CAPSTONE PROJECT:-

MOBILE PRICE RANGE PREDICTION

BY

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PROBLEM STATEMENT

- Mobile phones have become a great necessity for almost all individuals now days. People wants more features and best specification in phone and that too at cheaper cost. The demand of the phone is so high that there is a huge competition prevailing between mobile manufactures. To stay ahead in a race, these companies try to bring new features and innovation so that people are lured toward buying their brand smartphones.
- Price of mobile phones is influenced by different factor. Brand name, newness of the model, internal memory, RAM, connectivity, are some of the important factor in determining the price. As a business point of view, it become an utmost priority to analyze the factor form time to time and come with best set of specification and price ranges so that people buy their phones.
- Hence, Through this exercise and our prediction we will try to help companies estimate price range competition to other manufacturer and also it will be useful for customers to verify the price of mobile.

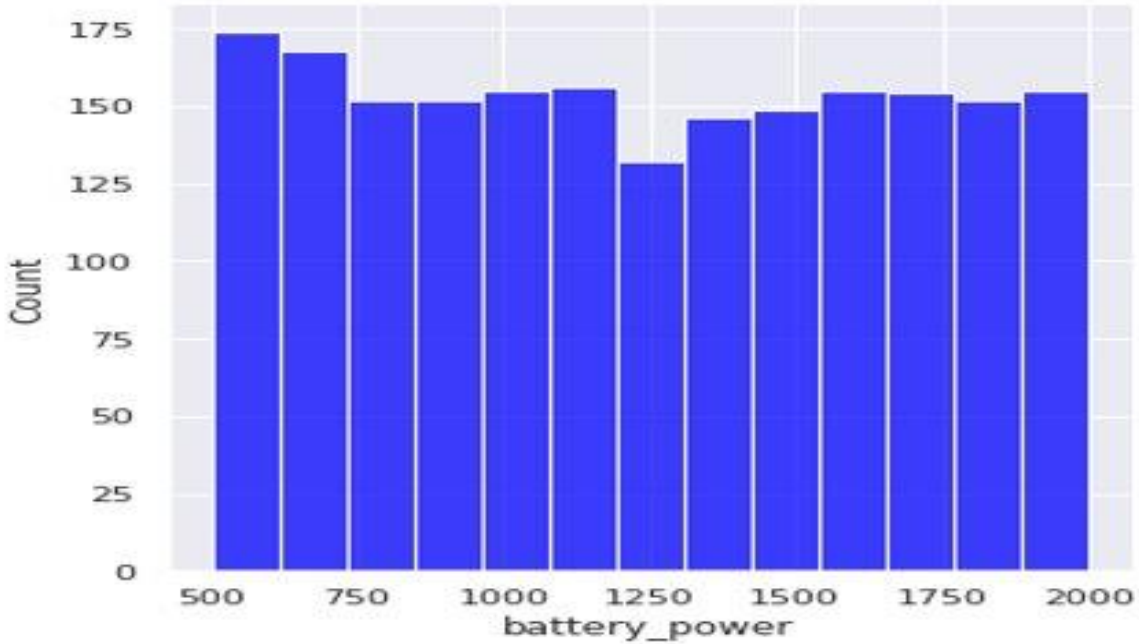
DATA SUMMARY

- The content of the data had the following features:
- battery_power : Total energy a battery can store in one time measured in mAh
- blue : Has bluetooth or not
- clock_speed : speed at which microprocessor executes instructions
- dual _sim : Has dual sim support or not
- fc : Front Camera megapixels
- four_g : Has 4G or not
- int_memory : Internal Memory in Gigabytes
- m_dep : Mobile Depth in cm
- mobile_wt : Weight of mobile phone
- n_cores : Number of cores of processor

DATA SUMMARY

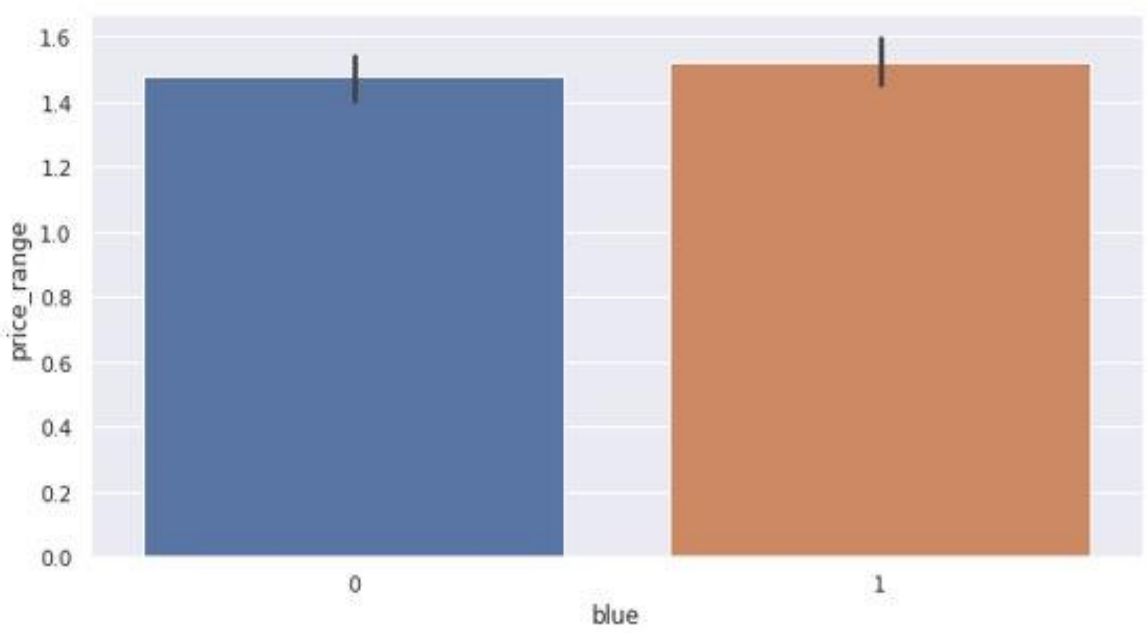
- pc : Primary Camera megapixels
- px_height : Pixel Resolution Height
- px_width : Pixel Resolution Width
- ram : Random Access Memory in Megabytes
- sc_h : Screen Height of mobile in cm
- sc_w : Screen Width of mobile in cm
- talk_time : longest time that a single battery charge will last when you are
- three_g : Has 3G or not
- touch_screen : Has touch screen or not
- wifi : Has wifi or not
- price_range : This is the target variable with values of 0(low cost), 1(medium cost), 2(high cost) and 3(very high cost).

EDA

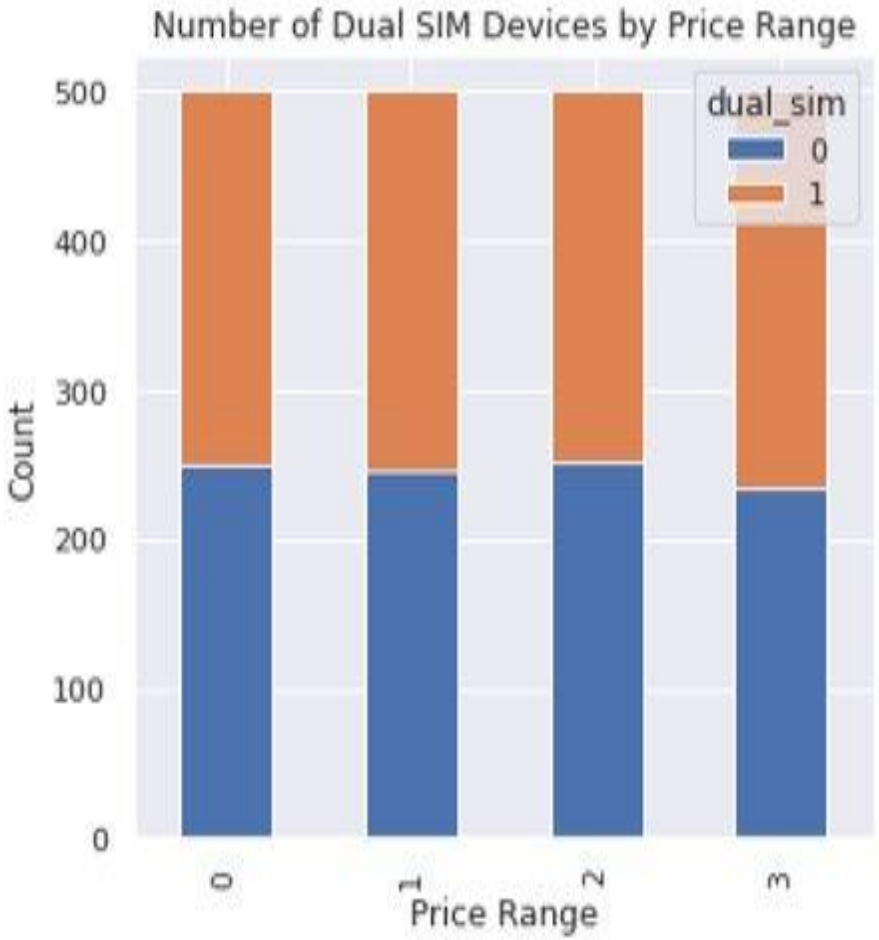


1.All category phones are distributed with equal price range
2.This plot visualizes how the battery capacity, measured in mAh, is distributed across the dataset. We can observe that the distribution of battery capacity is positively correlated with the price range of the mobile phones, as there is a gradual increase in the battery capacity as the price range increases. This suggests that there is a strong relationship between the battery capacity and the price of a mobile phone, and that consumers may be willing to pay more for a mobile phone with a higher battery capacity.

