Data Analysis, RIT Business Competition

In [1]:
```python
import folium
import requests
import json
import geojson
import numpy as np
import pandas as pd
import seaborn as sns
import typing
from datetime import datetime
from scipy.stats import percentileofscore
from matplotlib import pyplot as plt
from colorama import Fore


import warnings
from IPython.display import HTML, display
warnings.simplefilter(action='ignore', category=FutureWarning)
```

Data cleaning

Shops data

In [2]:
```python
df_info = pd.read_csv(r'pharm_info.csv')
```

In [3]:
```python
df_info.head()
```

Out[3]:

	storenum	storename	telephone	address1	address2	city	state	zipcode	zipcode4	longitude	latitude	website
0	2850.0	CVS - 1142	585-671-5665	1900 EMPIRE BOULEVARD	NaN	WEBSTER	NY	14580	1934.0	-77.501365	43.191229	HTTP://WWW.CVS.COM
1	2849.0	CVS - 2067	585-321-2581	2580 EAST HENRIETTA ROAD	NaN	ROCHESTER	NY	14623	4526.0	-77.606816	43.069235	HTTP://WWW.CVS.COM
2	2852.0	CVS - 2217	585-723-3051	878 LONG POND ROAD	NaN	GREECE	NY	14612	3049.0	-77.695905	43.238923	HTTP://WWW.CVS.COM
3	4603.0	CVS - 2218	585-581-5101	3750 MOUNT READ BOULEVARD	NaN	ROCHESTER	NY	14616	3436.0	-77.658331	43.227241	HTTP://WWW.CVS.COM
4	6057.0	CVS - 2501	585-426-2991	2709 CHILI AVENUE	NaN	ROCHESTER	NY	14624	4123.0	-77.709106	43.122328	HTTP://WWW.CVS.COM

In [4]:
```python
#Dropping stores with no store numbers and coercing type
df_info = df_info.dropna(subset=['storenum'])

#Changing zipcode dtype
df_info['zipcode'] = df_info['zipcode'].astype(str)
```

In [5]:
```python
df_info.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 69 entries, 0 to 68
Data columns (total 13 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   storenum   69 non-null     float64
 1   storename  69 non-null     object 
 2   telephone  69 non-null     object 
 3   address1   69 non-null     object 
 4   address2   2 non-null      object 
 5   city       69 non-null     object 
 6   state      69 non-null     object 
 7   zipcode    69 non-null     object 
 8   zipcode4   69 non-null     float64
 9   longitude  69 non-null     float64
 10  latitude   69 non-null     float64
 11  website    69 non-null     object 
 12  orgname    69 non-null     object 
dtypes: float64(4), object(9)
memory usage: 7.5+ KB
```

In [6]:
```python
#Dropping columns that I don't think will be useful for data analysis
df_info = df_info.drop(['telephone','address1','address2','state','website','zipcode4'],axis = 1)
```

In [7]:
```python
df_info.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 69 entries, 0 to 68
Data columns (total 7 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   storenum   69 non-null     float64
 1   storename  69 non-null     object 
 2   city       69 non-null     object 
 3   zipcode    69 non-null     object 
 4   longitude  69 non-null     float64
 5   latitude   69 non-null     float64
 6   orgname    69 non-null     object 
dtypes: float64(3), object(4)
memory usage: 4.3+ KB
```

Sales data

In [8]:
```python
df_sales = pd.read_csv(r'pharm_sales.csv')
```

In [9]:
```python
#Changing date column to datetime object
df_sales['date'] = pd.to_datetime(df_sales['date'])
df_sales.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 990746 entries, 0 to 990745
Data columns (total 10 columns):
 #   Column                Non-Null Count   Dtype         
---  ------                --------------   -----         
 0   invnum                990746 non-null  object        
 1   date                  990746 non-null  datetime64[ns]
 2   storenum              990746 non-null  int64         
 3   vendornum             990745 non-null  float64       
 4   itemnum               990746 non-null  int64         
 5   itemcategory          990746 non-null  object        
 6   productcost           990746 non-null  float64       
 7   product_retail_price  990746 non-null  float64       
 8   units_sold            990746 non-null  int64         
 9   sales_num             990745 non-null  float64       
dtypes: datetime64[ns](1), float64(4), int64(3), object(2)
memory usage: 75.6+ MB
```

Merging the two dataframes

In [10]:
```python
#Merging both of them using the storenumber field as that is unique for stores.

df_merged = pd.merge(df_sales, df_info, on='storenum', how = 'outer')
```

Renaming columns

In [11]:
```python
df_merged = df_merged.rename(columns = {'sales_num':'revenue_original'})
```

In [12]:
```python
df_merged.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 990746 entries, 0 to 990745
Data columns (total 16 columns):
 #   Column                Non-Null Count   Dtype         
---  ------                --------------   -----         
 0   invnum                990746 non-null  object        
 1   date                  990746 non-null  datetime64[ns]
 2   storenum              990746 non-null  int64         
 3   vendornum             990745 non-null  float64       
 4   itemnum               990746 non-null  int64         
 5   itemcategory          990746 non-null  object        
 6   productcost           990746 non-null  float64       
 7   product_retail_price  990746 non-null  float64       
 8   units_sold            990746 non-null  int64         
 9   revenue_original      990745 non-null  float64       
 10  storename             990746 non-null  object        
 11  city                  990746 non-null  object        
 12  zipcode               990746 non-null  object        
 13  longitude             990746 non-null  float64       
 14  latitude              990746 non-null  float64       
 15  orgname               990746 non-null  object        
dtypes: datetime64[ns](1), float64(6), int64(3), object(6)
memory usage: 128.5+ MB
```

In [13]:
```python
# Dropping nulls
df_merged = df_merged.dropna()

df_merged = df_merged.reset_index(drop=True)
```

Adding new fields and fixing types

In [14]:
```python
# Original sales figures are off, this is probably a safer bet, might ignore taxes
df_merged['revenue_original'] = df_merged['product_retail_price'] * df_merged['units_sold']

# Total cost per sale.
df_merged['inventory_cost'] = df_merged['productcost'] * df_merged['units_sold']

# inventory costs are 68% of a businesses cost
#https://blog.shelvingdesignsystems.com/what-does-it-really-cost-to-start-a-pharmacy
df_merged['total_cost'] = df_merged['inventory_cost']/0.68

#Cost of non inventory overhead
df_merged['overhead_cost'] = df_merged['total_cost'] - df_merged['inventory_cost']

# Profit per sale
df_merged['profit'] = df_merged['revenue_original'] - df_merged['total_cost']

# Margin per unit
df_merged['margin'] = df_merged['product_retail_price'] - df_merged['productcost']

# Making store number field a string
df_merged['storenum'] = df_merged['storenum'].astype(str)
```

In [15]:
```python
df_merged.info()
```

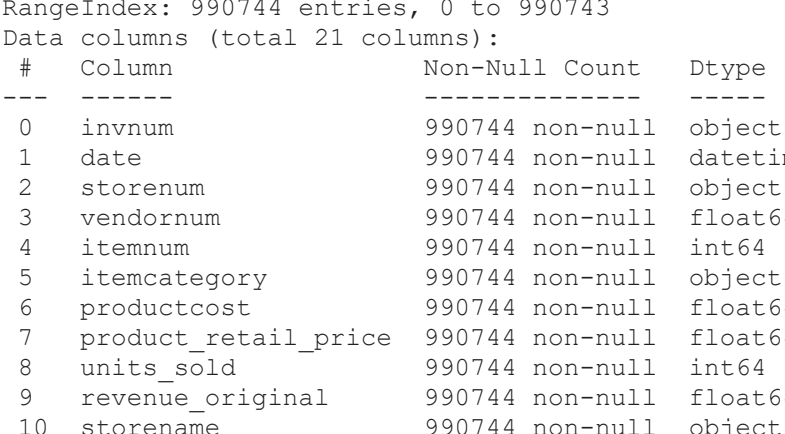
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 990744 entries, 0 to 990743
Data columns (total 21 columns):
 #   Column                Non-Null Count   Dtype         
---  ------                --------------   -----         
 0   invnum                990744 non-null  object        
 1   date                  990744 non-null  datetime64[ns]
 2   storenum              990744 non-null  object        
 3   vendornum             990744 non-null  float64       
 4   itemnum               990744 non-null  int64         
 5   itemcategory          990744 non-null  object        
 6   productcost           990744 non-null  float64       
 7   product_retail_price  990744 non-null  float64       
 8   units_sold            990744 non-null  int64         
 9   revenue_original      990744 non-null  float64       
 10  storename             990744 non-null  object        
 11  city                  990744 non-null  object        
 12  zipcode               990744 non-null  object        
 13  longitude             990744 non-null  float64       
 14  latitude              990744 non-null  float64       
 15  orgname               990744 non-null  object        
 16  inventory_cost        990744 non-null  float64       
 17  total_cost            990744 non-null  float64       
 18  overhead_cost         990744 non-null  float64       
 19  profit                990744 non-null  float64       
 20  margin                990744 non-null  float64       
dtypes: datetime64[ns](1), float64(11), int64(2), object(7)
memory usage: 158.7+ MB
```

The plot below will help me see whether I should worry too much about dropping shops or not.

If there is a huge range in variance between sales, then I should.

In [16]:
```python
df_merged.groupby(['date'])['units_sold'].sum().plot(color = 'green')
```

Out[16]:
```
<AxesSubplot:xlabel='date'>
```



Sale patterns are random, IE not that much yearly variation, thus I will drop pharmicies which made no sales in 2021, which I will assume is an indication for being closed.

Dropping shops that probably closed.

Do we know the stores closed beyond a shadow of a doubt? No.

However doing any analysis would be moot if we don't have the data normalized in some way shape or form. It seems to me the best way to do that would be to normalize over a specific period of time. And to further normalize the data, I'll drop stores that did not have any sales past the year of 2021, then analyze with only those stores over a reasonable timeframe, where the loss of data wouldn't be too high.

In [17]:
```python
#Making a new dataframe with only sales past 2021

