CS156 (Introduction to AI), Spring 2021

Homework 7 submission

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Any special notes or anything you would like to communicate to me about this homework submission goes in here.

References and sources

List all your references and sources here. This includes all sites/discussion boards/blogs/posts/etc. where you grabbed some code examples.

https://scikit-learn.org/stable/modules/generated/sklearn.neural_network.MLPClassifier.html https://seaborn.pydata.org/generated/seaborn.violinplot.html https://stackabuse.com/seaborn-violin-plot-tutorial-and-examples/ https://www.geeksforgeeks.org/violinplot-using-seaborn-in-python/

Solution

Load libraries and set random number generator seed

In [66]:
```
import numpy as np
import pandas as pd
from sklearn import datasets
import matplotlib.pyplot as plt
from PIL import Image
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.neural_network import MLPClassifier
from sklearn.metrics import plot_confusion_matrix
from sklearn.exceptions import ConvergenceWarning
from sklearn.datasets  import load_digits
from sklearn.model_selection import cross_val_score
```

In [67]:
```
np.random.seed(42)
```

Code the solution

Load dataset and flatten

In [68]:
```
mnist = load_digits()
n_samples = len(mnist.images)
images = mnist.images.reshape((n_samples, -1))
labels = mnist.target
images = images.astype("float32")/255
labels
```

Out[68]:
```
array([0, 1, 2, ..., 8, 9, 8])
```

Train split model and then train each model. Also print and store cross validation scores array and test set score

In [69]:
```
X_train, X_test, Y_train, Y_test = train_test_split(images, labels, test_size=0.2, ra
X_train.shape, Y_train.shape, X_test.shape, Y_test.shape
```

Out[69]:
```
((1437, 64), (1437,), (360, 64), (360,))
```

In [70]:
```
model1 = MLPClassifier(random_state=1, max_iter=2000)
model1.fit(X_train, Y_train)

scores1 = cross_val_score(model1, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores1)
print('Mean Cross Validation Accuracy', np.mean(scores1))
model1_score = model1.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.93333333 0.87777778 0.95543175 0.9637883
0.90529248]
Mean Cross Validation Accuracy 0.9271247291860105
```

In [71]:
```
model2 = MLPClassifier(hidden_layer_sizes=(400,150,50), max_iter= 2000,activation = '
model2.fit(X_train, Y_train)

scores2 = cross_val_score(model2, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores2)
print('Mean Cross Validation Accuracy', np.mean(scores2))
model2_score = model2.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.93055556 0.88888889 0.94150418 0.93036212
0.87743733]
Mean Cross Validation Accuracy 0.9137496131228723
```

In [72]:
```
model3 = MLPClassifier(hidden_layer_sizes=(400,150,50), max_iter=2000,activation = 'lo
model3.fit(X_train, Y_train)

scores3 = cross_val_score(model3, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores3)
print('Mean Cross Validation Accuracy', np.mean(scores3))
model3_score = model3.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.86111111 0.81666667 0.86908078 0.88857939
0.81058496]
Mean Cross Validation Accuracy 0.8492045806251933
```

In [73]:
```
model4 = MLPClassifier(hidden_layer_sizes=(64,32,16), max_iter=2000,activation = 'relu
model4.fit(X_train, Y_train)

scores4 = cross_val_score(model4, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores4)
print('Mean Cross Validation Accuracy', np.mean(scores4))
model4_score = model4.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.91666667 0.87222222 0.91922006 0.92479109
0.8913649 ]
Mean Cross Validation Accuracy 0.9048529866914267
```

In [74]:
```
model5 = MLPClassifier(hidden_layer_sizes=(32,16), max_iter=2000,activation = 'relu',r
model5.fit(X_train, Y_train)

scores5 = cross_val_score(model5, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores5)
print('Mean Cross Validation Accuracy', np.mean(scores5))
model5_score = model5.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.925      0.83888889 0.91364903 0.91922006
0.87743733]
Mean Cross Validation Accuracy 0.894839059114825
```

In [75]:
```
model6 = MLPClassifier(hidden_layer_sizes=(120,64,16), max_iter=2000,activation = 'rel
model6.fit(X_train, Y_train)

scores6 = cross_val_score(model6, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores6)
print('Mean Cross Validation Accuracy', np.mean(scores6))
model6_score = model5.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.9        0.85833333 0.93314763 0.93314763
0.85236769]
Mean Cross Validation Accuracy 0.8953992571959146
```

In [76]:
```
model7 = MLPClassifier(hidden_layer_sizes=(320,120,32), max_iter=2000,activation = 're
model7.fit(X_train, Y_train)

scores7 = cross_val_score(model7, images, labels, cv= 5)
print('Individual cross_validation accuracies:', scores7)
print('Mean Cross Validation Accuracy', np.mean(scores7))
model7_score = model7.score(X_test, Y_test)
```

```
Individual cross_validation accuracies: [0.91944444 0.90277778 0.94428969 0.93036212
0.88857939]
Mean Cross Validation Accuracy 0.9170906839987619
```

Create a dataframe that stores the model name and cross-validation scores (makes it easier to plot)

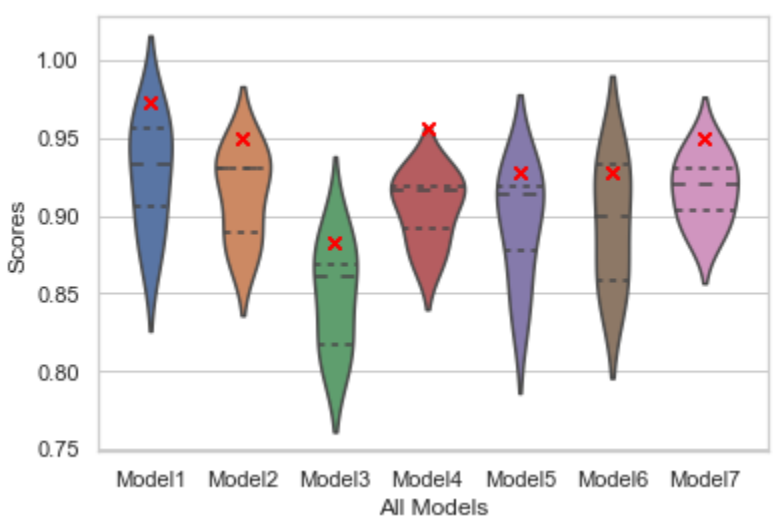
In [77]:
```
model_scores = [model1_score, model2_score, model3_score, model4_score, model5_score,
cross_validation_scores = [scores1, scores2, scores3, scores4, scores5, scores6, score
```

In [78]:
```
df = pd.DataFrame(columns = ['All Models', 'Scores'])

for i in range(len(cross_validation_scores)):
    model_name = "Model"+str(i+1)
    for y in cross_validation_scores[i]:
        new_row = {"All Models": model_name, "Scores": y}
        df = df.append(new_row, ignore_index=True)
```

Plot Violion plot

In [90]:
```
sns.violinplot(x='All Models', y = 'Scores', data = df, inner="quartile")
for i in range(7):
    plt.plot(model_scores, marker = 'x', linestyle = 'None', color = "red")
sns.set(style="whitegrid")
plt.show()
```



In [ ]:
```
```

In [ ]:
```
```