Data Science Project 1

July 10, 2023

[1]:
```
import pandas as pd
import numpy as np
```

[2]:
```
df = pd.read_csv('Mobile_phone_price.csv')
df.head()
```

[2]:
```
     Brand              Model Storage    RAM  Screen Size (inches)  \
0    Apple      iPhone 13 Pro   128 GB   6 GB                  6.1
1  Samsung   Galaxy S21 Ultra   256 GB  12 GB                  6.8
2  OnePlus              9 Pro   128 GB   8 GB                  6.7
3   Xiaomi  Redmi Note 10 Pro   128 GB   6 GB                 6.67
4   Google            Pixel 6   128 GB   8 GB                  6.4

          Camera (MP)  Battery Capacity (mAh) Price ($)
0        12 + 12 + 12                    3095       999
1  108 + 10 + 10 + 12                    5000      1199
2     48 + 50 + 8 + 2                    4500       899
3      64 + 8 + 5 + 2                    5020       279
4           50 + 12.2                    4614       799
```

[3]:
```
df.shape
```

[3]:
```
(407, 8)
```

[4]:
```
df['RAM '].unique()
```

[4]:
```
array(['6 GB', '12 GB', '8 GB', '4 GB', '3 GB', '2 GB', '4GB', '8GB',
       '6GB', '12GB', '3GB', '2GB', '5GB', '12', '3', '6', '8', '4', '16',
       '2'], dtype=object)
```

[5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 407 entries, 0 to 406
Data columns (total 8 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Brand                   407 non-null    object
 1   Model                   407 non-null    object
```

```
  2   Storage                 407 non-null    object
  3   RAM                     407 non-null    object
  4   Screen Size (inches)    407 non-null    object
  5   Camera (MP)             407 non-null    object
  6   Battery Capacity (mAh)  407 non-null    int64
  7   Price ($)               407 non-null    object
dtypes: int64(1), object(7)
memory usage: 25.6+ KB
```

```
[6]: df.describe()
```

```
[6]:        Battery Capacity (mAh)
     count              407.000000
     mean              4676.476658
     std                797.193713
     min               1821.000000
     25%               4300.000000
     50%               5000.000000
     75%               5000.000000
     max               7000.000000
```

```
[8]: df.isna().sum()
```

```
[8]: Brand                     0
     Model                     0
     Storage                   0
     RAM                       0
     Screen Size (inches)      0
     Camera (MP)               0
     Battery Capacity (mAh)    0
     Price ($)                 0
     dtype: int64
```

```
[9]: df.nunique()
```

```
[9]: Brand                      16
     Model                     239
     Storage                    13
     RAM                        20
     Screen Size (inches)       41
     Camera (MP)               143
     Battery Capacity (mAh)     48
     Price ($)                  89
     dtype: int64
```

```
[10]: df['Price ($)'].unique()
```

```
[10]: array(['999', '1199', '899', '279', '799', '249', '699', '329', '449',
              '199', '299', '379', '179', '729', '599', '139', '189', '399',
              '259', '159', '229', '499', '129', '529', '369', '1099', '169',
              '99', '459', '239', '1299', '429', '659', '269', '359', '$799 ',
              '$399 ', '$699 ', '$329 ', '$999 ', '$549 ', '$1,299 ', '$899 ',
              '$449 ', '$319 ', '$269 ', '$349 ', '$279 ', '$249 ', '$299 ',
              '$969 ', '$1,199 ', '$149 ', '$139 ', '$99 ', '$199 ', '$169 ',
              '$499 ', '$179 ', '$219 ', '$229 ', '$239 ', '$109 ', '$189 ',
              '$389 ', '$309 ', '$369 ', '$129 ', '$849 ', '$469 ', '$209 ',
              '$119 ', '$339 ', '$429 ', '$159 ', '$379 ', '$289 ', '130', '749',
              '149', '969', '649', '349', '419', '1399', '1999', '119', '319',
              '1049'], dtype=object)
```

```
[11]: df["Screen Size (inches)"].unique()
```

```
[11]: array(['6.1', '6.8', '6.7', '6.67', '6.4', '6.55', '6.78', '6.43', '6.5',
              '6.62', '5.4', '6.2', '6.51', '6.6', '4.7', '6.58', '6.52', '6.44',
              '6.53', '6.56', '6.8 + 3.9', '4.5', '6.39', '5.9', '5.5', '6.81',
              '5.99', '6.82', '6.3', '6.22', '6', '6.35', '6.9', '6.76', '6.49',
              '6.72', '5.7', '6.47', '7.6 (unfolded)', '6.15', '6.57'],
             dtype=object)
```

```
[12]: df[df['Screen Size (inches)'] == '6.8 + 3.9']
```

```
[12]:    Brand Model Storage  RAM  Screen Size (inches)         Camera (MP)  \
      88    LG  Wing    256GB  8GB             6.8 + 3.9  64MP + 13MP + 12MP

          Battery Capacity (mAh) Price ($)
      88                    4000      $999
```

```
[13]: df[df['Screen Size (inches)'] == '7.6 (unfolded)']
```

```
[13]:        Brand               Model Storage  RAM  Screen Size (inches)  \
      373  Samsung  Galaxy Z Fold2 5G      256   12        7.6 (unfolded)

          Camera (MP)  Battery Capacity (mAh) Price ($)
      373    12+12+12                    4500      1999
```

```
[14]: df[~df['Price ($)'].str.isnumeric()]
```

```
[14]:        Brand         Model Storage  RAM  Screen Size (inches)  \
      77     Apple     iPhone 13    128GB  4GB                  6.1
      78   Samsung   Galaxy S21    128GB  8GB                  6.2
      79   OnePlus        Nord 2    128GB  8GB                 6.43
      80    Google       Pixel 6    128GB  8GB                  6.4
      81    Xiaomi  Poco X4 Pro    128GB  6GB                 6.67
      ..       …            …      …   …                   …
      283     Oppo           A31    128GB  4GB                  6.5
```

```
284     Vivo          Y15    64GB  4GB                6.35
285   Realme    Narzo 10A    32GB  3GB                 6.5
286   Xiaomi      Redmi 9T  128GB  4GB                6.53
287  Samsung  Galaxy A30s    64GB  4GB                 6.4

