Data Science with python minor project

Done by

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Problem statement

To create a classification model to predict whether price range of mobile based on certain specifications.

Context: An entrepreneur has started his own mobile company. He wants to give tough fight to big companies like Apple, Samsung etc. He does not know how to estimate price of mobiles his company creates. In this competitive mobile phone market, one cannot simply assume things. To solve this problem, he collects sales data of mobile phones of various companies. He wants to find out some relation between features of a mobile phone (e.g., RAM, Internal Memory etc) and its selling price. But he is not so good at Machine Learning. So, he needs your help to solve this problem. In this problem you do not have to predict actual price but a price range indicating how high the price.

Given Dataset:

https://drive.google.com/file/d/1pjDDlI4kJ75GLOOj_HkFqqeV8Of_c6H1/view?usp=share_link

Modules

- **Pandas:** Pandas is a powerful data manipulation library in Python that is commonly used in machine learning classification tasks. It provides data structures for efficiently storing and manipulating tabular data, which is a common data format in classification problems. Pandas can be used to load data from various sources such as CSV files, SQL databases, and Excel spreadsheets.
- **Matplotlib:** Matplotlib is a widely used data visualization library in Python that can be helpful in machine learning classification tasks. It provides a variety of tools for creating visualizations of data, such as line plots, scatter plots, histograms, and bar charts. Matplotlib can also be used to create visualizations that help in understanding the decision boundary of the classifier.
- **Seaborn:** Seaborn is a data visualization library in Python that is built on top of Matplotlib. It provides a high-level interface for creating informative and attractive statistical graphics. Seaborn is commonly used in machine learning classification tasks to create visualizations that help in understanding the relationship between the features and the target variable.
- **sklearn:** Scikit-learn (or sklearn) is a powerful and widely used machine learning library in Python that provides a wide range of algorithms and tools for performing classification tasks. It is built on top of other scientific computing libraries such as NumPy, Pandas, and Matplotlib, and provides a consistent and easy-to-use interface for various machine learning tasks.

Models

- **Logistic Regression :** Logistic Regression is a widely used classification algorithm in machine learning that is used to predict binary or categorical outcomes. It is a supervised learning algorithm that is used for both binary and multi-class classification problems. It is simple and easy to implement.
- **K-Nearest Neighbors (KNN) :** It is a popular classification algorithm in machine learning that is used to classify data points based on the similarity between their features and the features of other data points in the training set.
- **Support Vector Machine (SVM) :** It is a powerful and popular classification algorithm in machine learning that is used to classify data points by finding a hyperplane in a high-dimensional space that best separates the data points of different classes. The hyperplane is chosen to maximize the margin between the closest data points of different classes, which is called the support vectors.

data-science-minor-project

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0.0.1 MOBILE PRICE CLASSIFICATION using ML algorithm LR, KNN, SVM Models

[2]:
```
# IMPORT REQUIRED LIBRARIES

import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

[3]:
```
# READ CSV DATASET FILES
train = pd.read_csv(r'train.csv')
test = pd.read_csv(r'test.csv')
```

[4]:
```
# DISPLAY ROWN & COLUMNS
pd.set_option('display.max_rows',None)
pd.set_option('display.max_columns',None)
```

[5]:
```
train.head() # function that displays first 5 rows
```

[5]:

	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
0	842	0	2.2	0	1	0	7	0.6	188	2	2	20	756	2549	9	7	19	0	0	1	1
1	1021	1	0.5	1	0	1	53	0.7	136	3	6	905	1988	2631	17	3	7	1	1	0	2
2	563	1	0.5	1	2	1	41	0.9	145	5	6	1263	1716	2603	11	2	9	1	1	0	2
3	615	1	2.5	0	0	0	10	0.8	131	6	9	1216	1786	2769	16	8	11	1	0	0	2
4	1821	1	1.2	0	13	1	44	0.6	141	2	14	1208	1212	1411	8	2	15	1	1	0	2

```
4        1             1     0            1
```

[6]:
```
test.head()
```

[6]:
```
   id  battery_power  blue  clock_speed  dual_sim  fc  four_g  int_memory  \
0   1           1043     1          1.8         1  14       0           5
1   2            841     1          0.5         1   4       1          61
2   3           1807     1          2.8         0   1       0          27
3   4           1546     0          0.5         1  18       1          25
4   5           1434     0          1.4         0  11       1          49

   m_dep  mobile_wt  n_cores  pc  px_height  px_width   ram  sc_h  sc_w  \
0    0.1        193        3  16        226      1412  3476    12     7
1    0.8        191        5  12        746       857  3895     6     0
2    0.9        186        3   4       1270      1366  2396    17    10
3    0.5         96        8  20        295      1752  3893    10     0
4    0.5        108        6  18        749       810  1773    15     8

   talk_time  three_g  touch_screen  wifi
0          2        0             1     0
1          7        1             0     0
2         10        0             1     1
3          7        1             1     0
4          7        1             0     1
```

[7]:
```
# drop function drops 'id' column
test.drop('id', axis = 1,inplace = True)
```

[8]:
```
test.head()
```

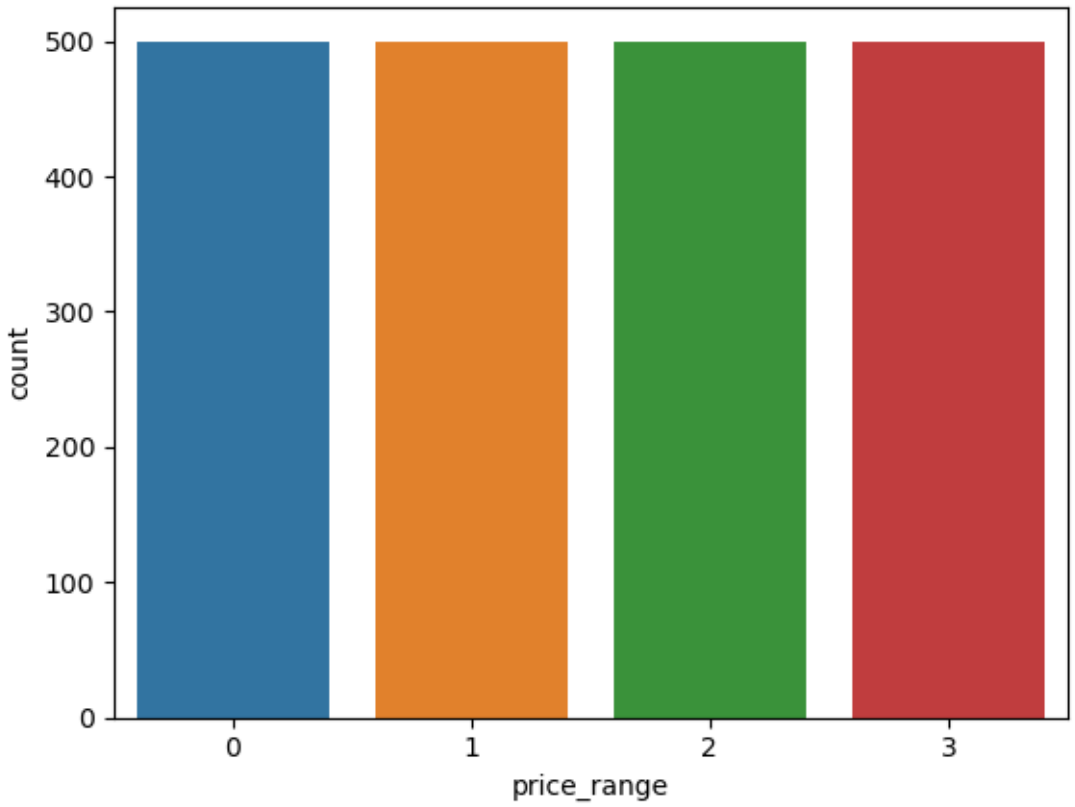
[8]:
```
   battery_power  blue  clock_speed  dual_sim  fc  four_g  int_memory  m_dep  \
0           1043     1          1.8         1  14       0           5    0.1
1            841     1          0.5         1   4       1          61    0.8
2           1807     1          2.8         0   1       0          27    0.9
3           1546     0          0.5         1  18       1          25    0.5
4           1434     0          1.4         0  11       1          49    0.5