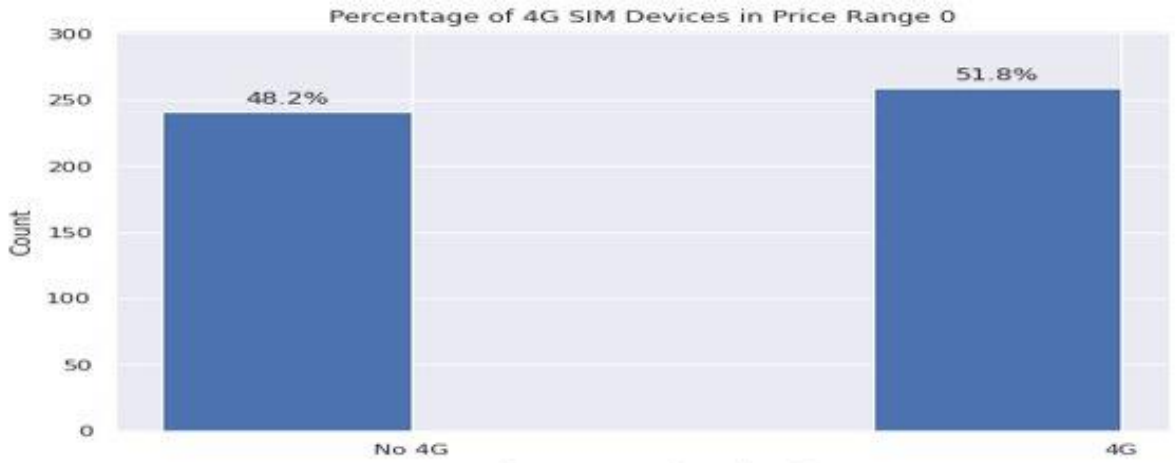
EDA

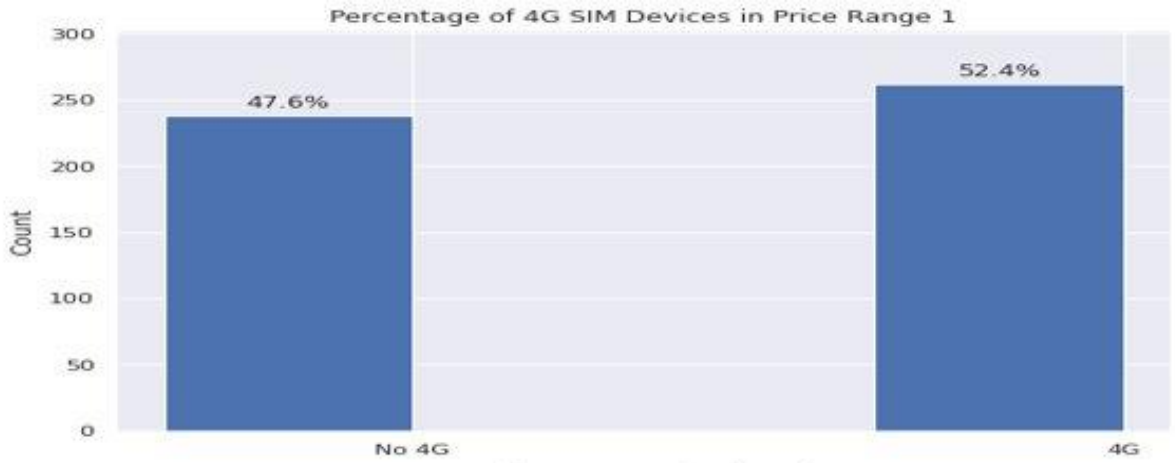


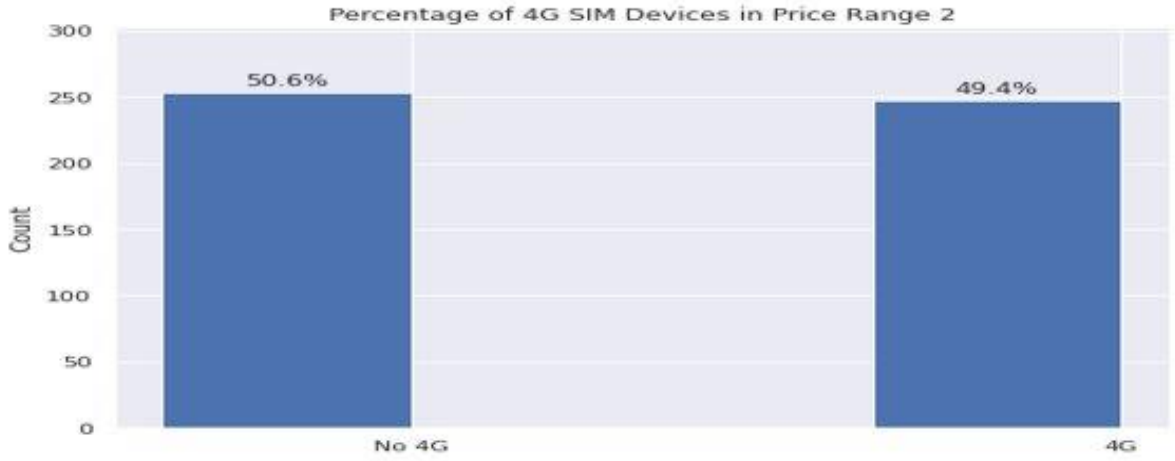
1. Almost half the devices have Bluetooth, and half don't.
2. The scatter plot shows a clear positive correlation between RAM and price range, with the majority of the data points clustering towards the upper right corner. This suggests that as the price range increases, the amount of RAM in the device generally increases as well.

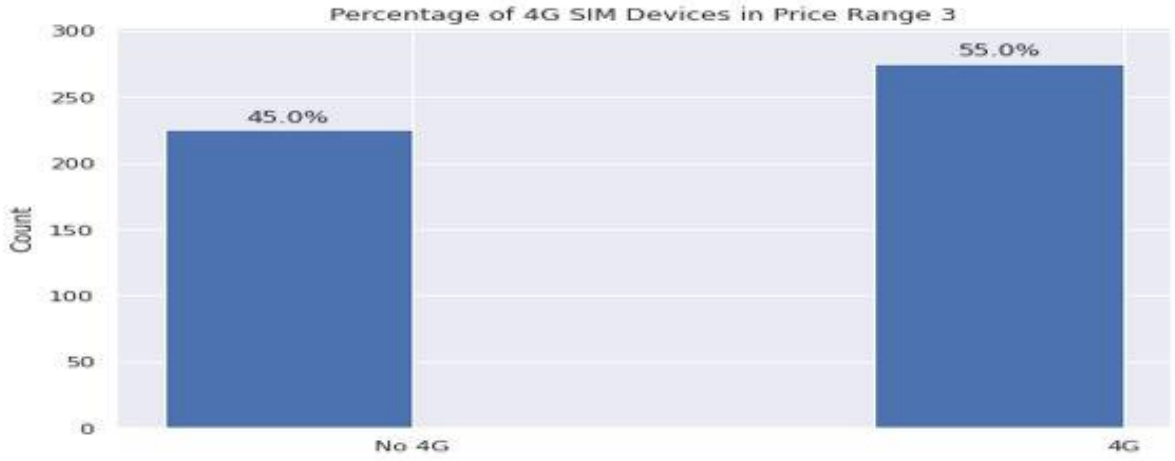


We can observe that, upto low, medium, high almost it is same but for very high price range it is seen that it is found that the count is raised who using dual devices and count is increasing for dual devices.



