Predict Stress Level By Sleeping Hours

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In [2]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split

from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
import time
from sklearn.ensemble import RandomForestClassifier, VotingClassifier
from sklearn.model_selection import GridSearchCV


from sklearn.metrics import confusion_matrix, classification_report, accuracy_score

import warnings
warnings.filterwarnings("ignore")
```

In [55]:
```
data = pd.read_csv("https://raw.githubusercontent.com/Lindaaa0/Dataset/master/SaYoPillow.csv")
data
```

Out[55]:

	sr	rr	t	lm	bo	rem	sr.1	hr	sl
0	93.800	25.680	91.840	16.600	89.840	99.60	1.840	74.20	3
1	91.640	25.104	91.552	15.880	89.552	98.88	1.552	72.76	3
2	60.000	20.000	96.000	10.000	95.000	85.00	7.000	60.00	1
3	85.760	23.536	90.768	13.920	88.768	96.92	0.768	68.84	3
4	48.120	17.248	97.872	6.496	96.248	72.48	8.248	53.12	0
...	...	...	...	...	...	...	...	...	...
625	69.600	20.960	92.960	10.960	90.960	89.80	3.440	62.40	2
626	48.440	17.376	98.064	6.752	96.376	73.76	8.376	53.44	0
627	97.504	27.504	86.880	17.752	84.256	101.88	0.000	78.76	4
628	58.640	19.728	95.728	9.728	94.592	84.32	6.728	59.32	1
629	73.920	21.392	93.392	11.392	91.392	91.96	4.088	63.48	2

630 rows × 9 columns

In [4]:
```
data.columns = ['snoring_rate', 'respiration_rate', 'body_temperature', 'limb_movement',
                'blood_oxygen', 'eye_movement', 'sleeping_hours', 'heart_rate', 'stress_level']
```

Exploratory Data Analysis (EDA)