   mobile_wt  n_cores  pc  px_height  px_width   ram  sc_h  sc_w  talk_time  \
0        193        3  16        226      1412  3476    12     7          2
1        191        5  12        746       857  3895     6     0          7
2        186        3   4       1270      1366  2396    17    10         10
3         96        8  20        295      1752  3893    10     0          7
4        108        6  18        749       810  1773    15     8          7

   three_g  touch_screen  wifi
0        0             1     0
1        1             0     0
```

```
2          0              1      1
3          1              1      0
4          1              0      1
```

[9]:
```
# target feature is price_range which is balanced
sns.countplot(train['price_range'])
```

```
C:\Users\samyu\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

[9]: <AxesSubplot:xlabel='price_range', ylabel='count'>



[10]:
```
# train set:2000 rows & 21 columns, test set: 1000 rows & 20 columns
train.shape, test.shape # shape() function
```

[10]: ((2000, 21), (1000, 20))

[11]:
```
# checks presence of null values in dataset
train.isnull().sum() # 0 null values
```

[11]:
```
battery_power    0
blue             0
clock_speed      0
dual_sim         0
fc               0
four_g           0
int_memory       0
m_dep            0
mobile_wt        0
n_cores          0
pc               0
px_height        0
px_width         0
ram              0
sc_h             0
sc_w             0
talk_time        0
three_g          0
touch_screen     0
wifi             0
price_range      0
dtype: int64
```

[12]:
```
train.info() # displays dataset information
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2000 entries, 0 to 1999
Data columns (total 21 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   battery_power  2000 non-null   int64
 1   blue           2000 non-null   int64
 2   clock_speed    2000 non-null   float64
 3   dual_sim       2000 non-null   int64
 4   fc             2000 non-null   int64
 5   four_g         2000 non-null   int64
 6   int_memory     2000 non-null   int64
 7   m_dep          2000 non-null   float64
 8   mobile_wt      2000 non-null   int64
 9   n_cores        2000 non-null   int64
 10  pc             2000 non-null   int64
 11  px_height      2000 non-null   int64
 12  px_width       2000 non-null   int64
 13  ram            2000 non-null   int64
```

```
 14  sc_h           2000 non-null   int64
 15  sc_w           2000 non-null   int64
 16  talk_time      2000 non-null   int64
 17  three_g        2000 non-null   int64
 18  touch_screen   2000 non-null   int64
 19  wifi           2000 non-null   int64
 20  price_range    2000 non-null   int64
dtypes: float64(2), int64(19)
memory usage: 328.2 KB
```

[13]:
```
test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 20 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   battery_power  1000 non-null   int64
 1   blue           1000 non-null   int64
 2   clock_speed    1000 non-null   float64
 3   dual_sim       1000 non-null   int64
 4   fc             1000 non-null   int64
 5   four_g         1000 non-null   int64
 6   int_memory     1000 non-null   int64
 7   m_dep          1000 non-null   float64
 8   mobile_wt      1000 non-null   int64
 9   n_cores        1000 non-null   int64
 10  pc             1000 non-null   int64
 11  px_height      1000 non-null   int64
 12  px_width       1000 non-null   int64
 13  ram            1000 non-null   int64
 14  sc_h           1000 non-null   int64
 15  sc_w           1000 non-null   int64
 16  talk_time      1000 non-null   int64
 17  three_g        1000 non-null   int64
 18  touch_screen   1000 non-null   int64
 19  wifi           1000 non-null   int64
dtypes: float64(2), int64(18)
memory usage: 156.4 KB
```

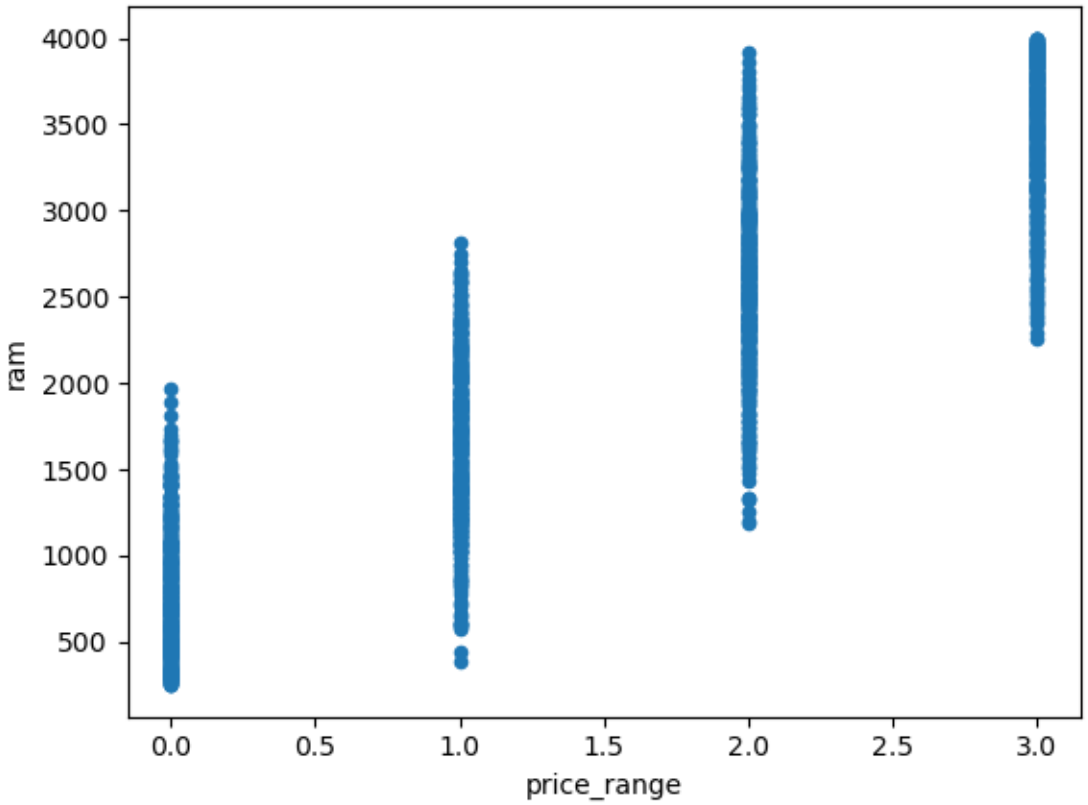
[14]:
```
# displays description of dataset
train.describe() # eg: count(), mean(), std(),etc,..
```

