K - Nearest Neighbours Classification. ¶

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Notes:

- For a two class problem, we choose, k = odd.
- k must not be a multiple of the number of classes.
- Low values of k like k = 1 or k = 2 may be subjected to outliers.

Manual Illustration.

In [82]:
```
k = 5
```

Defining the Euclidean distance for three independent featu feature.

In [6]:
```
import numpy as np
def distance(arr1, arr2):
    return np.sqrt(((arr1 - arr2)**2).sum())
```

Defining the dataframe.

In [13]:

```
import pandas as pd
a = np.random.randint(0,200, size = (10,3))
b = np.random.randint(0,2, size = (10,1))
f_names = ['f1','f2','f3','f4']
dd = pd.DataFrame(np.concatenate((a,b), axis = 1), columns = f_names)
dd
```

	f1	f2	f3	f4
0	31	34	131	1
1	62	165	28	1
2	157	120	80	1
3	160	89	17	1
4	100	35	36	0
5	14	141	141	1
6	44	41	21	0
7	5	162	24	1
8	177	154	130	1
9	40	75	86	1

In [22]:
```
x = dd.iloc[:,[0,1,2]].values
y = dd.iloc[:, 3].values
print(x, '\n\n')
print(y.reshape(-1,1))
```

```
[[ 31  34 131]
 [ 62 165  28]
 [157 120  80]
 [160  89  17]
 [100  35  36]
 [ 14 141 141]
 [ 44  41  21]
 [  5 162  24]
 [177 154 130]
 [ 40  75  86]]


[[1]
 [1]
 [1]
 [1]
 [0]
 [1]
 [0]
 [1]
 [1]
 [1]]
```

New tuple: (65,23,45)

In [33]:
```
t = np.array([65,23,45])
```

Finding the Euclidean distances from each tuple in the train tuple (unknown).

In [83]:
```
dd['distances'] = [distance(x[ii],t) for ii in range(x.shape[0])]
dd
```

	f1	f2	f3	f4	distances
0	31	34	131	1	137.437258
1	62	165	28	1	177.048016
2	157	120	80	1	211.513593
3	160	89	17	1	182.430809
4	100	35	36	0	110.372098
5	14	141	141	1	198.416229
6	44	41	21	0	62.040309
7	5	162	24	1	162.683742
8	177	154	130	1	266.507036
9	40	75	86	1	119.256027

In [64]:
```
yy = dd[['f4','distances' ]]
```

In [65]:
```
yyy = yy.groupby(['distances']).mean().head(k)
yyy
```

	f4
distances	
62.040309	0
110.372098	0
119.256027	1
137.437258	1
162.683742	1

In [78]:
```
m = yyy['f4'].value_counts()
m
```

```
1    3
0    2
Name: f4, dtype: int64
```

In [81]:
```
if m[1]>m[0]:
    print(1)
elif m[1]<m[0]:
    print(0)
```

```
1
```

Use Case.

