#MLP ASSIGNMENT OVER MNIST DATASET

###MLP WHICH IS APPLYING THE MULTI LAYER PERCEPTRONS WE USE THIS DEEP LEARNING TECHNIQUES WITH THE HIDDEN LAYERS WITH THE CELLS OF ACTIVATION FUNCTIONA THAT ARE INTERNALLY CONNECTED AND PEFORM THE BACKPRPOGATION INORDER TO REDUCE THE LOSS BETWEEN PREDICTED VALUE AND THE ACTUAL VALUE. WE USE THE OPTIMIASTION FUNCTIONS TO MINIMISE THE LOSS OF STOCHASTIC GRADIENT DESCENT WE WILL CONVERGE TO MINIMISE OUT LOSS. WE WILL TRAIN MODELS AND VALIDATE THE MODELS USING THE TEST DATA.

In [0]:
```
from keras.utils import np_utils
from keras.datasets import mnist
import seaborn as sns
from keras.initializers import RandomNormal
```

```
Using TensorFlow backend.
```

In [0]:
```
import matplotlib.pyplot as plt
import numpy as np
import time
```

In [0]:
```
def dynamicplot(x,validationy,testy,ax):
  ax.plot(x,validationy,label='validatiomn loss')
  ax.plot(x,testy,label='testloss')
  plt.xlabel('epoch')
  plt.ylabel('categroicalcrossentropy')
  plt.legend()
  plt.show()
```

In [0]:
```
(xtrain,ytrain),(xtest,ytest)=mnist.load_data()
```

```
Downloading data from https://s3.amazonaws.com/img-datasets/mnist.npz (https://s3.amazonaws.com/img-datasets/mnist.npz)
11493376/11490434 [==============================] - 0s 0us/step
```

In [0]:
```
print(xtrain[0][27])
```

```
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
```

In [0]:
```
#the imput is of shape 3dimensional vector
print(xtrain.shape)
```

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

In [0]:
```
#we want it as 60000data points and reshape data as 784 which data is 784 pixels
xtrain=xtrain.reshape(xtrain.shape[0],xtrain.shape[1]*xtrain.shape[2])
xtest=xtest.reshape(xtest.shape[0],xtest.shape[1]*xtest.shape[2])
print(xtrain.shape)
print(xtest.shape)
```

```
(60000, 784)
(10000, 784)
```

In [0]:
```
print(ytrain.shape)
```

```
(60000,)
```

In [0]:
```
#the values are between 0 and 255
#normalixzing  the data
xtrain=xtrain/255
xtest=xtest/255
```

In [0]:
```
print(xtrain[0])
```

```
[0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.
```

In [0]:
```
print(xtrain[0].shape)
```

```
(784,)
```

In [0]:
```
#onehot encode the ytrain just comnverting the features into ccategorical
ytrain=np_utils.to_categorical(ytrain,10)
ytest=np_utils.to_categorical(ytest,10)
```

In [0]:
```
from keras.models import Sequential
from keras.layers import Dense,Activation,Dropout
from keras.layers.normalization import BatchNormalization

outputdimensions=10
inputdimensions=xtrain.shape[1]
print(inputdimensions)
```

```
784
```

In [0]:
```
print(ytest.shape)
print(xtest.shape)
```

```
(10000, 10)
(10000, 784)
```

In [0]:
```
model=Sequential()
model.add(Dense(364,input_dim=inputdimensions,activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.5))
model.add(Dense(52,activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.5))
model.add(Dense(10,activation='softmax'))
model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accurac
history=model.fit(xtrain,ytrain,batch_size=128,epochs=20,validation_data=(xtest,
```

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/20
60000/60000 [==============================] - 17s 291us/step - loss: 0.5176 -
acc: 0.8458 - val_loss: 0.1616 - val_acc: 0.9501
Epoch 2/20
60000/60000 [==============================] - 12s 193us/step - loss: 0.2525 -
acc: 0.9274 - val_loss: 0.1228 - val_acc: 0.9627
Epoch 3/20
60000/60000 [==============================] - 12s 197us/step - loss: 0.2003 -
acc: 0.9425 - val_loss: 0.1027 - val_acc: 0.9691
Epoch 4/20
60000/60000 [==============================] - 12s 200us/step - loss: 0.1701 -
acc: 0.9508 - val_loss: 0.0916 - val_acc: 0.9721
Epoch 5/20
60000/60000 [==============================] - 12s 197us/step - loss: 0.1530 -
acc: 0.9551 - val_loss: 0.0858 - val_acc: 0.9741
Epoch 6/20
60000/60000 [==============================] - 11s 190us/step - loss: 0.1368 -
acc: 0.9608 - val_loss: 0.0807 - val_acc: 0.9745
Epoch 7/20
60000/60000 [==============================] - 12s 198us/step - loss: 0.1283 -
acc: 0.9625 - val_loss: 0.0749 - val_acc: 0.9781
Epoch 8/20
60000/60000 [==============================] - 12s 198us/step - loss: 0.1194 -
acc: 0.9653 - val_loss: 0.0755 - val_acc: 0.9778
Epoch 9/20
60000/60000 [==============================] - 12s 200us/step - loss: 0.1149 -
acc: 0.9665 - val_loss: 0.0679 - val_acc: 0.9802
Epoch 10/20
60000/60000 [==============================] - 12s 200us/step - loss: 0.1052 -
acc: 0.9693 - val_loss: 0.0663 - val_acc: 0.9803
Epoch 11/20
60000/60000 [==============================] - 12s 200us/step - loss: 0.1002 -
acc: 0.9699 - val_loss: 0.0660 - val_acc: 0.9804
Epoch 12/20
60000/60000 [==============================] - 11s 191us/step - loss: 0.0961 -
acc: 0.9715 - val_loss: 0.0690 - val_acc: 0.9799
Epoch 13/20
60000/60000 [==============================] - 12s 194us/step - loss: 0.0949 -
acc: 0.9720 - val_loss: 0.0697 - val_acc: 0.9786
Epoch 14/20
60000/60000 [==============================] - 11s 191us/step - loss: 0.0895 -
acc: 0.9735 - val_loss: 0.0646 - val_acc: 0.9798
Epoch 15/20
60000/60000 [==============================] - 12s 197us/step - loss: 0.0872 -
```