[14]:

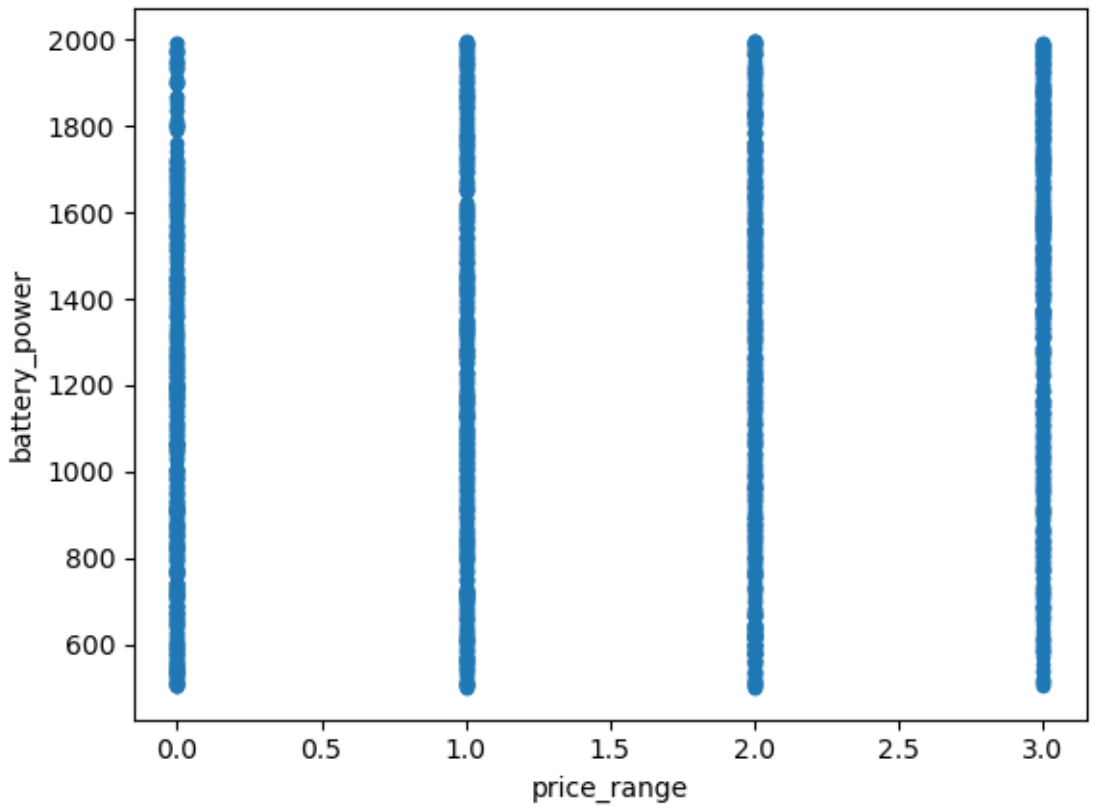
	battery_power	blue	clock_speed	dual_sim	fc	\
count	2000.000000	2000.0000	2000.000000	2000.000000	2000.000000	
mean	1238.518500	0.4950	1.522250	0.509500	4.309500	
std	439.418206	0.5001	0.816004	0.500035	4.341444	

```
min       501.000000     0.0000     0.500000     0.000000     0.000000
25%       851.750000     0.0000     0.700000     0.000000     1.000000
50%      1226.000000     0.0000     1.500000     1.000000     3.000000
75%      1615.250000     1.0000     2.200000     1.000000     7.000000
max      1998.000000     1.0000     3.000000     1.000000    19.000000

            four_g   int_memory        m_dep    mobile_wt      n_cores  \
count  2000.000000  2000.000000  2000.000000  2000.000000  2000.000000
mean      0.521500    32.046500     0.501750   140.249000     4.520500
std       0.499662    18.145715     0.288416    35.399655     2.287837
min       0.000000     2.000000     0.100000    80.000000     1.000000
25%       0.000000    16.000000     0.200000   109.000000     3.000000
50%       1.000000    32.000000     0.500000   141.000000     4.000000
75%       1.000000    48.000000     0.800000   170.000000     7.000000
max       1.000000    64.000000     1.000000   200.000000     8.000000

                pc    px_height     px_width          ram         sc_h  \
count  2000.000000  2000.000000  2000.000000  2000.000000  2000.000000
mean      9.916500   645.108000  1251.515500  2124.213000    12.306500
std       6.064315   443.780811   432.199447  1084.732044     4.213245
min       0.000000     0.000000   500.000000   256.000000     5.000000
25%       5.000000   282.750000   874.750000  1207.500000     9.000000
50%      10.000000   564.000000  1247.000000  2146.500000    12.000000
75%      15.000000   947.250000  1633.000000  3064.500000    16.000000
max      20.000000  1960.000000  1998.000000  3998.000000    19.000000

              sc_w    talk_time      three_g  touch_screen         wifi  \
count  2000.000000  2000.000000  2000.000000   2000.000000  2000.000000
mean      5.767000    11.011000     0.761500      0.503000     0.507000
std       4.356398     5.463955     0.426273      0.500116     0.500076
min       0.000000     2.000000     0.000000      0.000000     0.000000
25%       2.000000     6.000000     1.000000      0.000000     0.000000
50%       5.000000    11.000000     1.000000      1.000000     1.000000
75%       9.000000    16.000000     1.000000      1.000000     1.000000
max      18.000000    20.000000     1.000000      1.000000     1.000000

       price_range
count  2000.000000
mean      1.500000
std       1.118314
min       0.000000
25%       0.750000
50%       1.500000
75%       2.250000
max       3.000000
```

