Model_Selection_Training_Cluster_2_0

In [1]:

```
import pandas as pd
import numpy as np
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.metrics  import roc_auc_score,accuracy_score
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
import pickle
```

```
C:\Users\Dinesh\AppData\Roaming\Python\Python39\site-packages\scipy\__ini
t__.py:177: UserWarning: A NumPy version >=1.18.5 and <1.26.0 is required
for this version of SciPy (detected version 1.26.4
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

In [2]:

```
df = pd.read_csv("Data/Cluster_data.csv")
```

In [3]:

```
df.head()
```

Out[3]:

	age	sex	on_thyroxine	query_on_thyroxine	on_antithyroid_medication	sick	pregnant	t
0	42.0	0.0	0.0	0.0	0.0	0.0	0.0	
1	24.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	47.0	1.0	0.0	0.0	0.0	0.0	0.0	
3	71.0	0.0	1.0	0.0	0.0	0.0	0.0	
4	71.0	0.0	0.0	0.0	0.0	0.0	0.0	

5 rows × 22 columns

In [4]:

```
list_of_clusters = df["Cluster"].unique()
```

In [5]:

```
list_of_clusters
```

Out[5]:

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

Cluster 2

In [6]:

```
cluster_data_2 = df[df["Cluster"] == list_of_clusters[0]]
```

In [7]:
```
cluster_data_2.head()
```

Out[7]:

	age	sex	on_thyroxine	query_on_thyroxine	on_antithyroid_medication	sick	pregnant	t
0	42.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	47.0	1.0	0.0	0.0	0.0	0.0	0.0	
3	71.0	0.0	1.0	0.0	0.0	0.0	0.0	
5	19.0	0.0	1.0	0.0	0.0	0.0	0.0	
8	67.0	0.0	0.0	0.0	0.0	0.0	0.0	

5 rows × 22 columns

In [8]:
```
cluster_feature_2 = cluster_data_2.drop(["Cluster", "Label"], axis = 1)
cluster_label_2 = cluster_data_2["Label"]
```

In [9]:
```
x_train, x_test, y_train, y_test = train_test_split(cluster_feature_2, clus
```

Random Forest

In [10]:
```
clf = RandomForestClassifier()
```

In [11]:
```
clf.fit(x_train, y_train)
```

Out[11]:
```
RandomForestClassifier()
```

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In [12]:
```
clf.score(x_test, y_test)
```

Out[12]:
```
0.9928774928774928
```

In [13]:
```
clf.score(x_train, y_train)
```

Out[13]:
```
1.0
```

In [14]:
```
param_clf = {"n_estimators": [10, 50, 100, 130, 160, 200, 250],
             "criterion": ['gini', 'entropy'],
            "max_depth": range(2, 8, 1),
             "max_features": ['sqrt', 'log2']
}
```

In [17]:

```
grid = GridSearchCV(estimator=clf, param_grid=param_clf, cv=10, n_jobs=-1,
```

In [23]:

```
grid.fit(x_train, y_train)
```

Out[23]:

```
GridSearchCV(cv=10, error_score='raise', estimator=RandomForestClassifier
(),
             n_jobs=-1,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': range(2, 8),
                         'max_features': ['sqrt', 'log2'],
                         'n_estimators': [10, 50, 100, 130, 160, 200, 25
0]})
```

In [24]:

```
grid.best_params_
```

Out[24]:

```
{'criterion': 'entropy',
 'max_depth': 7,
 'max_features': 'sqrt',
 'n_estimators': 100}
```

In [15]:

```
clf = RandomForestClassifier(criterion='entropy', max_depth=7, max_features
```

In [16]:

```
clf.fit(x_train, y_train)
```

Out[16]:

```
RandomForestClassifier(criterion='entropy', max_depth=7)
```

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In [17]:

```
clf.score(x_test, y_test)
```

Out[17]:

```
0.8860398860398860
```

In [18]:

```
clf.score(x_train, y_train)
```

Out[18]:

```
0.9016493585827734
```

In [19]:

```
prediction_clf = clf.predict_proba(x_test)
if len(y_test.unique()) == 1:
    clf_score_2 = accuracy_score(y_test, prediction_clf)
else:
    clf_score_2 = roc_auc_score(y_test, prediction_clf, multi_class="ovr")
clf_score_2
```

Out[19]:

```
0.9848749197961503
```

KNN

In [20]:

```
knn = KNeighborsClassifier()
```

In [21]:

```
knn.fit(x_train, y_train)
```

Out[21]:

```
KNeighborsClassifier()
```

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In [22]:

```
knn.score(x_test, y_test)
```

Out[22]:

```
0.9301994301994302
```

In [23]:

```
knn.score(x_train, y_train)
```

Out[23]:

```
0.9578497251069029
```

In [48]:

```
param_knn = {
    'n_neighbors' : [i for i in range(5, 25)],
    'algorithm' : ['auto', 'ball_tree', 'kd_tree', 'brute'],
    'leaf_size' : [8,9,11,12,21,24,23,45,67,78,],
    'p' : [1,2],
    'weights' : ['uniform','distance']
}
```

In [49]:

```
grid = GridSearchCV(estimator=knn, param_grid=param_knn, cv=10, n_jobs=-1,
```

In [50]:

```
grid.fit(x_train, y_train)
```

Out[50]:

```
GridSearchCV(cv=10, error_score='raise',
             estimator=KNeighborsClassifier(leaf_size=10, weights='distan
ce'),
             n_jobs=-1,
             param_grid={'algorithm': ['auto', 'ball_tree', 'kd_tree', 'b
rute'],
                         'leaf_size': [8, 9, 11, 12, 21, 24, 23, 45, 67,
78],
                         'n_neighbors': [5, 6, 7, 8, 9, 10, 11, 12, 13, 1
4, 15,
                                         16, 17, 18, 19, 20, 21, 22, 23,
24],
                         'p': [1, 2], 'weights': ['uniform', 'distanc
e']})
```

In [51]:

```
grid.best_params_
```

Out[51]:

```
{'algorithm': 'auto',
 'leaf_size': 8,
 'n_neighbors': 5,
 'p': 2,
 'weights': 'distance'}
```

In [24]:
```
knn = KNeighborsClassifier(algorithm='auto', leaf_size=8, n_neighbors=5,p=2
```

In [25]:
```
knn.fit(x_train, y_train)
```

Out[25]:
```
KNeighborsClassifier(leaf_size=8, weights='distance')
```

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In [26]:
```
knn.score(x_test, y_test)
```

Out[26]:
```
0.9387464387464387
```

In [27]:
```
knn.score(x_train,y_train)
```

Out[27]:
```
1.0
```

In [28]:
```
prediction_score = knn.predict_proba(x_test)
if len(y_test.unique()) == 1:
    knn_score_2 = accuracy_score(y_test, prediction_score)
else:
    knn_score_2 = roc_auc_score(y_test, prediction_score, multi_class="ovr'
```

SVM

In [29]:
```
svm = SVC()
```

In [30]:
```
svm.fit(x_train, y_train)
```

Out[30]:
```
SVC()
```

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In [31]:
```
svm.score(x_test, y_test)
```

Out[31]:
```
0.6723646723646723
```

In [32]:
```
svm.score(x_train,y_train)
```

Out[32]:
```
0.6945632254123396
```

In [70]:
```
param_svm = {
    'kernel' :['linear', 'poly', 'rbf', 'sigmoid']
}
```

In [71]:
```
grid = GridSearchCV(estimator=svm, param_grid=param_svm, cv=10, n_jobs=3, e
```

In [72]:
```
grid.fit(x_train, y_train)
```

Out[72]:
```
GridSearchCV(cv=10, error_score='raise', estimator=SVC(), n_jobs=3,
             param_grid={'kernel': ['linear', 'poly', 'rbf', 'sigmoid']})
```

In [73]:
```
grid.best_params_
```

Out[73]:
```
{'kernel': 'linear'}
```

In [33]:
```
svm = SVC(kernel='linear')
```

In [34]:
```
svm.fit(x_train, y_train)
```

Out[34]:
```
SVC(kernel='linear')
```

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In [35]:
```
svm.score(x_test, y_test)
```

Out[35]:
```
0.7165242165242165
```

In [36]:
```
svm.score(x_train, y_train)
```

Out[36]:
```
0.7532070861331704
```

In [37]:
```
prediction_svm_2 = svm.score(x_test,y_test)
```

Decision Tree

In [38]:
```
dt = DecisionTreeClassifier()
```

In [39]:
```
dt.fit(x_train, y_train)
```

Out[39]:
```
DecisionTreeClassifier()
```

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In [40]:
```
dt.score(x_test, y_test)
```

Out[40]:
```
0.9672364672364673
```

In [41]:
```
dt.score(x_train, y_train)
```

Out[41]:
```
1.0
```

In [87]:
```
parm_dt = {"criterion" : ['gini', 'entropy'],
             "splitter" : ['best', 'random'],
             "max_depth" : range(2, 40, 1),
             "min_samples_split" : range(2, 10, 1),
             "min_samples_leaf" : range(1, 10, 1)}
```

In [94]:
```
grid = GridSearchCV(estimator=dt, param_grid=parm_dt, cv=10, n_jobs=3, err
```

In [95]:
```
grid.fit(x_train, y_train)
```

Out[95]:
```
GridSearchCV(cv=10, error_score='raise', estimator=DecisionTreeClassifier
(),
             n_jobs=3,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': range(2, 40),
                         'min_samples_leaf': range(1, 10),
                         'min_samples_split': range(2, 10),
                         'splitter': ['best', 'random']})
```

In [96]:
```
grid.best_params_
```

Out[96]:
```
{'criterion': 'gini',
 'max_depth': 35,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'splitter': 'random'}
```

In [42]:
```
dt = DecisionTreeClassifier(criterion='gini', max_depth= 35, min_samples_le
```

In [43]:
```
dt.fit(x_train, y_train)
```

Out[43]:
```
DecisionTreeClassifier(max_depth=35, splitter='random')
```

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In [44]:
```
dt.score(x_test, y_test)
```

Out[44]:
```
0.9786324786324786
```

In [45]:
```
dt.score(x_train, y_train)
```

Out[45]:
```
1.0
```

In [46]:
```
prediction_dt = dt.predict_proba(x_test)
dt_score_2 = roc_auc_score(y_test, prediction_dt, multi_class='ovr')
```

Cluster 0

In [47]:
```
cluster_data_0 = df[df["Cluster"] == list_of_clusters[1]]
```

In [48]:
```
cluster_data_0.head()
```

Out[48]:

	age	sex	on_thyroxine	query_on_thyroxine	on_antithyroid_medication	sick	pregnant	t
1	24.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	71.0	0.0	0.0	0.0	0.0	0.0	0.0	
6	60.0	0.0	0.0	0.0	0.0	0.0	0.0	
7	81.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	69.0	1.0	0.0	0.0	0.0	0.0	0.0	

5 rows × 22 columns

In [49]:
```
cluster_features_0 = cluster_data_0.drop(columns = ['Cluster','Label'],axis
```

In [50]:
```
cluster_label_0 = cluster_data_0['Label']
```

In [51]:
```
x_train, x_test, y_train,y_test = train_test_split(cluster_features_0, clus
```

Random Forest

In [52]:
```
clf_0 = RandomForestClassifier()
```

In [53]:
```
clf_0.fit(x_train, y_train)
```

Out[53]:
```
RandomForestClassifier()
```

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In [54]:
```
clf_0.score(x_test, y_test)
```

Out[54]:
```
0.9922644163150492
```

In [55]:
```
clf_0.score(x_train, y_train)
```

Out[55]:
```
1.0
```

In [56]:
```
param_clf_0 = {"n_estimators" : [10, 20, 67, 240, 110, 100, 250],
               "criterion" : ['gini', 'entropy'],
               "max_depth" : range(2,8,1),
               "max_features" : ['sqrt', 'log2']
}
```

In [120]:
```
grid = GridSearchCV(estimator =clf_0, param_grid = param_clf_0,cv= 10, n_jo
```

In [121]:
```
grid.fit(x_train, y_train)
```

Out[121]:
```
GridSearchCV(cv=10, error_score='raise', estimator=RandomForestClassifier
(),
             n_jobs=-1,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': range(2, 8),
                         'max_features': ['sqrt', 'log2'],
                         'n_estimators': [10, 20, 67, 240, 110, 100, 25
0]})
```

In [122]:
```
grid.best_params_
```

Out[122]:
```
{'criterion': 'gini',
 'max_depth': 7,
 'max_features': 'log2',
 'n_estimators': 250}
```

In [57]:
```
clf_0 = RandomForestClassifier(criterion= 'gini', max_depth= 7,max_features
```

In [58]:
```
clf_0.fit(x_train, y_train)
```

Out[58]:
```
RandomForestClassifier(max_depth=7, max_features='log2', n_estimators=25
0)
```

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In [59]:
```
clf_0.score(x_test, y_test)
```

Out[59]:
```
0.8291139240506329
```

In [60]:
```
clf_0.score(x_train, y_train)
```

Out[60]:
```
0.8395173453996984
```

In [61]:
```
prediction_clf = clf_0.predict_proba(x_test)
if len(y_test.unique()) == 1:
    clf_score_0 = accuracy_score(y_test, prediction_clf)
else:
    clf_score_0 = roc_auc_score(y_test, prediction_clf, multi_class="ovr")
clf_score_0
```

Out[61]:
```
0.934690768293213
```

KNN

In [62]:
```
knn_0 = KNeighborsClassifier()
```

In [63]:
```
knn_0.fit(x_train, y_train)
```

Out[63]:
```
KNeighborsClassifier()
```

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In [64]:
```
knn_0.score(x_test, y_test)
```

Out[64]:
```
0.9205344585091421
```

In [65]:
```
knn_0.score(x_train, y_train)
```

Out[65]:
```
0.9282051282051282
```

In [132]:
```
param_knn_0 = {'n_neighbors' : [i for i in range(5, 25)],
    'algorithm' : ['auto', 'ball_tree', 'kd_tree', 'brute'],
    'leaf_size' : [8,9,11,12,21,50,20,60,70,100],
    'p' : [1,2],
    'weights' : ['uniform','distance']