df_merged_open = df_merged.loc[df_merged['date'] >= '2021-01-01']

df_merged_open = df_merged_open.reset_index(drop = True)
```

In [18]:
```python
# Finding the shops that had sales in 2021, and keeping the values in a variable to assign to another dataframe

shops_still_open = df_merged_open['storenum'].unique()

shops_still_open
```

Out[18]:
```
array(['3696', '2528', '5501', '5057', '5338', '5126', '2673', '4796',
       '5533', '4997', '4641', '2561', '4140', '5051', '2527', '4594',
       '2633', '2636', '2627', '4361', '2626', '4795', '5131', '2532',
       '5507', '5127', '5128', '4622', '2696', '4601', '4802', '4596',
       '5375', '4599', '4803', '4377', '4801', '4603', '5539', '2852',
       '2850', '3825', '4804', '4797', '4800', '5664', '4799', '2695',
       '5970', '5891', '6057', '6064'], dtype=object)
```

In [19]:
```python
# Number of stores still open.

df_merged_open['storenum'].nunique()
```

Out[19]:
```
52
```

In [20]:
```python
52/69
```

Out[20]:
```
0.7536231884057971
```

I lost 25% of the stores by only keeping the stores that were open in 2021, I need to see how much of the total dataset I will lose.

In [21]:
```python
df_merged_final = df_merged[(df_merged['storenum'].isin(shops_still_open)) & (df_merged['date'] >= '2018-01-01'

df_merged_final = df_merged_final.reset_index(drop = True)
```

In [22]:
```python
df_info_final = df_info.loc[df_info['storenum'].isin(shops_still_open)]
df_info_final = df_info_final.reset_index(drop = True)

df_info_final.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 52 entries, 0 to 51
Data columns (total 7 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   storenum   52 non-null     float64
 1   storename  52 non-null     object 
 2   city       52 non-null     object 
 3   zipcode    52 non-null     object 
 4   longitude  52 non-null     float64
 5   latitude   52 non-null     float64
 6   orgname    52 non-null     object 
dtypes: float64(3), object(4)
memory usage: 3.0+ KB
```

In [23]:
```python
df_merged_final.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 371147 entries, 0 to 371146
Data columns (total 21 columns):
 #   Column                Non-Null Count   Dtype         
---  ------                --------------   -----         
 0   invnum                371147 non-null  object        
 1   date                  371147 non-null  datetime64[ns]
 2   storenum              371147 non-null  object        
 3   vendornum             371147 non-null  float64       
 4   itemnum               371147 non-null  int64         
 5   itemcategory          371147 non-null  object        
 6   productcost           371147 non-null  float64       
 7   product_retail_price  371147 non-null  float64       
 8   units_sold            371147 non-null  int64         
 9   revenue_original      371147 non-null  float64       
 10  storename             371147 non-null  object        
 11  city                  371147 non-null  object        
 12  zipcode               371147 non-null  object        
 13  longitude             371147 non-null  float64       
 14  latitude              371147 non-null  float64       
 15  orgname               371147 non-null  object        
 16  inventory_cost        371147 non-null  float64       
 17  total_cost            371147 non-null  float64       
 18  overhead_cost         371147 non-null  float64       
 19  profit                371147 non-null  float64       
 20  margin                371147 non-null  float64       
dtypes: datetime64[ns](1), float64(11), int64(2), object(7)
memory usage: 59.5+ MB
```

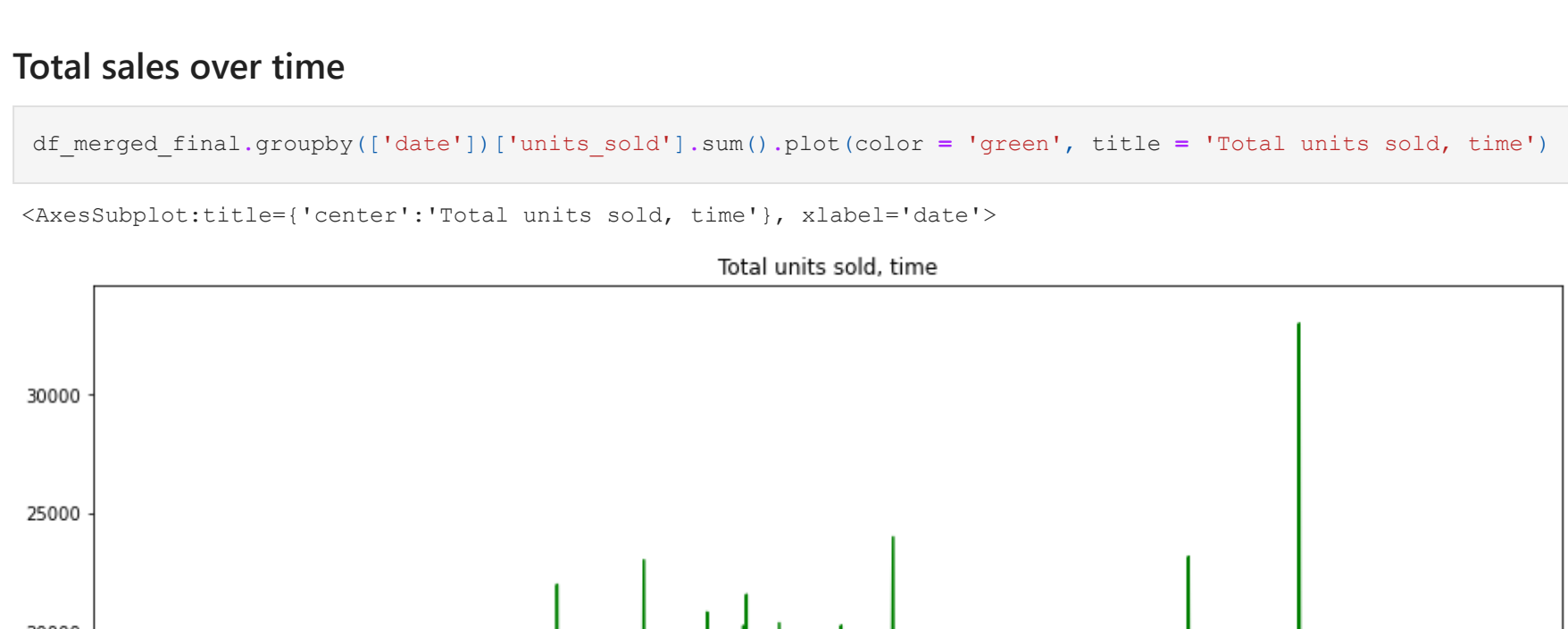
In [24]:
```python
# Saving as csv

