Homework 3

Please submit the solution to gradescope by 11:59 PM, Oct 10, Thursday.

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In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import requests
from bs4 import BeautifulSoup
```

1. DataFrame with MultiIndex (12 points)

You are given the following MultiIndexed DataFrame temperature_data which contains monthly average temperatures (in °C) for different cities over two years.

- 1.1. Display the temperature data for the year 2019.
- 1.2. Display the temperature data for 'New York' city across all years.
- 1.3. Display the temperature data for the month of 'Jan' across all cities and years.
- 1.4. Display temperature data for 'Los Angeles' city for the year 2020.
- 1.5. Display the temperature data for the 'Chicago' and 'Houston' cities for the month of 'Feb' in the year 2019.
- 1.6. Display the temperature data for the months 'Mar' and 'Apr' for all cities in the year 2020.

In [ ]:
```
index = pd.MultiIndex.from_product(
    [['2019', '2020'], ['New York', 'Los Angeles', 'Chicago', 'Houston'], [
    names=['Year', 'City', 'Month']
)

np.random.seed(42)
data = np.random.uniform(-10, 35, size=(32, 1))

temperature_data = pd.DataFrame(data, index=index, columns=['Avg_Temperatur
temperature_data.sort_index(inplace=True)
temperature_data
```

Out[ ]:

			Avg_Temperature

Year	City	Month	
2019	Chicago	Apr	33.645943
		Feb	21.863266
		Jan	17.050176
		Mar	-9.073698
	Houston	Apr	-1.746797
		Feb	-0.444740
		Jan	27.459919
		Mar	-1.817876
	Los Angeles	Apr	28.977927
		Feb	-2.980247
		Jan	-2.979161
		Mar	-7.386237
	New York	Apr	16.939632
		Feb	32.782144
		Jan	6.854305
		Mar	22.939727
2020	Chicago	Apr	13.140550
		Feb	25.332918
		Jan	10.523149
		Mar	-1.014680
	Houston	Apr	-2.326414
		Feb	-7.909731
		Jan	16.658656
		Mar	17.339518
	Los Angeles	Apr	6.486283
		Feb	-3.722776
		Jan	17.533380
		Mar	3.146509
	New York	Apr	3.105311
		Feb	13.614039

		Jan	3.690901
		Mar	9.437526

In [ ]:
```
#1.1
temperature_data.loc[:"2019"]
```

Out[ ]:

			Avg_Temperature
Year	City	Month	
2019	Chicago	Apr	33.645943
		Feb	21.863266
		Jan	17.050176
		Mar	-9.073698
	Houston	Apr	-1.746797
		Feb	-0.444740
		Jan	27.459919
		Mar	-1.817876
	Los Angeles	Apr	28.977927
		Feb	-2.980247
		Jan	-2.979161
		Mar	-7.386237
	New York	Apr	16.939632
		Feb	32.782144
		Jan	6.854305
		Mar	22.939727

In [ ]:
```
#1.2
temperature_data.loc[:, 'New York', :]
```

Out[ ]:

Year	Month	Avg_Temperature
2019	Apr	16.939632
	Feb	32.782144
	Jan	6.854305
	Mar	22.939727
2020	Apr	3.105311
	Feb	13.614039
	Jan	3.690901
	Mar	9.437526

In [ ]:
```
#1.3
temperature_data.loc[:, :, "Jan"]
```

Out[ ]:

Year	City	Avg_Temperature
2019	Chicago	17.050176
	Houston	27.459919
	Los Angeles	-2.979161
	New York	6.854305
2020	Chicago	10.523149
	Houston	16.658656
	Los Angeles	17.533380
	New York	3.690901

In [ ]:
```
#1.4
temperature_data.loc["2020", "Los Angeles", :]
```

Out[ ]:

Month	Avg_Temperature
Apr	6.486283
Feb	-3.722776
Jan	17.533380
Mar	3.146509

In [ ]:
```
#1.5
temperature_data.loc[("2019", ["Chicago", "Houston"], "Feb")]
```

Out[ ]:

Year	City	Month	Avg_Temperature
2019	**Chicago**	**Feb**	21.863266
	Houston	**Feb**	-0.444740

In [ ]:
```
#1.6
temperature_data.loc["2020", :, ["Mar", "Apr"]]
```

Out[ ]:

Year	City	Month	Avg_Temperature
2020	**Chicago**	**Mar**	-1.014680
	Houston	**Mar**	17.339518
	Los Angeles	**Mar**	3.146509
	New York	**Mar**	9.437526
	Chicago	**Apr**	13.140550
	Houston	**Apr**	-2.326414
	Los Angeles	**Apr**	6.486283
	New York	**Apr**	3.105311

2. Data Merge and Join (68 points)

2.1 Load `product_data.csv` and `sales_data.csv` as DataFrames. (2 points) (In the columns, both `ProductID` and `ID_Product` refers to the product ID.)

2.2 Calculate Total Quantity Sold per Product, i.e., create a pd.Series called `product_sales_df` that contains the sales data for each product and display it. The index of the pd.Series is the product name. (10 points)

2.3 Perform a join to merge `product_sales_df` with the product data on ProductID to include all products. Why does the merged table have missing data? (10 points)

2.4 Fill the missing data in the table from 2.3 with 0. Calculate total and average quantities sold for each category, i.e., create a new DataFrame that contains three columns: `Category`, `TotalQuantitySold`, and `AverageQuantitySold`. (5 points)

2.5 Calculate the total revenue per product and identifying the product that generated the highest revenue. The revenue equals the `sales` $\times$ `unit price`. (10 points)