}
```

In [133]:
```
grid = GridSearchCV(estimator = knn_0, param_grid = param_knn_0, cv= 10, n_
```

In [137]:
```
grid.fit(x_train, y_train)
```

Out[137]:
```
GridSearchCV(cv=10, error_score='raise', estimator=KNeighborsClassifier
(),
             n_jobs=-1,
             param_grid={'algorithm': ['auto', 'ball_tree', 'kd_tree', 'b
rute'],
                         'leaf_size': [8, 9, 11, 12, 21, 50, 20, 60, 70,
100],
                         'n_neighbors': [5, 6, 7, 8, 9, 10, 11, 12, 13, 1
4, 15,
                                         16, 17, 18, 19, 20, 21, 22, 23,
24],
                         'p': [1, 2], 'weights': ['uniform', 'distanc
e']})
```

In [138]:
```
grid.best_params_
```

Out[138]:
```
{'algorithm': 'auto',
 'leaf_size': 8,
 'n_neighbors': 5,
 'p': 1,
 'weights': 'distance'}
```

In [66]:
```
knn_0 = KNeighborsClassifier(algorithm= 'auto', leaf_size= 8, n_neighbors=
```

In [67]:
```
knn_0.fit(x_train, y_train)
```

Out[67]:
```
KNeighborsClassifier(leaf_size=8, p=1, weights='distance')
```

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In [68]:
```
knn_0.score(x_test, y_test)
```

Out[68]:
```
0.9240506329113924
```

In [69]:
```
knn_0.score(x_train, y_train)
```

Out[69]:
```
1.0
```

In [70]:
```
prediction_score = knn_0.predict_proba(x_test)
if len(y_test.unique()) == 1:
    knn_score_0 = accuracy_score(y_test, prediction_score)
else:
    knn_score_0 = roc_auc_score(y_test, prediction_score, multi_class="ovr'
```

SVM

In [71]:
```
svm_0 = SVC()
```

In [72]:
```
svm_0.fit(x_train, y_train)
```

Out[72]:
```
SVC()
```

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In [73]:
```
svm_0.score(x_test, y_test)
```

Out[73]:
```
0.6315049226441631
```

In [74]:
```
svm_0.score(x_train, y_train)
```

Out[74]:
```
0.6132730015082957
```

In [148]:
```
param_svm_0 = {
    'kernel' :['linear', 'poly', 'rbf', 'sigmoid']
}
```

In [149]:
```
grid = GridSearchCV(estimator = svm_0, param_grid = param_svm_0, cv= 10, n_
```

In [150]:
```
grid.fit(x_train, y_train)
```

Out[150]:
```
GridSearchCV(cv=10, error_score='raise', estimator=SVC(), n_jobs=-1,
             param_grid={'kernel': ['linear', 'poly', 'rbf', 'sigmoid']})
```

In [151]:
```
grid.best_params_
```

Out[151]:
```
{'kernel': 'linear'}
```

In [75]:
```
svm_0 = SVC(kernel= 'linear')
```

In [76]:
```
svm_0.fit(x_train, y_train)
```

Out[76]:
```
SVC(kernel='linear')
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [77]:
```
svm_0.score(x_test, y_test)
```

