Heart-Failure Prediction with machine learning

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Introduction

Heart diseases has increased due to smoking, lack of physical activity and other reasons which put pressure on the heart. Heart failure occurs when the heart cannot pump enough blood to meet the needs of the body. Machine learning can predict patients survival from their data by simulating them and important features can help in survival.

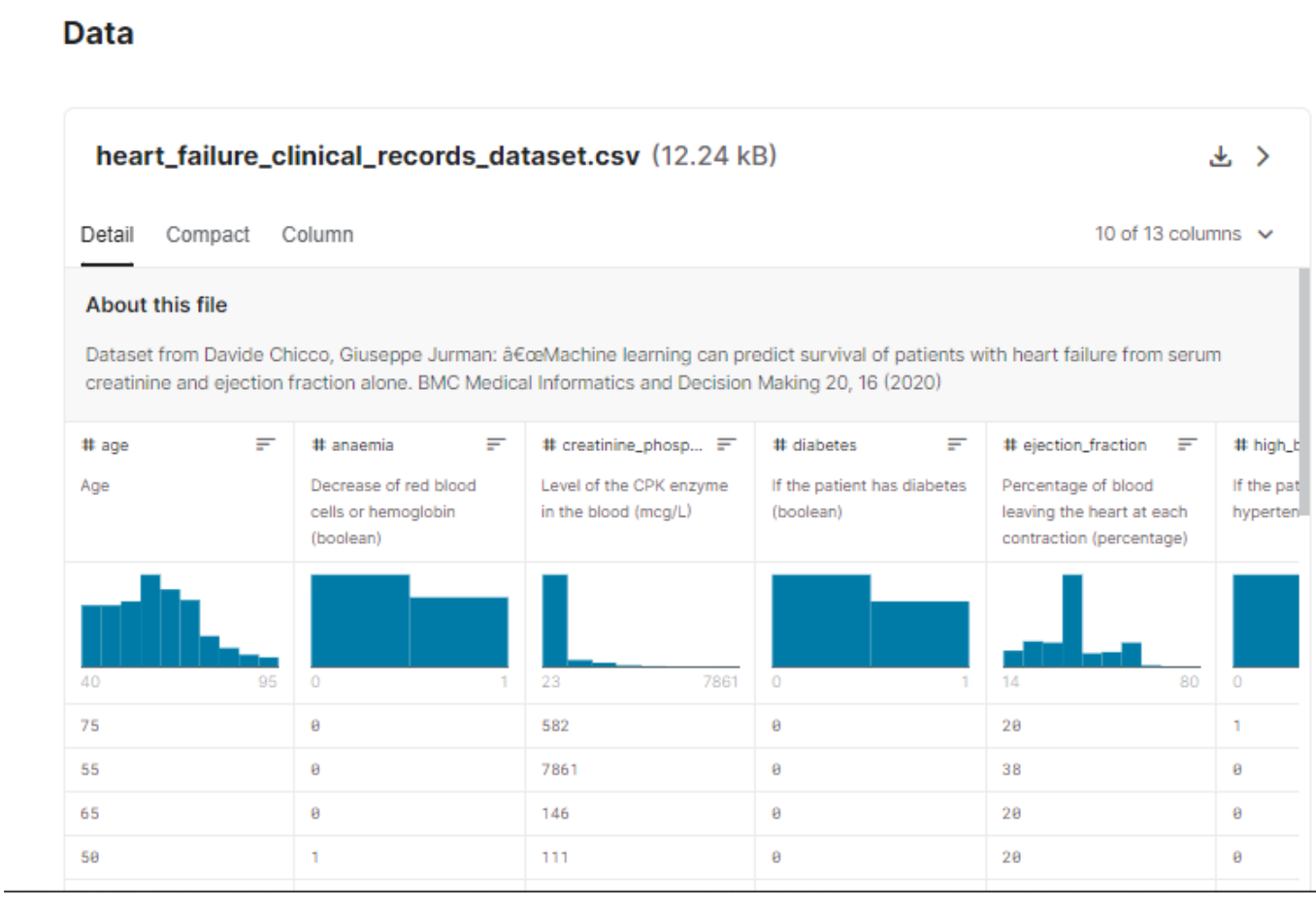


Figure 1: Dataset
[1]

This data-set contain the medical records of 299 heart failure patients collected at the Faisalabad Institute of Cardiology, during April–December 2015. The data-set contains 13 features.