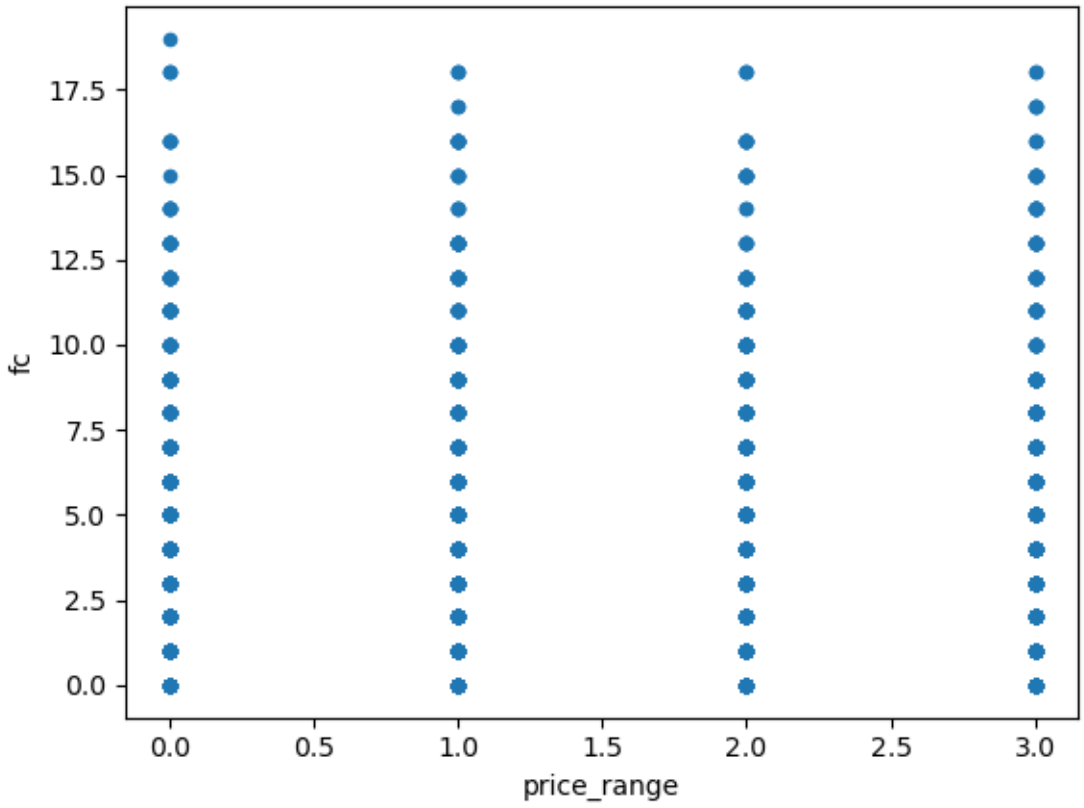
[43]:
```
train.plot(x='price_range', y = 'ram', kind = 'scatter')
plt.show()
```



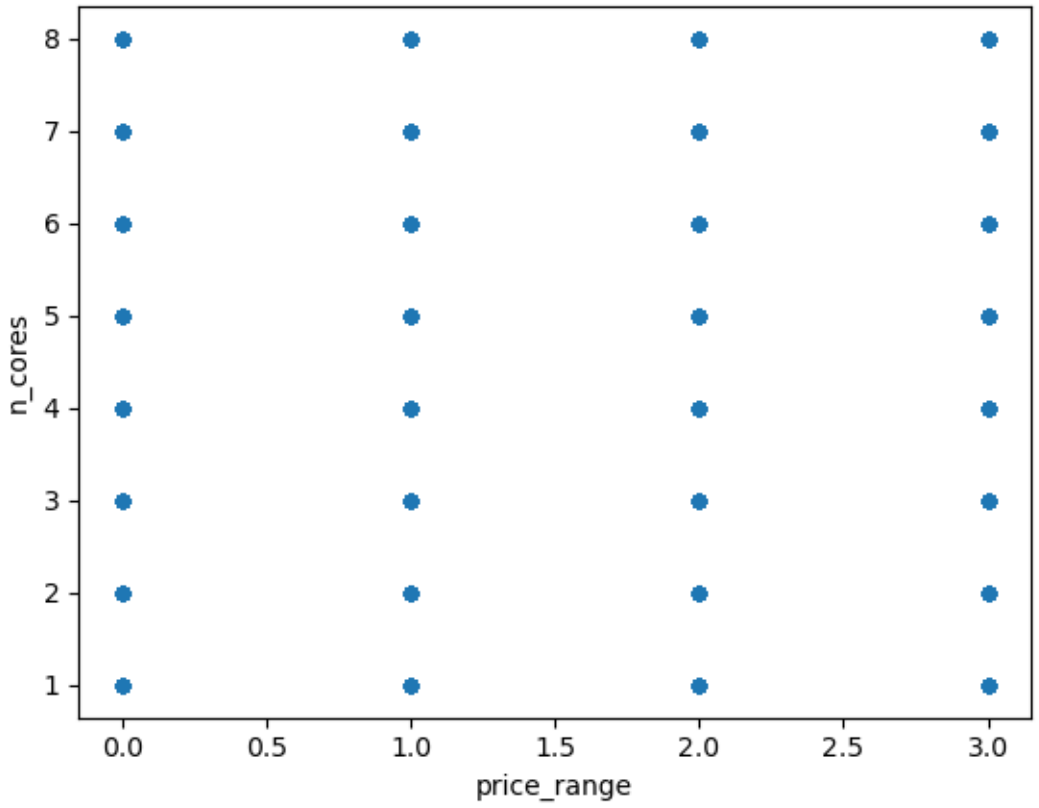
[16]:
```
train.plot(x = 'price_range', y = 'battery_power', kind = 'scatter')
plt.show()
```



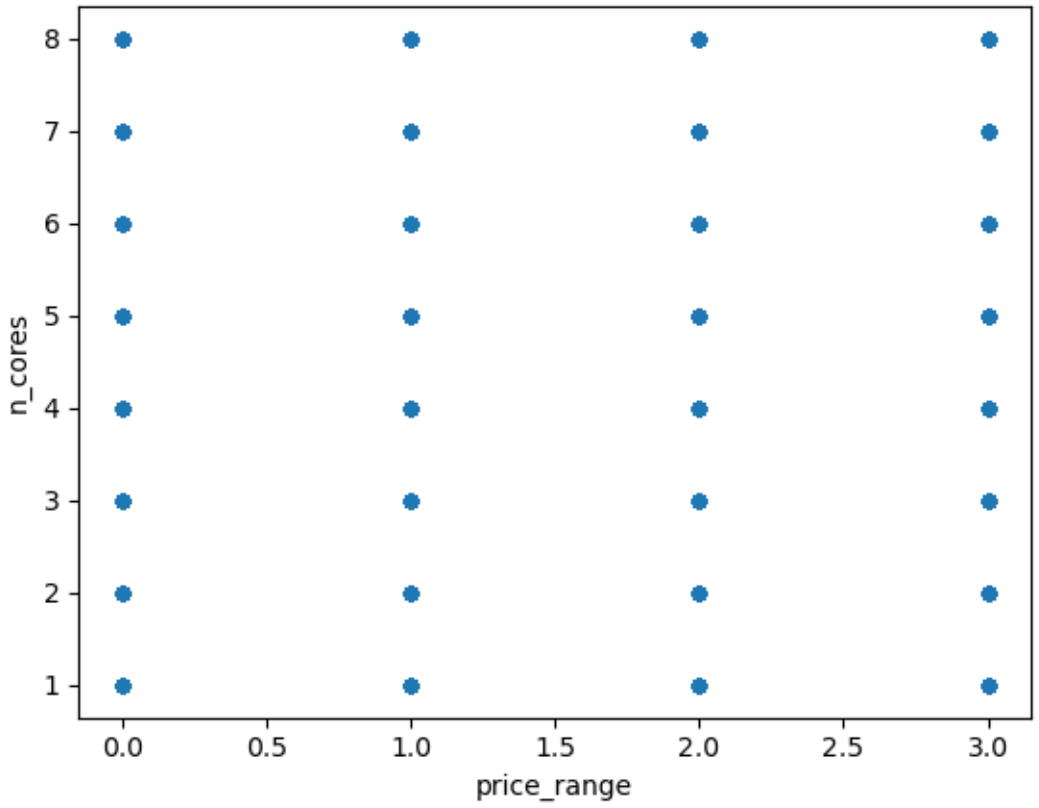
[17]:
```
train.plot(x = 'price_range', y = 'fc', kind = 'scatter')
plt.show()
```