2.6 Identify Top Products per Category Based on Total Quantity Sold, i.e., create a table with three columns. The first column is the `category` name, the second column is the name of the product with the highest sales in that category, and the third column is the sales for that product. (10 points)

2.7 Create a table with two layers of row index, showing the total revenue for each category in each month. The first row index is the category and the second row index is the month. (5 points)

2.8 Creat a histogram to show the total quantity sold per category. Properly display the x-axis, y-axis and the title of the plot. (6 points)

2.9 Create a pivot table of the total quantity and the average quantity sold by product and month. The row index should be the product name, and the column index has two layers: The upper layer is the month, and the lower layer is the `TotalQuantity` and `AverageQuantity`. For example, the first column index in the upper layer is `2023-01`. Under `2023-01`, there are two columns named `AverageQuantity` (mean) and `TotalQuantity` (sum). (10 points)

Hint: You can use swaplevel function in pd.DataFrame to change the index layer. For example: `pivot_table = pivot_table.swaplevel(0, 1, axis=1)` can swap the index layer for the pivot table

In [ ]:
```
# 2.1
product_data = pd.read_csv("product_data.csv")
sales_data = pd.read_csv("sales_data.csv")
product_data
```

Out[ ]:

	ID_Product	ProductName	Category	UnitPrice
0	P101	Samsung Galaxy S21	Smartphones	799.99
1	P102	Apple iPhone 13	Smartphones	999.99
2	P103	HP Spectre x360	Laptops	1199.99
3	P104	Dell XPS 13	Laptops	1099.99
4	P105	Apple MacBook Air	Laptops	999.99
5	P106	LG OLED55CXPUA	Televisions	1499.99
6	P107	Sony WH-1000XM4	Headphones	349.99
7	P108	Bose QuietComfort 35 II	Headphones	299.99
8	P109	Canon EOS R5	Cameras	3899.99
9	P110	Nikon Z7 II	Cameras	2999.99
10	P111	Apple iPad Pro	Tablets	799.99
11	P112	Microsoft Surface Pro 7	Tablets	749.99
12	P113	Samsung Galaxy Tab S7	Tablets	649.99
13	P114	Sony PlayStation 5	Gaming Consoles	499.99
14	P115	Microsoft Xbox Series X	Gaming Consoles	499.99
15	P116	Apple Watch Series 6	Smartwatches	399.99
16	P117	Fitbit Versa 3	Smartwatches	229.99
17	P118	KitchenAid Stand Mixer	Home Appliances	379.99
18	P119	Instant Pot Duo 7-in-1	Home Appliances	89.99
19	P120	Roomba i7+ Robot Vacuum	Home Appliances	799.99
20	P132	Xerox Printer	Office Supply	129.99

In [ ]:
```
#2.2
product_sales_df = sales_data.groupby("ProductID")["Quantity"].sum()
product_sales_df
```

Out[ ]:
```
ProductID
P101    3
P102    2
P103    3
P104    2
P105    5
P106    2
P107    4
P108    5
P109    1
P111    3
P112    2
P113    3
P114    2
P115    2
P116    3
P117    3
P118    2
P119    5
P120    2
Name: Quantity, dtype: int64
```

In [ ]:
```
#2.3
product_sales = pd.merge(product_sales_df, product_data,
         left_on="ProductID", right_on="ID_Product", how="outer")
product_sales
```

Out[ ]:

	Quantity	ID_Product	ProductName	Category	UnitPrice
0	3.0	P101	Samsung Galaxy S21	Smartphones	799.99
1	2.0	P102	Apple iPhone 13	Smartphones	999.99
2	3.0	P103	HP Spectre x360	Laptops	1199.99
3	2.0	P104	Dell XPS 13	Laptops	1099.99
4	5.0	P105	Apple MacBook Air	Laptops	999.99
5	2.0	P106	LG OLED55CXPUA	Televisions	1499.99
6	4.0	P107	Sony WH-1000XM4	Headphones	349.99
7	5.0	P108	Bose QuietComfort 35 II	Headphones	299.99
8	1.0	P109	Canon EOS R5	Cameras	3899.99
9	3.0	P111	Apple iPad Pro	Tablets	799.99
10	2.0	P112	Microsoft Surface Pro 7	Tablets	749.99
11	3.0	P113	Samsung Galaxy Tab S7	Tablets	649.99
12	2.0	P114	Sony PlayStation 5	Gaming Consoles	499.99
13	2.0	P115	Microsoft Xbox Series X	Gaming Consoles	499.99
14	3.0	P116	Apple Watch Series 6	Smartwatches	399.99
15	3.0	P117	Fitbit Versa 3	Smartwatches	229.99
16	2.0	P118	KitchenAid Stand Mixer	Home Appliances	379.99
17	5.0	P119	Instant Pot Duo 7-in-1	Home Appliances	89.99
18	2.0	P120	Roomba i7+ Robot Vacuum	Home Appliances	799.99
19	NaN	P110	Nikon Z7 II	Cameras	2999.99
20	NaN	P132	Xerox Printer	Office Supply	129.99

The merged table would have missing data in the Quantity column if certain products were not marked as sold.

In [ ]:
```
#2.4
product_sales = product_sales.fillna(0)
summaries = pd.DataFrame()
summaries["AverageQuantitySold"] = product_sales.groupby("Category")["Quant
summaries["TotalQuantitySold"] = product_sales.groupby("Category")["Quantit
summaries
```

Out[ ]:

Category	AverageQuantitySold	TotalQuantitySold
Cameras	0.500000	1.0
Gaming Consoles	2.000000	4.0
Headphones	4.500000	9.0
Home Appliances	3.000000	9.0
Laptops	3.333333	10.0
Office Supply	0.000000	0.0
Smartphones	2.500000	5.0
Smartwatches	3.000000	6.0
Tablets	2.666667	8.0
Televisions	2.000000	2.0

In [ ]:

```
#2.5
product_sales["Revenue"] = product_sales["Quantity"] * product_sales["UnitP
product_sales
```

Out[ ]:

	Quantity	ID_Product	ProductName	Category	UnitPrice	Revenue
0	3.0	P101	Samsung Galaxy S21	Smartphones	799.99	2399.97
1	2.0	P102	Apple iPhone 13	Smartphones	999.99	1999.98
2	3.0	P103	HP Spectre x360	Laptops	1199.99	3599.97
3	2.0	P104	Dell XPS 13	Laptops	1099.99	2199.98
4	5.0	P105	Apple MacBook Air	Laptops	999.99	4999.95
5	2.0	P106	LG OLED55CXPUA	Televisions	1499.99	2999.98
6	4.0	P107	Sony WH-1000XM4	Headphones	349.99	1399.96
7	5.0	P108	Bose QuietComfort 35 II	Headphones	299.99	1499.95
8	1.0	P109	Canon EOS R5	Cameras	3899.99	3899.99
9	3.0	P111	Apple iPad Pro	Tablets	799.99	2399.97
10	2.0	P112	Microsoft Surface Pro 7	Tablets	749.99	1499.98
11	3.0	P113	Samsung Galaxy Tab S7	Tablets	649.99	1949.97
12	2.0	P114	Sony PlayStation 5	Gaming Consoles	499.99	999.98
13	2.0	P115	Microsoft Xbox Series X	Gaming Consoles	499.99	999.98
14	3.0	P116	Apple Watch Series 6	Smartwatches	399.99	1199.97
15	3.0	P117	Fitbit Versa 3	Smartwatches	229.99	689.97
16	2.0	P118	KitchenAid Stand Mixer	Home Appliances	379.99	759.98
17	5.0	P119	Instant Pot Duo 7-in-1	Home Appliances	89.99	449.95
18	2.0	P120	Roomba i7+ Robot Vacuum	Home Appliances	799.99	1599.98
19	0.0	P110	Nikon Z7 II	Cameras	2999.99	0.00
20	0.0	P132	Xerox Printer	Office Supply	129.99	0.00

In [ ]:

```
#2.6
product_sales = product_sales.set_index('ProductName')

category_quantity = pd.DataFrame({
    "Sales" :  product_sales.groupby("Category")["Revenue"].max(),
    "Product_Name" : product_sales.groupby("Category")["Revenue"].idxmax()
```

```
    })

category_quantity
```

Out[ ]:

Category	Sales	Product_Name
Cameras	3899.99	Canon EOS R5
Gaming Consoles	999.98	Sony PlayStation 5
Headphones	1499.95	Bose QuietComfort 35 II
Home Appliances	1599.98	Roomba i7+ Robot Vacuum
Laptops	4999.95	Apple MacBook Air
Office Supply	0.00	Xerox Printer
Smartphones	2399.97	Samsung Galaxy S21
Smartwatches	1199.97	Apple Watch Series 6
Tablets	2399.97	Apple iPad Pro
Televisions	2999.98	LG OLED55CXPUA

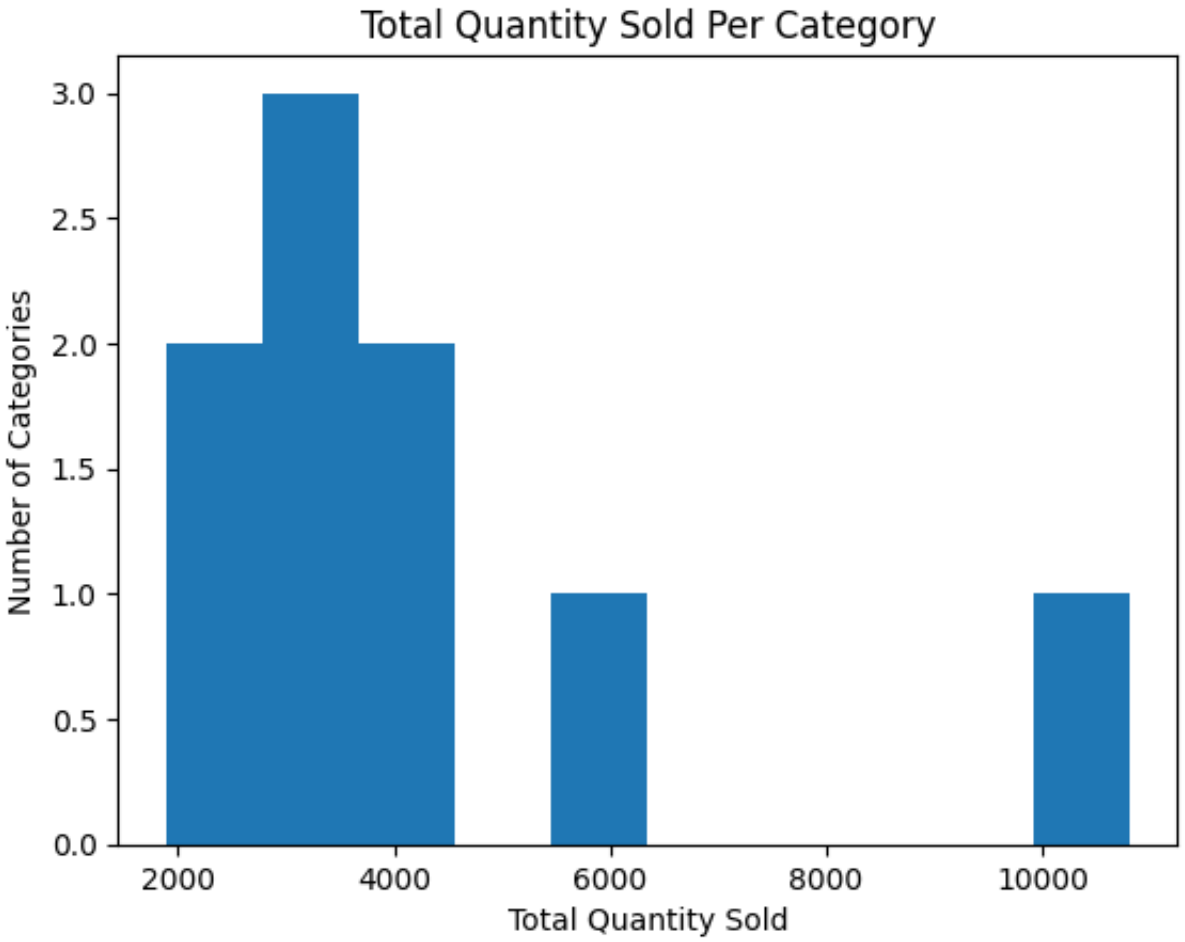
In [ ]:
```
#2.7
sales_product_data = pd.merge(
    sales_data, product_data,
    left_on="ProductID", right_on="ID_Product"
    )