```
acc: 0.9739 - val_loss: 0.0634 - val_acc: 0.9817
Epoch 16/20
60000/60000 [==============================] - 12s 195us/step - loss: 0.0821 -
acc: 0.9757 - val_loss: 0.0618 - val_acc: 0.9818
Epoch 17/20
60000/60000 [==============================] - 12s 196us/step - loss: 0.0813 -
acc: 0.9757 - val_loss: 0.0651 - val_acc: 0.9809
Epoch 18/20
60000/60000 [==============================] - 12s 197us/step - loss: 0.0793 -
acc: 0.9763 - val_loss: 0.0674 - val_acc: 0.9809
Epoch 19/20
60000/60000 [==============================] - 12s 198us/step - loss: 0.0738 -
acc: 0.9778 - val_loss: 0.0631 - val_acc: 0.9813
Epoch 20/20
60000/60000 [==============================] - 12s 207us/step - loss: 0.0733 -
acc: 0.9784 - val_loss: 0.0621 - val_acc: 0.9816
```

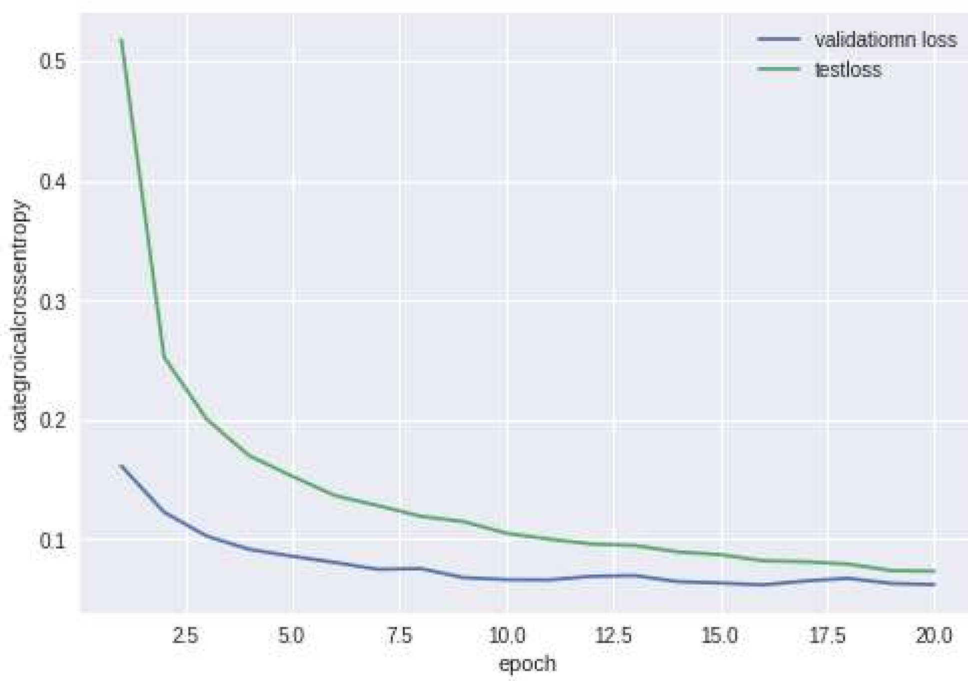
In [0]:

```
score=model.evaluate(xtest,ytest,verbose=0)
print('test score',score[0])
print('test accuracy',score[1])
```

```
test score 0.0621104669367196
test accuracy 0.9816
```

In [0]:

```
fig,ax=plt.subplots()
x=list(range(1,21))
validationy=history.history['val_loss']
testy=history.history['loss']
dynamicplot(x,validationy,testy,ax)
```



In [0]:

```
model1=Sequential()
model1.add(Dense(364,input_dim=inputdimensions,activation='relu'))
model1.add(BatchNormalization())
model1.add(Dropout(0.5))
model1.add(Dense(512,input_dim=inputdimensions,activation='relu'))
model1.add(BatchNormalization())
model1.add(Dropout(0.2))
model1.add(Dense(52,activation='relu'))
model1.add(BatchNormalization())
model1.add(Dropout(0.3))
model1.add(Dense(10,activation='softmax'))
model1.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accura
history=model1.fit(xtrain,ytrain,batch_size=128,epochs=20,validation_data=(xtest
```

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/20
60000/60000 [==============================] - 26s 441us/step - loss: 0.3885 -
acc: 0.8828 - val_loss: 0.1358 - val_acc: 0.9583
Epoch 2/20
60000/60000 [==============================] - 19s 319us/step - loss: 0.1926 -
acc: 0.9423 - val_loss: 0.1065 - val_acc: 0.9677
Epoch 3/20
60000/60000 [==============================] - 19s 315us/step - loss: 0.1561 -
acc: 0.9535 - val_loss: 0.0942 - val_acc: 0.9706
Epoch 4/20
60000/60000 [==============================] - 19s 318us/step - loss: 0.1291 -
acc: 0.9618 - val_loss: 0.0854 - val_acc: 0.9735
Epoch 5/20
60000/60000 [==============================] - 19s 323us/step - loss: 0.1197 -
acc: 0.9640 - val_loss: 0.0748 - val_acc: 0.9772
Epoch 6/20
60000/60000 [==============================] - 19s 320us/step - loss: 0.1115 -
acc: 0.9664 - val_loss: 0.0766 - val_acc: 0.9776
Epoch 7/20
60000/60000 [==============================] - 19s 319us/step - loss: 0.1025 -
acc: 0.9685 - val_loss: 0.0791 - val_acc: 0.9762
Epoch 8/20
60000/60000 [==============================] - 19s 320us/step - loss: 0.0982 -
acc: 0.9698 - val_loss: 0.0668 - val_acc: 0.9806
Epoch 9/20
60000/60000 [==============================] - 20s 329us/step - loss: 0.0916 -
acc: 0.9720 - val_loss: 0.0588 - val_acc: 0.9805
Epoch 10/20
60000/60000 [==============================] - 19s 323us/step - loss: 0.0848 -
acc: 0.9746 - val_loss: 0.0618 - val_acc: 0.9815
Epoch 11/20
60000/60000 [==============================] - 19s 321us/step - loss: 0.0789 -
acc: 0.9759 - val_loss: 0.0666 - val_acc: 0.9809
Epoch 12/20
60000/60000 [==============================] - 19s 321us/step - loss: 0.0738 -
acc: 0.9764 - val_loss: 0.0644 - val_acc: 0.9815
Epoch 13/20
60000/60000 [==============================] - 19s 315us/step - loss: 0.0721 -
acc: 0.9772 - val_loss: 0.0637 - val_acc: 0.9812
Epoch 14/20
60000/60000 [==============================] - 19s 315us/step - loss: 0.0730 -
```

```
acc: 0.9772 - val_loss: 0.0605 - val_acc: 0.9826
Epoch 15/20
60000/60000 [==============================] - 20s 326us/step - loss: 0.0677 -
acc: 0.9791 - val_loss: 0.0591 - val_acc: 0.9826
Epoch 16/20
60000/60000 [==============================] - 20s 330us/step - loss: 0.0606 -
acc: 0.9809 - val_loss: 0.0597 - val_acc: 0.9833
Epoch 17/20
60000/60000 [==============================] - 19s 319us/step - loss: 0.0613 -
acc: 0.9797 - val_loss: 0.0583 - val_acc: 0.9832
Epoch 18/20
60000/60000 [==============================] - 19s 317us/step - loss: 0.0609 -
acc: 0.9799 - val_loss: 0.0571 - val_acc: 0.9836
Epoch 19/20
60000/60000 [==============================] - 19s 316us/step - loss: 0.0603 -
acc: 0.9806 - val_loss: 0.0542 - val_acc: 0.9846
Epoch 20/20
60000/60000 [==============================] - 19s 324us/step - loss: 0.0536 -
acc: 0.9830 - val_loss: 0.0620 - val_acc: 0.9827
```