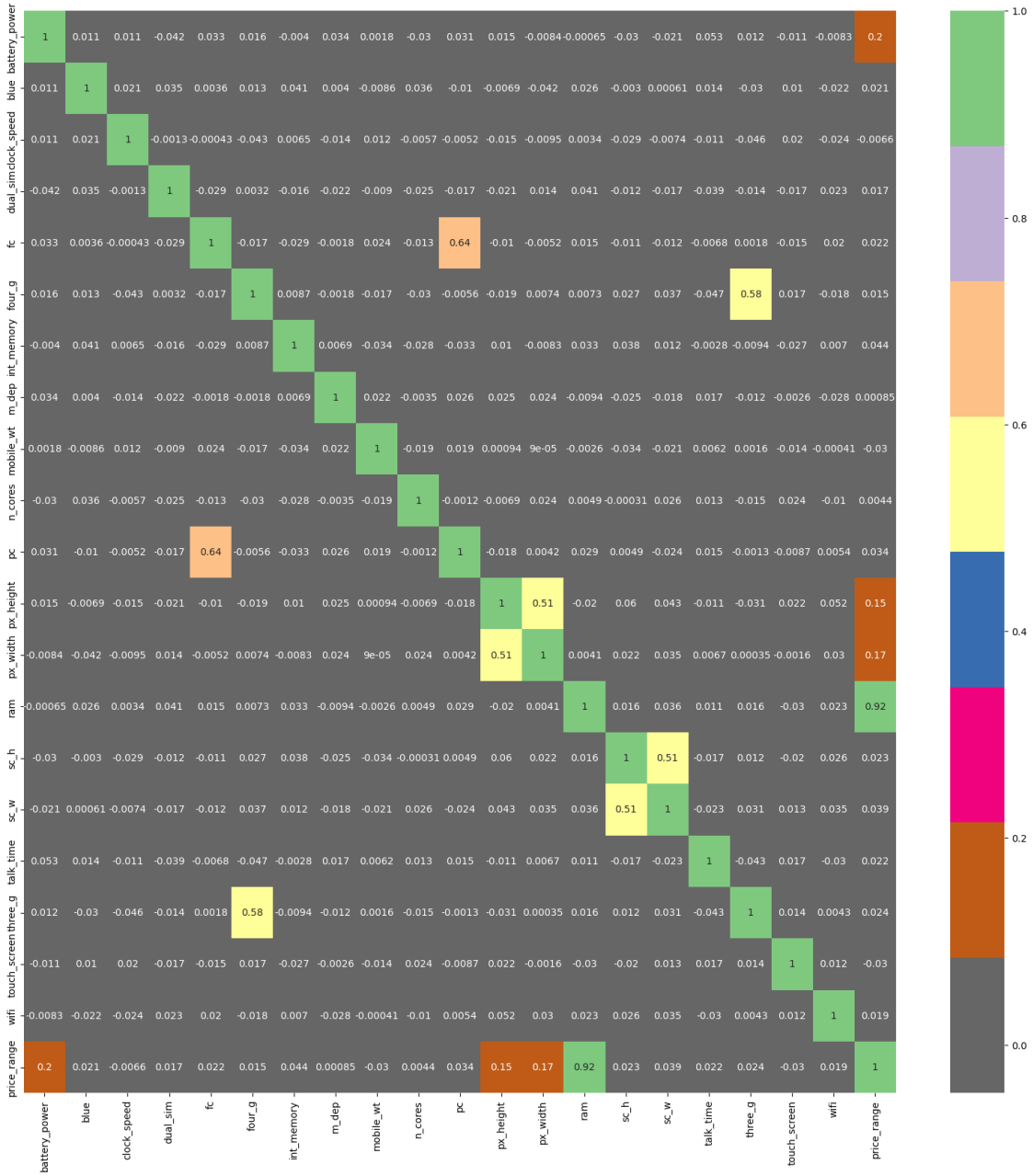
[18]:
```
train.plot(x = 'price_range', y = 'n_cores', kind = 'scatter')
plt.show()
```



[19]:
```
train.plot(x = 'price_range', y = 'n_cores', kind = 'scatter')
plt.show()
```

