In [87]:
```python
import numpy as np
import pandas as pd

from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, classification_report
from sklearn.metrics import precision_score, recall_score
```

Reading excel file

In [88]:
```python
data_file = pd.read_csv("Data_for_UCI_named.csv")   # read csv file
```

In [89]:
```python
data_file
```

Out[89]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4	sta
0	2.959060	3.079885	8.381025	9.780754	3.763085	-0.782604	-1.257395	-1.723086	0.650456	0.859578	0.887445	0.958034	0.05534
1	9.304097	4.902524	3.047541	1.369357	5.067812	-1.940058	-1.872742	-1.255012	0.413441	0.862414	0.562139	0.781760	-0.00595
2	8.971707	8.848428	3.046479	1.214518	3.405158	-1.207456	-1.277210	-0.920492	0.163041	0.766689	0.839444	0.109853	0.00347
3	0.716415	7.669600	4.486641	2.340563	3.963791	-1.027473	-1.938944	-0.997374	0.446209	0.976744	0.929381	0.362718	0.02887
4	3.134112	7.608772	4.943759	9.857573	3.525811	-1.125531	-1.845975	-0.554305	0.797110	0.455450	0.656947	0.820923	0.04986
...	...	...	...	...	...	...	...	...	...	...	...	...	
9995	2.930406	9.487627	2.376524	6.187797	3.343416	-0.658054	-1.449106	-1.236256	0.601709	0.779642	0.813512	0.608385	0.02389
9996	3.392299	1.274827	2.954947	6.894759	4.349512	-1.663661	-0.952437	-1.733414	0.502079	0.567242	0.285880	0.366120	-0.02580
9997	2.364034	2.842030	8.776391	1.008906	4.299976	-1.380719	-0.943884	-1.975373	0.487838	0.986505	0.149286	0.145984	-0.03181
9998	9.631511	3.994398	2.757071	7.821347	2.514755	-0.966330	-0.649915	-0.898510	0.365246	0.587558	0.889118	0.818391	0.03778
9999	6.530527	6.781790	4.349695	8.673138	3.492807	-1.390285	-1.532193	-0.570329	0.073056	0.505441	0.378761	0.942631	0.04526

10000 rows × 14 columns

In [90]:
```python
data_file.columns
```

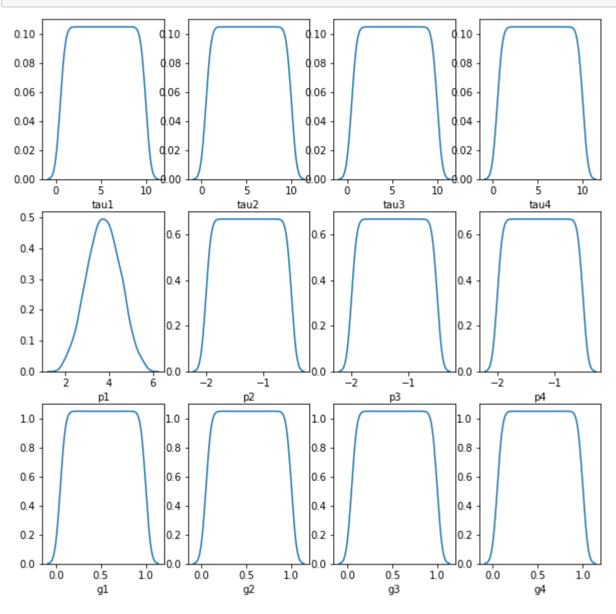
Out[90]:
```
Index(['tau1', 'tau2', 'tau3', 'tau4', 'p1', 'p2', 'p3', 'p4', 'g1', 'g2',
       'g3', 'g4', 'stab', 'stabf'],
      dtype='object')
```

In [91]:
```python
data_file.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 14 columns):
tau1     10000 non-null float64
tau2     10000 non-null float64
tau3     10000 non-null float64
tau4     10000 non-null float64
p1       10000 non-null float64
p2       10000 non-null float64
p3       10000 non-null float64
p4       10000 non-null float64
g1       10000 non-null float64
g2       10000 non-null float64
g3       10000 non-null float64
g4       10000 non-null float64
stab     10000 non-null float64
stabf    10000 non-null object
dtypes: float64(13), object(1)
memory usage: 1.1+ MB
```