In [5]:
```
data.isnull().sum()
```

Out[5]:
```
snoring_rate        0
respiration_rate    0
body_temperature    0
limb_movement       0
blood_oxygen        0
eye_movement        0
sleeping_hours      0
heart_rate          0
stress_level        0
dtype: int64
```

Tidak ada missing value pada tiap variabel/instances

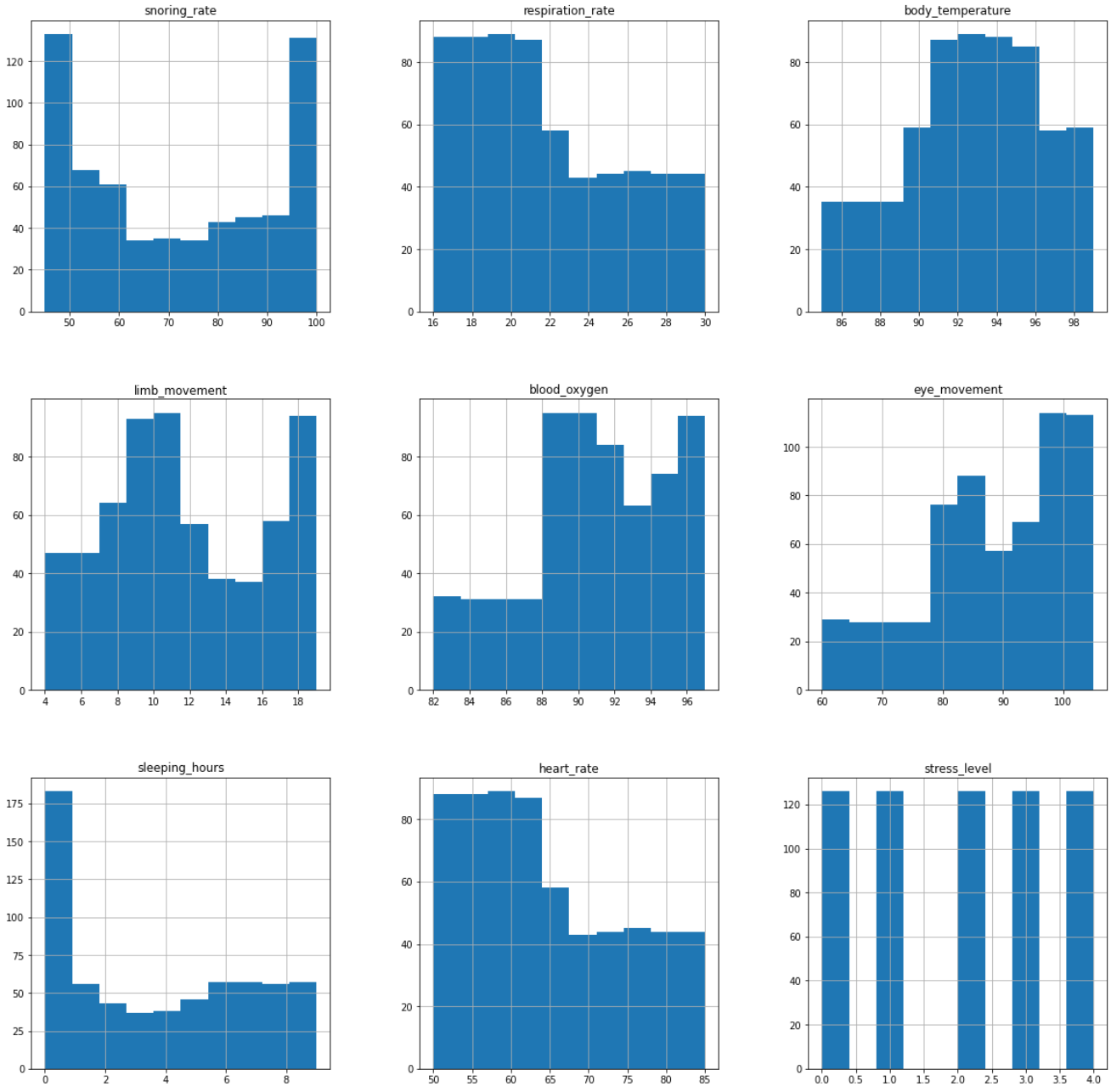
In [6]:
```
data.describe()
```

Out[6]:

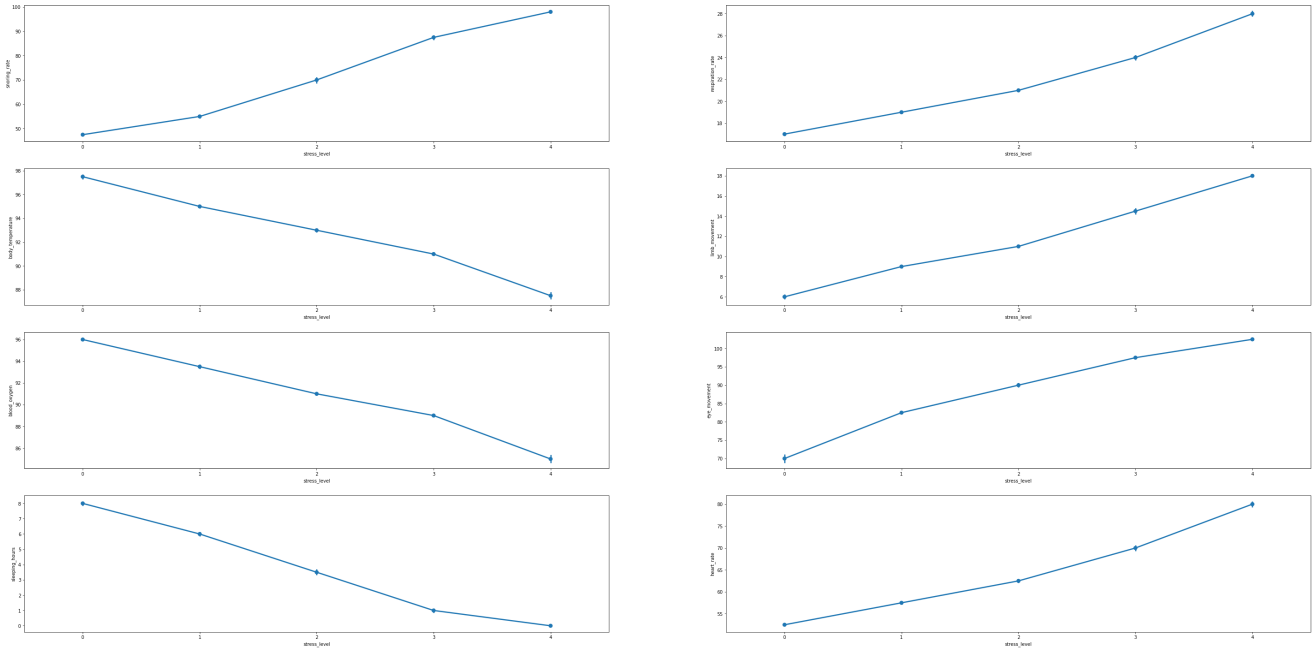
	snoring_rate	respiration_rate	body_temperature	limb_movement	blood_oxygen	eye_movement	sleeping_hours	heart_rate	stress_level
count	630.000000	630.000000	630.00000	630.000000	630.000000	630.000000	630.000000	630.000000	630.000000
mean	71.600000	21.800000	92.80000	11.700000	90.900000	88.500000	3.700000	64.500000	2.000000
std	19.372833	3.966111	3.52969	4.299629	3.902483	11.893747	3.054572	9.915277	1.415337
min	45.000000	16.000000	85.00000	4.000000	82.000000	60.000000	0.000000	50.000000	0.000000
25%	52.500000	18.500000	90.50000	8.500000	88.500000	81.250000	0.500000	56.250000	1.000000
50%	70.000000	21.000000	93.00000	11.000000	91.000000	90.000000	3.500000	62.500000	2.000000
75%	91.250000	25.000000	95.50000	15.750000	94.250000	98.750000	6.500000	72.500000	3.000000
max	100.000000	30.000000	99.00000	19.000000	97.000000	105.000000	9.000000	85.000000	4.000000

Data Visualization

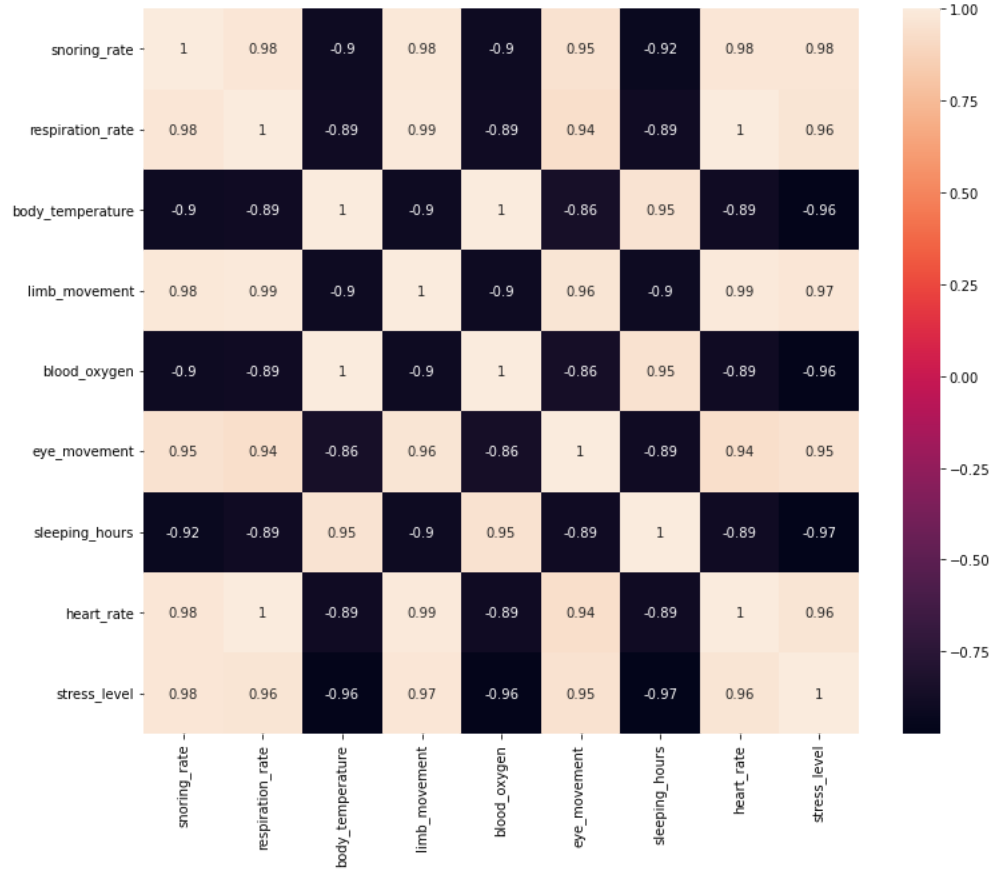
In [7]:
```
dist = data.hist(figsize = (20, 20))
```



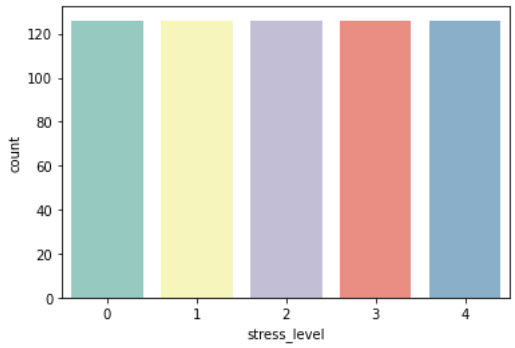
In [8]:
```
fig = plt.figure(figsize=(50, 25))
