DSUP LAB

NAME:

DATE:

Experiment no. 1

AIM : Introduction to Pandas , Environment setup ,Introduction to Data Structure, introduction to Series and Data Frame

Pandas is an open-source Python Library providing high-performance data manipulation and analysis tool using its powerful data structures. The name Pandas is derived from the word Panel Data – an Econometrics from Multidimensional data.

In 2008, developer Wes McKinney started developing pandas when in need of high performance, flexible tool for analysis of data.

Prior to Pandas, Python was majorly used for data munging and preparation. It had very little contribution towards data analysis. Pandas solved this problem. Using Pandas, we can accomplish five typical steps in the processing and analysis of data, regardless of the origin of data — load, prepare, manipulate, model, and analyze.

Python with Pandas is used in a wide range of fields including academic and commercial domains including finance, economics, Statistics, analytics, etc.

Key Features of Pandas

- **Fast and efficient DataFrame object with default and customized indexing.**
- **Tools for loading data into in-memory data objects from different file formats.**
- **Data alignment and integrated handling of missing data.**
- **Reshaping and pivoting of date sets.**
- **Label-based slicing, indexing and subsetting of large data sets.**
- **Columns from a data structure can be deleted or inserted.**
- **Group by data for aggregation and transformations.**
- **High performance merging and joining of data.**
- **Time Series functionality.**

Python Pandas - Environment Setup

Standard Python distribution doesn't come bundled with Pandas module. A lightweight alternative is to install NumPy using popular Python package installer, pip.

```
pip install pandas
```

If you install Anaconda Python package, Pandas will be installed by default with the following –

Windows

- **Anaconda (from https://www.continuum.io) is a free Python distribution for SciPy stack. It is also available for Linux and Mac.**

- **Canopy (https://www.enthought.com/products/canopy/) is available as free as well as commercial distribution with full SciPy stack for Windows, Linux and Mac.**
- **Python (x,y) is a free Python distribution with SciPy stack and Spyder IDE for Windows OS. (Downloadable from http://python-xy.github.io/)**

Linux

Package managers of respective Linux distributions are used to install one or more packages in SciPy stack.

For Ubuntu Users

```
sudo apt-get install python-numpy python-scipy
python-matplotlibipythonipythonnotebook
python-pandas python-sympy python-nose
```

For Fedora Users

```
sudo yum install numpyscipy python-matplotlibipython python-pandas sympy
python-nose atlas-devel
```

Introduction to Data Structures

Pandas deals with the following three data structures −

- **Series**
- **DataFrame**
- **Panel**

These data structures are built on top of Numpy array, which means they are fast.

Dimension & Description

The best way to think of these data structures is that the higher dimensional data structure is a container of its lower dimensional data structure. For example, DataFrame is a container of Series, Panel is a container of DataFrame.

Data Structure	Dimensions	Description
Series	1	1D labeled homogeneous array, sizeimmutable.
Data Frames	2	General 2D labeled, size-mutable tabular structure with potentially heterogeneously typed columns.
Panel	3	General 3D labeled, size-mutable array.

Building and handling two or more dimensional arrays is a tedious task, burden is placed on the user to consider the orientation of the data set when writing functions. But using Pandas data structures, the mental effort of the user is reduced.

For example, with tabular data (DataFrame) it is more semantically helpful to think of the index (the rows) and the columns rather than axis 0 and axis 1.

Mutability

All Pandas data structures are value mutable (can be changed) and except Series all are size mutable. Series is size immutable.

Note − DataFrame is widely used and one of the most important data structures. Panel is used much less.

Series

Series is a one-dimensional array like structure with homogeneous data. For example, the following series is a collection of integers 10, 23, 56, …

10	23	56	17	52	61	73	90	26	72

Key Points

- Homogeneous data
- Size Immutable
- Values of Data Mutable

DataFrame

DataFrame is a two-dimensional array with heterogeneous data. For example,

Name	Age	Gender	Rating
Steve	32	Male	3.45
Lia	28	Female	4.6
Vin	45	Male	3.9
Katie	38	Female	2.78

The table represents the data of a sales team of an organization with their overall performance rating. The data is represented in rows and columns. Each column represents an attribute and each row represents a person.

