Manyam Avinash

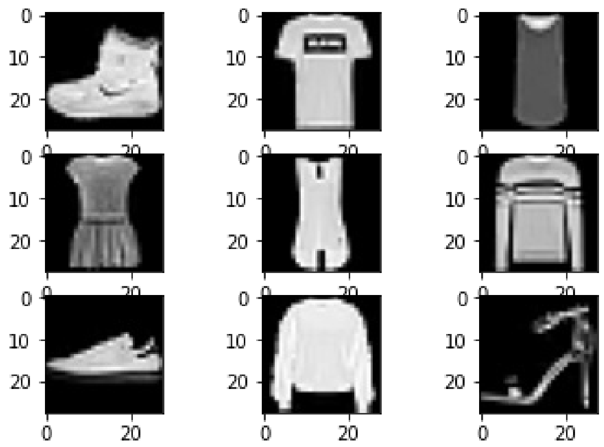
187233

CSE3B

In [1]:

```
# example of loading the fashion mnist dataset
from matplotlib import pyplot
from keras.datasets import fashion_mnist
# load dataset
(trainX, trainy), (testX, testy) = fashion_mnist.load_data()
# summarize loaded dataset
print('Train: X=%s, y=%s' % (trainX.shape, trainy.shape))
print('Test: X=%s, y=%s' % (testX.shape, testy.shape))
# plot first few images
for i in range(9):
 # define subplot
 pyplot.subplot(330 + 1 + i)
 # plot raw pixel data
 pyplot.imshow(trainX[i], cmap=pyplot.get_cmap('gray'))
# show the figure
pyplot.show()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/train-l
abels-idx1-ubyte.gz
32768/29515 [==================================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/train-i
mages-idx3-ubyte.gz
26427392/26421880 [==============================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/t10k-la
bels-idx1-ubyte.gz
8192/5148 [===============================================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/t10k-im
ages-idx3-ubyte.gz
4423680/4422102 [===============================] - 0s 0us/step
Train: X=(60000, 28, 28), y=(60000,)
Test: X=(10000, 28, 28), y=(10000,)
```



In [13]:

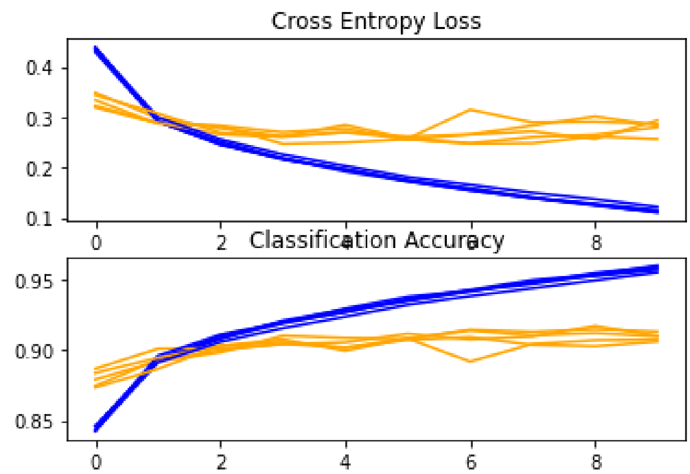
```
# baseline cnn model for fashion mnist
from numpy import mean
from numpy import std
from matplotlib import pyplot
from sklearn.model_selection import KFold
from keras.datasets import fashion_mnist
from keras.utils import to_categorical
from keras.models import Sequential
from keras.layers import Conv2D
```

```
from keras.layers import MaxPooling2D
from keras.layers import Dense
from keras.layers import Flatten
from keras.optimizers import SGD

# load train and test dataset
def load_dataset():
 # load dataset
 (trainX, trainY), (testX, testY) = fashion_mnist.load_data()
 # reshape dataset to have a single channel
 trainX = trainX.reshape((trainX.shape[0], 28, 28, 1))
 testX = testX.reshape((testX.shape[0], 28, 28, 1))
 # one hot encode target values
 trainY = to_categorical(trainY)
 testY = to_categorical(testY)
 return trainX, trainY, testX, testY

# scale pixels
def prep_pixels(train, test):
 # convert from integers to floats
 train_norm = train.astype('float32')
 test_norm = test.astype('float32')
 # normalize to range 0-1
 train_norm = train_norm / 255.0
 test_norm = test_norm / 255.0
 # return normalized images
 return train_norm, test_norm

# define cnn model
def define_model():
 model = Sequential()
 model.add(Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_uniform', input_
shape=(28, 28, 1)))
 model.add(MaxPooling2D((2, 2)))
 model.add(Flatten())
 model.add(Dense(100, activation='relu', kernel_initializer='he_uniform'))
 model.add(Dense(10, activation='softmax'))
 # compile model
 opt = SGD(lr=0.01, momentum=0.9)
 model.compile(optimizer=opt, loss='categorical_crossentropy', metrics=['accuracy'])
 return model

# evaluate a model using k-fold cross-validation
def evaluate_model(dataX, dataY, n_folds=5):
 scores, histories = list(), list()
 # prepare cross validation
 kfold = KFold(n_folds, shuffle=True, random_state=1)
 # enumerate splits
 for train_ix, test_ix in kfold.split(dataX):
  # define model
  model = define_model()
  # select rows for train and test
  trainX, trainY, testX, testY = dataX[train_ix], dataY[train_ix], dataX[test_ix], dataY
[test_ix]
  # fit model
  history = model.fit(trainX, trainY, epochs=10, batch_size=32, validation_data=(testX,
testY), verbose=0)
  # evaluate model
  _, acc = model.evaluate(testX, testY, verbose=0)
  print('> %.3f' % (acc * 100.0))
  # append scores
  scores.append(acc)
  histories.append(history)
 return scores, histories

# plot diagnostic learning curves
def summarize_diagnostics(histories):
 for i in range(len(histories)):
  # plot loss
  pyplot.subplot(211)
  pyplot.title('Cross Entropy Loss')
  pyplot.plot(histories[i].history['loss'], color='blue', label='train')
```

