

Market Positioning of mobile KNN

```
In [10]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

import warnings
warnings.filterwarnings('ignore')
```

```
In [11]: MPKNN = pd.read_csv(r"C:\Users\Vicky Yewle\Downloads\Machine Learning\Datasets\MobilePriceRangePrediction\Mobile Price Range Predi
MPKNN.head()
```

```
Out[11]:
```

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	...	px_height	px_width	ram	sc_h	sc_w	talk_time
0	842	0	2.2	0	1	0	7	0.6	188	2	...	20	756	2549	9	7	1
1	1021	1	0.5	1	0	1	53	0.7	136	3	...	905	1988	2631	17	3	1
2	563	1	0.5	1	2	1	41	0.9	145	5	...	1263	1716	2603	11	2	1
3	615	1	2.5	0	0	0	10	0.8	131	6	...	1216	1786	2769	16	8	1
4	1821	1	1.2	0	13	1	44	0.6	141	2	...	1208	1212	1411	8	2	1

5 rows × 21 columns



```
In [12]: MPKNN.shape
```

```
Out[12]: (2000, 21)
```

```
In [13]: MPKNN.info()
MPKNN.describe()
```

```
<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   float64 
 9   n_cores          2000 non-null   int64  
 10  px_height       2000 non-null   int64  
 11  px_width        2000 non-null   int64  
 12  ram             2000 non-null   int64  
 13  sc_h            2000 non-null   int64  
 14  sc_w            2000 non-null   int64  
 15  talk_time       2000 non-null   float64 
 16  two_sim        ...
```

```

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

```

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	...	px_height
count	2000.000000	2000.0000	2000.000000	2000.000000	2000.000000	2000.000000	2000.000000	2000.000000	2000.000000	2000.000000	...	2000.000000
mean	1238.518500	0.4950	1.522250	0.509500	4.309500	0.521500	32.046500	0.501750	140.249000	4.520500	...	645.108000
std	439.418206	0.5001	0.816004	0.500035	4.341444	0.499662	18.145715	0.288416	35.399655	2.287837	...	443.780811
min	501.000000	0.0000	0.500000	0.000000	0.000000	0.000000	2.000000	0.100000	80.000000	1.000000	...	0.000000
25%	851.750000	0.0000	0.700000	0.000000	1.000000	0.000000	16.000000	0.200000	109.000000	3.000000	...	282.750000
50%	1226.000000	0.0000	1.500000	1.000000	3.000000	1.000000	32.000000	0.500000	141.000000	4.000000	...	564.000000
75%	1615.250000	1.0000	2.200000	1.000000	7.000000	1.000000	48.000000	0.800000	170.000000	7.000000	...	947.250000
max	1998.000000	1.0000	3.000000	1.000000	19.000000	1.000000	64.000000	1.000000	200.000000	8.000000	...	1960.000000

8 rows × 21 columns



```
In [14]: MPKNN = MPKNN[MPKNN['sc_w']>0]
```

```
MPKNN = MPKNN[MPKNN['px_height']>0]
MPKNN.describe()
```

Out[14]:

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	...	px_heig
count	1819.000000	1819.000000	1819.000000	1819.000000	1819.000000	1819.000000	1819.000000	1819.000000	1819.000000	1819.000000	...	1819.000000
mean	1238.031336	0.503573	1.519406	0.504673	4.319956	0.524464	32.156130	0.499835	140.578340	4.531061	...	647.0868
std	439.989288	0.500125	0.813975	0.500116	4.355982	0.499538	18.105723	0.288875	35.437231	2.288705	...	444.7411
min	501.000000	0.000000	0.500000	0.000000	0.000000	0.000000	2.000000	0.100000	80.000000	1.000000	...	1.000000
25%	845.000000	0.000000	0.700000	0.000000	1.000000	0.000000	16.000000	0.200000	109.000000	3.000000	...	284.000000
50%	1231.000000	1.000000	1.500000	1.000000	3.000000	1.000000	32.000000	0.500000	141.000000	5.000000	...	562.000000
75%	1611.000000	1.000000	2.200000	1.000000	7.000000	1.000000	48.000000	0.800000	170.500000	7.000000	...	952.000000
max	1998.000000	1.000000	3.000000	1.000000	19.000000	1.000000	64.000000	1.000000	200.000000	8.000000	...	1960.000000

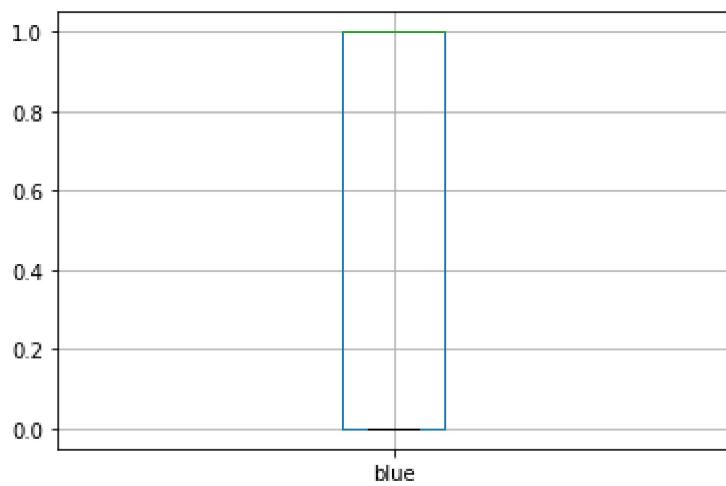
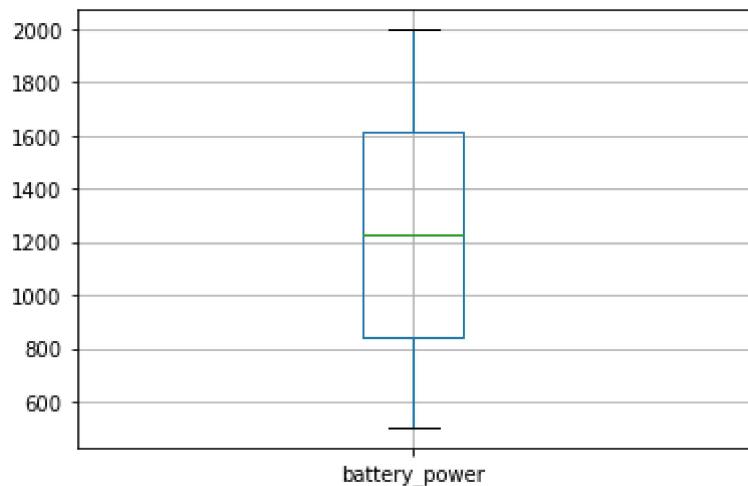
8 rows × 21 columns

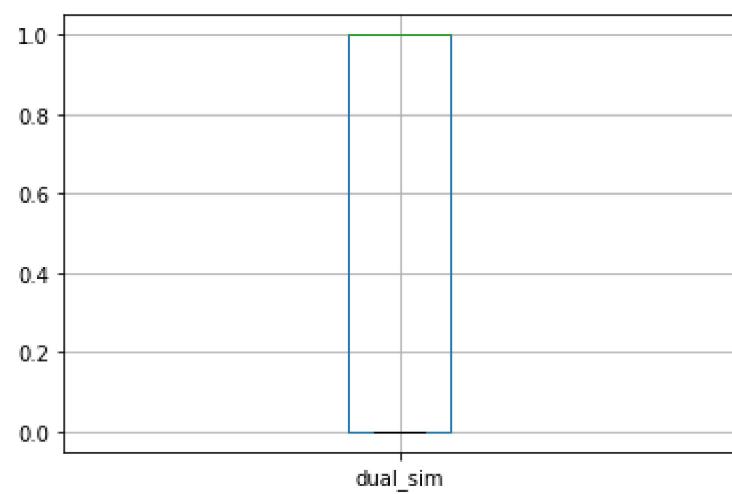
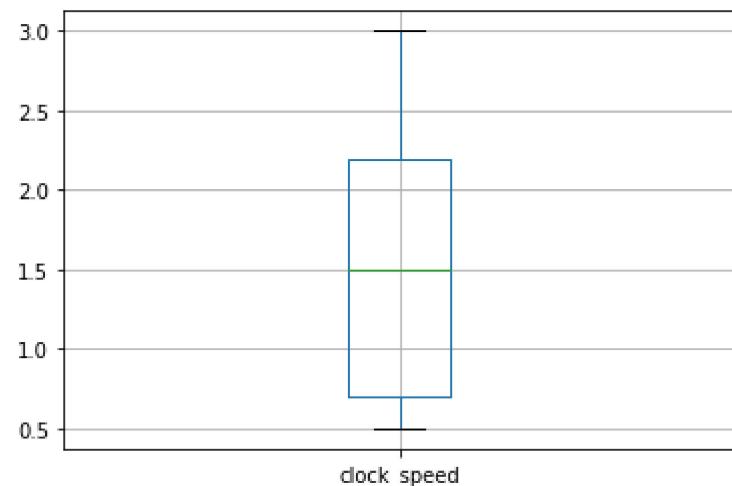


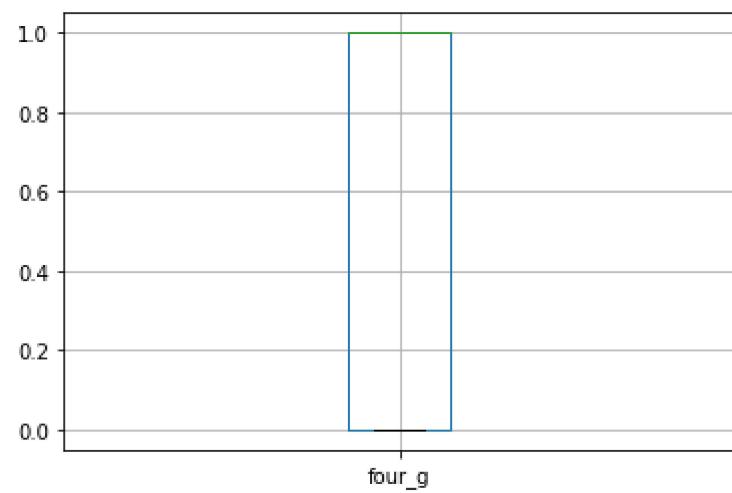
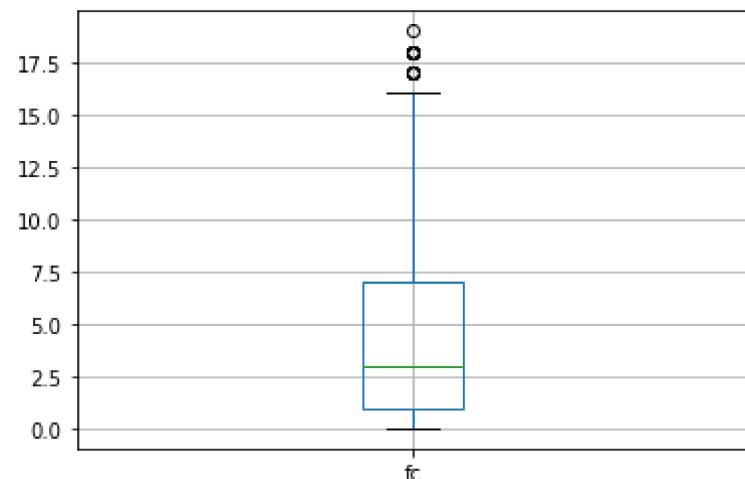
In [15]:

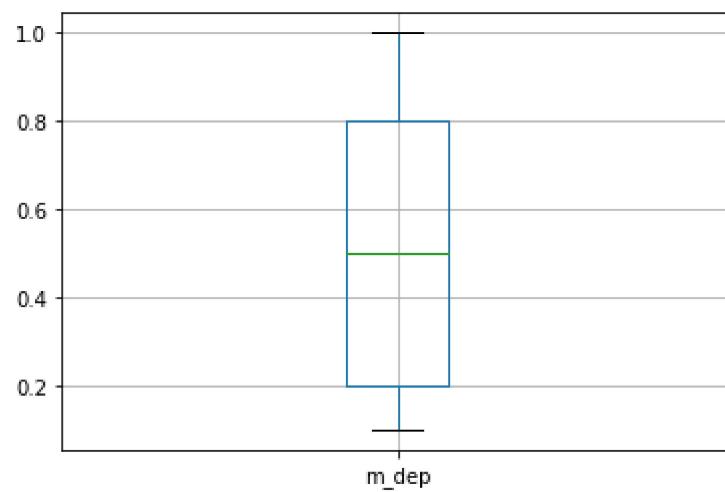
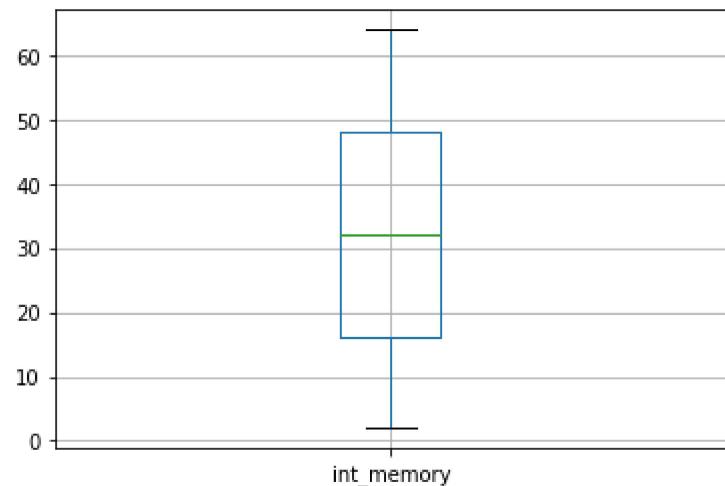
```
# to find outlier we have plotted boxplot
```