rows = 4
columns = 2
for i in range(len(data.columns[:-1])):
  fig.add_subplot(rows, columns, (i+1))
  img = sns.pointplot(x='stress_level',y=data.columns[i],data=data)
plt.show()
```



In [9]:
```
plt.figure(figsize = (12, 10))
p = sns.heatmap(data.corr(), annot = True)
```



In [10]:
```
sns.countplot(x="stress_level", data = data, palette = "Set3")
plt.show()
```



Scaling Data

In [11]:
```
#dropping dependent variable
sc = StandardScaler()
X = pd.DataFrame(sc.fit_transform(data.drop(["stress_level"],axis = 1),), columns=['snoring_rate', 'respiration_rate', 'body_temp
                 'blood_oxygen', 'eye_movement', 'sleeping_hours', 'heart_rate'])
X.head()
```

Out[11]:

	snoring_rate	respiration_rate	body_temperature	limb_movement	blood_oxygen	eye_movement	sleeping_hours	heart_rate
0	1.146845	0.979066	-0.272195	1.140539	-0.271838	0.934005	-0.609407	0.979066
1	1.035260	0.833720	-0.353853	0.972949	-0.345696	0.873421	-0.703767	0.833720
2	-0.599252	-0.454206	0.907316	-0.395697	1.051448	-0.294506	1.081206	-0.454206
3	0.731501	0.438056	-0.576145	0.516734	-0.546753	0.708498	-0.960635	0.438056
4	-1.212970	-1.148636	1.438095	-1.211299	1.371498	-1.347997	1.490099	-1.148636

In [12]:
```
#assigning target variable
y = data.stress_level
y
```

Out[12]:
```
0      3
1      3
2      1
3      3
4      0
      ..
625    2
626    0
627    4
628    1
629    2
Name: stress_level, Length: 630, dtype: int64
```

Model Building

In [31]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state = 42)
```

