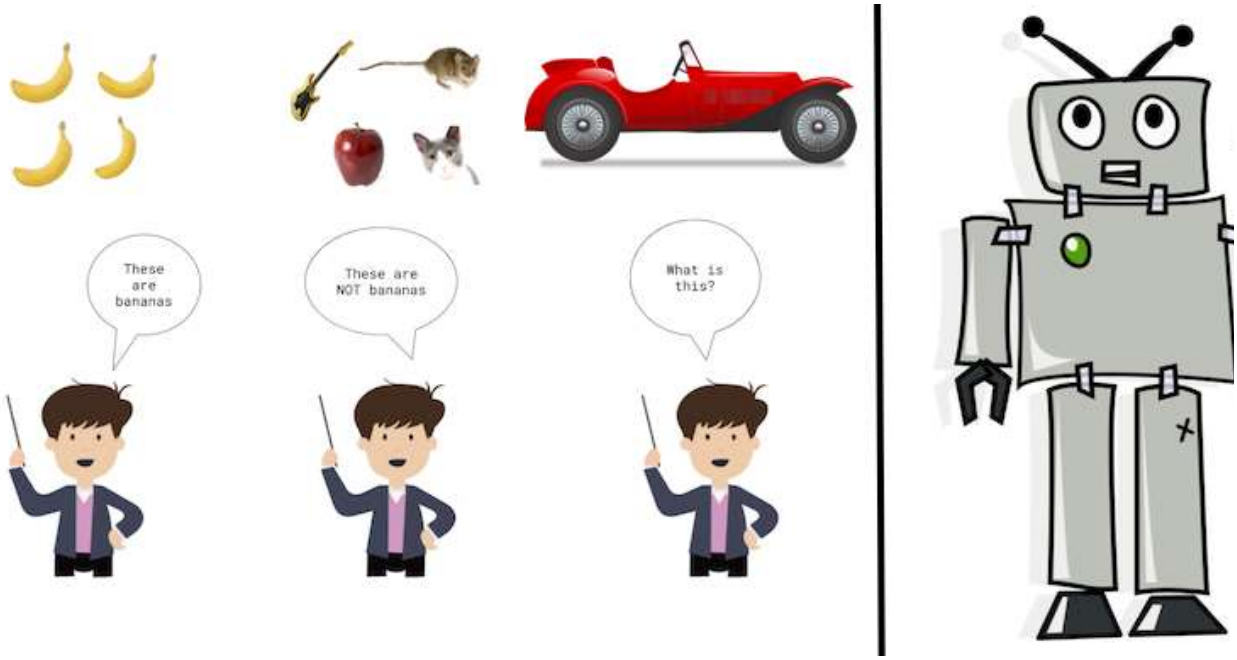
Task 1: Introduction

Welcome to this project on how to avoid overfitting with regularization. We will take
regularization techniques: weight regularization and dropout regularization.



Task 2: Importing the Data

Note: If you are starting the notebook from this task, you can run cells from all previ
going to the top menu and then selecting Kernel > Restart and Run All

In [1]:
```
from tensorflow.python.keras.datasets import fashion_mnist
(X_train, y_train), (X_test, y_test)= fashion_mnist.load_data()
```

In [2]:
```
print(X_train.shape, y_train.shape)
print(X_test.shape, y_test.shape)
```

```
(60000, 28, 28) (60000,)
(10000, 28, 28) (10000,)
```

In [3]:
```
import matplotlib.pyplot as plt
%matplotlib inline

plt.figure(figsize=(10,10))
for i in range(16):
    plt.subplot(4,4,i+1)#rows,columns,index
    plt.imshow(X_train[i], cmap='binary')#because grey scale images(color map)
plt.show()
```

Task 3: Processing the Data

Note: If you are starting the notebook from this task, you can run cells from all previ
going to the top menu and then selecting Kernel > Restart and Run All

Original Label: [5] is converted to -> One Hot Encoded Label: [0, 0, 0, 0, 0, 1, 0, 0, 0

In [4]:
```
from tensorflow.python.keras.utils import to_categorical
y_train= to_categorical(y_train)#gives back one hot encoded representation
y_test= to_categorical(y_test)

print(y_train.shape, y_test.shape)
print(y_train[0])
```

```
(60000, 10) (10000, 10)
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
```