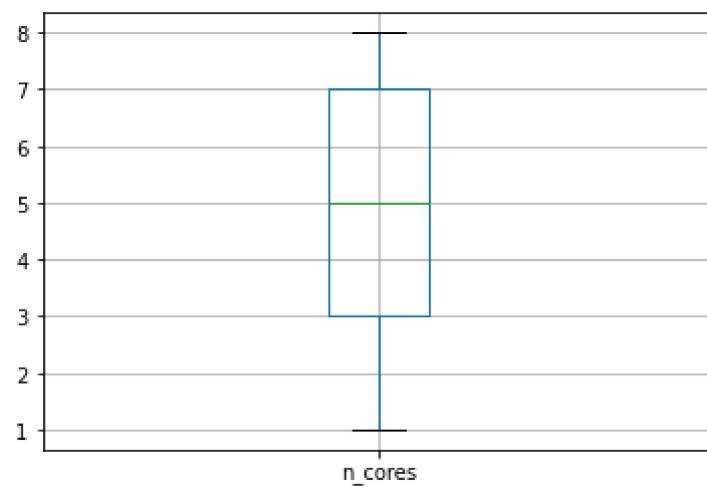
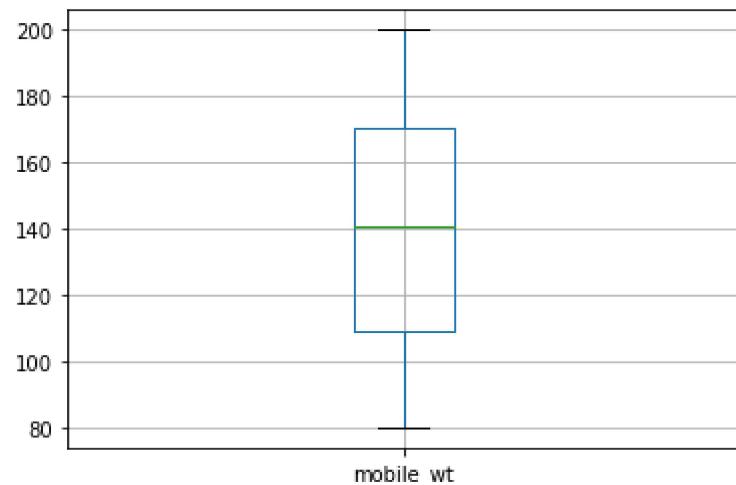
```
for column in MPKNN:
    plt.figure()
    MPKNN.boxplot([column])
```

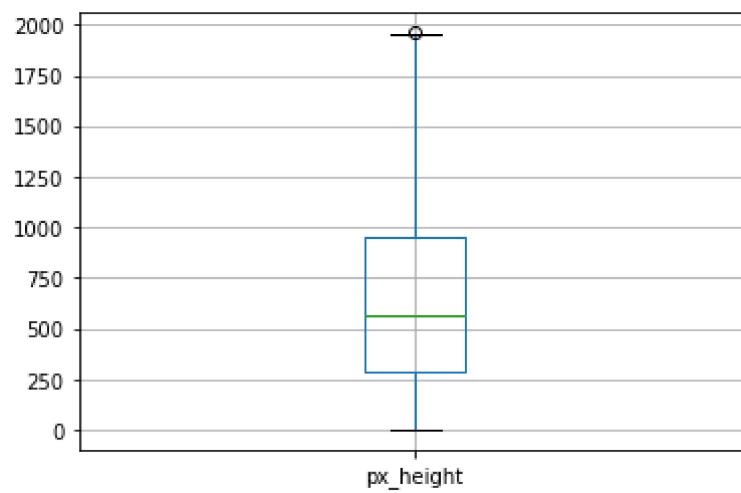
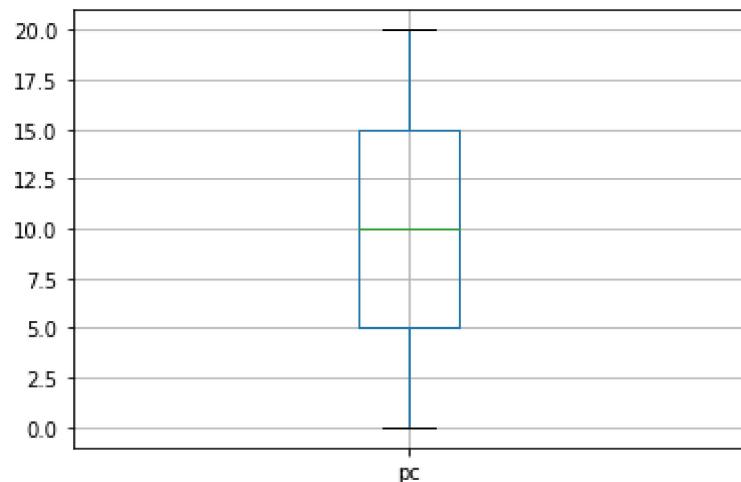


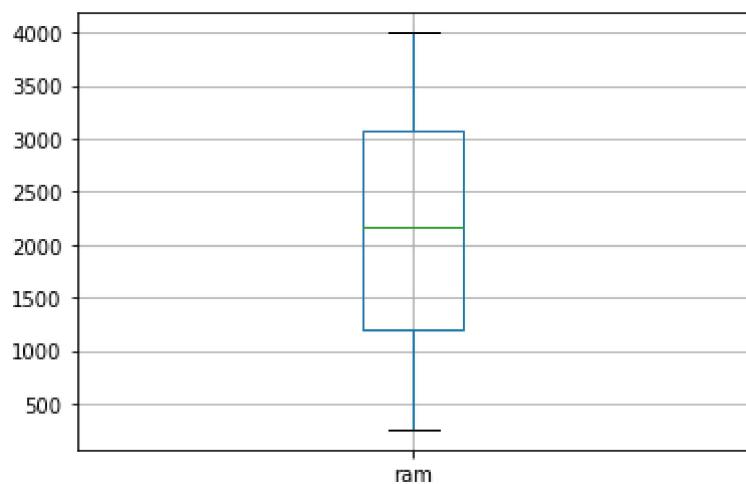
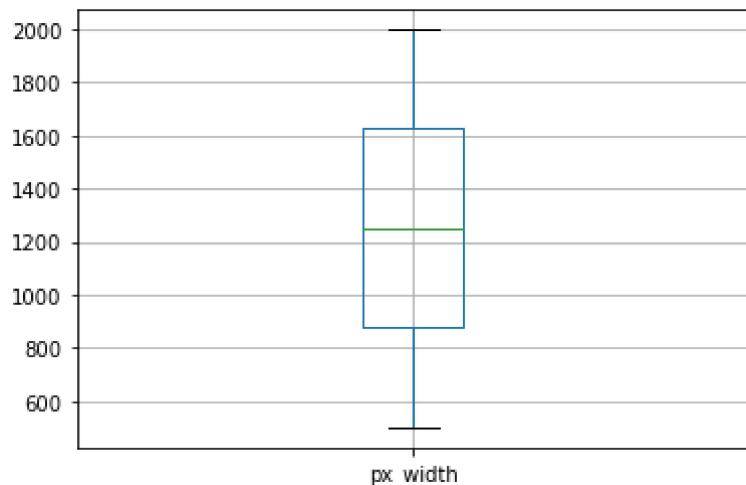


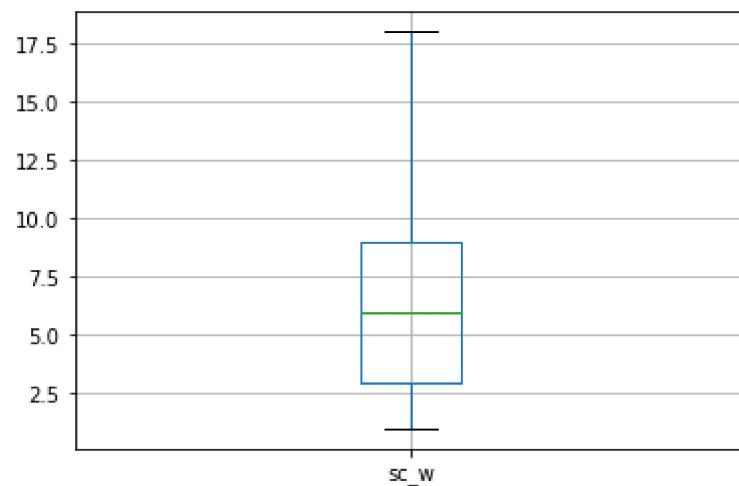
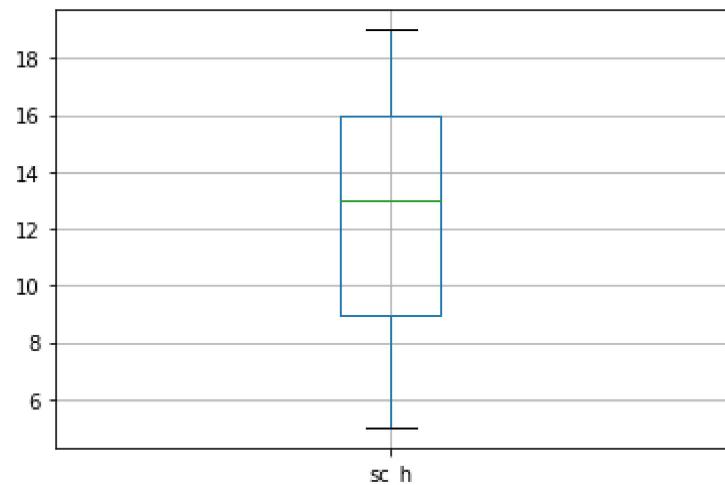


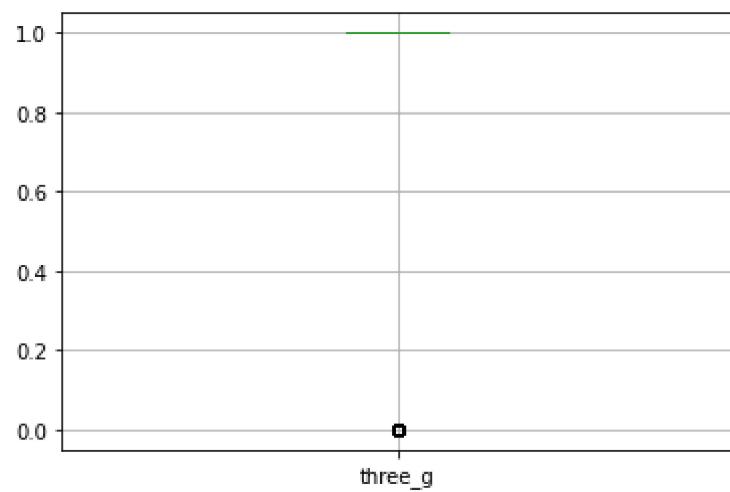
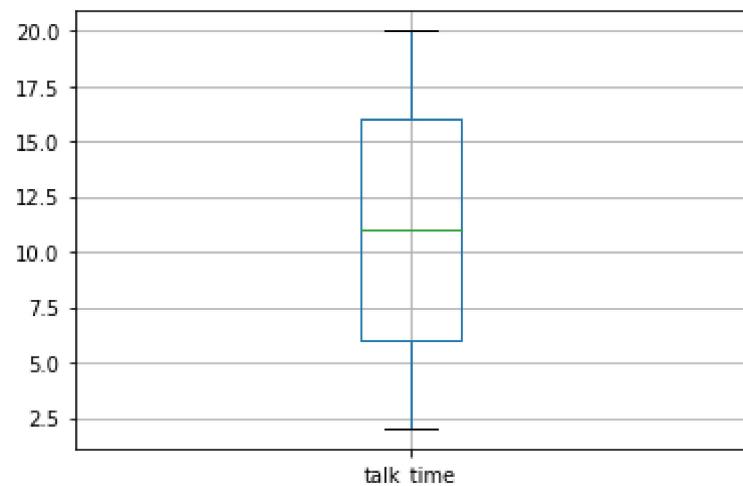


