Read data

we import pandas and read and take a look at the data

In [ ]:
```
import pandas as pd
RISK_LEVEL = "RiskLevel"

df = pd.read_csv("./Maternal Health Risk Data Set.csv")
df
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate	RiskLevel
0	25	130	80	15.0	98.0	86	high risk
1	35	140	90	13.0	98.0	70	high risk
2	29	90	70	8.0	100.0	80	high risk
3	30	140	85	7.0	98.0	70	high risk
4	35	120	60	6.1	98.0	76	low risk
...	...	...	...	...	...	...	...
1009	22	120	60	15.0	98.0	80	high risk
1010	55	120	90	18.0	98.0	60	high risk
1011	35	85	60	19.0	98.0	86	high risk
1012	43	120	90	18.0	98.0	70	high risk
1013	32	120	65	6.0	101.0	76	mid risk

1014 rows × 7 columns

Other quick reviews ...

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1014 entries, 0 to 1013
Data columns (total 7 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   Age          1014 non-null   int64  
 1   SystolicBP   1014 non-null   int64  
 2   DiastolicBP  1014 non-null   int64  
 3   BS           1014 non-null   float64
 4   BodyTemp     1014 non-null   float64
 5   HeartRate    1014 non-null   int64  
 6   RiskLevel    1014 non-null   object 
dtypes: float64(2), int64(4), object(1)
memory usage: 55.6+ KB
```

In [ ]:
```
df.describe()
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate
count	1014.000000	1014.000000	1014.000000	1014.000000	1014.000000	1014.000000
mean	29.871795	113.198225	76.460552	8.725986	98.665089	74.301775
std	13.474386	18.403913	13.885796	3.293532	1.371384	8.088702
min	10.000000	70.000000	49.000000	6.000000	98.000000	7.000000
25%	19.000000	100.000000	65.000000	6.900000	98.000000	70.000000
50%	26.000000	120.000000	80.000000	7.500000	98.000000	76.000000
75%	39.000000	120.000000	90.000000	8.000000	98.000000	80.000000
max	70.000000	160.000000	100.000000	19.000000	103.000000	90.000000

all categories

In [ ]:
```
df[RISK_LEVEL].value_counts()
```

Out[ ]:
```
low risk     406
mid risk     336
high risk    272
Name: RiskLevel, dtype: int64
```

Now we convert string data values to numeric values using label encoding

In [ ]:
```
from sklearn.preprocessing import LabelEncoder
label_encoder = LabelEncoder()
df[RISK_LEVEL] = label_encoder.fit_transform(df[RISK_LEVEL])
df
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate	RiskLevel
0	25	130	80	15.0	98.0	86	0
1	35	140	90	13.0	98.0	70	0
2	29	90	70	8.0	100.0	80	0
3	30	140	85	7.0	98.0	70	0
4	35	120	60	6.1	98.0	76	1
...	...	...	...	...	...	...	...
1009	22	120	60	15.0	98.0	80	0
1010	55	120	90	18.0	98.0	60	0
1011	35	85	60	19.0	98.0	86	0
1012	43	120	90	18.0	98.0	70	0
1013	32	120	65	6.0	101.0	76	2

1014 rows × 7 columns

Check for null values

In [ ]:
```
df.isnull().sum()
```

Out[ ]:
```
Age           0
SystolicBP    0
DiastolicBP   0
BS            0
BodyTemp      0
HeartRate     0
RiskLevel     0
dtype: int64
```

Normalize the range of values... this makes our model fit more accurate especially for KNN

