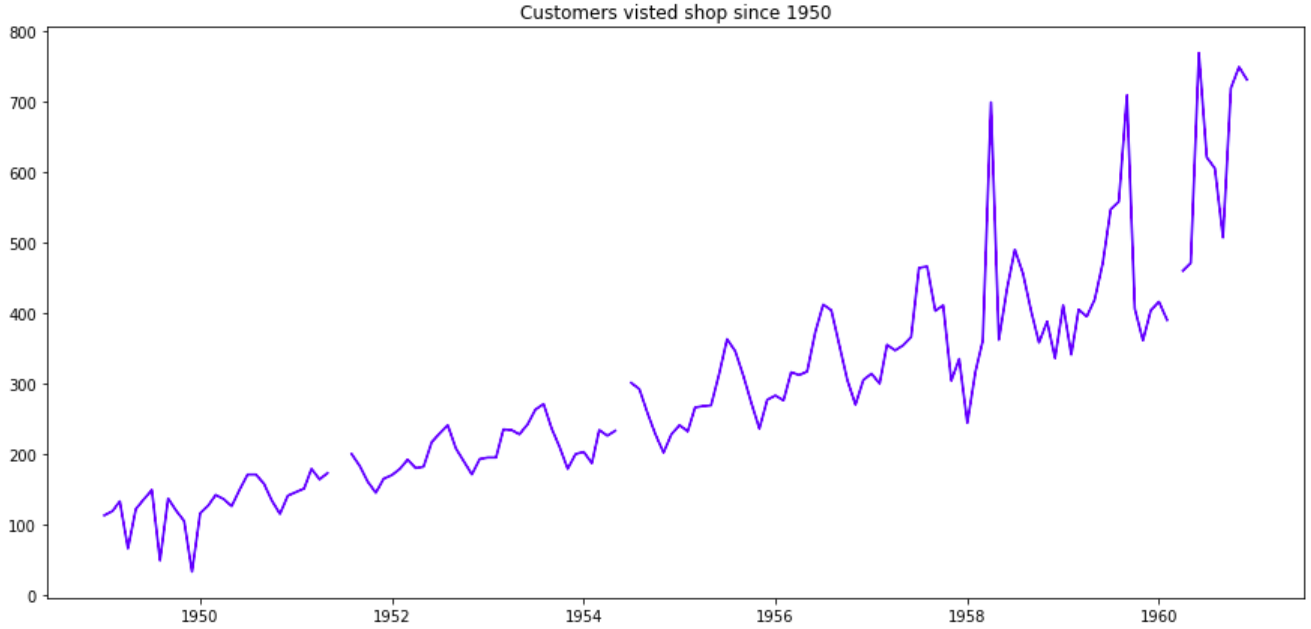
Predicting The Missing Values

- Using the features which do not have missing values, we can predict the nulls with the help of a machine learning algorithm.
- This method may result in better accuracy, unless a missing value is expected to have a very high variance.
  - Example: linear regression to replace the nulls in the feature ‘age’, using other available features.

Using Algorithms Which Support Missing Values

- KNN is a machine learning algorithm which works on the principle of distance measure.
- This algorithm can be used when there are nulls present in the dataset.
- While the algorithm is applied, KNN considers the missing values by taking the majority of the K nearest values.
- In this particular dataset, taking into account the person's age, sex, class etc, we will assume that people having same data for the above mentioned features will have the same kind of fare.
- Another algorithm which can be used here is RandomForest.
- This model produces a robust result because it works well on non-linear and the categorical data.

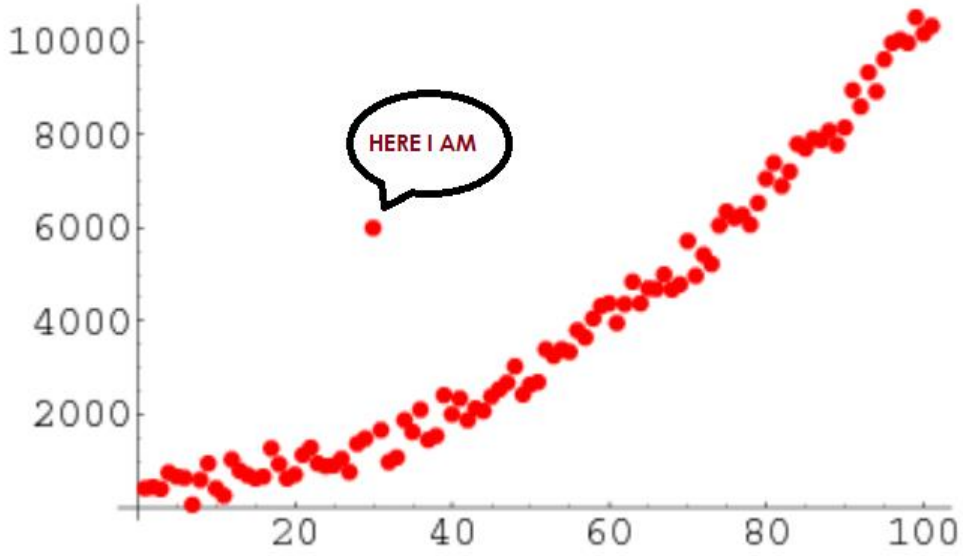
Time Series Imputations

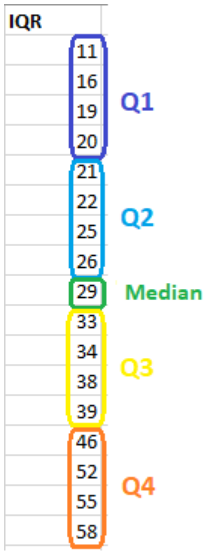


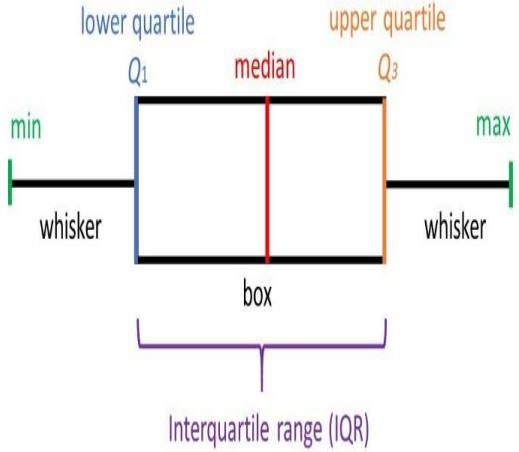
Interpolation is the process of estimating and inserting missing values in time series data.

Outliers

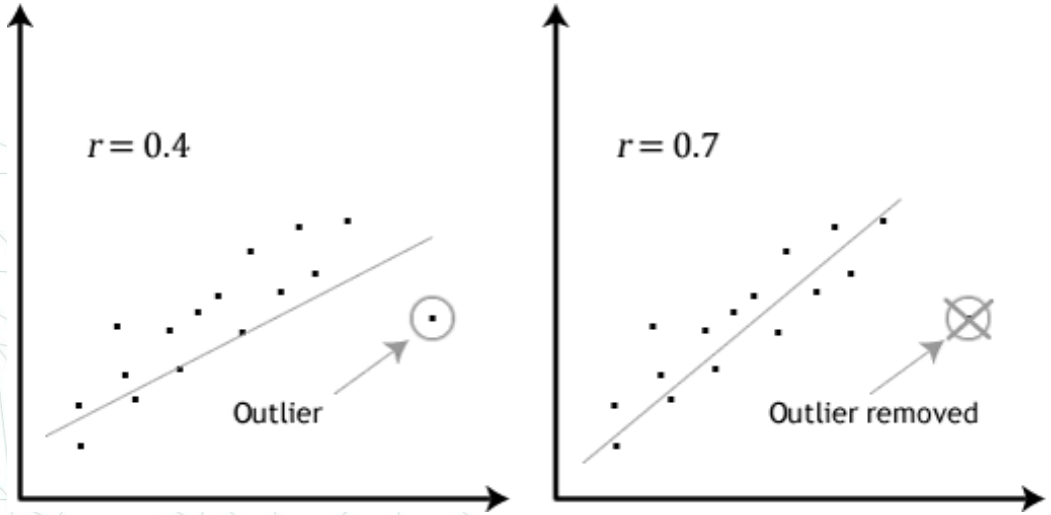
- An **outlier** is an observation that lies an abnormal distance from other values in a random sample from a population.





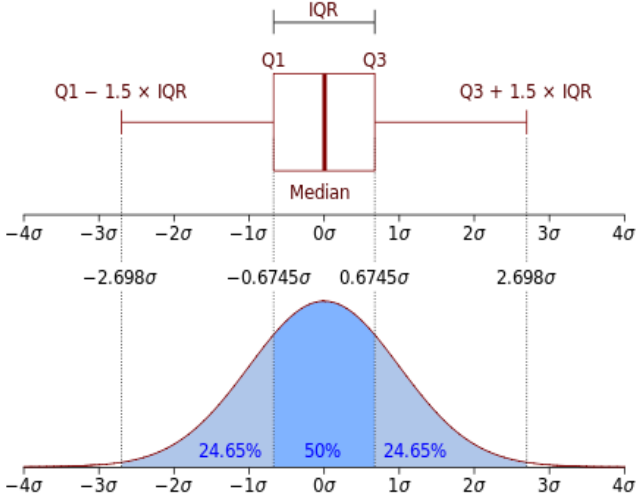


Impact Of Outliers On Linear Regression



How To Identify Outliers?

- Box Plot
- Histogram
- Scatter Plot
- Interquartile Range (IQR) based metho
- Standard Deviation based method



Exercise

Find Q_1 , Q_2 , and Q_3 for the following data set. Identify any outliers, and draw a box-and-whisker plot.

$$\{5, 40, 42, 46, 48, 49, 50, 50, 52, 53, 55, 56, 58, 75, 102\}$$

There are 15 values, arranged in increasing order. So, Q_2 is the 8^{th} data point, 50 .

Q_1 is the 4^{th} data point, 46 , and Q_3 is the 12^{th} data point, 56 .

The interquartile range IQR is $Q_3 - Q_1$ or $56 - 47 = 10$.

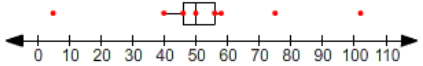
Now we need to find whether there are values less than $Q_1 - (1.5 \times \text{IQR})$ or greater than $Q_3 + (1.5 \times \text{IQR})$.

$$Q_1 - (1.5 \times \text{IQR}) = 46 - 15 = 31$$

$$Q_3 + (1.5 \times \text{IQR}) = 56 + 15 = 71$$

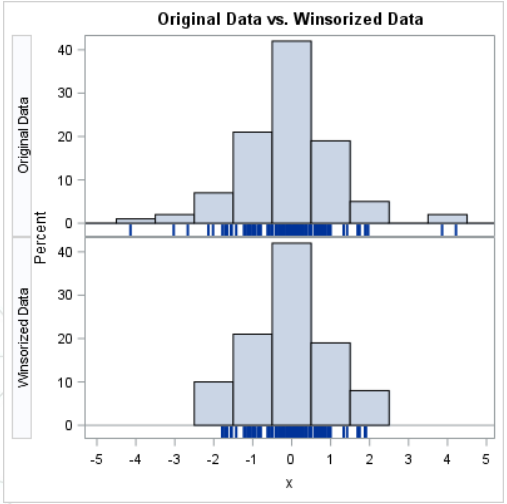
Since 5 is less than 31 and 75 and 102 are greater than 71 , there are 3 outliers.

The box-and-whisker plot is as shown. Note that 40 and 58 are shown as the ends of the whiskers, with the outliers plotted separately.



How To Handle The Outliers?

- Doing nothing
- Deleting/Trimming
- Winsorizing (replace the extreme values with a certain percentile value)
- Transformation
- Binning
- Use robust estimators
- Imputing



- List of Machine Learning algorithms which are sensitive to outliers: 1- Linear Regression 2- Logistic Regression 3- Support Vector Machine 4- K- Nearest Neighbors 5- K-Means Clustering 6- Hierarchical Clustering 7- Principal Component Analysis 8- AdaBoost
- List of Machine Learning algorithms which are **not** sensitive to outliers: 1- Decision Tree 2- Random Forest 3- XGBoost 4- Naive Bayes 5- DBSCAN 6- NN

Pandas Agenda

Basic

- Introduction
- Getting Started
- Pandas Series
- DataFrames
- Read CSV
- Read JSON
- Analyze Data

Cleaning Data

- Clean Data
- Clean Empty Cells
- Clean Wrong Format
- Clean Wrong Data
- Remove Duplicates

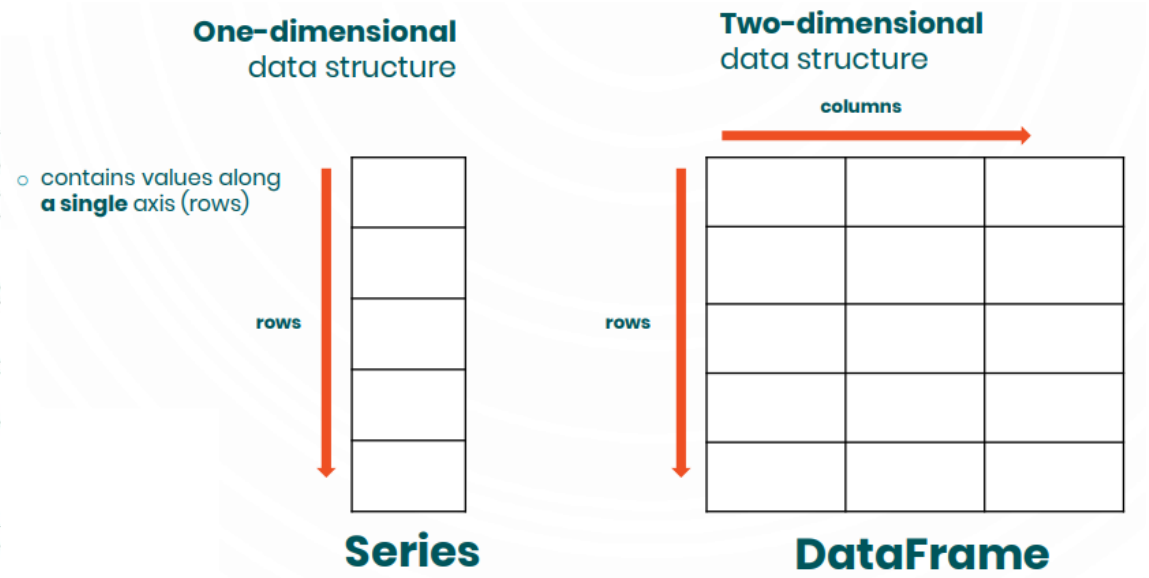
Advanced

- Correlations
- Plotting

Pandas

- Pandas is an open source library built on top of NumPy
- It allows for fast analysis and data cleaning and preparation
- It excels in performance and productivity.
- It also has built-in visualization features.
- It can work with data from a wide variety of sources.