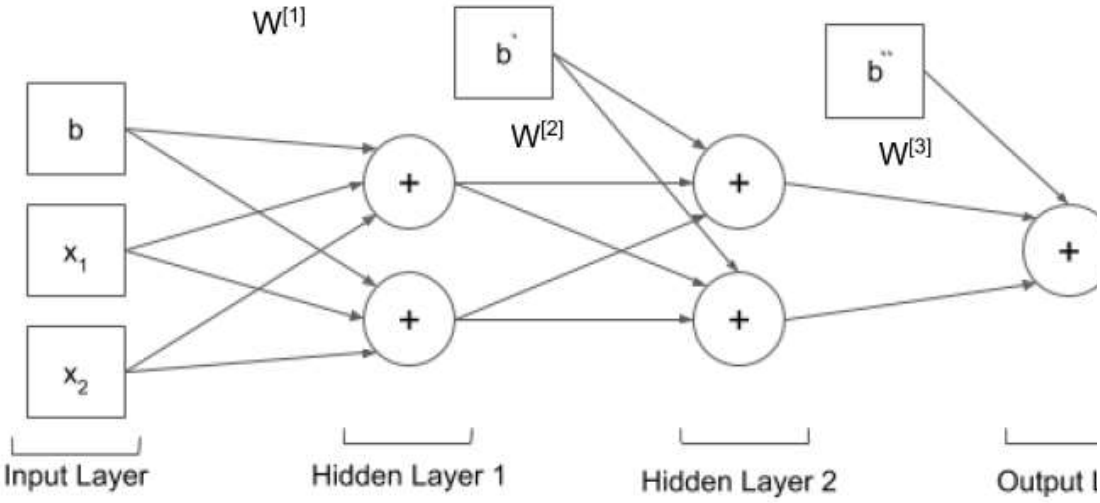
In [5]:
```
import numpy as np
X_train= np.reshape(X_train, (60000, 28*28))#
X_test= np.reshape(X_test, (10000, 28*28))

#normalize data
X_train= X_train/255.
X_test= X_test/255.
```

We use algorithms like gradient descent to find optimal values for weights and biase learns values by trying to reduce the overall loss value for the model. If loss reduces are moving in the right direction. For every iteration of training we compute loss valu values to try and move towards a lower loss value. Cause of overfitting- Parameters and influence outputs. L2 normalization- adds some loss to the loss therefore forces become low.

Task 4: Regularization and Dropout

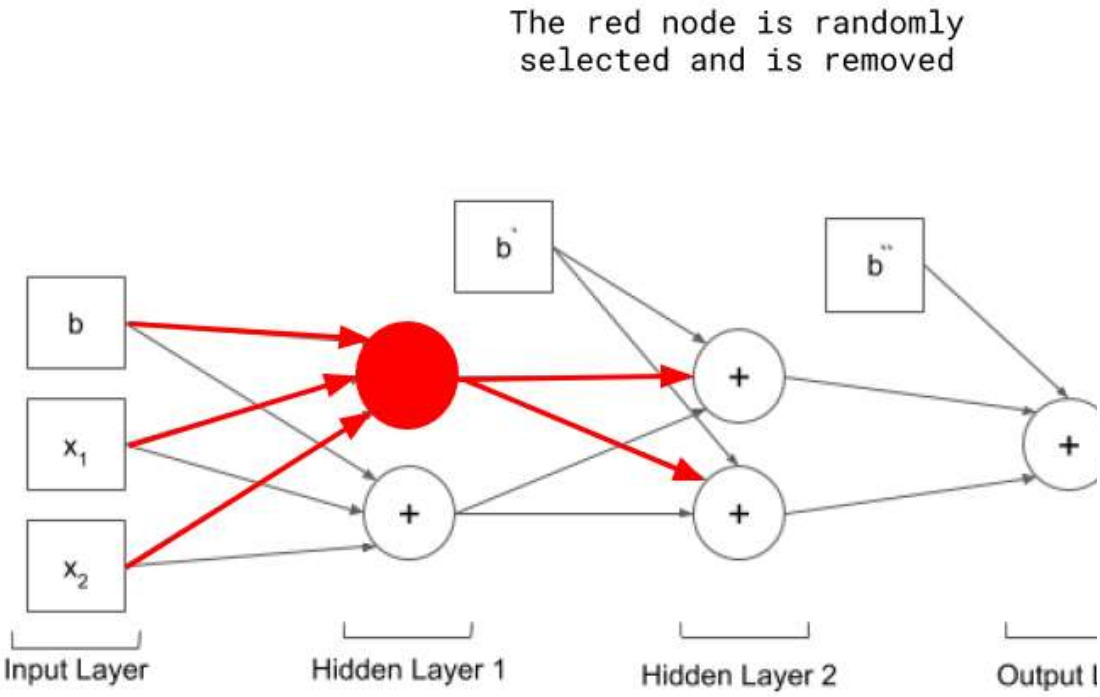
Note: If you are starting the notebook from this task, you can run cells from all previ going to the top menu and then selecting Kernel > Restart and Run All

