Train a simple convnet on the Fashion MNIST dataset

```
#pip install -U tensorflow --quiet
```

In this, we will see how to deal with image data and train a convnet for image classification task.

Load the `fashion_mnist` dataset

** Use keras.datasets to load the dataset **

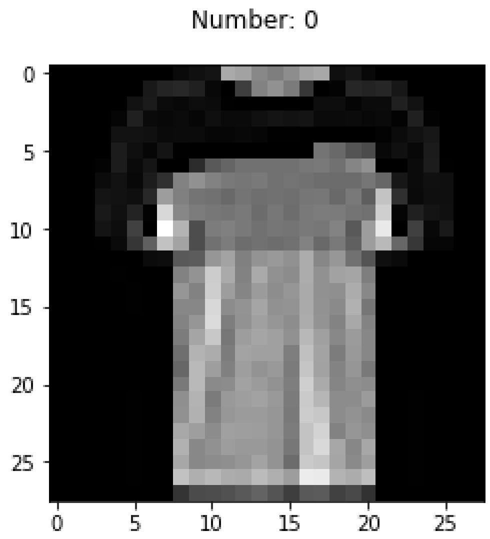
```
#import tensorflow as tf
import keras
```

```
from keras.datasets import fashion_mnist
(x_train, y_train), (x_test, y_test) = fashion_mnist.load_data()
```

Find no.of samples are there in training and test datasets

```
import matplotlib.pyplot as plt
import numpy as np

img_num = np.random.randint(0, x_test.shape[0]) #Get a random integer between 0 and number of
plt.imshow(x_test[img_num],cmap='gray') #Show the image from test dataset
plt.suptitle('Number: ' + str(y_test[img_num]))
plt.show()
```



```
from keras.utils import np_utils
```

```
print('--- THE DATA ---')
print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')
```

```
--- THE DATA ---
x_train shape: (60000, 28, 28)
60000 train samples
10000 test samples
```

Find dimensions of an image in the dataset

```
x_train.shape
```

```
(60000, 28, 28)
```

```
x_test.shape
```

```
(10000, 28, 28)
```

Convert train and test labels to one hot vectors

** check `keras.utils.to_categorical()` **

```
y_train = np_utils.to_categorical(y_train, 10)
y_test = np_utils.to_categorical(y_test, 10)
```

Normalize both the train and test image data from 0-255 to 0-1

Reshape the data from 28x28 to 28x28x1 to match input dimensions in Conv2D l

```
#Both steps done at one step
x_train = x_train.reshape(x_train.shape[0], 28, 28, 1).astype('float32')
x_test = x_test.reshape(x_test.shape[0], 28, 28, 1).astype('float32')
x_train /= 255
x_test /= 255
```

```
x_train.shape
```

```
(60000, 28, 28, 1)
```

Import the necessary layers from keras to build the model

```
from keras.layers import Dense, Activation, Dropout, Flatten, Reshape
from keras.layers import Convolution2D, MaxPooling2D
from keras.models import Sequential
```

```
Sequential()
```

```
<keras.engine.sequential.Sequential at 0x7fed25555ef0>
```