In [ ]:
```
from sklearn.preprocessing import MinMaxScaler, minmax_scale

df.iloc[:, :-1] = MinMaxScaler().fit_transform(df.iloc[:, :-1])
df
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate	RiskLevel
0	0.250000	0.666667	0.607843	0.692308	0.0	0.951807	0
1	0.416667	0.777778	0.803922	0.538462	0.0	0.759036	0
2	0.316667	0.222222	0.411765	0.153846	0.4	0.879518	0
3	0.333333	0.777778	0.705882	0.076923	0.0	0.759036	0
4	0.416667	0.555556	0.215686	0.007692	0.0	0.831325	1
...	...	...	...	...	...	...	...
1009	0.200000	0.555556	0.215686	0.692308	0.0	0.879518	0
1010	0.750000	0.555556	0.803922	0.923077	0.0	0.638554	0
1011	0.416667	0.166667	0.215686	1.000000	0.0	0.951807	0
1012	0.550000	0.555556	0.803922	0.923077	0.0	0.759036	0
1013	0.366667	0.555556	0.313725	0.000000	0.6	0.831325	2

1014 rows × 7 columns

Split the features and labels(X and Y)

In [ ]:
```
Y = df[RISK_LEVEL]
X = df.drop(RISK_LEVEL, axis=1)
```

In [ ]:
```
X
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate
0	0.250000	0.666667	0.607843	0.692308	0.0	0.951807
1	0.416667	0.777778	0.803922	0.538462	0.0	0.759036
2	0.316667	0.222222	0.411765	0.153846	0.4	0.879518
3	0.333333	0.777778	0.705882	0.076923	0.0	0.759036
4	0.416667	0.555556	0.215686	0.007692	0.0	0.831325
...	...	...	...	...	...	...
1009	0.200000	0.555556	0.215686	0.692308	0.0	0.879518
1010	0.750000	0.555556	0.803922	0.923077	0.0	0.638554

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate
1011	0.416667	0.166667	0.215686	1.000000	0.0	0.951807
1012	0.550000	0.555556	0.803922	0.923077	0.0	0.759036
1013	0.366667	0.555556	0.313725	0.000000	0.6	0.831325

1014 rows × 6 columns

In [ ]:
```
Y
```

Out[ ]:
```
0       0
1       0
2       0
3       0
4       1
       ..
1009    0
1010    0
1011    0
1012    0
1013    2
Name: RiskLevel, Length: 1014, dtype: int64
```

Randomly split the dataset to 0.3 test and 0.7 train.

In [ ]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size=0.3, random_state=None)
x_train
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate
796	0.216667	0.666667	0.411765	0.061538	0.0	0.855422
855	0.166667	0.555556	0.509804	0.077692	0.4	0.759036
422	0.433333	0.777778	1.000000	0.061538	0.8	0.831325
475	0.150000	0.555556	0.607843	0.076923	0.0	0.759036
388	0.216667	0.555556	0.411765	0.138462	0.0	0.759036
...	...	...	...	...	...	...
671	0.083333	0.333333	0.000000	0.061538	0.2	0.843373
189	0.050000	0.222222	0.313725	0.146154	0.6	0.879518
616	0.366667	0.555556	0.607843	0.115385	0.0	0.759036
708	0.150000	0.555556	0.607843	0.076923	0.0	0.759036
909	0.083333	0.555556	0.607843	0.146154	0.0	0.759036

709 rows × 6 columns

In [ ]:
```
x_test
```

Out[ ]:

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate
1009	0.200000	0.555556	0.215686	0.692308	0.0	0.879518
438	0.333333	0.555556	0.607843	0.061538	0.0	0.759036
574	0.216667	0.222222	0.215686	0.115385	0.0	0.831325
910	0.116667	0.000000	0.019608	0.146154	0.0	0.759036
659	0.433333	0.555556	0.803922	0.076923	0.0	0.903614
...	...	...	...	...	...	...
143	0.250000	0.555556	0.803922	0.053846	0.6	0.879518
768	0.100000	0.333333	0.411765	0.069231	0.0	0.879518
688	0.500000	0.555556	0.803922	0.461538	0.0	0.879518
724	0.350000	0.555556	0.215686	0.007692	0.0	0.831325
870	0.350000	0.555556	0.215686	0.007692	0.0	0.831325

305 rows × 6 columns

Here we define 3 functions to make our job simple later

first one just run the cross_val_score method and pring the result.

second fit and test the model on the train part

and finally the third one test the model that't been trained on "train" section, on the "test" section of the dataset

In [ ]:

```
from sklearn.model_selection import ShuffleSplit, cross_val_score
from sklearn.metrics import accuracy_score
cv = ShuffleSplit(n_splits=10, random_state=None)
def runCrossVal(model):
    score = cross_val_score(model, x_train, y_train, cv=cv).mean() * 100
    print(f"accuracy on cross_val_score: {score}")
    return model

def runOnTrain(model):
    model.fit(x_train, y_train)
    predicted_y = model.predict(x_train)
    print(f"accuracy on train: {accuracy_score(y_true=y_train, y_pred=predicted_y)*100}")

def runModelOnTest(model):
    runCrossVal(model)
    runOnTrain(model)
    model.fit(x_train, y_train)
    predicted_y = model.predict(x_test)
    print(f"accuracy on test data: {accuracy_score(y_true=y_test, y_pred=predicted_y)*100}")
    return model, y_test, predicted_y
```

Now we test the model over the dataset

In [ ]:
```
from sklearn.tree import DecisionTreeClassifier as DecisionTree
```

starting by the default parameters ...