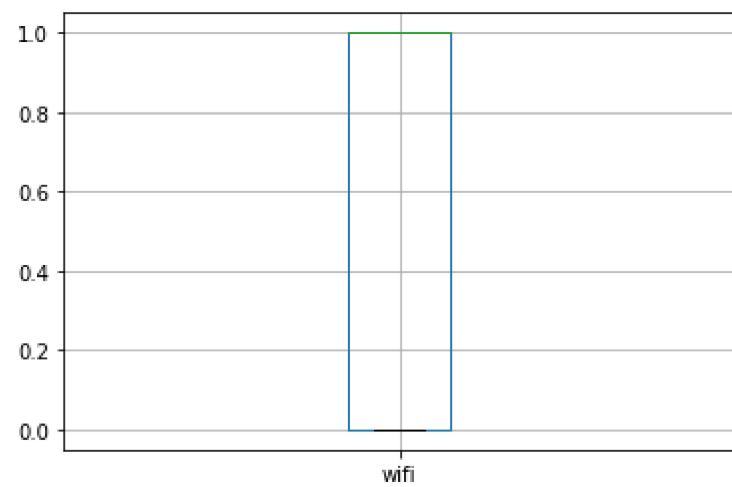
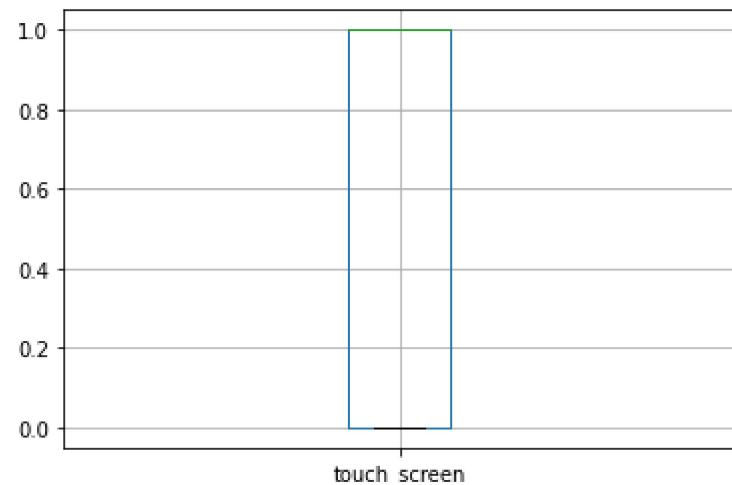


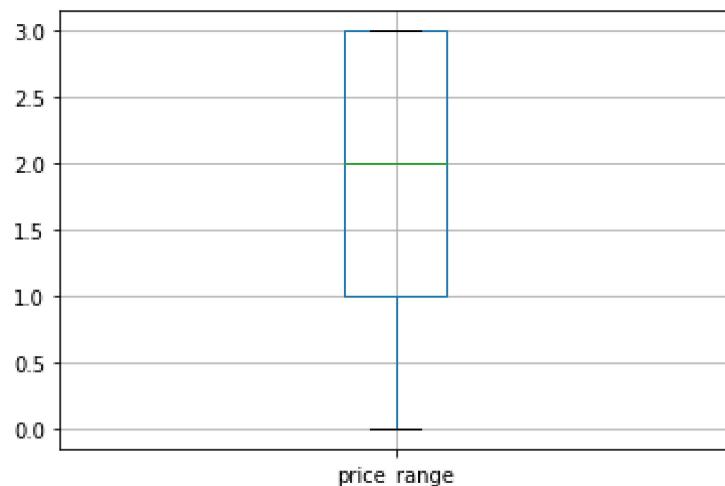












```
In [16]: # to find the outliers in FC column the below is done
```

```
from scipy import stats
import numpy as np
z=np.abs(stats.zscore(MPKNN['fc']))

thresold = 3
print(np.where(z>3))

(array([ 86, 205, 277, 1263, 1282, 1292, 1418, 1544, 1554, 1706, 1708,
       1714], dtype=int64),)
```

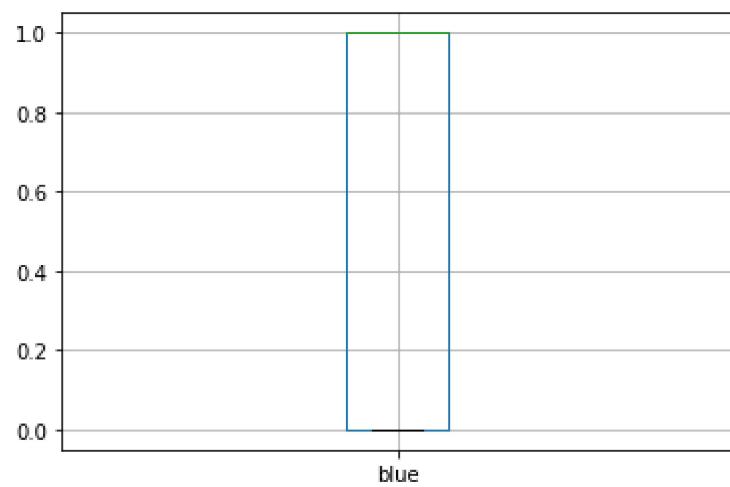
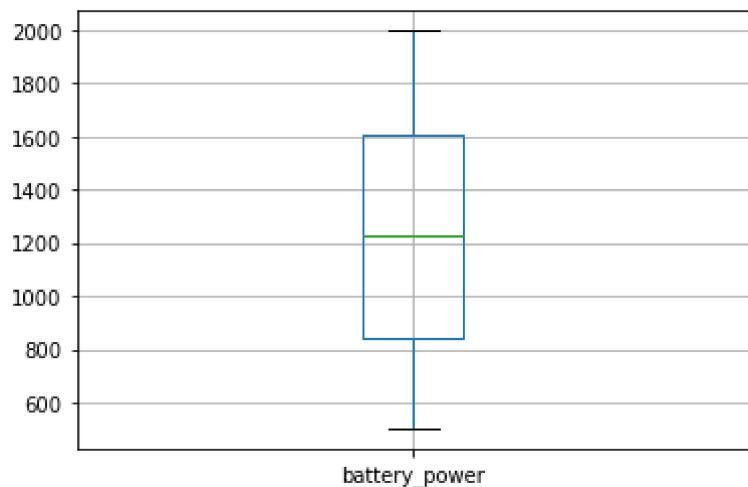
```
In [17]: print(z[86])
```

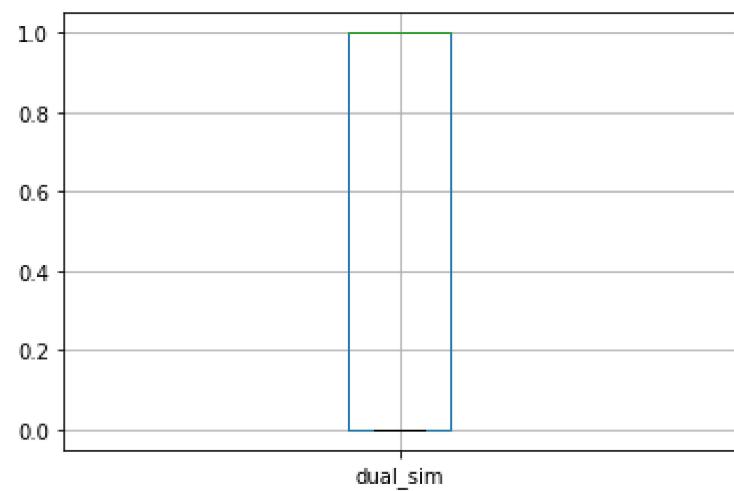
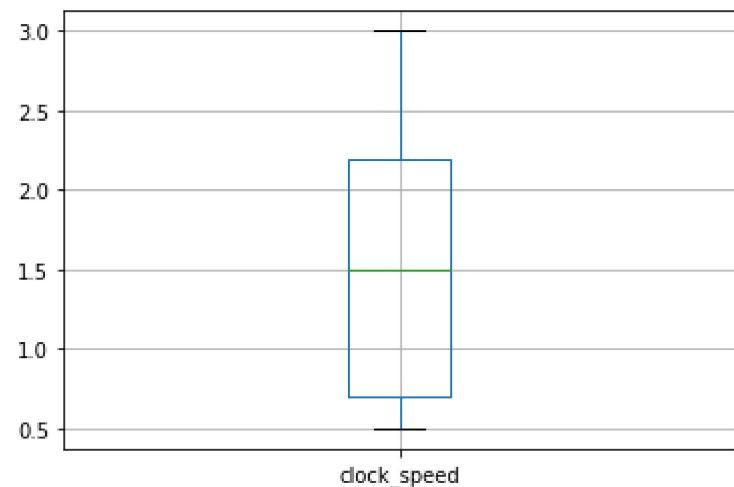
```
MPKNN = MPKNN[(z<3)]
```

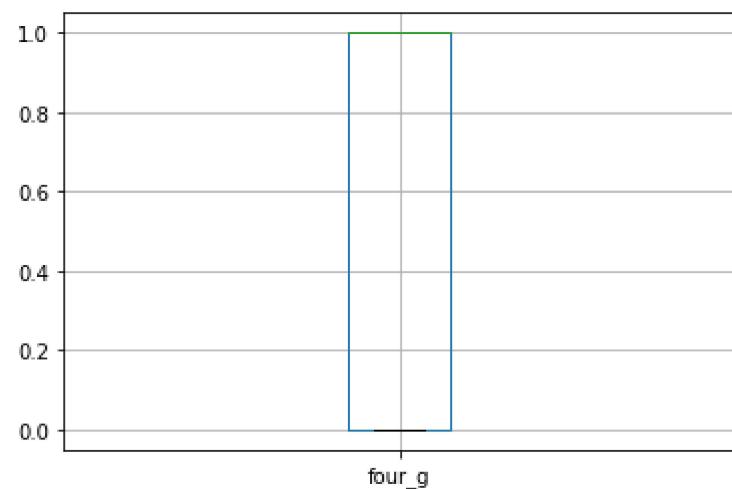
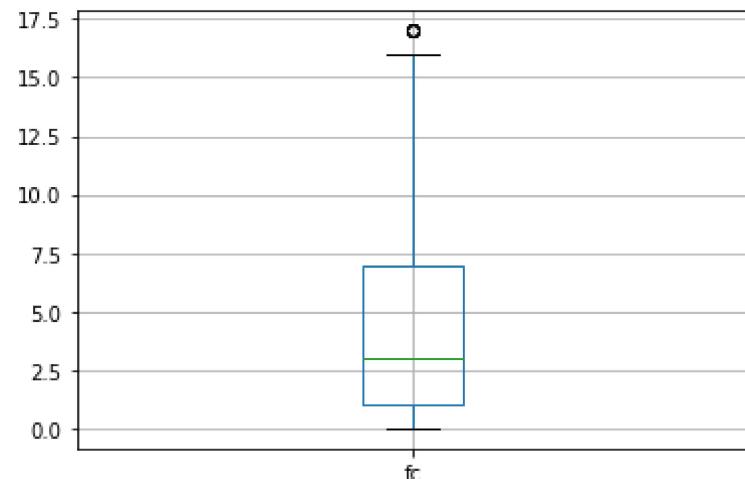
```
3.141382522813342
```

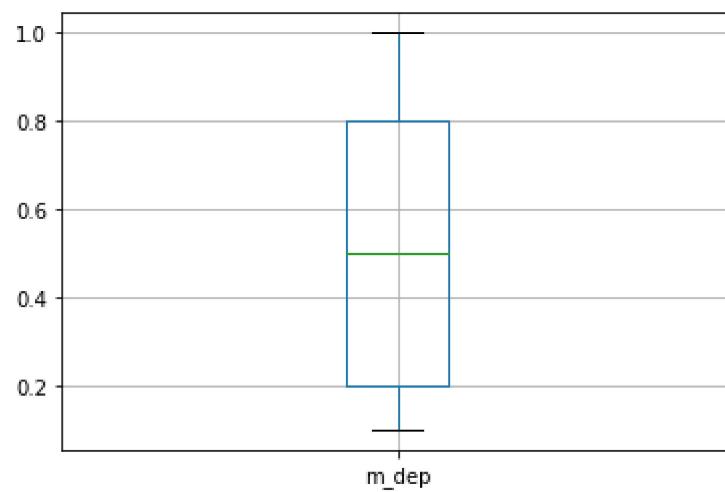
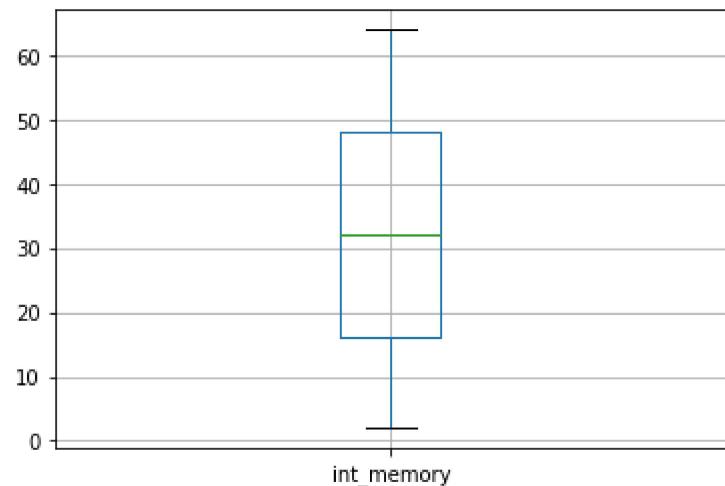
```
In [18]: for column in MPKNN:
```

