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1 CS/STAT 180 Lab 3: Intro to Pandas

[1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

1.1 Introduction:

Welcome to your first pandas lab!

Much of this lab has been adapted from this link pandas introduction lab from the ACME major. Feel free to read through it and use it as you complete this lab.

1.1.1 Lab Objective:

The goal of this lab is for you to become more comfortable in Python's pandas library. We'll introduce you to pandas data structures, syntax, and powerful capacity.

1.1.2 Important Hints

Notice that most of the functions we learn about in this lab return new values. In order to save these values, we must store them.

For example, `df.drop(columns=['column1'])` will drop the column1 from df, but we must call `df = df.drop(columns=['column1'])` to store the changed dataframe. Alternatively, you can set the `inplace` argument to `True` to save changes to the df without explicit reassignment.

Series: The following cell creates a pandas series, which is essentially a list with an index for each entry in the list. The index is generally used as a label for the data. In this example, the name serves as the index.

[2]:

```
# Run the below cell to create a new Series:
math = pd.Series([80, 96, 78, 59],['Mark', 'Barbara', 'Eleanor', 'David'])
print(math)
```

```
Mark       80
Barbara    96
Eleanor    78
David      59
dtype: int64
```

Notice that each element in the above series ‘math’ is a number 1-100, and each of these elements are labeled with a name. The dtype (data type) of this series is an int64. Let’s say these numbers represent each student’s grade in their math class.

1.2 Exercise 1: Pandas Series

Create a pandas series of type int64 called ‘english’ storing our four student’s english grades:

Mark -> 90

Barbara -> 87

Eleanor -> 97

David -> 65

[3]:

```
#Create a pandas series below:
english = pd.Series([90, 87, 97, 65], ['Mark', 'Barbara', 'Eleanor', 'David'])
print(english)
```

```
Mark       90
Barbara    87
Eleanor    97
David      65
dtype: int64
```

DataFrame

The next, and most important, data structure in pandas is the DataFrame. A DataFrame is a collection of multiple Series objects, and it is essentially a 2d array/list with each row labeled by an index, and each column labeled as a column.

Below we initialize a DataFrame, ‘simple_grades’, using the ‘math’ and ‘english’ Series that we created above.

[4]:

```
simple_grades = pd.DataFrame({"Math": math, "English": english})
print(simple_grades)
```

```
         Math  English
Mark       80       90
Barbara    96       87
Eleanor    78       97
David      59       65
```

Notice that we now have numbers that are labelled twice. Mark’s English grade is an 90. Eleanor’s Math grade is a 78.

We can also initialize a DataFame using a NumPy array, since pandas is built on top of NumPy. We do that below and call it ‘grades’.

[5]:
```
data = np.array([[52.0, 73.0], [10.0, 39.0], [35.0, np.nan], [np.nan, 26.0],[np.
 ↪nan,99.0],[81.0,68.0]])
grades = pd.DataFrame(data, columns = ['Math', 'English'], index =␣
 ↪['Barbara','David','Eleanor','Greg','Lauren','Mark'])
```

[6]:
```
# look at the column labels of grades
print(grades.columns)

# look at the index labels of grades
print(grades.index)

# look at the values (2d array) of grades
print(grades.values)
```

```
Index(['Math', 'English'], dtype='object')
Index(['Barbara', 'David', 'Eleanor', 'Greg', 'Lauren', 'Mark'], dtype='object')
[[52. 73.]
 [10. 39.]
 [35. nan]
 [nan 26.]
 [nan 99.]
 [81. 68.]]
```

1.3 Exercise 2:

To access data in a DataFrame, we use the .loc and the .iloc indexers.

The .loc index selects rows and columns based on their labels. In the below examples, we are looking at the rows of ‘David’ and ‘Greg’, while only viewing the ‘Math’ column. Notice that a list of indices is used to view multiple rows by name.