#df_merged_final.to_csv('pharm_sales_final.csv')
#df_info_final.to_csv('pharm_info_final.csv')
```

EDA

Total sales over time

In [95]:
```python
df_merged_final.groupby(['date'])['units_sold'].sum().plot(color = 'green', title = 'Total units sold, time')
```

Out[95]:
```
<AxesSubplot:title={'center':'Total units sold, time'}, xlabel='date'>
```



Zipcode

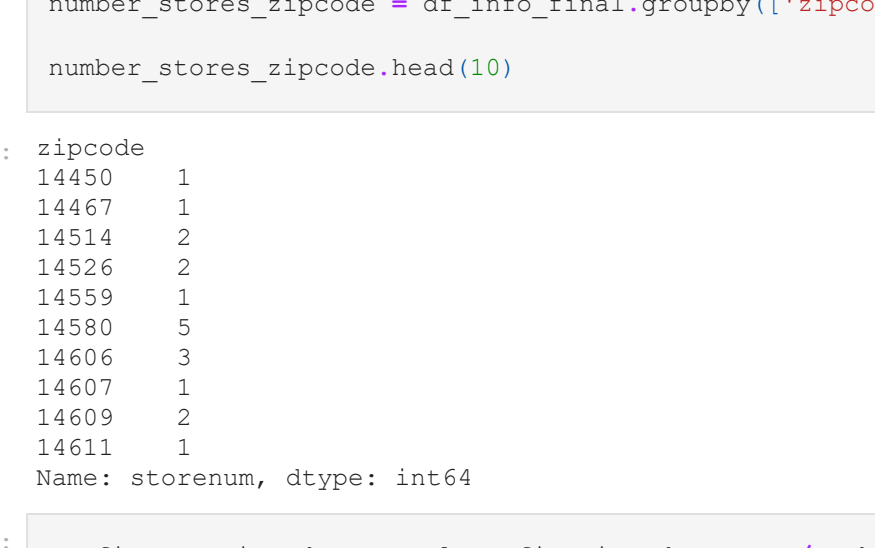
Profit

In [25]:
```python
total_profit_zipcode_groups = df_merged_final.groupby(['zipcode']).sum().sort_values(['profit'], ascending = Tr

total_profit_zipcode_groups.sort_values().head(10)
```

Out[25]:
```
zipcode
14615     1307.171765
14467     1613.135294
14609     2322.936471
14625     2499.000588
14450     3041.305882
14611     3220.129412
14612     5725.337059
14607     6543.948824
14559     7186.052353
14526    11423.208824
Name: profit, dtype: float64
```

In [26]:
```python
total_profit_zipcode_groups.plot(kind = 'bar',
                          color = 'green',
                          ylabel = 'Total ($) ',
                          title = 'Profit per zipcode')
```

Out[26]:
```
<AxesSubplot:title={'center':'Profit per zipcode'}, xlabel='zipcode', ylabel='Total ($) '>
```



In [27]:
```python
number_stores_zipcode = df_info_final.groupby(['zipcode']).count()['storenum']

number_stores_zipcode.head(10)
```

Out[27]:
```
zipcode
14450    1
14467    1
14514    2
14526    2
14559    1
14580    5
14606    3
14607    1
14609    2
14611    1
Name: storenum, dtype: int64
```

In [28]:
```python
profit_per_zipcode = total_profit_zipcode_groups/number_stores_zipcode
profit_per_zipcode.sort_values().head()
```

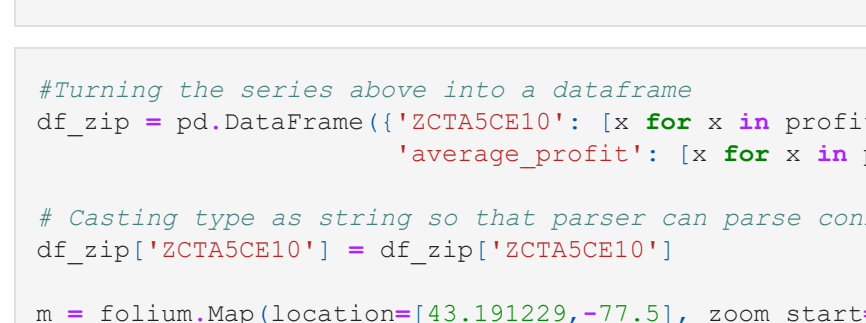
Out[28]:
```
zipcode
14609    1161.468235
14615    1307.171765
14467    1613.135294
14625    2499.000588
14612    2862.668529
dtype: float64
```

In [29]:
```python
profit_per_zipcode.max()/profit_per_zipcode.mean()
```

Out[29]:
```
12.17106385903507
```

In [30]:
```python
profit_per_zipcode.sort_values().plot(kind = 'bar',
                          color = 'green',
                          ylabel = 'Total ($) ',
                          title = 'Average Profit/ Zipcode')
```

Out[30]:
```
<AxesSubplot:title={'center':'Average Profit/ Zipcode'}, xlabel='zipcode', ylabel='Total ($) '>
```



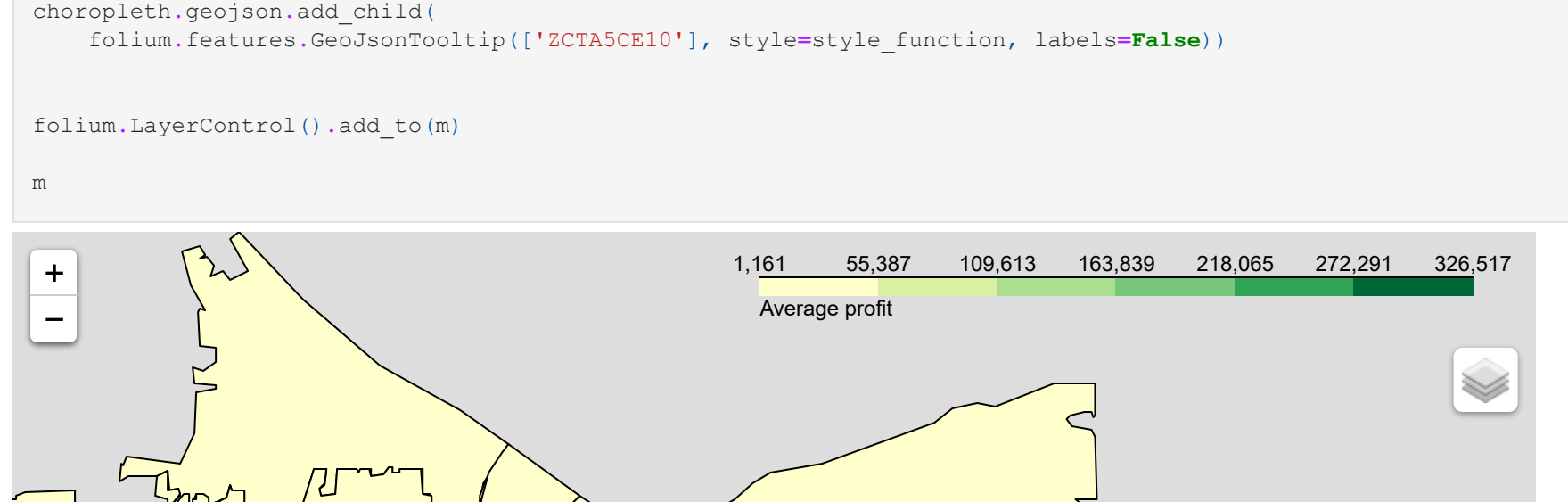
Choropleth map

In [31]:
```python
# Link below has all the zipcode boundaries in NY state, I'll only keep the ones I need
url='https://github.com/OpenDataDE/State-zip-code-GeoJSON/raw/master/ny_new_york_zip_codes_geo.min.json'
gj =  requests.get(url).json()
```

In [32]:
```python
# Making new geojson file
ziplist = df_merged_final['zipcode'].unique() #list of zips in your dataframe

inziplist = []
for  ft in gj['features']:
    if ft['properties']['ZCTA5CE10'] in ziplist:
        inziplist.append(ft)

new_zip_json = {}
new_zip_json['type'] = 'FeatureCollection'
new_zip_json['features'] = inziplist
```

In [33]:
```python
#Turning the series above into a dataframe
df_zip = pd.DataFrame({'ZCTA5CE10': [x for x in profit_per_zipcode.index],
                       'average_profit': [x for x in profit_per_zipcode.values]})

# Casting type as string so that parser can parse connect it to geojson file
df_zip['ZCTA5CE10'] = df_zip['ZCTA5CE10']

m = folium.Map(location=[43.191229,-77.5], zoom_start=11, tile = 'stamenwatercolor')



style_function = "font-size: 15px; font-weight: bold"

choropleth = folium.Choropleth(
    geo_data = new_zip_json,
    name = "choropleth",
    data = df_zip,
    columns = ['ZCTA5CE10', 'average_profit'],
    key_on = 'feature.properties.ZCTA5CE10',
    fill_color = "YlGn",
    fill_opacity = 4,
    line_opacity = 2,
    legend_name = "Average profit",
    labels = True
).add_to(m)