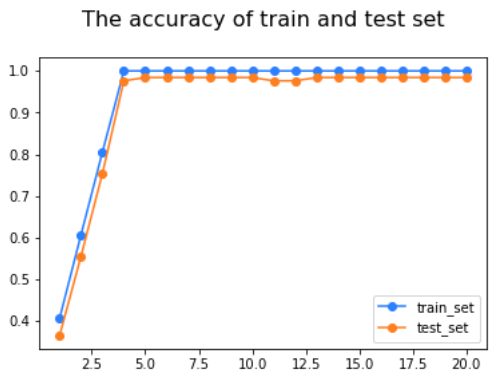
Decision Tree

In [47]:
```
dt = DecisionTreeClassifier()
dt.fit(X_train, y_train)
predict = dt.predict(X_test)
print("Confusion Matrix")
print("=================")
print(confusion_matrix(y_test, predict), "\n")

print("Classification Report")
print("======================")
print(classification_report(y_test, predict))
```

```
Confusion Matrix
=================
[[23  0  0  0  0]
 [ 1 23  0  0  0]
 [ 0  0 28  0  0]
 [ 0  0  0 25  1]
 [ 0  0  0  0 25]]

Classification Report
======================
              precision    recall  f1-score   support

           0       0.96      1.00      0.98        23
           1       1.00      0.96      0.98        24
           2       1.00      1.00      1.00        28
           3       1.00      0.96      0.98        26
           4       0.96      1.00      0.98        25

    accuracy                           0.98       126
   macro avg       0.98      0.98      0.98       126
weighted avg       0.98      0.98      0.98       126
```