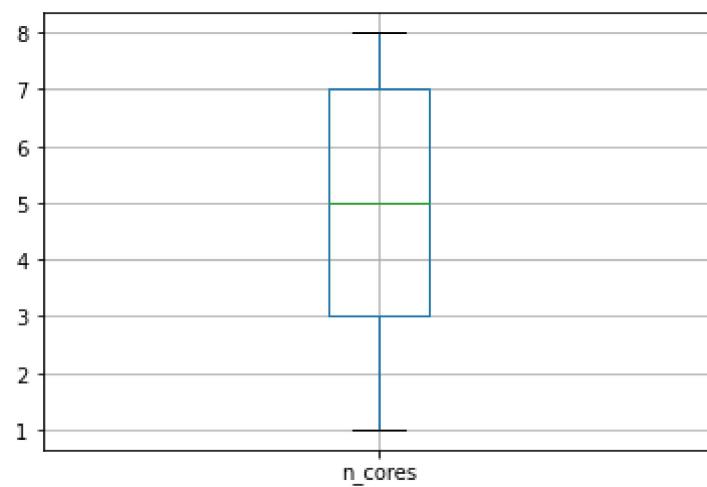
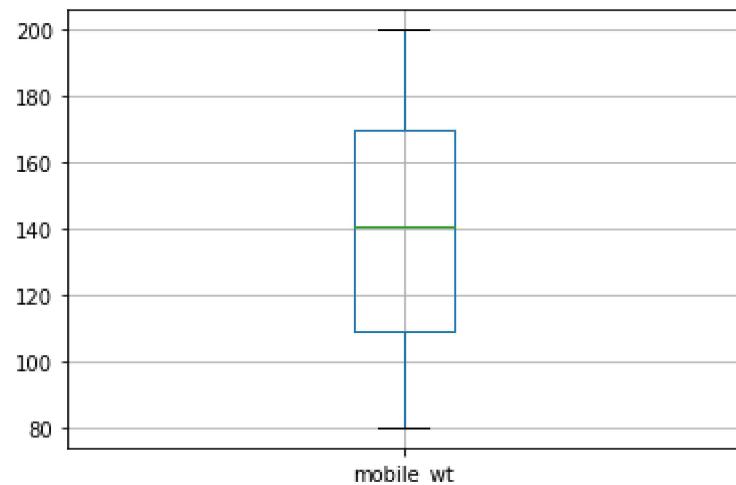
```
    plt.figure()
    MPKNN.boxplot([column])
```

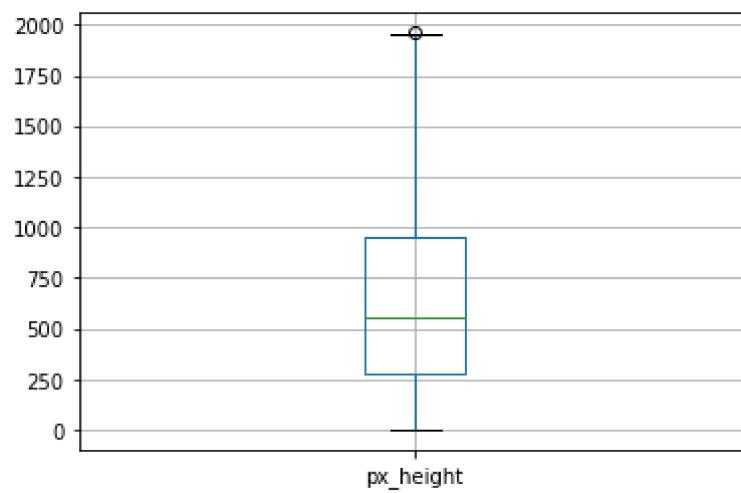
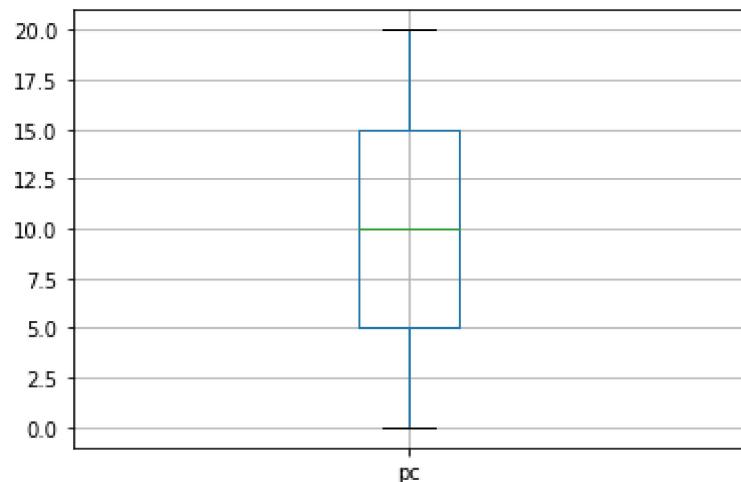


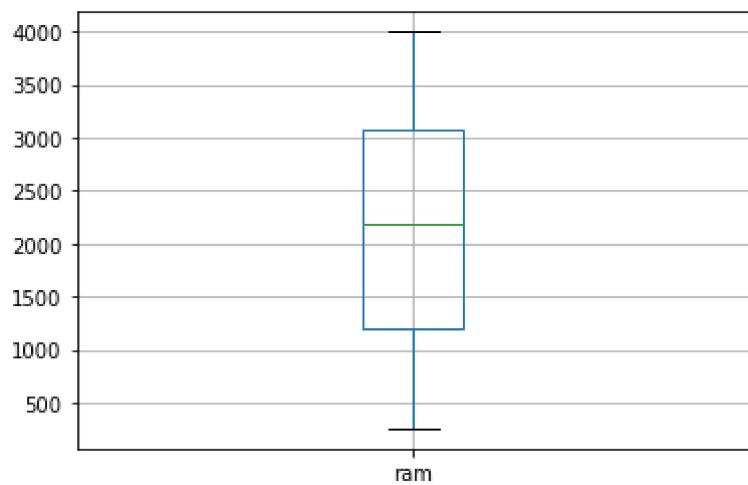
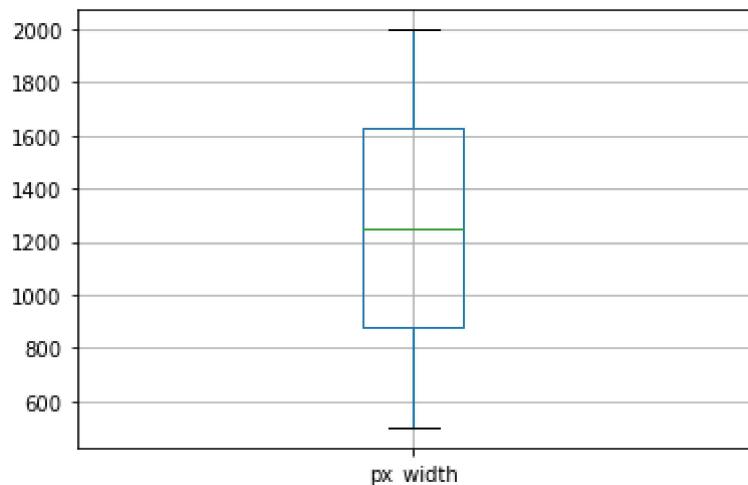


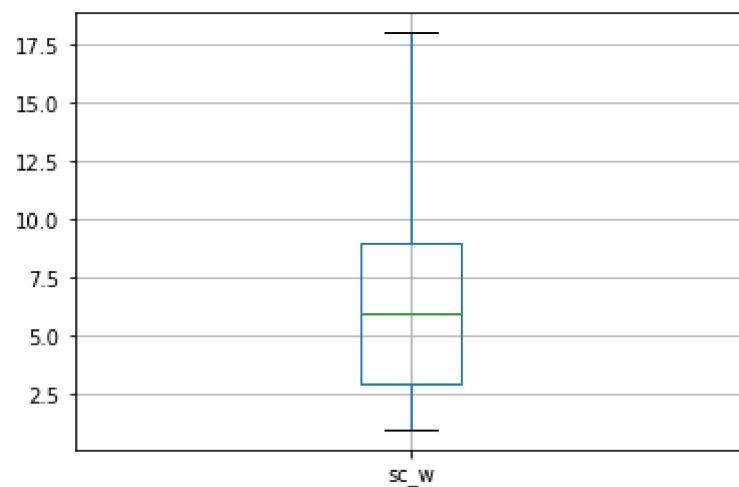
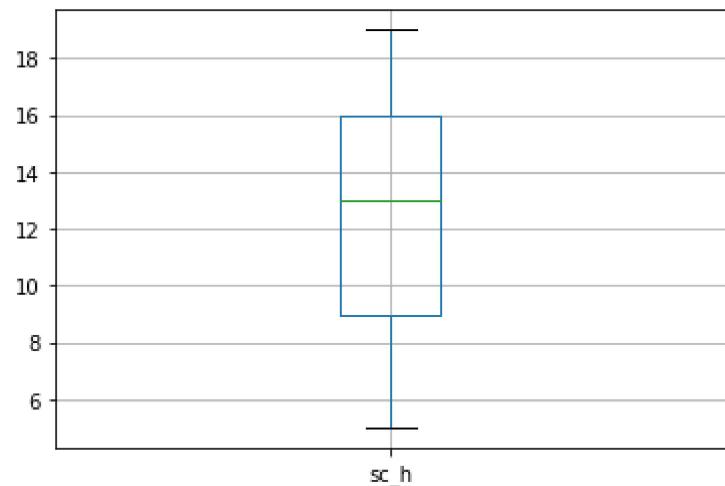


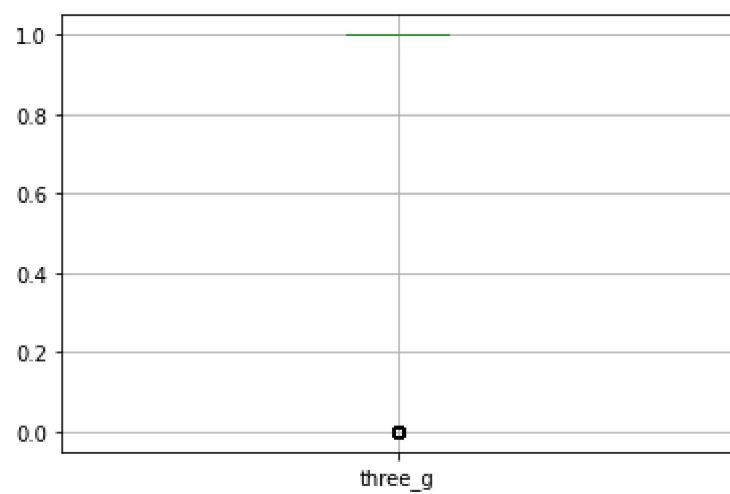
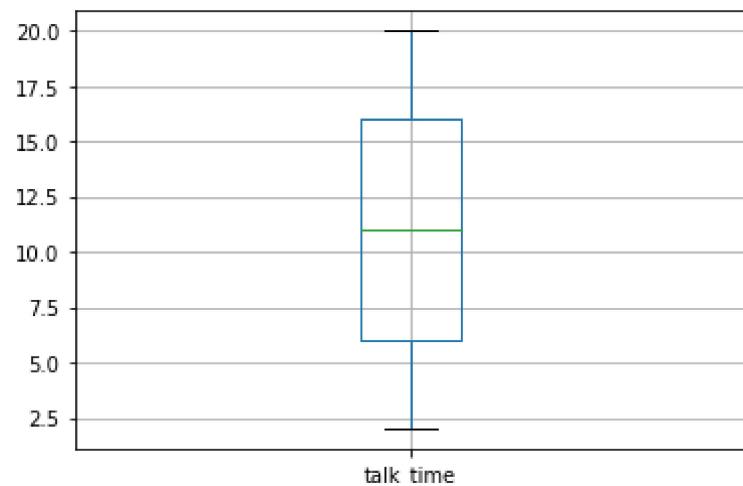