In [ ]:
```
runModelOnTest(DecisionTree())
DecisionTree()
```

Out[ ]:
```
accuracy on cross_val_score: 82.67605633802816
accuracy on train: 92.80677009873061
accuracy on test data: 81.9672131147541
DecisionTreeClassifier()
```

Playing with parameters

we're checking that the paramter must not make the model overfit and also give us a good accuracy over the "test" section

In [ ]:
```
runModelOnTest(DecisionTree(criterion='entropy', max_depth=12))
DecisionTree(criterion='entropy', max_depth=12)
```

Out[ ]:
```
accuracy on cross_val_score: 81.69014084507043
accuracy on train: 88.57545839210155
accuracy on test data: 78.36065573770492
DecisionTreeClassifier(criterion='entropy', max_depth=12)
```

In [ ]:
```
runModelOnTest(DecisionTree(splitter="random"))
DecisionTree(splitter="random")
```

Out[ ]:
```
accuracy on cross_val_score: 79.01408450704224
accuracy on train: 92.80677009873061
accuracy on test data: 82.29508196721311
DecisionTreeClassifier(splitter='random')
```

These sounds like the best parameters for DecisionTree. However it looks like it has overfit. but it's not bad for DecisionTree model.

In [ ]:
```
runModelOnTest(DecisionTree(min_samples_split=3))
DecisionTree(min_samples_split=3)
```

Out[ ]:
```
accuracy on cross_val_score: 79.01408450704226
accuracy on train: 92.2425952045134
accuracy on test data: 79.34426229508198
DecisionTreeClassifier(min_samples_split=3)
```

Now KNN

In [ ]:
```
from sklearn.neighbors import KNeighborsClassifier as KNN
runModelOnTest(KNN())
KNN()
```

Out[ ]:
```
accuracy on cross_val_score: 67.04225352112675
accuracy on train: 79.12552891396332
accuracy on test data: 69.83606557377048
KNeighborsClassifier()
```

In [ ]:
```
runModelOnTest(KNN(6))
KNN(6)
```

```
accuracy on cross_val_score: 69.43661971830987
accuracy on train: 77.71509167842031
accuracy on test data: 69.83606557377048
```

Out[ ]:
```
KNeighborsClassifier(n_neighbors=6)
```

In [ ]:
```
runModelOnTest(KNN(7))
KNN(7)
```

```
accuracy on cross_val_score: 70.0
accuracy on train: 77.99717912552892
accuracy on test data: 71.47540983606558
```
Out[ ]:
```
KNeighborsClassifier(n_neighbors=7)
```

In [ ]:
```
runModelOnTest(KNN(4))
KNN(4)
```

```
accuracy on cross_val_score: 67.32394366197184
accuracy on train: 81.10014104372355
accuracy on test data: 67.8688524590164
```
Out[ ]:
```
KNeighborsClassifier(n_neighbors=4)
```

In [ ]:
```
runModelOnTest(KNN(3))
KNN(3)
```

```
accuracy on cross_val_score: 70.28169014084507
accuracy on train: 86.31875881523273
accuracy on test data: 67.21311475409836
```
Out[ ]:
```
KNeighborsClassifier(n_neighbors=3)
```

n_neighbors = 2; seems the best parameter

In [ ]:
```
runModelOnTest(KNN(2))
KNN(2)
```

```
accuracy on cross_val_score: 71.40845070422534
accuracy on train: 89.42172073342736
accuracy on test data: 75.08196721311475
```
Out[ ]:
```
KNeighborsClassifier(n_neighbors=2)
```

In [ ]:
```
runModelOnTest(KNN(1))
KNN(1)
```

```
accuracy on cross_val_score: 80.70422535211267
accuracy on train: 91.53737658674189
accuracy on test data: 79.67213114754098
```
Out[ ]:
```
KNeighborsClassifier(n_neighbors=1)
```

In [ ]:
```
from sklearn.svm import SVC
runModelOnTest(SVC())
SVC()
```

```
accuracy on cross_val_score: 65.77464788732395
accuracy on train: 67.55994358251057
accuracy on test data: 72.45901639344262
```
Out[ ]:
```
SVC()
```