# add labels indicating zipcode
style_function = "font-size: 15px; font-weight: bold"
choropleth.geojson.add_child(
    folium.features.GeoJsonTooltip(['ZCTA5CE10'], style=style_function, labels=False))


folium.LayerControl().add_to(m)

m
```

Out[33]:



Heatmap

In [34]:
```python
df_zip = df_zip.rename(columns = {'ZCTA5CE10': 'zipcode', 'average_profit': 'AverageProfit'})
df_zip.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 22 entries, 0 to 21
Data columns (total 2 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   zipcode        22 non-null     object 
 1   AverageProfit  22 non-null     float64
dtypes: float64(1), object(1)
memory usage: 480.0+ bytes
```

In [147…
```python
df_demographics = pd.read_csv('zip_demographics.csv')

df_demographics['zipcode'] = df_demographics['zipcode'].astype(str)
df_demographics['PopulationDensity'] = df_demographics['CurrentPopulation']/df_demographics['Area']

df_demographics.head()
```

Out[147…

	zipcode	CurrentPopulation	RacialMajority	UnemploymentRate	MedianHouseholdIncome	AverageAdjustedGrossIncome	SchoolTestPerformar
0	14580	50587	White	5.3	75618.0	81510.0	Above Avera
1	14623	27173	White	5.5	54283.0	49130.0	Above Avera
2	14612	34515	White	7.3	62148.0	61510.0	Avera
3	14616	28534	White	10.8	55438.0	46270.0	Above Avera
4	14624	36296	White	6.5	69312.0	62360.0	Avera

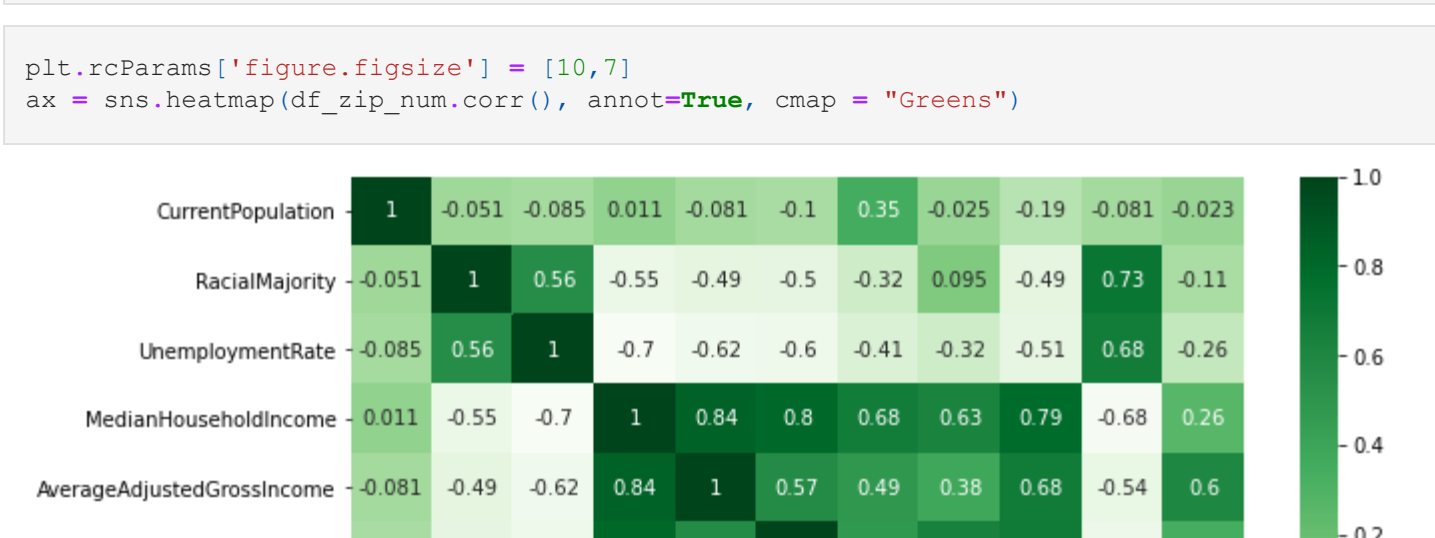
In [148…
```python
#Label encoding
encode_dict = {"SchoolTestPerformance":     {'Poor': 1, 'Below Average': 2, 'Average':3,
                                             'Above Average':4, 'Excellent':5},"RacialMajority": {'White': 0, 'E

df_demographics = df_demographics.replace(encode_dict)
```

In [149…
```python
df_demographics.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 25 entries, 0 to 24
Data columns (total 12 columns):
 #   Column                          Non-Null Count  Dtype  
---  ------                          --------------  -----  
 0   zipcode                         25 non-null     object 
 1   CurrentPopulation               25 non-null     int64  
 2   RacialMajority                  25 non-null     int64  
 3   UnemploymentRate                25 non-null     float64
 4   MedianHouseholdIncome           25 non-null     float64
 5   AverageAdjustedGrossIncome      25 non-null     float64
 6   SchoolTestPerformance           25 non-null     int64  
 7   Area                            25 non-null     float64
 8   SchoolRacialMajority            25 non-null     object 
 9   SchoolRacialMajorityPercentage  25 non-null     float64
 10  RacialMajorityPercentage        25 non-null     float64
 11  PopulationDensity               25 non-null     float64
dtypes: float64(7), int64(3), object(2)
memory usage: 2.5+ KB
```

In [150…
```python
df_zips_merged = pd.merge(df_demographics, df_zip, on='zipcode', how = 'outer')
df_zip_num = df_zips_merged.select_dtypes(include = ['float64', 'int64'])
```

In [153…
```python
plt.rcParams['figure.figsize'] = [10,7]
ax = sns.heatmap(df_zip_num.corr(), annot=True, cmap = "Greens")
```



Store , most profitible

In [40]:
```python
total_profit_store_num = df_merged_final.groupby(['storenum']).sum().sort_values(['profit'], ascending = True)

total_profit_store_num.sort_values().head()