Out[77]:
```
0.6870604781997187
```

In [78]:

```
svm_0.score(x_train, y_train)
```

Out[78]:

```
0.6911010558069381
```

In [79]:

```
prediction_svm_0 = svm_0.score(x_test,y_test)
```

Decision Tree

In [80]:

```
dt_0 = DecisionTreeClassifier()
```

In [81]:

```
dt_0.fit(x_train, y_train)
```

Out[81]:

```
DecisionTreeClassifier()
```

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In [82]:

```
dt_0.score(x_test, y_test)
```

Out[82]:

```
0.9683544303797469
```

In [83]:

```
dt_0.score(x_train, y_train)
```

Out[83]:

```
1.0
```

In [163]:

```
param_dt_0 = { "criterion" : ['gini', 'entropy'],
             "splitter" : ['best', 'random'],
             "max_depth" : range(2, 40, 1),
             "min_samples_split" : range(2, 10, 1),
             "min_samples_leaf" : range(1, 10, 1)

}
```

In [164]:

```
grid = GridSearchCV(estimator = dt_0, param_grid = param_dt_0, cv= 10, n_j
```

In [165]:

```
grid.fit(x_train, y_train)
```

Out[165]:

```
GridSearchCV(cv=10, error_score='raise', estimator=DecisionTreeClassifier
(),
             n_jobs=-1,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': range(2, 40),
                         'min_samples_leaf': range(1, 10),
                         'min_samples_split': range(2, 10),
                         'splitter': ['best', 'random']})
```

In [166]:
```
grid.best_params_
```

Out[166]:
```
{'criterion': 'gini',
 'max_depth': 39,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'splitter': 'random'}
```

In [84]:
```
dt_0 = DecisionTreeClassifier(criterion= 'gini', max_depth= 39, min_samples
```