Neural Networl



W = Weights and b = biases

Dropouts:



Task 5: Creating the Experiment Part 1

Note: If you are starting the notebook from this task, you can run cells from all previ
going to the top menu and then selecting Kernel > Restart and Run All

If we apply dropout to a hidden layer. During training some nodes of this layer will b
be removed from the network. By doing this we are forcing the model to not assign
weights.

In [6]:
```
from tensorflow.python.keras.models import Sequential
from tensorflow.python.keras.layers import Dense, Dropout
from tensorflow.python.keras.regularizers import l2

nodes= 64

def create_model(weight_reg= False, dropout_reg=False):
    model= Sequential()
    if weight_reg:
        model.add(Dense(nodes, activation='relu',
                        input_shape= (784,), kernel_regularizer= l2(0.001)))
        #regularization penalty=0.001
        model.add(Dense(nodes, activation='relu', kernel_regularizer=l2(0.001)))
    else:
        model.add(Dense(nodes, activation='relu', input_shape=(784,)))
        model.add(Dense(nodes, activation='relu'))
    if dropout_reg:
        model.add(Dropout(0.2))
        #20 percent of nodes of preceding layer will be deactivated
    model.add(Dense(10, activation='softmax'))
    model.compile(loss='categorical_crossentropy',
                  optimizer='adam',
                  metrics=['accuracy'])
    #adaptive moment estimation
    model.summary()
    return model
```

Task 6: Creating the Experiment Part 2

Note: If you are starting the notebook from this task, you can run cells from all previ
going to the top menu and then selecting Kernel > Restart and Run All

In [7]:
```
def show_acc(h, E):
    plt.plot(range(E), h.history['acc'], label='Training')
    plt.plot(range(E), h.history['val_acc'], label='Validation')
    plt.ylim([0.7, 1.0])
    plt.legend()
    plt.show()
    return
```

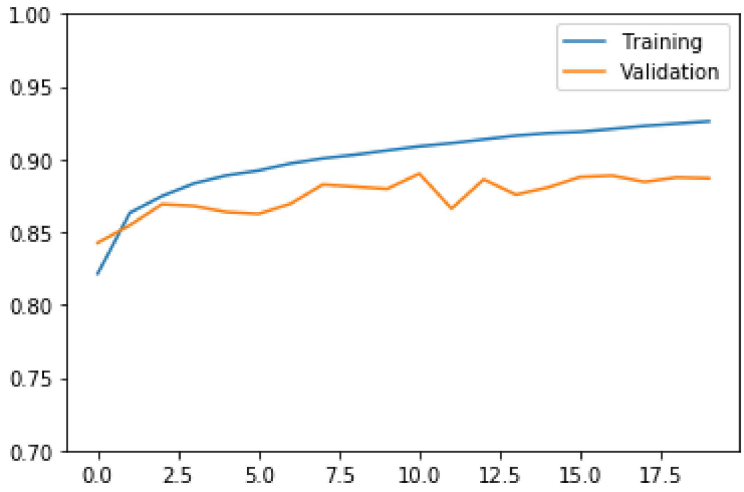
In [8]:
```
from tensorflow.python.keras.callbacks import LambdaCallback

simple_log= LambdaCallback(on_epoch_end= lambda e, l: print(e, end='.'))

def run_experiment(E=20, weight_reg= False, dropout_reg=False):
    m= create_model(weight_reg, dropout_reg)
    h= m.fit(X_train, y_train, epochs=E, verbose=False, validation_data=(X_test,
             callbacks= [simple_log])
    show_acc(h,E)
    return
```