Model Development

We analyze a data-set of 299 patients with heart failure which is collected in 2015. We apply KNN, Naive Bayes and Decision Tree to predict the patients survival and also to rank the features corresponding to the most important risk factors. We also compare these results with machine learning algorithms.

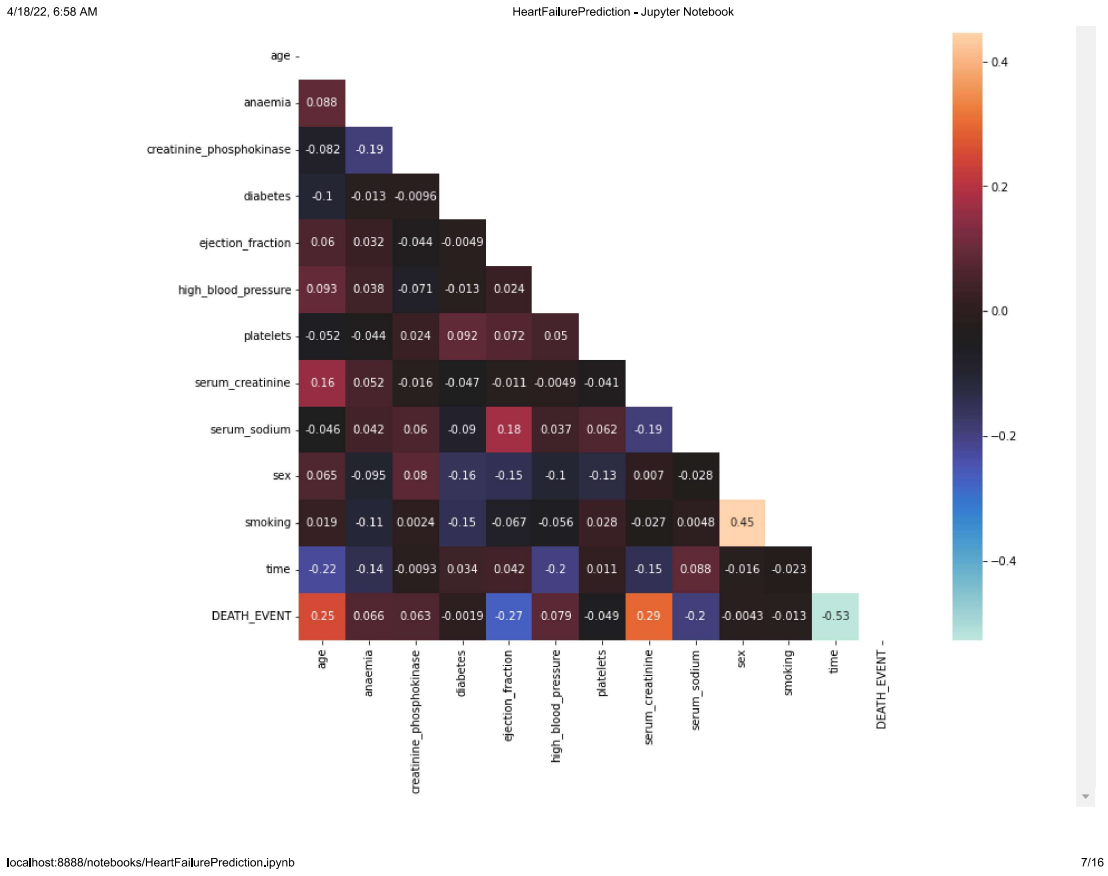


Figure 2: Heatmap

0.1 Algorithm: KNN

Algo: KNeighborsClassifier

In [14]:

```
knn=np.zeros(100);
for i in range(0,len(knn)):
    knn_model = KNeighborsClassifier(n_neighbors=i+1)
    knn_model.fit(X_train, y_train)
    yhpredict_knn=knn_model.predict(X_test)
    knn[i]=accuracy_score(y_test, yhpredict_knn)

# print("KNN Accuracy: ",np.round(knn.max(),3),' with N = ',knn.argmax()+1)
print("KNN Accuracy: ",np.round(knn.max(),3))
plt.plot(np.arange(0,100),knn)
plt.plot(knn.argmax(),knn.max(),'or')
plt.title('KNN Accuracy Score')