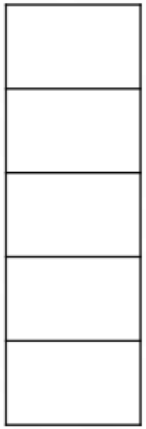
Pandas Data Structure



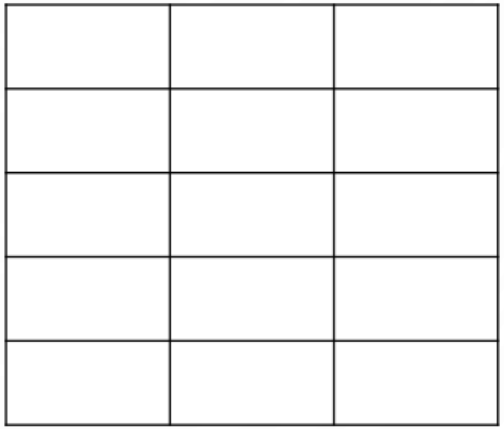
Pandas Data Structure

Single column data

- corresponds to a **single variable**
- information of a **single type**



Series

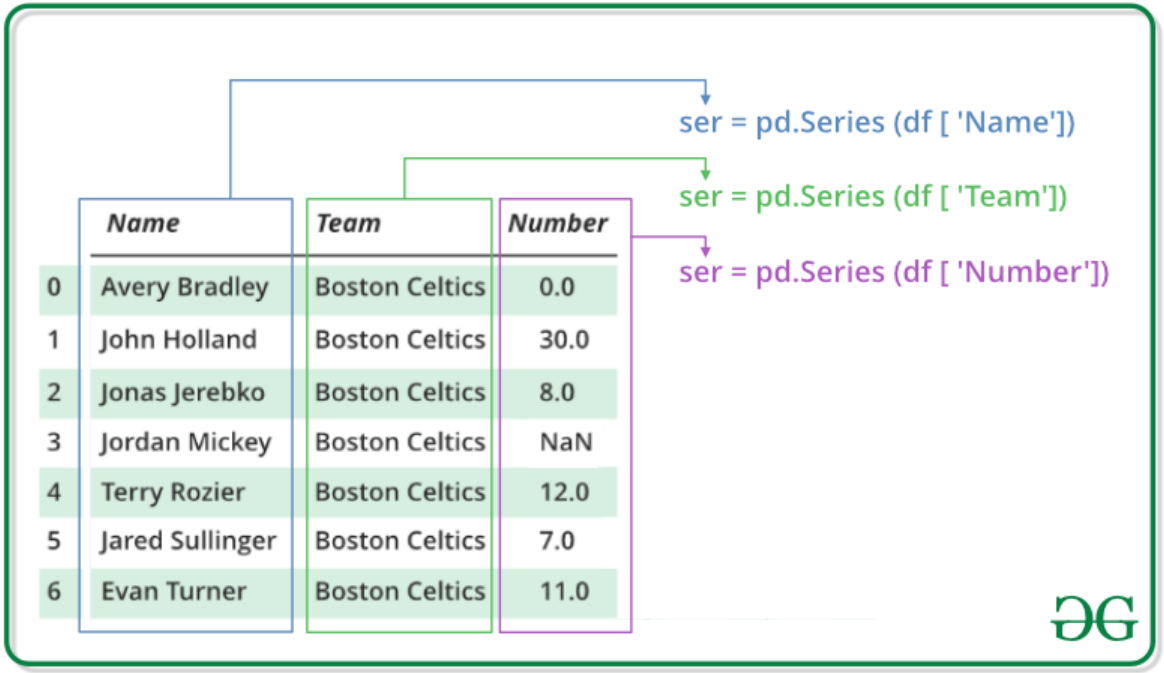


DataFrame

Multi-column data

- each column represents a **different** variable
- every column contains data of **its own type**
- the information can potentially **be heterogeneous**

Pandas Data Structure



	Name	Team	Number
0	Avery Bradley	Boston Celtics	0.0
1	John Holland	Boston Celtics	30.0
2	Jonas Jerebko	Boston Celtics	8.0
3	Jordan Mickey	Boston Celtics	NaN
4	Terry Rozier	Boston Celtics	12.0
5	Jared Sullinger	Boston Celtics	7.0
6	Evan Turner	Boston Celtics	11.0

Creating a Series

pd.Series(data=None, index=None)

```
# simple list
lst = ['G','E','E','K','S','F','O','R','G','E','E','K','S']


# forming series
s = pd.Series(lst)
```

```
# simple dict
dct = {'G':2,'E':4,'K':2,'S':2,'F':1,'O':1,'R':1}


# forming series
s = pd.Series(dct)
```

```
# numpy array
arr = np.array(['G','E','E','K','S','F','O','R','G','E','E','K','S'])


# forming series
s = pd.Series(arr)
```

Indexing & Slicing A Series

Series1

A	1
B	2
C	3
D	4

```
series1['A']

series1[0]

series1[0:3]

series1[0:5:2]

series1['A':'C']
```

Arithmetic Operation

A	1
B	2
C	3
D	4

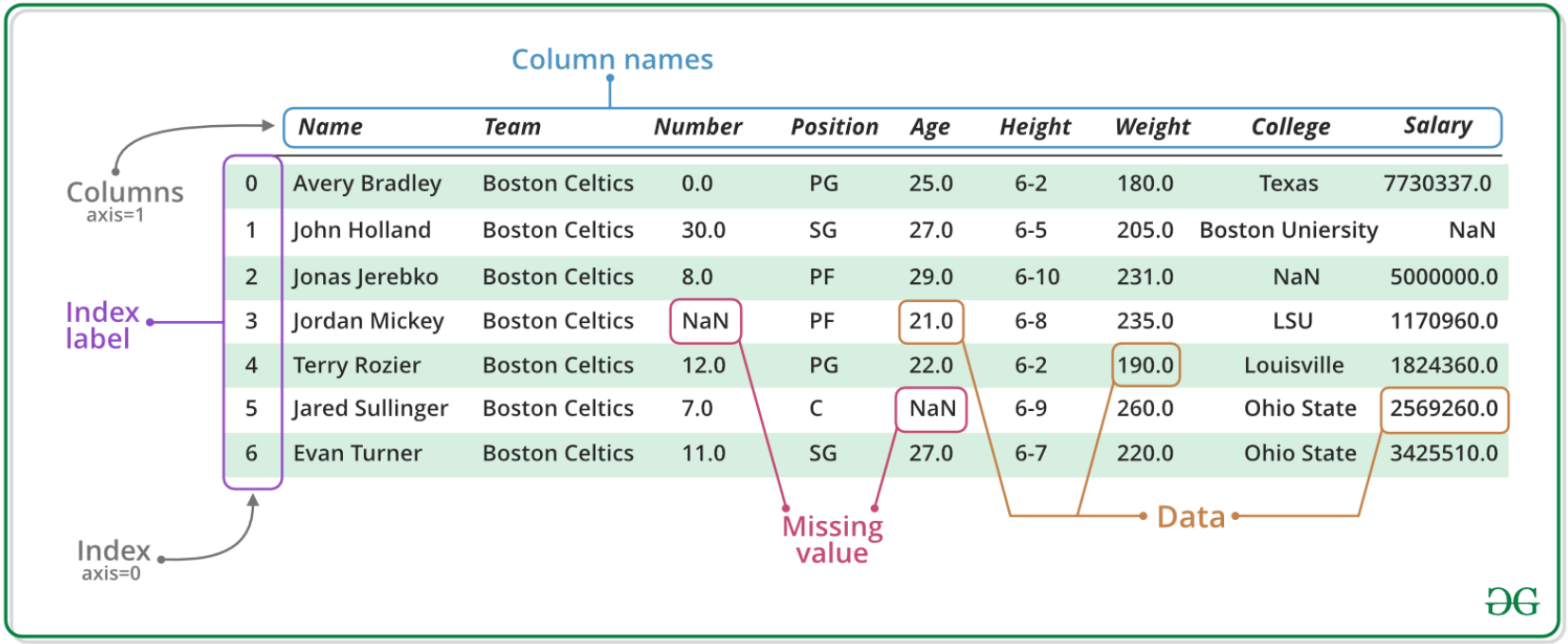
+

A	1
C	2
E	3
F	4

=

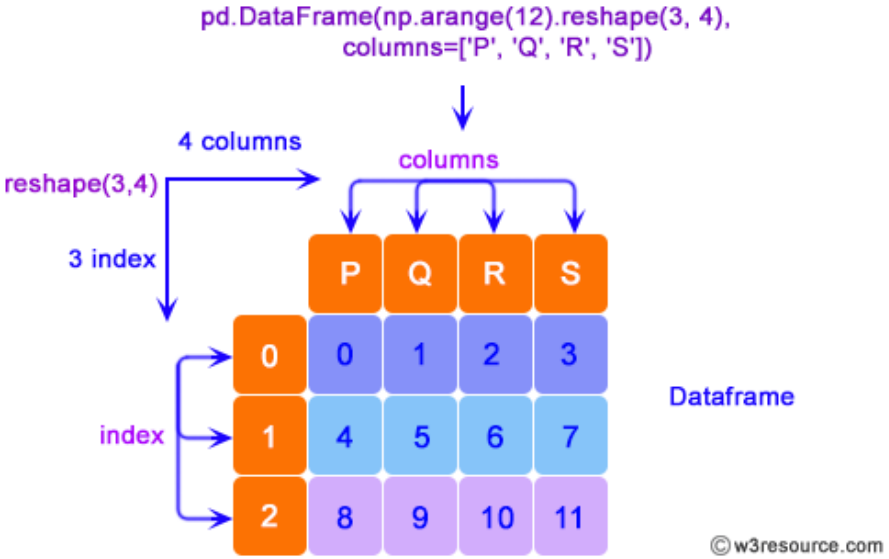
A	2
B	NaN
C	5
D	NaN
E	NaN
F	NaN

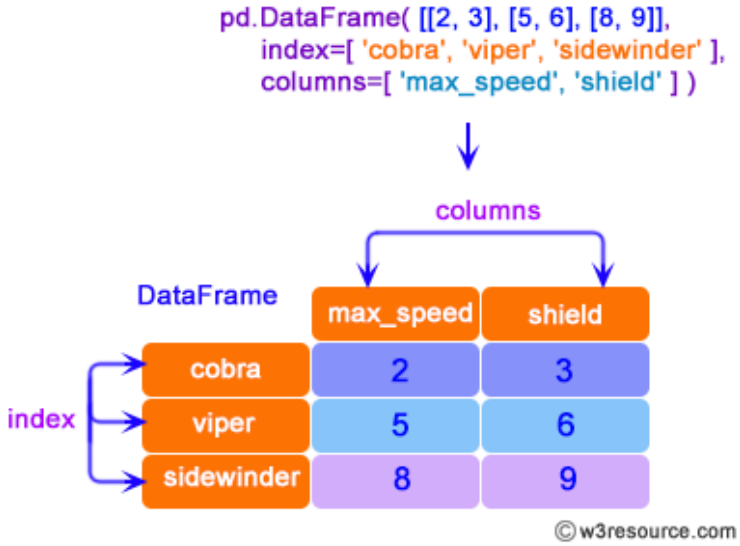
Pandas Data Structure



	Name	Team	Number	Position	Age	Height	Weight	College	Salary
0	Avery Bradley	Boston Celtics	0.0	PG	25.0	6-2	180.0	Texas	7730337.0
1	John Holland	Boston Celtics	30.0	SG	27.0	6-5	205.0	Boston Uniersity	NaN
2	Jonas Jerebko	Boston Celtics	8.0	PF	29.0	6-10	231.0	NaN	5000000.0
3	Jordan Mickey	Boston Celtics	NaN	PF	21.0	6-8	235.0	LSU	1170960.0
4	Terry Rozier	Boston Celtics	12.0	PG	22.0	6-2	190.0	Louisville	1824360.0
5	Jared Sullinger	Boston Celtics	7.0	C	NaN	6-9	260.0	Ohio State	2569260.0
6	Evan Turner	Boston Celtics	11.0	SG	27.0	6-7	220.0	Ohio State	3425510.0

Creating a DataFrame



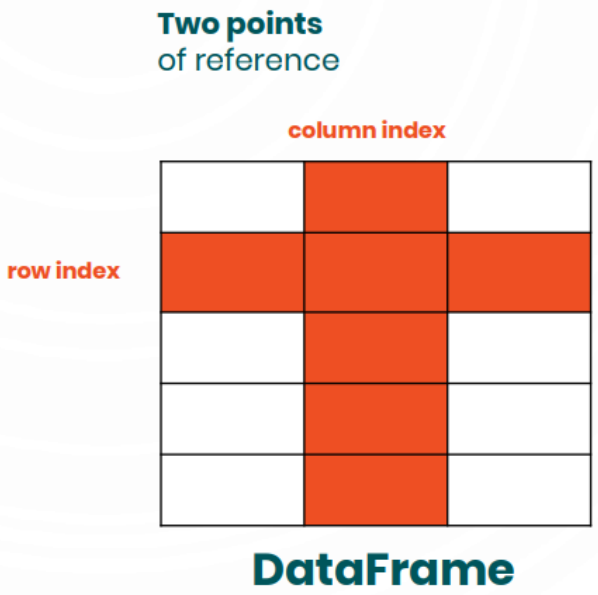


Creating a DataFrame

```
# Named Index
fruit = {
    'oranges' : [3,2,0,1],
    'apples' : [0,3,7,2],
    'grapes' : [5,6,9,0],
    'pear'   : [1,23,45,1]
}
df = pd.DataFrame(fruit ,index = ['June','July','August','September'])
df
```

	oranges	apples	grapes	pear
June	3	0	5	1
July	2	3	6	23
August	0	7	9	45
September	1	2	0	1