sales_product_data["Revenue"] = sales_product_data["Quantity"] * sales_prod

sales_product_data.groupby(by=["Month", "Category"])["Revenue"].sum()
```

Out[ ]:
```
Month    Category
2023-01  Cameras            3899.99
         Gaming Consoles     999.98
         Headphones         2299.93
         Home Appliances    1449.95
         Laptops            8599.92
         Smartphones        4399.95
         Smartwatches       1259.96
         Tablets            3649.95
         Televisions        2999.98
2023-02  Gaming Consoles     999.98
         Headphones          599.98
         Home Appliances    1359.96
         Laptops            2199.98
         Smartwatches        629.98
         Tablets            2199.97
Name: Revenue, dtype: float64
```

In [ ]:
```
#2.8
plt.hist(
    sales_product_data.groupby("Category")["Revenue"].sum()
    )
plt.xlabel("Total Quantity Sold")
plt.ylabel("Number of Categories")
plt.title("Total Quantity Sold Per Category");
```



In [ ]:
```
#2.9
pivot_table = sales_product_data.pivot_table(
    index='ProductName', columns=['Month'],
    values='Quantity', aggfunc=['sum', 'mean'])
pivot_table.columns = pd.MultiIndex.from_product(
    [pivot_table.columns.levels[1],
     ['TotalQuantity', 'AverageQuantity']])
pivot_table
```

Out[ ]:

Month	2023-01		2023-02	
	TotalQuantity	AverageQuantity	TotalQuantity	AverageQuantity
ProductName				
Apple MacBook Air	4.0	1.0	2.0	1.0
Apple Watch Series 6	2.0	1.0	2.0	1.0
Apple iPad Pro	2.0	1.0	2.0	1.0
Apple iPhone 13	2.0	NaN	1.0	NaN
Bose QuietComfort 35 II	3.0	2.0	1.5	2.0
Canon EOS R5	1.0	NaN	1.0	NaN
Dell XPS 13	2.0	NaN	1.0	NaN
Fitbit Versa 3	2.0	1.0	2.0	1.0
HP Spectre x360	2.0	1.0	1.0	1.0
Instant Pot Duo 7-in-1	3.0	2.0	3.0	2.0
KitchenAid Stand Mixer	1.0	1.0	1.0	1.0
LG OLED55CXPUA	2.0	NaN	1.0	NaN
Microsoft Surface Pro 7	1.0	1.0	1.0	1.0
Microsoft Xbox Series X	1.0	1.0	1.0	1.0
Roomba i7+ Robot Vacuum	1.0	1.0	1.0	1.0
Samsung Galaxy S21	3.0	NaN	1.5	NaN
Samsung Galaxy Tab S7	2.0	1.0	2.0	1.0
Sony PlayStation 5	1.0	1.0	1.0	1.0
Sony WH-1000XM4	4.0	NaN	2.0	NaN

3. Webscrapping: Collect the Emails of all faculty in the STOR department (20 points)

Use web scrapping technique to collect the email information of all faculty in the UNC STOR department from the webpage: https://stor.unc.edu/people/faculty/

3.1. Create a pd.DataFrame that contains three columns: `faculty_name`, `title` and `email_address`. (10 points) For example, one row of the dataframe is `Liu, Mo`, `Assistant Professor`, and `Mo_Liu@unc.edu`.

3.2. Notice that in the DataFrame in 3.1, the last name and first name of each person are stored in the same column and separated by `,`. Create two new columns `First_Name` and `Last_Name` that contains the first name and last name seperately. (10 points)

In [ ]:
```
url = "http://stor.unc.edu/people/faculty"