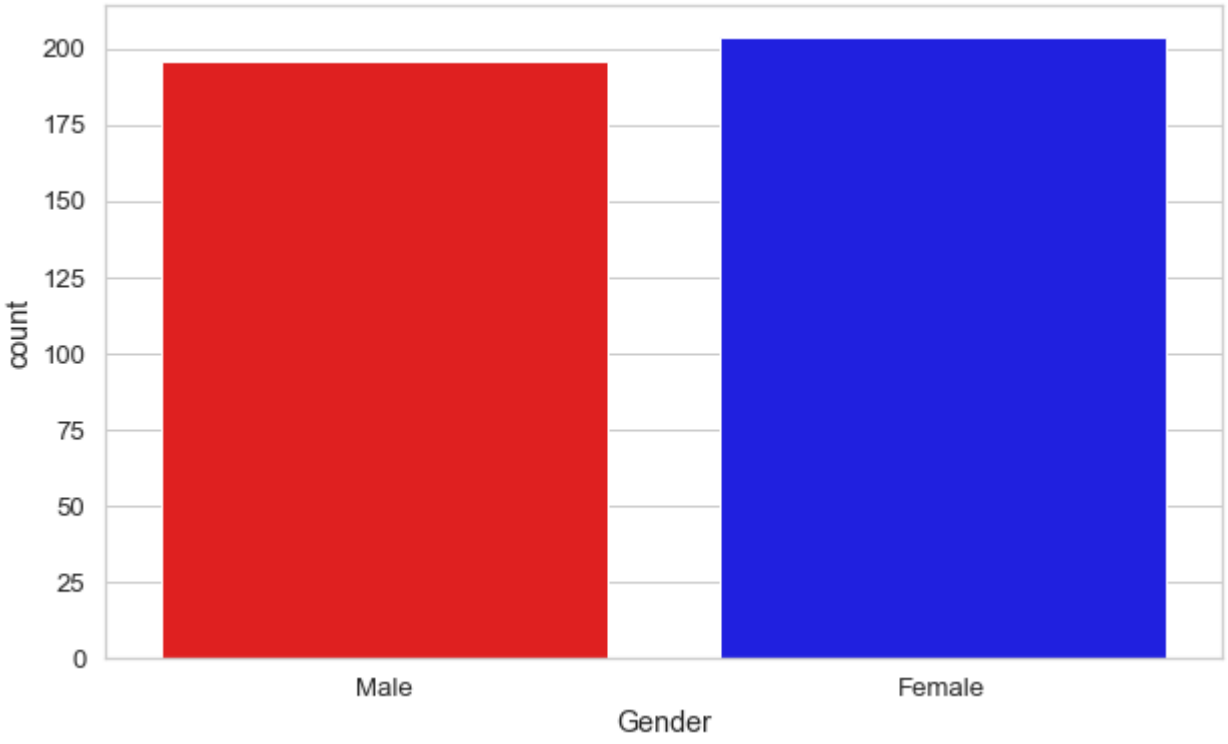
In [84]:
```
### Importing the libraries.

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import os

os.chdir(r'C:\Users\acer\Desktop\P14-Machine-Learning-AZ-Template-Folder\Machine

## Getting the dataset.

df = pd.read_csv('Social_Network_Ads.csv')
df.head()
```

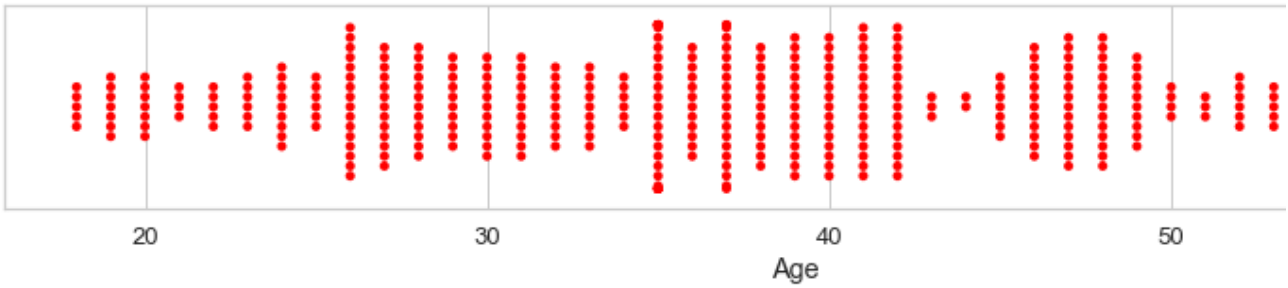
	User ID	Gender	Age	EstimatedSalary	Purchased
0	15624510	Male	19	19000	0
1	15810944	Male	35	20000	0
2	15668575	Female	26	43000	0
3	15603246	Female	27	57000	0
4	15804002	Male	19	76000	0

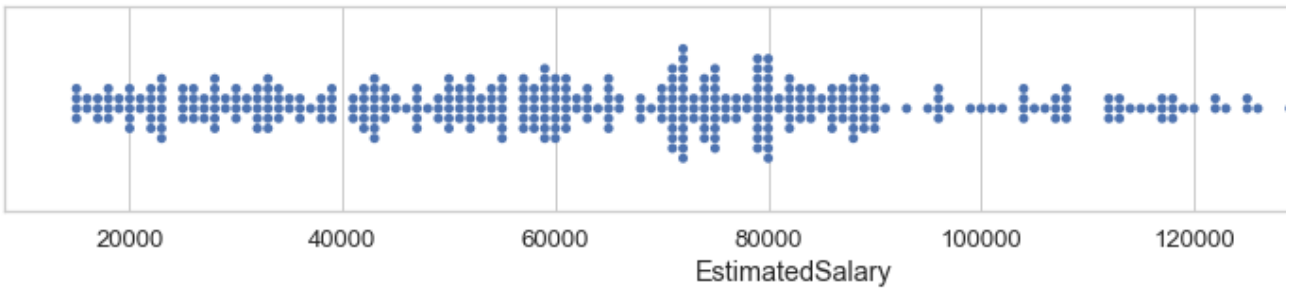
Data Visualization.