                Camera (MP)  Battery Capacity (mAh) Price ($)
77                12MP + 12MP                  2815      $799
78         64MP + 12MP + 12MP                  4000      $799
79           50MP + 8MP + 2MP                  4500      $399
80                50MP + 12MP                  4600      $699
81   48MP + 8MP + 2MP + 2MP                    5160      $329
..                        …                    …        …
283          12MP + 2MP + 2MP                  4230      $199
284          13MP + 8MP + 2MP                  5000      $189
285          12MP + 2MP + 2MP                  5000      $129
286  48MP + 8MP + 2MP + 2MP                    6000      $229
287          25MP + 8MP + 5MP                  4000      $279

[210 rows x 8 columns]
```

[15]:

```
#cleaning
df['Price ($)'] = df['Price ($)'].str.replace('$','')
df['Price ($)'] = df['Price ($)'].str.replace(',','')
df['Price ($)'] = df['Price ($)'].astype(int)
df.describe()
```

```
/var/folders/y2/yvk5dqns6f56zzw8h5m1qs280000gn/T/ipykernel_9055/4063708403.py:2:
FutureWarning: The default value of regex will change from True to False in a
future version. In addition, single character regular expressions will *not* be
treated as literal strings when regex=True.
  df['Price ($)'] = df['Price ($)'].str.replace('$','')
```

[15]:

```
       Battery Capacity (mAh)    Price ($)
count              407.000000   407.000000
mean              4676.476658   408.314496
std                797.193713   299.684768
min               1821.000000    99.000000
25%               4300.000000   199.000000
50%               5000.000000   299.000000
75%               5000.000000   499.000000
max               7000.000000  1999.000000
```

[16]:

```
import re
```

[17]:

```
s = '$1,29.9'
s = re.sub('\D', '', s)
s
```

```
[17]: '1299'
```

```
[21]: s = pd.Series([1, 2, 3, 4, 5, 6, 7, 8, 9])
      s.describe()
```

```
[21]: count    9.000000
      mean     5.000000
      std      2.738613
      min      1.000000
      25%      3.000000
      50%      5.000000
      75%      7.000000
      max      9.000000
      dtype: float64
```

```
[18]: df['RAM '].unique()
```

```
[18]: array(['6 GB', '12 GB', '8 GB', '4 GB', '3 GB', '2 GB', '4GB', '8GB',
             '6GB', '12GB', '3GB', '2GB', '5GB', '12', '3', '6', '8', '4', '16',
             '2'], dtype=object)
```

```
[32]: df['RAM '] = df['RAM '].str.replace('[^0-9]', '', regex = True)
      df['RAM '] = df['RAM '].astype(int)
      df.describe()
```

```
[32]:              RAM   Battery Capacity (mAh)    Price ($)  battery dollar
      count  407.000000              407.000000   407.000000      407.000000
      mean     5.837838             4676.476658   408.314496       17.870116
      std      2.431980              797.193713   299.684768       11.334885
      min      2.000000             1821.000000    99.000000        2.251126
      25%      4.000000             4300.000000   199.000000        8.347245
      50%      6.000000             5000.000000   299.000000       16.722408
      75%      8.000000             5000.000000   499.000000       25.125628
      max     16.000000             7000.000000  1999.000000       50.505051
```

```
[19]: df.sort_values(by = ['Battery Capacity (mAh)'])
```

```
[19]:        Brand                Model Storage   RAM  Screen Size (inches)  \
      289    Apple      iPhone SE (2020)      64     3                   4.7
      32     Apple  iPhone SE (2nd Gen)    64 GB  3 GB                   4.7
      379    Apple      iPhone SE (2020)     128     3                   4.7
      333    Apple      iPhone SE (2020)      64     3                   4.7
      62     Apple      iPhone SE (2020)   64 GB  3 GB                   4.7
      ..       …                   …      …    …                   …
      286   Xiaomi             Redmi 9T    128GB   4GB                  6.53
      175   Realme                 C25s    128GB   4GB                   6.5
      236  Samsung           Galaxy M12     64GB   4GB                   6.5
      208  Samsung           Galaxy M62    128GB   8GB                   6.7
```

```
334  Samsung           Galaxy M51      128     6                  6.7

                 Camera (MP)  Battery Capacity (mAh)  Price ($)
289                       12                    1821        399
32                        12                    1821        399
379                       12                    1821        449
333                       12                    1821        399
62                        12                    1821        399
..                        …                     …        …
286   48MP + 8MP + 2MP + 2MP                    6000        229
175         13MP + 2MP + 2MP                    6000        149
236   48MP + 5MP + 2MP + 2MP                    6000        179
208  64MP + 12MP + 5MP + 5MP                    7000        429
334                64+12+5+5                    7000        449

[407 rows x 8 columns]
```

[20]:

```
df.sort_values(by = ['Battery Capacity (mAh)', 'Price ($)'], ascending = [True,␣
  ↪False])
```

[20]:

```
        Brand                Model Storage   RAM  Screen Size (inches)  \
379     Apple     iPhone SE (2020)     128     3                   4.7
32      Apple  iPhone SE (2nd Gen)   64 GB  3 GB                   4.7
62      Apple     iPhone SE (2020)   64 GB  3 GB                   4.7
289     Apple     iPhone SE (2020)      64     3                   4.7
333     Apple     iPhone SE (2020)      64     3                   4.7
..        …                    …      …   …                  …
198  Motorola   Moto G9 Power Lite    64GB   4GB                   6.5
217     Nokia                  C30    32GB   2GB                  6.82
397    Xiaomi              Poco M3     128     4                  6.53
334   Samsung           Galaxy M51     128     6                   6.7
208   Samsung           Galaxy M62   128GB   8GB                   6.7

                 Camera (MP)  Battery Capacity (mAh)  Price ($)
379                       12                    1821        449
32                        12                    1821        399
62                        12                    1821        399
289                       12                    1821        399
333                       12                    1821        399
..                        …                     …        …
198         48MP + 2MP + 2MP                    6000        149
217               13MP + 2MP                    6000        149
397                   48+2+2                    6000        149
334                64+12+5+5                    7000        449
208  64MP + 12MP + 5MP + 5MP                    7000        429