In [ ]:
```
runModelOnTest(SVC(C=2))
SVC(C=2)
```

```
accuracy on cross_val_score: 68.73239436619718
accuracy on train: 67.55994358251057
accuracy on test data: 72.1311475409836
```
Out[ ]:
```
SVC(C=2)
```

In [ ]:
```
runModelOnTest(SVC(C=100))
SVC(C=100)
```

```
accuracy on cross_val_score: 69.01408450704226
accuracy on train: 77.29196050775741
accuracy on test data: 65.24590163934427
```
Out[ ]:
```
SVC(C=100)
```

And this seems the best for SVC

In [ ]:
```
runModelOnTest(SVC(C=100, gamma=1))
SVC(C=100, gamma=1)
```

```
accuracy on cross_val_score: 66.47887323943662
accuracy on train: 73.90691114245416
accuracy on test data: 71.47540983606558
```
Out[ ]:
```
SVC(C=100, gamma=1)
```

In [ ]:
```
runModelOnTest(SVC(C=100, gamma=1, coef0=0.2))
SVC(C=100, gamma=1, coef0=0.2)
```

Out[ ]:
```
accuracy on cross_val_score: 65.49295774647888
accuracy on train: 73.90691114245416
accuracy on test data: 71.47540983606558
SVC(C=100, coef0=0.2, gamma=1)
```

In [ ]:
```
runModelOnTest(SVC(C=100, coef0=0.1, kernel="linear"))
SVC(C=100, coef0=0.1, kernel="linear")
```

Out[ ]:
```
accuracy on cross_val_score: 60.28169014084506
accuracy on train: 63.18758815232722
accuracy on test data: 68.52459016393443
SVC(C=100, coef0=0.1, kernel='linear')
```

In [ ]:
```
runModelOnTest(SVC(C=2, coef0=0.1, kernel="sigmoid"))
SVC(C=2, coef0=0.1, kernel="sigmoid")
```

Out[ ]:
```
accuracy on cross_val_score: 19.859154929577468
accuracy on train: 20.87447108603667
accuracy on test data: 24.59016393442623
SVC(C=2, coef0=0.1, kernel='sigmoid')
```

Now the RandomForest

it seems that it has overfit a lot. we play with parameters to avoid that

In [ ]:
```
from sklearn.ensemble import RandomForestClassifier as RandomForest
runModelOnTest(RandomForest())
RandomForest()
```

Out[ ]:
```
accuracy on cross_val_score: 82.11267605633805
accuracy on train: 92.80677009873061
accuracy on test data: 81.63934426229508
RandomForestClassifier()
```

In [ ]:
```
runModelOnTest(RandomForest(n_estimators=150))
RandomForest(n_estimators=150)
```

Out[ ]:
```
accuracy on cross_val_score: 82.11267605633802
accuracy on train: 92.80677009873061
accuracy on test data: 82.29508196721311
RandomForestClassifier(n_estimators=150)
```

In [ ]:
```
runModelOnTest(RandomForest(n_estimators=80))
RandomForest(n_estimators=80)
```

Out[ ]:
```
accuracy on cross_val_score: 83.2394366197183
accuracy on train: 92.80677009873061
accuracy on test data: 80.98360655737706
RandomForestClassifier(n_estimators=80)
```

In [ ]:
```
runModelOnTest(RandomForest(n_estimators=300))
RandomForest(n_estimators=300)
```

Out[ ]:
```
accuracy on cross_val_score: 83.09859154929578
accuracy on train: 92.80677009873061
accuracy on test data: 81.63934426229508
RandomForestClassifier(n_estimators=300)
```

In [ ]:
```
runModelOnTest(RandomForest(n_estimators=300, max_depth=12))
RandomForest(n_estimators=300, max_depth=12)
```

Out[ ]:
```
accuracy on cross_val_score: 81.83098591549296
accuracy on train: 92.6657263751763
accuracy on test data: 81.63934426229508
RandomForestClassifier(max_depth=12, n_estimators=300)
```

In [ ]:
```
runModelOnTest(RandomForest(n_estimators=300, max_depth=10))
RandomForest(n_estimators=300, max_depth=10)
```

Out[ ]:
```
accuracy on cross_val_score: 81.97183098591549
accuracy on train: 90.97320169252468
accuracy on test data: 81.31147540983606
RandomForestClassifier(max_depth=10, n_estimators=300)
```