Indexing & Slicing Data frame



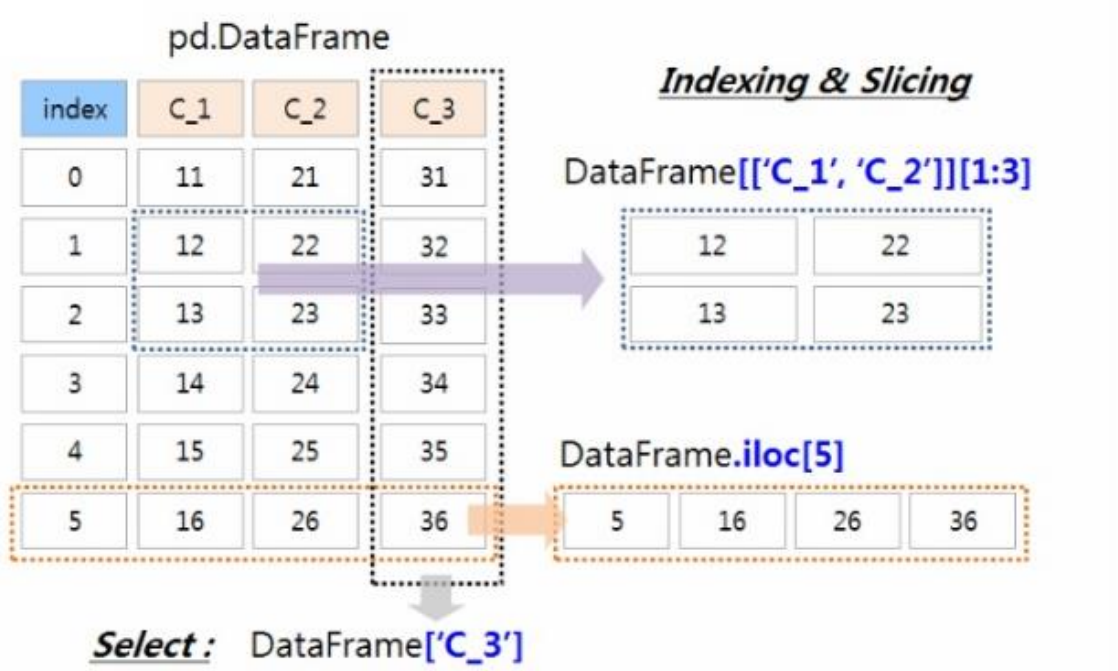
loc Vs. iloc


df.loc[START:STOP:STEP , START:STOP:STEP]
Select Rows by Names/Labels
Select Columns by Names/Labels
df.iloc[START:STOP:STEP , START:STOP:STEP]
Select Rows by Indexing Position
Select Columns by Indexing Position

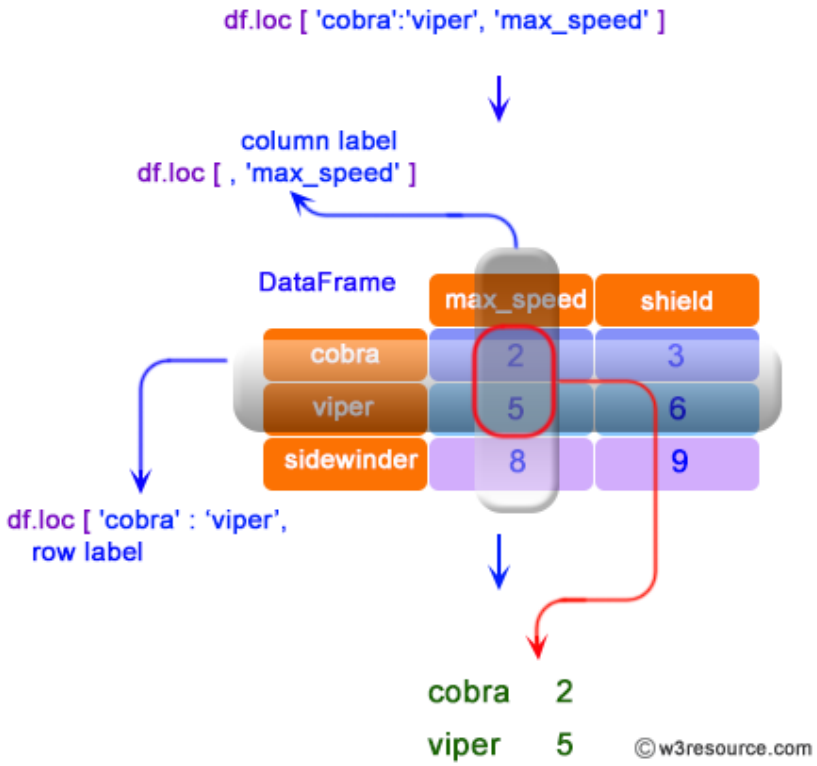
loc Vs. iloc

	loc[] - By Label	iloc[] - By Index
Select Single Row	df.loc['r2']	df.iloc[1]
Select Single Column	df.loc[:, "Courses"]	df.iloc[:, 0]
Select Multiple Rows	df.loc[['r2','r3']]	df.iloc[[1,2]]
Select Multiple Columns	df.loc[:, ["Courses","Fee"]]	df.iloc[:, [0,1]]
Select Rows Range	df.loc['r1':'r4']	df.iloc[0:4]
Select Columns Range	df.loc[:,'Fee':'Discount']	df.iloc[:,1:4]
Select Alternate Rows	df.loc['r1':'r4':1]	df.iloc[0:4:1]
Select Alternate Columns	df.loc[:,'Fee':'Discount':1]	df.iloc[:,1:4:1]

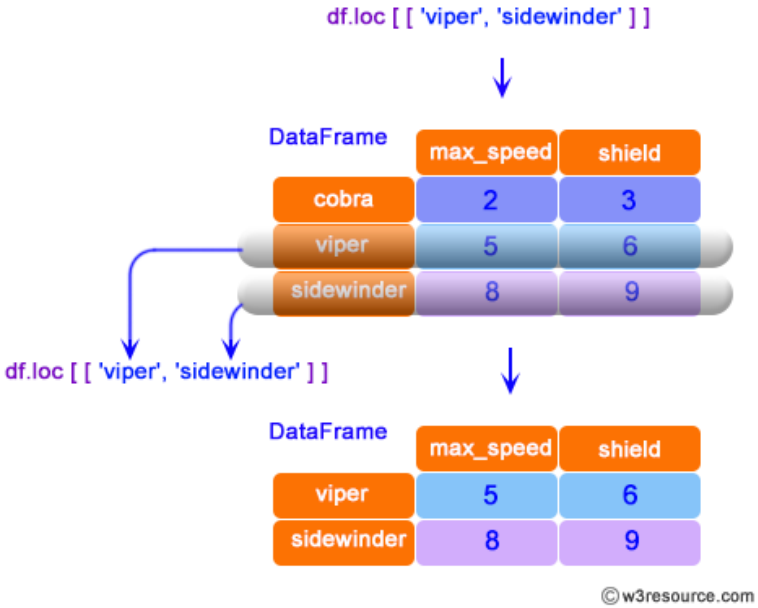
Indexing and slicing

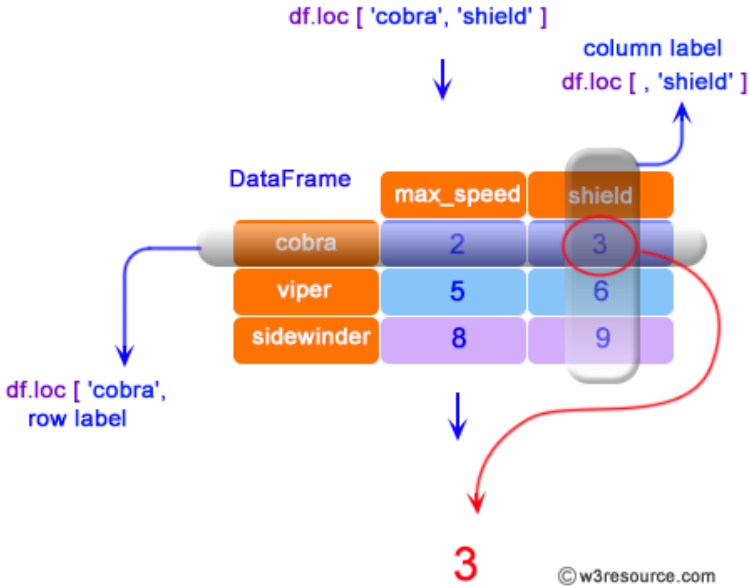


loc Vs. iloc

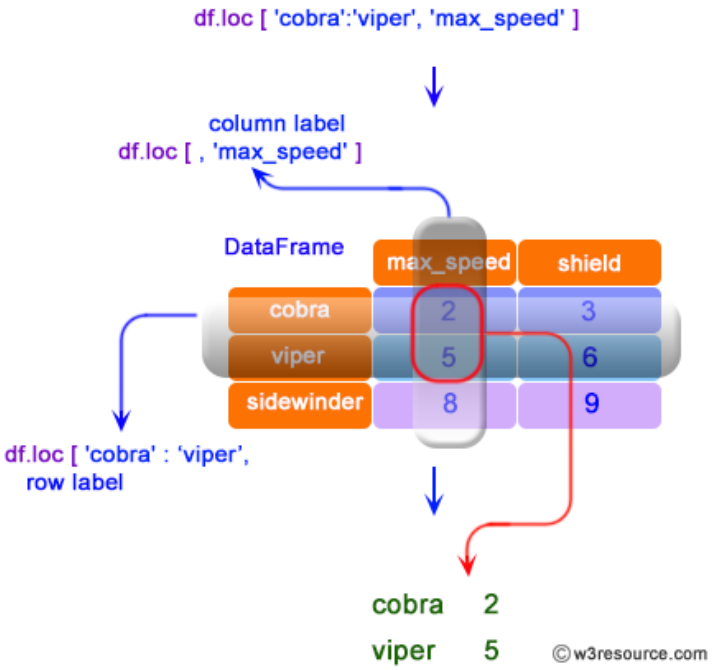

df.loc ['cobra':'viper', 'max_speed']
column label
df.loc [, 'max_speed']
DataFrame
max_speed
shield
cobra
2
3
viper
5
6
sidewinder
8
9
df.loc ['cobra' : 'viper',
row label
cobra 2
viper 5
©w3resource.com

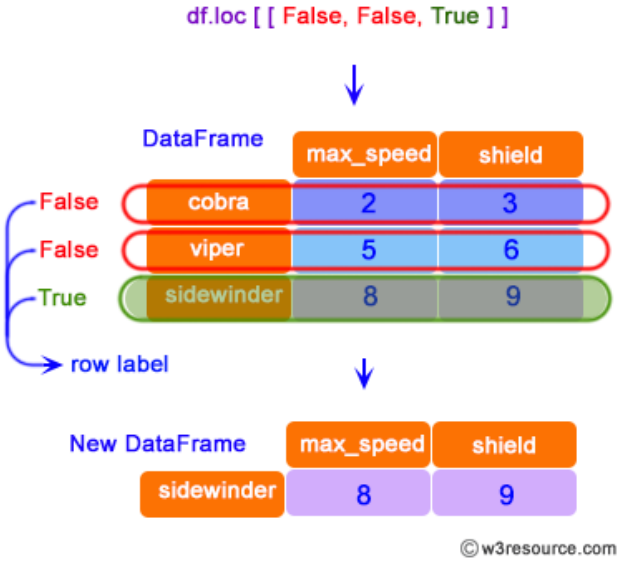
loc Vs. iloc


df.loc [['viper', 'sidewinder']]
DataFrame
max_speed
shield
cobra
2
3
viper
5
6
sidewinder
8
9
df.loc [['viper', 'sidewinder']]
DataFrame
max_speed
shield
viper
5
6
sidewinder
8
9
©w3resource.com

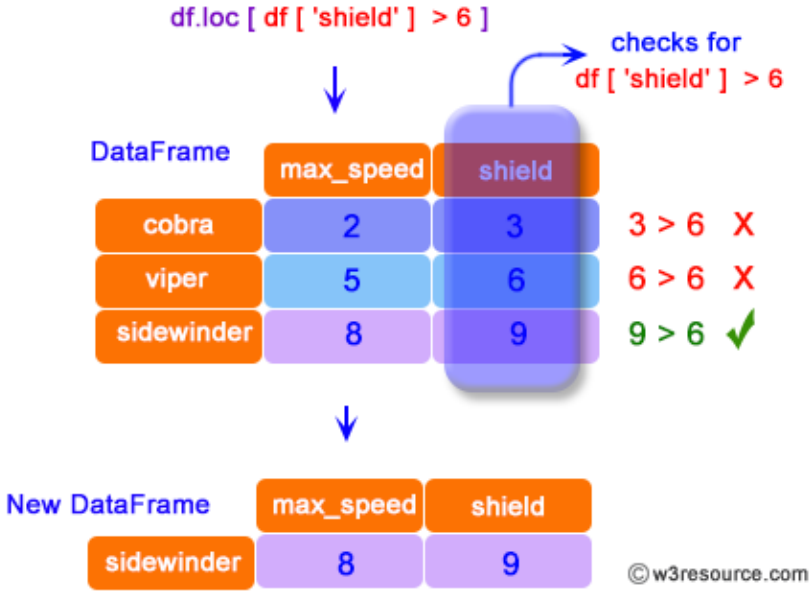

df.loc ['cobra', 'shield']
column label
df.loc [, 'shield']
DataFrame
max_speed
shield
cobra
2
3
viper
5
6
sidewinder
8
9
df.loc ['cobra',
row label
3
©w3resource.com