In [45]:
```
train_scores, test_scores = list(), list()

values = [i for i in range (1, 21)]
for i in values:
    model = DecisionTreeClassifier(max_depth = i)
    model.fit(X_train, y_train)
    train_yhat = model.predict(X_train)
    train_acc = accuracy_score(y_train, train_yhat)
    train_scores.append(train_acc)
    test_yhat = model.predict(X_test)
    test_acc = accuracy_score(y_test, test_yhat)
    test_scores.append(test_acc)
    print('>%d, train: %.3f, test: %.3f' % (i, train_acc, test_acc))

    # plot of train and test scores vs tree depth
plt.plot(values, train_scores, '-o', label='train_set', color = '#2B80FF')
plt.plot(values, test_scores, '-o', label='test_set', color = '#ff7e20')
plt.legend()
plt.title("The accuracy of train and test set\n", fontsize = 16)
plt.show()
```

```
>1, train: 0.407, test: 0.365
>2, train: 0.607, test: 0.556
>3, train: 0.806, test: 0.754
>4, train: 1.000, test: 0.976
>5, train: 1.000, test: 0.984
>6, train: 1.000, test: 0.984
>7, train: 1.000, test: 0.984
>8, train: 1.000, test: 0.984
>9, train: 1.000, test: 0.984
>10, train: 1.000, test: 0.984
>11, train: 1.000, test: 0.976
>12, train: 1.000, test: 0.976
>13, train: 1.000, test: 0.984
>14, train: 1.000, test: 0.984
>15, train: 1.000, test: 0.984
>16, train: 1.000, test: 0.984
>17, train: 1.000, test: 0.984
>18, train: 1.000, test: 0.984
>19, train: 1.000, test: 0.984
>20, train: 1.000, test: 0.984
```



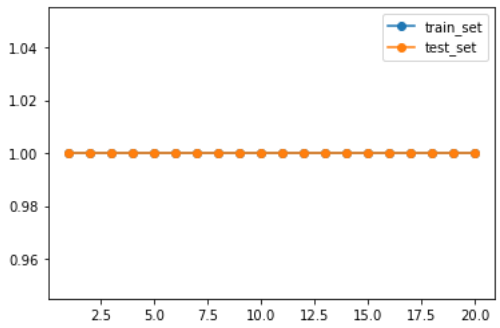
SVM

In [16]:
```
svc_model = SVC()
svc_model.fit(X_train, y_train)

svc_pred = svc_model.predict(X_test)
print(confusion_matrix(y_test, svc_pred))
print(classification_report(y_test, svc_pred))
```

```
[[16  0  0  0  0]
 [ 0 10  0  0  0]
 [ 0  0 14  0  0]
 [ 0  0  0 14  0]
 [ 0  0  0  0  9]]
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      1.00      1.00        10
           2       1.00      1.00      1.00        14
           3       1.00      1.00      1.00        14
           4       1.00      1.00      1.00         9

    accuracy                           1.00        63
   macro avg       1.00      1.00      1.00        63
weighted avg       1.00      1.00      1.00        63
```

In [17]:
```
train_scores, test_scores = list(), list()

values = [i for i in range (1, 21)]
for i in values:
    model = SVC()
    model.fit(X_train, y_train)
    train_yhat = model.predict(X_train)
    train_acc = accuracy_score(y_train, train_yhat)
    train_scores.append(train_acc)
    test_yhat = model.predict(X_test)
    test_acc = accuracy_score(y_test, test_yhat)
    test_scores.append(test_acc)
    print('>%d, train: %.3f, test: %.3f' % (i, train_acc, test_acc))

    # plot of train and test scores vs tree depth
plt.plot(values, train_scores, '-o', label='train_set')
plt.plot(values, test_scores, '-o', label='test_set')
plt.legend()
plt.show()
```

```
>1, train: 1.000, test: 1.000
>2, train: 1.000, test: 1.000
>3, train: 1.000, test: 1.000
>4, train: 1.000, test: 1.000
>5, train: 1.000, test: 1.000
>6, train: 1.000, test: 1.000
>7, train: 1.000, test: 1.000
>8, train: 1.000, test: 1.000
>9, train: 1.000, test: 1.000
>10, train: 1.000, test: 1.000
>11, train: 1.000, test: 1.000
>12, train: 1.000, test: 1.000
>13, train: 1.000, test: 1.000
>14, train: 1.000, test: 1.000
>15, train: 1.000, test: 1.000
>16, train: 1.000, test: 1.000
>17, train: 1.000, test: 1.000
>18, train: 1.000, test: 1.000
>19, train: 1.000, test: 1.000
>20, train: 1.000, test: 1.000
```