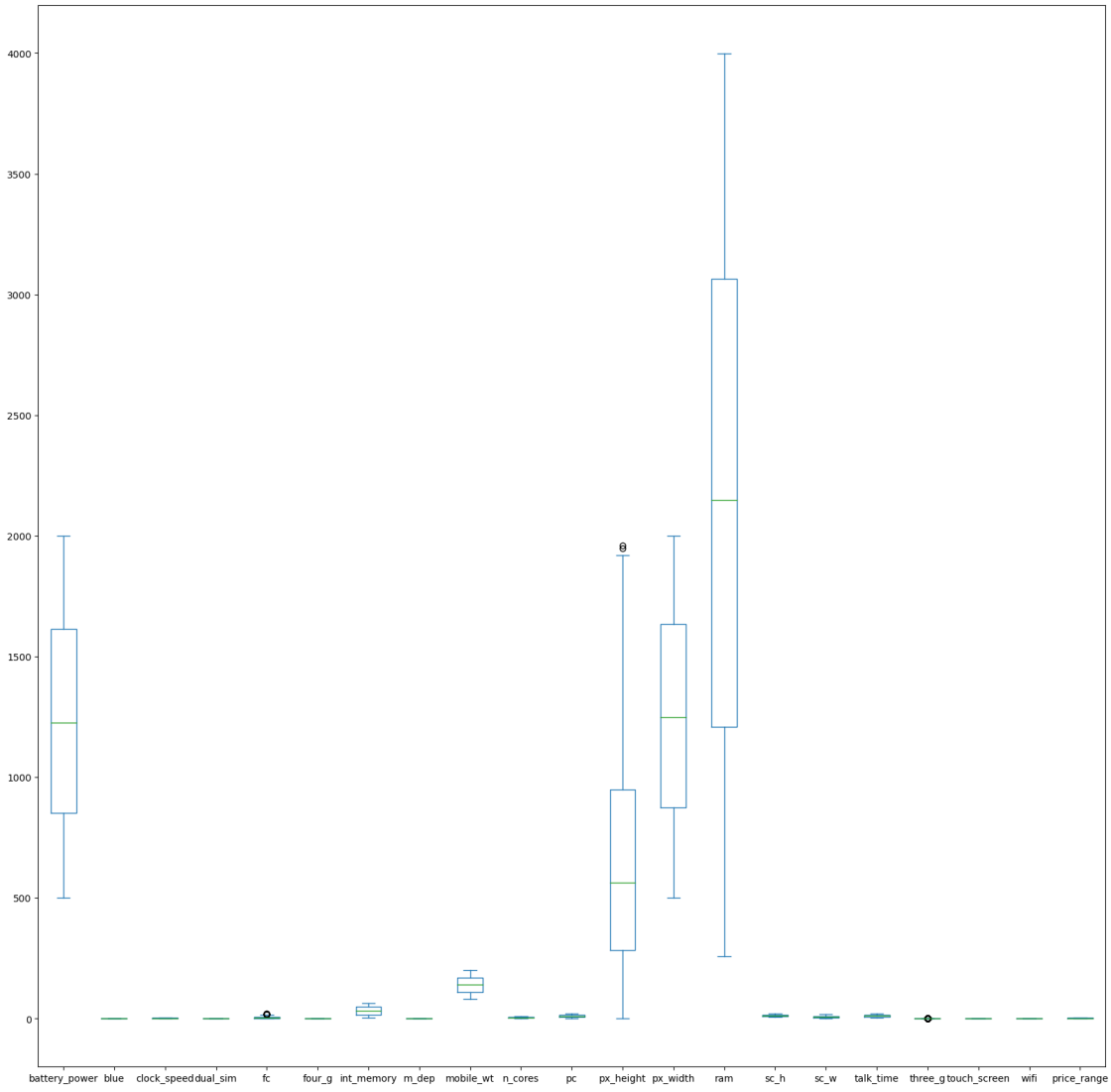


[20]:
```
# to check correlation()
plt.figure(figsize = (20,20))
sns.heatmap(train.corr(), annot = True,cmap = plt.cm.Accent_r)
plt.show()
```



[21]:
```
# to check outliers
train.plot(kind = 'box', figsize = (20,20))
```

[21]: <AxesSubplot:>



[22]:
```
x = train.drop('price_range',axis = 1)
y = train['price_range']
```

[24]:
```
# to split dataset as train set & test set to evaluate model
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.1,␣
 ↪random_state = 101)
```

[25]:
```
# apply standardization to train & test set
from sklearn.preprocessing import StandardScaler
sc = StandardScaler() # helps to group in range of 0 and 1
x_train = sc.fit_transform(x_train)
x_test = sc.transform(x_test)
```

```
test = sc.transform(test)
```

[26]:
```
x_train
```

[26]:
```
array([[-1.62737257, -0.98675438, -1.01271559, …, -1.78222729,
        -1.00892875, -0.99888951],
       [-0.75199354,  1.01342342,  0.58093235, …, -1.78222729,
         0.99115027, -0.99888951],
       [-0.20630271,  1.01342342,  0.70352065, …,  0.56109566,
        -1.00892875,  1.00111173],
       …,
       [ 0.69636086,  1.01342342, -0.03200917, …,  0.56109566,
        -1.00892875, -0.99888951],
       [ 0.83733099, -0.98675438, -1.2578922 , …,  0.56109566,
        -1.00892875,  1.00111173],
       [ 0.4144206 , -0.98675438, -0.39977408, …,  0.56109566,
         0.99115027,  1.00111173]])
```

[27]:
```
x_test
```

[27]:
```
array([[ 0.28481903, -0.98675438, -1.2578922 , …,  0.56109566,
        -1.00892875, -0.99888951],
       [-1.44092821, -0.98675438, -1.2578922 , …,  0.56109566,
         0.99115027,  1.00111173],
       [-1.49322358, -0.98675438, -0.15459747, …,  0.56109566,
        -1.00892875,  1.00111173],
       …,
       [-0.55418061,  1.01342342,  0.33575574, …,  0.56109566,
        -1.00892875, -0.99888951],
       [ 0.09610095, -0.98675438, -0.89012729, …,  0.56109566,
         0.99115027,  1.00111173],
       [-1.60690917, -0.98675438,  1.07128556, …,  0.56109566,
         0.99115027, -0.99888951]])
```

[28]:
```
test
```

[28]:
```
array([[-0.4541373 ,  1.01342342,  0.33575574, …, -1.78222729,
         0.99115027, -0.99888951],
       [-0.91342707,  1.01342342, -1.2578922 , …,  0.56109566,
        -1.00892875, -0.99888951],
       [ 1.2829785 ,  1.01342342,  1.56163877, …, -1.78222729,
         0.99115027,  1.00111173],
       …,
       [-0.13127022, -0.98675438, -0.15459747, …,  0.56109566,
        -1.00892875, -0.99888951],
       [ 0.65998148,  1.01342342, -1.2578922 , …, -1.78222729,
         0.99115027, -0.99888951],
```

```
        [ 0.06199528,  1.01342342, -1.2578922 , …,  0.56109566,
         -1.00892875,  1.00111173]])
```

[29]:
```
# using DecisionTreeClassifier model
from sklearn.tree import DecisionTreeClassifier
dtc = DecisionTreeClassifier()
dtc.fit(x_train, y_train)
```

[29]:
```
DecisionTreeClassifier()
```

[30]:
```
# test the set
pred = dtc.predict(x_test)
pred
```

[30]:
```
array([1, 1, 2, 1, 0, 1, 2, 1, 1, 1, 0, 1, 2, 1, 1, 0, 1, 1, 1, 0, 3, 1,
       2, 3, 2, 2, 2, 1, 0, 0, 2, 3, 0, 0, 3, 0, 0, 0, 1, 1, 1, 2, 3, 2,
       3, 1, 1, 3, 3, 1, 0, 0, 2, 3, 3, 2, 0, 3, 2, 3, 2, 2, 3, 1, 3, 2,
       0, 1, 0, 2, 1, 2, 3, 2, 1, 3, 3, 2, 0, 2, 0, 0, 2, 1, 2, 2, 2, 1,
       0, 0, 3, 3, 0, 2, 0, 3, 2, 0, 2, 3, 0, 2, 2, 3, 0, 2, 0, 0, 2, 0,
       1, 0, 3, 2, 2, 2, 1, 3, 2, 0, 3, 3, 2, 3, 1, 3, 3, 2, 1, 1, 1, 0,
       1, 1, 0, 2, 3, 0, 2, 3, 1, 3, 0, 1, 0, 0, 1, 3, 3, 0, 2, 1, 3, 2,
       3, 2, 2, 0, 3, 1, 2, 2, 2, 2, 1, 2, 1, 1, 3, 3, 1, 2, 0, 3, 1, 3,
       1, 2, 2, 1, 2, 1, 0, 0, 3, 2, 1, 2, 1, 3, 1, 0, 2, 3, 0, 3, 0, 0,
       3, 0], dtype=int64)
```

[31]:
```
# computes accuracy & confusion_matrix of dataset

from sklearn.metrics import accuracy_score, confusion_matrix
dtc_acc = accuracy_score(pred, y_test)
print(dtc_acc)
print(confusion_matrix(pred, y_test)) # accuracy is 83%
```

```
0.835
[[43  4  0  0]
 [ 7 37  7  0]
 [ 0  5 48  3]
 [ 0  0  7 39]]
```

[34]:
```
# using support vector machine
from sklearn.svm import SVC
knn = SVC()
knn.fit(x_train, y_train)
```