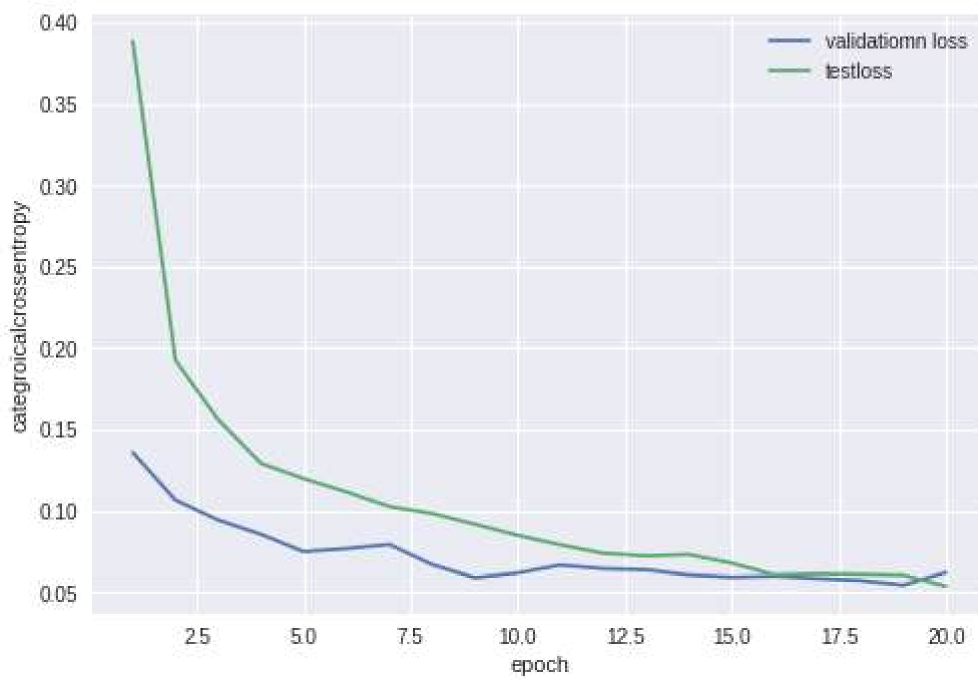
In [0]:

```
score=model.evaluate(xtest,ytest,verbose=0)
print('test score',score[0])
print('test accuracy',score[1])
```

```
test score 0.0621104669367196
test accuracy 0.9816
```

In [0]:

```
fig,ax=plt.subplots()
x=list(range(1,21))
validationy=history.history['val_loss']
testy=history.history['loss']
dynamicplot(x,validationy,testy,ax)
```



```
In [0]: model2=Sequential()
model2.add(Dense(364,input_dim=inputdimensions,activation='relu'))
model2.add(BatchNormalization())
model2.add(Dropout(0.2))
model2.add(Dense(512,input_dim=inputdimensions,activation='relu'))
model2.add(BatchNormalization())
model2.add(Dropout(0.3))
model2.add(Dense(784,input_dim=inputdimensions,activation='relu'))
model2.add(BatchNormalization())
model2.add(Dropout(0.4))
model2.add(Dense(512,input_dim=inputdimensions,activation='relu'))
model2.add(BatchNormalization())
model2.add(Dropout(0.5))
model2.add(Dense(200,activation='relu'))
model2.add(BatchNormalization())
model2.add(Dropout(0.6))
model2.add(Dense(10,activation='softmax'))
model2.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accura
history=model2.fit(xtrain,ytrain,batch_size=128,epochs=20,validation_data=(xtest
```