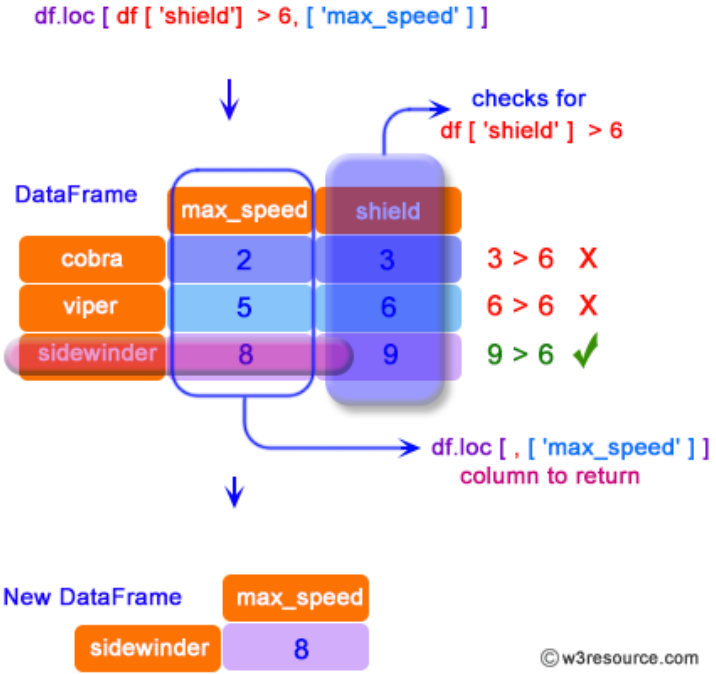
loc Vs. iloc


df.loc ['cobra':'viper', 'max_speed']
column label
df.loc [, 'max_speed']
DataFrame
max_speed
shield
cobra
2
3
viper
5
6
sidewinder
8
9
df.loc ['cobra' : 'viper',
row label
cobra 2
viper 5
©w3resource.com

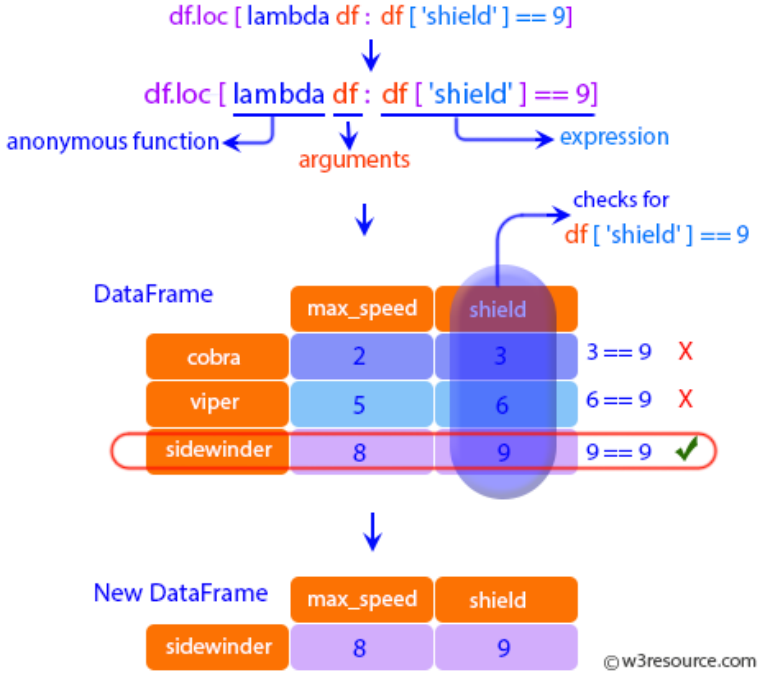

df.loc [[False, False, True]]
DataFrame
max_speed
shield
False
cobra
2
3
False
viper
5
6
True
sidewinder
8
9
row label
New DataFrame
max_speed
shield
sidewinder
8
9
©w3resource.com

loc Vs. iloc


df.loc [df ['shield'] > 6]
checks for
df ['shield'] > 6
DataFrame
max_speed
shield
cobra
2
3
3 > 6 X
viper
5
6
6 > 6 X
sidewinder
8
9
9 > 6
New DataFrame
max_speed
shield
sidewinder
8
9
©w3resource.com


df.loc [df ['shield'] > 6, ['max_speed']]
checks for
df ['shield'] > 6
DataFrame
max_speed
shield
cobra
2
3
3 > 6 X
viper
5
6
6 > 6 X
sidewinder
8
9
9 > 6
df.loc [, ['max_speed']]
column to return
New DataFrame
max_speed
sidewinder
8
©w3resource.com

loc Vs. iloc


df.loc [lambda df : df ['shield'] == 9]
df.loc [lambda df : df ['shield'] == 9]
anonymous function
arguments
expression
checks for
df ['shield'] == 9
DataFrame
max_speed
shield
cobra
2
3
3 == 9 X
viper
5
6
6 == 9 X
sidewinder
8
9
9 == 9
New DataFrame
max_speed
shield
sidewinder
8
9
©w3resource.com

Filter

```
# filter Rows Based on condition
df[df["Courses"] == 'Spark']
df.loc[df['Courses'] == value]
df.query("Courses == 'Spark'")
df.loc[df['Courses'] != 'Spark']
df.loc[df['Courses'].isin(values)]
df.loc[~df['Courses'].isin(values)]
```

Filter

```
# filter Multiple Conditions using Multiple Columns
df.loc[(df['Discount'] >= 1000) & (df['Discount'] <= 2000)]
df.loc[(df['Discount'] >= 1200) & (df['Fee'] >= 23000 )]
```

DON'T

df **and** df2

df **or** df2

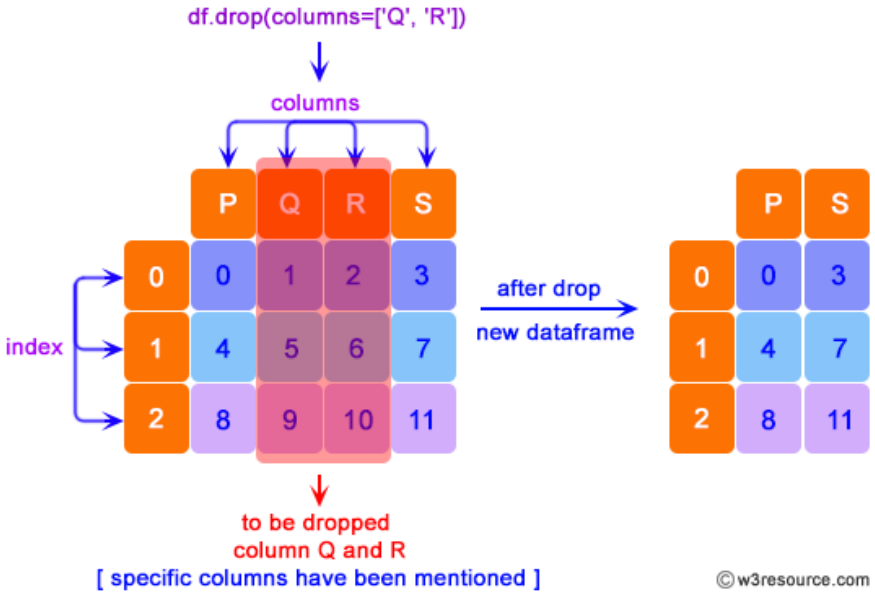
Filter

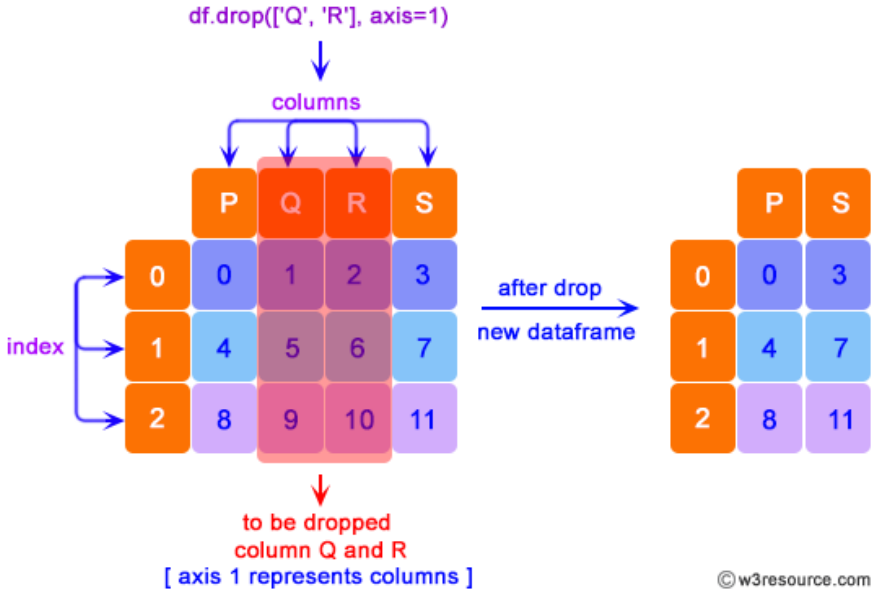
```
# Other examples
df[df['Courses'].str.contains("Spark")]
df[df['Courses'].str.lower().str.contains("spark")]
df[df['Courses'].str.startswith("P")]
```

Analyzing Data Frames

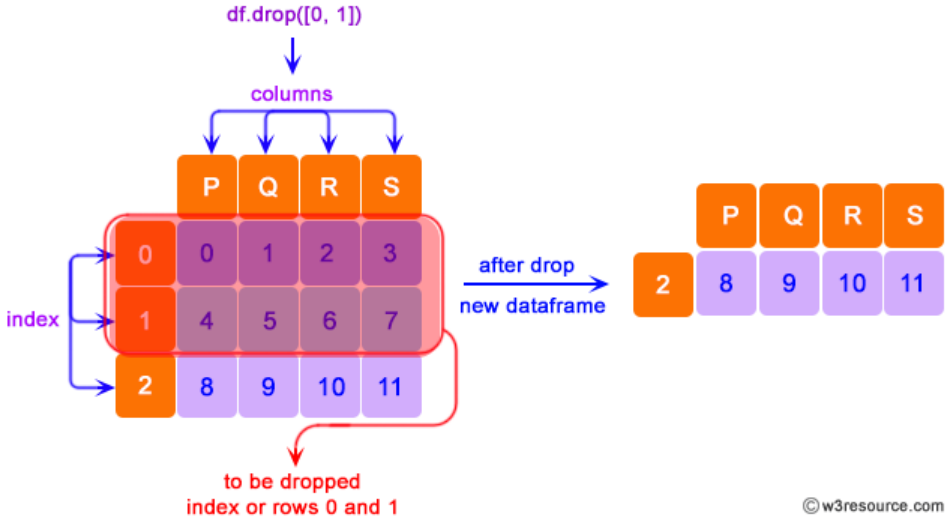
- head()
- tail()
- info()
- describe()

Drop Function





Drop Function

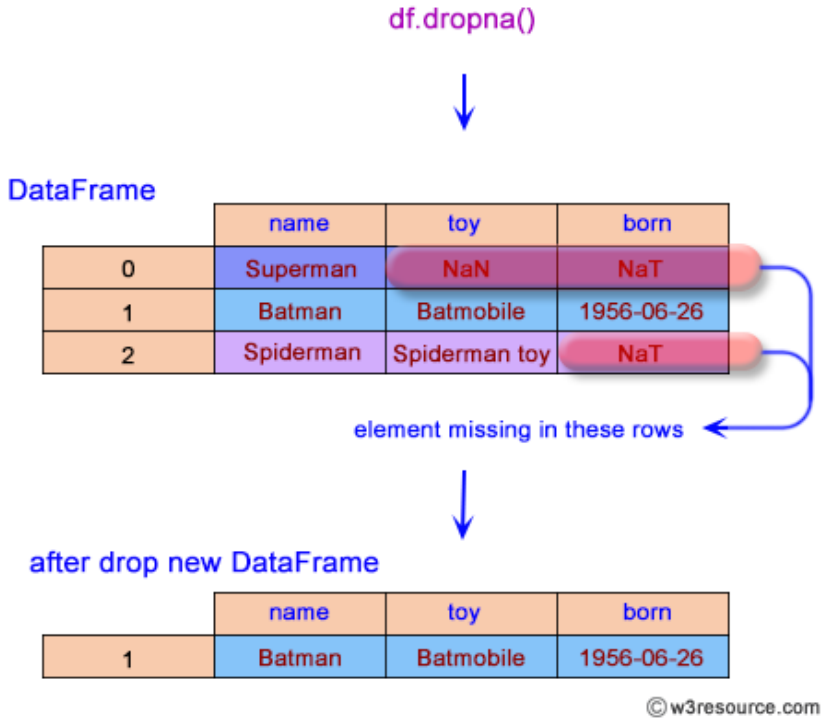


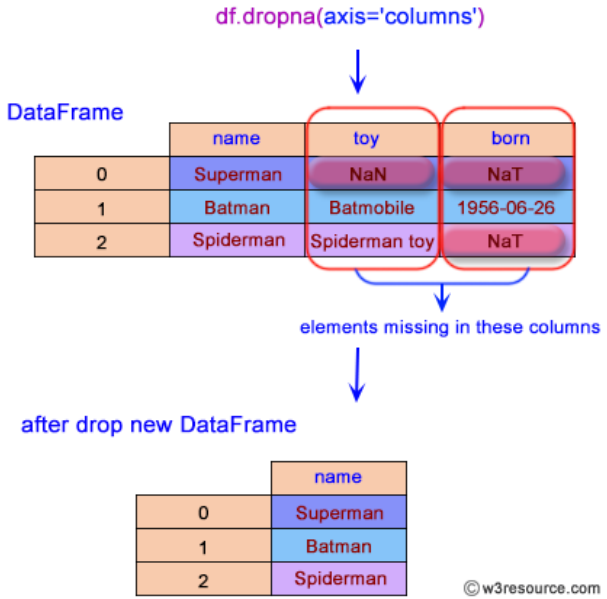
Cleaning Empty Cells

```
dropna(self, axis=0, how="any", thresh=None, subset=None,
inplace=False)
```

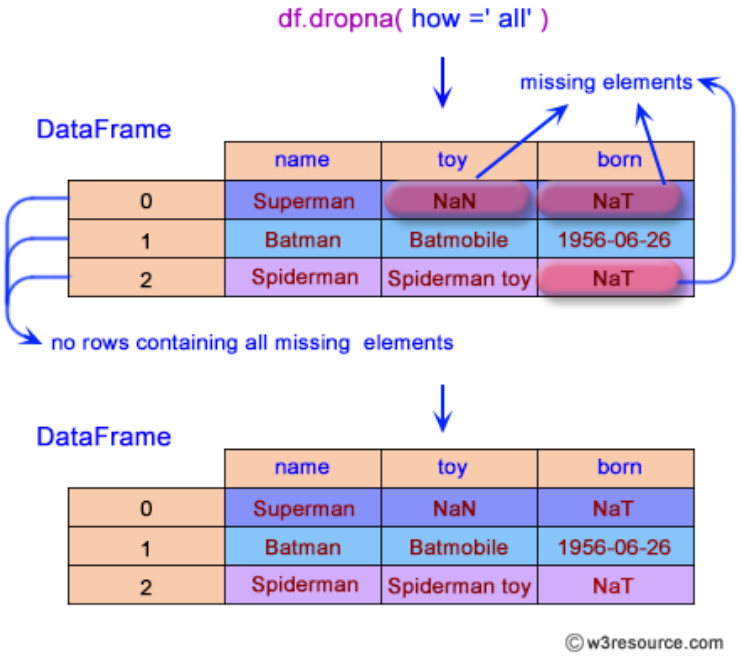
- **axis**: possible values are {0 or 'index', 1 or 'columns'}, default 0. If 0, drop rows with null values. If 1, drop columns with missing values.
- **how**: possible values are {'any', 'all'}, default 'any'. If 'any', drop the row/column if any of the values is null. If 'all', drop the row/column if all the values are missing.
- **thresh**: an int value to specify the threshold for the drop operation.
- **subset**: specifies the rows/columns to look for null values.
- **inplace**: a boolean value. If True, the source DataFrame is changed and None is returned.