#Keep 4641 in mind
```

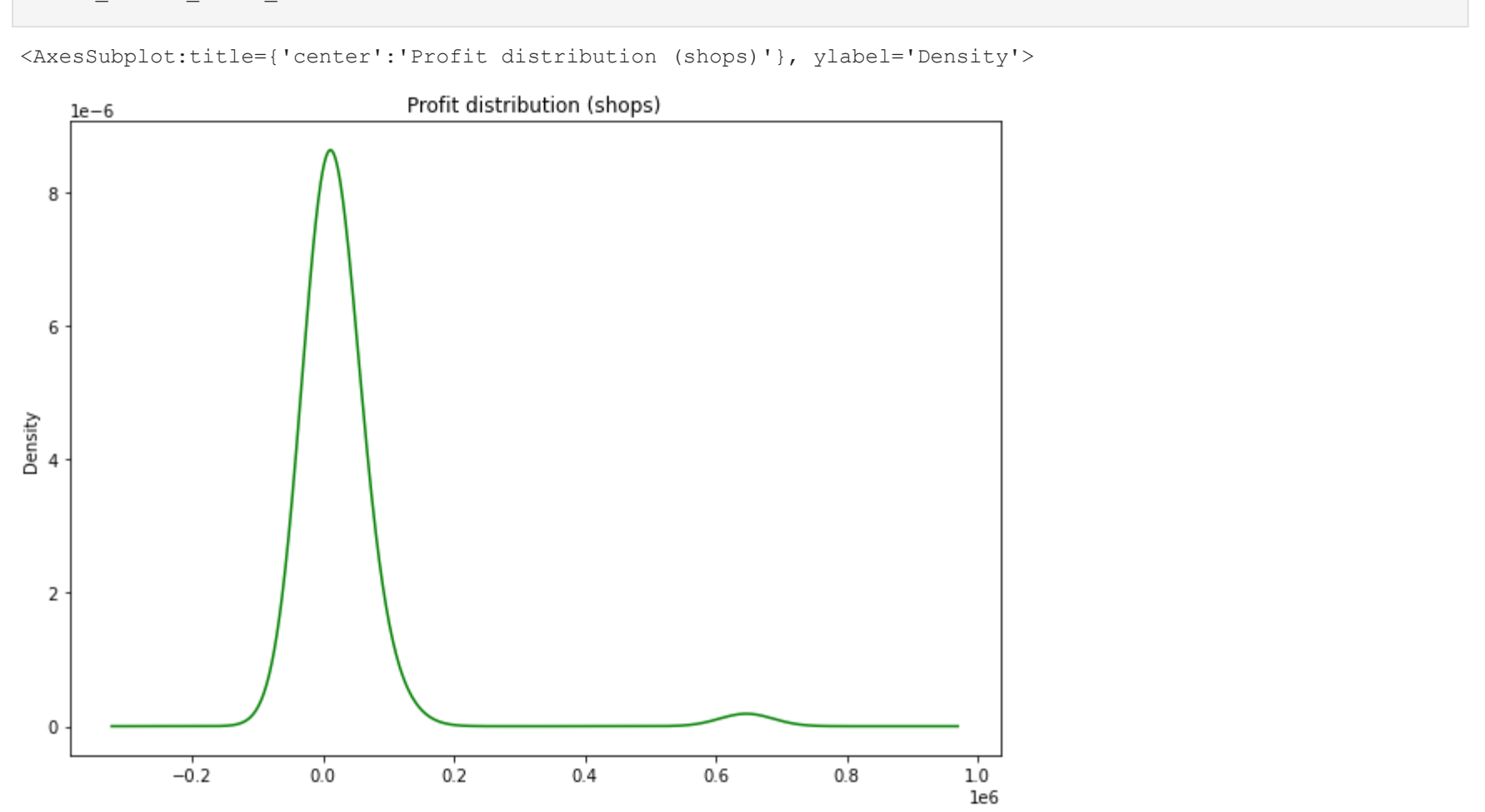
Out[40]:
```
storenum
5970     257.497647
6064     328.004706
2695     486.239412
2696    1270.866471
5891    1307.171765
Name: profit, dtype: float64
```

In [41]:
```python
total_profit_store_num.describe()
```

Out[41]:
```
count        52.000000
mean      28282.520667
std       90299.770394
min         257.497647
25%        3175.423529
50%        6484.453824
75%       18233.935441
max      646563.885882
Name: profit, dtype: float64
```

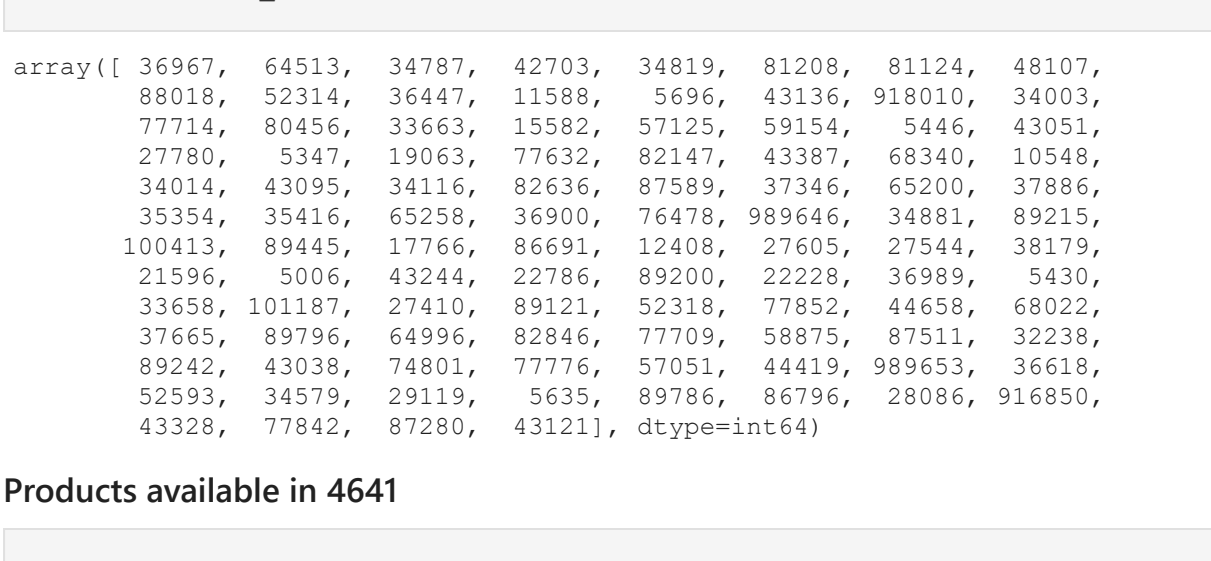
In [42]:
```python
total_profit_store_num.sort_values().plot(kind = 'bar',
                              color = 'green',
                              ylabel = 'Total ($) ',
                              title = 'Profit / Store (number)',
                                     figsize = (15,5))
```

Out[42]:
```
<AxesSubplot:title={'center':'Profit / Store (number)'}, xlabel='storenum', ylabel='Total ($) '>
```



In [43]:
```python
total_profit_store_num.plot.kde(color = 'green', title = 'Profit distribution (shops)')
```

Out[43]:
```
<AxesSubplot:title={'center':'Profit distribution (shops)'}, ylabel='Density'>
```



Most profitible products & product sets

Top 500 profitible

In [44]:
```python
profit_products = df_merged_final.groupby(['itemnum'])['profit'].sum().sort_values().tail(500)

profit_products_set = set(np.array(profit_products.index))

#numpy arrays for well formatted output
np.array(profit_products.index)[0:100]
```

Out[44]:
```
array([ 36967,  64513,  34787,  42703,  34819,  81208,  81124,  48107,
        88018,  52314,  36447,  11588,   5696,  43136, 918010,  34003,
        77714,  80456,  33663,  15582,  57125,  59154,   5446,  43051,
        27780,   5347,  19063,  77632,  82147,  43387,  68340,  10548,
        34014,  43095,  34116,  82636,  87589,  37346,  65200,  37886,
        35354,  35416,  65258,  36900,  76478, 989646,  34881,  89215,
       100413,  89445,  17766,  86691,  12408,  27605,  27544,  38179,
        21596,   5006,  43244,  22786,  89200,  22228,  36989,   5430,
        33658, 101187,  27410,  89121,  52318,  77852,  44658,  68022,
        37665,  89796,  64996,  82846,  77709,  58875,  87511,  32238,
        89242,  43038,  74801,  77776,  57051,  44419, 989653,  36618,
        52593,  34579,  29119,   5635,  89786,  86796,  28086, 916850,
        43328,  77842,  87280,  43121], dtype=int64)
```

Products available in 4641

In [45]:
```python
products_4641_set = set(df_merged_final.loc[df_merged_final['storenum'] == '4641']['itemnum'].unique())

np.array(products_4641_set)
```

Out[45]:
```
array({11776, 11777, 25604, 34820, 25606, 36873, 36875, 11788, 36878, 43025, 43026, 43028, 19476, 11290, 11294,
11296, 36904, 43050, 43051, 10802, 10803, 10805, 10807, 39492, 77903, 36965, 89191, 36968, 36969, 37991, 36971,
37996, 37994, 37998, 89194, 89196, 43121, 89199, 28275, 12404, 19061, 43126, 34423, 19064, 28279, 12408, 19066,
43124, 38008, 43125, 43136, 34433, 27780, 77956, 40070, 27783, 40592, 40593, 40594, 37012, 86691, 86692, 38056,
100015, 39419, 17086, 26820, 26821, 26824, 26826, 84172, 34001, 34004, 34006, 42716, 41693, 45276, 72928, 6525
1, 88294, 65254, 65256, 88296, 26858, 31474, 31475, 78078, 78079, 40192, 43777, 1799, 15626, 46350, 43285, 3817
4, 38176, 38178, 38180, 38194, 81204, 10550, 81206, 17206, 43331, 43334, 43336, 43338, 88406, 64858, 73055, 648
64, 64863, 64866, 52579, 86884, 86885, 86886, 64870, 64865, 87403, 87408, 52594, 52596, 77714, 27544, 68009, 77
740, 75183, 28081, 86456, 75208, 36301, 36304, 36306, 36308, 68052, 58838, 66518, 26585, 37338, 53214, 27102, 4
8101, 32231, 32232, 48105, 32234, 32235, 32236, 39917, 39918, 27629, 87026, 58868, 65013, 27125, 58872, 11771,
11774},
      dtype=object)
```

In [232…
```python
len(products_4641_set)
```

Out[232…
```
159
```

In [46]:
```python
reccomended_products_set = profit_products_set - products_4641_set