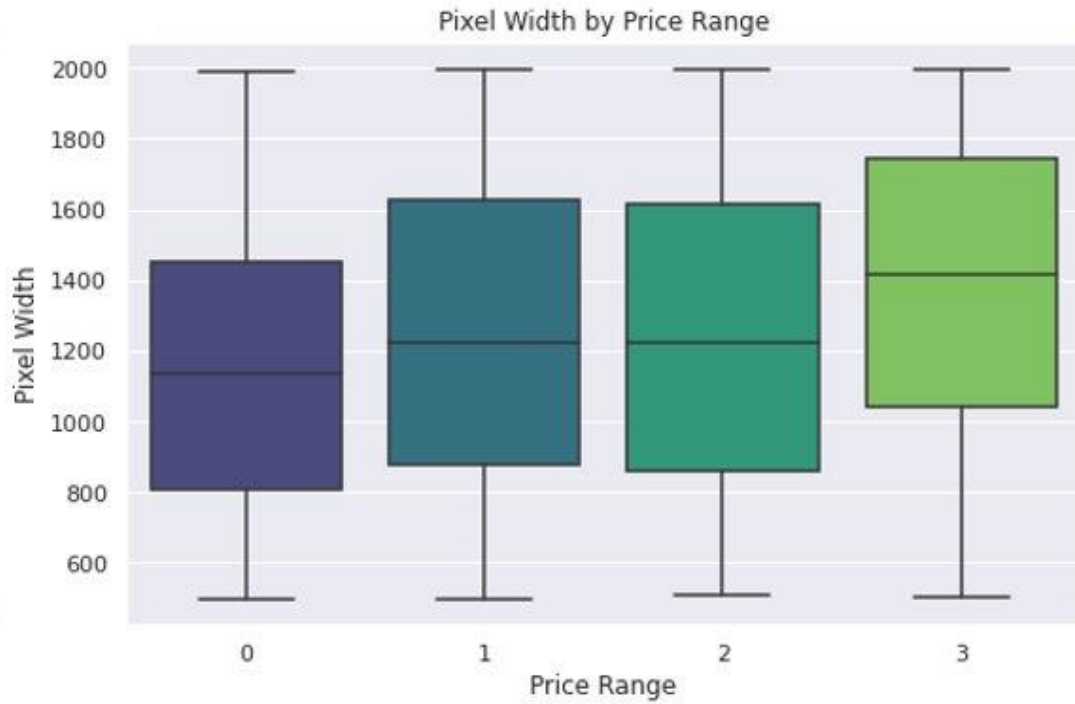




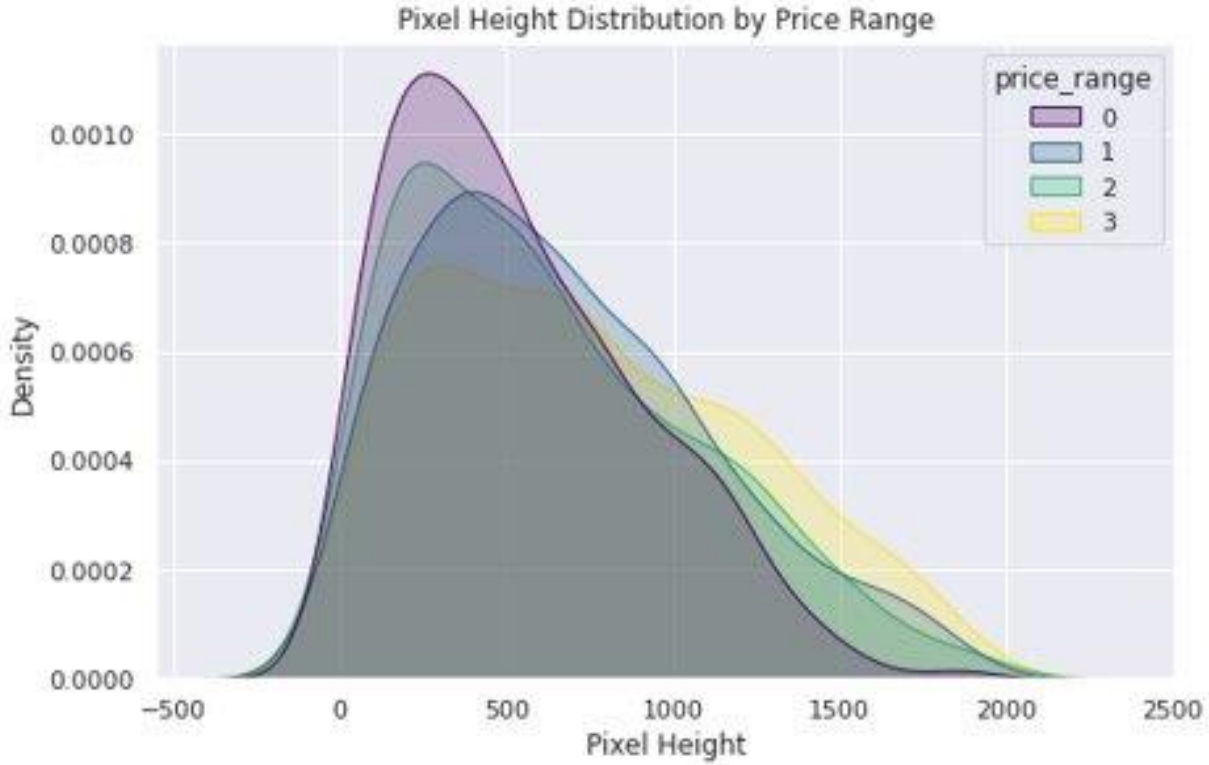


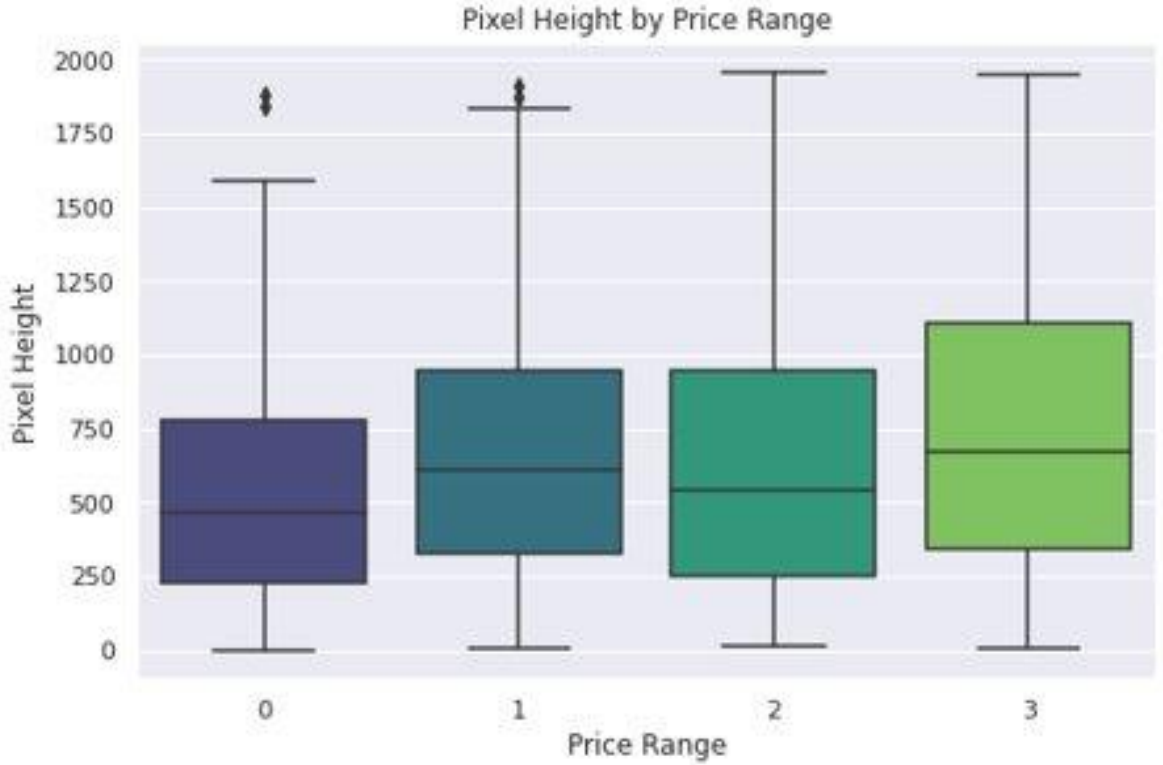
I have found that at low, medium,very high prices the mobile phones having sim in more numbers but at high prices it is showing slightly collapse.