[34]:
```
SVC()
```

[35]:
```
# test the dataset
pred1 = knn.predict(x_test)
```

```
pred1
```

[35]:
```
array([1, 1, 2, 1, 1, 1, 2, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 3, 1,
       2, 3, 2, 2, 2, 2, 0, 0, 2, 3, 0, 0, 3, 0, 0, 0, 1, 1, 1, 1, 3, 2,
       3, 0, 2, 3, 3, 1, 0, 1, 2, 3, 2, 2, 0, 3, 2, 3, 2, 2, 3, 1, 3, 1,
       0, 1, 0, 2, 1, 2, 3, 2, 1, 3, 3, 2, 1, 2, 0, 0, 2, 2, 2, 2, 2, 1,
       0, 0, 3, 2, 0, 2, 0, 3, 2, 0, 2, 3, 0, 1, 3, 3, 0, 3, 0, 0, 2, 0,
       1, 0, 3, 2, 1, 1, 1, 3, 1, 0, 3, 2, 2, 3, 1, 2, 3, 2, 1, 1, 1, 0,
       0, 1, 0, 1, 3, 0, 2, 3, 1, 3, 0, 0, 0, 1, 1, 3, 2, 0, 2, 0, 2, 2,
       3, 2, 2, 0, 3, 2, 2, 2, 1, 2, 1, 2, 1, 0, 3, 3, 1, 2, 0, 3, 1, 3,
       2, 2, 3, 2, 1, 1, 0, 1, 2, 2, 2, 2, 0, 3, 1, 0, 2, 2, 0, 2, 0, 0,
       3, 0], dtype=int64)
```

[36]:
```
# computes accuracy & confusion_matrix
from sklearn.metrics import accuracy_score
svc_acc = accuracy_score(pred1, y_test)
print(svc_acc)
print(confusion_matrix(pred1, y_test)) # accuracy is 88%
```

```
0.88
[[46  3  0  0]
 [ 4 40  8  0]
 [ 0  3 52  4]
 [ 0  0  2 38]]
```

[37]:
```
# using logistic regression model
from sklearn.linear_model import LogisticRegression
lr = LogisticRegression()
lr.fit(x_train, y_train)
```

[37]:
```
LogisticRegression()
```

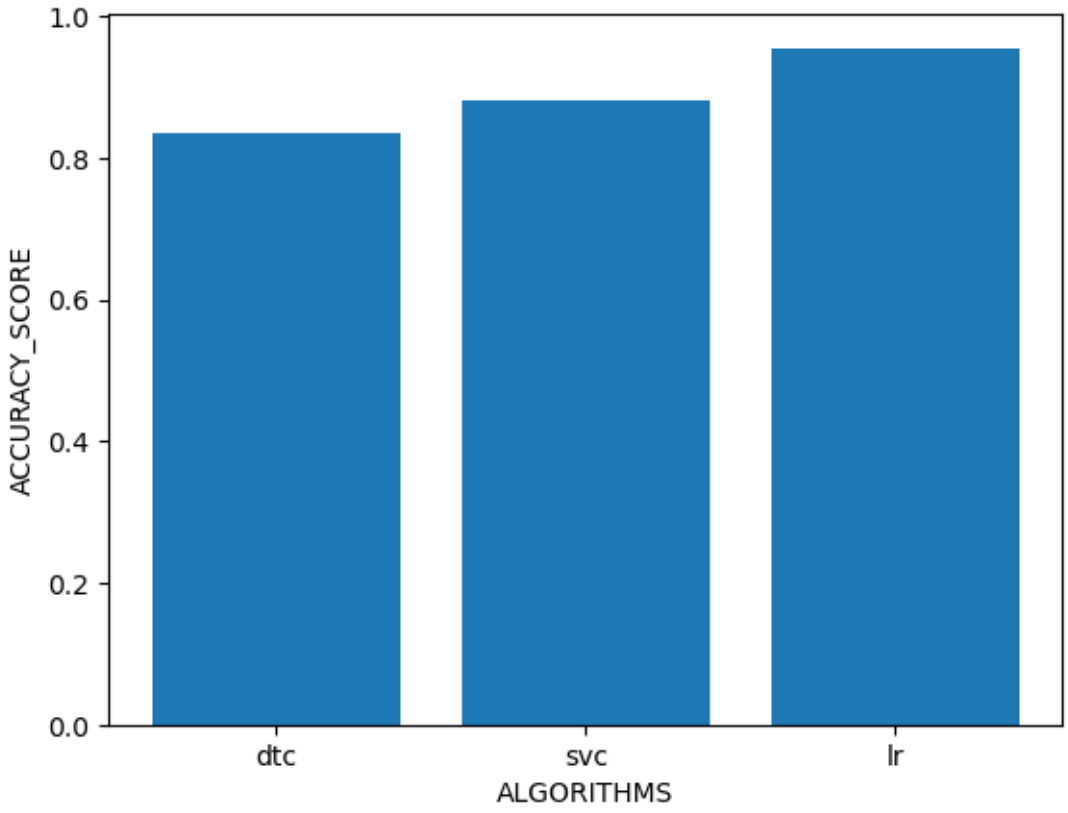
[38]:
```
# test the dataset
pred2 = lr.predict(x_test)
pred2
```

[38]:
```
array([1, 1, 2, 1, 1, 1, 2, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 3, 1,
       2, 3, 2, 2, 2, 2, 0, 0, 2, 3, 0, 0, 3, 0, 0, 0, 1, 1, 1, 2, 3, 2,
       3, 0, 1, 3, 3, 1, 0, 0, 3, 3, 3, 3, 1, 3, 2, 3, 2, 2, 3, 1, 3, 1,
       0, 0, 0, 2, 1, 2, 3, 2, 1, 3, 3, 2, 0, 2, 0, 0, 2, 1, 2, 2, 2, 1,
       0, 0, 3, 2, 0, 2, 0, 3, 2, 0, 2, 3, 0, 1, 3, 3, 0, 3, 0, 0, 2, 0,
       1, 0, 3, 2, 2, 1, 1, 3, 1, 0, 3, 2, 2, 3, 1, 2, 3, 2, 1, 1, 1, 0,
       0, 1, 0, 2, 3, 0, 2, 3, 1, 3, 0, 0, 0, 1, 1, 2, 2, 0, 3, 1, 2, 2,
       3, 2, 2, 0, 3, 2, 2, 2, 2, 2, 1, 2, 1, 1, 3, 3, 1, 2, 0, 3, 1, 3,
       2, 2, 3, 2, 2, 1, 0, 1, 3, 2, 1, 2, 0, 3, 1, 0, 2, 2, 0, 2, 0, 0,
       3, 0], dtype=int64)
```

[39]:
```
# computes accuracy & confusion_matrix
from sklearn.metrics import accuracy_score
lr_acc = accuracy_score(pred2, y_test)
print(lr_acc)
print(confusion_matrix(pred2,y_test)) # aaccuracy is 95%
```

```
0.955
[[49  1  0  0]
 [ 1 45  3  0]
 [ 0  0 56  1]
 [ 0  0  3 41]]
```

[40]:
```
plt.bar(x=['dtc','svc','lr'], height = [dtc_acc, svc_acc, lr_acc])
plt.xlabel("ALGORITHMS")
plt.ylabel("ACCURACY_SCORE")
plt.show() # Logistic regression has high accuracy rate
```