In [92]:
```python
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

In [93]:
```python
figure = plt.figure(figsize = (10,10))
column_list =list(data_file.columns[:-2])
for i, v in enumerate(column_list):
    figure.add_subplot(3, 4, i+1)
    sns.distplot(data_file[v], hist = False)          #plotting all the values
```



In [95]:
```python
# Seperated the target and data from each other
# target = stabf and data is all the data except stabf and stab
def preprocess_inputs(df, task='classification'):
    df = df.copy()

    if task == 'classification':
        df = df.drop('stab', axis=1)

        y = df['stabf'].copy()
        X = df.drop('stabf', axis=1).copy()

    elif task == 'regression':
        df = df.drop('stabf', axis=1)

        y = df['stab'].copy()
        X = df.drop('stab', axis=1).copy()

    X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.8, shuffle=True, random_stat
e=1)

    return X_train, X_test, y_train, y_test
```

CLASSIFICATION

In [96]:
```python
# Train test splitting
X_train, X_test, y_train, y_test = preprocess_inputs(data_file, task='classification')
```

In [97]:
```python
X_train
```

Out[97]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4
2694	6.255995	2.542401	7.024714	9.476518	3.529888	-1.224881	-0.688228	-1.616780	0.568221	0.618403	0.685739	0.660088
5140	5.070581	5.490253	8.075688	0.761075	4.220888	-1.280596	-1.902185	-1.038107	0.443515	0.097244	0.916955	0.129254
2568	1.220072	8.804028	3.874283	8.433949	3.614027	-1.039236	-0.953566	-1.621224	0.908353	0.923594	0.238881	0.660156
3671	7.498402	6.697603	8.798626	2.126236	3.134585	-1.581906	-0.589386	-0.963293	0.260826	0.899003	0.964752	0.600598
7427	7.074006	1.337511	6.100756	7.759156	2.526922	-0.922540	-0.632600	-0.971782	0.984580	0.716082	0.836928	0.165162
...	...	...	...	...	...	...	...	...	...	...	...	...
2895	9.504984	5.265415	2.029617	8.026334	3.449756	-0.922754	-1.526305	-1.000696	0.191864	0.611297	0.080008	0.350312
7813	8.035818	4.632548	1.177810	1.204950	4.093208	-1.568218	-0.819966	-1.705024	0.223384	0.317770	0.726623	0.441620
905	7.052560	3.264057	1.405949	4.497549	3.741358	-0.629026	-1.407945	-1.704387	0.868306	0.605566	0.100591	0.747320
5192	5.085242	1.790031	2.486392	2.848192	3.159670	-0.892898	-1.025461	-1.241311	0.473917	0.418512	0.326253	0.982488
235	1.205354	6.995045	5.930860	2.523856	5.230127	-1.755047	-1.567927	-1.907153	0.861961	0.202768	0.848373	0.739993

8000 rows × 12 columns

In [98]:
```python
y_train
```

Out[98]:
```
2694    unstable
5140    unstable
2568    unstable
3671    unstable
7427    unstable
          ...
2895      stable
7813      stable
905     unstable
5192    unstable
235       stable
Name: stabf, Length: 8000, dtype: object
```

Stochastic Gradient Descent

In [99]:
```python
from sklearn.linear_model import SGDClassifier
sgd_clf = SGDClassifier()
sgd_clf.fit(X_train, y_train)                    # fitting data
```

Out[99]:
```
SGDClassifier(alpha=0.0001, average=False, class_weight=None,
              early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
              l1_ratio=0.15, learning_rate='optimal', loss='hinge',
              max_iter=1000, n_iter_no_change=5, n_jobs=None, penalty='l2',
              power_t=0.5, random_state=None, shuffle=True, tol=0.001,
              validation_fraction=0.1, verbose=0, warm_start=False)
```

In [100]:
```python
X_test[:5]        # Checking for first 5 test data
```

Out[100]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4
9953	6.877876	4.113820	9.356768	8.299753	4.056779	-1.897470	-1.590581	-0.568728	0.276567	0.845536	0.112440	0.822562
3850	5.802841	6.271371	4.731540	3.819867	3.579569	-1.709480	-1.067511	-0.802579	0.077527	0.416478	0.912846	0.861306
4962	2.286998	4.385142	2.830232	5.293880	3.035814	-1.202764	-0.902011	-0.931039	0.924216	0.130186	0.703887	0.063811
3886	5.019920	2.209962	6.266080	0.578901	4.322584	-1.960207	-1.074561	-1.287815	0.546910	0.065992	0.427349	0.814648
5437	7.646145	9.187896	5.484219	9.934313	3.634226	-1.254541	-1.335366	-1.044319	0.561528	0.121611	0.787318	0.300314

In [101]:
```python
y_test            # Checking for first 5 test data labels
```

Out[101]:
```
9953    unstable
3850    unstable
4962      stable
3886      stable
5437    unstable
          ...
3919      stable
162       stable
7903      stable
2242    unstable
2745    unstable
Name: stabf, Length: 2000, dtype: object
```

In [102]:
```python
sgd_clf.predict(X_test)        # Predicting first 5 test data labels
```

Out[102]:
```
array(['unstable', 'unstable', 'stable', ..., 'unstable', 'stable',
       'unstable'], dtype='<U8')
```

In [103]:
```python
from sklearn.model_selection import cross_val_score
score = cross_val_score(sgd_clf, X_train,y_train, scoring ='roc_auc', cv=4)
score.mean()
```

Out[103]: 0.881347713758724

In [104]:
```python
y_pred = sgd_clf.predict(X_test)
```

In [105]:
```python
confusion_matrix(y_test,y_pred)        # confusion matrix values
```

Out[105]:
```
array([[ 539,  173],
       [ 252, 1036]], dtype=int64)
```

In [106]:
```python
# precision score and recall score
precision_score(y_test,y_pred, pos_label="stable"), recall_score(y_test,y_pred, pos_label="stable")
```

Out[106]: (0.6814159292035398, 0.7570224719101124)

In [107]:
```python
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