[7]:
```
grades.loc[['David','Greg'],'Math']
```

[7]:
```
David     10.0
Greg       NaN
Name: Math, dtype: float64
```

The .iloc method selects rows and columns based on their integer position

[8]:
```
grades.iloc[[1,3],0]
```

[8]:
```
David     10.0
Greg       NaN
Name: Math, dtype: float64
```

Use `.loc` to print Eleanor and Mark’s grades in both English and Math

[9]:

```
grades.loc[["Eleanor", "Mark"], ["Math", "English"]]
```

[9]:

```
         Math  English
Eleanor  35.0      NaN
Mark     81.0     68.0
```

You can access an entire column of a DataFrame by using simple square brackets and the name of the column.

[10]:

```
grades['Math']
```

[10]:

```
Barbara    52.0
David      10.0
Eleanor    35.0
Greg        NaN
Lauren      NaN
Mark       81.0
Name: Math, dtype: float64
```

Using the same logic, we can also create a new column using either a numpy array, a list, or a single value.

[11]:

```
grades['History'] = np.random.randint(0, 100, 6)
grades['History'] = 100
```

To view the beginning of a DataFrame, we can use .head(n). This makes it a lot easier to get an idea of what the data look like without printing the entire dataframe (especially when the df is huge!).

[12]:

```
grades.head(3)
```

[12]:

```
         Math  English  History
Barbara  52.0     73.0      100
David    10.0     39.0      100
Eleanor  35.0      NaN      100
```

You can use .reindex to change the order of either the rows or columns, and .sort_values to sort the DataFrame by a specified column value.

[13]:

```
grades.reindex(columns = ['English', 'Math', 'History'])
grades.sort_values('Math', ascending = False)
```

[13]:

```
         Math  English  History
Mark     81.0     68.0      100
Barbara  52.0     73.0      100
Eleanor  35.0      NaN      100
David    10.0     39.0      100
Greg      NaN     26.0      100
Lauren    NaN     99.0      100
```

You can also drop columns from a dataframe by using df.drop(columns=[])

[14]:
```
grades.drop(columns = ['Math'])
```

[14]:
```
         English  History
Barbara     73.0      100
David       39.0      100
Eleanor      NaN      100
Greg        26.0      100
Lauren      99.0      100
Mark        68.0      100
```

1.4 Exercise 3: Girlfriend Vs. Fortnite

The costs.csv downloaded earlier contains an estimate of my costs over the past few semesters. * Read in the costs.csv file (Hint: try looking at pandas.read_csv()) * Add a column called 'girlfriend' with all values set to 500 * Reindex the columns such that the amount spent on rent is the first column and the other columns stay in the same order * Sort the DataFrame in descending order based on how much I spent on fortnite_skins * Reset all the values in the rent column to 1000

[15]:
```
#Girl Friend Data
!curl -o costs.csv https://raw.githubusercontent.com/wingated/cs180_labs/main/
 ↪costs.csv
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   125  100   125    0     0    384      0 --:--:-- --:--:-- --:--:--   383
--:--:-- --:--:-- --:--:--     0
```

[16]:
```
import pandas as pd

df = pd.read_csv("costs.csv")

df['girlfriend'] = 500
cols = ['rent'] + [col for col in df.columns if col != 'rent']
df = df[cols]
df = df.sort_values(by = 'fortnite_skins', ascending = False) # descending order
df['rent'] = 1000
display(df.head())
```

```
   rent  books  food  fortnite_skins  girlfriend
2  1000    300   775              40         500
3  1000    312   750              18         500
4  1000    330   712              16         500
0  1000    385   800              15         500
1  1000    280   700              10         500
```

1.5 Exercise 4: Pandas Methods

Pandas DataFrames provide many useful methods for summarizing and analyzing data:

- `.mean()`: Computes the mean (average) of each column.
- `.max()`: Returns the maximum value in each column.
- `.sum()`: Calculates the sum of each column.
- `.min()`: Returns the minimum value in each column.
- `.count()`: Counts the number of non-null values in each column.
- `.std()`: Computes the standard deviation of each column.