Data Type of Columns

The data types of the four columns are as follows −

Column	Type
Name	String

Age	Integer
Gender	String
Rating	Float

Key Points

- Heterogeneous data
- Size Mutable
- Data Mutable

Panel

Panel is a three-dimensional data structure with heterogeneous data. It is hard to represent the panel in graphical representation. But a panel can be illustrated as a container of DataFrame.

Key Points

- Heterogeneous data
- Size Mutable
- Data Mutable

Python Pandas - Series

eries is a one-dimensional labeled array capable of holding data of any type (integer, string, float, python objects, etc.). The axis labels are collectively called index.

pandas.Series

A pandas Series can be created using the following constructor −

```
pandas.Series( data, index, dtype, copy)
```

The parameters of the constructor are as follows −

Sr.No	Parameter & Description
1	**Data** data takes various forms like ndarray, list, constants
2	**Index** Index values must be unique and hashable, same length as data. Default np.arrange(n) if no index is passed.
3	**Dtype** dtype is for data type. If None, data type will be inferred

4	**Copy** **Copy data. Default False**

A series can be created using various inputs like −

- **Array**
- **Dict**
- **Scalar value or constant**

Create an Empty Series

A basic series, which can be created is an Empty Series.

Example

```
#import the pandas library and aliasing as pd
import pandas as pd
s = pd.Series()
print s
```

Its output is as follows −

```
Series([], dtype: float64)
```

Create a Series from ndarray

If data is an ndarray, then index passed must be of the same length. If no index is passed, then by default index will be range(n) where n is array length, i.e., [0,1,2,3…. range(len(array))-1].

Example 1

```
#import the pandas library and aliasing as pd
import pandas as pd
import numpy as np
data = np.array(['a','b','c','d'])
s = pd.Series(data)
print s
```

Its output is as follows −

```
0   a
1   b
2   c
3   d
dtype: object
```

We did not pass any index, so by default, it assigned the indexes ranging from 0 to len(data)-1, i.e., 0 to 3.

Example 2

```
#import the pandas library and aliasing as pd
import pandas as pd
import numpy as np
data = np.array(['a','b','c','d'])
s = pd.Series(data,index=[100,101,102,103])
print s
```

Its output is as follows −

```
100  a
101  b
102  c
103  d
dtype: object
```

We passed the index values here. Now we can see the customized indexed values in the output.

Create a Series from dict

A dict can be passed as input and if no index is specified, then the dictionary keys are taken in a sorted order to construct index. If index is passed, the values in data corresponding to the labels in the index will be pulled out.

Example 1

```
#import the pandas library and aliasing as pd
import pandas as pd
import numpy as np
data = {'a' : 0., 'b' : 1., 'c' : 2.}
s = pd.Series(data)
print s
```

Its output is as follows −

```
a 0.0
b 1.0
c 2.0
dtype: float64
```

Observe − Dictionary keys are used to construct index.

Example 2

```
#import the pandas library and aliasing as pd
import pandas as pd
import numpy as np
data = {'a' : 0., 'b' : 1., 'c' : 2.}
s = pd.Series(data,index=['b','c','d','a'])
print s
```

Its output is as follows −

```
b 1.0
c 2.0
d NaN
a 0.0
dtype: float64
```

Observe − Index order is persisted and the missing element is filled with NaN (Not a Number).

Create a Series from Scalar

If data is a scalar value, an index must be provided. The value will be repeated to match the length of index

```
#import the pandas library and aliasing as pd
import pandas as pd
import numpy as np
```

```
s = pd.Series(5, index=[0, 1, 2, 3])
print s
```

Its output is as follows −

```
0  5
1  5
2  5
3  5
dtype: int64
```

Accessing Data from Series with Position

Data in the series can be accessed similar to that in an ndarray.