      stable       0.68      0.76      0.72       712
    unstable       0.86      0.80      0.83      1288

    accuracy                           0.79      2000
   macro avg       0.77      0.78      0.77      2000
weighted avg       0.79      0.79      0.79      2000
```

Support Vector Machines

In [108]:
```python
from sklearn import svm
svm_clf = svm.SVC()
svm_clf.fit(X_train, y_train)
```

```
C:\Users\17328\Anaconda3\lib\site-packages\sklearn\svm\base.py:193: FutureWarning: The default value
of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features.
Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
```

Out[108]:
```
SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
    decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
    kernel='rbf', max_iter=-1, probability=False, random_state=None,
    shrinking=True, tol=0.001, verbose=False)
```

In [109]:
```python
X_test[:5]         # Checking for first 5 test data
```

Out[109]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4
9953	6.877876	4.113820	9.356768	8.299753	4.056779	-1.897470	-1.590581	-0.568728	0.276567	0.845536	0.112440	0.822562
3850	5.802841	6.271371	4.731540	3.819867	3.579569	-1.709480	-1.067511	-0.802579	0.077527	0.416478	0.912846	0.861306
4962	2.286998	4.385142	2.830232	5.293880	3.035814	-1.202764	-0.902011	-0.931039	0.924216	0.130186	0.703887	0.063811
3886	5.019920	2.209962	6.266080	0.578901	4.322584	-1.960207	-1.074561	-1.287815	0.546910	0.065992	0.427349	0.814648
5437	7.646145	9.187896	5.484219	9.934313	3.634226	-1.254541	-1.335366	-1.044319	0.561528	0.121611	0.787318	0.300314

In [110]:
```python
y_test[:5]      # Checking for first 5 test data
```

Out[110]:
```
9953    unstable
3850    unstable
4962      stable
3886      stable
5437    unstable
Name: stabf, dtype: object
```

In [111]:
```python
svm_clf.predict(X_test[:5])      # Predicting first 5 test data
```

Out[111]:
```
array(['unstable', 'unstable', 'stable', 'stable', 'unstable'],
      dtype=object)
```

In [112]:
```python
y_pred_svm = svm_clf.predict(X_test)       # predicting all test data
```

In [113]:
```python
confusion_matrix(y_test, y_pred_svm)
```

Out[113]:
```
array([[ 602,  110],
       [  61, 1227]], dtype=int64)
```

In [114]:
```python
precision_score(y_test, y_pred_svm, pos_label = "stable"), recall_score(y_test, y_pred_svm, pos_label
= "stable")
```

Out[114]: (0.9079939668174962, 0.8455056179775281)

In [115]:
```python
print(classification_report(y_test, y_pred_svm))
```