total_set_4641 = products_4641_set | reccomended_products_set

np.array(reccomended_products_set)
```

```
Out[46]: array({34819, 34821, 69637, 36874, 77842, 77843, 36886, 36887, 69657, 43036, 77852, 43038, 49185, 49186, 36900,
49189, 36903, 36908, 88116, 34871, 100413, 34881, 100423, 26710, 43095, 86112, 36967, 36970, 36974, 36976, 4312
0, 36978, 41077, 43127, 43128, 88186, 36989, 43137, 34972, 34995, 45248, 28866, 28867, 26823, 84171, 26828, 268
27, 45277, 45278, 82147, 88298, 86251, 43244, 22784, 22786, 4356, 22788, 266, 16676, 10548, 43316, 69946, 6994
7, 43328, 43333, 43337, 74086, 45419, 43387, 10627, 10628, 37258, 27025, 27026, 68022, 29119, 68036, 68037, 989
646, 16850, 989653, 37336, 88536, 37346, 37347, 88548, 37348, 88556, 35314, 35316, 35317, 35318, 918010, 4626,
35354, 10784, 10791, 10792, 37418, 10804, 10808, 12856, 10809, 80456, 35416, 35418, 29287, 19063, 19067, 8828,
19068, 41604, 64136, 86670, 86672, 64147, 86693, 47786, 82607, 33467, 76478, 17087, 82627, 76487, 82636, 82637,
41692, 41694, 17127, 41705, 68340, 4866, 4867, 86796, 27410, 19226, 37663, 37665, 27433, 72504, 27453, 45886, 1
01187, 82787, 86887, 41846, 33658, 33663, 5006, 15248, 82846, 82847, 64418, 31658, 5036, 5037, 82867, 27605, 48
099, 48102, 31719, 48106, 48107, 48108, 48122, 37886, 64513, 25607, 25608, 19477, 19486, 27680, 11297, 89121, 1
1299, 11298, 48164, 74801, 37938, 64573, 89154, 89164, 66636, 35918, 89175, 64601, 52314, 21596, 52316, 52318,
21598, 21597, 37993, 89193, 35947, 89197, 87150, 89198, 89200, 37997, 40053, 38006, 89207, 64636, 89215, 40071,
33937, 89242, 64676, 38058, 44217, 38088, 64715, 5326, 5327, 5329, 34003, 34007, 34008, 15582, 34014, 64736, 53
46, 5347, 81124, 34029, 34030, 87280, 64752, 34036, 40186, 89339, 40193, 64776, 15627, 15628, 66836, 156
44, 38177, 38179, 89387, 64816, 15667, 5430, 81208, 11586, 11588, 34116, 5446, 34117, 87380, 73053, 64867, 6486
8, 89445, 17766, 89447, 5486, 52593, 916850, 34162, 87409, 66936, 44419, 40327, 64904, 28043, 64914, 75165, 465
04, 75181, 28086, 28087, 87485, 67006, 75210, 36305, 36307, 87510, 87511, 44516, 64996, 32233, 89577, 32238, 58
875, 17916, 11773, 5635, 89610, 11786, 85526, 89626, 17956, 87589, 17958, 89646, 34359, 34366, 5696, 34368, 876
19, 15940, 28233, 28236, 18006, 87643, 24157, 24158, 36447, 87646, 87647, 42599, 65127, 15982, 30318, 5744, 446
58, 34422, 22156, 22157, 34449, 40599, 34456, 34457, 34458, 59037, 77487, 65200, 89786, 89787, 22207, 67267, 89
796, 22215, 42703, 22228, 57051, 42717, 42718, 65257, 65258, 89836, 89837, 36618, 59154, 34579, 34578, 20248, 1
0008, 57125, 87849, 57148, 77632, 14192, 77683, 87937, 77699, 77709, 20366, 65426, 18348, 77741, 18352, 34746,
34747, 49086, 34753, 67526, 67527, 77776, 28625, 88018, 28627, 26586, 53213, 53216, 34787},
      dtype=object)
```

```
In [47]: products_2633_set = set(df_merged_final.loc[df_merged_final['storenum'] == '2633']['itemnum'].unique())
```

```
In [48]: def colors_256(color_):

    num1 = str(color_)
    num2 = str(color_).ljust(3, ' ')

    if color_ % 16 == 0:
        return(f"\033[38;5;{num1}m {num2} \033[0;0m\n")
    else:
        return(f"\033[38;5;{num1}m {num2} \033[0;0m")

x = '{'+ ','.join([Fore.RED + str(x) if x in products_2633_set else str(x) for x in total_set_4641]) + '}'
x = x.replace(' ', '')

print(x)
```

```
{34819,34820,34821,69637,36873,36874,36875,36878,43025,43026,77842,43028,77843,36886,36887,69657,43036,77852,43
038,49185,49186,36900,49189,36903,36904,43050,43051,36908,88116,34871,100413,34881,100423,77903,26710,43095,861
12,36965,36967,36968,36969,36970,36971,36974,36976,43121,43120,36978,12404,43124,43126,43125,12408,41077,43127,
43128,88186,36989,43136,43137,77956,37012,34972,34995,45248,28866,28867,26820,26821,26823,26824,26826,84171,841
72,26828,26827,45276,45277,45278,82147,88294,88296,26858,88298,86251,43244,78078,78079,22784,22786,4356,22788,2
66,43285,16676,10548,43316,10550,69946,69947,43328,43331,43333,43334,43336,43337,43338,88406,74086,45419,43387,
10627,10628,37258,27025,27026,68009,68022,86456,29119,68036,68037,989646,16850,68052,989653,37336,88536,37338,2
7102,37346,37347,88548,37348,88556,35314,35316,27125,35317,35318,918010,39419,4626,35354,10784,10791,10792,3741
8,10802,10803,10804,10805,10807,10808,12856,10809,39492,80456,35416,35418,29287,19061,19063,19064,19066,19067,8
828,19068,41604,64136,86670,86672,64147,86691,86692,86693,47786,82607,33467,17086,76478,17087,82627,76487,8263
6,82637,41692,41693,41694,17127,41705,31474,31475,68340,43777,4866,4867,86796,27410,19226,37663,37665,27433,172
06,72504,27453,45886,101187,82787,86884,86885,86886,86887,41846,33658,33663,5006,15248,27544,82846,82847,64418,
31658,5036,5037,82867,27605,66518,48099,48101,48102,31719,48105,48106,48107,48108,39917,39918,27629,87026,4812
2,37886,64513,25604,25606,25607,25608,19476,19477,11290,11294,19486,11296,27680,11297,89121,11299,11298,48164,7
4801,37938,64573,89154,89164,66636,35918,89175,64601,52314,21596,52316,52318,21598,21597,89191,37991,37993,3799
4,89194,37996,89196,37998,89199,89193,35947,89197,87150,89198,89200,37997,40053,38008,38006,89207,64636,89215,2
7780,40070,27783,40071,33937,89242,64676,38056,38058,44217,38088,64715,5326,5327,34001,5329,34003,34004,34006,3
4007,34008,15582,34014,72928,64736,5346,5347,81124,34029,34030,87280,64752,34036,40186,89339,40192,40193,64776,
15626,15627,15628,46350,23828,66836,15644,38174,38176,38177,38178,38179,38180,89387,64816,38194,15667,81204,812
06,5430,81208,11586,11588,34116,5446,34117,87380,64858,73053,73055,64864,64863,64866,52579,64865,64867,64870,64
868,89445,17766,89447,87403,5486,87408,52593,52594,916850,52596,34162,87409,66936,44419,40327,64904,28043,6491
4,75165,46504,75181,75183,28081,28086,28087,87485,67006,75208,75210,36301,36304,36305,36306,36307,36308,58838,8
7510,87511,44516,64996,32231,32232,32233,32234,32235,32236,89577,32238,58868,65013,58872,11771,58875,17916,1177
4,11773,11776,11777,5635,89610,11786,11788,85526,89626,17956,87589,17958,89646,34359,34366,5696,34368,87619,159
40,28233,28236,18006,87643,24157,24158,36447,87646,87647,42599,65127,15982,30318,5744,44658,28275,34422,34423,2
8279,34433,22156,22157,40592,40593,40594,34449,40599,34456,34457,34458,59037,100015,77487,65200,89786,89787,222
07,67267,89796,22215,42703,22228,57051,42716,42717,42718,65251,65254,65256,65257,65258,89836,89837,1799,36618,5
9154,34579,34578,20248,10008,57125,87849,57148,77632,14192,77683,87937,77699,77709,20366,77714,65426,77740,1834
8,77741,18352,34746,34747,49086,34753,67526,67527,77776,28625,88018,28627,26585,26586,53213,53214,53216,34787}
```

Shop reccomendations

Pre-eliminary calculations

```
In [49]: stores_14618 = df_merged_final.loc[df_merged_final['zipcode'] == '14618' ]['storenum'].unique()
stores_14618
```

```
Out[49]: array(['4641', '2633'], dtype=object)
```

```
In [50]: total_profit_store_num['4641'] #61.5th percentile
```

```
Out[50]: 6469.285882352976
```

```
In [51]: percentile_of_4641 = percentileofscore(total_profit_store_num, total_profit_store_num['4641'])
percentile_of_4641
```