Task 7: Results

Note: If you are starting the notebook from this task, you can run cells from all previ
going to the top menu and then selecting Kernel > Restart and Run All

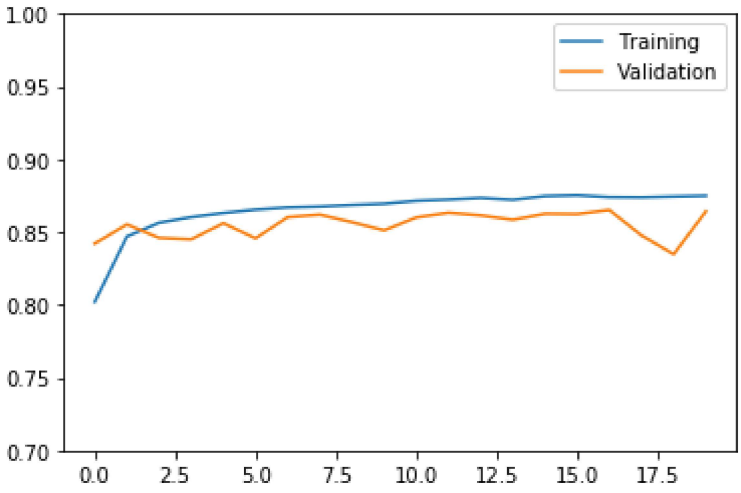
In [9]:
```
run_experiment()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 64)                50240
_________________________________________________________________
dense_1 (Dense)              (None, 64)                4160
_________________________________________________________________
dense_2 (Dense)              (None, 10)                650
=================================================================
Total params: 55,050
Trainable params: 55,050
Non-trainable params: 0
_________________________________________________________________
0.1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.
```



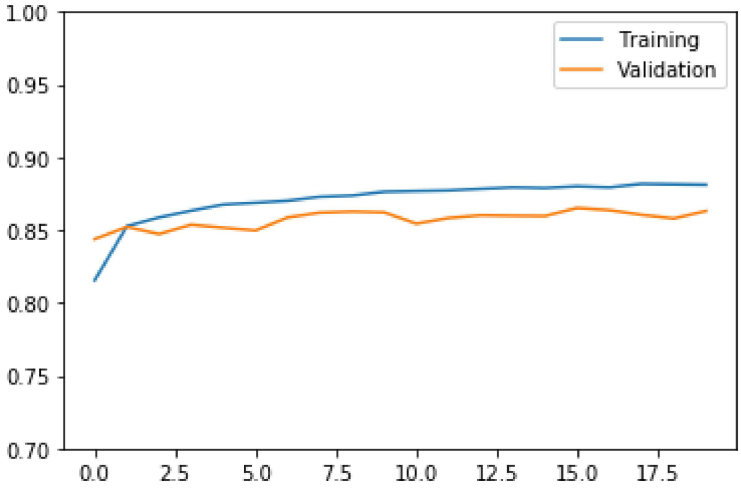
In [11]:
```
run_experiment(weight_reg= True, dropout_reg=True)
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_3 (Dense)              (None, 64)                50240
_________________________________________________________________
dense_4 (Dense)              (None, 64)                4160
_________________________________________________________________
dropout (Dropout)            (None, 64)                0
_________________________________________________________________
dense_5 (Dense)              (None, 10)                650
=================================================================
Total params: 55,050
Trainable params: 55,050
Non-trainable params: 0
_________________________________________________________________
0.1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.
```



In [12]:
```
run_experiment(weight_reg= True, dropout_reg=False)
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_6 (Dense)              (None, 64)                50240
_________________________________________________________________
dense_7 (Dense)              (None, 64)                4160
_________________________________________________________________
dense_8 (Dense)              (None, 10)                650
=================================================================
Total params: 55,050
Trainable params: 55,050
Non-trainable params: 0
_________________________________________________________________
0.1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.
```



In [13]:
```
run_experiment(weight_reg= False, dropout_reg=True)
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_9 (Dense)              (None, 64)                50240
_________________________________________________________________
dense_10 (Dense)             (None, 64)                4160
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_11 (Dense)             (None, 10)                650
=================================================================
Total params: 55,050
Trainable params: 55,050
Non-trainable params: 0
_________________________________________________________________
0.1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.
```