```
              precision    recall  f1-score   support

      stable       0.91      0.85      0.88       712
    unstable       0.92      0.95      0.93      1288

    accuracy                           0.91      2000
   macro avg       0.91      0.90      0.91      2000
weighted avg       0.91      0.91      0.91      2000
```

Naive Bayes

In [116]:
```python
from sklearn.naive_bayes import GaussianNB
```

In [117]:
```python
gnb = GaussianNB()
```

In [118]:
```python
gnb.fit(X_train, y_train)
```

Out[118]: GaussianNB(priors=None, var_smoothing=1e-09)

In [119]:
```python
X_test[:5]     # Checking for first 5 test data
```

Out[119]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4
9953	6.877876	4.113820	9.356768	8.299753	4.056779	-1.897470	-1.590581	-0.568728	0.276567	0.845536	0.112440	0.822562
3850	5.802841	6.271371	4.731540	3.819867	3.579569	-1.709480	-1.067511	-0.802579	0.077527	0.416478	0.912846	0.861306
4962	2.286998	4.385142	2.830232	5.293880	3.035814	-1.202764	-0.902011	-0.931039	0.924216	0.130186	0.703887	0.063811
3886	5.019920	2.209962	6.266080	0.578901	4.322584	-1.960207	-1.074561	-1.287815	0.546910	0.065992	0.427349	0.814648
5437	7.646145	9.187896	5.484219	9.934313	3.634226	-1.254541	-1.335366	-1.044319	0.561528	0.121611	0.787318	0.300314

In [120]:
```python
y_test[:5]      # Checking for first 5 test data
```

Out[120]:
```
9953    unstable
3850    unstable
4962      stable
3886      stable
5437    unstable
Name: stabf, dtype: object
```

In [121]:
```python
gnb.predict(X_test[:5])     # Predicting first 5 test data
```

Out[121]:
```
array(['unstable', 'unstable', 'stable', 'stable', 'unstable'],
      dtype='<U8')
```

In [122]:
```python
y_pred_gnb = gnb.predict(X_test)     # Predicting all test data
```

In [123]:
```python
confusion_matrix(y_test, y_pred_gnb)
```

Out[123]:
```
array([[ 476,  236],
       [ 106, 1182]], dtype=int64)
```

In [124]:
```python
precision_score(y_test, y_pred_gnb, pos_label = "stable"), recall_score(y_test, y_pred_gnb, pos_label
= "stable")
```

Out[124]: (0.8178694158075601, 0.6685393258426966)

In [125]:
```python
print(classification_report(y_test, y_pred_gnb))
```

```
              precision    recall  f1-score   support

      stable       0.82      0.67      0.74       712
    unstable       0.83      0.92      0.87      1288

    accuracy                           0.83      2000
   macro avg       0.83      0.79      0.80      2000
weighted avg       0.83      0.83      0.82      2000
```

Decision Trees

In [126]:
```python
from sklearn import tree
tree_clf = tree.DecisionTreeClassifier()
tree_clf.fit(X_train, y_train)
```

Out[126]:
```
DecisionTreeClassifier(class_weight=None, criterion='gini', max_depth=None,
                       max_features=None, max_leaf_nodes=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, presort=False,
                       random_state=None, splitter='best')
```

In [127]:
```python
X_test[:5]      # Checking for first 5 test data
```

Out[127]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4
9953	6.877876	4.113820	9.356768	8.299753	4.056779	-1.897470	-1.590581	-0.568728	0.276567	0.845536	0.112440	0.822562
3850	5.802841	6.271371	4.731540	3.819867	3.579569	-1.709480	-1.067511	-0.802579	0.077527	0.416478	0.912846	0.861306
4962	2.286998	4.385142	2.830232	5.293880	3.035814	-1.202764	-0.902011	-0.931039	0.924216	0.130186	0.703887	0.063811
3886	5.019920	2.209962	6.266080	0.578901	4.322584	-1.960207	-1.074561	-1.287815	0.546910	0.065992	0.427349	0.814648
5437	7.646145	9.187896	5.484219	9.934313	3.634226	-1.254541	-1.335366	-1.044319	0.561528	0.121611	0.787318	0.300314

In [128]:
```python
y_test[:5]      # Checking for first 5 test data
```

Out[128]:
```
9953    unstable
3850    unstable
4962      stable
3886      stable
5437    unstable
Name: stabf, dtype: object
```

In [129]:
```python
tree_clf.predict(X_test[:5])        # Predicting first 5 test data
```

Out[129]:
```
array(['unstable', 'unstable', 'stable', 'stable', 'unstable'],
      dtype=object)
```

In [130]:
```python
y_pred_tree = tree_clf.predict(X_test)  # Predicting all test data
```

In [131]:
```python
confusion_matrix(y_test, y_pred_tree)
```

Out[131]:
```
array([[ 576,  136],
       [ 144, 1144]], dtype=int64)
```

In [132]:
```python
precision_score(y_test, y_pred_tree, pos_label = "stable"), recall_score(y_test, y_pred_tree, pos_labe
l = "stable")
```

Out[132]: (0.8, 0.8089887640449438)

In [133]:
```python
print(classification_report(y_test, y_pred_tree))
```