Example 1

Retrieve the first element. As we already know, the counting starts from zero for the array, which means the first element is stored at zeroth position and so on.

```
import pandas as pd
s = pd.Series([1,2,3,4,5],index = ['a','b','c','d','e'])

#retrieve the first element
print s[0]
```

Its output is as follows −

```
1
```

Example 2

Retrieve the first three elements in the Series. If a : is inserted in front of it, all items from that index onwards will be extracted. If two parameters (with : between them) is used, items between the two indexes (not including the stop index)

```
import pandas as pd
s = pd.Series([1,2,3,4,5],index = ['a','b','c','d','e'])

#retrieve the first three element
print s[:3]
```

Its output is as follows −

```
a  1
b  2
c  3
dtype: int64
```

Example 3

Retrieve the last three elements.

```
import pandas as pd
s = pd.Series([1,2,3,4,5],index = ['a','b','c','d','e'])

#retrieve the last three element
print s[-3:]
```

Its output is as follows −

```
c  3
d  4
```

```
e  5
dtype: int64
```

Retrieve Data Using Label (Index)

A Series is like a fixed-size dict in that you can get and set values by index label.

Example 1

Retrieve a single element using index label value.

```
import pandas as pd
s = pd.Series([1,2,3,4,5],index = ['a','b','c','d','e'])

#retrieve a single element
print s['a']
```

Its output is as follows −

```
1
```

Example 2

Retrieve multiple elements using a list of index label values.

```
import pandas as pd
s = pd.Series([1,2,3,4,5],index = ['a','b','c','d','e'])

#retrieve multiple elements
print s[['a','c','d']]
```

Its output is as follows −

```
a  1
c  3
d  4
dtype: int64
```

Example 3

If a label is not contained, an exception is raised.

```
import pandas as pd
s = pd.Series([1,2,3,4,5],index = ['a','b','c','d','e'])

#retrieve multiple elements
print s['f']
```

Its output is as follows −

```
…
KeyError: 'f'
```

Python Pandas - DataFrame

A Data frame is a two-dimensional data structure, i.e., data is aligned in a tabular fashion in rows and columns.