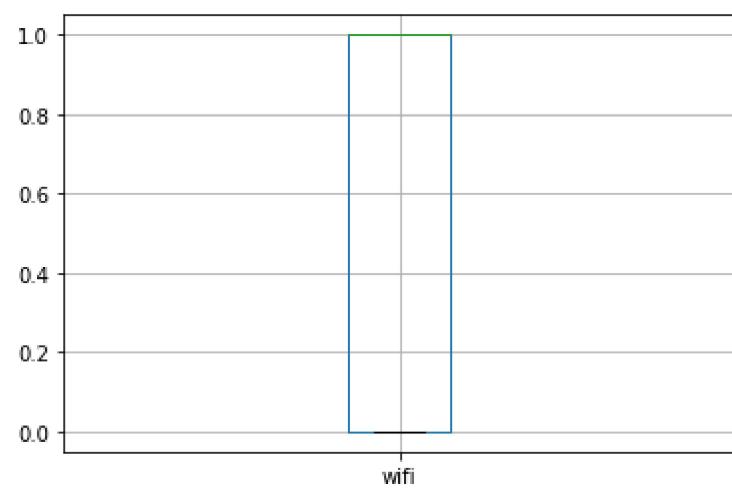
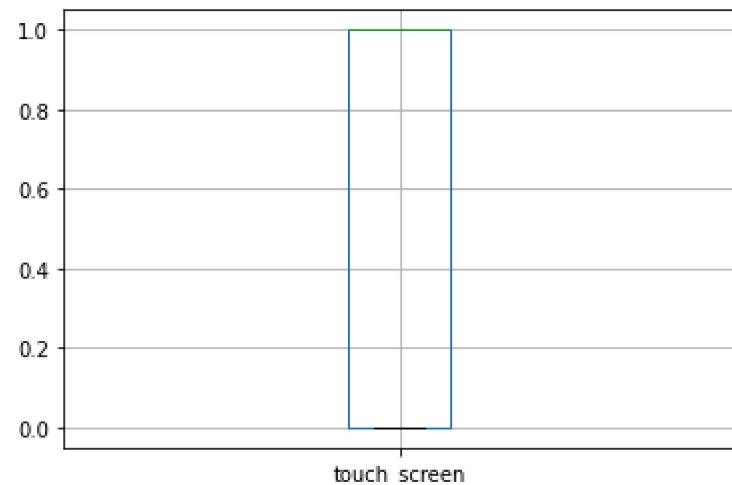


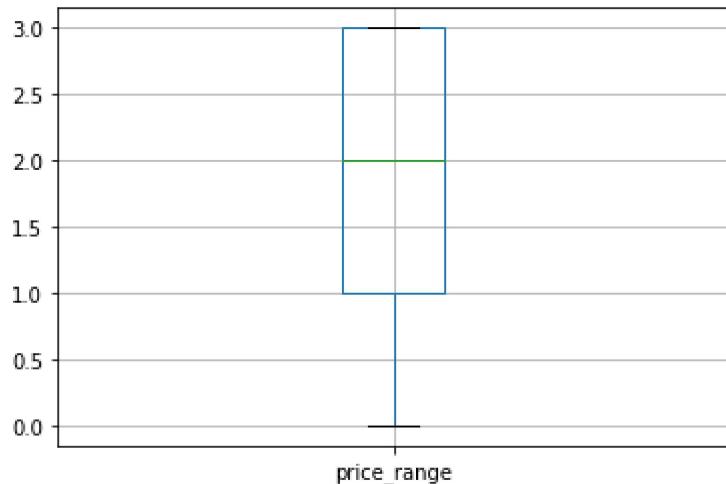












```
In [19]: y= MPKNN['price_range']
X=MPKNN.drop('price_range',axis =1)

from sklearn.model_selection import train_test_split as tts

X_train,X_test, y_train, y_test = tts (X,y,train_size=0.8,
                                         test_size=0.2,random_state=100)
```

```
In [20]: from sklearn.preprocessing import MinMaxScaler as mms

scaler = mms()
Columns = list(X_train.columns)
X_train[Columns]= scaler.fit_transform(X_train[Columns])
X_train
```

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	pc	px_height	px_width	ram
689	0.136364	1.0	0.00	0.0	0.294118	1.0	0.887097	0.888889	0.625000	0.714286	0.45	0.567926	0.583445	0.334848
1819	0.290107	1.0	0.00	1.0	0.176471	1.0	0.903226	0.000000	0.625000	0.571429	0.60	0.325332	0.391856	0.592464
515	0.889706	0.0	0.08	0.0	0.117647	0.0	0.000000	0.555556	0.083333	0.857143	0.30	0.093973	0.102804	0.727418
318	0.004679	0.0	0.12	0.0	0.411765	1.0	0.645161	0.222222	0.116667	0.000000	0.40	0.018897	0.038051	0.108765
1244	0.145053	0.0	0.92	0.0	0.588235	0.0	0.919355	0.777778	0.275000	0.714286	0.65	0.604188	0.592123	0.419027
...

MarketPositioning of KNN

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	pc	px_height	px_width	ram	
59	0.375668	0.0	0.36	1.0	0.117647	1.0	0.741935	1.000000	0.400000	0.571429	0.20	0.063841	0.122163	0.709246	0.7
393	0.584225	1.0	0.24	0.0	0.176471	1.0	0.112903	0.888889	0.541667	0.857143	0.95	0.241573	0.150868	0.965526	1.0
88	0.111631	0.0	0.00	1.0	0.000000	0.0	0.016129	0.000000	0.625000	0.571429	0.65	0.339122	0.469292	0.665420	0.2
872	0.045455	1.0	0.00	1.0	0.588235	1.0	0.032258	0.777778	0.750000	0.285714	0.95	0.178243	0.439920	0.559861	0.2
1703	0.294786	0.0	0.36	1.0	0.470588	0.0	0.403226	0.444444	0.091667	0.428571	0.45	0.384065	0.688919	0.088455	0.0

1445 rows × 20 columns



```
In [21]: X_test[Columns]=scaler.transform(X_test[Columns])
X_test
```

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	pc	px_height	px_width	ram	
150	0.228610	1.0	0.00	0.0	0.058824	1.0	0.870968	0.000000	0.558333	0.571429	0.85	0.070480	0.200267	0.557189	0.3
504	0.775401	1.0	0.36	0.0	0.000000	0.0	0.435484	0.222222	0.325000	0.142857	0.00	0.272727	0.240988	0.089524	0.2
991	0.239973	1.0	0.44	1.0	0.764706	0.0	0.741935	0.444444	0.891667	0.857143	0.90	0.170072	0.642857	0.431320	0.8
34	0.095588	1.0	0.88	0.0	0.000000	0.0	0.322581	0.666667	0.641667	1.000000	0.15	0.157814	0.254339	0.268840	0.5
563	0.527406	0.0	0.00	0.0	0.000000	0.0	0.016129	0.000000	0.525000	0.714286	0.20	0.305414	0.406542	0.256013	0.2
...	
954	0.281417	1.0	0.08	0.0	0.000000	1.0	0.725806	1.000000	0.641667	1.000000	0.70	0.660368	0.873164	0.322822	0.8
387	0.039439	0.0	0.00	0.0	0.823529	0.0	0.338710	1.000000	0.550000	1.000000	0.75	0.180797	0.936582	0.562266	0.8
647	0.842914	1.0	0.88	1.0	0.764706	1.0	0.370968	0.888889	0.908333	0.000000	0.70	0.152196	0.018024	0.438268	0.6
1756	0.911096	0.0	0.56	1.0	0.117647	0.0	0.887097	0.000000	0.841667	0.714286	0.30	0.652196	0.863151	0.889898	1.0
1166	0.332888	1.0	0.52	1.0	0.000000	1.0	0.403226	0.000000	0.725000	0.428571	0.05	0.009193	0.163551	0.290754	0.8

362 rows × 20 columns



In [22]: `# simple KNN formula`

```
from sklearn.neighbors import KNeighborsClassifier
knn= KNeighborsClassifier(n_neighbors=5)

knn.fit(X_train,y_train)
y_train_pred = knn.predict(X_train)
knn.score(X_train, y_train_pred)
```

Out[22]: 1.0

In [23]: `knn.score(X_test,y_test)`

Out[23]: 0.38950276243093923

In [24]: `# Let's check the evaluation metrics of our default model`

```
# Importing classification report and confusion matrix from sklearn metrics
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

# Making predictions
y_pred = knn.predict(X_test)

# Printing classification report
print(classification_report(y_test, y_pred))
print(confusion_matrix(y_test,y_pred))
```

	precision	recall	f1-score	support
0	0.44	0.58	0.50	88
1	0.33	0.34	0.34	94
2	0.30	0.30	0.30	97
3	0.58	0.35	0.44	83
accuracy			0.39	362
macro avg	0.41	0.39	0.39	362
weighted avg	0.40	0.39	0.39	362


```
[[51 20 14  3]
 [40 32 19  3]
 [24 29 29 15]
 [ 2 16 36 29]]
```

In [25]: `from sklearn.feature_selection import RFE`

```
from sklearn.linear_model import LinearRegression  
  
lm = LinearRegression()  
lm.fit(X_train, y_train)  
  
rfe=RFE(lm,4)  
rfe = rfe.fit(X_train,y_train)
```

In [26]: `list(zip(X_train.columns,rfe.support_,rfe.ranking_))`

Out[26]: `[('battery_power', True, 1),
 ('blue', False, 15),
 ('clock_speed', False, 10),
 ('dual_sim', False, 6),
 ('fc', False, 8),
 ('four_g', False, 17),
 ('int_memory', False, 3),
 ('m_dep', False, 16),
 ('mobile_wt', False, 2),
 ('n_cores', False, 7),
 ('pc', False, 9),
 ('px_height', True, 1),
 ('px_width', True, 1),
 ('ram', True, 1),
 ('sc_h', False, 4),
 ('sc_w', False, 5),
 ('talk_time', False, 12),
 ('three_g', False, 14),
 ('touch_screen', False, 13),
 ('wifi', False, 11)]`

In [27]: `col = X_train.columns[rfe.support_]
col`

Out[27]: `Index(['battery_power', 'px_height', 'px_width', 'ram'], dtype='object')`

In [28]: `from sklearn.neighbors import KNeighborsClassifier
X_train_subset = X_train[list(X_train.columns[rfe.support_])]
X_test_subset = X_test[list(X_train.columns[rfe.support_])]

knn= KNeighborsClassifier(n_neighbors=5)

knn.fit(X_train_subset,y_train)
y_train_pred = knn.predict(X_train_subset)
knn.score(X_train_subset, y_train_pred)`

```
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

# Making predictions
y_pred = knn.predict(X_test_subset)

# Printing classification report
print(classification_report(y_test, y_pred))
print(confusion_matrix(y_test,y_pred))
```

	precision	recall	f1-score	support
0	0.93	0.94	0.94	88
1	0.89	0.85	0.87	94
2	0.84	0.87	0.85	97
3	0.90	0.90	0.90	83
accuracy			0.89	362
macro avg	0.89	0.89	0.89	362
weighted avg	0.89	0.89	0.89	362

$$\begin{bmatrix} [83 & 5 & 0 & 0] \\ [6 & 80 & 8 & 0] \\ [0 & 5 & 84 & 8] \\ [0 & 0 & 8 & 75] \end{bmatrix}$$

In [29]:

```
from sklearn.model_selection import cross_val_score
import numpy as np

knn_cv = KNeighborsClassifier(n_neighbors=3)

cv_scores = cross_val_score(knn_cv, X_train_subset, y_train, cv=7)

print(cv_scores)
print('cv_scores_mean:{}' .format(np.mean(cv_scores)))
```

$$\begin{bmatrix} 0.84541063 & 0.88405797 & 0.85024155 & 0.90291262 & 0.87378641 & 0.86407767 \\ 0.88834951 \end{bmatrix}$$

cv_scores_mean:0.872690908359967

In [30]:

```
# GridSearchCV to find optimal min_samples_split
from sklearn.model_selection import GridSearchCV

# specify number of folds for k-fold CV
```

```
knn2=KNeighborsClassifier()

# parameters to build the model on
param_grid = {'n_neighbors': np.arange(1,250)}

# fit tree on training data
knn_gscv= GridSearchCV(knn2, param_grid,
                        scoring="accuracy",
                        cv=7,
                        n_jobs=-1,
                        verbose=20)
knn_gscv.fit(X_train_subset, y_train)
```