```
              precision    recall  f1-score   support

      stable       0.80      0.81      0.80       712
    unstable       0.89      0.89      0.89      1288

    accuracy                           0.86      2000
   macro avg       0.85      0.85      0.85      2000
weighted avg       0.86      0.86      0.86      2000
```

K Nearest Neighbors

In [134]:
```python
from sklearn.neighbors import KNeighborsClassifier
```

In [135]:
```python
classifier = KNeighborsClassifier(n_neighbors=5)
classifier.fit(X_train, y_train)
```

Out[135]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=5, p=2,
                     weights='uniform')
```

In [136]:
```python
X_test[:5]         # Checking for first 5 test data
```

Out[136]:

	tau1	tau2	tau3	tau4	p1	p2	p3	p4	g1	g2	g3	g4
9953	6.877876	4.113820	9.356768	8.299753	4.056779	-1.897470	-1.590581	-0.568728	0.276567	0.845536	0.112440	0.822562
3850	5.802841	6.271371	4.731540	3.819867	3.579569	-1.709480	-1.067511	-0.802579	0.077527	0.416478	0.912846	0.861306
4962	2.286998	4.385142	2.830232	5.293880	3.035814	-1.202764	-0.902011	-0.931039	0.924216	0.130186	0.703887	0.063811
3886	5.019920	2.209962	6.266080	0.578901	4.322584	-1.960207	-1.074561	-1.287815	0.546910	0.065992	0.427349	0.814648
5437	7.646145	9.187896	5.484219	9.934313	3.634226	-1.254541	-1.335366	-1.044319	0.561528	0.121611	0.787318	0.300314

In [137]:
```python
y_test[:5]      # Checking for first 5 test data
```

Out[137]:
```
9953    unstable
3850    unstable
4962      stable
3886      stable
5437    unstable
Name: stabf, dtype: object
```

In [138]:
```python
classifier.predict(X_test[:5])        # Predicting first 5 test data
```

Out[138]:
```
array(['unstable', 'unstable', 'unstable', 'stable', 'unstable'],
      dtype=object)
```

In [139]:
```python
y_pred_knn = classifier.predict(X_test)     # Predicting all test data
```

In [140]:
```python
confusion_matrix(y_test, y_pred_knn)
```

Out[140]:
```
array([[ 488,  224],
       [ 189, 1099]], dtype=int64)
```

In [141]:
```python
precision_score(y_test, y_pred_knn, pos_label = "stable"), recall_score(y_test, y_pred_knn, pos_label
= "stable")
```

Out[141]: (0.7208271787296898, 0.6853932584269663)

In [142]:
```python
print(classification_report(y_test, y_pred_knn))
```

```
              precision    recall  f1-score   support

      stable       0.72      0.69      0.70       712
    unstable       0.83      0.85      0.84      1288

    accuracy                           0.79      2000
   macro avg       0.78      0.77      0.77      2000
weighted avg       0.79      0.79      0.79      2000
```

In conclusion, it can be seen through the 5 predictive models that Decision tree is performing better than others due to overfitting

Attributes and Distributions are evaluated

Confusion matrix , precision and recall score are calculated for all 5 models

1. Stochastic Gradient Descent

2. Support vector machines

3. Naive Bayes

4. Decision trees

5. Knn