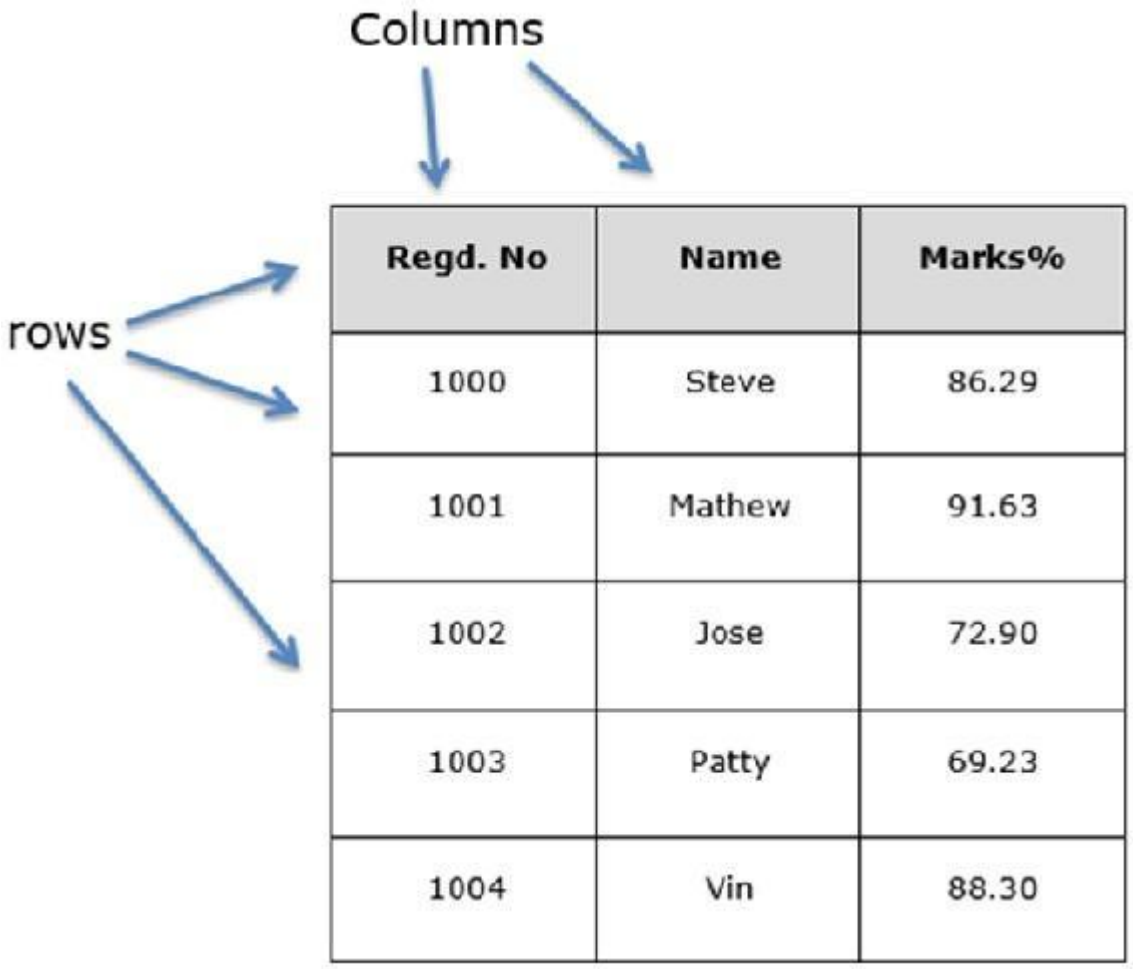
Features of DataFrame

- **Potentially columns are of different types**
- **Size – Mutable**
- **Labeled axes (rows and columns)**

- **Can Perform Arithmetic operations on rows and columns**

Structure

Let us assume that we are creating a data frame with student's data.



Regd. No	Name	Marks%
1000	Steve	86.29
1001	Mathew	91.63
1002	Jose	72.90
1003	Patty	69.23
1004	Vin	88.30

You can think of it as an SQL table or a spreadsheet data representation.

pandas.DataFrame

A pandas DataFrame can be created using the following constructor −

```
pandas.DataFrame( data, index, columns, dtype, copy)
```

The parameters of the constructor are as follows −

Sr.No	Parameter & Description
1	**data** **data takes various forms like ndarray, series, map, lists, dict,** **constants and also another DataFrame.**
2	**index**

	For the row labels, the Index to be used for the resulting frame is Optional Default np.arange(n) if no index is passed.
3	columns For column labels, the optional default syntax is - np.arange(n). This is only true if no index is passed.
4	dtype Data type of each column.
5	copy This command (or whatever it is) is used for copying of data, if the default is False.

Create DataFrame

A pandas DataFrame can be created using various inputs like −

- **Lists**
- **dict**
- **Series**
- **Numpy ndarrays**
- **Another DataFrame**

In the subsequent sections of this chapter, we will see how to create a DataFrame using these inputs.

Create an Empty DataFrame

A basic DataFrame, which can be created is an Empty Dataframe.

Example

```
#import the pandas library and aliasing as pd
import pandas as pd
df = pd.DataFrame()
print df
```

Its output is as follows −

```
Empty DataFrame
Columns: []
Index: []
```

Create a DataFrame from Lists

The DataFrame can be created using a single list or a list of lists.

Example 1

```
import pandas as pd
data = [1,2,3,4,5]
df = pd.DataFrame(data)
print df
```

Its output is as follows −

```
     0
0    1
1    2
2    3
3    4
4    5
```

Example 2

```
import pandas as pd
data = [['Alex',10],['Bob',12],['Clarke',13]]
df = pd.DataFrame(data,columns=['Name','Age'])
print df
```

Its output is as follows −

```
      Name      Age
0     Alex      10
1     Bob       12
2     Clarke    13
```

Example 3

```
import pandas as pd
data = [['Alex',10],['Bob',12],['Clarke',13]]
df = pd.DataFrame(data,columns=['Name','Age'],dtype=float)
print df
```

Its output is as follows −

```
      Name     Age
0     Alex     10.0
1     Bob      12.0
2     Clarke   13.0
```

Note − Observe, the dtype parameter changes the type of Age column to floating point.