In [ ]:
```
runModelOnTest(RandomForest(n_estimators=300, max_depth=9))
RandomForest(n_estimators=300, max_depth=9)
```

```
accuracy on cross_val_score: 80.4225352112676
accuracy on train: 88.99858956276445
accuracy on test data: 79.67213114754098
```
Out[ ]: RandomForestClassifier(max_depth=9, n_estimators=300)

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", max_depth=9))
RandomForest(criterion="entropy", max_depth=9)
```

```
accuracy on cross_val_score: 82.8169014084507
accuracy on train: 88.01128349788434
accuracy on test data: 78.68852459016394
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=9)

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", n_estimators=50, max_depth=9))
RandomForest(criterion="entropy", n_estimators=50, max_depth=9)
```

```
accuracy on cross_val_score: 81.97183098591549
accuracy on train: 89.56276445698167
accuracy on test data: 79.67213114754098
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=9, n_estimators=50)

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", min_samples_split=2, max_depth=9))
RandomForest(criterion="entropy", min_samples_split=2, max_depth=9)
```

```
accuracy on cross_val_score: 83.23943661971832
accuracy on train: 89.28067700987306
accuracy on test data: 79.67213114754098
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=9)

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", min_samples_split=4, max_depth=9))
RandomForest(criterion="entropy", min_samples_split=4, max_depth=9)
```

```
accuracy on cross_val_score: 82.25352112676056
accuracy on train: 88.15232722143864
accuracy on test data: 75.73770491803279
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=9, min_samples_split=4)

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", min_samples_leaf=2, max_depth=10))
RandomForest(criterion="entropy", min_samples_leaf=2, max_depth=10)
```

```
accuracy on cross_val_score: 78.73239436619718
accuracy on train: 88.71650211565584
accuracy on test data: 77.37704918032787
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=10, min_samples_leaf=2)

This seems good

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", max_features='auto'))
RandomForest(criterion="entropy", max_features='auto')
```

```
accuracy on cross_val_score: 81.97183098591549
accuracy on train: 92.80677009873061
accuracy on test data: 81.63934426229508
```
Out[ ]: RandomForestClassifier(criterion='entropy')

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", max_features='log2'))
RandomForest(criterion="entropy", max_features='log2')
```

```
accuracy on cross_val_score: 80.70422535211267
accuracy on train: 92.80677009873061
accuracy on test data: 80.65573770491802
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_features='log2')

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", max_features='sqrt', max_depth=9))
RandomForest(criterion="entropy", max_features='sqrt', max_depth=9)
```

```
accuracy on cross_val_score: 81.12676056338029
accuracy on train: 88.71650211565584
accuracy on test data: 79.34426229508198
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=9, max_features='sqrt')

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", max_features='sqrt', max_depth=10))
RandomForest(criterion="entropy", max_features='sqrt', max_depth=10)
```

```
accuracy on cross_val_score: 81.97183098591549
accuracy on train: 91.11424541607899
accuracy on test data: 79.34426229508198
```
Out[ ]: RandomForestClassifier(criterion='entropy', max_depth=10, max_features='sqrt')

In [ ]:
```
runModelOnTest(RandomForest(criterion="entropy", max_features='sqrt', max_depth=8))
RandomForest(criterion="entropy", max_features='sqrt', max_depth=8)
```

```
accuracy on cross_val_score: 78.59154929577466
accuracy on train: 87.58815232722144
accuracy on test data: 79.67213114754098
```

Out[ ]:
```
RandomForestClassifier(criterion='entropy', max_depth=8, max_features='sqrt')
```

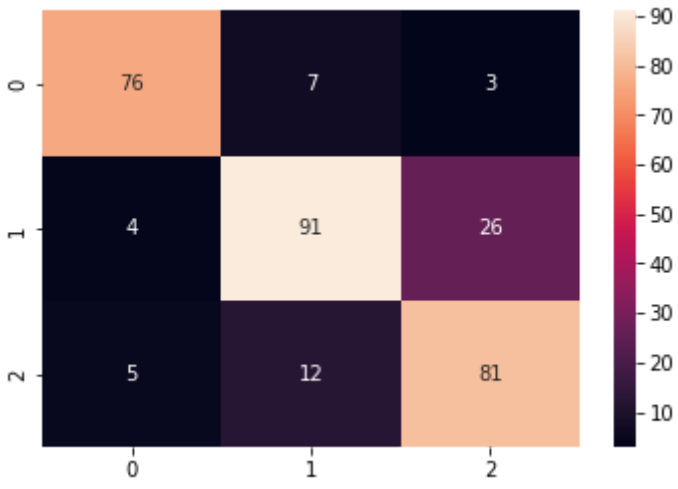
In [ ]:
```
model, y_test, y_predict  = runModelOnTest(RandomForest(criterion="entropy", max_features='log2'))
```

```
accuracy on cross_val_score: 81.12676056338029
accuracy on train: 92.80677009873061
accuracy on test data: 81.31147540983606
```