# Call the GET request
response = requests.get(url)

soup = BeautifulSoup(response.text, "html.parser")
```

In [ ]:
```
#for a in soup.select(".bi-envelope+ a"):
    #print(a.get_text().strip())

scrape = ".js-wpv-view-layout-129 .row:nth-child(9) .faculty-holder , .facu

faculty_name = []
title = []
email_address = []

for a in soup.select(scrape):
    a = a.get_text().strip()
    if ", " in a:
        faculty_name.append(a)
    elif "Professor" in a:
        title.append(a)
    elif "unc.edu" in a:
        email_address.append(a)

print(len(faculty_name) == len(title) == len(email_address))
```

```
True
```

In [ ]:
```
# since the len of all three lists are the same
# and the text scrapes one line at a time
# we can match them up by index
faculty = pd.DataFrame({
```

```
    "faculty_name": faculty_name,
    "title": title,
    "email_address": email_address
})
faculty.head(10)
```

Out[ ]:

	faculty_name	title	email_address
0	Abayomi, Oluremi	Teaching Assistant Professor	abayomio@unc.edu
1	Banerjee, Sayan	Associate Professor	sayan@email.unc.edu
2	Budhiraja, Amarjit	Professor	amarjit@unc.edu
3	Fraiman, Nicolas	Associate Professor	fraiman@email.unc.edu
4	Hannig, Jan	Professor	jan.hannig@unc.edu
5	Ji, Chuanshu	Associate Professor	cji@email.unc.edu
6	Kulkarni, Vidyadhar	Professor	vkulkarn@email.unc.edu
7	Li, Yao	Assistant Professor	yaoli@ad.unc.edu
8	Liu, Mo	Assistant Professor	Mo_Liu@unc.edu
9	Marron, J. S. (Steve)	Distinguished Professor	marron@unc.edu

In [ ]:

```
# 3.2 - creating First_Name and Last_Name columns:
faculty = faculty.assign(First_Name='', Last_Name='')

# splitting and adding
for idx in range(0, len(faculty)):
    name = str(faculty["faculty_name"][idx])
    (last, first) = name.split(", ")
    faculty["First_Name"][idx] = first
    faculty["Last_Name"][idx] = last


faculty.head(10)
```

Out[ ]:

	faculty_name	title	email_address	First_Name	Last_Name
0	Abayomi, Oluremi	Teaching Assistant Professor	abayomio@unc.edu	Oluremi	Abayomi
1	Banerjee, Sayan	Associate Professor	sayan@email.unc.edu	Sayan	Banerjee
2	Budhiraja, Amarjit	Professor	amarjit@unc.edu	Amarjit	Budhiraja
3	Fraiman, Nicolas	Associate Professor	fraiman@email.unc.edu	Nicolas	Fraiman
4	Hannig, Jan	Professor	jan.hannig@unc.edu	Jan	Hannig
5	Ji, Chuanshu	Associate Professor	cji@email.unc.edu	Chuanshu	Ji
6	Kulkarni, Vidyadhar	Professor	vkulkarn@email.unc.edu	Vidyadhar	Kulkarni
7	Li, Yao	Assistant Professor	yaoli@ad.unc.edu	Yao	Li
8	Liu, Mo	Assistant Professor	Mo_Liu@unc.edu	Mo	Liu
9	Marron, J. S. (Steve)	Distinguished Professor	marron@unc.edu	J. S. (Steve)	Marron