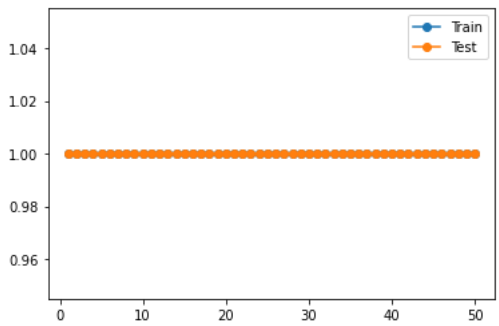
KNN

In [18]:
```
knn = KNeighborsClassifier()
knnModel = knn.fit(X_train, y_train)
knnPred = knn.predict(X_train)
print(confusion_matrix(y_train, knnPred))
print(classification_report(y_train, knnPred))


knnPred = knn.predict(X_test)
print(confusion_matrix(y_test, knnPred))
print(classification_report(y_test, knnPred))
```

```
[[110   0   0   0   0]
 [  0 116   0   0   0]
 [  0   0 112   0   0]
 [  0   0   0 112   0]
 [  0   0   0   0 117]]
              precision    recall  f1-score   support

           0       1.00      1.00      1.00       110
           1       1.00      1.00      1.00       116
           2       1.00      1.00      1.00       112
           3       1.00      1.00      1.00       112
           4       1.00      1.00      1.00       117

    accuracy                           1.00       567
   macro avg       1.00      1.00      1.00       567
weighted avg       1.00      1.00      1.00       567

[[16  0  0  0  0]
 [ 0 10  0  0  0]
 [ 0  0 14  0  0]
 [ 0  0  0 14  0]
 [ 0  0  0  0  9]]
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      1.00      1.00        10
           2       1.00      1.00      1.00        14
           3       1.00      1.00      1.00        14
           4       1.00      1.00      1.00         9

    accuracy                           1.00        63
   macro avg       1.00      1.00      1.00        63
weighted avg       1.00      1.00      1.00        63
```

In [19]:
```
train_scores, test_scores = list(), list()
values = [i for i in range(1, 51)]
for i in values:
    model = KNeighborsClassifier(n_neighbors=i)
    model.fit(X_train, y_train)
    train_yhat = model.predict(X_train)
    train_acc = accuracy_score(y_train, train_yhat)
    train_scores.append(train_acc)
    test_yhat = model.predict(X_test)
    test_acc = accuracy_score(y_test, test_yhat)
    test_scores.append(test_acc)
    print('>%d, train: %.3f, test: %.3f' % (i, train_acc, test_acc))
# plot of train and test scores vs number of neighbors
plt.plot(values, train_scores, '-o', label='Train')
plt.plot(values, test_scores, '-o', label='Test')
plt.legend()
plt.show()
```

```
>1, train: 1.000, test: 1.000
>2, train: 1.000, test: 1.000
>3, train: 1.000, test: 1.000
>4, train: 1.000, test: 1.000
>5, train: 1.000, test: 1.000
>6, train: 1.000, test: 1.000
>7, train: 1.000, test: 1.000
>8, train: 1.000, test: 1.000
>9, train: 1.000, test: 1.000
>10, train: 1.000, test: 1.000
>11, train: 1.000, test: 1.000
>12, train: 1.000, test: 1.000
>13, train: 1.000, test: 1.000
>14, train: 1.000, test: 1.000
>15, train: 1.000, test: 1.000
>16, train: 1.000, test: 1.000
>17, train: 1.000, test: 1.000
>18, train: 1.000, test: 1.000
>19, train: 1.000, test: 1.000
>20, train: 1.000, test: 1.000
>21, train: 1.000, test: 1.000
>22, train: 1.000, test: 1.000
>23, train: 1.000, test: 1.000
>24, train: 1.000, test: 1.000
>25, train: 1.000, test: 1.000
>26, train: 1.000, test: 1.000
>27, train: 1.000, test: 1.000
>28, train: 1.000, test: 1.000
>29, train: 1.000, test: 1.000
>30, train: 1.000, test: 1.000
>31, train: 1.000, test: 1.000
>32, train: 1.000, test: 1.000
>33, train: 1.000, test: 1.000
>34, train: 1.000, test: 1.000
>35, train: 1.000, test: 1.000
>36, train: 1.000, test: 1.000
>37, train: 1.000, test: 1.000
>38, train: 1.000, test: 1.000
>39, train: 1.000, test: 1.000
>40, train: 1.000, test: 1.000
>41, train: 1.000, test: 1.000
>42, train: 1.000, test: 1.000
>43, train: 1.000, test: 1.000
>44, train: 1.000, test: 1.000
>45, train: 1.000, test: 1.000
>46, train: 1.000, test: 1.000
>47, train: 1.000, test: 1.000
>48, train: 1.000, test: 1.000
>49, train: 1.000, test: 1.000
>50, train: 1.000, test: 1.000
```