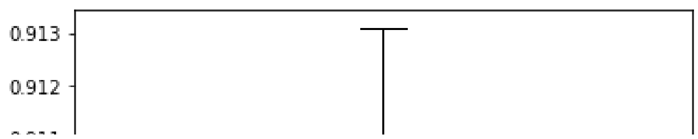
```
  pyplot.plot(histories[i].history['val_loss'], color='orange', label='test')
  # plot accuracy
  pyplot.subplot(212)
  pyplot.title('Classification Accuracy')
  pyplot.plot(histories[i].history['accuracy'], color='blue', label='train')
  pyplot.plot(histories[i].history['val_accuracy'], color='orange', label='test')
 pyplot.show()

# summarize model performance
def summarize_performance(scores):
 # print summary
 print('Accuracy: mean=%.3f std=%.3f, n=%d' % (mean(scores)*100, std(scores)*100, len(sco
res)))
 # box and whisker plots of results
 pyplot.boxplot(scores)
 pyplot.show()

# run the test harness for evaluating a model
def run_test_harness():
 # load dataset
 trainX, trainY, testX, testY = load_dataset()
 # prepare pixel data
 trainX, testX = prep_pixels(trainX, testX)
 # evaluate model
 scores, histories = evaluate_model(trainX, trainY)
 # learning curves
 summarize_diagnostics(histories)
 # summarize estimated performance
 summarize_performance(scores)

# entry point, run the test harness
run_test_harness()
```

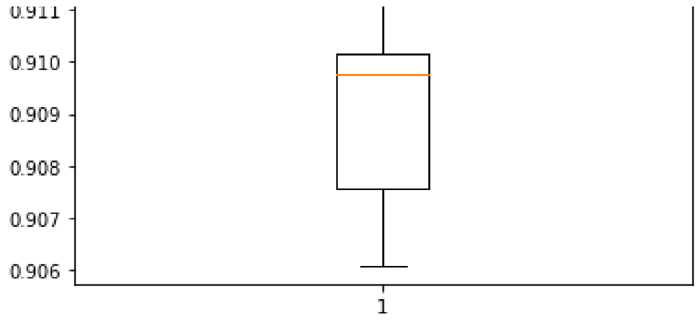
```
> 90.608
> 91.308
> 91.017
> 90.975
> 90.758
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:76: MatplotlibDeprecationWar
ning: Adding an axes using the same arguments as a previous axes currently reuses the ear
lier instance.  In a future version, a new instance will always be created and returned.
Meanwhile, this warning can be suppressed, and the future behavior ensured, by passing a
unique label to each axes instance.
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:81: MatplotlibDeprecationWar
ning: Adding an axes using the same arguments as a previous axes currently reuses the ear
lier instance.  In a future version, a new instance will always be created and returned.
Meanwhile, this warning can be suppressed, and the future behavior ensured, by passing a
unique label to each axes instance.
```




```
Accuracy: mean=90.933 std=0.239, n=5
```