[407 rows x 8 columns]
```

[21]:
```
df.nlargest(5, 'Battery Capacity (mAh)')
```

[21]:
```
       Brand           Model Storage   RAM  Screen Size (inches)  \
208  Samsung      Galaxy M62    128GB   8GB                  6.7
334  Samsung      Galaxy M51      128     6                  6.7
20    Xiaomi  Redmi 10 Prime   128 GB  6 GB                  6.5
29    Realme              9i   128 GB  4 GB                  6.5
35    Realme            C25s   128 GB  4 GB                  6.5

                 Camera (MP)  Battery Capacity (mAh)  Price ($)
208  64MP + 12MP + 5MP + 5MP                    7000        429
334                64+12+5+5                    7000        449
20            50 + 8 + 2 + 2                    6000        179
29                50 + 2 + 2                    6000        189
35                13 + 2 + 2                    6000        159
```

[22]:
```
df.loc[df['Brand'] == 'Xiaomi']
```

[22]:
```
      Brand                  Model Storage   RAM  Screen Size (inches)  \
3    Xiaomi      Redmi Note 10 Pro   128 GB  6 GB                 6.67
7    Xiaomi            Poco X3 Pro   128 GB  6 GB                 6.67
15   Xiaomi       Mi 11 Lite 5G NE   128 GB  6 GB                 6.55
20   Xiaomi         Redmi 10 Prime   128 GB  6 GB                  6.5
24   Xiaomi  Redmi Note 10 Pro Max   128 GB  6 GB                 6.67
..      …                    …      …   …                  …
380  Xiaomi               Redmi 9C       64     3                 6.53
386  Xiaomi      Redmi Note 10 Pro      128     6                 6.67
389  Xiaomi               Redmi 9T      128     4                 6.53
397  Xiaomi                Poco M3      128     4                 6.53
403  Xiaomi          Mi 10 Lite 5G      128     6                 6.57

         Camera (MP)  Battery Capacity (mAh)  Price ($)
3     64 + 8 + 5 + 2                    5020        279
7     48 + 8 + 2 + 2                    5160        249
15        64 + 8 + 5                    4250        329
20    50 + 8 + 2 + 2                    6000        179
24   108 + 8 + 5 + 2                    5020        279
..               …                     …        …
380           13+2+2                    5000        119
386        108+8+5+2                    5020        329
389         48+8+2+2                    6000        199
397           48+2+2                    6000        149
403         48+8+2+2                    4160        349

[67 rows x 8 columns]
```

[23]:
```
df.loc[df['Brand'] == 'Xiaomi', ['Brand', 'Model', 'Price ($)']]
```

```
[23]:      Brand                 Model  Price ($)
      3    Xiaomi      Redmi Note 10 Pro        279
      7    Xiaomi            Poco X3 Pro        249
      15   Xiaomi        Mi 11 Lite 5G NE        329
      20   Xiaomi          Redmi 10 Prime        179
      24   Xiaomi  Redmi Note 10 Pro Max        279
      ..      …                      …         …
      380  Xiaomi               Redmi 9C        119
      386  Xiaomi      Redmi Note 10 Pro        329
      389  Xiaomi               Redmi 9T        199
      397  Xiaomi                Poco M3        149
      403  Xiaomi           Mi 10 Lite 5G        349

      [67 rows x 3 columns]
```

```
[24]: df.iloc[5:10, 1:4]
```

```
[24]:            Model Storage    RAM
      5       iPhone 13  128 GB   4 GB
      6   Galaxy Z Flip3  256 GB   8 GB
      7      Poco X3 Pro  128 GB   6 GB
      8   Reno6 Pro+ 5G  128 GB   8 GB
      9       X70 Pro+  256 GB  12 GB
```

```
[25]: df['battery dollar'] = df['Battery Capacity (mAh)'] / df['Price ($)']
      df
      #semakin tinggi nilai battery dollar, berarti semakin besar kapasitasnya tetapi␣
       ↪harganya murah
```

```
[25]:       Brand              Model Storage    RAM  Screen Size (inches)  \
      0      Apple      iPhone 13 Pro   128 GB   6 GB                   6.1
      1    Samsung  Galaxy S21 Ultra   256 GB  12 GB                   6.8
      2    OnePlus              9 Pro   128 GB   8 GB                   6.7
      3     Xiaomi  Redmi Note 10 Pro   128 GB   6 GB                  6.67
      4     Google            Pixel 6   128 GB   8 GB                   6.4
      ..      …                 …     …    …                    …
      402  Samsung   Galaxy Note20 5G      128      8                   6.7
      403   Xiaomi      Mi 10 Lite 5G      128      6                  6.57
      404    Apple  iPhone 12 Pro Max      128      6                   6.7
      405     Oppo              Reno3      128      8                   6.4
      406  Samsung     Galaxy S10 Lite      128      6                   6.7

                Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar
      0         12 + 12 + 12                    3095        999        3.098098
      1    108 + 10 + 10 + 12                    5000       1199        4.170142
      2       48 + 50 + 8 + 2                    4500        899        5.005562
      3        64 + 8 + 5 + 2                    5020        279       17.992832
```

```
4            50 + 12.2                  4614      799        5.774718
..                   …                   …      …            …
402           12+64+12                  4300     1049        4.099142
403           48+8+2+2                  4160      349       11.919771
404           12+12+12                  3687     1099        3.354868
405          48+13+8+2                  4025      429        9.382284
406            48+12+5                  4500      649        6.933744

[407 rows x 9 columns]
```

```
[26]: df.iloc[0,1]
```

```
[26]: 'iPhone 13 Pro'
```

```
[27]: df.sort_values(by=['battery dollar'], ascending = False)
```

```
[27]:        Brand              Model Storage   RAM  Screen Size (inches)  \
273     Realme                C11     32GB   2GB                   6.5
216     Realme           C11 2021     32GB   2GB                  6.52
53      Realme         Narzo 50i     32 GB  2 GB                   6.5
109   Motorola     Moto E7i Power     32GB   2GB                   6.5
250     Realme           C11 2021     32GB   2GB                   6.5
..         …                  …      …     …                …
361     Huawei           P40 Pro+      512     8                  6.58
338      Apple      iPhone XS Max      256     4                   6.5
384      Apple      iPhone 12 Pro      128     6                   6.1
369      Apple     iPhone 12 mini      256     4                   5.4
373    Samsung  Galaxy Z Fold2 5G      256    12         7.6 (unfolded)

      Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar
273    13MP + 2MP                    5000         99       50.505051
216     8MP + 2MP                    5000         99       50.505051
53         50 + 2                    5000         99       50.505051
109    13MP + 2MP                    5000         99       50.505051
250     8MP + 2MP                    5000         99       50.505051
..            …                     …        …             …
361  50+40+12+3D                    4200       1399        3.002144
338         12+12                    3174       1099        2.888080
384      12+12+12                    2815        999        2.817818
369         12+12                    2227        899        2.477197
373      12+12+12                    4500       1999        2.251126

[407 rows x 9 columns]
```

```
[28]: df.groupby(['Brand']).agg({'Battery Capacity (mAh)': ['mean'], 'Price ($)':␣
       ↪['min']})
```

[28]:

```
           Battery Capacity (mAh) Price ($)
                             mean       min
Brand
Apple                 2863.900000       399
Asus                  5000.000000       699
Blackberry            3500.000000       399
CAT                   4200.000000       299
Google                4019.857143       499
Huawei                4161.666667       199
LG                    4100.000000       349
Motorola              5021.739130        99
Nokia                 4502.857143        99
OnePlus               4415.000000       299
Oppo                  4631.339286       139
Realme                5176.744186        99
Samsung               4936.708861       129
Sony                  4500.000000      1299
Vivo                  4750.000000       139
Xiaomi                5101.791045       119
```

[29]:

```
df.groupby(['Brand'])['Battery Capacity (mAh)', 'Price ($)'].mean().
 ↪sort_values(by=['Price ($)'])
```

```
/var/folders/y2/yvk5dqns6f56zzw8h5m1qs280000gn/T/ipykernel_9055/2900169093.py:1:
FutureWarning: Indexing with multiple keys (implicitly converted to a tuple of
keys) will be deprecated, use a list instead.
  df.groupby(['Brand'])['Battery Capacity (mAh)', 'Price
($)'].mean().sort_values(by=['Price ($)'])
```

[29]:

```
            Battery Capacity (mAh)    Price ($)
Brand
Realme                 5176.744186   206.906977
Nokia                  4502.857143   244.714286
Motorola               5021.739130   278.130435
Xiaomi                 5101.791045   282.880597
CAT                    4200.000000   299.000000
Vivo                   4750.000000   323.000000
Oppo                   4631.339286   376.142857
Samsung                4936.708861   480.405063
Blackberry             3500.000000   499.000000
LG                     4100.000000   615.666667
OnePlus                4415.000000   644.333333
Google                 4019.857143   699.000000
Apple                  2863.900000   745.666667
Huawei                 4161.666667   783.166667
Asus                   5000.000000   874.000000
Sony                   4500.000000  1299.000000
```

[30]:
```
df.groupby('Brand').agg(average_price = ('Price ($)', 'mean'), sum_price =␣
 ↪('Price ($)', 'sum'))
```

[30]:
```
            average_price  sum_price
Brand
Apple          745.666667      22370
Asus           874.000000       3496
Blackberry     499.000000       1497
CAT            299.000000        299
Google         699.000000       4893
Huawei         783.166667       9398
LG             615.666667       1847
Motorola       278.130435       6397
Nokia          244.714286       6852
OnePlus        644.333333       9665
Oppo           376.142857      21064
Realme         206.906977       8897
Samsung        480.405063      37952
Sony          1299.000000       1299
Vivo           323.000000      11305
Xiaomi         282.880597      18953
```

[36]:
```
pd.crosstab(df['Brand'], df['RAM '])
```

[36]:
```
RAM         2   3   4   5   6   8   12  16
Brand
Apple        0  11  14   0   5   0   0   0
Asus         0   0   0   0   1   3   0   0
Blackberry   0   0   1   0   2   0   0   0
CAT          0   1   0   0   0   0   0   0
Google       0   0   0   0   2   5   0   0
Huawei       0   0   2   0   0  10   0   0
LG           0   0   0   0   2   1   0   0
Motorola     1   2  14   2   3   0   1   0
Nokia        4   8  10   0   4   2   0   0
OnePlus      0   0   0   0   3   8   4   0
Oppo         0   4  13   0  14  15  10   0
Realme       5   2  20   0   5  11   0   0
Samsung      1   4  26   0  29  12   6   1
Sony         0   0   0   0   0   1   0   0
Vivo         0   5   5   0   4  18   3   0
Xiaomi       0   1  23   0  33   9   1   0
```

[34]:
```
df.pivot_table(index = ['Brand'], values = 'Price ($)', aggfunc = 'mean')
```

[34]:
```
               Price ($)
Brand
```

```
Apple          745.666667
Asus           874.000000
Blackberry     499.000000
CAT            299.000000
Google         699.000000
Huawei         783.166667
LG             615.666667
Motorola       278.130435
Nokia          244.714286
OnePlus        644.333333
Oppo           376.142857
Realme         206.906977
Samsung        480.405063
Sony          1299.000000
Vivo           323.000000
Xiaomi         282.880597
```

[37]:
```
df.groupby(['Brand']).agg(avg_price = ('Price ($)', 'mean'))
```

[37]:
```
              avg_price
Brand
Apple          745.666667
Asus           874.000000
Blackberry     499.000000
CAT            299.000000
Google         699.000000
Huawei         783.166667
LG             615.666667
Motorola       278.130435
Nokia          244.714286
OnePlus        644.333333
Oppo           376.142857
Realme         206.906977
Samsung        480.405063
Sony          1299.000000
Vivo           323.000000
Xiaomi         282.880597
```

[38]:
```
df.pivot_table(index = 'Brand', values = 'Price ($)', columns = 'RAM ', aggfunc␣
 ↪= 'mean')
```

[38]:
```
RAM              2           3           4     5            6             8   \
Brand
Apple          NaN  494.454545  838.285714   NaN  1039.000000           NaN
Asus           NaN         NaN         NaN   NaN   699.000000    932.333333
Blackberry     NaN         NaN  399.000000   NaN   549.000000           NaN
CAT            NaN  299.000000         NaN   NaN          NaN           NaN
```