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/20
60000/60000 [==============================] - 28s 469us/step - loss: 0.5001 -
acc: 0.8530 - val_loss: 0.1449 - val_acc: 0.9583
Epoch 2/20
60000/60000 [==============================] - 26s 435us/step - loss: 0.1877 -
acc: 0.9456 - val_loss: 0.1093 - val_acc: 0.9699
Epoch 3/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.1483 -
acc: 0.9575 - val_loss: 0.0906 - val_acc: 0.9734
Epoch 4/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.1207 -
acc: 0.9648 - val_loss: 0.1021 - val_acc: 0.9707
Epoch 5/20
60000/60000 [==============================] - 26s 432us/step - loss: 0.1090 -
acc: 0.9682 - val_loss: 0.0855 - val_acc: 0.9740
Epoch 6/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.0957 -
acc: 0.9720 - val_loss: 0.0856 - val_acc: 0.9747
Epoch 7/20
60000/60000 [==============================] - 26s 433us/step - loss: 0.0884 -
acc: 0.9749 - val_loss: 0.0719 - val_acc: 0.9796
Epoch 8/20
60000/60000 [==============================] - 26s 433us/step - loss: 0.0822 -
acc: 0.9765 - val_loss: 0.0910 - val_acc: 0.9759
Epoch 9/20
60000/60000 [==============================] - 26s 437us/step - loss: 0.0784 -
acc: 0.9772 - val_loss: 0.0880 - val_acc: 0.9745
Epoch 10/20
60000/60000 [==============================] - 26s 437us/step - loss: 0.0734 -
acc: 0.9786 - val_loss: 0.0678 - val_acc: 0.9803
Epoch 11/20
60000/60000 [==============================] - 26s 442us/step - loss: 0.0647 -
acc: 0.9814 - val_loss: 0.0635 - val_acc: 0.9811
Epoch 12/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.0619 -
```

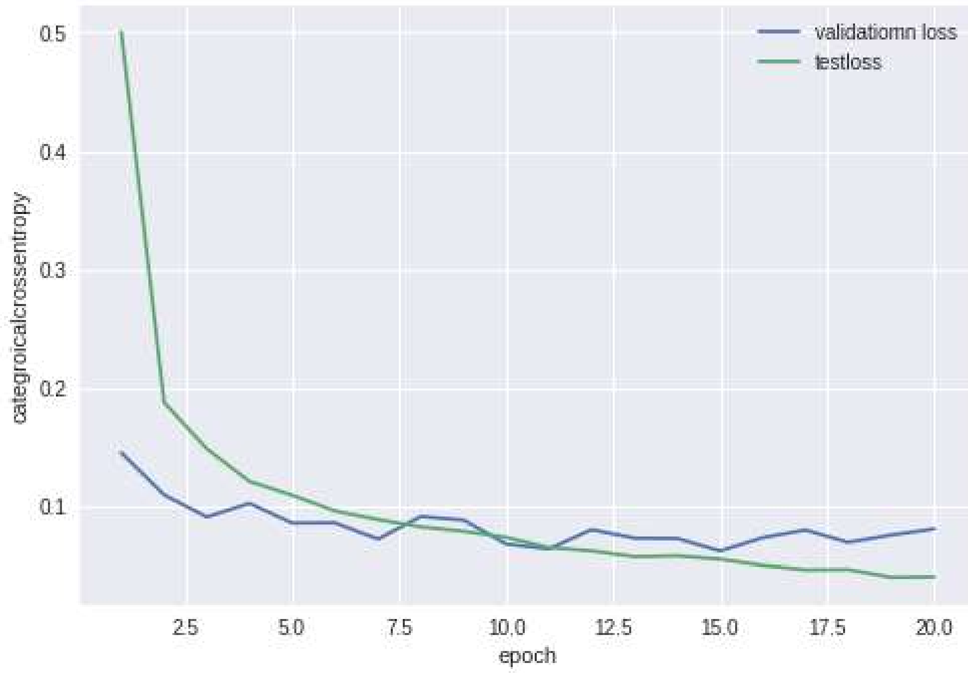
```
acc: 0.9824 - val_loss: 0.0798 - val_acc: 0.9798
Epoch 13/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.0570 -
acc: 0.9834 - val_loss: 0.0727 - val_acc: 0.9807
Epoch 14/20
60000/60000 [==============================] - 26s 437us/step - loss: 0.0578 -
acc: 0.9837 - val_loss: 0.0723 - val_acc: 0.9798
Epoch 15/20
60000/60000 [==============================] - 26s 436us/step - loss: 0.0550 -
acc: 0.9838 - val_loss: 0.0619 - val_acc: 0.9832
Epoch 16/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.0498 -
acc: 0.9852 - val_loss: 0.0731 - val_acc: 0.9808
Epoch 17/20
60000/60000 [==============================] - 26s 433us/step - loss: 0.0460 -
acc: 0.9867 - val_loss: 0.0795 - val_acc: 0.9798
Epoch 18/20
60000/60000 [==============================] - 26s 435us/step - loss: 0.0463 -
acc: 0.9863 - val_loss: 0.0692 - val_acc: 0.9814
Epoch 19/20
60000/60000 [==============================] - 26s 433us/step - loss: 0.0398 -
acc: 0.9882 - val_loss: 0.0753 - val_acc: 0.9803
Epoch 20/20
60000/60000 [==============================] - 26s 434us/step - loss: 0.0402 -
acc: 0.9879 - val_loss: 0.0804 - val_acc: 0.9825
```

In [0]:

```
score=model.evaluate(xtest,ytest,verbose=0)
print('test score',score[0])
print('test accuracy',score[1])
```

```
test score 0.07184817352769897
test accuracy 0.9785
```

In [0]:
```
fig,ax=plt.subplots()
x=list(range(1,21))
validationy=history.history['val_loss']
testy=history.history['loss']
dynamicplot(x,validationy,testy,ax)
```



In [0]:

```
model3=Sequential()
model3.add(Dense(364,input_dim=inputdimensions,activation='relu'))
model3.add(BatchNormalization())
model3.add(Dense(512,input_dim=inputdimensions,activation='relu'))
model3.add(BatchNormalization())
model3.add(Dense(52,activation='relu'))
model3.add(BatchNormalization())
model3.add(Dense(10,activation='softmax'))
model3.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accura
history=model3.fit(xtrain,ytrain,batch_size=128,epochs=20,validation_data=(xtest
```

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/20
60000/60000 [==============================] - 13s 210us/step - loss: 0.1939 -
acc: 0.9429 - val_loss: 0.1124 - val_acc: 0.9655
Epoch 2/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0750 -
acc: 0.9768 - val_loss: 0.0809 - val_acc: 0.9734
Epoch 3/20
60000/60000 [==============================] - 10s 169us/step - loss: 0.0488 -
acc: 0.9845 - val_loss: 0.0829 - val_acc: 0.9732
Epoch 4/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0388 -
acc: 0.9879 - val_loss: 0.0793 - val_acc: 0.9748
Epoch 5/20
60000/60000 [==============================] - 10s 165us/step - loss: 0.0313 -
acc: 0.9897 - val_loss: 0.0809 - val_acc: 0.9766
Epoch 6/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0275 -
acc: 0.9910 - val_loss: 0.0745 - val_acc: 0.9777
Epoch 7/20
60000/60000 [==============================] - 10s 167us/step - loss: 0.0230 -
acc: 0.9925 - val_loss: 0.0861 - val_acc: 0.9740
Epoch 8/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0206 -
acc: 0.9929 - val_loss: 0.0719 - val_acc: 0.9787
Epoch 9/20
60000/60000 [==============================] - 10s 168us/step - loss: 0.0167 -
acc: 0.9945 - val_loss: 0.0745 - val_acc: 0.9789
Epoch 10/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0164 -
acc: 0.9944 - val_loss: 0.0745 - val_acc: 0.9802
Epoch 11/20
60000/60000 [==============================] - 10s 168us/step - loss: 0.0167 -
acc: 0.9946 - val_loss: 0.0817 - val_acc: 0.9775
Epoch 12/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0131 -
acc: 0.9957 - val_loss: 0.0673 - val_acc: 0.9819
Epoch 13/20
60000/60000 [==============================] - 10s 167us/step - loss: 0.0163 -
acc: 0.9942 - val_loss: 0.0836 - val_acc: 0.9785
Epoch 14/20
60000/60000 [==============================] - 10s 167us/step - loss: 0.0133 -
acc: 0.9955 - val_loss: 0.0744 - val_acc: 0.9806
Epoch 15/20
60000/60000 [==============================] - 10s 169us/step - loss: 0.0093 -
```

```
acc: 0.9970 - val_loss: 0.0680 - val_acc: 0.9813
Epoch 16/20
60000/60000 [==============================] - 10s 168us/step - loss: 0.0094 -
acc: 0.9969 - val_loss: 0.0724 - val_acc: 0.9807
Epoch 17/20
60000/60000 [==============================] - 10s 167us/step - loss: 0.0099 -
acc: 0.9966 - val_loss: 0.0828 - val_acc: 0.9790
Epoch 18/20
60000/60000 [==============================] - 10s 166us/step - loss: 0.0114 -
acc: 0.9962 - val_loss: 0.0765 - val_acc: 0.9816
Epoch 19/20
60000/60000 [==============================] - 10s 170us/step - loss: 0.0092 -
acc: 0.9971 - val_loss: 0.0749 - val_acc: 0.9812
Epoch 20/20
60000/60000 [==============================] - 12s 197us/step - loss: 0.0071 -
acc: 0.9976 - val_loss: 0.0722 - val_acc: 0.9818
```

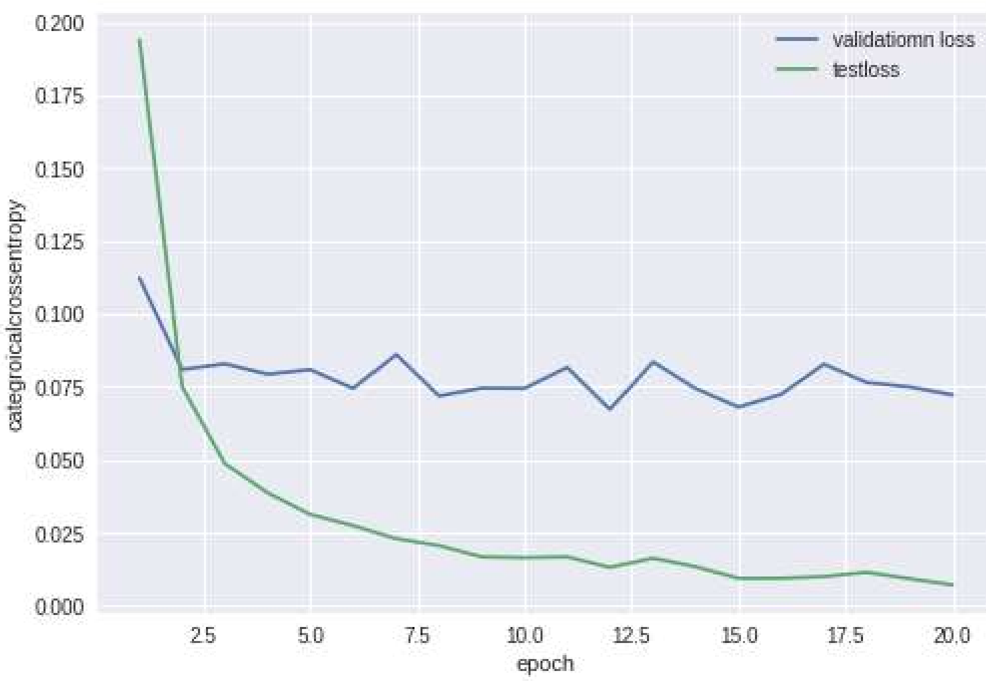
In [0]:

```
score=model.evaluate(xtest,ytest,verbose=0)
print('test score',score[0])
print('test accuracy',score[1])
```

```
test score 0.12161973871234805
test accuracy 0.9695
```

In [0]:

```
fig,ax=plt.subplots()
x=list(range(1,21))
validationy=history.history['val_loss']
testy=history.history['loss']
dynamicplot(x,validationy,testy,ax)
```