Build a model

** with 2 Conv layers having `32 3x3 filters` in both convolutions with `relu activations` and `flatt` fully connected layers (or Dense Layers) having 128 and 10 neurons with `relu` and `softmax` activatio `categorical_crossentropy` loss with `adam` optimizer train the model with early stopping `patience=5`

```
TRAIN = False
BATCH_SIZE = 32
EPOCHS = 10


# Define model
    model = Sequential()

    # 1st Conv Layer
    model.add(Convolution2D(32, 3, 3, input_shape=(28, 28, 1)))
    model.add(Activation('relu'))

    # 2nd Conv Layer
    model.add(Convolution2D(32, 3, 3))
    model.add(Activation('relu'))

    # Fully Connected Layer
    model.add(Flatten())
    model.add(Dense(128))
    model.add(Activation('relu'))

    # Prediction Layer
    model.add(Dense(10))
    model.add(Activation('softmax'))

    # Loss and Optimizer
    model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

    # Store Training Results
    early_stopping = keras.callbacks.EarlyStopping(monitor='val_acc', patience=10, verbose=1,
    callback_list = [early_stopping]

    # Train the model
    model.fit(x_train, y_train, batch_size=BATCH_SIZE,nb_epoch=EPOCHS,
             validation_data=(x_test, y_test), callbacks=callback_list)
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:4: UserWarning: Update your
  after removing the cwd from sys.path.
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:8: UserWarning: Update your

/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:29: UserWarning: The `nb_ep
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/op
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

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WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

60000/60000 [==============================] - 28s 470us/step - loss: 0.3693 - acc: 0.86
Epoch 2/10
60000/60000 [==============================] - 20s 334us/step - loss: 0.2313 - acc: 0.91
Epoch 3/10
60000/60000 [==============================] - 20s 333us/step - loss: 0.1670 - acc: 0.93
Epoch 4/10
60000/60000 [==============================] - 19s 325us/step - loss: 0.1161 - acc: 0.95
Epoch 5/10
60000/60000 [==============================] - 19s 322us/step - loss: 0.0778 - acc: 0.97
Epoch 6/10
60000/60000 [==============================] - 19s 321us/step - loss: 0.0505 - acc: 0.98
Epoch 7/10
60000/60000 [==============================] - 19s 320us/step - loss: 0.0381 - acc: 0.98
Epoch 8/10
60000/60000 [==============================] - 19s 322us/step - loss: 0.0256 - acc: 0.99
Epoch 9/10
60000/60000 [==============================] - 19s 321us/step - loss: 0.0256 - acc: 0.99
Epoch 10/10
60000/60000 [==============================] - 19s 320us/step - loss: 0.0182 - acc: 0.99
<keras.callbacks.History at 0x7fed2540fda0>
```

Now, to the above model add `max` pooling layer of `filter size 2x2` and `dropout` conv layers and run the model

```
loss_and_metrics = model.evaluate(x_test, y_test)
print(loss_and_metrics)
print(loss_and_metrics)
```

```
10000/10000 [==============================] - 1s 91us/step
[0.49650015604533254, 0.911]
```

```
BATCH_SIZE = 32
EPOCHS = 10


 # Define Model
    model2 = Sequential()

    # 1st Conv Layer
    model2.add(Convolution2D(32, 3, 3, input_shape=(28, 28, 1)))
    model2.add(Activation('relu'))

    # 2nd Conv Layer
    model2.add(Convolution2D(32, 3, 3))
    model2.add(Activation('relu'))

    # Max Pooling
    model2.add(MaxPooling2D(pool_size=(2,2)))

    # Dropout
    model2.add(Dropout(0.25))

    # Fully Connected Layer
    model2.add(Flatten())
    model2.add(Dense(128))
    model2.add(Activation('relu'))

    # More Dropout
    model2.add(Dropout(0.5))

    # Prediction Layer
    model2.add(Dense(10))
    model2.add(Activation('softmax'))

    # Loss and Optimizer
    model2.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

    # Store Training Results
    early_stopping = keras.callbacks.EarlyStopping(monitor='val_acc', patience=7, verbose=1,
    callback_list = [early_stopping]

    # Train the model
    model2.fit(x_train, y_train, batch_size=BATCH_SIZE, nb_epoch=EPOCHS,
              validation_data=(x_test, y_test), callbacks=callback_list)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:4: UserWarning: Update your
  after removing the cwd from sys.path.
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:8: UserWarning: Update your

/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:38: UserWarning: The `nb_ep
Train on 60000 samples, validate on 10000 samples
Epoch 1/10
60000/60000 [==============================] - 19s 317us/step - loss: 0.5117 - acc: 0.81
Epoch 2/10
60000/60000 [==============================] - 18s 308us/step - loss: 0.3493 - acc: 0.87
Epoch 3/10
60000/60000 [==============================] - 18s 308us/step - loss: 0.3037 - acc: 0.89
Epoch 4/10
60000/60000 [==============================] - 18s 307us/step - loss: 0.2736 - acc: 0.89
Epoch 5/10
60000/60000 [==============================] - 18s 308us/step - loss: 0.2513 - acc: 0.90
Epoch 6/10
60000/60000 [==============================] - 18s 307us/step - loss: 0.2334 - acc: 0.91
Epoch 7/10
60000/60000 [==============================] - 18s 305us/step - loss: 0.2221 - acc: 0.91
Epoch 8/10
60000/60000 [==============================] - 18s 306us/step - loss: 0.2069 - acc: 0.92
Epoch 9/10
60000/60000 [==============================] - 18s 306us/step - loss: 0.1999 - acc: 0.92
Epoch 10/10
60000/60000 [==============================] - 18s 306us/step - loss: 0.1870 - acc: 0.92
<keras.callbacks.History at 0x7fed20334f98>
```