Fitting 7 folds for each of 249 candidates, totalling 1743 fits

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 tasks    elapsed:  5.7s
[Parallel(n_jobs=-1)]: Done   2 tasks    elapsed:  5.7s
[Parallel(n_jobs=-1)]: Done   3 tasks    elapsed:  5.8s
[Parallel(n_jobs=-1)]: Done   4 tasks    elapsed:  5.8s
[Parallel(n_jobs=-1)]: Done   5 tasks    elapsed:  5.8s
[Parallel(n_jobs=-1)]: Done   6 tasks    elapsed:  5.9s
[Parallel(n_jobs=-1)]: Done   7 tasks    elapsed:  5.9s
[Parallel(n_jobs=-1)]: Done   8 tasks    elapsed:  5.9s
[Parallel(n_jobs=-1)]: Done   9 tasks    elapsed:  5.9s
[Parallel(n_jobs=-1)]: Done  10 tasks   elapsed:  5.9s
[Parallel(n_jobs=-1)]: Done  11 tasks   elapsed:  5.9s
[Parallel(n_jobs=-1)]: Done  12 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  13 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  14 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  15 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  16 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  17 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  18 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  19 tasks   elapsed:  6.0s
[Parallel(n_jobs=-1)]: Done  20 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  21 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  22 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  23 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  24 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  25 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  26 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  27 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  28 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  29 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  30 tasks   elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  31 tasks   elapsed:  6.1s
```

```
[Parallel(n_jobs=-1)]: Done  32 tasks    | elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  33 tasks    | elapsed:  6.1s
[Parallel(n_jobs=-1)]: Done  34 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  35 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  36 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Batch computation too fast (0.1893s.) Setting batch_size=2.
[Parallel(n_jobs=-1)]: Done  37 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  38 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  39 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  40 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  41 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  42 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  43 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  44 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  45 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  46 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  47 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  48 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  49 tasks    | elapsed:  6.2s
[Parallel(n_jobs=-1)]: Done  50 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  51 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  52 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  53 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  54 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  55 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  56 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Done  58 tasks    | elapsed:  6.3s
[Parallel(n_jobs=-1)]: Batch computation too fast (0.1310s.) Setting batch_size=4.
[Parallel(n_jobs=-1)]: Done  60 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  62 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  64 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  66 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  68 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  70 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  72 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  74 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  76 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  78 tasks    | elapsed:  6.4s
[Parallel(n_jobs=-1)]: Done  80 tasks    | elapsed:  6.5s
[Parallel(n_jobs=-1)]: Done  82 tasks    | elapsed:  6.5s
[Parallel(n_jobs=-1)]: Done  84 tasks    | elapsed:  6.5s
[Parallel(n_jobs=-1)]: Done  86 tasks    | elapsed:  6.5s
[Parallel(n_jobs=-1)]: Done  88 tasks    | elapsed:  6.5s
[Parallel(n_jobs=-1)]: Done  92 tasks    | elapsed:  6.6s
[Parallel(n_jobs=-1)]: Done  96 tasks    | elapsed:  6.6s
[Parallel(n_jobs=-1)]: Done 100 tasks   | elapsed:  6.6s
[Parallel(n_jobs=-1)]: Done 104 tasks   | elapsed:  6.6s
```

```
[Parallel(n_jobs=-1)]: Done 108 tasks | elapsed: 6.6s
[Parallel(n_jobs=-1)]: Done 112 tasks | elapsed: 6.6s
[Parallel(n_jobs=-1)]: Done 116 tasks | elapsed: 6.6s
[Parallel(n_jobs=-1)]: Done 120 tasks | elapsed: 6.7s
[Parallel(n_jobs=-1)]: Done 124 tasks | elapsed: 6.7s
[Parallel(n_jobs=-1)]: Done 128 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 132 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 136 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 140 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 144 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 148 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 152 tasks | elapsed: 6.8s
[Parallel(n_jobs=-1)]: Done 156 tasks | elapsed: 6.9s
[Parallel(n_jobs=-1)]: Done 160 tasks | elapsed: 6.9s
[Parallel(n_jobs=-1)]: Done 164 tasks | elapsed: 6.9s
[Parallel(n_jobs=-1)]: Done 168 tasks | elapsed: 7.0s
[Parallel(n_jobs=-1)]: Done 172 tasks | elapsed: 7.0s
[Parallel(n_jobs=-1)]: Done 176 tasks | elapsed: 7.0s
[Parallel(n_jobs=-1)]: Done 180 tasks | elapsed: 7.0s
[Parallel(n_jobs=-1)]: Done 184 tasks | elapsed: 7.0s
[Parallel(n_jobs=-1)]: Done 188 tasks | elapsed: 7.0s
[Parallel(n_jobs=-1)]: Done 192 tasks | elapsed: 7.1s
[Parallel(n_jobs=-1)]: Done 196 tasks | elapsed: 7.1s
[Parallel(n_jobs=-1)]: Done 200 tasks | elapsed: 7.1s
[Parallel(n_jobs=-1)]: Done 204 tasks | elapsed: 7.1s
[Parallel(n_jobs=-1)]: Done 208 tasks | elapsed: 7.1s
[Parallel(n_jobs=-1)]: Done 212 tasks | elapsed: 7.1s
[Parallel(n_jobs=-1)]: Done 216 tasks | elapsed: 7.2s
[Parallel(n_jobs=-1)]: Done 220 tasks | elapsed: 7.2s
[Parallel(n_jobs=-1)]: Done 224 tasks | elapsed: 7.2s
[Parallel(n_jobs=-1)]: Done 228 tasks | elapsed: 7.3s
[Parallel(n_jobs=-1)]: Done 232 tasks | elapsed: 7.3s
[Parallel(n_jobs=-1)]: Done 236 tasks | elapsed: 7.3s
[Parallel(n_jobs=-1)]: Done 240 tasks | elapsed: 7.3s
[Parallel(n_jobs=-1)]: Done 244 tasks | elapsed: 7.3s
[Parallel(n_jobs=-1)]: Done 248 tasks | elapsed: 7.3s
[Parallel(n_jobs=-1)]: Done 252 tasks | elapsed: 7.4s
[Parallel(n_jobs=-1)]: Done 256 tasks | elapsed: 7.4s
[Parallel(n_jobs=-1)]: Done 260 tasks | elapsed: 7.4s
[Parallel(n_jobs=-1)]: Done 264 tasks | elapsed: 7.4s
[Parallel(n_jobs=-1)]: Done 268 tasks | elapsed: 7.5s
[Parallel(n_jobs=-1)]: Done 272 tasks | elapsed: 7.5s
[Parallel(n_jobs=-1)]: Done 276 tasks | elapsed: 7.5s
[Parallel(n_jobs=-1)]: Done 280 tasks | elapsed: 7.5s
[Parallel(n_jobs=-1)]: Done 284 tasks | elapsed: 7.5s
[Parallel(n_jobs=-1)]: Done 288 tasks | elapsed: 7.6s
[Parallel(n_jobs=-1)]: Done 292 tasks | elapsed: 7.6s
```

```
[Parallel(n_jobs=-1)]: Done 296 tasks | elapsed: 7.6s
[Parallel(n_jobs=-1)]: Done 300 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 304 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 308 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 312 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 316 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 320 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 324 tasks | elapsed: 7.7s
[Parallel(n_jobs=-1)]: Done 328 tasks | elapsed: 7.8s
[Parallel(n_jobs=-1)]: Done 332 tasks | elapsed: 7.8s
[Parallel(n_jobs=-1)]: Done 336 tasks | elapsed: 7.8s
[Parallel(n_jobs=-1)]: Done 340 tasks | elapsed: 7.8s
[Parallel(n_jobs=-1)]: Done 344 tasks | elapsed: 7.9s
[Parallel(n_jobs=-1)]: Done 348 tasks | elapsed: 7.9s
[Parallel(n_jobs=-1)]: Done 352 tasks | elapsed: 7.9s
[Parallel(n_jobs=-1)]: Done 356 tasks | elapsed: 7.9s
[Parallel(n_jobs=-1)]: Done 360 tasks | elapsed: 8.0s
[Parallel(n_jobs=-1)]: Done 364 tasks | elapsed: 8.0s
[Parallel(n_jobs=-1)]: Done 368 tasks | elapsed: 8.0s
[Parallel(n_jobs=-1)]: Done 372 tasks | elapsed: 8.0s
[Parallel(n_jobs=-1)]: Done 376 tasks | elapsed: 8.0s
[Parallel(n_jobs=-1)]: Done 380 tasks | elapsed: 8.1s
[Parallel(n_jobs=-1)]: Done 384 tasks | elapsed: 8.1s
[Parallel(n_jobs=-1)]: Done 388 tasks | elapsed: 8.1s
[Parallel(n_jobs=-1)]: Done 392 tasks | elapsed: 8.1s
[Parallel(n_jobs=-1)]: Done 396 tasks | elapsed: 8.2s
[Parallel(n_jobs=-1)]: Done 400 tasks | elapsed: 8.2s
[Parallel(n_jobs=-1)]: Done 404 tasks | elapsed: 8.2s
[Parallel(n_jobs=-1)]: Done 408 tasks | elapsed: 8.2s
[Parallel(n_jobs=-1)]: Done 412 tasks | elapsed: 8.2s
[Parallel(n_jobs=-1)]: Done 416 tasks | elapsed: 8.2s
[Parallel(n_jobs=-1)]: Done 420 tasks | elapsed: 8.3s
[Parallel(n_jobs=-1)]: Done 424 tasks | elapsed: 8.3s
[Parallel(n_jobs=-1)]: Done 428 tasks | elapsed: 8.3s
[Parallel(n_jobs=-1)]: Done 432 tasks | elapsed: 8.3s
[Parallel(n_jobs=-1)]: Done 436 tasks | elapsed: 8.3s
[Parallel(n_jobs=-1)]: Done 440 tasks | elapsed: 8.4s
[Parallel(n_jobs=-1)]: Done 444 tasks | elapsed: 8.4s
[Parallel(n_jobs=-1)]: Done 448 tasks | elapsed: 8.4s
[Parallel(n_jobs=-1)]: Done 452 tasks | elapsed: 8.4s
[Parallel(n_jobs=-1)]: Done 456 tasks | elapsed: 8.4s
[Parallel(n_jobs=-1)]: Done 460 tasks | elapsed: 8.4s
[Parallel(n_jobs=-1)]: Done 464 tasks | elapsed: 8.5s
[Parallel(n_jobs=-1)]: Done 468 tasks | elapsed: 8.5s
[Parallel(n_jobs=-1)]: Done 472 tasks | elapsed: 8.6s
[Parallel(n_jobs=-1)]: Done 476 tasks | elapsed: 8.6s
[Parallel(n_jobs=-1)]: Done 480 tasks | elapsed: 8.6s
```

```
[Parallel(n_jobs=-1)]: Done 484 tasks    elapsed: 8.6s
[Parallel(n_jobs=-1)]: Done 488 tasks    elapsed: 8.6s
[Parallel(n_jobs=-1)]: Done 492 tasks    elapsed: 8.6s
[Parallel(n_jobs=-1)]: Done 496 tasks    elapsed: 8.7s
[Parallel(n_jobs=-1)]: Done 500 tasks    elapsed: 8.7s
[Parallel(n_jobs=-1)]: Done 504 tasks    elapsed: 8.7s
[Parallel(n_jobs=-1)]: Done 508 tasks    elapsed: 8.7s
[Parallel(n_jobs=-1)]: Done 512 tasks    elapsed: 8.7s
[Parallel(n_jobs=-1)]: Done 516 tasks    elapsed: 8.7s
[Parallel(n_jobs=-1)]: Done 520 tasks    elapsed: 8.8s
[Parallel(n_jobs=-1)]: Done 524 tasks    elapsed: 8.8s
[Parallel(n_jobs=-1)]: Done 528 tasks    elapsed: 8.8s
[Parallel(n_jobs=-1)]: Done 532 tasks    elapsed: 8.8s
[Parallel(n_jobs=-1)]: Done 536 tasks    elapsed: 8.9s
[Parallel(n_jobs=-1)]: Done 540 tasks    elapsed: 8.9s
[Parallel(n_jobs=-1)]: Done 544 tasks    elapsed: 8.9s
[Parallel(n_jobs=-1)]: Done 548 tasks    elapsed: 8.9s
[Parallel(n_jobs=-1)]: Done 552 tasks    elapsed: 8.9s
[Parallel(n_jobs=-1)]: Done 556 tasks    elapsed: 8.9s
[Parallel(n_jobs=-1)]: Done 560 tasks    elapsed: 9.0s
[Parallel(n_jobs=-1)]: Done 564 tasks    elapsed: 9.0s
[Parallel(n_jobs=-1)]: Done 568 tasks    elapsed: 9.0s
[Parallel(n_jobs=-1)]: Done 572 tasks    elapsed: 9.0s
[Parallel(n_jobs=-1)]: Done 576 tasks    elapsed: 9.1s
[Parallel(n_jobs=-1)]: Done 580 tasks    elapsed: 9.1s
[Parallel(n_jobs=-1)]: Done 584 tasks    elapsed: 9.1s
[Parallel(n_jobs=-1)]: Done 588 tasks    elapsed: 9.1s
[Parallel(n_jobs=-1)]: Done 592 tasks    elapsed: 9.1s
[Parallel(n_jobs=-1)]: Done 596 tasks    elapsed: 9.1s
[Parallel(n_jobs=-1)]: Done 600 tasks    elapsed: 9.2s
[Parallel(n_jobs=-1)]: Done 604 tasks    elapsed: 9.2s
[Parallel(n_jobs=-1)]: Done 608 tasks    elapsed: 9.2s
[Parallel(n_jobs=-1)]: Done 612 tasks    elapsed: 9.2s
[Parallel(n_jobs=-1)]: Done 616 tasks    elapsed: 9.2s
[Parallel(n_jobs=-1)]: Done 620 tasks    elapsed: 9.3s
[Parallel(n_jobs=-1)]: Done 624 tasks    elapsed: 9.3s
[Parallel(n_jobs=-1)]: Done 628 tasks    elapsed: 9.3s
[Parallel(n_jobs=-1)]: Done 632 tasks    elapsed: 9.3s
[Parallel(n_jobs=-1)]: Done 636 tasks    elapsed: 9.4s
[Parallel(n_jobs=-1)]: Done 640 tasks    elapsed: 9.4s
[Parallel(n_jobs=-1)]: Done 644 tasks    elapsed: 9.4s
[Parallel(n_jobs=-1)]: Done 648 tasks    elapsed: 9.4s
[Parallel(n_jobs=-1)]: Done 652 tasks    elapsed: 9.4s
[Parallel(n_jobs=-1)]: Done 656 tasks    elapsed: 9.5s
[Parallel(n_jobs=-1)]: Done 660 tasks    elapsed: 9.5s
[Parallel(n_jobs=-1)]: Done 664 tasks    elapsed: 9.5s
[Parallel(n_jobs=-1)]: Done 668 tasks    elapsed: 9.5s
```