plt.xlabel('N')
plt.ylabel('Accuracy')
plt.show()
```

```
KNN Accuracy:  0.678
```

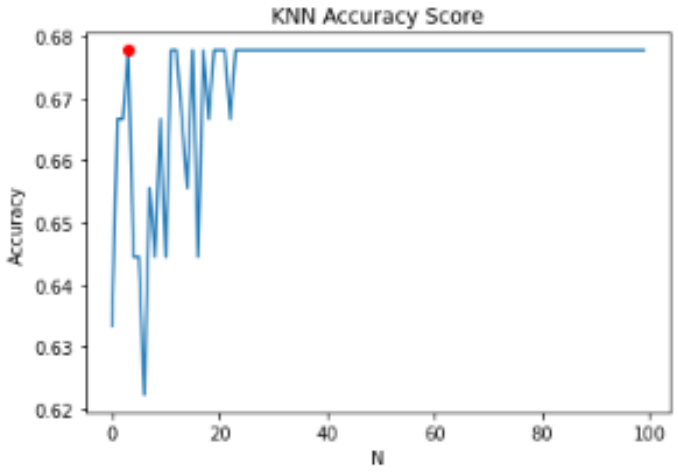


Figure 3: KNN

0.2 Algorithm: GaussianNB

Algo: GaussianNB

In [18]:

```
gnb=np.zeros(100)
params_NB = np.logspace(0,-9, num=100)
for i in range(0,len(params_NB)):
    gnb_model = GaussianNB(var_smoothing=params_NB[i])
    gnb_model.fit(X_train, y_train)
    yhpredict_gnb=gnb_model.predict(X_test)
    gnb[i]=accuracy_score(y_test, yhpredict_gnb)

# print("Naive Bayes Accuracy: ",np.round(gnb.max(),3),' with Smoothing = ',params_NB[gnb.argmax()])
print("Naive Bayes Accuracy: ",np.round(gnb.max(),3))
plt.plot(params_NB,gnb,'.-')
plt.plot(params_NB[gnb.argmax()],gnb.max(),'or')
plt.title('Naive Bayes Accuracy Score')
plt.xscale('log')
# plt.xlabel('Var Smoothing')
plt.ylabel('Accuracy')
plt.show()
```

```
Naive Bayes Accuracy:  0.789
```