Pixel Width Distribution by Price Range
price_range
0
1
2
3
Density
0.0008
0.0006
0.0004
0.0002
0.0000
500
1000
1500
2000
Pixel Width


Pixel Width by Price Range
Pixel Width
2000
1800
1600
1400
1200
1000
800
600
0
1
2
3
Price Range

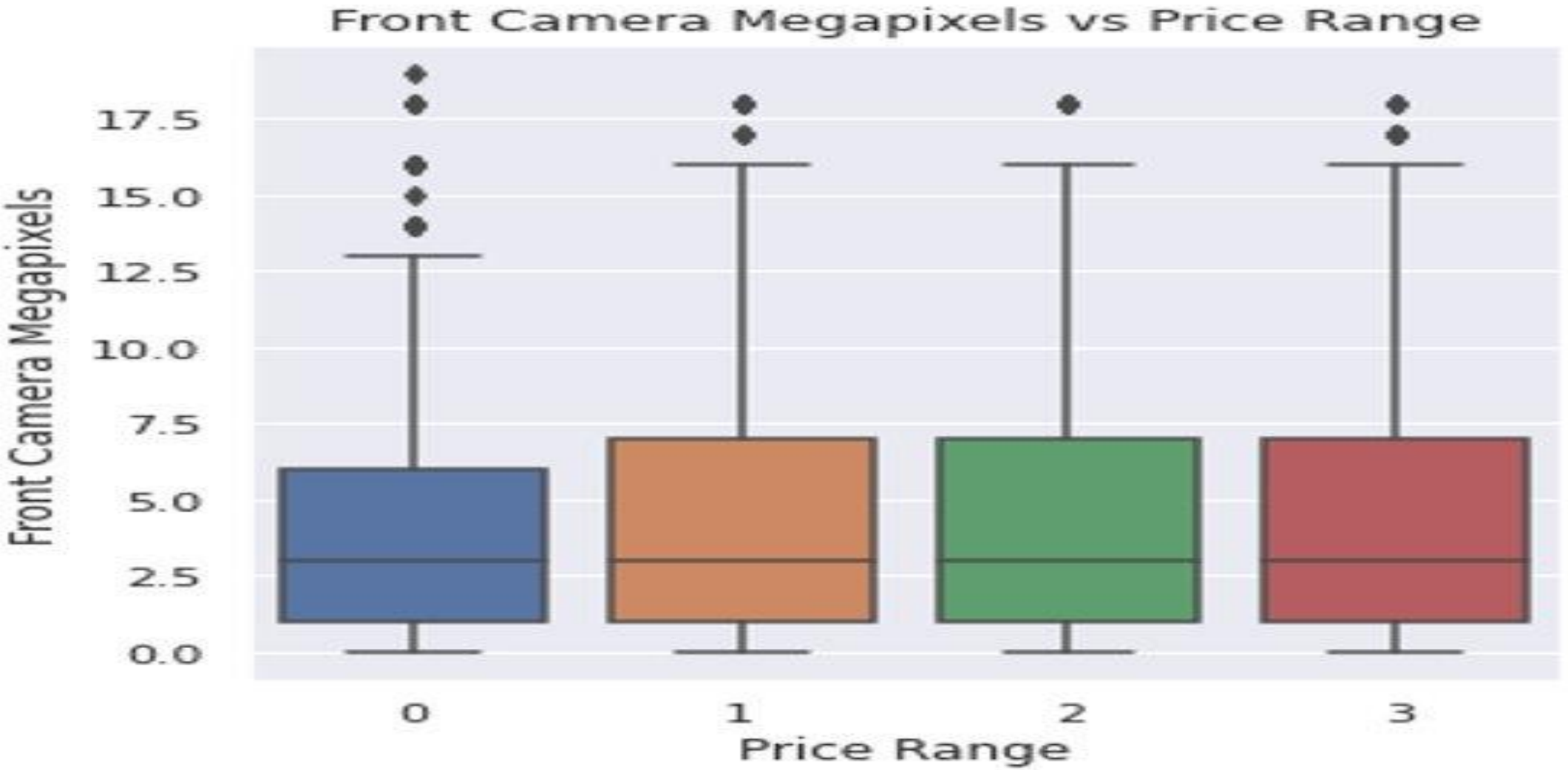
FUTURISTIC FEATURES



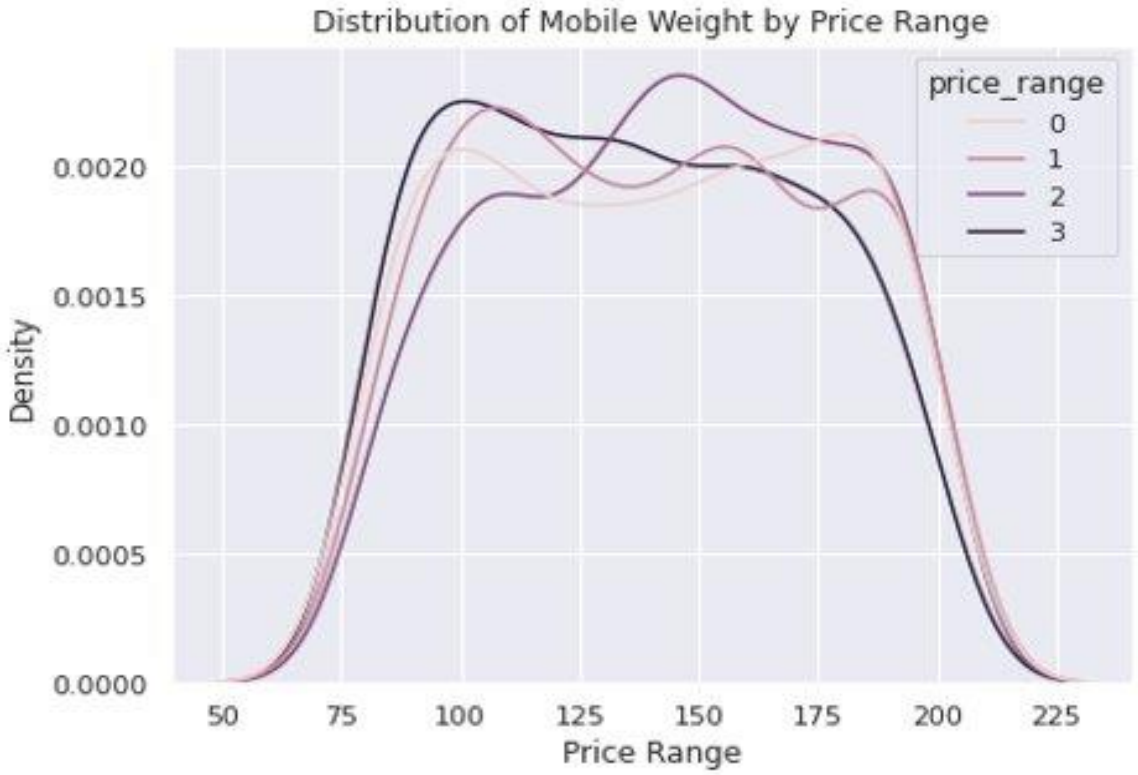


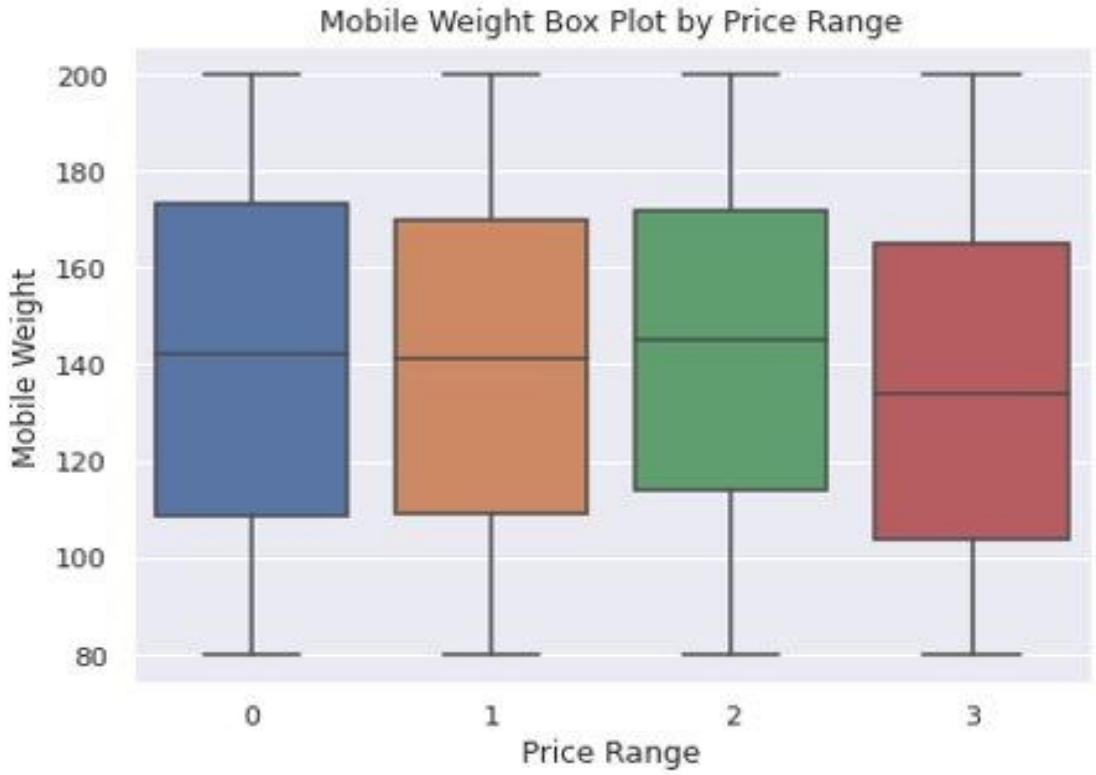
Based on the analysis of the pixel width distribution across different price ranges, it can be observed that there is not a continuous increase in pixel width as we move from low cost to very high cost mobile phones. In particular, mobile phones with medium cost and high cost have almost