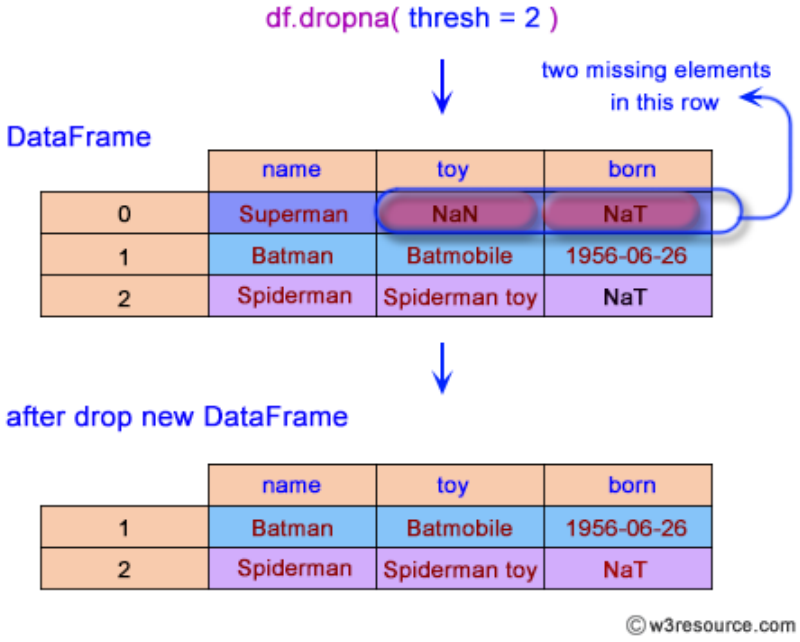
Cleaning Empty Cells



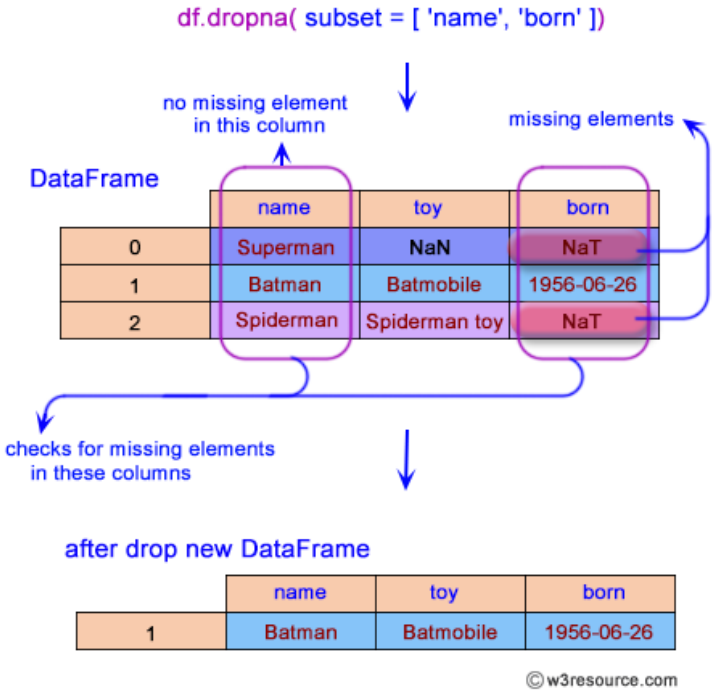


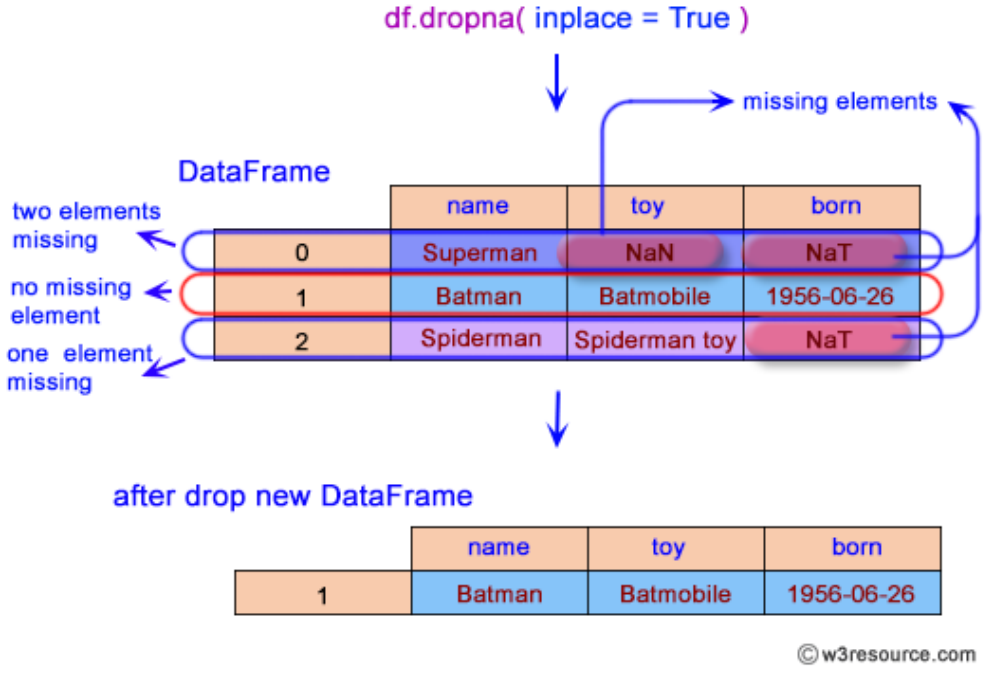
Cleaning Empty Cells



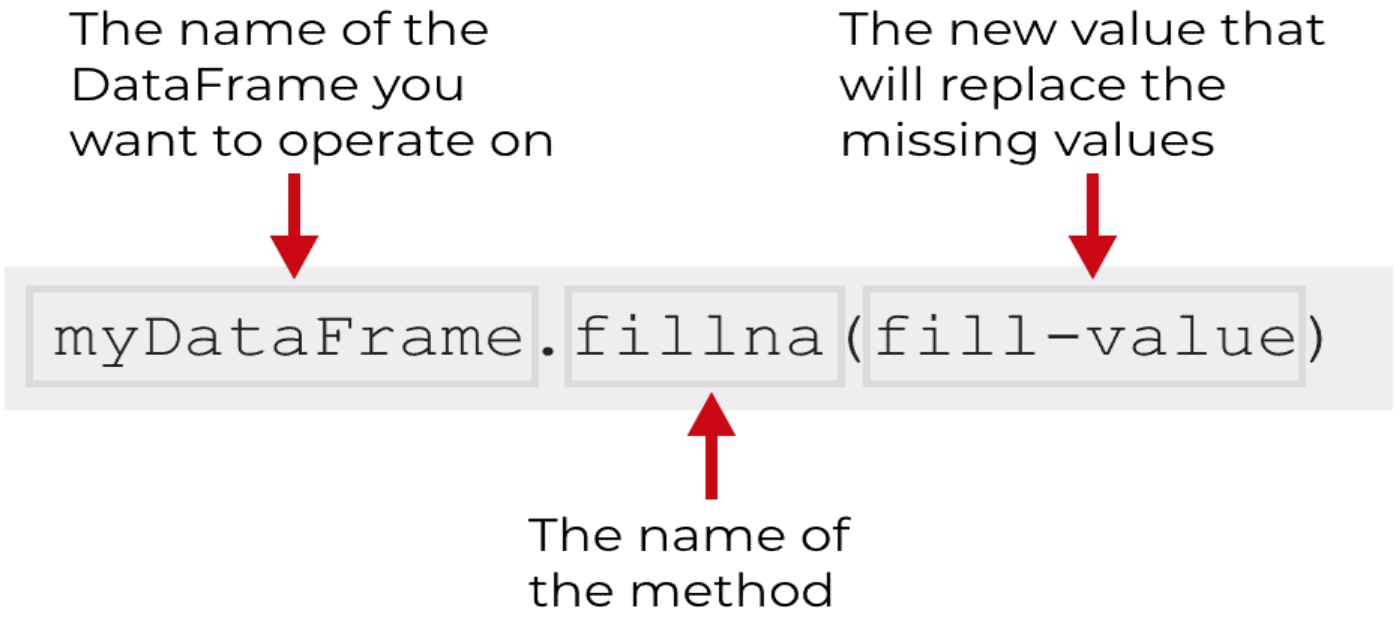


Cleaning Empty Cells

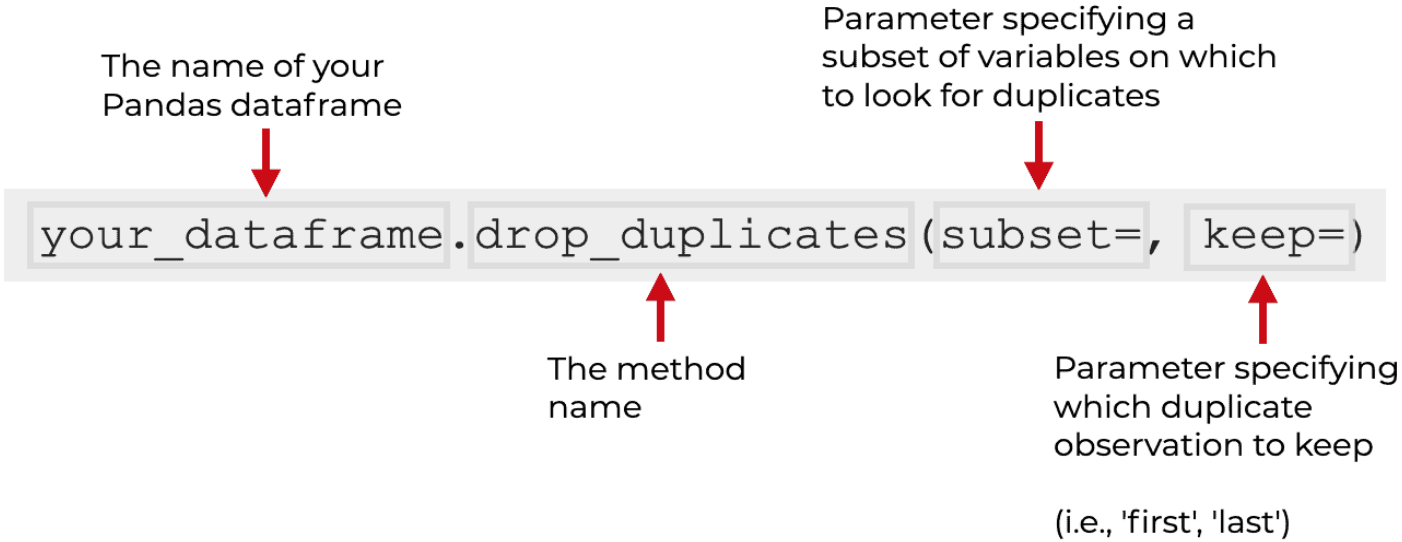




Fillna


The name of the DataFrame you want to operate on
The new value that will replace the missing values
myDataFrame.fillna(fill-value)
The name of the method

Removing Duplicates

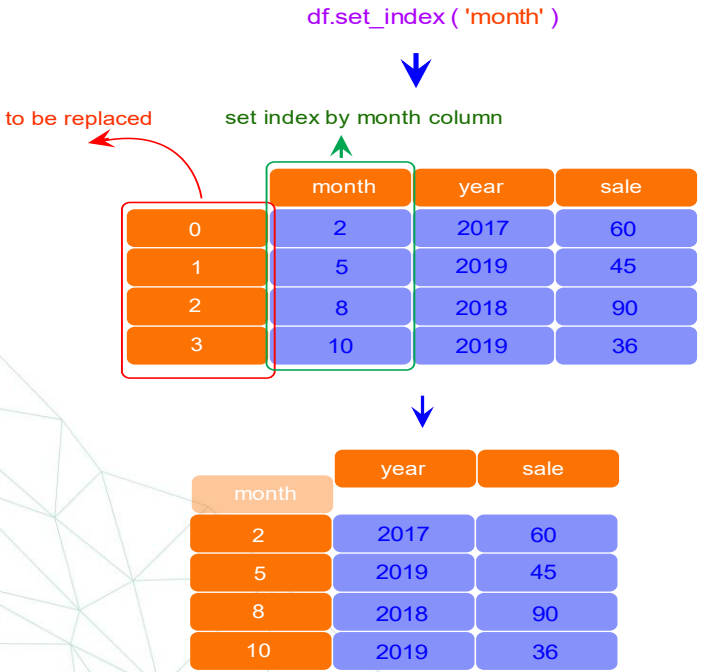


Removing Duplicates

```
your_dataframe.drop_duplicates()
```

name	region	sales	expense
William	East	50000	42000
~~William~~	~~East~~	~~50000~~	~~42000~~
Emma	North	52000	43000
Emma	West	52000	43000
Anika	East	65000	44000
Anika	East	72000	53000

Set DataFrame Index



Reset DataFrame Index

	A	B	C
1	a1	1	c1
3	a2	2	c2
5	a3	3	c3
7	a4	4	c4

→

	A	B	C
0	a1	1	c1
1	a2	2	c2
2	a3	3	c3
3	a4	4	c4

The name of the DataFrame you want to operate on

Which "level" of the index you want to remove, if the index has multiple levels (default is all levels)

Whether you want to operate on directly on the DataFrame (default is `False`)