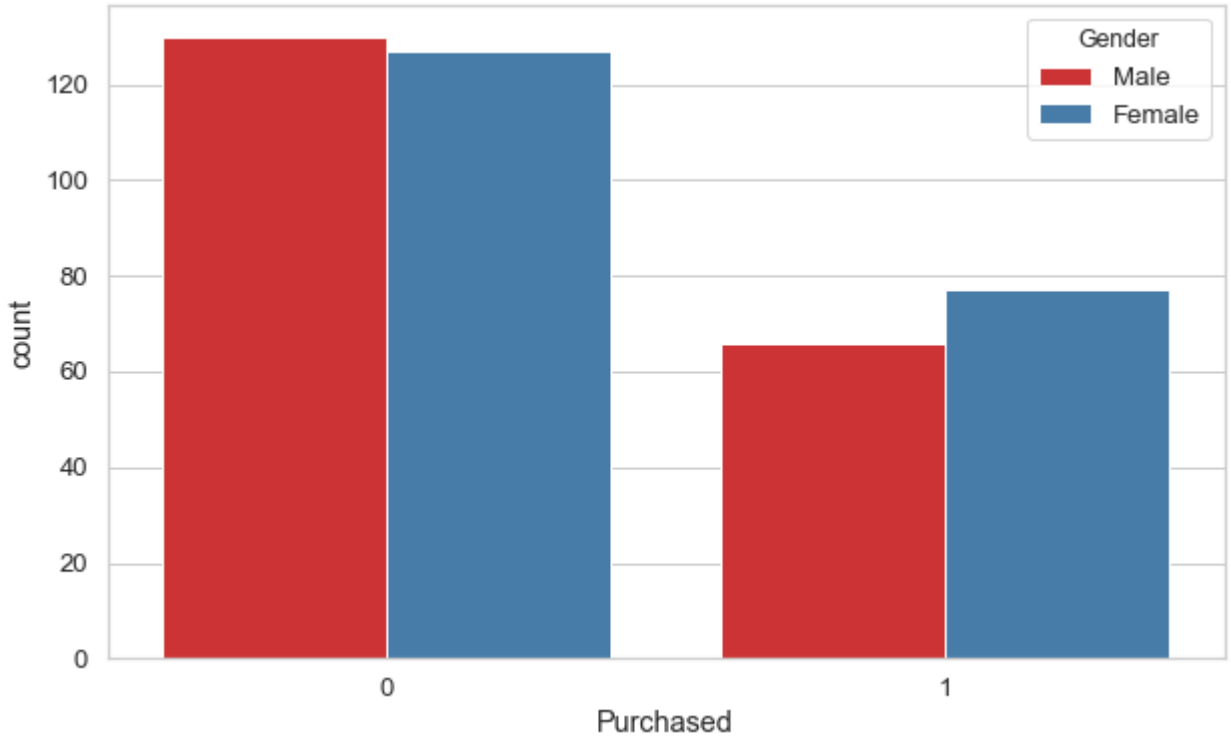
In [88]:

```
plt.figure(figsize = (10,6))
sns.set(style = 'whitegrid', font_scale = 1.2)

sns.countplot(df.Gender, palette = ['red','blue'])
plt.show()

plt.figure(figsize = (15,2))
sns.set(style = 'whitegrid', font_scale = 1.2)

sns.swarmplot(df.Age, color = 'red')
plt.show()

plt.figure(figsize = (15,2))
sns.set(style = 'whitegrid', font_scale = 1.2)

sns.swarmplot(df.EstimatedSalary)
plt.show()

plt.figure(figsize = (10,6))
sns.set(style = 'whitegrid', font_scale = 1.2)

sns.countplot(df.Purchased, hue = df.Gender, palette = 'Set1')
plt.show()
```