equal pixel width, indicating that this may not be the sole driving factor in deciding the price range of mobile phones. Other features such as processor, camera quality, storage capacity, and brand value may also play a significant role in determining the price range. Therefore, a holistic approach considering multiple factors is necessary for accurate pricing and positioning of mobile phones in the market.Pixel height is almost similar as we move from Low cost to Very high cost.little variation in pixel height

EDA

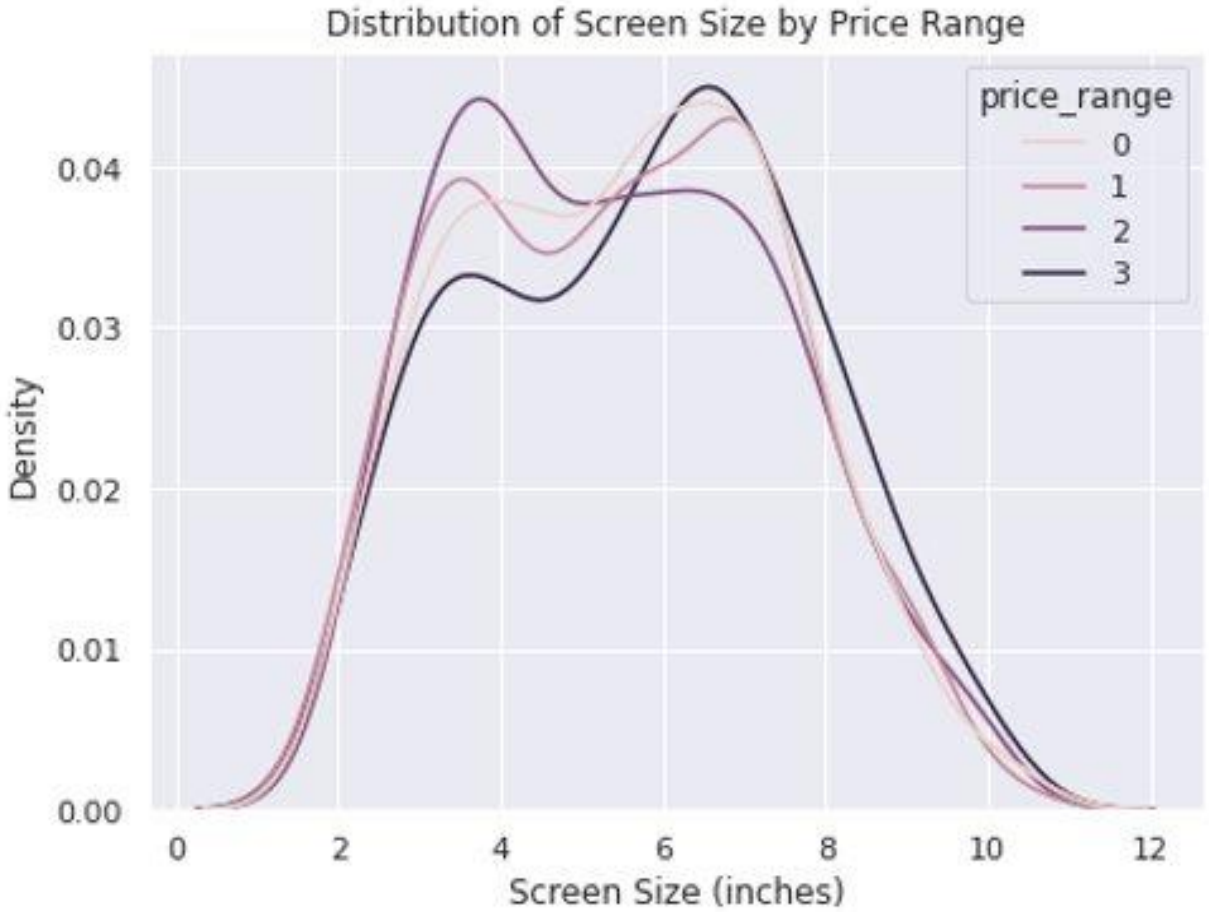


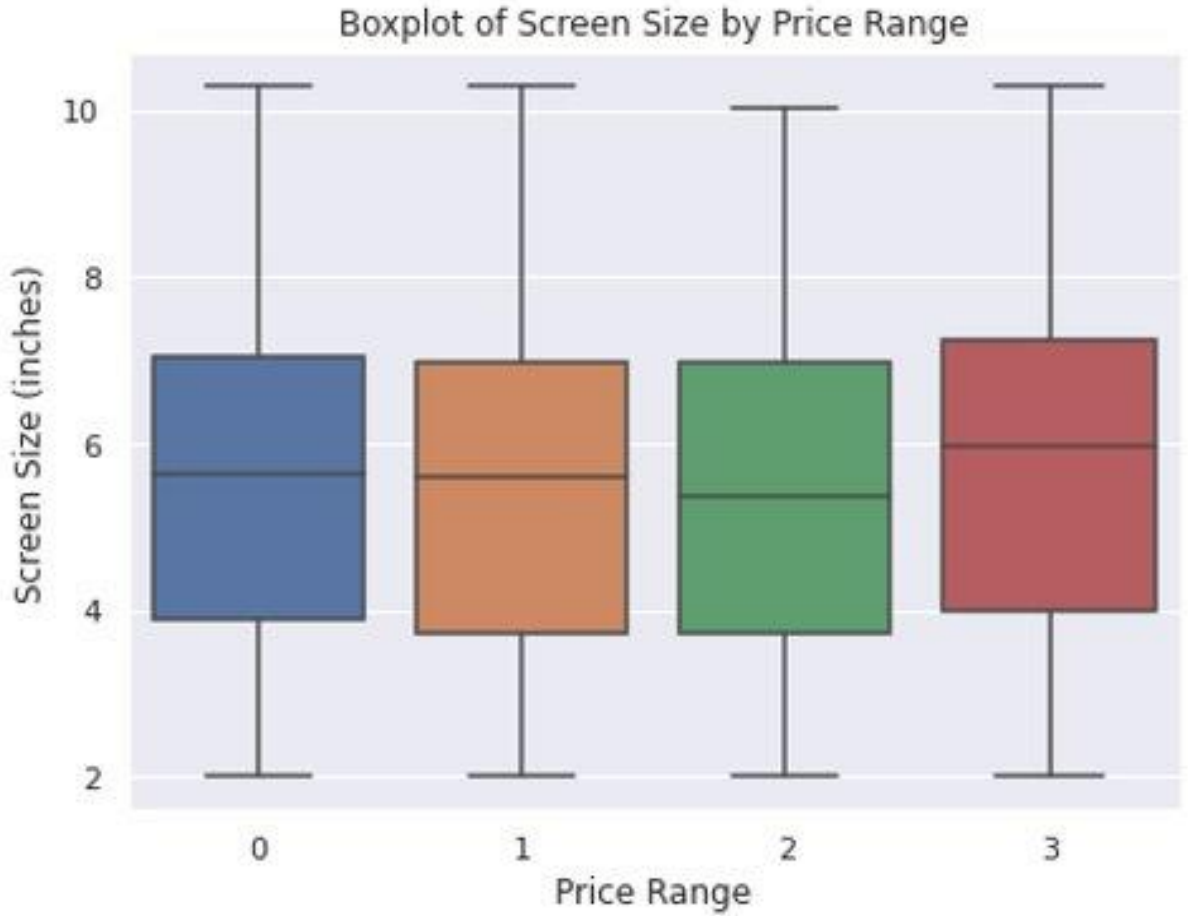
It is almost same impcact of price range in all categories.