```
[Parallel(n_jobs=-1)]: Done 672 tasks | elapsed: 9.6s
[Parallel(n_jobs=-1)]: Done 676 tasks | elapsed: 9.6s
[Parallel(n_jobs=-1)]: Done 680 tasks | elapsed: 9.6s
[Parallel(n_jobs=-1)]: Done 684 tasks | elapsed: 9.7s
[Parallel(n_jobs=-1)]: Done 688 tasks | elapsed: 9.7s
[Parallel(n_jobs=-1)]: Done 692 tasks | elapsed: 9.7s
[Parallel(n_jobs=-1)]: Done 696 tasks | elapsed: 9.7s
[Parallel(n_jobs=-1)]: Done 700 tasks | elapsed: 9.7s
[Parallel(n_jobs=-1)]: Done 704 tasks | elapsed: 9.7s
[Parallel(n_jobs=-1)]: Done 708 tasks | elapsed: 9.8s
[Parallel(n_jobs=-1)]: Done 712 tasks | elapsed: 9.8s
[Parallel(n_jobs=-1)]: Done 716 tasks | elapsed: 9.8s
[Parallel(n_jobs=-1)]: Done 720 tasks | elapsed: 9.9s
[Parallel(n_jobs=-1)]: Done 724 tasks | elapsed: 9.9s
[Parallel(n_jobs=-1)]: Done 728 tasks | elapsed: 9.9s
[Parallel(n_jobs=-1)]: Done 732 tasks | elapsed: 9.9s
[Parallel(n_jobs=-1)]: Done 736 tasks | elapsed: 9.9s
[Parallel(n_jobs=-1)]: Done 740 tasks | elapsed: 10.0s
[Parallel(n_jobs=-1)]: Done 744 tasks | elapsed: 10.0s
[Parallel(n_jobs=-1)]: Done 748 tasks | elapsed: 10.0s
[Parallel(n_jobs=-1)]: Done 752 tasks | elapsed: 10.0s
[Parallel(n_jobs=-1)]: Done 756 tasks | elapsed: 10.1s
[Parallel(n_jobs=-1)]: Done 760 tasks | elapsed: 10.1s
[Parallel(n_jobs=-1)]: Done 764 tasks | elapsed: 10.1s
[Parallel(n_jobs=-1)]: Done 768 tasks | elapsed: 10.1s
[Parallel(n_jobs=-1)]: Done 772 tasks | elapsed: 10.1s
[Parallel(n_jobs=-1)]: Done 776 tasks | elapsed: 10.2s
[Parallel(n_jobs=-1)]: Done 780 tasks | elapsed: 10.2s
[Parallel(n_jobs=-1)]: Done 784 tasks | elapsed: 10.2s
[Parallel(n_jobs=-1)]: Done 788 tasks | elapsed: 10.2s
[Parallel(n_jobs=-1)]: Done 792 tasks | elapsed: 10.3s
[Parallel(n_jobs=-1)]: Done 796 tasks | elapsed: 10.3s
[Parallel(n_jobs=-1)]: Done 800 tasks | elapsed: 10.3s
[Parallel(n_jobs=-1)]: Done 804 tasks | elapsed: 10.4s
[Parallel(n_jobs=-1)]: Done 808 tasks | elapsed: 10.4s
[Parallel(n_jobs=-1)]: Done 812 tasks | elapsed: 10.4s
[Parallel(n_jobs=-1)]: Done 816 tasks | elapsed: 10.4s
[Parallel(n_jobs=-1)]: Done 820 tasks | elapsed: 10.4s
[Parallel(n_jobs=-1)]: Done 824 tasks | elapsed: 10.5s
[Parallel(n_jobs=-1)]: Done 828 tasks | elapsed: 10.5s
[Parallel(n_jobs=-1)]: Done 832 tasks | elapsed: 10.5s
[Parallel(n_jobs=-1)]: Done 836 tasks | elapsed: 10.5s
[Parallel(n_jobs=-1)]: Done 840 tasks | elapsed: 10.5s
[Parallel(n_jobs=-1)]: Done 844 tasks | elapsed: 10.6s
[Parallel(n_jobs=-1)]: Done 848 tasks | elapsed: 10.6s
[Parallel(n_jobs=-1)]: Done 852 tasks | elapsed: 10.6s
[Parallel(n_jobs=-1)]: Done 856 tasks | elapsed: 10.6s
```

```
[Parallel(n_jobs=-1)]: Done 860 tasks | elapsed: 10.6s
[Parallel(n_jobs=-1)]: Done 864 tasks | elapsed: 10.7s
[Parallel(n_jobs=-1)]: Done 868 tasks | elapsed: 10.7s
[Parallel(n_jobs=-1)]: Done 872 tasks | elapsed: 10.7s
[Parallel(n_jobs=-1)]: Done 876 tasks | elapsed: 10.8s
[Parallel(n_jobs=-1)]: Done 880 tasks | elapsed: 10.8s
[Parallel(n_jobs=-1)]: Done 884 tasks | elapsed: 10.8s
[Parallel(n_jobs=-1)]: Done 888 tasks | elapsed: 10.8s
[Parallel(n_jobs=-1)]: Done 892 tasks | elapsed: 10.8s
[Parallel(n_jobs=-1)]: Done 896 tasks | elapsed: 10.9s
[Parallel(n_jobs=-1)]: Done 900 tasks | elapsed: 10.9s
[Parallel(n_jobs=-1)]: Done 904 tasks | elapsed: 10.9s
[Parallel(n_jobs=-1)]: Done 908 tasks | elapsed: 11.0s
[Parallel(n_jobs=-1)]: Done 912 tasks | elapsed: 11.0s
[Parallel(n_jobs=-1)]: Done 916 tasks | elapsed: 11.0s
[Parallel(n_jobs=-1)]: Done 920 tasks | elapsed: 11.0s
[Parallel(n_jobs=-1)]: Done 924 tasks | elapsed: 11.0s
[Parallel(n_jobs=-1)]: Done 928 tasks | elapsed: 11.0s
[Parallel(n_jobs=-1)]: Done 932 tasks | elapsed: 11.1s
[Parallel(n_jobs=-1)]: Done 936 tasks | elapsed: 11.1s
[Parallel(n_jobs=-1)]: Done 940 tasks | elapsed: 11.1s
[Parallel(n_jobs=-1)]: Done 944 tasks | elapsed: 11.1s
[Parallel(n_jobs=-1)]: Done 948 tasks | elapsed: 11.1s
[Parallel(n_jobs=-1)]: Done 952 tasks | elapsed: 11.2s
[Parallel(n_jobs=-1)]: Done 956 tasks | elapsed: 11.2s
[Parallel(n_jobs=-1)]: Done 960 tasks | elapsed: 11.2s
[Parallel(n_jobs=-1)]: Done 964 tasks | elapsed: 11.2s
[Parallel(n_jobs=-1)]: Done 968 tasks | elapsed: 11.3s
[Parallel(n_jobs=-1)]: Done 972 tasks | elapsed: 11.3s
[Parallel(n_jobs=-1)]: Done 976 tasks | elapsed: 11.3s
[Parallel(n_jobs=-1)]: Done 980 tasks | elapsed: 11.3s
[Parallel(n_jobs=-1)]: Done 984 tasks | elapsed: 11.3s
[Parallel(n_jobs=-1)]: Done 988 tasks | elapsed: 11.3s
[Parallel(n_jobs=-1)]: Done 992 tasks | elapsed: 11.4s
[Parallel(n_jobs=-1)]: Done 996 tasks | elapsed: 11.4s
[Parallel(n_jobs=-1)]: Done 1000 tasks | elapsed: 11.4s
[Parallel(n_jobs=-1)]: Done 1004 tasks | elapsed: 11.4s
[Parallel(n_jobs=-1)]: Done 1008 tasks | elapsed: 11.4s
[Parallel(n_jobs=-1)]: Done 1012 tasks | elapsed: 11.4s
[Parallel(n_jobs=-1)]: Done 1016 tasks | elapsed: 11.5s
[Parallel(n_jobs=-1)]: Done 1020 tasks | elapsed: 11.5s
[Parallel(n_jobs=-1)]: Done 1024 tasks | elapsed: 11.5s
[Parallel(n_jobs=-1)]: Done 1028 tasks | elapsed: 11.5s
[Parallel(n_jobs=-1)]: Done 1032 tasks | elapsed: 11.6s
[Parallel(n_jobs=-1)]: Done 1036 tasks | elapsed: 11.6s
[Parallel(n_jobs=-1)]: Done 1040 tasks | elapsed: 11.6s
[Parallel(n_jobs=-1)]: Done 1044 tasks | elapsed: 11.6s
```

[Parallel(n_jobs=-1)]: Done 1048 tasks	elapsed: 11.6s
[Parallel(n_jobs=-1)]: Done 1052 tasks	elapsed: 11.7s
[Parallel(n_jobs=-1)]: Done 1056 tasks	elapsed: 11.7s
[Parallel(n_jobs=-1)]: Done 1060 tasks	elapsed: 11.7s
[Parallel(n_jobs=-1)]: Done 1064 tasks	elapsed: 11.7s
[Parallel(n_jobs=-1)]: Done 1068 tasks	elapsed: 11.7s
[Parallel(n_jobs=-1)]: Done 1072 tasks	elapsed: 11.7s
[Parallel(n_jobs=-1)]: Done 1076 tasks	elapsed: 11.8s
[Parallel(n_jobs=-1)]: Done 1080 tasks	elapsed: 11.8s
[Parallel(n_jobs=-1)]: Done 1084 tasks	elapsed: 11.8s
[Parallel(n_jobs=-1)]: Done 1088 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1092 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1096 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1100 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1104 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1108 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1112 tasks	elapsed: 11.9s
[Parallel(n_jobs=-1)]: Done 1116 tasks	elapsed: 12.0s
[Parallel(n_jobs=-1)]: Done 1120 tasks	elapsed: 12.0s
[Parallel(n_jobs=-1)]: Done 1124 tasks	elapsed: 12.0s
[Parallel(n_jobs=-1)]: Done 1128 tasks	elapsed: 12.0s
[Parallel(n_jobs=-1)]: Done 1132 tasks	elapsed: 12.1s
[Parallel(n_jobs=-1)]: Done 1136 tasks	elapsed: 12.1s
[Parallel(n_jobs=-1)]: Done 1140 tasks	elapsed: 12.1s
[Parallel(n_jobs=-1)]: Done 1144 tasks	elapsed: 12.1s
[Parallel(n_jobs=-1)]: Done 1148 tasks	elapsed: 12.1s
[Parallel(n_jobs=-1)]: Done 1152 tasks	elapsed: 12.2s
[Parallel(n_jobs=-1)]: Done 1156 tasks	elapsed: 12.2s
[Parallel(n_jobs=-1)]: Done 1160 tasks	elapsed: 12.2s
[Parallel(n_jobs=-1)]: Done 1164 tasks	elapsed: 12.2s
[Parallel(n_jobs=-1)]: Done 1168 tasks	elapsed: 12.2s
[Parallel(n_jobs=-1)]: Done 1172 tasks	elapsed: 12.2s
[Parallel(n_jobs=-1)]: Done 1176 tasks	elapsed: 12.3s
[Parallel(n_jobs=-1)]: Done 1180 tasks	elapsed: 12.3s
[Parallel(n_jobs=-1)]: Done 1184 tasks	elapsed: 12.4s
[Parallel(n_jobs=-1)]: Done 1188 tasks	elapsed: 12.4s
[Parallel(n_jobs=-1)]: Done 1192 tasks	elapsed: 12.4s
[Parallel(n_jobs=-1)]: Done 1196 tasks	elapsed: 12.4s
[Parallel(n_jobs=-1)]: Done 1200 tasks	elapsed: 12.4s
[Parallel(n_jobs=-1)]: Done 1204 tasks	elapsed: 12.4s
[Parallel(n_jobs=-1)]: Done 1208 tasks	elapsed: 12.5s
[Parallel(n_jobs=-1)]: Done 1212 tasks	elapsed: 12.5s
[Parallel(n_jobs=-1)]: Done 1216 tasks	elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1220 tasks	elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1224 tasks	elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1228 tasks	elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1232 tasks	elapsed: 12.6s