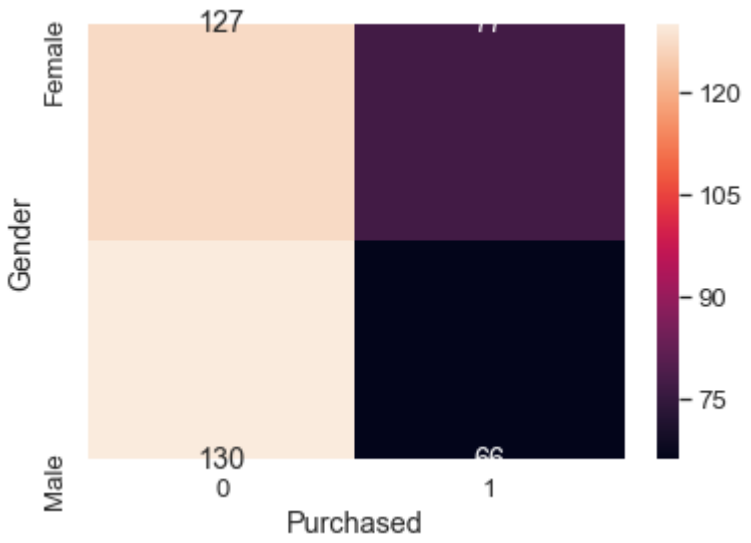

200
175
150
125
100
75
50
25
0
count
Male
Female
Gender


20
30
40
50
Age


20000
40000
60000
80000
100000
120000
EstimatedSalary



In [98]:
```
p = pd.crosstab(df.Gender, df.Purchased)
sns.heatmap(p, annot = True, fmt = '.0f')
plt.show()
```



Creating dependent and independent variables.

In [99]:
```
X = df.iloc[:, [2,3]].values
y = df.iloc[:,-1].values

### Train Test Split.

from sklearn.model_selection import train_test_split
X_train,X_test, y_train, y_test = train_test_split(X,y, test_size = 0.25, random_

### Scaling the data.

from sklearn.preprocessing import StandardScaler as SScale
sc = SScale()
X_train = sc.fit_transform(X_train)
X_test = sc.fit_transform(X_test)
```

Fitting the training data into the classifier.

In [102]:
```
from sklearn.neighbors import KNeighborsClassifier as KNN
```

In [103]:
```
classifier = KNN(n_neighbors = 5, metric = 'minkowski', p = 2)
# The default metric is Minkowski and with p = 2, is equivalent to the Standard E
# When p = 1, it is equivalent to using Manhattan distance.
```

In [104]:
```
classifier.fit(X_train, y_train)
```

```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=5, p=2,
                     weights='uniform')
```

Making predictions.

In [107]:
```
predictions = classifier.predict(X_test)
predictions
```

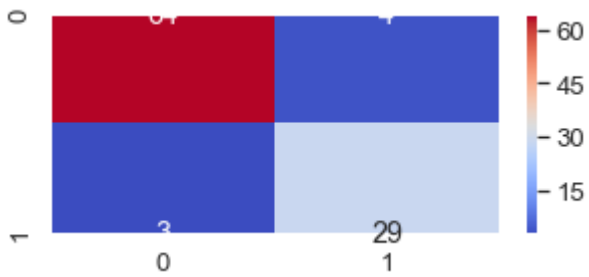
```
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1,
       0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
       1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1,
       0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1,
       1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1], dtype=int64)
```

Confusion Matrix.

In [108]:
```
from sklearn.metrics import confusion_matrix as CM

cm = CM(y_test, predictions)
cm
```

```
array([[64,  4],
       [ 3, 29]], dtype=int64)
```

In [109]:
```
plt.figure(figsize = (5,2))
sns.set(style = 'whitegrid', font_scale = 1.2)

sns.heatmap(cm, annot = True, fmt = 'd', cmap ='coolwarm')
plt.show()
```



The classifier has made 7 incorrect predictions.