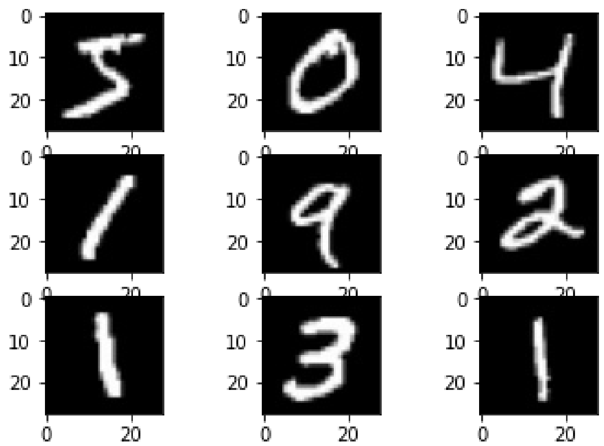




In [14]:

```
# example of loading the mnist dataset
from keras.datasets import mnist
from matplotlib import pyplot
# load dataset
(trainX, trainy), (testX, testy) = mnist.load_data()
# summarize loaded dataset
print('Train: X=%s, y=%s' % (trainX.shape, trainy.shape))
print('Test: X=%s, y=%s' % (testX.shape, testy.shape))
# plot first few images
for i in range(9):
 # define subplot
 pyplot.subplot(330 + 1 + i)
 # plot raw pixel data
 pyplot.imshow(trainX[i], cmap=pyplot.get_cmap('gray'))
# show the figure
pyplot.show()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.n
pz
11493376/11490434 [==============================] - 0s 0us/step
Train: X=(60000, 28, 28), y=(60000,)
Test: X=(10000, 28, 28), y=(10000,)
```



In [15]:

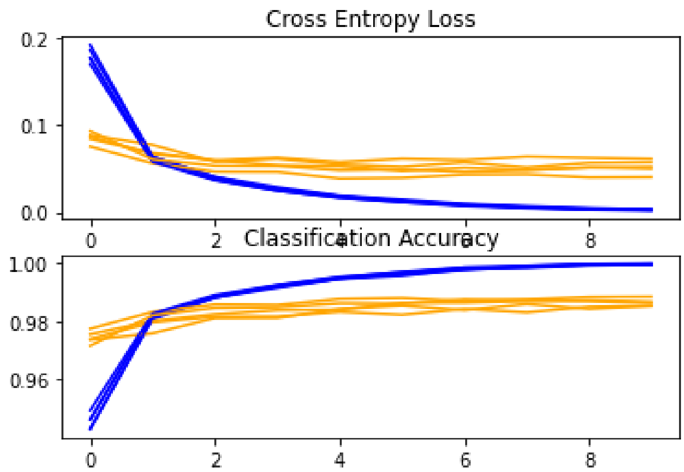
```
# baseline cnn model for mnist
from numpy import mean
from numpy import std
from matplotlib import pyplot
from sklearn.model_selection import KFold
from keras.datasets import mnist
from keras.utils import to_categorical
from keras.models import Sequential
from keras.layers import Conv2D
from keras.layers import MaxPooling2D
from keras.layers import Dense
from keras.layers import Flatten
from keras.optimizers import SGD

# load train and test dataset
def load_dataset():
 # load dataset
```

```
	(trainX, trainY), (testX, testY) = mnist.load_data()
	# reshape dataset to have a single channel
	trainX = trainX.reshape((trainX.shape[0], 28, 28, 1))
	testX = testX.reshape((testX.shape[0], 28, 28, 1))
	# one hot encode target values
	trainY = to_categorical(trainY)
	testY = to_categorical(testY)
	return trainX, trainY, testX, testY

# scale pixels
def prep_pixels(train, test):
	# convert from integers to floats
	train_norm = train.astype('float32')
	test_norm = test.astype('float32')
	# normalize to range 0-1
	train_norm = train_norm / 255.0
	test_norm = test_norm / 255.0
	# return normalized images
	return train_norm, test_norm

# define cnn model
def define_model():
	model = Sequential()
	model.add(Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_uniform', input_
shape=(28, 28, 1)))
	model.add(MaxPooling2D((2, 2)))
	model.add(Flatten())
	model.add(Dense(100, activation='relu', kernel_initializer='he_uniform'))
	model.add(Dense(10, activation='softmax'))
	# compile model
	opt = SGD(lr=0.01, momentum=0.9)
	model.compile(optimizer=opt, loss='categorical_crossentropy', metrics=['accuracy'])
	return model

# evaluate a model using k-fold cross-validation
def evaluate_model(dataX, dataY, n_folds=5):
	scores, histories = list(), list()
	# prepare cross validation
	kfold = KFold(n_folds, shuffle=True, random_state=1)
	# enumerate splits
	for train_ix, test_ix in kfold.split(dataX):
		# define model
		model = define_model()
		# select rows for train and test
		trainX, trainY, testX, testY = dataX[train_ix], dataY[train_ix], dataX[test_ix], dataY
[test_ix]
		# fit model
		history = model.fit(trainX, trainY, epochs=10, batch_size=32, validation_data=(testX,
testY), verbose=0)
		# evaluate model
		_, acc = model.evaluate(testX, testY, verbose=0)
		print('> %.3f' % (acc * 100.0))
		# stores scores
		scores.append(acc)
		histories.append(history)
	return scores, histories

# plot diagnostic learning curves
def summarize_diagnostics(histories):
	for i in range(len(histories)):
		# plot loss
		pyplot.subplot(2, 1, 1)
		pyplot.title('Cross Entropy Loss')
		pyplot.plot(histories[i].history['loss'], color='blue', label='train')
		pyplot.plot(histories[i].history['val_loss'], color='orange', label='test')
		# plot accuracy
		pyplot.subplot(2, 1, 2)
		pyplot.title('Classification Accuracy')
		pyplot.plot(histories[i].history['accuracy'], color='blue', label='train')
		pyplot.plot(histories[i].history['val_accuracy'], color='orange', label='test')
	pyplot.show()
```