Now, to the above model, lets add Data Augmentation

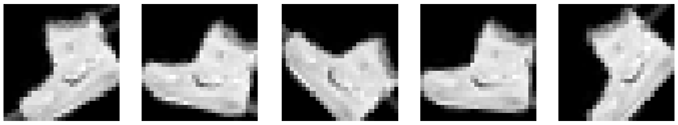
Import the ImageDataGenrator from keras and fit the training images

```
from keras.preprocessing.image import ImageDataGenerator

# This will do preprocessing and realtime data augmentation:
datagen = ImageDataGenerator(
    featurewise_center=False,  # set input mean to 0 over the dataset
    samplewise_center=False,  # set each sample mean to 0
    featurewise_std_normalization=False,  # divide inputs by std of the dataset
    samplewise_std_normalization=False,  # divide each input by its std
    zca_whitening=False,  # apply ZCA whitening
    rotation_range=50,  # randomly rotate images in the range (degrees, 0 to 180)
    width_shift_range=0.01,  # randomly shift images horizontally (fraction of total width)
    width_shift_range=0.01,  # randomly shift images horizontally (fraction of total width)
    height_shift_range=0.01,  # randomly shift images vertically (fraction of total height)
    horizontal_flip=False,  # randomly flip images
    vertical_flip=False)  # randomly flip images

# Prepare the generator
datagen.fit(x_train)



    # Define Model
    model3 = Sequential()

    # 1st Conv Layer
    model3.add(Convolution2D(32, 3, 3, input_shape=(28, 28, 1)))
    model3.add(Activation('relu'))

    # 2nd Conv Layer
    model3.add(Convolution2D(32, 3, 3))
    model3.add(Activation('relu'))

    # Max Pooling
    model3.add(MaxPooling2D(pool_size=(2,2)))

    # Dropout
    model3.add(Dropout(0.15))

    # Fully Connected Layer
    model3.add(Flatten())
    model3.add(Dense(128))
    model3.add(Activation('relu'))

    # More Dropout
    model3.add(Dropout(0.2))

    # Prediction Layer
    model3.add(Dense(10))
    model3.add(Activation('softmax'))

    # Loss and Optimizer
    model3.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

    # Store Training Results
    early_stopping = keras.callbacks.EarlyStopping(monitor='val_acc', patience=7, verbose=1,
    callback_list = [early_stopping]
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:4: UserWarning: Update your
  after removing the cwd from sys.path.
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:8: UserWarning: Update your
```

Showing 5 versions of the first image in training dataset using image datagenerator.flow()

```
from matplotlib import pyplot as plt
gen = datagen.flow(x_train[0:1], batch_size=1)
for i in range(1, 6):
    plt.subplot(1,5,i)
    plt.axis("off")
    plt.imshow(gen.next().squeeze(), cmap='gray')
    plt.plot()
plt.show()
```