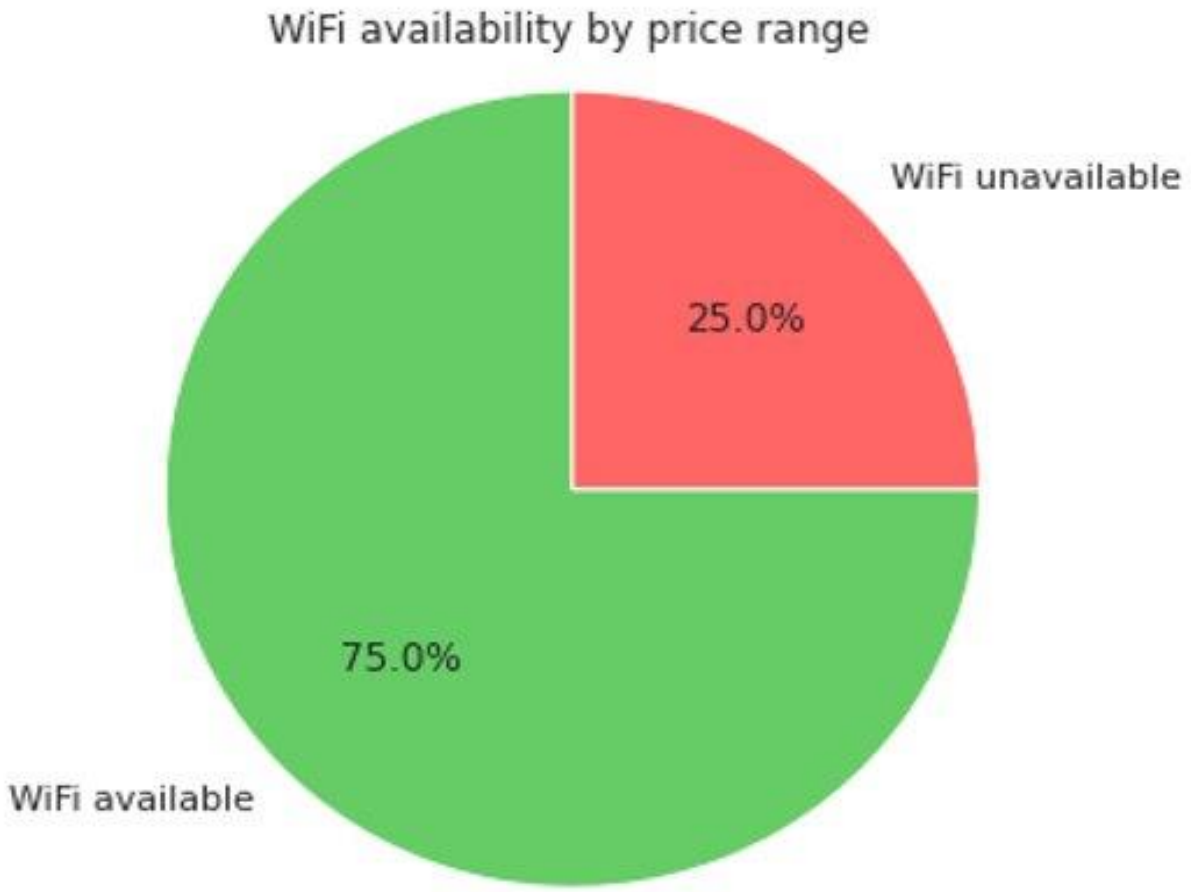


The distribution of primary camera megapixels across different target categories is relatively consistent, indicating that this feature may not significantly influence the price range of mobile phones. This consistency is a positive sign for prediction modeling, as it suggests that this feature may not be a major confounding factor in predicting the price range.

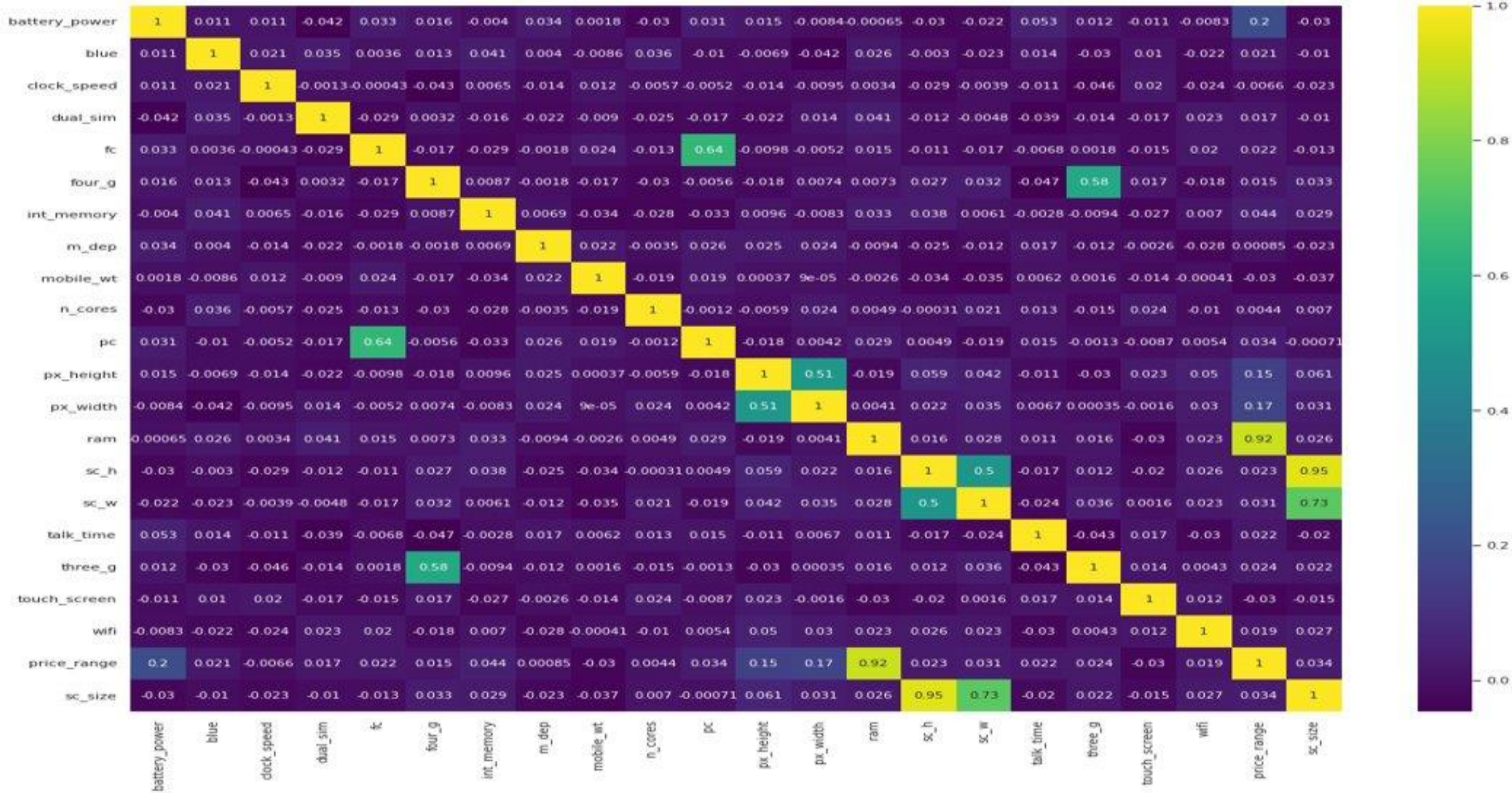




It can be observed that mobile phones with higher price ranges tend to be lighter in weight compared to lower price range phones.