In [0]:

```
model4=Sequential()
model4.add(Dense(364,input_dim=inputdimensions,activation='relu'))
model4.add(Dense(512,input_dim=inputdimensions,activation='relu'))
model4.add(Dense(20,input_dim=inputdimensions,activation='relu'))
model4.add(Dense(10,input_dim=inputdimensions,activation='relu'))
model4.add(Dense(60,input_dim=inputdimensions,activation='relu'))
model4.add(Dense(52,activation='relu'))
model4.add(Dense(10,activation='softmax'))
model4.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accura
history1=model4.fit(xtrain,ytrain,batch_size=128,epochs=20,validation_data=(xtes
```

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/20
60000/60000 [==============================] - 20s 328us/step - loss: 0.3797 -
acc: 0.8813 - val_loss: 0.1399 - val_acc: 0.9600
Epoch 2/20
60000/60000 [==============================] - 15s 256us/step - loss: 0.1165 -
acc: 0.9656 - val_loss: 0.1081 - val_acc: 0.9672
Epoch 3/20
60000/60000 [==============================] - 15s 242us/step - loss: 0.0787 -
acc: 0.9764 - val_loss: 0.0844 - val_acc: 0.9759
Epoch 4/20
60000/60000 [==============================] - 15s 246us/step - loss: 0.0594 -
acc: 0.9820 - val_loss: 0.0892 - val_acc: 0.9752
Epoch 5/20
60000/60000 [==============================] - 15s 250us/step - loss: 0.0448 -
acc: 0.9858 - val_loss: 0.0905 - val_acc: 0.9742
Epoch 6/20
60000/60000 [==============================] - 15s 248us/step - loss: 0.0362 -
acc: 0.9886 - val_loss: 0.0816 - val_acc: 0.9773
Epoch 7/20
60000/60000 [==============================] - 15s 246us/step - loss: 0.0316 -
acc: 0.9901 - val_loss: 0.0901 - val_acc: 0.9769
Epoch 8/20
60000/60000 [==============================] - 15s 252us/step - loss: 0.0274 -
acc: 0.9913 - val_loss: 0.0977 - val_acc: 0.9756
Epoch 9/20
60000/60000 [==============================] - 15s 252us/step - loss: 0.0234 -
acc: 0.9925 - val_loss: 0.1007 - val_acc: 0.9772
Epoch 10/20
60000/60000 [==============================] - 15s 249us/step - loss: 0.0224 -
acc: 0.9928 - val_loss: 0.0952 - val_acc: 0.9773
Epoch 11/20
60000/60000 [==============================] - 14s 237us/step - loss: 0.0183 -
acc: 0.9939 - val_loss: 0.0868 - val_acc: 0.9801
Epoch 12/20
60000/60000 [==============================] - 15s 249us/step - loss: 0.0213 -
acc: 0.9935 - val_loss: 0.1202 - val_acc: 0.9717
Epoch 13/20
60000/60000 [==============================] - 15s 248us/step - loss: 0.0158 -
acc: 0.9949 - val_loss: 0.0904 - val_acc: 0.9805
Epoch 14/20
60000/60000 [==============================] - 15s 250us/step - loss: 0.0135 -
acc: 0.9958 - val_loss: 0.1000 - val_acc: 0.9789
Epoch 15/20
60000/60000 [==============================] - 15s 242us/step - loss: 0.0106 -
```

```
acc: 0.9968 - val_loss: 0.0963 - val_acc: 0.9806
Epoch 16/20
60000/60000 [==============================] - 15s 252us/step - loss: 0.0152 -
acc: 0.9952 - val_loss: 0.0987 - val_acc: 0.9793
Epoch 17/20
60000/60000 [==============================] - 15s 247us/step - loss: 0.0137 -
acc: 0.9960 - val_loss: 0.1016 - val_acc: 0.9789
Epoch 18/20
60000/60000 [==============================] - 14s 241us/step - loss: 0.0105 -
acc: 0.9968 - val_loss: 0.1085 - val_acc: 0.9799
Epoch 19/20
60000/60000 [==============================] - 15s 243us/step - loss: 0.0119 -
acc: 0.9966 - val_loss: 0.0958 - val_acc: 0.9810
Epoch 20/20
60000/60000 [==============================] - 15s 243us/step - loss: 0.0094 -
acc: 0.9972 - val_loss: 0.0930 - val_acc: 0.9823
```

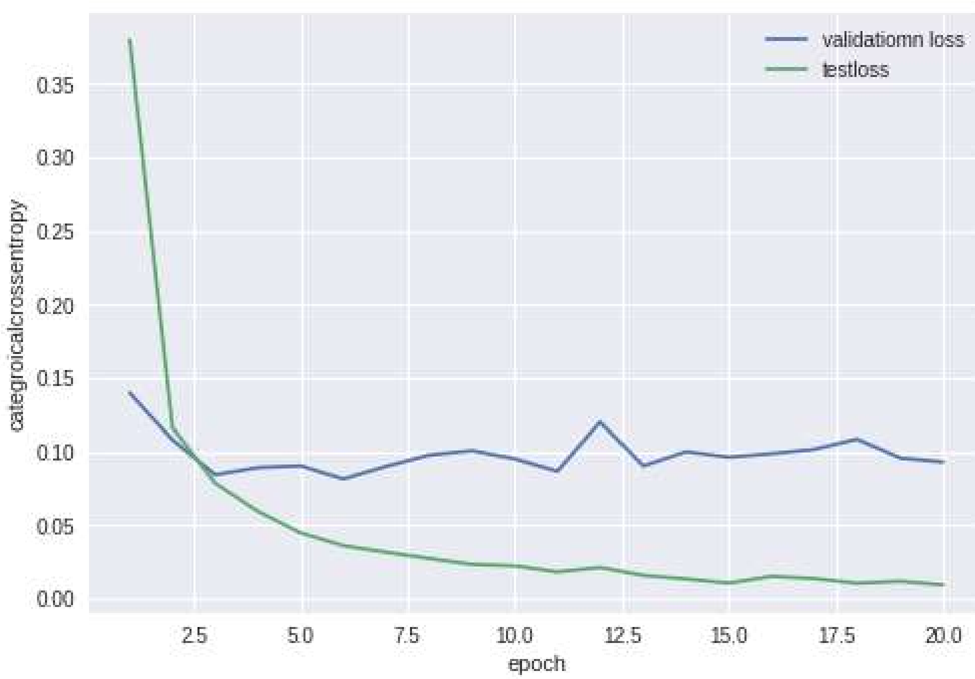
In [0]:

```
score=model.evaluate(xtest,ytest,verbose=0)
print('test score',score[0])
print('test accuracy',score[1])
```

```
test score 0.12161973871234805
test accuracy 0.9695
```

In [0]:

```
fig,ax=plt.subplots()
x=list(range(1,21))
validationy=history1.history['val_loss']
testy=history1.history['loss']
dynamicplot(x,validationy,testy,ax)
```



with out dropouts and batchnormalisation the test accuracy is decreasing

#DOCUMENTATION CONCLUSION AND KEYTAKEAWAYS.

In [0]:
```
import pandas as pd

data = [[3,[364,562,10],0.06,0.982,'yes','yes'],[4,[364,512,52,10],0.071,0.9785,
pd.DataFrame(data, columns=["number of layers",'layers', "testscore",'testsccura
```

Out[48]:

	number of layers	layers	testscore	testsccuracy	using_dropouts	using_batch_normalisation
1	3	[364, 562, 10]	0.060	0.9820	yes	yes
2	4	[364, 512, 52, 10]	0.071	0.9785	yes	yes
3	6	[364, 512, 784, 512, 200, 10]	0.060	0.9785	yes	yes
4	6	[364, 512, 784, 512, 200, 10]	0.060	0.9785	no	yes
5	6	[364, 512, 784, 512, 200, 10]	0.060	0.9785	no	no

AS THE PART OF ASSIGNEMENT TASKWE USE THE MULTIPLE HIDDEN LAYERS WITH THE DIFFERENT DROPOUT RATES AND BATCH NORMALISATION LAYER. WE USE THE DROPUTS TO PREVENT THE MODEL FORM OVERFITTING WE WILL SWITH OF THE SOME OF THE CELLS IN THE HIDDEN LAYER BASED ON THE PERCENTAGE OF DROPOUT.WE ALSO USE THE BATCH NORMALISATION LAYER TO PERFORM THE BATCHNORMALISATION BECAUSE AFTER WE SEND THE DATA THROUGH THE ACTIVATION FUNCTIONS AND SUMMING WIL HAPPEN OVER THE DATA WHICH LEADS THE DATA TO LOOSE OTS ORIGINAL BEHAVIOR SO WE USE THE BATCH NORMALISATION TO NORMALIE THE DATA .

WE HAVE LOADED THE DATA AND NORMALISED THE OBTAINED DATA.WE CAN USE DIFFERENT ACTIVATION FUNCTIONS LIKE SIGMOID,RELU,TANH AND PERFORM THE ACTIVATION. WE FIT THE DATA. WE VARIED THE NUMBER OF DENSE LAYERS AND THE NUMBER OF CELLS IN THE EACH LAYER AND OBSERVED HOE THE MODEL IS CONVERGING REDUCING THE LOSS OF CATEGORICAL CROSS ENTROPY.WE USING THE GRAPH WE VISUALISED THE MODEL IS CONVERGING AND DEVIATING AND AGAIN CONVERGING O REDUCE ERROR. THE MAIN THING IS WE GONNA CONSIDER THE OUTPUT LAYER AS THE SOFTMAX LAYER IN WHICH THE OUTPUT IS TAKEN IN THE FORM OF PROBABILITIES THAT IT BELONGS T0 EACH CLASS LABEL AND WE TAKE MAXIMUM OUT OF THAT PROBABILITY.

###IF WE OBSERVE WE HAVE OBTAINED THE MORE ACCURACY WITH THE SIMPLE MODEL ITESELF USING THE BATCH NORMALISATION AND DROPOUT LAYER . IF WE OBSERVE THE MODELS PERFORMNCE IS REDUCING WHEN THE DROPOUTS AND BATCH NORMALISATION ARE NOT USED.

WITH SIMPLE DEEPLEARNING MODEL OF MLP WITHOUT ANY FEATUERS WE ARE ABLE TOACHIEVE ACCURACY OF 98 PERCENT.

In [0]:

```

```