Create a DataFrame from Dict of ndarrays / Lists

All the ndarrays must be of same length. If index is passed, then the length of the index should equal to the length of the arrays.

If no index is passed, then by default, index will be range(n), where n is the array length.

Example 1

```
import pandas as pd
data = {'Name':['Tom', 'Jack', 'Steve', 'Ricky'],'Age':[28,34,29,42]}
df = pd.DataFrame(data)
print df
```

Its output is as follows −

```
      Age      Name
0     28         Tom
1     34       Jack
2     29      Steve
3     42      Ricky
```

Note − Observe the values 0,1,2,3. They are the default index assigned to each using the function range(n).

Example 2

Let us now create an indexed DataFrame using arrays.

```
import pandas as pd
data = {'Name':['Tom', 'Jack', 'Steve', 'Ricky'],'Age':[28,34,29,42]}
df = pd.DataFrame(data, index=['rank1','rank2','rank3','rank4'])
print df
```

Its output is as follows −

```
         Age    Name
rank1    28      Tom
rank2    34     Jack
rank3    29    Steve
rank4    42    Ricky
```

Note − Observe, the index parameter assigns an index to each row.

Create a DataFrame from List of Dicts

List of Dictionaries can be passed as input data to create a DataFrame. The dictionary keys are by default taken as column names.

Example 1

The following example shows how to create a DataFrame by passing a list of dictionaries.

```
import pandas as pd
data = [{'a': 1, 'b': 2},{'a': 5, 'b': 10, 'c': 20}]
df = pd.DataFrame(data)
print df
```

Its output is as follows −

```
    a    b      c
0   1   2     NaN
1   5   10   20.0
```

Note − Observe, NaN (Not a Number) is appended in missing areas.

Example 2

The following example shows how to create a DataFrame by passing a list of dictionaries and the row indices.

```
import pandas as pd
data = [{'a': 1, 'b': 2},{'a': 5, 'b': 10, 'c': 20}]
df = pd.DataFrame(data, index=['first', 'second'])
print df
```

Its output is as follows −

```
        a   b       c
first   1   2     NaN
second  5   10   20.0
```

Example 3

The following example shows how to create a DataFrame with a list of dictionaries, row indices, and column indices.

```
import pandas as pd
data = [{'a': 1, 'b': 2},{'a': 5, 'b': 10, 'c': 20}]

#With two column indices, values same as dictionary keys
df1 = pd.DataFrame(data, index=['first', 'second'], columns=['a', 'b'])

#With two column indices with one index with other name
df2 = pd.DataFrame(data, index=['first', 'second'], columns=['a', 'b1'])
print df1
print df2
```

Its output is as follows −

```
#df1 output
         a  b
first    1  2
second   5  10

#df2 output
         a  b1
first    1  NaN
second   5  NaN
```

Note − Observe, df2 DataFrame is created with a column index other than the dictionary key; thus, appended the NaN's in place. Whereas, df1 is created with column indices same as dictionary keys, so NaN's appended.

Create a DataFrame from Dict of Series

Dictionary of Series can be passed to form a DataFrame. The resultant index is the union of all the series indexes passed.

Example

```
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd'])}

df = pd.DataFrame(d)
print df
```

Its output is as follows −

```
      one    two
a     1.0    1
b     2.0    2
c     3.0    3
d     NaN    4
```

Note − Observe, for the series one, there is no label 'd' passed, but in the result, for the d label, NaN is appended with NaN.

Let us now understand column selection, addition, and deletion through examples.

Column Selection

We will understand this by selecting a column from the DataFrame.