In [85]:
```
dt_0.fit(x_train, y_train)
```

Out[85]:
```
DecisionTreeClassifier(max_depth=39, splitter='random')
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [86]:
```
dt_0.score(x_test, y_test)
```

Out[86]:
```
0.9669479606188467
```

In [87]:
```
dt_0.score(x_train,y_train)
```

Out[87]:
```
1.0
```

In [88]:
```
prediction_dt = dt_0.predict_proba(x_test)
dt_score_0 = roc_auc_score(y_test, prediction_dt, multi_class='ovr')
```

Model Accuracy

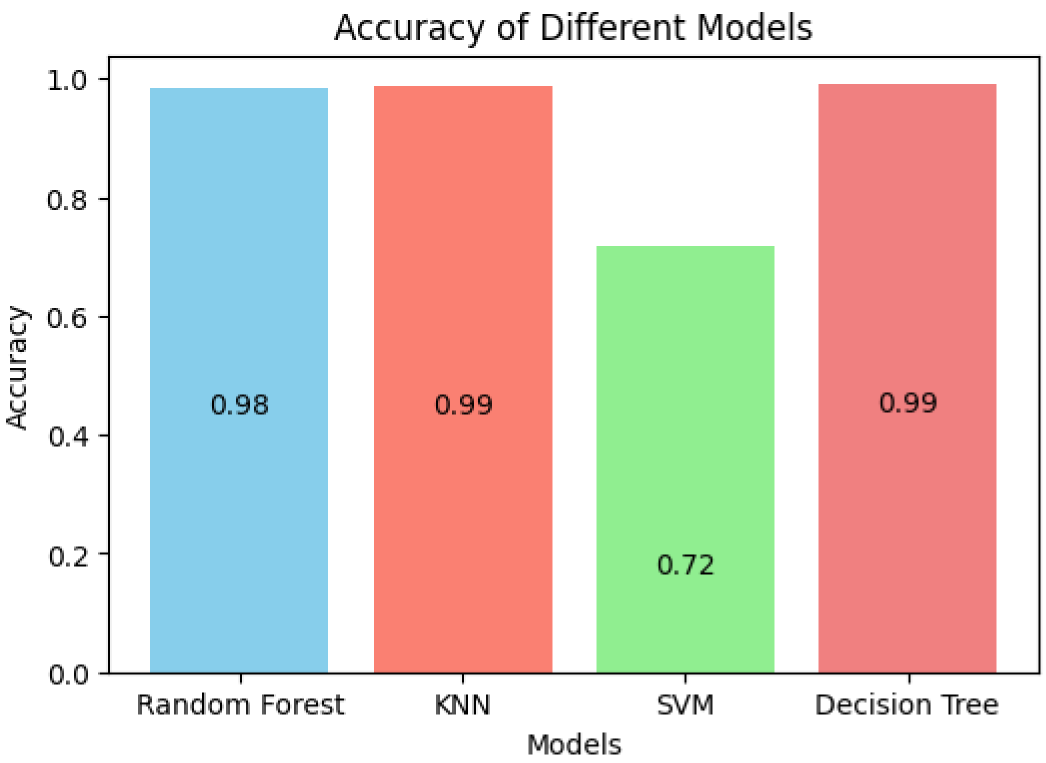
Cluster number 2

In [89]:
```
import matplotlib.pyplot as plt
```

In [90]:
```
models = ['Random Forest', 'KNN', 'SVM', 'Decision Tree']

accuracies = [clf_score_2, knn_score_2, prediction_svm_2, dt_score_2]
colors = ['skyblue', 'salmon', 'lightgreen', 'lightcoral']