Around in 25% the wifi is not available and in 75% the wifi is available

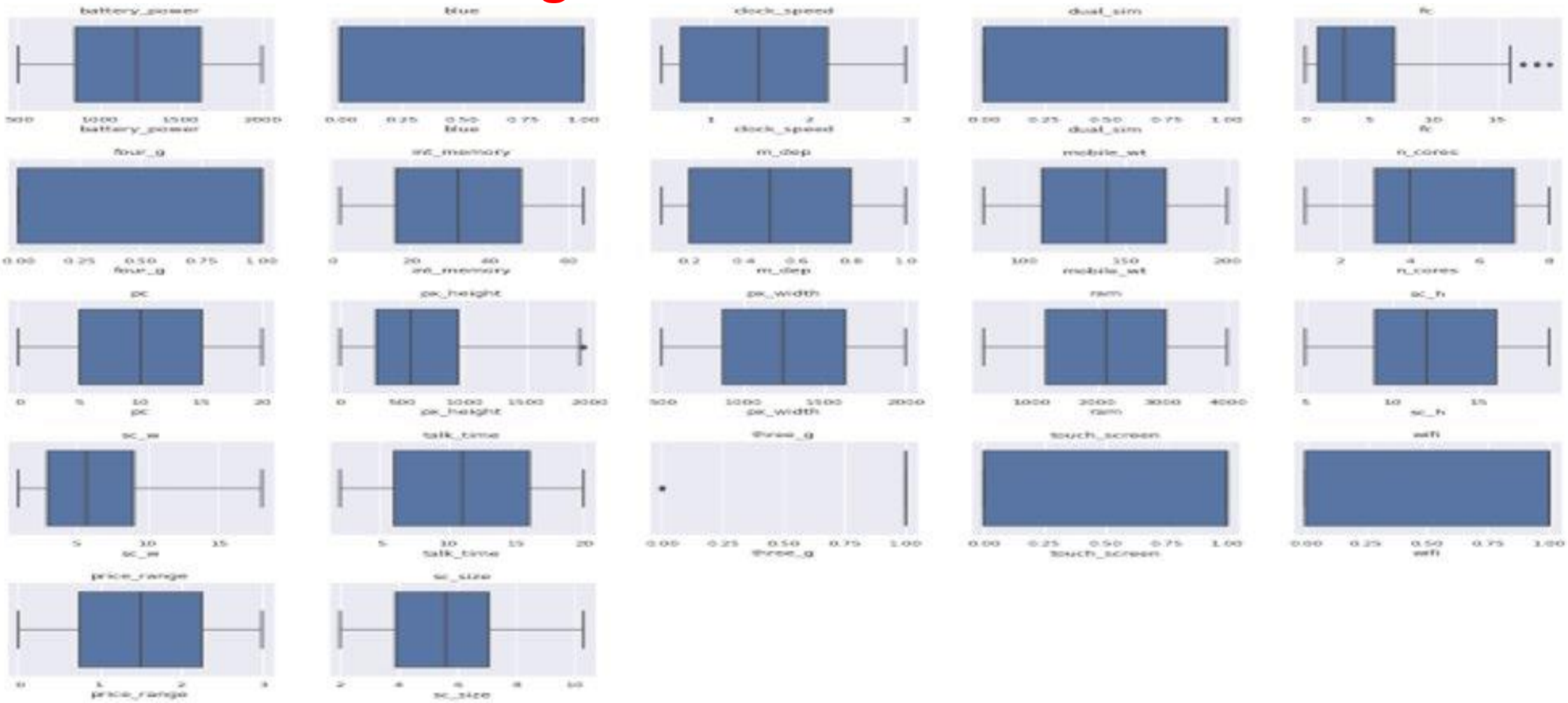

battery_power 1 0.011 0.011 -0.042 0.033 0.016 -0.004 0.034 0.0018 -0.03 0.031 0.015 -0.0084 -0.00065 -0.03 -0.022 0.053 0.012 -0.011 -0.0083 0.2 -0.03
blue 0.011 1 0.021 0.035 0.0036 0.013 0.041 0.004 -0.0086 0.036 -0.01 -0.0069 -0.042 0.026 -0.003 -0.023 0.014 -0.03 0.01 -0.022 0.021 -0.01
clock_speed 0.011 0.021 1 -0.0013 -0.00043 -0.043 0.0065 -0.014 0.012 -0.0057 -0.0052 -0.014 -0.0095 0.0034 -0.029 -0.0039 -0.011 -0.046 0.02 -0.024 -0.0066 -0.023
dual_sim -0.042 0.035 -0.0013 1 -0.029 0.0032 -0.016 -0.022 -0.009 -0.025 -0.017 -0.022 0.014 0.041 -0.012 -0.0048 -0.039 -0.014 -0.017 0.023 0.017 -0.01
fc 0.033 0.0036 -0.00043 -0.029 1 -0.017 -0.029 -0.0018 0.024 -0.013 0.64 -0.0098 -0.0052 0.015 -0.011 -0.017 -0.0068 0.0018 -0.015 0.02 0.022 -0.013
four_g 0.016 0.013 -0.043 0.0032 -0.017 1 0.0087 -0.0018 -0.017 -0.03 -0.0056 -0.018 0.0074 0.0073 0.027 0.032 -0.047 0.58 0.017 -0.018 0.015 0.033
int_memory -0.004 0.041 0.0065 -0.016 -0.029 0.0087 1 0.0069 -0.034 -0.028 -0.033 0.0096 -0.0083 0.033 0.038 0.0061 -0.0028 -0.0094 -0.027 0.007 0.044 0.029
m_dep 0.034 0.004 -0.014 -0.022 -0.0018 -0.0018 0.0069 1 0.022 -0.0035 0.026 0.025 0.024 -0.0094 -0.025 -0.012 0.017 -0.012 -0.0026 -0.028 0.00085 -0.023
mobile_wt 0.0018 -0.0086 0.012 -0.009 0.024 -0.017 -0.034 0.022 1 -0.019 0.019 0.00037 9e-05 -0.0026 -0.034 -0.035 0.0062 0.0016 -0.014 -0.00041 -0.03 -0.037
n_cores -0.03 0.036 -0.0057 -0.025 -0.013 -0.03 -0.028 -0.0035 -0.019 1 -0.0012 -0.0059 0.024 0.0049 -0.00031 0.021 0.013 -0.015 0.024 -0.01 0.0044 0.007
pc 0.031 -0.01 -0.0052 -0.017 0.64 -0.0056 -0.033 0.026 0.019 -0.0012 1 -0.018 0.0042 0.029 0.0049 -0.019 0.015 -0.0013 -0.0087 0.0054 0.034 -0.00071
px_height 0.015 -0.0069 -0.014 -0.022 -0.0098 -0.018 0.0096 0.025 0.00037 -0.0059 -0.018 1 0.51 -0.019 0.059 0.042 -0.011 -0.03 0.023 0.05 0.15 0.061
px_width -0.0084 -0.042 -0.0095 0.014 -0.0052 0.0074 -0.0083 0.024 9e-05 0.024 0.0042 0.51 1 0.0041 0.022 0.035 0.0067 0.00035 -0.0016 0.03 0.17 0.031
ram -0.00065 0.026 0.0034 0.041 0.015 0.0073 0.033 -0.0094 -0.0026 0.0049 0.029 -0.019 0.0041 1 0.016 0.028 0.011 0.016 -0.03 0.023 0.92 0.026
sc_h -0.03 -0.003 -0.029 -0.012 -0.011 0.027 0.038 -0.025 -0.034 -0.00031 0.0049 0.059 0.022 0.016 1 0.5 -0.017 0.012 -0.02 0.026 0.023 0.95
sc_w -0.022 -0.023 -0.0039 -0.0048 -0.017 0.032 0.0061 -0.012 -0.035 0.021 -0.019 0.042 0.035 0.028 0.5 1 -0.024 0.036 0.0016 0.023 0.031 0.73
talk_time 0.053 0.014 -0.011 -0.039 -0.0068 -0.047 -0.0028 0.017 0.0062 0.013 0.015 -0.011 0.0067 0.011 -0.017 -0.024 1 -0.043 0.017 -0.03 0.022 -0.02
three_g 0.012 -0.03 -0.046 -0.014 0.0018 0.58 -0.0094 -0.012 0.0016 -0.015 -0.0013 -0.03 0.00035 0.016 0.012 0.036 -0.043 1 0.014 0.0043 0.024 0.022
touch_screen -0.011 0.01 0.02 -0.017 -0.015 0.017 -0.027 -0.0026 -0.014 0.024 -0.0087 0.023 -0.0016 -0.03 -0.02 0.0016 0.017 0.014 1 0.012 -0.03 -0.015
wifi -0.0083 -0.022 -0.024 0.023 0.02 -0.018 0.007 -0.028 -0.00041 -0.01 0.0054 0.05 0.03 0.023 0.026 0.023 -0.03 0.0043 0.012 1 0.019 0.027
price_range 0.2 0.021 -0.0066 0.017 0.022 0.015 0.044 0.00085 -0.03 0.0044 0.034 0.15 0.17 0.92 0.023 0.031 0.022 0.024 -0.03 0.019 1 0.034
sc_size -0.03 -0.01 -0.023 -0.01 -0.013 0.033 0.029 -0.023 -0.037 0.007 -0.00071 0.061 0.031 0.026 0.95 0.73 -0.02 0.022 -0.015 0.027 0.034 1
battery_power blue clock_speed dual_sim fc four_g int_memory m_dep mobile_wt n_cores pc px_height px_width ram sc_h sc_w talk_time three_g touch_screen wifi price_range sc_size
1.0 0.8 0.6 0.4 0.2 0.0