These methods can be used on the entire DataFrame or on specific columns or rows. For example, `df['column'].mean()` computes the mean of a single column, while `df.mean()` computes the mean for all numeric columns. Most of these methods ignore missing values (`NaN`) by default, making them robust for real-world data analysis.

Calculate the mean cost of each column in the costs DataFrame in the cell below.

```
[17]: display(df.mean())
```

```
rent              1000.000000
books              287.833333
food               772.833333
fortnite_skins      17.333333
girlfriend         500.000000
dtype: float64
```

1.6 Exercise 5: Supplements

Now we will return to the grades DataFrame that we created earlier.

Dealing with missing data is a difficult topic in data science. The pandas default for missing values is NaN. These can be difficult to deal with because any operation (addition, multiplication, etc) involving an NaN value will always result in an NaN, so finding the mean of a column or adding up all the rows will be meaningless.

What do we do with NaN values? The answer is always: it depends, but we should also ask: why do we have missing values? It could be that some people only filled out half the survey, it could be that the data should read 0.0 but it wasn't filled out. It could mean (in our example) that the student isn't enrolled in that class. It could be many reasons, and we should always figure them out first!

In pandas we can do a couple things with NaN values.

To drop all rows containing NaN values, we can simply call DataFrame.dropna()

Or we could fill the NaN values with a specified value, like 0.0:

```
[18]: grades.fillna(0.0)
```

```
[18]:          Math  English  History
      Barbara  52.0     73.0      100
      David    10.0     39.0      100
      Eleanor  35.0      0.0      100
      Greg      0.0     26.0      100
      Lauren    0.0     99.0      100
```

```
Mark      81.0      68.0       100
```

The supplements.csv downloaded below contains vitamin information (in mg) for 20 different supplements I'm considering as I get ready for summer: * Read in the supplements.csv file * Fill all the na values using backwards filling, that is, set method='bfill' (HINT: put method='bfill' in the function call! Google it if you're confused) * Sort the DataFrame by my most important vitamin, vitamin b6, in descending order * Use .drop() to create a new df, subset_df, containing all the vitamins in the supplements file except vitamin_d * Create a boxplot of all columns in subset_df (hint - make sure to call plt.show() at the end!!)

[19]:

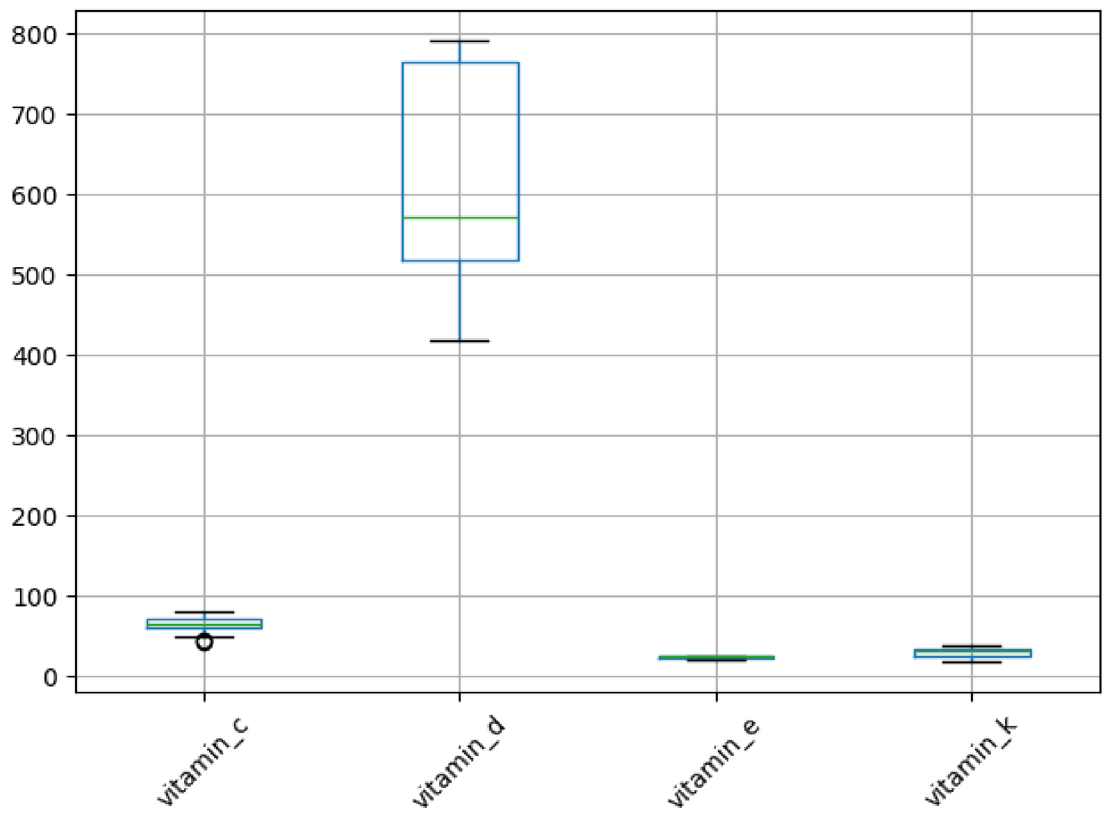
```
!curl -o supplements.csv https://raw.githubusercontent.com/porterjenkins/CS180/
  ↪main/data/supplements.csv
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   338  100   338    0     0   1028      0 --:--:-- --:--:-- --:--:--  1030
```

[20]:

```
import pandas as pd
import matplotlib.pyplot as plt
df = pd.read_csv("supplements.csv")
df = df.bfill()
df = df.sort_values(by = "vitamin_b6", ascending = False)
subset_df = df.drop(columns = ["vitamin_b6"])
subset_df.boxplot(rot = 45)
plt.tight_layout()
plt.show()

display(df)
```



```
    vitamin_c  vitamin_d  vitamin_e  vitamin_k  vitamin_b6
15       77.0      790.0       23.0       23.0        10.0
14       80.0      790.0       23.0       38.0        10.0
2        71.0      664.0       22.0       30.0         9.0
3        49.0      506.0       20.0       37.0         9.0
9        59.0      476.0       20.0       32.0         9.0
10       65.0      585.0       24.0       18.0         8.0
5        69.0      417.0       24.0       38.0         8.0
7        59.0      768.0       24.0       31.0         8.0
11       80.0      516.0       23.0       30.0         7.0
18       68.0      517.0       24.0       20.0         6.0
0        65.0      547.0       21.0       25.0         6.0
1        65.0      744.0       21.0       25.0         6.0
6        51.0      556.0       20.0       31.0         5.0
17       42.0      764.0       22.0       20.0         5.0
12       59.0      591.0       23.0       30.0         3.0
19       68.0      770.0       24.0       31.0         3.0
8        69.0      439.0       24.0       37.0         1.0
16       71.0      771.0       24.0       18.0         1.0
13       60.0      549.0       22.0       32.0         0.0
4        43.0      520.0       24.0       23.0         0.0
```

1.7 Exercise 6

Write something that you noticed in the supplements data. Feel free to poke around, plot some more things, and find something interesting!

[21]:

```
"""
I find it interesting that there are no names for the supplements. They are␣
 ↪just numbered.
"""
```

[21]:

```
'\nI find it interesting that there are no names for the supplements. They are
just numbered. \n'
```

I thoroughly enjoyed this lab, I can image a lot of real world applications for this library and for what we did in this lab(obviously on a much larger scale).