Run the above model using fit_generator()

```
model3.fit_generator(datagen.flow(x_train, y_train,batch_size=32),
                    samples_per_epoch=x_train.shape[0],
                    nb_epoch=10,
                    validation_data=(x_test, y_test), callbacks=callback_list)
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:4: UserWarning: The semanti
  after removing the cwd from sys.path.
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:4: UserWarning: Update your
  after removing the cwd from sys.path.
Epoch 1/10
1875/1875 [==============================] - 34s 18ms/step - loss: 0.6573 - acc: 0.7595
Epoch 2/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.4641 - acc: 0.8311
Epoch 3/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.4145 - acc: 0.8481
Epoch 4/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3827 - acc: 0.8579
Epoch 5/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3625 - acc: 0.8662
Epoch 6/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3415 - acc: 0.8746
Epoch 7/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3313 - acc: 0.8781
Epoch 8/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3227 - acc: 0.8819
Epoch 9/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3132 - acc: 0.8841
Epoch 10/10
1875/1875 [==============================] - 33s 18ms/step - loss: 0.3055 - acc: 0.8879
<keras.callbacks.History at 0x7fed253c42b0>
```

Report the final train and validation accuracy

```
loss_and_metrics = model3.evaluate(x_train, y_train)
print(loss_and_metrics)
```

```
60000/60000 [==============================] - 5s 87us/step
[0.24732203457752863, 0.9106666666666666]
```

DATA AUGMENTATION ON CIFAR10 DATASET

One of the best ways to improve the performance of a Deep Learning model is to add more data to th instances from the wild that are representative of the distinction task, we want to develop a set of me have. There are many ways to augment existing datasets and produce more robust models. In the ima full power of the convolutional neural network, which is able to capture translational invariance. This t image recognition such a difficult task in the first place. You want the dataset to be representative of lightings, and miscellaneous distortions that are of interest to the vision task.

Import neessary libraries for data augmentation

```
from keras.preprocessing.image import ImageDataGenerator
```

Load CIFAR10 dataset

```
from keras.datasets import  cifar10
```

```
 (x_train_n, y_train_n), (x_test_n, y_test_n) = cifar10.load_data()
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170500096/170498071 [==============================] - 11s 0us/step
```

```
y_train_n = np_utils.to_categorical(y_train_n, 10)
y_test_n = np_utils.to_categorical(y_test_n, 10)

print('--- THE DATA ---')
print('x_train shape:', x_train_n.shape)
print(x_train_n.shape[0], 'train samples')
print(x_test_n.shape[0], 'test samples')
```

```
--- THE DATA ---
x_train shape: (50000, 32, 32, 3)
50000 train samples
10000 test samples
```

Create a data_gen funtion to genererator with image rotation,shifting image hori random flip horizontally.

```
datagen_n = ImageDataGenerator(
    featurewise_center=False,  # set input mean to 0 over the dataset
    samplewise_center=False,  # set each sample mean to 0
    featurewise_std_normalization=False,  # divide inputs by std of the dataset
    samplewise_std_normalization=False,  # divide each input by its std
    zca_whitening=False,  # apply ZCA whitening
    rotation_range=60,  # randomly rotate images in the range (degrees, 0 to 180)
    width_shift_range=0.01,  # randomly shift images horizontally (fraction of total width)
    height_shift_range=0.01,  # randomly shift images vertically (fraction of total height)
    horizontal_flip=True,  # randomly flip images
    vertical_flip=True)  # randomly flip images
```

```
x_train_n = x_train_n.astype('float32')
x_test_n = x_test_n.astype('float32')

x_train_n /= 255
x_test_n /= 255
```

Prepare/fit the generator.

```
# Prepare the generator
datagen_n.fit(x_train_n)
```

Generate 5 images for 1 of the image of CIFAR10 train dataset.

```
gen = datagen.flow(x_train_n[:1], batch_size=1)
for i in range(1, 6):
    plt.subplot(1,5,i)
    plt.axis("off")
    plt.imshow(gen.next().squeeze())
    plt.plot()
```