```
Out[51]: 50.0
```

Helper functions

```
In [52]: def sale_timedelta(storenumber,df):
    # Returns number of days between first and last sale in specific shops

    start = df.loc[df['storenum'] == storenumber]['date'].describe()['first']
    stop = df.loc[df['storenum'] == storenumber]['date'].describe()['last']

    return int((stop-start).days)

sale_timedelta('4641',df_merged_final)
```

```
Out[52]: 1179
```

```
In [53]: # All unique stores.
storenums = df_merged_final['storenum'].unique()
storenums
```

```
Out[53]: array(['3696', '2528', '5501', '5057', '5338', '5126', '2673', '4796',
       '5533', '4997', '4641', '2561', '4140', '5051', '2527', '4594',
       '2633', '2636', '2627', '4361', '2626', '4795', '5131', '2532',
       '5507', '5127', '5128', '4622', '2696', '4601', '4802', '4596',
       '5375', '4599', '4803', '4377', '4801', '4603', '5539', '2852',
       '2850', '3825', '4804', '4797', '4800', '5664', '4799', '2695',
       '5970', '5891', '6057', '6064'], dtype=object)
```

```
In [54]: # Getting time delta of all stores
stores_daysdelta_list = np.array([(store,sale_timedelta(store,df_merged_final)) for store in storenums])
```

```
In [55]: stores_daysdelta_list[0:5]
```

```
Out[55]: array([['3696', '1182'],
       ['2528', '1180'],
       ['5501', '1176'],
       ['5057', '1178'],
       ['5338', '1173']], dtype='<U4')
```

```
In [56]: #Turning array to series, for index matching
idx, values = zip(*stores_daysdelta_list)

stores_timedelta_series = pd.Series((int(x) for x in values), idx)
```

```
In [57]: # Finding profit per day
store_profit_perday= total_profit_store_num/stores_timedelta_series

store_profit_perday.sort_values().tail()
```

```
Out[57]: 2626     54.743972
2527     60.304628
2528     65.689499
2561     90.813035
2633    546.545973
dtype: float64
```

```
In [58]: for index in store_profit_perday.tail().index:
    print(store_profit_perday[index])
```

```
2.189442190669386
3.458126361655788
0.8909953185426444
10.059784313725558
3.904817927170887
```

Comparison plots

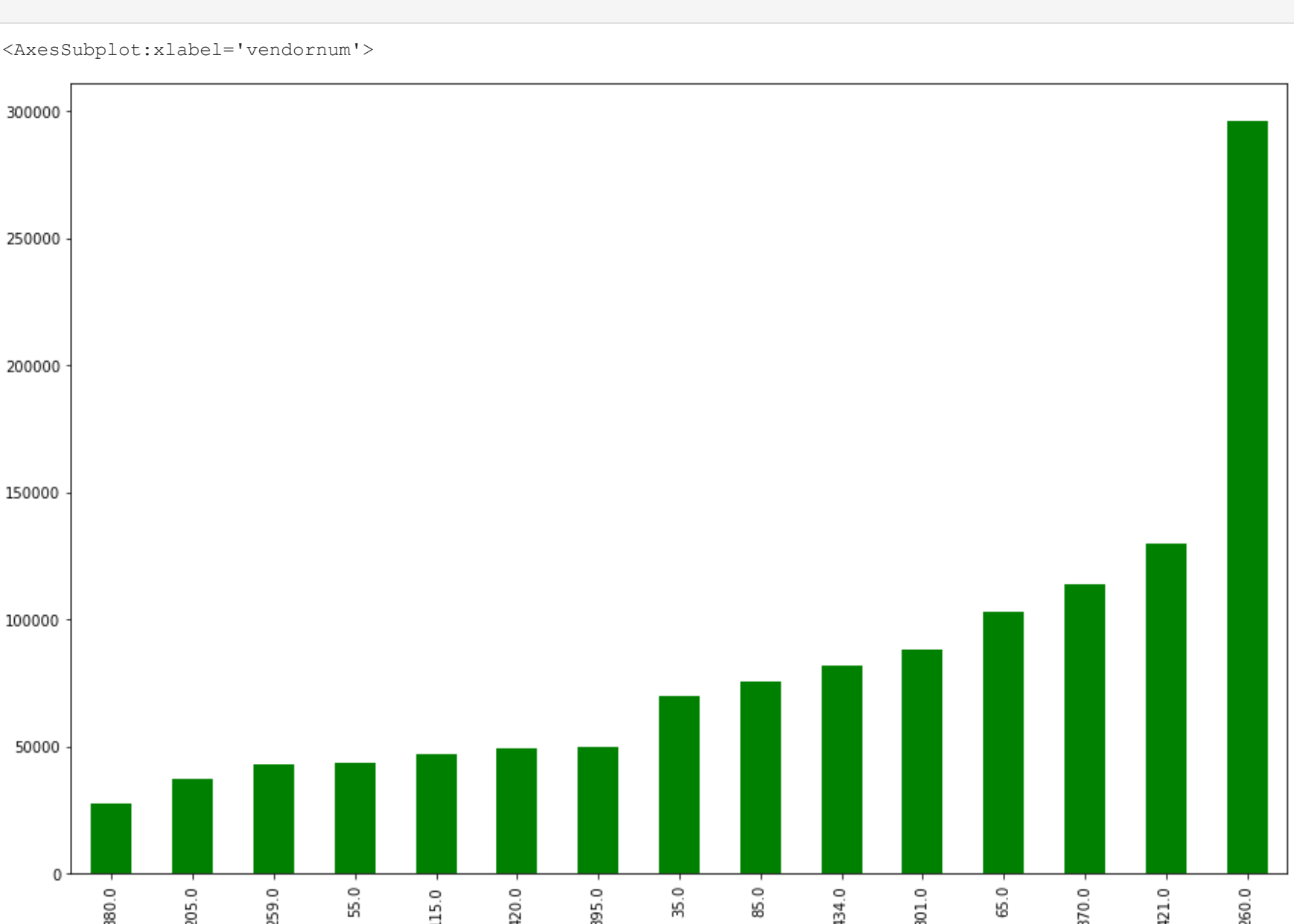
```
In [176…: # class else write 100 lines of code
class Option:
    def __init__(self, name: str,cost: float,daily_profit: float,fixed_cost: float,n: int,days: int,investment:

        self.name = name
        self.cost = cost
        self.daily_profit = daily_profit
        self.fixed_cost = fixed_cost
        self.n = n
        self.days = days
        self.investment = investment

    def cashplot(self):
        if self.n != 1 or self.n != 0:
            self.cost = (self.cost*self.n)-(self.fixed_cost*(self.n-1))
            self.daily_profit = self.daily_profit*self.n


        cashsum_pharmacy = 0
        pharmacy_profit = [self.daily_profit for i in range(1,self.days)]
        pharmacy_cash = np.append([self.cost+self.daily_profit],pharmacy_profit) if self.investment \
        else np.append([-self.cost+self.daily_profit],pharmacy_profit)

        summed_list = []
        for v in pharmacy_cash:
            cashsum_pharmacy += v
            summed_list.append(cashsum_pharmacy)

        return summed_list

    def breakeven(self):
        if self.investment:
            return 0
        return self.cost//self.daily_profit


    def profit(self):
        if self.investment:
            return self.cashplot()[-1] - self.cost
        return self.cashplot()[-1]

    def plot(self):
        interval = range(1,self.days+1)
        plt.rcParams['figure.figsize'] = [15, 10]
        plt.plot(interval, self.cashplot(), label=self.name)
        plt.ylabel('$')
        plt.xlabel('days')
        plt.title('Net positive cashflow over 10 years')
        plt.legend()
        plt.grid(True)
```

```
In [302…: consise_list = []

consise_list.append(Option('Buy 4641',0,store_profit_perday['4641'],0,1,3650,False))
consise_list.append(Option('Building pharmacy',0,store_profit_perday.mean(),0,1,3650,False))
```