Classification Report:

In [110]:
```
from sklearn.metrics import classification_report as CR

print(CR(y_test, predictions))
```

```
              precision    recall  f1-score   support

           0       0.96      0.94      0.95        68
           1       0.88      0.91      0.89        32

    accuracy                           0.93       100
   macro avg       0.92      0.92      0.92       100
weighted avg       0.93      0.93      0.93       100
```

Interpretation:

- Precision for 0:
  - If the item is not purchased, the classifier will predict it accurately 96% of th
- Precision for 1:
  - If the item is purchased, the classifier will predict it accurately 88% of the ti
- Recall for 0:
  - 94% of all the non-purchasers are correctly predicted by the classifier as n
- Recall for 1:
  - 91% of all the purchasers are correctly predicted by the classifier as purcha

Visualising the Training set results.

In [113]:
```
plt.figure(figsize = (10,8))
sns.set(style = 'whitegrid', font_scale = 1.2)

from matplotlib.colors import ListedColormap
X_set, y_set = X_train, y_train
X1, X2 = np.meshgrid(np.arange(start = X_set[:, 0].min() - 1, stop = X_set[:, 0].
                     np.arange(start = X_set[:, 1].min() - 1, stop = X_set[:, 1].
plt.contourf(X1, X2, classifier.predict(np.array([X1.ravel(), X2.ravel()]).T).res
             alpha = 0.75, cmap = ListedColormap(('lightyellow', 'blue')))
plt.xlim(X1.min(), X1.max())
plt.ylim(X2.min(), X2.max())
for i, j in enumerate(np.unique(y_set)):
    plt.scatter(X_set[y_set == j, 0], X_set[y_set == j, 1],
                c = ListedColormap(('purple', 'black'))(i), label = j, s = 15)
plt.title('Classifier (Training set)')
plt.xlabel('Age')
plt.ylabel('Estimated Salary')
plt.legend()
plt.show()
```

```
'c' argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping
engths matches with 'x' & 'y'.  Please use a 2-D array with a single row if you really want to specify t
oints.
'c' argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping
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oints.
```