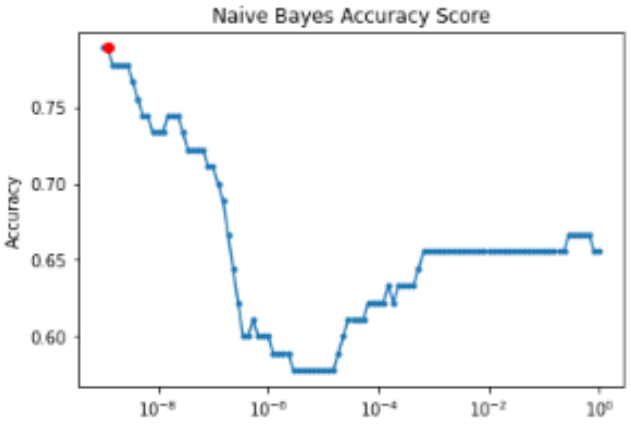


Figure 4: GaussianNB

0.3 Algorithm: DecisionTree

Algo: DecisionTreeClassifier

In [16]:
```
# e_dtc=np.zeros(100)
# params_NB = np.logspace(0,-9, num=100)
# for i in range(0,len(params_NB)):
#     e_dtc = DecisionTreeClassifier(n_neighbors=i+1)
#     dtc_model.fit(X_train, y_train)
#     yh_dtc=dtc_model.predict(X_test)
#     e_dtc[i]=accuracy_score(y_test, yh_dtc)

# print("Naive Bayes Prediction Accuracy Score: ",np.round(e_dtc.max(),3),' with N = ',e_dtc.argmax()+1)
# plt.plot(np.arange(1,101),e_dtc)
# plt.plot(e_dtc.argmax()+1,e_dtc.max(),'or')
# plt.title('Naive Bayes Accuracy Score')
# plt.xscale('log')
# plt.xlabel('Var Smoothing')
# plt.ylabel('Accuracy')
# plt.show()

dtree = DecisionTreeClassifier(random_state=4)
dtree.fit(X_train, y_train)
predictions= dtree.predict(X_test)
dtree_accuracy = accuracy_score(y_test, predictions)
print('DecisionTree Accuracy: ',np.round(dtree_accuracy,3))
# plt.plot([X_test, predictions])
# plt.show
```

```
DecisionTree Accuracy:  0.756
```

Figure 5: DecisionTree

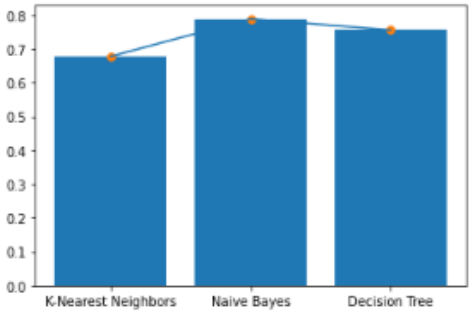
Comparison

Comparing Algorithms in Bar Chart

In [17]:
```
plt.bar(['K-Nearest Neighbors','Naive Bayes','Decision Tree'],[knn.max(),gnb.max(),dtree_accuracy.max()])
plt.scatter(['K-Nearest Neighbors','Naive Bayes','Decision Tree'],[knn.max(),gnb.max(),dtree_accuracy.max()])
plt.plot(['K-Nearest Neighbors','Naive Bayes','Decision Tree'],[knn.max(),gnb.max(),dtree_accuracy.max()])

print("KNN Accuracy: ",np.round(knn.max(),3))
print("Naive Bayes Accuracy: ",np.round(gnb.max(),3))
print('DecisionTree Accuracy: ',np.round(dtree_accuracy,3))
```

```
KNN Accuracy:  0.678
Naive Bayes Accuracy:  0.789
DecisionTree Accuracy:  0.756
```



Naive Bayes shows the highest Accuracy score and KNN shows the lowest accuracy score among the three algorithms. Accuracy of Naive Bayes and Decision Tree algorithms are almost similar.

Figure 6: Comparison

Discussion

It might be possible to predict the survival of patients with heart failure from their serum creatinine and ejection fraction, but also that the prediction made on these two features alone can be more accurate than the predictions made on the complete dataset.
KNN Accuracy: 0.678
Naive Bayes Accuracy: 0.789
DecisionTree Accuracy: 0.756
We can see that, between three algorithms, Naive bayes shows the highest accuracy.

Conclusion

In this project, use of machine learning in medical is shown and it has the potential to impact on clinical practice. Now it's the new supporting tool for the physicians to predict if a heart failure patient will survive or not. If a patient survive after heart failure doctors can monitor how should the live to avoid further problems with prediction of machine learning algorithm.

References

[1] D.and Jurman Chicco. "Machine learning can predict survival of patients with heart failure from serum creatinine and ejection fraction alone". In: (). DOI: https://doi.org/10.1186/s12911-020-1023-5.