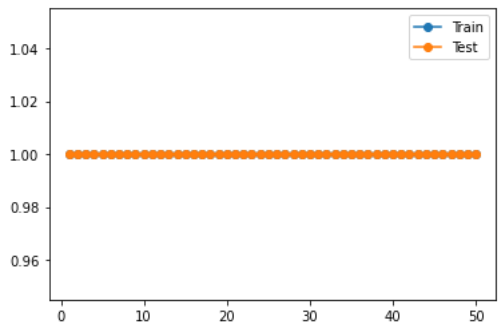
Voting Classifier

In [22]:
```
estimators =[('svm', svc_model), ('KNN', knn), ('DecisionTree', dt)]

ensemble = VotingClassifier(estimators, voting = 'hard')

ensembleModel = ensemble.fit(X_train, y_train)

ensemblePred = ensemble.predict(X_test)
print(classification_report(y_test, ensemblePred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      1.00      1.00        10
           2       1.00      1.00      1.00        14
           3       1.00      1.00      1.00        14
           4       1.00      1.00      1.00         9

    accuracy                           1.00        63
   macro avg       1.00      1.00      1.00        63
weighted avg       1.00      1.00      1.00        63
```

In [23]:
```
train_scores, test_scores = list(), list()
values = [i for i in range(1, 51)]
for i in values:
    model = ensemble
    model.fit(X_train, y_train)
    train_yhat = model.predict(X_train)
    train_acc = accuracy_score(y_train, train_yhat)
    train_scores.append(train_acc)
    test_yhat = model.predict(X_test)
    test_acc = accuracy_score(y_test, test_yhat)
    test_scores.append(test_acc)
    print('>%d, train: %.3f, test: %.3f' % (i, train_acc, test_acc))
# plot of train and test scores vs number of neighbors
plt.plot(values, train_scores, '-o', label='Train')
plt.plot(values, test_scores, '-o', label='Test')
plt.legend()
plt.show()
```

```
>1, train: 1.000, test: 1.000
>2, train: 1.000, test: 1.000
>3, train: 1.000, test: 1.000
>4, train: 1.000, test: 1.000
>5, train: 1.000, test: 1.000
>6, train: 1.000, test: 1.000
>7, train: 1.000, test: 1.000
>8, train: 1.000, test: 1.000
>9, train: 1.000, test: 1.000
>10, train: 1.000, test: 1.000
>11, train: 1.000, test: 1.000
>12, train: 1.000, test: 1.000
>13, train: 1.000, test: 1.000
>14, train: 1.000, test: 1.000
>15, train: 1.000, test: 1.000
>16, train: 1.000, test: 1.000
>17, train: 1.000, test: 1.000
>18, train: 1.000, test: 1.000
>19, train: 1.000, test: 1.000
>20, train: 1.000, test: 1.000
>21, train: 1.000, test: 1.000
>22, train: 1.000, test: 1.000
>23, train: 1.000, test: 1.000
>24, train: 1.000, test: 1.000
>25, train: 1.000, test: 1.000
>26, train: 1.000, test: 1.000
>27, train: 1.000, test: 1.000
>28, train: 1.000, test: 1.000
>29, train: 1.000, test: 1.000
>30, train: 1.000, test: 1.000
>31, train: 1.000, test: 1.000
>32, train: 1.000, test: 1.000
>33, train: 1.000, test: 1.000
>34, train: 1.000, test: 1.000
>35, train: 1.000, test: 1.000
>36, train: 1.000, test: 1.000
>37, train: 1.000, test: 1.000
>38, train: 1.000, test: 1.000
>39, train: 1.000, test: 1.000
>40, train: 1.000, test: 1.000
>41, train: 1.000, test: 1.000
>42, train: 1.000, test: 1.000
>43, train: 1.000, test: 1.000
>44, train: 1.000, test: 1.000
>45, train: 1.000, test: 1.000
>46, train: 1.000, test: 1.000
>47, train: 1.000, test: 1.000
>48, train: 1.000, test: 1.000
>49, train: 1.000, test: 1.000
>50, train: 1.000, test: 1.000
```