```
[Parallel(n_jobs=-1)]: Done 1236 tasks | elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1240 tasks | elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1244 tasks | elapsed: 12.6s
[Parallel(n_jobs=-1)]: Done 1248 tasks | elapsed: 12.7s
[Parallel(n_jobs=-1)]: Done 1252 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1256 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1260 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1264 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1268 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1272 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1276 tasks | elapsed: 12.8s
[Parallel(n_jobs=-1)]: Done 1280 tasks | elapsed: 12.9s
[Parallel(n_jobs=-1)]: Done 1284 tasks | elapsed: 13.0s
[Parallel(n_jobs=-1)]: Done 1288 tasks | elapsed: 13.0s
[Parallel(n_jobs=-1)]: Done 1292 tasks | elapsed: 13.0s
[Parallel(n_jobs=-1)]: Done 1296 tasks | elapsed: 13.0s
[Parallel(n_jobs=-1)]: Done 1300 tasks | elapsed: 13.0s
[Parallel(n_jobs=-1)]: Done 1304 tasks | elapsed: 13.0s
[Parallel(n_jobs=-1)]: Done 1308 tasks | elapsed: 13.1s
[Parallel(n_jobs=-1)]: Done 1312 tasks | elapsed: 13.1s
[Parallel(n_jobs=-1)]: Done 1316 tasks | elapsed: 13.1s
[Parallel(n_jobs=-1)]: Done 1320 tasks | elapsed: 13.2s
[Parallel(n_jobs=-1)]: Done 1324 tasks | elapsed: 13.2s
[Parallel(n_jobs=-1)]: Done 1328 tasks | elapsed: 13.2s
[Parallel(n_jobs=-1)]: Done 1332 tasks | elapsed: 13.2s
[Parallel(n_jobs=-1)]: Done 1336 tasks | elapsed: 13.2s
[Parallel(n_jobs=-1)]: Done 1340 tasks | elapsed: 13.3s
[Parallel(n_jobs=-1)]: Done 1344 tasks | elapsed: 13.3s
[Parallel(n_jobs=-1)]: Done 1348 tasks | elapsed: 13.3s
[Parallel(n_jobs=-1)]: Done 1352 tasks | elapsed: 13.4s
[Parallel(n_jobs=-1)]: Done 1356 tasks | elapsed: 13.4s
[Parallel(n_jobs=-1)]: Done 1360 tasks | elapsed: 13.4s
[Parallel(n_jobs=-1)]: Done 1364 tasks | elapsed: 13.4s
[Parallel(n_jobs=-1)]: Done 1368 tasks | elapsed: 13.4s
[Parallel(n_jobs=-1)]: Done 1372 tasks | elapsed: 13.4s
[Parallel(n_jobs=-1)]: Done 1376 tasks | elapsed: 13.5s
[Parallel(n_jobs=-1)]: Done 1380 tasks | elapsed: 13.5s
[Parallel(n_jobs=-1)]: Done 1384 tasks | elapsed: 13.5s
[Parallel(n_jobs=-1)]: Done 1388 tasks | elapsed: 13.6s
[Parallel(n_jobs=-1)]: Done 1392 tasks | elapsed: 13.6s
[Parallel(n_jobs=-1)]: Done 1396 tasks | elapsed: 13.6s
[Parallel(n_jobs=-1)]: Done 1400 tasks | elapsed: 13.6s
[Parallel(n_jobs=-1)]: Done 1404 tasks | elapsed: 13.7s
[Parallel(n_jobs=-1)]: Done 1408 tasks | elapsed: 13.7s
[Parallel(n_jobs=-1)]: Done 1412 tasks | elapsed: 13.7s
[Parallel(n_jobs=-1)]: Done 1416 tasks | elapsed: 13.7s
[Parallel(n_jobs=-1)]: Done 1420 tasks | elapsed: 13.7s
```

[Parallel(n_jobs=-1)]: Done 1424 tasks	elapsed: 13.8s
[Parallel(n_jobs=-1)]: Done 1428 tasks	elapsed: 13.8s
[Parallel(n_jobs=-1)]: Done 1432 tasks	elapsed: 13.8s
[Parallel(n_jobs=-1)]: Done 1436 tasks	elapsed: 13.8s
[Parallel(n_jobs=-1)]: Done 1440 tasks	elapsed: 13.9s
[Parallel(n_jobs=-1)]: Done 1444 tasks	elapsed: 13.9s
[Parallel(n_jobs=-1)]: Done 1448 tasks	elapsed: 13.9s
[Parallel(n_jobs=-1)]: Done 1452 tasks	elapsed: 13.9s
[Parallel(n_jobs=-1)]: Done 1456 tasks	elapsed: 13.9s
[Parallel(n_jobs=-1)]: Done 1460 tasks	elapsed: 13.9s
[Parallel(n_jobs=-1)]: Done 1464 tasks	elapsed: 14.0s
[Parallel(n_jobs=-1)]: Done 1468 tasks	elapsed: 14.0s
[Parallel(n_jobs=-1)]: Done 1472 tasks	elapsed: 14.0s
[Parallel(n_jobs=-1)]: Done 1476 tasks	elapsed: 14.0s
[Parallel(n_jobs=-1)]: Done 1480 tasks	elapsed: 14.1s
[Parallel(n_jobs=-1)]: Done 1484 tasks	elapsed: 14.1s
[Parallel(n_jobs=-1)]: Done 1488 tasks	elapsed: 14.1s
[Parallel(n_jobs=-1)]: Done 1492 tasks	elapsed: 14.1s
[Parallel(n_jobs=-1)]: Done 1496 tasks	elapsed: 14.1s
[Parallel(n_jobs=-1)]: Done 1500 tasks	elapsed: 14.2s
[Parallel(n_jobs=-1)]: Done 1504 tasks	elapsed: 14.2s
[Parallel(n_jobs=-1)]: Done 1508 tasks	elapsed: 14.2s
[Parallel(n_jobs=-1)]: Done 1512 tasks	elapsed: 14.3s
[Parallel(n_jobs=-1)]: Done 1516 tasks	elapsed: 14.3s
[Parallel(n_jobs=-1)]: Done 1520 tasks	elapsed: 14.3s
[Parallel(n_jobs=-1)]: Done 1524 tasks	elapsed: 14.3s
[Parallel(n_jobs=-1)]: Done 1528 tasks	elapsed: 14.3s
[Parallel(n_jobs=-1)]: Done 1532 tasks	elapsed: 14.4s
[Parallel(n_jobs=-1)]: Done 1536 tasks	elapsed: 14.4s
[Parallel(n_jobs=-1)]: Done 1540 tasks	elapsed: 14.4s
[Parallel(n_jobs=-1)]: Done 1544 tasks	elapsed: 14.4s
[Parallel(n_jobs=-1)]: Done 1548 tasks	elapsed: 14.4s
[Parallel(n_jobs=-1)]: Done 1552 tasks	elapsed: 14.5s
[Parallel(n_jobs=-1)]: Done 1556 tasks	elapsed: 14.5s
[Parallel(n_jobs=-1)]: Done 1560 tasks	elapsed: 14.5s
[Parallel(n_jobs=-1)]: Done 1564 tasks	elapsed: 14.6s
[Parallel(n_jobs=-1)]: Done 1568 tasks	elapsed: 14.6s
[Parallel(n_jobs=-1)]: Done 1572 tasks	elapsed: 14.6s
[Parallel(n_jobs=-1)]: Done 1576 tasks	elapsed: 14.6s
[Parallel(n_jobs=-1)]: Done 1580 tasks	elapsed: 14.6s
[Parallel(n_jobs=-1)]: Done 1584 tasks	elapsed: 14.7s
[Parallel(n_jobs=-1)]: Done 1588 tasks	elapsed: 14.7s
[Parallel(n_jobs=-1)]: Done 1592 tasks	elapsed: 14.7s
[Parallel(n_jobs=-1)]: Done 1596 tasks	elapsed: 14.7s
[Parallel(n_jobs=-1)]: Done 1600 tasks	elapsed: 14.8s
[Parallel(n_jobs=-1)]: Done 1604 tasks	elapsed: 14.8s
[Parallel(n_jobs=-1)]: Done 1608 tasks	elapsed: 14.8s

```
[Parallel(n_jobs=-1)]: Done 1612 tasks | elapsed: 14.8s
[Parallel(n_jobs=-1)]: Done 1616 tasks | elapsed: 14.9s
[Parallel(n_jobs=-1)]: Done 1620 tasks | elapsed: 14.9s
[Parallel(n_jobs=-1)]: Done 1624 tasks | elapsed: 15.0s
[Parallel(n_jobs=-1)]: Done 1628 tasks | elapsed: 15.0s
[Parallel(n_jobs=-1)]: Done 1632 tasks | elapsed: 15.0s
[Parallel(n_jobs=-1)]: Done 1636 tasks | elapsed: 15.0s
[Parallel(n_jobs=-1)]: Done 1640 tasks | elapsed: 15.0s
[Parallel(n_jobs=-1)]: Done 1644 tasks | elapsed: 15.0s
[Parallel(n_jobs=-1)]: Done 1648 tasks | elapsed: 15.1s
[Parallel(n_jobs=-1)]: Done 1652 tasks | elapsed: 15.1s
[Parallel(n_jobs=-1)]: Done 1656 tasks | elapsed: 15.1s
[Parallel(n_jobs=-1)]: Done 1660 tasks | elapsed: 15.2s
[Parallel(n_jobs=-1)]: Done 1664 tasks | elapsed: 15.2s
[Parallel(n_jobs=-1)]: Done 1668 tasks | elapsed: 15.2s
[Parallel(n_jobs=-1)]: Done 1672 tasks | elapsed: 15.2s
[Parallel(n_jobs=-1)]: Done 1676 tasks | elapsed: 15.3s
[Parallel(n_jobs=-1)]: Done 1680 tasks | elapsed: 15.3s
[Parallel(n_jobs=-1)]: Done 1684 tasks | elapsed: 15.3s
[Parallel(n_jobs=-1)]: Done 1688 tasks | elapsed: 15.3s
[Parallel(n_jobs=-1)]: Done 1692 tasks | elapsed: 15.3s
[Parallel(n_jobs=-1)]: Done 1696 tasks | elapsed: 15.4s
[Parallel(n_jobs=-1)]: Done 1697 tasks | elapsed: 15.4s
[Parallel(n_jobs=-1)]: Done 1701 tasks | elapsed: 15.4s
[Parallel(n_jobs=-1)]: Done 1705 tasks | elapsed: 15.4s
[Parallel(n_jobs=-1)]: Done 1706 tasks | elapsed: 15.4s
[Parallel(n_jobs=-1)]: Done 1707 tasks | elapsed: 15.4s
[Parallel(n_jobs=-1)]: Done 1708 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1712 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1716 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1720 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1721 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1722 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1723 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1724 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1725 tasks | elapsed: 15.5s
[Parallel(n_jobs=-1)]: Done 1728 out of 1743 | elapsed: 15.6s remaining: 0.0s
[Parallel(n_jobs=-1)]: Done 1743 out of 1743 | elapsed: 15.6s finished
```

```
Out[30]: GridSearchCV(cv=7, estimator=KNeighborsClassifier(), n_jobs=-1,
                      param_grid={'n_neighbors': array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13,
 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26,
 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39,
 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52,
 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65,
 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78,
 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89,
 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182,
```

```
183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195,  
196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208,  
209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221,  
222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234,  
235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247,  
248, 249]}},  
scoring='accuracy', verbose=20)
```

```
In [31]: knn_gscv.best_params_  
best_mod = knn_gscv.best_estimator_
```

```
In [32]: knn_gscv.best_score_
```

```
Out[32]: 0.8948287067746756
```

```
In [33]: from sklearn.metrics import accuracy_score  
  
y_pred = best_mod.predict(X_test_subset)  
print(accuracy_score(y_test,y_pred))
```

```
0.9116022099447514
```

```
In [ ]:
```