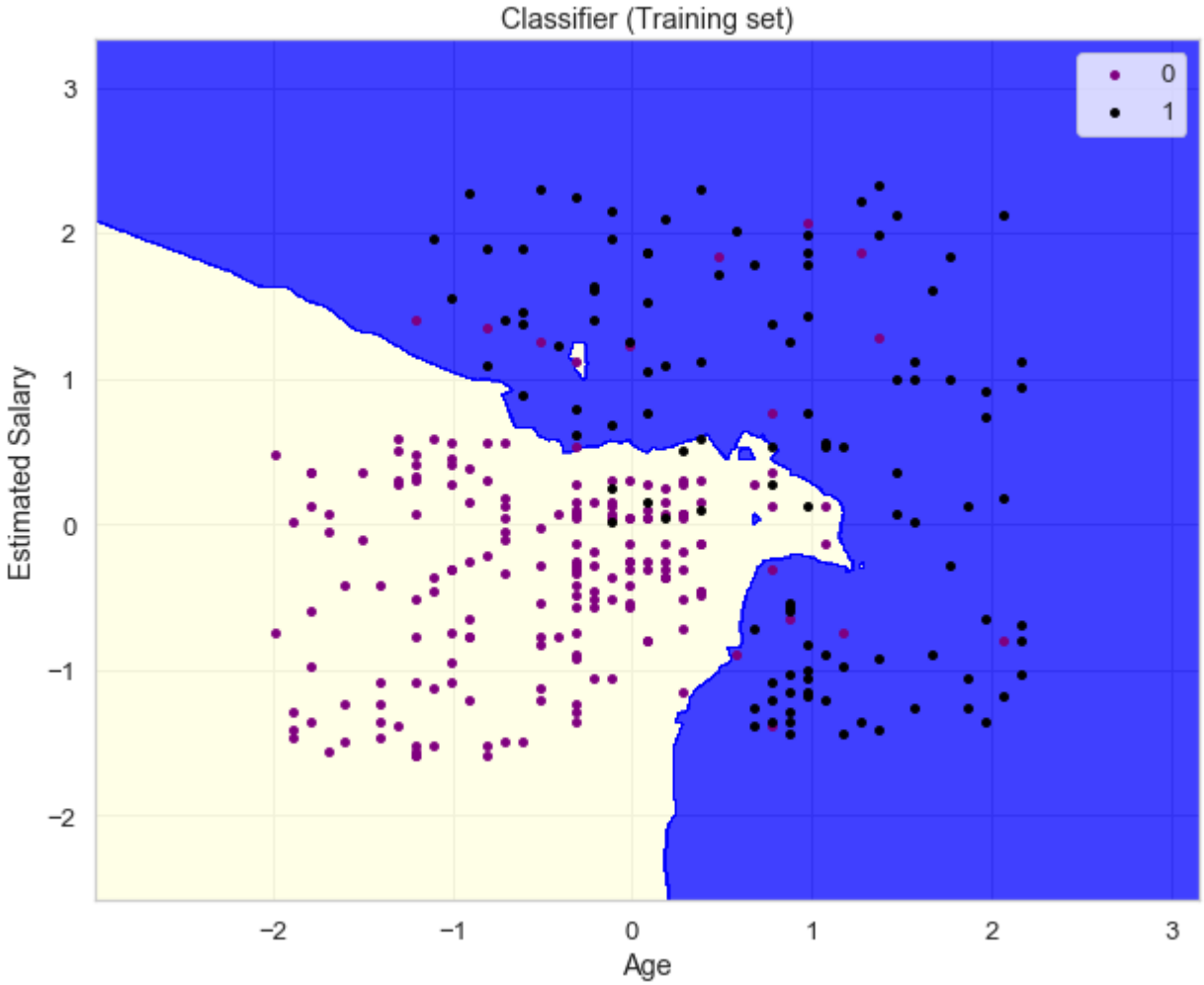

Visualising the Testing set results.

In [112]:

```
plt.figure(figsize = (10,8))
sns.set(style = 'whitegrid', font_scale = 1.2)

from matplotlib.colors import ListedColormap
X_set, y_set = X_test, y_test
X1, X2 = np.meshgrid(np.arange(start = X_set[:, 0].min() - 1, stop = X_set[:, 0].
                     np.arange(start = X_set[:, 1].min() - 1, stop = X_set[:, 1].
plt.contourf(X1, X2, classifier.predict(np.array([X1.ravel(), X2.ravel()]).T).res
             alpha = 0.75, cmap = ListedColormap(('white', 'black')))
plt.xlim(X1.min(), X1.max())
plt.ylim(X2.min(), X2.max())
for i, j in enumerate(np.unique(y_set)):
    plt.scatter(X_set[y_set == j, 0], X_set[y_set == j, 1],
                c = ListedColormap(('red', 'black'))(i), label = j, s = 15)
plt.title('Classifier (Test set)')
plt.xlabel('Age')
plt.ylabel('Estimated Salary')
plt.legend()
plt.show()
```

```
'c' argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping
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```
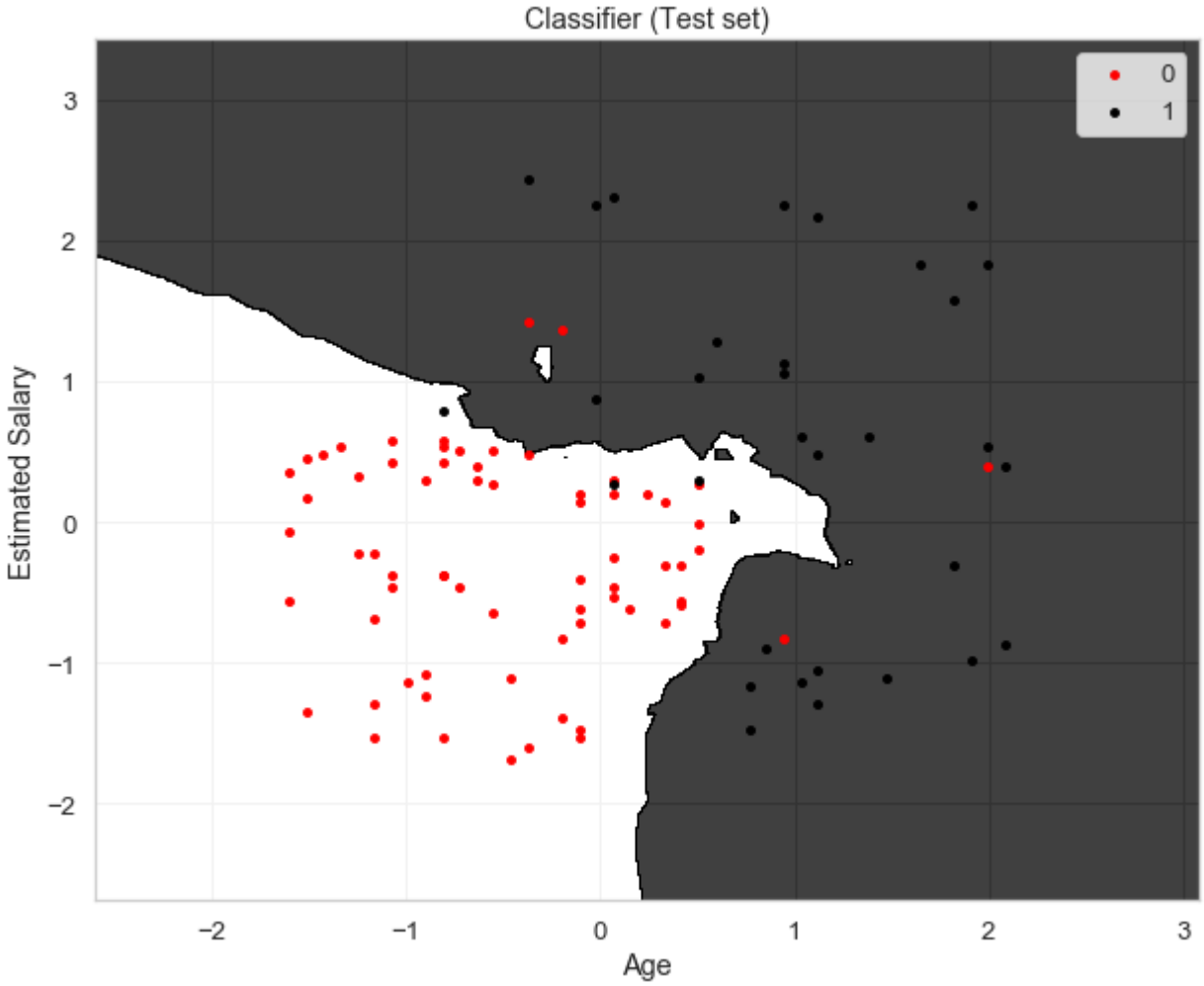



Optimal value for k.

- There is no strict way of finding the optimal value of k.
- We test it using loops and create confusion matrices and classification reports.

Fitting the training data into the classifier.

In [131]:

```
from sklearn.neighbors import KNeighborsClassifier as KNN
from sklearn.metrics import confusion_matrix as CM
from sklearn.metrics import accuracy_score as accScore

for ii in (range(1,82,8)):

    classifier = KNN(n_neighbors = ii, metric = 'minkowski', p = 2)
    # The default metric is Minkowski and with p = 2, is equivalent to the Standa
    # When p = 1, it is equivalent to using Manhattan distance.

    classifier.fit(X_train, y_train)
    ### Making predictions.

    predictions = classifier.predict(X_test)
    predictions

    print('For k = ', ii)

    ## Confusion Matrix.
    cm = CM(y_test, predictions)
    print('\n', cm, '\n')

    # Accuracy Score.

    #sklearn.metrics.accuracy_score(y_true, y_pred, normalize=True, sample_weight

    print((accScore(y_test, predictions)) * 100)
    print('\n')
```

```
For k =  1

 [[61  7]
 [ 5 27]]

88.0


For k =  9

 [[64  4]
 [ 3 29]]
```

```
93.0


For k =  17

 [[64  4]
 [ 3 29]]

93.0


For k =  25

 [[64  4]
 [ 3 29]]

93.0


For k =  33

 [[64  4]
 [ 3 29]]

93.0


For k =  41

 [[64  4]
 [ 4 28]]

92.0


For k =  49

 [[64  4]
 [ 4 28]]

92.0


For k =  57

 [[64  4]
 [ 6 26]]

90.0


For k =  65

 [[64  4]
 [ 7 25]]