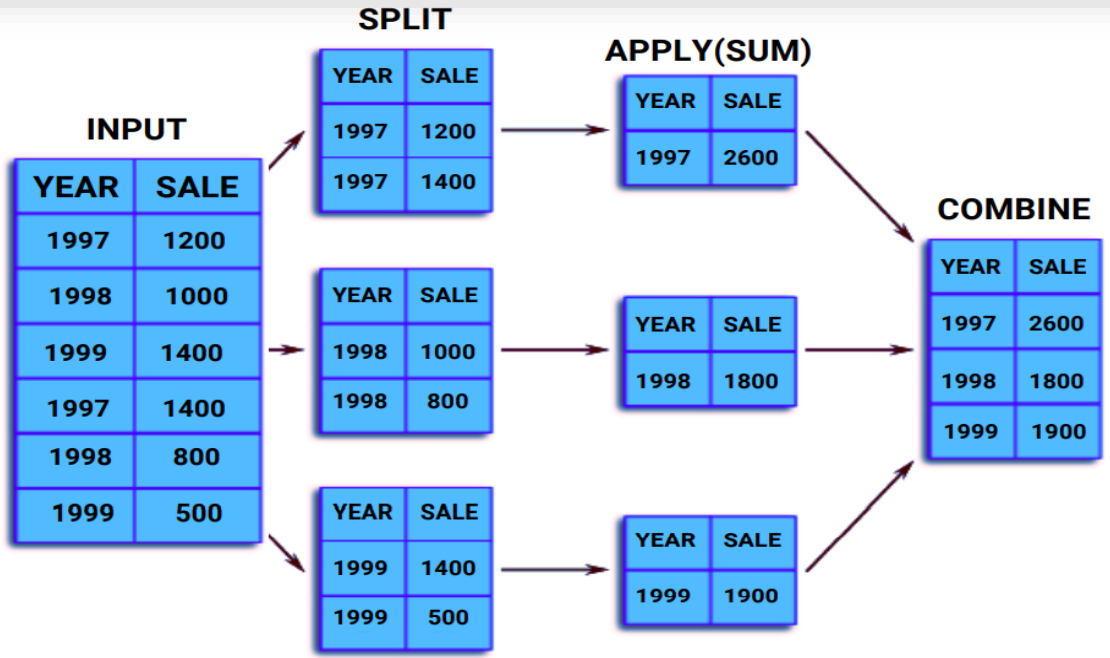
```
myDataFrame.reset_index(level=, drop=, inplace= )
```

The name of the method

Whether you want to delete the index when it is removed (default is `False`)

Group by

```
df.groupby('column_to_group')['column_to_agg'].agg_function()
```



Group by

df.groupby('column_to_group')['column_to_agg'].agg_function()

df.groupby('Name')['AvgBill'].sum()

Index	Name	Type	AvgBill
0	Liho Liho	Restaurant	$45.32
1	Chambers	Restaurant	$65.33
2	The Square	Bar	$12.45
3	Tosca Cafe	Restaurant	$180.34
4	Liho Liho	Restaurant	$145.42
5	Chambers	Restaurant	$25.35

→

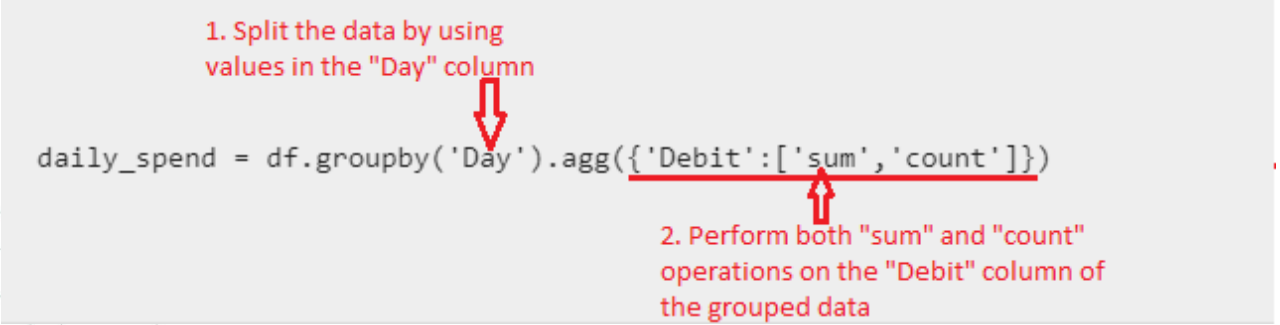
Liho Liho: $190.74
Chambers: $90.68
The Square: $12.45
Tosca Cafe: $180.34

Aggregation Methods

Aggregation Method	Description
.count()	The number of non-null records
.sum()	The sum of the values
.mean()	The arithmetic mean of the values
.median()	The median of the values
.min()	The minimum value of the group
.max()	The maximum value of the group
.mode()	The most frequent value in the group
.std()	The standard deviation of the group
.var()	The variance of the group

Group by Example

```
daily_spend_count = df.groupby('Day')['Debit'].count() daily_spend_sum =
df.groupby('Day')['Debit'].sum()
```




```
df.groupby(['Category','Month'])['Debit'].sum()
```

Sort

The name of the DataFrame you want to operate on

The column or list of columns you want to sort by

Whether you want to operate on directly on the DataFrame (default is `False`)

```
myDataFrame.sort_values(by, ascending =, inplace = )
```

The name of the method

Whether you want to sort in ascending order (default is `True`)

Correlations

	Maths	Physics	History
0	78	81	53
1	85	77	65
2	67	63	95
3	69	74	87
4	53	46	63
5	81	72	58
6	93	88	73
7	74	76	42

df.corr()

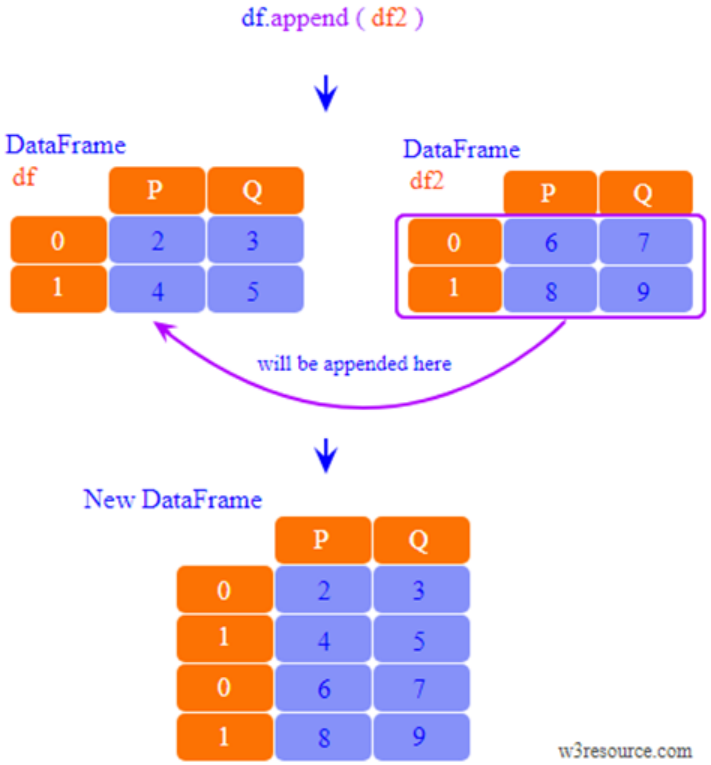
	Maths	Physics	History
Maths	1.000000	0.906340	-0.159063
Physics	0.906340	1.000000	-0.158783
History	-0.159063	-0.158783	1.000000

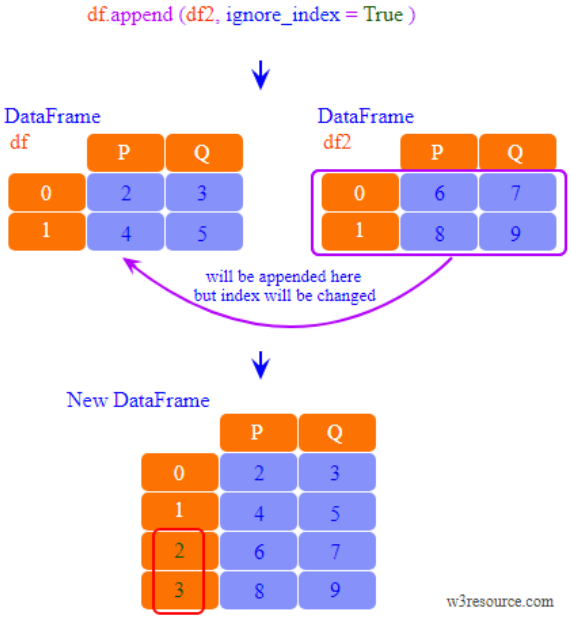
Data Integration

Column-1	...	Column-n
...	...	...

Data Integratio

append


df.append (df2)
DataFrame
df
P
Q
0
2
3
1
4
5
DataFrame
df2
P
Q
0
6
7
1
8
9
will be appended here
New DataFrame
P
Q
0
2
3
1
4
5
0
6
7
1
8
9
w3resource.com


df.append (df2, ignore_index = True)
DataFrame
df
P
Q
0
2
3
1
4
5
DataFrame
df2
P
Q
0
6
7
1
8
9
will be appended here
but index will be changed
New DataFrame
P
Q
0
2
3
1
4
5
2
6
7
3
8
9
w3resource.com

Concatenate

	Country	Currency
0	Japan	Yen
1	China	chin
2	India	rupees

	capital	population
0	Jaya'pura	456750
1	Toranto	3456545
2	Aukland	89752

Pandas concat( )

Default | axis = 0

	Country	Currency	capital	population
0	Japan	Yen	NaN	NaN
1	China	chin	NaN	NaN
2	India	rupees	NaN	NaN
0	NaN	NaN	Jaya'pura	456750.0
1	NaN	NaN	Toranto	3456545.0
2	NaN	NaN	Aukland	89752.0

axis = 1

```
1 pd.concat([data_3, my_df_drop], axis = 1)
```

	Country	Currency	capital	population
0	Japan	Yen	Jaya'pura	456750
1	China	chin	Toranto	3456545
2	India	rupees	Aukland	89752

Concatenate

	orange	apple	grapes
0	3	0	7
1	2	3	14
2	0	7	6
3	1	2	15

	grapes	mango	banana	pear	pineapple
0	13	10	20	21	30
1	12	13	23	24	33
3	2	2	4	51	30
4	55	9	0	22	36
5	98	76	9	25	31

Concat with axis = 0
is same as Append

Concat
axis = 0

Append

Concat
axis = 1

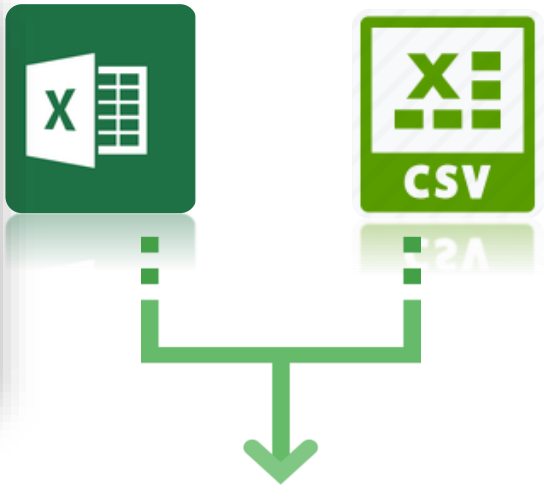
Concat with axis = 1

	orange	apple	grapes	mango	banana	pear	pineapple
0	3.0	0.0	7	NaN	NaN	NaN	NaN
1	2.0	3.0	14	NaN	NaN	NaN	NaN
2	0.0	7.0	6	NaN	NaN	NaN	NaN
3	1.0	2.0	15	NaN	NaN	NaN	NaN
0	NaN	NaN	13	10.0	20.0	21.0	30.0
1	NaN	NaN	12	13.0	23.0	24.0	33.0
3	NaN	NaN	2	2.0	4.0	51.0	30.0
4	NaN	NaN	55	9.0	0.0	22.0	36.0
5	NaN	NaN	98	76.0	9.0	25.0	31.0

	orange	apple	grapes	grapes	mango	banana	pear	pineapple
0	3.0	0.0	7.0	13.0	10.0	20.0	21.0	30.0
1	2.0	3.0	14.0	12.0	13.0	23.0	24.0	33.0
2	0.0	7.0	6.0	NaN	NaN	NaN	NaN	NaN
3	1.0	2.0	15.0	2.0	2.0	4.0	51.0	30.0
4	NaN	NaN	NaN	55.0	9.0	0.0	22.0	36.0
5	NaN	NaN	NaN	98.0	76.0	9.0	25.0	31.0

Merge Function

index	Year	Temperature
0	1956	16.99
1	1957	10.34
2	1958	21.01
3	1959	23.68
4	1960	24.59
5	1961	25.29
6	1962	8.77
7	1963	26.88
8	1964	15.04



index	Year	Rainfall
0	1956	1.01
1	1957	1.66
2	1958	3.5
3	1959	3.31
4	1960	3.61
5	1961	4.71
6	1962	2
7	1963	3.12
8	1964	1.96

Year	Temperature	Rainfall
...	...	...