plt.figure(figsize=(6, 4))
bars = plt.bar(models, accuracies, color=colors)
plt.xlabel('Models')
plt.ylabel('Accuracy')
plt.title('Accuracy of Different Models')
for bar, acc in zip(bars, accuracies):
    plt.text(bar.get_x() + bar.get_width() / 2, bar.get_height() - 0.55, f
plt.show()
```



As Decision Tree has the highest accuracy score we will consider DT as our Model for cluster number 2

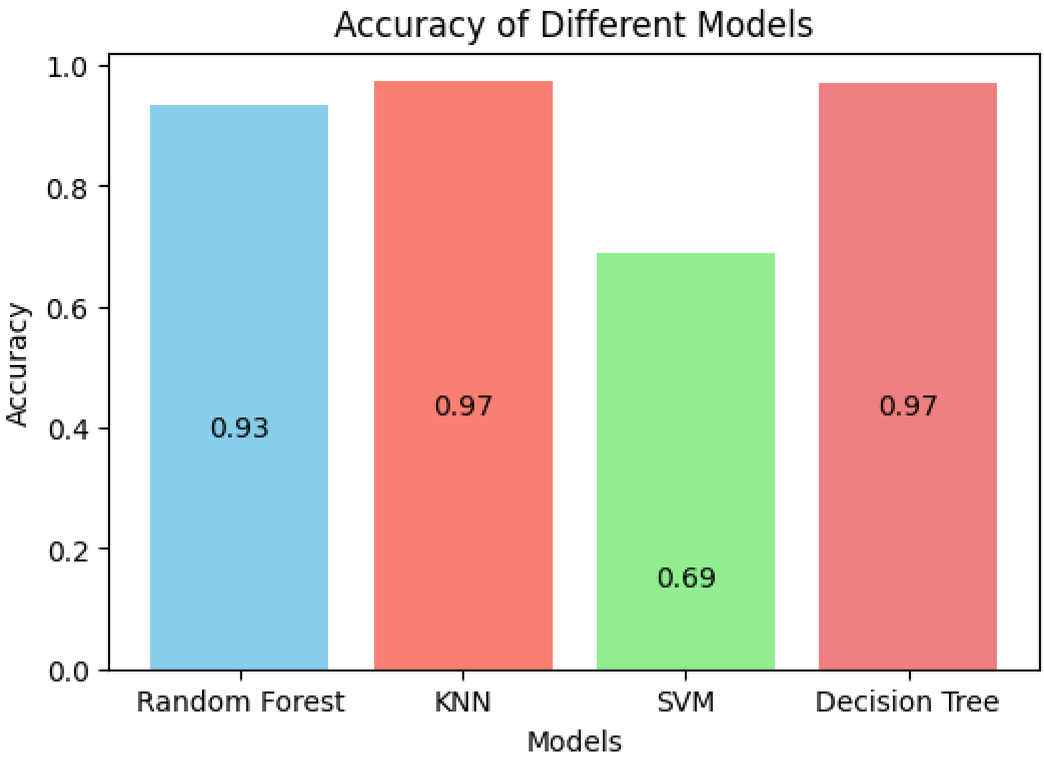
In [91]:
```
with open("dt.pkl", 'wb') as f:
    pickle.dump(dt,f)
```

Cluster number 0

In [92]:
```
models = ['Random Forest', 'KNN', 'SVM', 'Decision Tree']

accuracies = [clf_score_0, knn_score_0, prediction_svm_0, dt_score_0]
colors = ['skyblue', 'salmon', 'lightgreen', 'lightcoral']


plt.figure(figsize=(6, 4))
bars = plt.bar(models, accuracies, color=colors)
plt.xlabel('Models')
plt.ylabel('Accuracy')
plt.title('Accuracy of Different Models')
for bar, acc in zip(bars, accuracies):
    plt.text(bar.get_x() + bar.get_width() / 2, bar.get_height() - 0.55, f
plt.show()
```



As we have chosen KNN and DT for other two clusters so we will be considering Random Forest for cluster number 0

In [94]:
```
with open("clf.pkl", 'wb') as f:
    pickle.dump(clf_0,f)
```