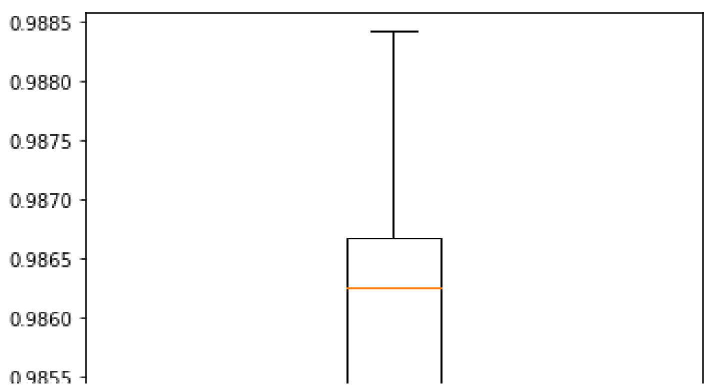
```
# summarize model performance
def summarize_performance(scores):
 # print summary
 print('Accuracy: mean=%.3f std=%.3f, n=%d' % (mean(scores)*100, std(scores)*100, len(sco
res)))
 # box and whisker plots of results
 pyplot.boxplot(scores)
 pyplot.show()

# run the test harness for evaluating a model
def run_test_harness():
 # load dataset
 trainX, trainY, testX, testY = load_dataset()
 # prepare pixel data
 trainX, testX = prep_pixels(trainX, testX)
 # evaluate model
 scores, histories = evaluate_model(trainX, trainY)
 # learning curves
 summarize_diagnostics(histories)
 # summarize estimated performance
 summarize_performance(scores)

# entry point, run the test harness
run_test_harness()
```

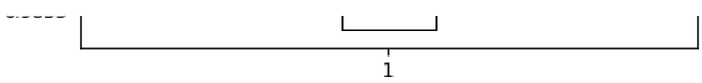
```
> 98.533
> 98.667
> 98.533
> 98.842
> 98.625
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:76: MatplotlibDeprecationWar
ning: Adding an axes using the same arguments as a previous axes currently reuses the ear
lier instance.  In a future version, a new instance will always be created and returned.
Meanwhile, this warning can be suppressed, and the future behavior ensured, by passing a
unique label to each axes instance.
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:81: MatplotlibDeprecationWar
ning: Adding an axes using the same arguments as a previous axes currently reuses the ear
lier instance.  In a future version, a new instance will always be created and returned.
Meanwhile, this warning can be suppressed, and the future behavior ensured, by passing a
unique label to each axes instance.
```




```
Accuracy: mean=98.640 std=0.113, n=5
```




1