Bagging

In [20]:
```
start = time.time()
param_dist = {'max_depth' :[2,3,4],
              'bootstrap': [True, False],
              'max_features': ['auto', 'sqrt', 'log2', None],
              'criterion': ['gini', 'entropy']}

fit_rf = RandomForestClassifier()
cv_rf = GridSearchCV(fit_rf, cv = 10, param_grid = param_dist, n_jobs = 3)

rfModel = cv_rf.fit(X_train, y_train)
print('Best Parameters using grid search: \n', cv_rf.best_params_)
end = time.time()
print('Time taken in grid search: {0: .2f}'.format(end - start))
```

```
Best Parameters using grid search:
 {'bootstrap': True, 'criterion': 'entropy', 'max_depth': 2, 'max_features': 'auto'}
Time taken in grid search:  61.92
```

In [21]:
```
rfPred = cv_rf.predict(X_test)
print(classification_report(y_test, rfPred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      0.90      0.95        10
           2       0.93      1.00      0.97        14
           3       1.00      0.93      0.96        14
           4       0.90      1.00      0.95         9

    accuracy                           0.97        63
   macro avg       0.97      0.97      0.96        63
weighted avg       0.97      0.97      0.97        63
```

In [27]:
```
rfPred = cv_rf.predict(X_train)
print(classification_report(y_train, rfPred))

rfPred = cv_rf.predict(X_test)
print(classification_report(y_test, rfPred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00       110
           1       1.00      1.00      1.00       116
           2       1.00      1.00      1.00       112
           3       1.00      1.00      1.00       112
           4       1.00      1.00      1.00       117

    accuracy                           1.00       567
   macro avg       1.00      1.00      1.00       567
weighted avg       1.00      1.00      1.00       567

              precision    recall  f1-score   support

           0       0.94      1.00      0.97        16
           1       1.00      0.90      0.95        10
           2       1.00      1.00      1.00        14
           3       1.00      0.93      0.96        14
           4       0.90      1.00      0.95         9

    accuracy                           0.97        63
   macro avg       0.97      0.97      0.97        63
weighted avg       0.97      0.97      0.97        63
```

In [25]:
```
train_scores, test_scores = list(), list()
values = [i for i in range(1, 21)]
for i in values:
    model = cv_rf
    model.fit(X_train, y_train)
    train_yhat = model.predict(X_train)
    train_acc = accuracy_score(y_train, train_yhat)
    train_scores.append(train_acc)
    test_yhat = model.predict(X_test)
    test_acc = accuracy_score(y_test, test_yhat)
    test_scores.append(test_acc)
    print('>%d, train: %.3f, test: %.3f' % (i, train_acc, test_acc))
# plot of train and test scores vs number of neighbors
plt.plot(values, train_scores, '-o', label='Train')
plt.plot(values, test_scores, '-o', label='Test')
plt.legend()
plt.show()
```

```
>1, train: 1.000, test: 0.968
>2, train: 1.000, test: 0.968
>3, train: 1.000, test: 0.968
>4, train: 1.000, test: 0.968
>5, train: 1.000, test: 0.968
>6, train: 1.000, test: 0.968
>7, train: 1.000, test: 0.968
>8, train: 1.000, test: 0.968
>9, train: 1.000, test: 0.968
>10, train: 1.000, test: 0.968
>11, train: 1.000, test: 0.968
>12, train: 1.000, test: 0.968
>13, train: 1.000, test: 0.968
>14, train: 1.000, test: 0.968
>15, train: 1.000, test: 0.968
>16, train: 1.000, test: 0.968
>17, train: 1.000, test: 0.968
>18, train: 1.000, test: 0.968
>19, train: 1.000, test: 0.968
>20, train: 1.000, test: 0.968
```