```
In [303…: store_profit_perday.mean()
```

```
Out[303…: 24.31777582684731
```

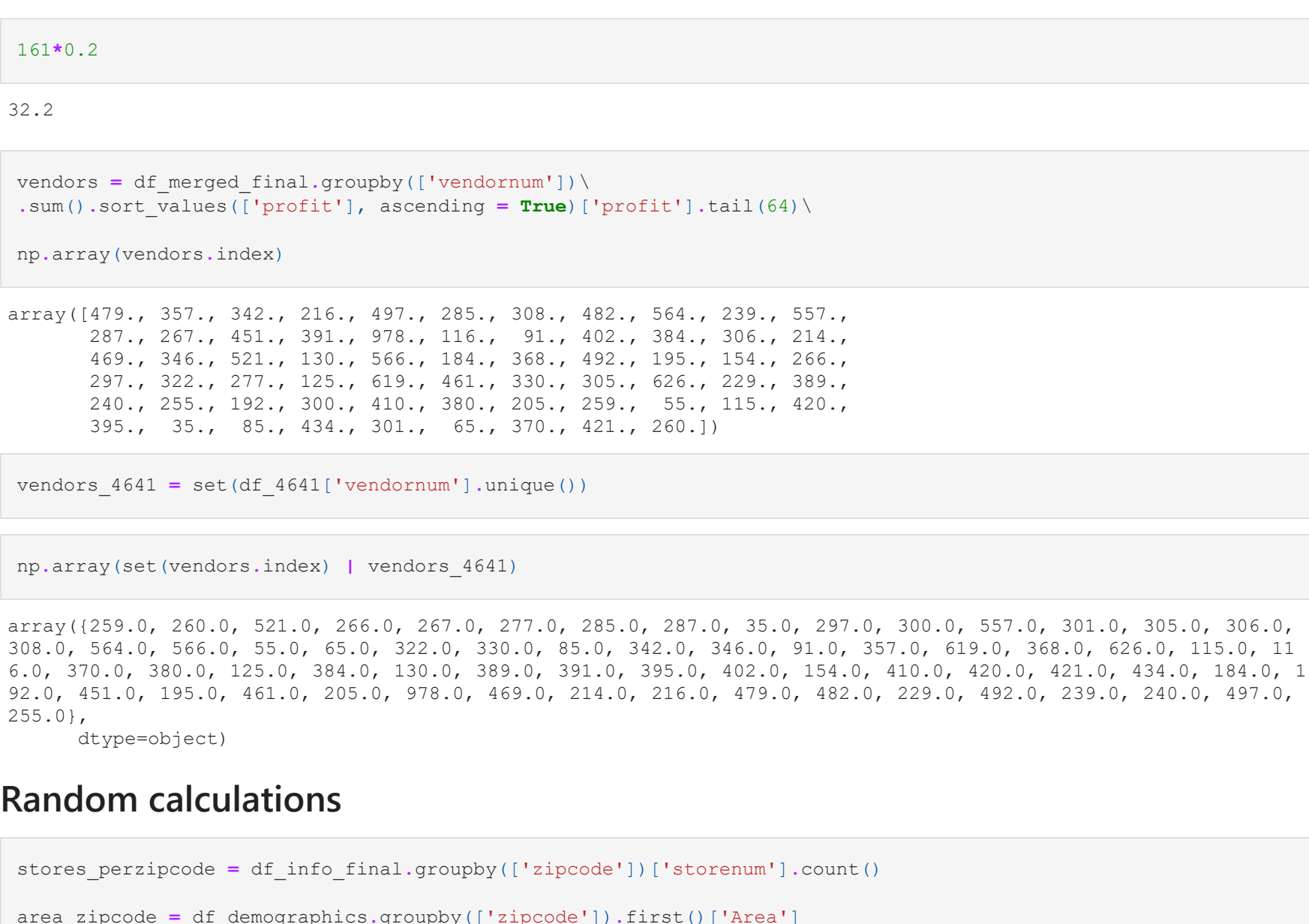
```
In [304…: for v in consise_list:
    v.plot()
```



Vendors

```
In [324…: df_merged_final.groupby(['vendornum'])\
.sum().sort_values(['profit'], ascending = True)['profit'].tail(15)\
.plot(kind = 'bar',color = 'green')
```

```
Out[324…: <AxesSubplot:xlabel='vendornum'>
```




```
In [346…: df_4641['vendornum'].nunique()
```

```
Out[346…: 26
```

```
In [325…: 161*0.2
```

```
Out[325…: 32.2
```

```
In [327…: vendors = df_merged_final.groupby(['vendornum'])\
.sum().sort_values(['profit'], ascending = True)['profit'].tail(64)\

np.array(vendors.index)
```

```
Out[327…: array([479., 357., 342., 216., 497., 285., 308., 482., 564., 239., 557.,
       287., 267., 451., 391., 978., 116.,  91., 402., 384., 306., 214.,
       469., 346., 521., 130., 566., 184., 368., 492., 195., 154., 266.,
       297., 322., 277., 125., 619., 461., 330., 305., 626., 229., 389.,
       240., 255., 192., 300., 410., 380., 205., 259.,  55., 115., 420.,
       395.,  35.,  85., 434., 301.,  65., 370., 421., 260.])
```

```
In [341…: vendors_4641 = set(df_4641['vendornum'].unique())
```

```
In [344…: np.array(set(vendors.index) | vendors_4641)
```

```
Out[344…: array({259.0, 260.0, 521.0, 266.0, 267.0, 277.0, 285.0, 287.0, 35.0, 297.0, 300.0, 557.0, 301.0, 305.0, 306.0,
308.0, 564.0, 566.0, 55.0, 65.0, 322.0, 330.0, 85.0, 342.0, 346.0, 91.0, 357.0, 619.0, 368.0, 626.0, 115.0, 11
6.0, 370.0, 380.0, 125.0, 384.0, 130.0, 389.0, 391.0, 395.0, 402.0, 154.0, 410.0, 420.0, 421.0, 434.0, 184.0, 1
92.0, 451.0, 195.0, 461.0, 205.0, 978.0, 469.0, 214.0, 216.0, 479.0, 482.0, 229.0, 492.0, 239.0, 240.0, 497.0,
255.0},
      dtype=object)
```

Random calculations

```
In [278…: stores_perzipcode = df_info_final.groupby(['zipcode'])['storenum'].count()

area_zipcode = df_demographics.groupby(['zipcode']).first()['Area']

store_perarea = stores_perzipcode/area_zipcode

store_perarea.corr(profit_per_zipcode, method= 'pearson')
```

```
Out[278…: -0.05322828236009978
```

```
In [279…: df_4641 = df_merged_final.loc[(df_merged_final['storenum'] == '4641') & (df_merged_final['date'] <= '2021-01-01
df_4641.head()
```

Out[279…:

	invnum	date	storenum	vendornum	itemnum	itemcategory	productcost	product_retail_price	units_sold	revenue_original	...
75633	INV-25073100004	2020-02-07	4641	259.0	11776	OTC/VMS	5.23	7.85	12	94.20	...
75634	INV-25073100005	2020-02-07	4641	260.0	37996	OTC/VMS	8.25	12.38	12	148.56	...
75635	INV-25073100010	2020-02-07	4641	259.0	11788	Personal hygiene	10.45	15.68	6	94.08	...
75636	INV-25073100003	2020-02-07	4641	421.0	86884	Skin care items	4.78	7.17	10	71.70	...
75637	INV-25073100008	2020-02-07	4641	192.0	65254	Skin care items	6.52	9.78	10	97.80	...

5 rows × 21 columns

```
In [280…: df_4641['month'] = df_4641['date'].dt.month
```

```
<ipython-input-280-27bfb62656d2>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ret
urning-a-view-versus-a-copy
  df_4641['month'] = df_4641['date'].dt.month
```

```
In [281…: df_4641['month']
```

```
Out[281…: 75633     2
75634     2
75635     2
75636     2
75637     2
         ..
79276    12
79277    12
79278    12
79279    12
79280    12
Name: month, Length: 3648, dtype: int64
```

```
In [282…: df_4641['Hour'] = df_4641['date'].dt.hour
df_4641['Minute'] = df_4641['date'].dt.minute
#df_4641['Count'] = 1
```

```
<ipython-input-282-99e25344d591>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ret
urning-a-view-versus-a-copy
  df_4641['Hour'] = df_4641['date'].dt.hour
<ipython-input-282-99e25344d591>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ret
urning-a-view-versus-a-copy
  df_4641['Minute'] = df_4641['date'].dt.minute
```

```
In [286…: months = range(1,13)

plt.rcParams['figure.figsize'] = [10, 5]
plt.bar(months,df_4641.groupby(['month']).count()['itemnum'],color = 'green')
plt.xticks(months)
plt.ylabel('Number of units sold')
plt.xlabel('Month number')
plt.grid()
plt.show()
```



```
In [287…: store_profit_perday.describe()
```

```
Out[287…: count     52.000000
mean      24.317776
std       76.238075
min        0.857565
25%        3.417513
50%        5.538680
75%       15.509820
max      546.545973
dtype: float64
```

```
In [288…: percentileofscore(store_profit_perday, store_profit_perday['4641'])
```

```
Out[288…: 48.07692307692308
```

```
In [ ]:
```