Example

```
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd'])}

df = pd.DataFrame(d)
print df ['one']
```

Its output is as follows −

```
a     1.0
b     2.0
c     3.0
d     NaN
Name: one, dtype: float64
```

Column Addition

We will understand this by adding a new column to an existing data frame.

Example

```
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd'])}

df = pd.DataFrame(d)

# Adding a new column to an existing DataFrame object with column label by
passing new series

print ("Adding a new column by passing as Series:")
df['three']=pd.Series([10,20,30],index=['a','b','c'])
print df

print ("Adding a new column using the existing columns in DataFrame:")
df['four']=df['one']+df['three']

print df
```

Its output is as follows −

```
Adding a new column by passing as Series:
     one   two   three
a    1.0    1    10.0
b    2.0    2    20.0
c    3.0    3    30.0
d    NaN    4    NaN

Adding a new column using the existing columns in DataFrame:
      one   two   three    four
a     1.0    1    10.0     11.0
b     2.0    2    20.0     22.0
c     3.0    3    30.0     33.0
d     NaN    4     NaN     NaN
```

Column Deletion

Columns can be deleted or popped; let us take an example to understand how.

Example

```
# Using the previous DataFrame, we will delete a column
# using del function
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd']),
   'three' : pd.Series([10,20,30], index=['a','b','c'])}

df = pd.DataFrame(d)
print ("Our dataframe is:")
print df

# using del function
print ("Deleting the first column using DEL function:")
del df['one']
print df

# using pop function
print ("Deleting another column using POP function:")
df.pop('two')
print df
```

Its output is as follows −

```
Our dataframe is:
      one   three  two
a     1.0    10.0   1
b     2.0    20.0   2
c     3.0    30.0   3
d     NaN     NaN   4

Deleting the first column using DEL function:
      three    two
a     10.0     1
b     20.0     2
c     30.0     3
d     NaN      4

Deleting another column using POP function:
   three
a  10.0
b  20.0
c  30.0
d  NaN
```

Row Selection, Addition, and Deletion

We will now understand row selection, addition and deletion through examples. Let us begin with the concept of selection.

Selection by Label

Rows can be selected by passing row label to a loc function.

```
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd'])}

df = pd.DataFrame(d)
print df.loc['b']
```

Its output is as follows −

```
one 2.0
two 2.0
Name: b, dtype: float64
```

The result is a series with labels as column names of the DataFrame. And, the Name of the series is the label with which it is retrieved.

Selection by integer location

Rows can be selected by passing integer location to an iloc function.

```
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd'])}

df = pd.DataFrame(d)
print df.iloc[2]
```

Its output is as follows −

```
one   3.0
two   3.0
Name: c, dtype: float64
```

Slice Rows

Multiple rows can be selected using ' : ' operator.

```
import pandas as pd

d = {'one' : pd.Series([1, 2, 3], index=['a', 'b', 'c']),
   'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd'])}

df = pd.DataFrame(d)
print df[2:4]
```

Its output is as follows −

```
   one  two
c  3.0    3
d  NaN    4
```

Addition of Rows

Add new rows to a DataFrame using the append function. This function will append the rows at the end.

```
import pandas as pd

df = pd.DataFrame([[1, 2], [3, 4]], columns = ['a','b'])
df2 = pd.DataFrame([[5, 6], [7, 8]], columns = ['a','b'])

df = df.append(df2)
print df
```

Its output is as follows −

```
   a  b
0  1  2
```

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

Deletion of Rows

Use index label to delete or drop rows from a DataFrame. If label is duplicated, then multiple rows will be dropped.

If you observe, in the above example, the labels are duplicate. Let us drop a label and will see how many rows will get dropped.

```
import pandas as pd

df = pd.DataFrame([[1, 2], [3, 4]], columns = ['a','b'])
df2 = pd.DataFrame([[5, 6], [7, 8]], columns = ['a','b'])

df = df.append(df2)

# Drop rows with label 0
df = df.drop(0)

print df
```

Its output is as follows −

```
  a b
1 3 4
1 7 8
```

In the above example, two rows were dropped because those two contain the same label 0.