```
Google        NaN         NaN         NaN    NaN   649.000000   719.000000
Huawei        NaN         NaN  264.000000    NaN          NaN   887.000000
LG            NaN         NaN         NaN    NaN   424.000000   999.000000
Motorola     99.0  184.000000  239.714286  399.0   359.000000          NaN
Nokia       134.0  142.750000  228.000000    NaN   474.000000   499.000000
OnePlus       NaN         NaN         NaN    NaN   309.000000   631.500000
Oppo          NaN  151.500000  190.538462    NaN   272.571429   407.666667
Realme       99.0  129.000000  166.500000    NaN   291.000000   305.363636
Samsung     129.0  139.250000  231.692308    NaN   441.068966   746.500000
Sony          NaN         NaN         NaN    NaN          NaN  1299.000000
Vivo          NaN  145.000000  179.000000    NaN   219.000000   322.888889
Xiaomi        NaN  119.000000  182.913043    NaN   279.909091   465.666667

RAM             12      16
Brand
Apple          NaN     NaN
Asus           NaN     NaN
Blackberry     NaN     NaN
CAT            NaN     NaN
Google         NaN     NaN
Huawei         NaN     NaN
LG             NaN     NaN
Motorola     699.0     NaN
Nokia          NaN     NaN
OnePlus      921.5     NaN
Oppo         805.0     NaN
Realme         NaN     NaN
Samsung     1349.0  1399.0
Sony           NaN     NaN
Vivo         999.0     NaN
Xiaomi      1199.0     NaN
```

[5]:

```
df.shape
```

[5]:

```
(407, 8)
```

[9]:

```
df_melt = df.melt(id_vars = ['Brand', 'Model', 'RAM ', 'Storage ', 'Screen Size (inches)', 'Camera (MP)'], \
       var_name = 'nama_kolom', value_name = 'nilai')
df_melt
```

[9]:

```
        Brand              Model  RAM  Storage  Screen Size (inches)  \
0       Apple      iPhone 13 Pro     6  128 GB                   6.1
1     Samsung   Galaxy S21 Ultra    12  256 GB                   6.8
2     OnePlus              9 Pro     8  128 GB                   6.7
3      Xiaomi  Redmi Note 10 Pro     6  128 GB                  6.67
4      Google            Pixel 6     8  128 GB                   6.4
```

```
…       …                …   …      …                  …
1216  Samsung   Galaxy Note20 5G     8      128                  6.7
1217   Xiaomi       Mi 10 Lite 5G     6      128                 6.57
1218    Apple  iPhone 12 Pro Max     6      128                  6.7
1219     Oppo              Reno3     8      128                  6.4
1220  Samsung    Galaxy S10 Lite     6      128                  6.7

             Camera (MP)              nama_kolom        nilai
0           12 + 12 + 12  Battery Capacity (mAh)  3095.000000
1     108 + 10 + 10 + 12  Battery Capacity (mAh)  5000.000000
2        48 + 50 + 8 + 2  Battery Capacity (mAh)  4500.000000
3         64 + 8 + 5 + 2  Battery Capacity (mAh)  5020.000000
4              50 + 12.2  Battery Capacity (mAh)  4614.000000
…                  …                     …          …
1216            12+64+12          battery dollar     4.099142
1217            48+8+2+2          battery dollar    11.919771
1218            12+12+12          battery dollar     3.354868
1219           48+13+8+2          battery dollar     9.382284
1220             48+12+5          battery dollar     6.933744

[1221 rows x 8 columns]
```

[15]:

```
df_melt.sort_values(by = ['Brand']).head(20)
```

[15]:

```
      Brand              Model  RAM  Storage  Screen Size (inches)  \
0     Apple      iPhone 13 Pro    6   128 GB                   6.1
469   Apple   iPhone SE (2020)    3    64 GB                   4.7
475   Apple          iPhone XR    3    64 GB                   6.1
481   Apple          iPhone 11    4   128 GB                   6.1
484   Apple          iPhone 13    4    128GB                   6.1
1147  Apple   iPhone SE (2020)    3       64                   4.7
1152  Apple      iPhone XS Max    4      256                   6.5
1161  Apple      iPhone 8 Plus    3       64                   5.5
891   Apple          iPhone 13    4    128GB                   6.1
888   Apple          iPhone 11    4   128 GB                   6.1
882   Apple          iPhone XR    3    64 GB                   6.1
1169  Apple          iPhone XR    3       64                   6.1
876   Apple   iPhone SE (2020)    3    64 GB                   4.7
1140  Apple          iPhone 11    4       64                   6.1
871   Apple  iPhone 13 Pro Max    6   256 GB                   6.7
859   Apple     iPhone 12 Mini    4    64 GB                   5.4
77    Apple          iPhone 13    4    128GB                   6.1
853   Apple          iPhone XR    3    64 GB                   6.1
74    Apple          iPhone 11    4   128 GB                   6.1
1176  Apple  iPhone 11 Pro Max    4       64                   6.5

       Camera (MP)              nama_kolom        nilai
```

```
0     12 + 12 + 12  Battery Capacity (mAh)  3095.000000
469             12               Price ($)   399.000000
475        12 + 12               Price ($)   499.000000
481        12 + 12               Price ($)   599.000000
484    12MP + 12MP               Price ($)   799.000000
1147            12          battery dollar     4.563910
1152         12+12          battery dollar     2.888080
1161         12+12          battery dollar     3.849785
891    12MP + 12MP          battery dollar     3.523154
888        12 + 12          battery dollar     5.191987
882        12 + 12          battery dollar     5.895792
1169            12          battery dollar     5.895792
876             12          battery dollar     4.563910
1140      12+12+12          battery dollar     4.449213
871   12 + 12 + 12          battery dollar     3.350269
859        12 + 12          battery dollar     3.185980
77     12MP + 12MP  Battery Capacity (mAh)  2815.000000
853             12          battery dollar     5.895792
74         12 + 12  Battery Capacity (mAh)  3110.000000
1176      12+12+12          battery dollar     3.611465
```

[17]:
```
df.stack().head(30)
```

[17]:
```
0  Brand                                    Apple
   Model                            iPhone 13 Pro
   Storage                                 128 GB
   RAM                                          6
   Screen Size (inches)                       6.1
   Camera (MP)                       12 + 12 + 12
   Battery Capacity (mAh)                    3095
   Price ($)                                  999
   battery dollar                        3.098098
1  Brand                                  Samsung
   Model                        Galaxy S21 Ultra
   Storage                                 256 GB
   RAM                                         12
   Screen Size (inches)                       6.8
   Camera (MP)                  108 + 10 + 10 + 12
   Battery Capacity (mAh)                    5000
   Price ($)                                 1199
   battery dollar                        4.170142
2  Brand                                  OnePlus
   Model                                    9 Pro
   Storage                                 128 GB
   RAM                                          8
   Screen Size (inches)                       6.7
   Camera (MP)                     48 + 50 + 8 + 2
   Battery Capacity (mAh)                      4500
   Price ($)                                    899
   battery dollar                          5.005562
3  Brand                                     Xiaomi
   Model                          Redmi Note 10 Pro
   Storage                                   128 GB
dtype: object
```