Pandas Merge

```
df.merge(right=other_df, on='common_column' ,
how='how_to_join' )
```

df

index	Year	Rainfall
0	1956	1.01
1	1957	1.66
2	1958	3.5
3	1959	3.31
4	1960	3.61
5	1961	4.71

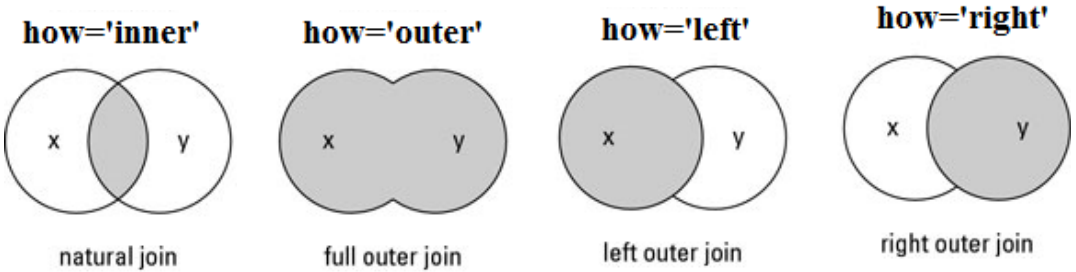
+

index	Year	Temperature
0	1956	16.99
1	1957	10.34
2	1958	21.01
3	1959	23.68
4	1960	24.59
5	1961	25.29

=

index	Year	Rainfall	Temperature
0	1956	1.01	16.99
1	1957	1.66	10.34
2	1958	3.5	21.01
3	1959	3.31	23.68
4	1960	3.61	24.59
5	1961	4.71	25.29

Pandas Merge



index	Year	Temperature
0	1956	16.99
1	1957	10.34
2	1958	21.01
3	1959	23.68
4	1960	24.59
5	1961	25.29

index	Year	Rainfall
0	1956	1.01
1	1958	3.5
2	1959	3.31
3	1960	3.61
4	1962	2
5	1963	3.12

index	Year	Temperature	Rainfall
0	1956	16.99	1.01
1	1957	10.34	Nan
2	1958	21.01	3.5
3	1959	23.68	3.31
4	1960	24.59	3.61
5	1961	25.29	Nan
6	1962	Nan	2
7	1963	Nan	3.12

Join

df_left.join(df_right, how='left')

df_names

Symbol	Name
APPL	Apple
MSFT	Mircosoft
TSLA	Tesla
GOOG	Google
NFLX	Netflix

df_portfolio

Symbol	Shares
TSLA	20
APPL	50
GOOG	50
AMZN	100

```
df_names.join(df_portfolio, how='left')
```

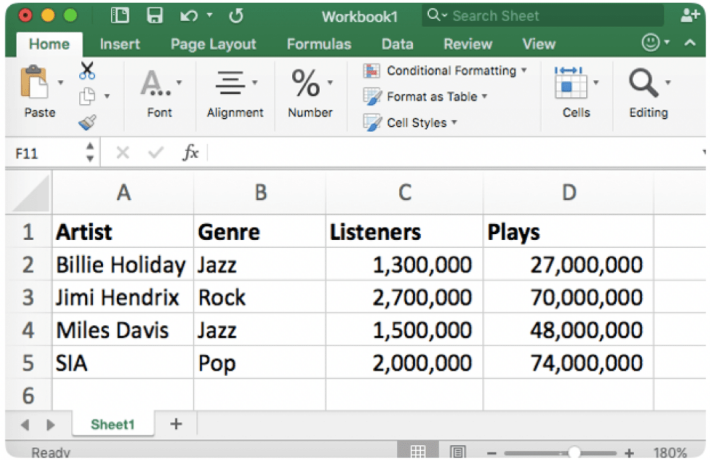
	Name	Shares
APPL	Apple	50.0
MSFT	Mircosoft	NaN
TSLA	Tesla	20.0
GOOG	Google	50.0
NFLX	Netflix	NaN

Pandas concat Vs append Vs join Vs merge

- **Concat** gives the flexibility to join based on the axis(all rows or all columns)
- **Append** is the specific case(axis=0, join='outer') of concat
- **Merge** is based on any particular column each of the two dataframes, this columns are variables on like 'left_on', 'right_on', 'on’.
- **Join** is based on the indexes (set by set_index) on how variable =['left','right','inner','outer']

Reading files

music.csv

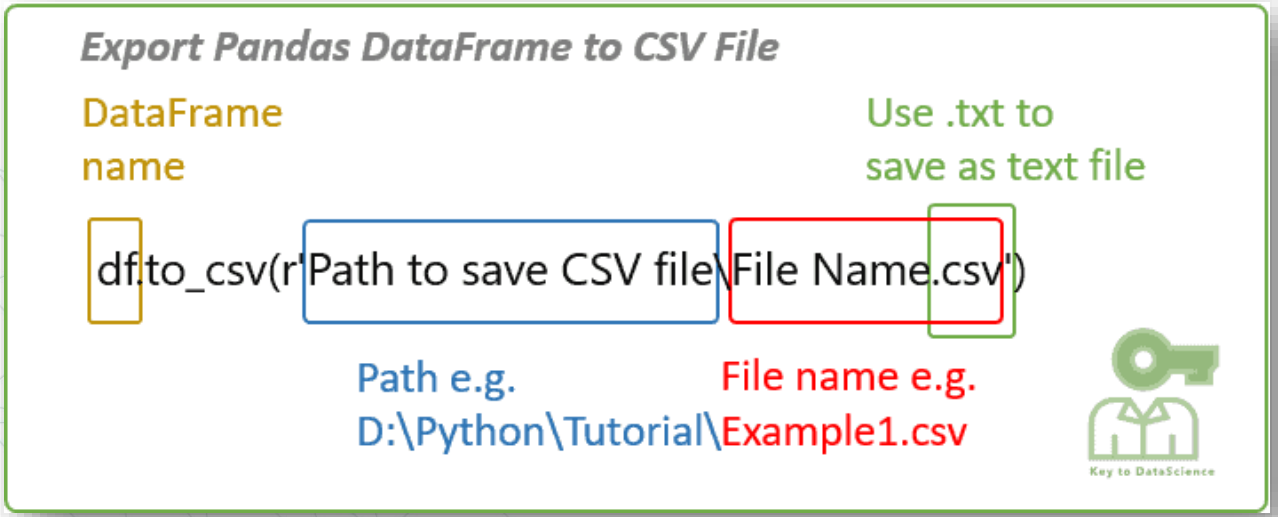


	A	B	C	D
1	**Artist**	**Genre**	**Listeners**	**Plays**
2	Billie Holiday	Jazz	1,300,000	27,000,000
3	Jimi Hendrix	Rock	2,700,000	70,000,000
4	Miles Davis	Jazz	1,500,000	48,000,000
5	SIA	Pop	2,000,000	74,000,000
6				

pandas.read_csv('music.csv')

	Artist	Genre	Listeners	Plays
0	Billie Holiday	Jazz	1,300,000	27,000,000
1	Jimi Hendrix	Rock	2,700,000	70,000,000
2	Miles Davis	Jazz	1,500,000	48,000,000
3	SIA	Pop	2,000,000	74,000,000

Export DataFrame to CSV File



Replace

The name of the dataframe you want to operate on

The a list of old values (passed to the `to_replace` parameter)

```
your_dataframe.replace(to_replace= […], value= new_val)
```

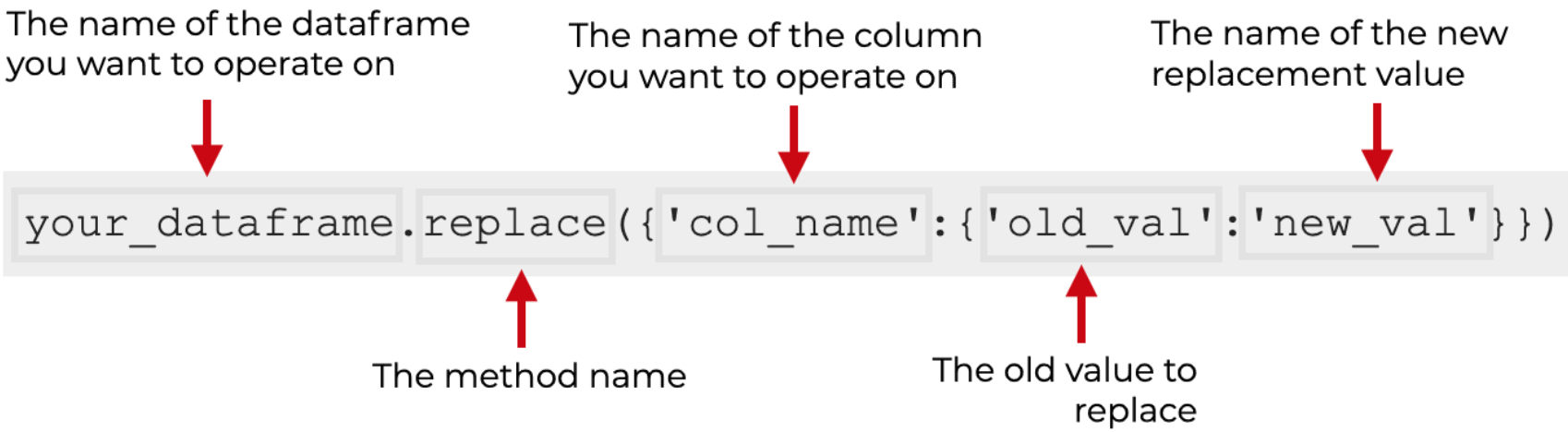
The method name

The new value (passed to the `value` parameter)

```
sales_data.replace(to_replace = -1, value = np.NaN)
```

```
sales_data.replace(to_replace = [-1,-999], value = np.NaN)
```

Replace


The name of the dataframe you want to operate on
The name of the column you want to operate on
The name of the new replacement value
your_dataframe.replace({'col_name':{'old_val':'new_val'}})
The method name
The old value to replace

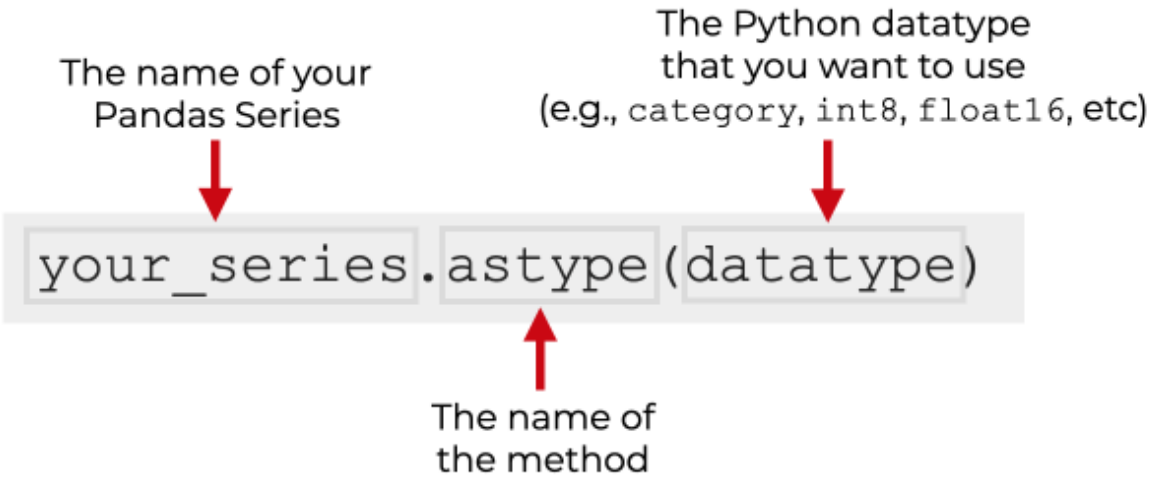
dtypes

df.dtypes

columns appears in series

float	float64
int	int64
datetime	datetime64[ns]
string	object

astype


The name of your
Pandas Series
The Python datatype
that you want to use
(e.g., category, int8, float16, etc)
your_series.astype(datatype)
The name of
the method

astype

The name of the dataframe column

```
your_dataframe.astype({'column':'datatype'})
```

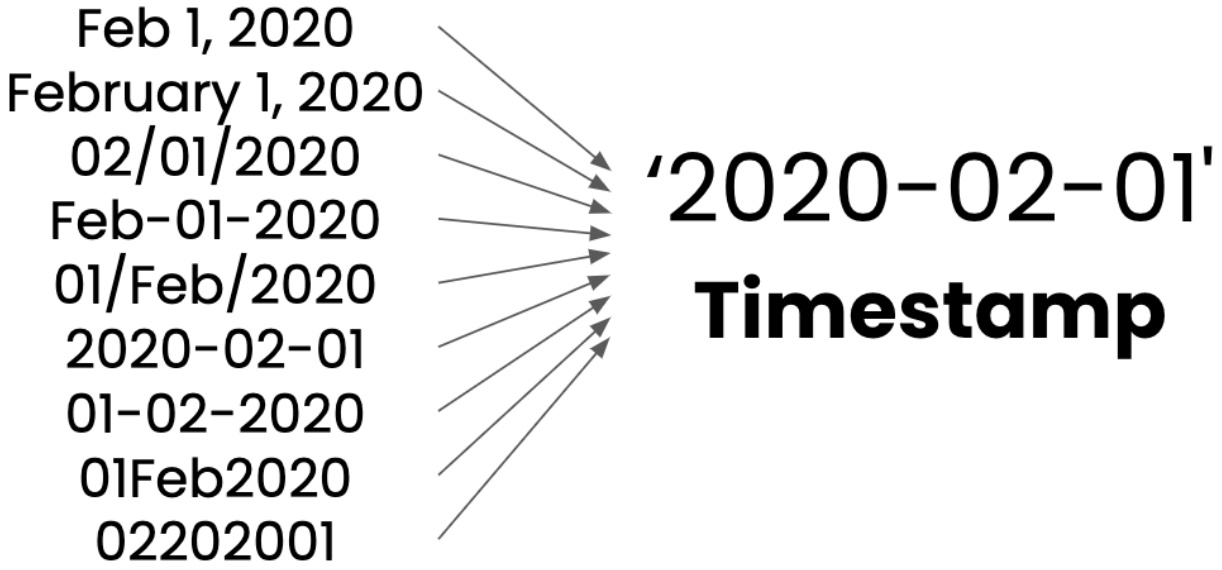
The datatype you want to use for that column

(e.g., `category`, `int8`, `float16`, etc)

to_datetime()

pd.to_datetime(format='Your_Datetime_format')

"Given a format, convert a string to a datetime object"




```
earthquakes['date_parsed']=pd.to_datetime(earthquakes['Date'],format="%m/%d/%y")
```

See also

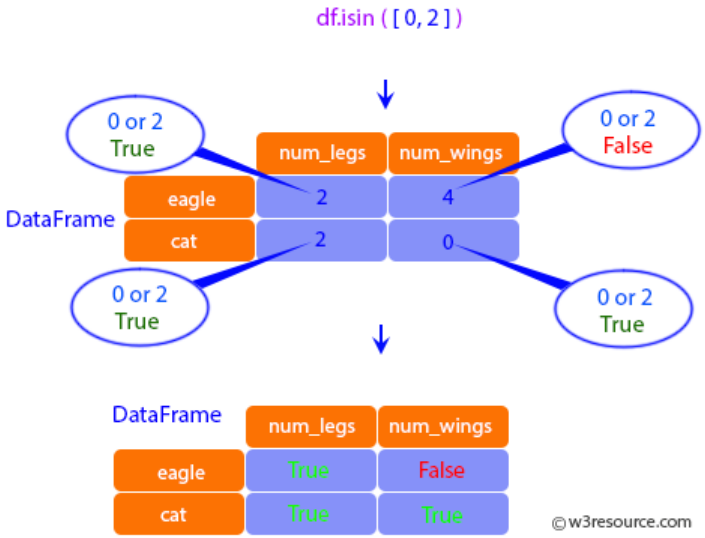
`to_datetime`
Convert argument to datetime.