- **The high correlation between RAM and price_range is a positive sign for businesses as it indicates that RAM will be a major deciding factor in estimating the price range of a mobile phone.**

- **However, there are also some cases of collinearity in the data. Specifically, there is a correlation between the pairs of features ('pc', 'fc') and ('px_width', 'px_height'). These correlations make sense, as a phone with a good front camera is likely to have a good back camera, and an increase in pixel height typically corresponds with an increase in pixel width.**

- **To address this collinearity, we could consider replacing the 'px_height' and 'px_width' features with a single feature representing the overall number of pixels in the screen. However, it is important to note that the 'fc' and 'pc' features should be kept separate, as they represent different aspects of the phone's camera capabilities (front camera megapixels vs. primary camera megapixels).**

Outliers handling



As we can see very less outliers are present so no need to remove

ML MODELS USED FOR TRANING AND TESTING

- Logistic Regression
- XGboost classifier
- Random forest classifier

- Classification report for Logistic Regression (Train set)=
- precision recall f1-score support

0	0.93	0.88	0.90	421
1	0.75	0.79	0.77	386
2	0.73	0.79	0.76	379
3	0.92	0.86	0.89	414
accuracy			0.83	1600
macro avg	0.83	0.83	0.83	1600
weighted avg	0.84	0.83	0.83	1600

Classification report for Logistic Regression (Test set)=

	precision	recall	f1-score	support
0	0.91	0.90	0.91	107
1	0.69	0.76	0.72	83
2	0.68	0.65	0.67	97
3	0.85	0.84	0.84	113
accuracy			0.79	400
macro avg	0.78	0.79	0.79	400
weighted avg	0.79	0.79	0.79	400

- Classification Report for XGBoost(Test set)=
- precision recall f1-score support

0	0.91	0.91	0.91	105
1	0.77	0.77	0.77	91
2	0.66	0.76	0.71	92
3	0.90	0.78	0.83	112
accuracy			0.81	400
macro avg	0.81	0.81	0.80	400
weighted avg	0.82	0.81	0.81	400

- Classification Report for XGBoost(Train set)=
- precision recall f1-score support

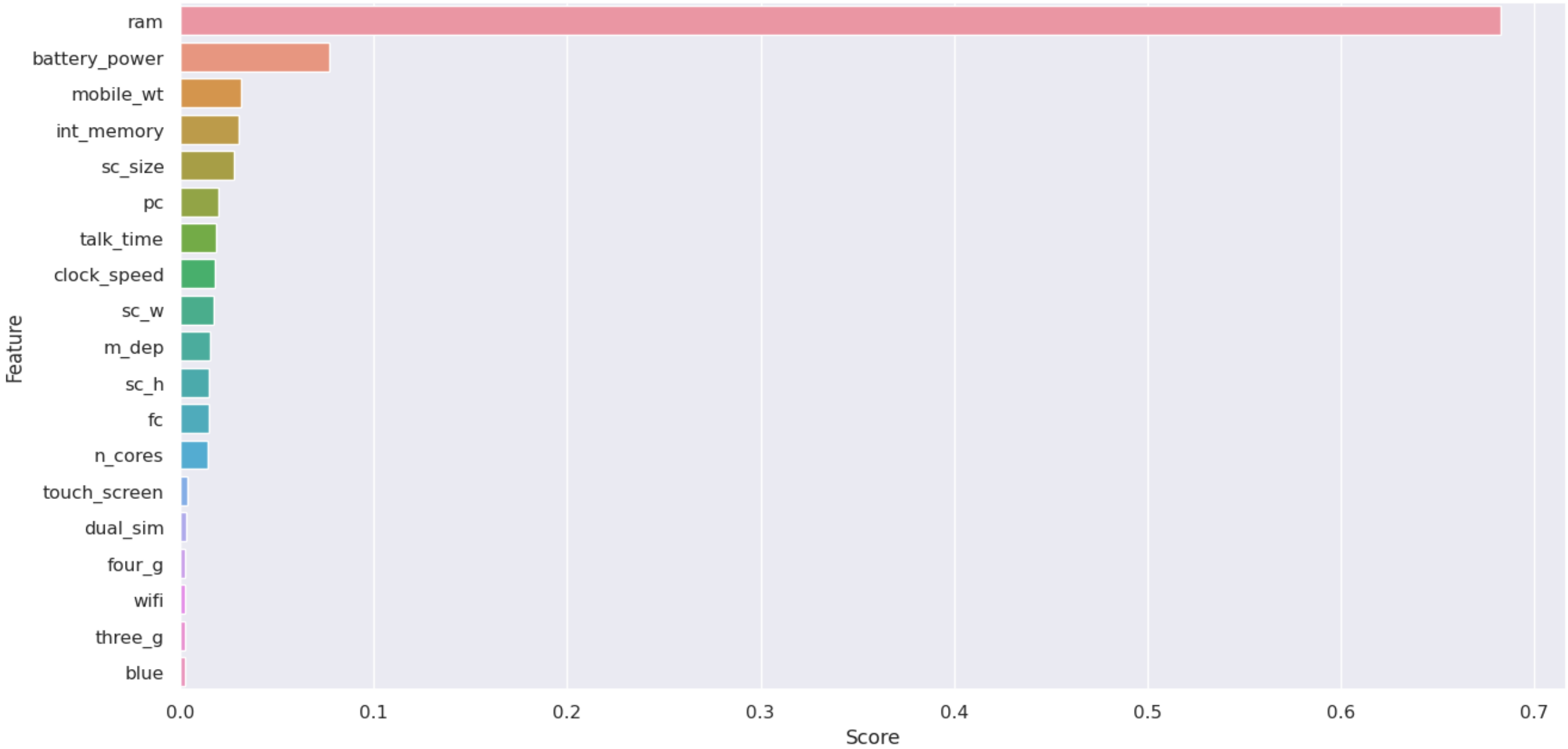
0	0.99	1.00	0.99	395
1	0.99	0.98	0.99	409
2	0.99	0.99	0.99	408
3	1.00	1.00	1.00	388
accuracy			0.99	1600
macro avg	0.99	0.99	0.99	1600
weighted avg	0.99	0.99	0.99	1600

- Rndom forest classifier
- precision recall f1-score support

0	0.92	0.94	0.93	105
1	0.78	0.75	0.76	91
2	0.63	0.72	0.67	92
3	0.87	0.78	0.82	112
accuracy			0.80	400
macro avg	0.80	0.80	0.80	400
weighted avg	0.81	0.80	0.80	400

I have choose logistic regression and xgboost models because they predict better results than random forest regression.

Feature importance



CONCLUSIONS

- Based on the exploratory data analysis (EDA), we observed that the mobile phones in the dataset are divided into four different price ranges, each having a similar number of elements. Additionally, we found that approximately half of the devices have Bluetooth, while the other half do not. Furthermore, we noted that as the price range increases, there is a gradual increase in battery power, and RAM shows continuous growth from low-cost to very high-cost phones. Moreover, the costly phones tend to be lighter than the lower-priced ones.

- Our analysis indicates that RAM, battery power, and pixel quality are the most significant factors affecting the price range of mobile phones. From our experiments, we concluded that logistic regression and XGBoost algorithms with hyperparameter tuning yielded the best results in predicting the price range of mobile phones.

- In summary, the EDA revealed that the dataset consists of mobile phones grouped into four price ranges, with similar numbers of devices in each range, and a 50-50 distribution of Bluetooth. We also observed that RAM and battery power increase with the price range, and higher-priced phones tend to be lighter. Our experiments suggest that the most important factors affecting the price range of mobile phones are RAM, battery power, and pixel quality. Finally, we found that logistic regression and XGBoost algorithms, coupled with hyperparameter tuning, provide the best performance in predicting the price range of mobile phones.

THANK YOU!