89.0
```

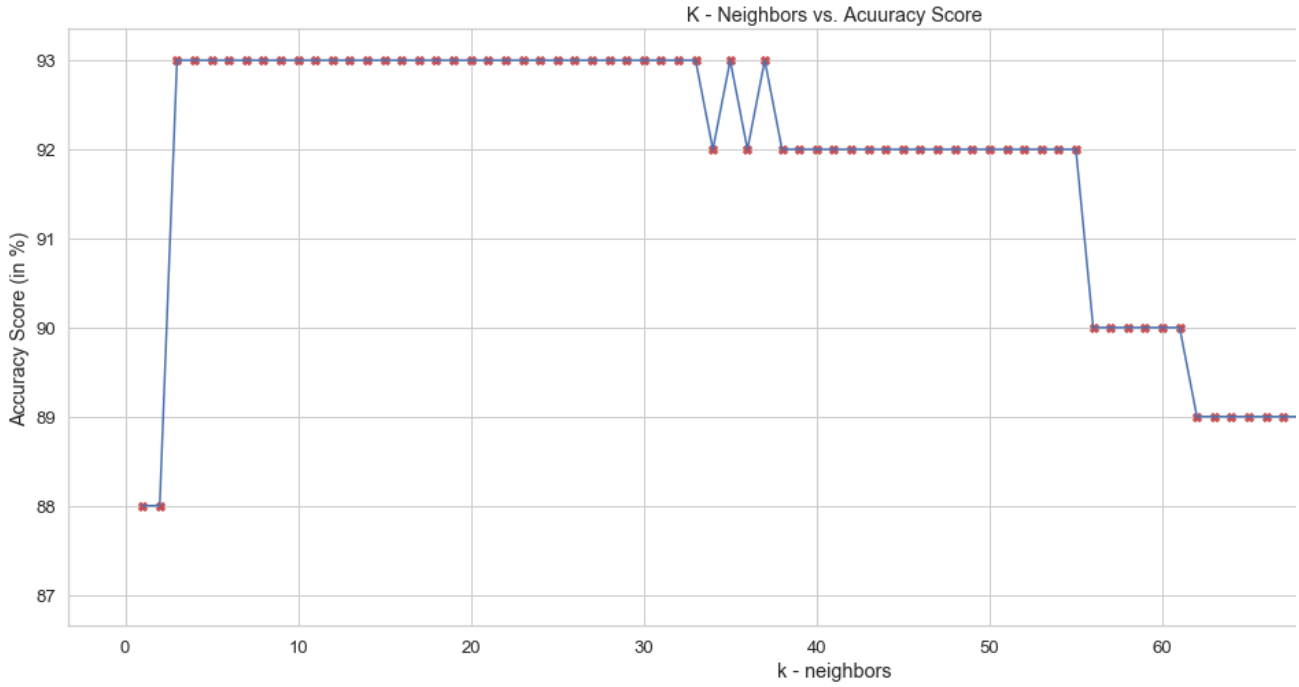
```
For k =  73

 [[64  4]
 [ 8 24]]

88.0


For k =  81

 [[65  3]
 [10 22]]

87.0
```

There is a general pattern that the accuracy score starts from minimum and reache decreases again as the value of k is increased.

Visualizing the same in a plot.

In [151]:

```
# Setting up a dictionary to store the values.
from sklearn.neighbors import KNeighborsClassifier as KNN
from sklearn.metrics import confusion_matrix as CM
from sklearn.metrics import accuracy_score as accScore

acc_scores = dict()
for ii in (range(1,82)):

    classifier = KNN(n_neighbors = ii, metric = 'minkowski', p = 2)
    classifier.fit(X_train, y_train)
    predictions = classifier.predict(X_test)

    # Accuracy Score.
    acc_scores[ii] = (accScore(y_test, predictions)) * 100

# Setting up the plot.
plt.figure(figsize = (20,8))
sns.set(style = 'whitegrid', font_scale = 1.2)

plt.plot(list(acc_scores.keys()), list(acc_scores.values()))
plt.scatter(list(acc_scores.keys()), list(acc_scores.values()), marker = 'X', col
plt.xlabel('k - neighbors')
plt.ylabel('Accuracy Score (in %)')
plt.title('K - Neighbors vs. Acuuracy Score')
plt.show()
```


K - Neighbors vs. Acuuracy Score
Accuracy Score (in %)
93
92
91
90
89
88
87
0
10
20
30
40
50
60
k - neighbors

The End.