[41]:
```
# test the set
lr.predict(test)
```

```
[41]: array([3, 3, 2, 3, 1, 3, 3, 1, 3, 0, 3, 3, 0, 0, 2, 0, 2, 1, 3, 2, 1, 3,
             1, 1, 3, 0, 2, 0, 3, 0, 2, 0, 3, 0, 1, 1, 3, 1, 2, 1, 1, 2, 0, 0,
             0, 1, 0, 3, 1, 2, 1, 0, 3, 0, 3, 0, 3, 1, 1, 3, 3, 3, 0, 1, 1, 1,
             2, 3, 1, 2, 1, 2, 2, 3, 3, 0, 2, 0, 1, 3, 0, 3, 3, 0, 3, 0, 3, 1,
             3, 0, 1, 2, 2, 1, 2, 2, 0, 2, 1, 2, 1, 0, 0, 3, 0, 2, 1, 1, 2, 3,
             3, 3, 1, 3, 3, 3, 3, 2, 3, 0, 0, 3, 2, 1, 2, 0, 3, 2, 2, 2, 0, 2,
             2, 1, 3, 1, 1, 0, 3, 2, 1, 2, 1, 3, 2, 3, 3, 3, 2, 3, 2, 3, 1, 0,
             3, 2, 3, 3, 3, 3, 3, 2, 3, 3, 3, 3, 1, 0, 3, 0, 0, 0, 2, 1, 0, 1,
             0, 0, 1, 2, 1, 0, 0, 1, 1, 2, 2, 1, 0, 0, 0, 1, 0, 3, 1, 0, 2, 2,
             3, 3, 1, 2, 3, 2, 3, 2, 2, 1, 0, 0, 1, 3, 0, 2, 3, 3, 0, 2, 0, 3,
             2, 3, 3, 1, 0, 1, 0, 3, 0, 1, 0, 2, 2, 1, 3, 1, 3, 0, 3, 1, 2, 0,
             0, 2, 1, 3, 3, 3, 1, 1, 3, 0, 0, 2, 3, 3, 1, 3, 1, 1, 3, 2, 1, 2,
             3, 3, 3, 1, 0, 0, 2, 3, 1, 1, 3, 2, 1, 3, 0, 0, 3, 0, 0, 3, 2, 3,
             3, 2, 1, 3, 3, 2, 3, 1, 2, 1, 2, 0, 2, 3, 1, 0, 0, 3, 0, 3, 0, 1,
             2, 0, 2, 3, 1, 3, 2, 2, 1, 2, 0, 0, 0, 1, 3, 2, 0, 0, 0, 3, 2, 0,
             2, 3, 1, 2, 2, 2, 3, 1, 3, 3, 2, 2, 2, 3, 3, 0, 3, 0, 3, 1, 3, 1,
             2, 3, 0, 1, 0, 3, 1, 3, 2, 3, 0, 0, 0, 0, 2, 0, 0, 2, 2, 1, 2, 2,
             2, 0, 1, 0, 0, 3, 2, 0, 3, 1, 2, 2, 1, 2, 3, 1, 1, 2, 2, 1, 2, 0,
             1, 1, 0, 3, 2, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 2, 2, 3, 2, 3, 0, 3,
             0, 3, 0, 1, 1, 0, 2, 0, 3, 2, 3, 3, 1, 3, 1, 3, 1, 2, 2, 0, 1, 2,
             1, 1, 0, 0, 0, 1, 2, 1, 0, 3, 2, 0, 2, 2, 0, 0, 3, 1, 2, 0, 2, 3,
             3, 0, 3, 0, 2, 3, 2, 3, 0, 2, 0, 2, 3, 0, 1, 1, 0, 0, 1, 1, 1, 3,
             3, 3, 2, 3, 1, 2, 2, 3, 3, 3, 2, 0, 2, 1, 2, 2, 1, 0, 2, 2, 0, 0,
             0, 3, 1, 0, 2, 2, 2, 0, 3, 1, 2, 2, 1, 3, 0, 2, 3, 0, 1, 1, 3, 3,
             2, 1, 1, 3, 2, 0, 3, 0, 2, 0, 3, 3, 1, 3, 2, 2, 3, 0, 1, 2, 3, 1,
             3, 2, 3, 1, 1, 0, 0, 3, 1, 0, 3, 2, 3, 3, 0, 3, 3, 3, 2, 3, 3, 1,
             2, 0, 2, 2, 3, 1, 0, 1, 1, 2, 2, 2, 0, 0, 2, 2, 3, 2, 0, 2, 1, 3,
             3, 0, 1, 3, 0, 2, 1, 1, 0, 0, 2, 1, 0, 1, 1, 2, 2, 0, 2, 2, 1, 0,
             3, 0, 0, 3, 2, 0, 0, 0, 0, 0, 3, 0, 3, 1, 3, 2, 1, 3, 3, 0, 1, 0,
             3, 2, 2, 2, 0, 3, 0, 2, 0, 2, 0, 0, 1, 1, 1, 2, 1, 3, 1, 3, 2, 2,
             1, 3, 2, 0, 2, 2, 0, 3, 3, 0, 2, 1, 1, 2, 0, 3, 2, 0, 3, 2, 3, 0,
             0, 3, 0, 2, 2, 3, 2, 2, 2, 2, 1, 2, 3, 0, 1, 0, 1, 2, 1, 0, 0, 1,
             0, 0, 3, 0, 1, 2, 0, 1, 0, 1, 3, 0, 3, 2, 3, 0, 0, 1, 2, 2, 1, 0,
             1, 1, 0, 1, 1, 0, 0, 3, 3, 0, 3, 1, 1, 3, 0, 1, 0, 2, 2, 0, 3, 1,
             0, 3, 0, 1, 0, 3, 3, 3, 2, 3, 0, 3, 2, 0, 0, 0, 3, 3, 2, 0, 2, 1,
             3, 0, 0, 2, 2, 0, 3, 1, 2, 1, 1, 1, 3, 1, 1, 1, 2, 1, 0, 2, 2, 0,
             2, 0, 0, 0, 0, 2, 3, 3, 3, 0, 1, 2, 1, 1, 0, 0, 2, 1, 0, 2, 0, 3,
             2, 2, 1, 2, 0, 2, 1, 3, 0, 0, 3, 2, 3, 0, 0, 2, 3, 3, 1, 3, 2, 1,
             0, 0, 3, 3, 1, 3, 0, 0, 0, 2, 2, 1, 2, 0, 3, 2, 1, 2, 3, 3, 0, 1,
             1, 2, 1, 2, 2, 0, 1, 3, 1, 1, 3, 0, 2, 3, 2, 1, 1, 1, 3, 3, 0, 2,
             3, 0, 2, 3, 2, 2, 2, 3, 2, 0, 1, 2, 1, 2, 1, 1, 2, 2, 2, 1, 2, 1,
             0, 1, 3, 1, 0, 1, 2, 3, 1, 0, 0, 3, 2, 2, 3, 0, 3, 2, 2, 1, 3, 0,
             1, 3, 1, 1, 1, 2, 3, 2, 0, 3, 0, 2, 3, 0, 3, 1, 3, 3, 1, 0, 2, 3,
             1, 0, 2, 1, 2, 1, 2, 0, 2, 2, 0, 2, 3, 2, 3, 0, 2, 1, 1, 2, 2, 3,
             3, 0, 2, 1, 2, 1, 3, 1, 1, 3, 0, 1, 0, 0, 3, 3, 2, 0, 0, 0, 0, 3,
             2, 3, 3, 0, 0, 2, 1, 0, 2, 2], dtype=int64)
```