In [ ]:
```
from sklearn.metrics import confusion_matrix
import seaborn as sns

cf_matrix = confusion_matrix(y_test, y_predict)
sns.heatmap(cf_matrix, annot=True)
```

Out[ ]:
```
<AxesSubplot:>
```



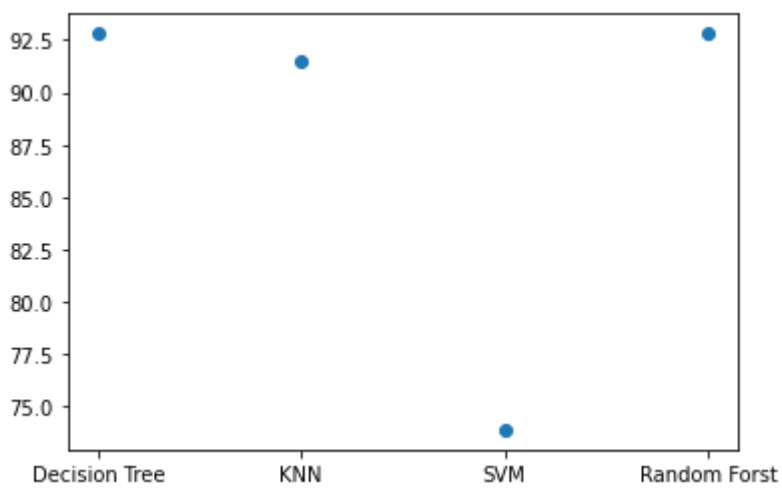
In [ ]:
```
import matplotlib.pyplot as plt
d = pd.DataFrame({"Model": ["Decision Tree", "KNN", "SVM", "Random Forst"],
                  "train acc": [92.8067, 91.5373, 73.9069, 92.8067],
                  "Cross Val": [78.8732, 80.7042, 66.4788, 81.9718],
                  "Test": [81.3114, 79.6721, 71.4754, 81.6393]})
d
```

Out[ ]:

	Model	train acc	Cross Val	Test
0	Decision Tree	92.8067	78.8732	81.3114
1	KNN	91.5373	80.7042	79.6721
2	SVM	73.9069	66.4788	71.4754
3	Random Forst	92.8067	81.9718	81.6393

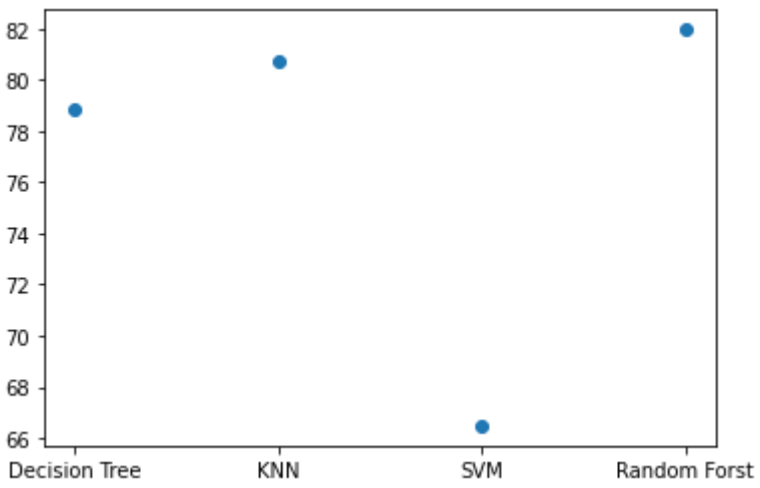
In [ ]:
```
plt.scatter(d["Model"], d["train acc"])
```

Out[ ]:
```
<matplotlib.collections.PathCollection at 0x7efbd6cc8e80>
```



In [ ]:
```
plt.scatter(d["Model"], d["Cross Val"])
```

Out[ ]:
```
<matplotlib.collections.PathCollection at 0x7efbd4bcfbb0>
```



In [ ]:
```
plt.scatter(d["Model"], d["Test"])
```

Out[ ]:
```
<matplotlib.collections.PathCollection at 0x7efbd8a7d730>
```