```
[24]: df_stacked = df.set_index(['Brand', 'Model', 'RAM ', 'Storage ', 'Screen Size␣
       ↪(inches)', 'Camera (MP)']).stack().reset_index()
      df_stacked
```

```
[24]:         Brand              Model  RAM  Storage  Screen Size (inches)  \
      0       Apple      iPhone 13 Pro    6   128 GB                   6.1
      1       Apple      iPhone 13 Pro    6   128 GB                   6.1
      2       Apple      iPhone 13 Pro    6   128 GB                   6.1
      3     Samsung  Galaxy S21 Ultra   12   256 GB                   6.8
      4     Samsung  Galaxy S21 Ultra   12   256 GB                   6.8
      …         …                 …    …       …                    …
      1216     Oppo              Reno3    8      128                   6.4
      1217     Oppo              Reno3    8      128                   6.4
      1218  Samsung     Galaxy S10 Lite    6      128                   6.7
      1219  Samsung     Galaxy S10 Lite    6      128                   6.7
      1220  Samsung     Galaxy S10 Lite    6      128                   6.7

                 Camera (MP)                 level_6            0
      0         12 + 12 + 12  Battery Capacity (mAh)  3095.000000
      1         12 + 12 + 12               Price ($)   999.000000
      2         12 + 12 + 12          battery dollar     3.098098
      3    108 + 10 + 10 + 12  Battery Capacity (mAh)  5000.000000
      4    108 + 10 + 10 + 12               Price ($)  1199.000000
      …                  …                       …          …
      1216         48+13+8+2               Price ($)   429.000000
      1217         48+13+8+2          battery dollar     9.382284
      1218           48+12+5  Battery Capacity (mAh)  4500.000000
      1219           48+12+5               Price ($)   649.000000
      1220           48+12+5          battery dollar     6.933744

      [1221 rows x 8 columns]
```

```
[25]: df_stacked.rename(columns = {'level_6': 'atribut', 0:'value'})
```

```
[25]:         Brand              Model  RAM  Storage  Screen Size (inches)  \
      0       Apple      iPhone 13 Pro    6   128 GB                   6.1
      1       Apple      iPhone 13 Pro    6   128 GB                   6.1
      2       Apple      iPhone 13 Pro    6   128 GB                   6.1
      3     Samsung  Galaxy S21 Ultra   12   256 GB                   6.8
```

```
4     Samsung  Galaxy S21 Ultra    12   256 GB                  6.8
…       …               …   …      …                  …
1216     Oppo             Reno3     8      128                  6.4
1217     Oppo             Reno3     8      128                  6.4
1218  Samsung   Galaxy S10 Lite     6      128                  6.7
1219  Samsung   Galaxy S10 Lite     6      128                  6.7
1220  Samsung   Galaxy S10 Lite     6      128                  6.7

             Camera (MP)                 atribut        value
0           12 + 12 + 12  Battery Capacity (mAh)  3095.000000
1           12 + 12 + 12               Price ($)   999.000000
2           12 + 12 + 12          battery dollar     3.098098
3     108 + 10 + 10 + 12  Battery Capacity (mAh)  5000.000000
4     108 + 10 + 10 + 12               Price ($)  1199.000000
…                  …                     …          …
1216           48+13+8+2               Price ($)   429.000000
1217           48+13+8+2          battery dollar     9.382284
1218             48+12+5  Battery Capacity (mAh)  4500.000000
1219             48+12+5               Price ($)   649.000000
1220             48+12+5          battery dollar     6.933744

[1221 rows x 8 columns]
```

[26]:
```
df
```

[26]:
```
       Brand              Model Storage   RAM  Screen Size (inches)  \
0      Apple      iPhone 13 Pro   128 GB     6                  6.1
1    Samsung   Galaxy S21 Ultra   256 GB    12                  6.8
2    OnePlus              9 Pro   128 GB     8                  6.7
3     Xiaomi  Redmi Note 10 Pro   128 GB     6                 6.67
4     Google            Pixel 6   128 GB     8                  6.4
..       …                …      …   …                  …
402  Samsung   Galaxy Note20 5G      128     8                  6.7
403   Xiaomi      Mi 10 Lite 5G      128     6                 6.57
404    Apple  iPhone 12 Pro Max      128     6                  6.7
405     Oppo              Reno3      128     8                  6.4
406  Samsung    Galaxy S10 Lite      128     6                  6.7

            Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar
0          12 + 12 + 12                    3095        999        3.098098
1    108 + 10 + 10 + 12                    5000       1199        4.170142
2       48 + 50 + 8 + 2                    4500        899        5.005562
3        64 + 8 + 5 + 2                    5020        279       17.992832
4             50 + 12.2                    4614        799        5.774718
..                  …                     …        …             …
402            12+64+12                    4300       1049        4.099142
403            48+8+2+2                    4160        349       11.919771
```

```
404           12+12+12                       3687       1099         3.354868
405          48+13+8+2                       4025        429         9.382284
406            48+12+5                       4500        649         6.933744

[407 rows x 9 columns]
```

[27]:

```
# mengkategorisasikan nilai Price menjadi 4 kategori dengan jumlah ukuran yang␣
 ↪sama, misal Bronze, Silver, Gold, Platinum
bin_labels = ['Bronze', 'Silver', 'Gold', 'Platinum']
results, bin_edges = pd.qcut(df['Price ($)'], q = 4, labels = bin_labels,␣
 ↪retbins = True)
```

[28]:

```
results
```

[28]:

```
0      Platinum
1      Platinum
2      Platinum
3        Silver
4      Platinum
         …
402    Platinum
403        Gold
404    Platinum
405        Gold
406    Platinum
Name: Price ($), Length: 407, dtype: category
Categories (4, object): ['Bronze' < 'Silver' < 'Gold' < 'Platinum']
```

[29]:

```
bin_edges
```

[29]:

```
array([  99.,  199.,  299.,  499., 1999.])
```

[30]:

```
results_table = pd.DataFrame(zip(bin_edges, bin_labels), columns =['Threshold',␣
 ↪'Tier'])
results_table
```

[30]:

```
   Threshold      Tier
0       99.0    Bronze
1      199.0    Silver
2      299.0      Gold
3      499.0  Platinum
```

[31]:

```
df['results'] = results
df
```

[31]:

```
       Brand              Model Storage   RAM  Screen Size (inches)  \
0      Apple      iPhone 13 Pro  128 GB     6                   6.1
1    Samsung  Galaxy S21 Ultra   256 GB    12                   6.8
```

```
2    OnePlus              9 Pro   128 GB     8                  6.7
3     Xiaomi  Redmi Note 10 Pro   128 GB     6                 6.67
4     Google            Pixel 6   128 GB     8                  6.4
..       …                …      …    …                 …
402  Samsung   Galaxy Note20 5G      128     8                  6.7
403   Xiaomi      Mi 10 Lite 5G      128     6                 6.57
404    Apple  iPhone 12 Pro Max      128     6                  6.7
405     Oppo              Reno3      128     8                  6.4
406  Samsung    Galaxy S10 Lite      128     6                  6.7

            Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar  \
0          12 + 12 + 12                    3095        999        3.098098
1     108 + 10 + 10 + 12                    5000       1199        4.170142
2        48 + 50 + 8 + 2                    4500        899        5.005562
3         64 + 8 + 5 + 2                    5020        279       17.992832
4              50 + 12.2                    4614        799        5.774718
..                    …                     …        …              …
402             12+64+12                    4300       1049        4.099142
403             48+8+2+2                    4160        349       11.919771
404             12+12+12                    3687       1099        3.354868
405            48+13+8+2                    4025        429        9.382284
406              48+12+5                    4500        649        6.933744

      results
0    Platinum
1    Platinum
2    Platinum
3      Silver
4    Platinum
..        …
402  Platinum
403      Gold
404  Platinum
405      Gold
406  Platinum

[407 rows x 10 columns]
```

[32]:

```
df['results'].value_counts()
```

[32]:

```
Bronze      119
Silver      101
Platinum     95
Gold         92
Name: results, dtype: int64
```

[33]:

```
bins = [0, 1000, 2000, 3000, 4000, 5000, 10000]
labels = [1, 2, 3, 4, 5, 6]
df['binned_battery'] = pd.cut(df['Battery Capacity (mAh)'], bins = bins, labels␣
 ↪= labels)
```

[34]:

```
df
```

[34]:

```
       Brand              Model Storage   RAM  Screen Size (inches)  \
0      Apple       iPhone 13 Pro   128 GB     6                  6.1
1    Samsung    Galaxy S21 Ultra   256 GB    12                  6.8
2    OnePlus              9 Pro   128 GB     8                  6.7
3     Xiaomi  Redmi Note 10 Pro   128 GB     6                 6.67
4     Google            Pixel 6   128 GB     8                  6.4
..       …                  …      …    …                   …
402  Samsung    Galaxy Note20 5G      128     8                  6.7
403   Xiaomi       Mi 10 Lite 5G      128     6                 6.57
404    Apple  iPhone 12 Pro Max      128     6                  6.7
405     Oppo              Reno3      128     8                  6.4
406  Samsung     Galaxy S10 Lite      128     6                  6.7

          Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar  \
0        12 + 12 + 12                    3095        999        3.098098
1    108 + 10 + 10 + 12                  5000       1199        4.170142
2       48 + 50 + 8 + 2                  4500        899        5.005562
3        64 + 8 + 5 + 2                  5020        279       17.992832
4             50 + 12.2                  4614        799        5.774718
..                  …                      …        …              …
402            12+64+12                  4300       1049        4.099142
403            48+8+2+2                  4160        349       11.919771
404            12+12+12                  3687       1099        3.354868
405           48+13+8+2                  4025        429        9.382284
406             48+12+5                  4500        649        6.933744

      results binned_battery
0    Platinum              4
1    Platinum              5
2    Platinum              5
3      Silver              6
4    Platinum              5
..        …             …
402  Platinum              5
403      Gold              5
404  Platinum              4
405      Gold              5
406  Platinum              5

[407 rows x 11 columns]
```

[35]:
```
df['binned_battery'].value_counts()
```

[35]:
```
5    268
6     66
4     52
3     16
2      5
1      0
Name: binned_battery, dtype: int64
```

[39]:
```
df['rank_price'] = df['Price ($)'].rank(ascending = True, method = 'first')
df
```

[39]:
```
        Brand              Model Storage   RAM  Screen Size (inches)  \
0       Apple      iPhone 13 Pro  128 GB     6                  6.1
1     Samsung   Galaxy S21 Ultra  256 GB    12                  6.8
2     OnePlus              9 Pro  128 GB     8                  6.7
3      Xiaomi  Redmi Note 10 Pro  128 GB     6                 6.67
4      Google            Pixel 6  128 GB     8                  6.4
..        …                  …      …    …                   …
402   Samsung    Galaxy Note20 5G     128     8                  6.7
403    Xiaomi        Mi 10 Lite 5G     128     6                 6.57
404     Apple   iPhone 12 Pro Max     128     6                  6.7
405      Oppo              Reno3     128     8                  6.4
406   Samsung     Galaxy S10 Lite     128     6                  6.7

           Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar  \
0         12 + 12 + 12                    3095        999        3.098098
1    108 + 10 + 10 + 12                    5000       1199        4.170142
2       48 + 50 + 8 + 2                    4500        899        5.005562
3        64 + 8 + 5 + 2                    5020        279       17.992832
4             50 + 12.2                    4614        799        5.774718
..                 …                      …         …              …
402           12+64+12                    4300       1049        4.099142
403           48+8+2+2                    4160        349       11.919771
404           12+12+12                    3687       1099        3.354868
405          48+13+8+2                    4025        429        9.382284
406            48+12+5                    4500        649        6.933744

      results binned_battery  rank_price
0    Platinum              4       374.0
1    Platinum              5       394.0
2    Platinum              5       367.0
3      Silver              6       174.0
4    Platinum              5       352.0
..        …             …          …
402  Platinum              5       386.0
```

```
403      Gold              5        250.0
404  Platinum              4        393.0
405      Gold              5        284.0
406  Platinum              5        325.0

[407 rows x 12 columns]
```

```
[40]: df.sort_values(by = ['rank_price'])
```

```
[40]:
        Brand                  Model Storage   RAM  Screen Size (inches)  \
53     Realme              Narzo 50i   32 GB     2                   6.5
107     Nokia               C20 Plus    32GB     3                   6.5
109  Motorola         Moto E7i Power    32GB     2                   6.5
216    Realme               C11 2021    32GB     2                  6.52
240     Nokia               C20 Plus    32GB     3                   6.5
..        …                   …      …   …                  …
87       Sony           Xperia 5 III   128GB     8                   6.1
288   Samsung   Galaxy Note 20 Ultra     256    12                   6.9
361    Huawei               P40 Pro+     512     8                  6.58
367   Samsung    Galaxy S20 Ultra 5G     512    16                   6.9
373   Samsung      Galaxy Z Fold2 5G     256    12        7.6 (unfolded)

            Camera (MP)  Battery Capacity (mAh)   Price ($)  battery dollar  \
53               50 + 2                    5000          99       50.505051
107           8MP + 2MP                    4950          99       50.000000
109          13MP + 2MP                    5000          99       50.505051
216           8MP + 2MP                    5000          99       50.505051
240           8MP + 2MP                    4950          99       50.000000
..                   …                     …        …             …
87   12MP + 12MP + 12MP                    4500        1299        3.464203
288           108+12+12                    4500        1299        3.464203
361         50+40+12+3D                    4200        1399        3.002144
367        108+48+12+3D                    5000        1399        3.573981
373            12+12+12                    4500        1999        2.251126

      results binned_battery   rank_price
53     Bronze              5          1.0
107    Bronze              5          2.0
109    Bronze              5          3.0
216    Bronze              5          4.0
240    Bronze              5          5.0
..        …             …         …
87   Platinum              5        403.0
288  Platinum              5        404.0
361  Platinum              5        405.0
367  Platinum              5        406.0
373  Platinum              5        407.0
```

```
[407 rows x 12 columns]
```

[38]:
```
df[df['rank_price'] == 4.5]
```

[38]:
```
        Brand           Model Storage  RAM  Screen Size (inches) Camera (MP)  \
53     Realme       Narzo 50i   32 GB    2                   6.5      50 + 2
107     Nokia       C20 Plus     32GB    3                   6.5   8MP + 2MP
109  Motorola  Moto E7i Power    32GB    2                   6.5  13MP + 2MP
216    Realme       C11 2021     32GB    2                  6.52   8MP + 2MP
240     Nokia       C20 Plus     32GB    3                   6.5   8MP + 2MP
250    Realme       C11 2021     32GB    2                   6.5   8MP + 2MP
261    Realme             C20    32GB    2                   6.5         8MP
273    Realme             C11    32GB    2                   6.5  13MP + 2MP

     Battery Capacity (mAh)  Price ($)  battery dollar results binned_battery  \
53                     5000         99       50.505051  Bronze              5
107                    4950         99       50.000000  Bronze              5
109                    5000         99       50.505051  Bronze              5
216                    5000         99       50.505051  Bronze              5
240                    4950         99       50.000000  Bronze              5
250                    5000         99       50.505051  Bronze              5
261                    5000         99       50.505051  Bronze              5
273                    5000         99       50.505051  Bronze              5

     rank_price
53          4.5
107         4.5
109         4.5
216         4.5
240         4.5
250         4.5
261         4.5
273         4.5
```

[41]:
```
body = ['Samsung', 'Xiaomi']
df[df['Brand'].isin(body)]
```

[41]:
```
       Brand              Model Storage   RAM  Screen Size (inches)  \
1    Samsung   Galaxy S21 Ultra  256 GB    12                   6.8
3     Xiaomi  Redmi Note 10 Pro  128 GB     6                  6.67
6    Samsung     Galaxy Z Flip3  256 GB     8                   6.7
7     Xiaomi         Poco X3 Pro  128 GB     6                  6.67
11   Samsung     Galaxy A52s 5G  128 GB     6                   6.5
..       …                  …       …   …                    …
397   Xiaomi            Poco M3     128     4                  6.53
398  Samsung      Galaxy A52 5G     128     6                   6.5
```

```
402  Samsung   Galaxy Note20 5G      128     8                  6.7
403   Xiaomi      Mi 10 Lite 5G      128     6                 6.57
406  Samsung    Galaxy S10 Lite      128     6                  6.7

            Camera (MP)  Battery Capacity (mAh)  Price ($)  battery dollar  \
1    108 + 10 + 10 + 12                    5000       1199        4.170142
3        64 + 8 + 5 + 2                    5020        279       17.992832
6               12 + 12                    3300        999        3.303303
7        48 + 8 + 2 + 2                    5160        249       20.722892
11      64 + 12 + 5 + 5                    4500        449       10.022272
..                    …                      …         …               …
397              48+2+2                    6000        149       40.268456
398          64+12+5+5                     4500        449       10.022272
402            12+64+12                    4300       1049        4.099142
403            48+8+2+2                    4160        349       11.919771
406             48+12+5                    4500        649        6.933744

      results binned_battery  rank_price
1    Platinum              5       394.0
3      Silver              6       174.0
6    Platinum              4       375.0
7      Silver              6       146.0
11       Gold              5       285.0
..        …             …          …
397    Bronze              6        48.0
398      Gold              5       300.0
402  Platinum              5       386.0
403      Gold              5       250.0
406  Platinum              5       325.0

[146 rows x 12 columns]
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[ ]:
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