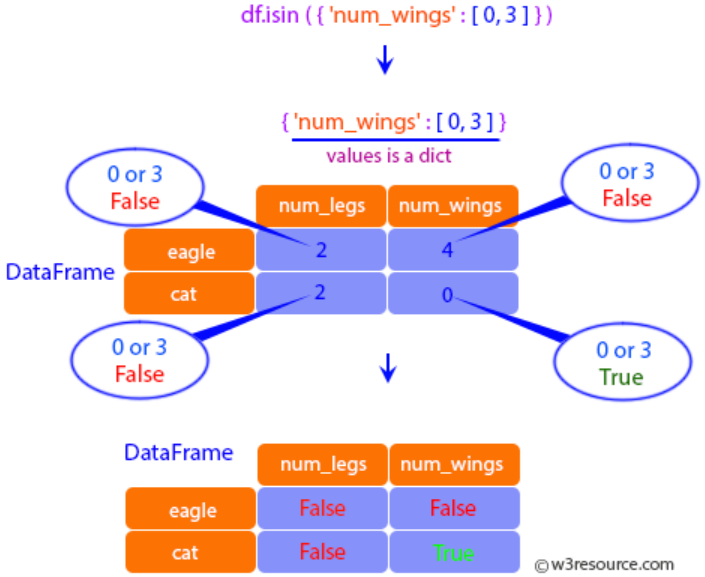
`to_timedelta`
Convert argument to timedelta.

`to_numeric`
Convert argument to numeric type.

`convert_dtypes`
Convert argument to best possible dtype.

isin


df.isin ([0, 2])
0 or 2 True
num_legs
num_wings
0 or 2 False
DataFrame
eagle
2
4
cat
2
0
0 or 2 True
0 or 2 True
DataFrame
num_legs
num_wings
eagle
True
False
cat
True
True
©w3resource.com


df.isin ({ 'num_wings' : [0, 3] })
{ 'num_wings' : [0, 3] }
values is a dict
0 or 3 False
num_legs
num_wings
0 or 3 False
DataFrame
eagle
2
4
cat
2
0
0 or 3 False
0 or 3 True
DataFrame
num_legs
num_wings
eagle
False
False
cat
False
True
©w3resource.com

where

pd.DataFrame.where(cond=**df<90**, other="A+")

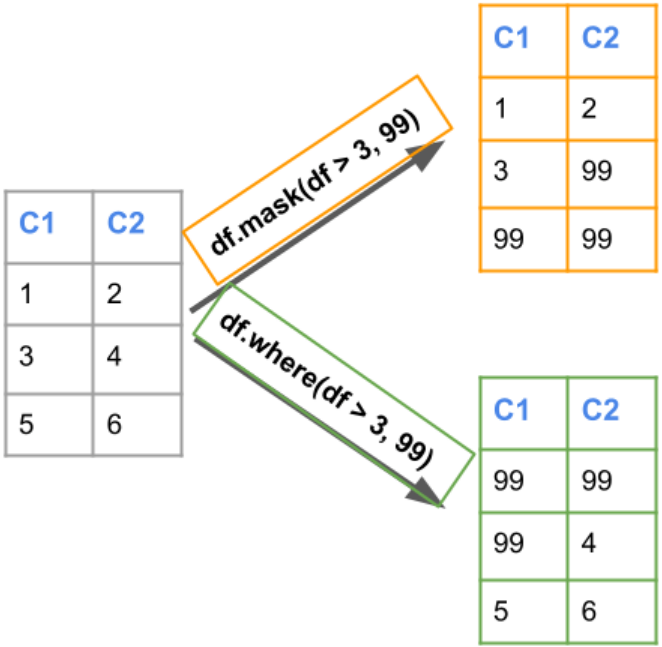
"Where a condition is false, replace a value"

Index	Test1	Test2	Test3
Bob	51	92	14
Sally	71	60	20
Frank	82	86	74
Patty	74	87	99

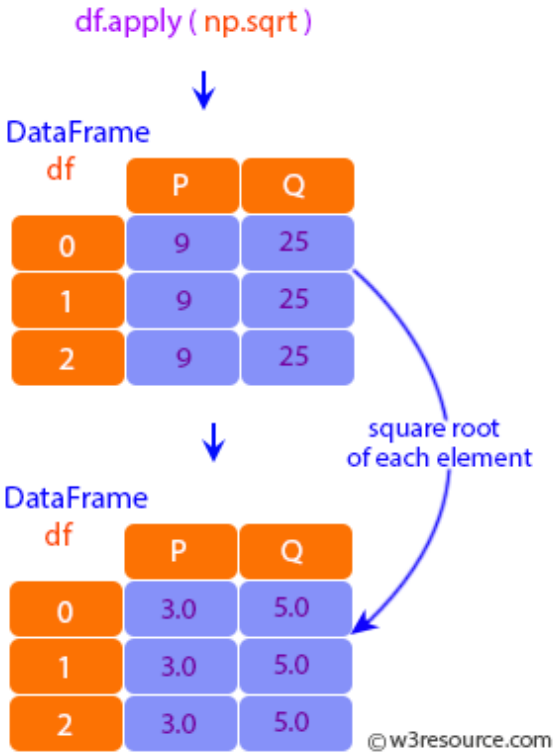
Index	Test1	Test2	Test3
Bob	51	A+	14
Sally	71	60	20
Frank	82	86	74
Patty	74	87	A+

mask

Pandas mask() vs where()



Apply Function



Apply Function

df.apply (np.sum, axis = 0)

DataFrame
df

	P	Q
0	9	25
1	9	25
2	9	25

np.sum
function apply
for each column

axis = 0
axis 0 represents index

for column P = index 0 + index 1 + index 2 = 9 + 9 + 9 = 27
for column Q = index 0 + index 1 + index 2 = 25 + 25 + 25 = 75

P	27
Q	75

df.apply (np.sum, axis = 1)

DataFrame
df

	P	Q
0	9	25
1	9	25
2	9	25

np.sum
function apply
for each row or index

axis = 1
axis 1 represents column

for index 0 = column P + column Q = 9 + 25 = 34
for index 1 = column P + column Q = 9 + 25 = 34
for index 2 = column P + column Q = 9 + 25 = 34

0	34
1	34
2	34

unique & nunique

Age	Department
26	Sales
28	Sales
27	Accounting
32	HR

```
df.nunique()
```

Age	4
Department	3

Distinct Values in Each Column

Height	Weight	Team
167	65	A
175	70	A
170	72	B
186	80	B
190	86	B
188	94	C
158	50	A
169	58	C
183	78	B
180	85	C

```
df['Team'].unique()
```

A
B
C

Unique Values in a Column

Value _ counts

region
East
North
East
South
West
West

.value_counts(...)

value	count
East	2
North	1
South	1
West	2

Select _ Dtypes

df. select_ Dtypes(include, exclude)

```
1. # select all numeric columns
2. df.select_dtypes(include='number')
```

Output:

	Age	Salary
0	26	70000.0
1	28	80000.0
2	27	72000.5
3	32	66000.0

interpolate

	Price
2020-12-04	10.0
2020-12-05	20.0
2020-12-06	NaN
2020-12-07	30.0
2020-12-08	50.0
2020-12-09	20.0
2020-12-10	NaN
2020-12-11	100.0
2020-12-12	30.0
2020-12-13	NaN

```
df.interpolate()
```

	Price
2020-12-04	10.0
2020-12-05	20.0
2020-12-06	25.0
2020-12-07	30.0
2020-12-08	50.0
2020-12-09	20.0
2020-12-10	60.0
2020-12-11	100.0
2020-12-12	30.0
2020-12-13	30.0

Get _ dummies

The name of the function

The column or columns you want to convert to dummy variables

(applicable for dataframes)

```
pd.get_dummies(data_object, columns=, drop_first=)
```

The object you want to operate on

(e.g., a dataframe, a Series, etc)

A True/False indicator that specifies if you want to drop the first level of the categorical variable

melt

Country	1800	1801	1802	1803	1804	1805	1806	1807	1808	1809	1810	1811	1812	1813	1814
Afghanistan	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M	3.28M
Angola	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M	1.57M
Albania	400k	402k	404k	405k	407k	409k	411k	413k	414k	416k	418k	420k	422k	424k	426k

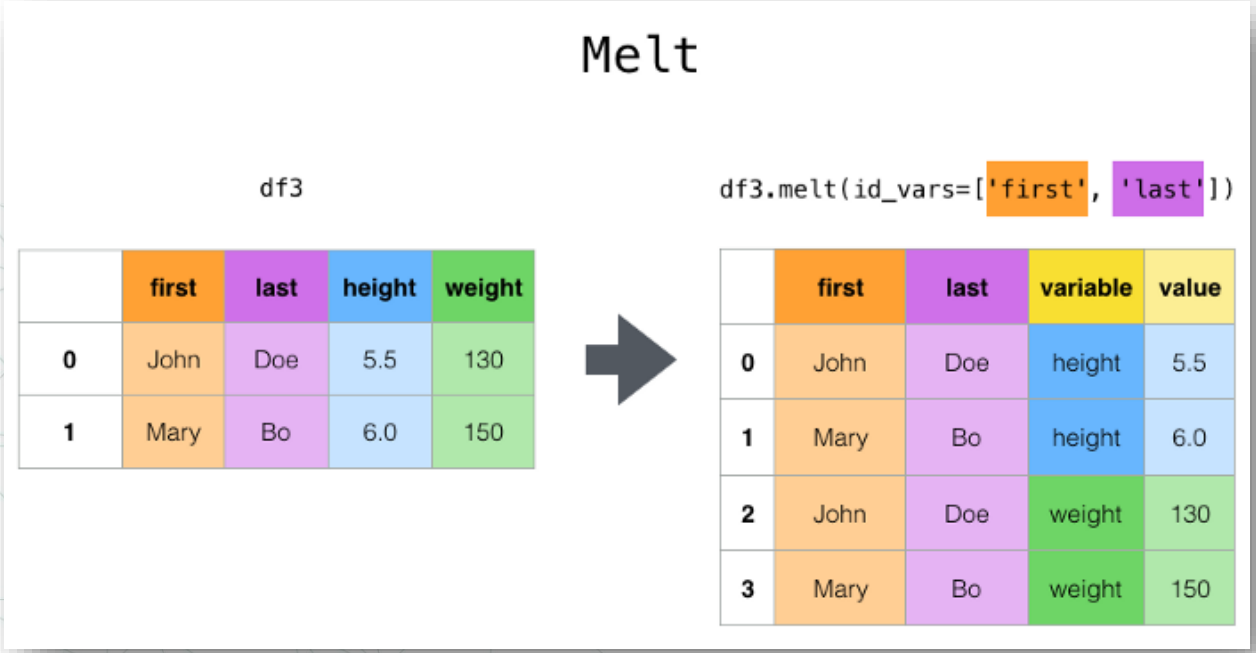
```
df=df.melt(id_vars=['country'],var_name='Year', value_name='total_Population')
```

- **id_vars** : *tuple, list, or ndarray, optional*
  Column(s) to use as identifier variables.
- **value_vars** : *tuple, list, or ndarray, optional*
  Column(s) to unpivot/melt. If not specified, uses all columns that are not set as id_vars.
- **var_name** : *scalar*
  Name to use for the 'variable' column. If None it uses frame.columns.name or 'variable'.
- **value_name** : *scalar, default 'value'*
  Name to use for the 'value' column.

```
1  df[df['country']=='Afghanistan']
✓ 0.4s
```

	country	Year	total_Population
0	Afghanistan	1800	3.28M
197	Afghanistan	1801	3.28M
394	Afghanistan	1802	3.28M
591	Afghanistan	1803	3.28M
788	Afghanistan	1804	3.28M
...	...	...	...
58312	Afghanistan	2096	75.8M
58509	Afghanistan	2097	75.6M
58706	Afghanistan	2098	75.4M
58903	Afghanistan	2099	75.2M
59100	Afghanistan	2100	74.9M

Reshaping Data in Pandas



	first	last	height	weight
0	John	Doe	5.5	130
1	Mary	Bo	6.0	150

	first	last	variable	value
0	John	Doe	height	5.5
1	Mary	Bo	height	6.0
2	John	Doe	weight	130
3	Mary	Bo	weight	150

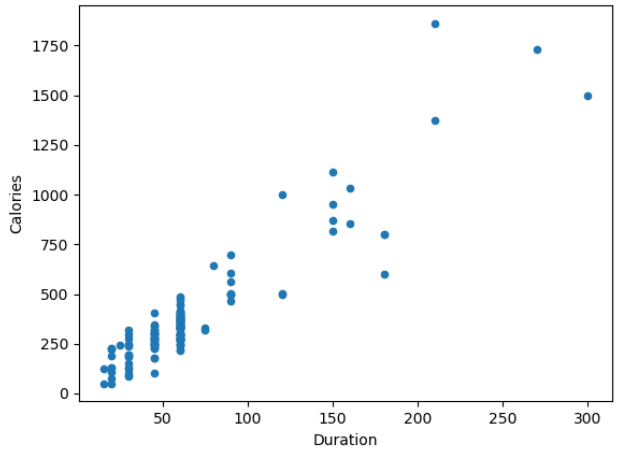
Pandas

- duplicated
- Isna = Isnull
- To_numpy
- Columns
- Index

Plot

- pandas.DataFrame.plot.area
- pandas.DataFrame.plot.bar
- pandas.DataFrame.plot.barh
- pandas.DataFrame.plot.box
- pandas.DataFrame.plot.density
- pandas.DataFrame.plot.hexbin
- pandas.DataFrame.plot.hist
- pandas.DataFrame.plot.kde
- pandas.DataFrame.plot.line
- pandas.DataFrame.plot.pie
- pandas.DataFrame.plot.scatter
- pandas.DataFrame.boxplot

```
df.plot(kind = 'scatter', x = 'Duration', y = 'Calories')

plt.show()
```



Practical Lab

- Inconsistent Data Entry (EX1)
- Parsing Dates (EX2)
- Character Encodings (EX3)
- Categorical Data (EX4)
- Handle Missing Values (EX5)
- Handle Outliers (EX6)
- Handle Duplicates(EX7)

Q&A

Questions and answers

Thanks