CME 216, ME 343 - Spring 2020

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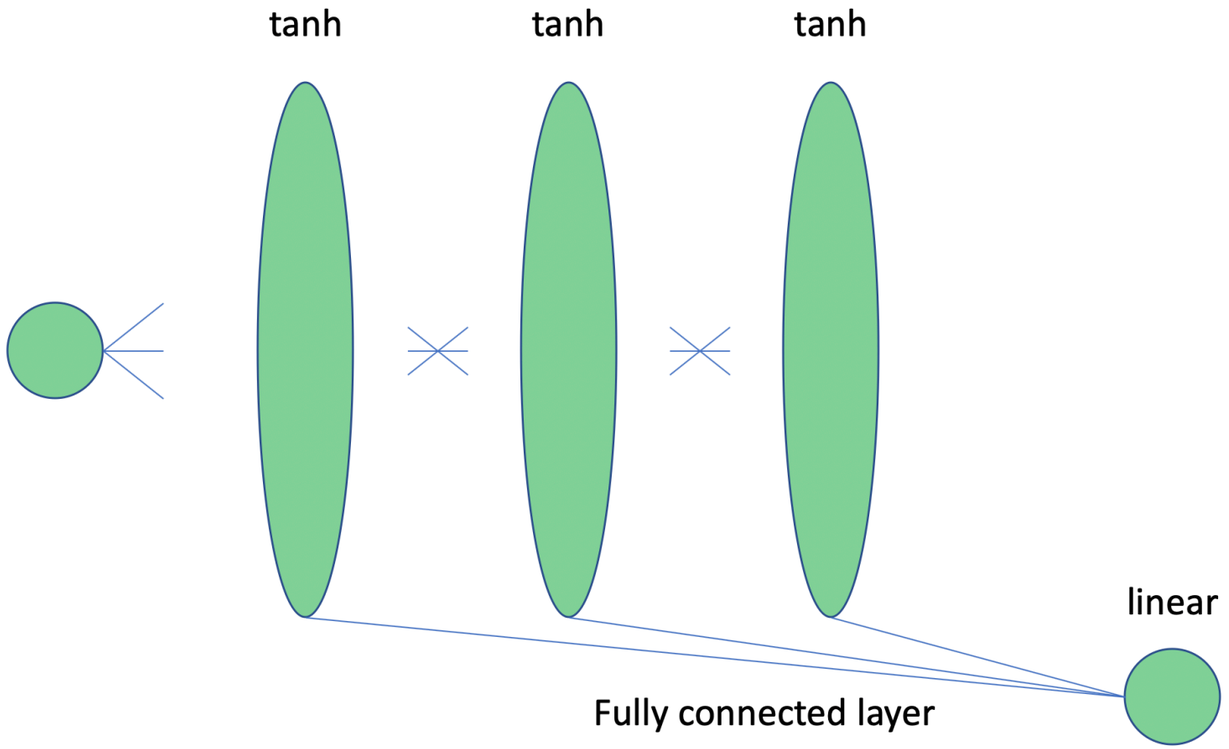
Let us now assume that we now want to code up the following DNN.


tanh
tanh
tanh
linear
Fully connected layer

Hidden layers 1, 2, and 3 are fully connected with the previous layer.

But then, the output layer is fully connected to hidden layers 1, 2, and 3.

This cannot be expressed using a sequential DNN.

We need to use the functional API for that.

It will look very similar to the previous syntax.

```
from tensorflow.keras import layers, Model
input_ = layers.Input(shape=1)
hidden1 = layers.Dense(4, activation="tanh")(input_)
hidden2 = layers.Dense(4, activation="tanh")(hidden1)
hidden3 = layers.Dense(4, activation="tanh")(hidden2)
concat = layers.Concatenate()([hidden1, hidden2, hidden3])
output = layers.Dense(1, activation="linear")(concat)
model = Model(inputs=[input_], outputs=[output])
```

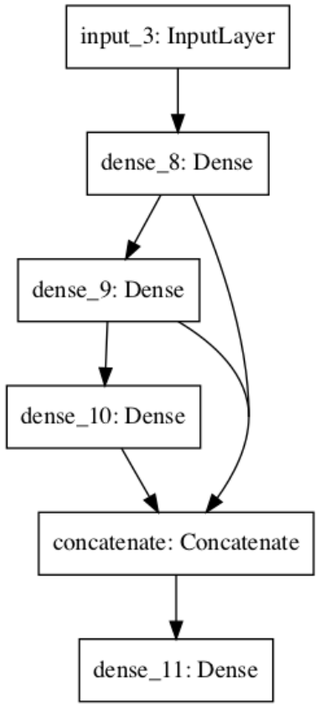
We recognize a new command

```
layers.Concatenate()([hidden1, hidden2, hidden3])
```

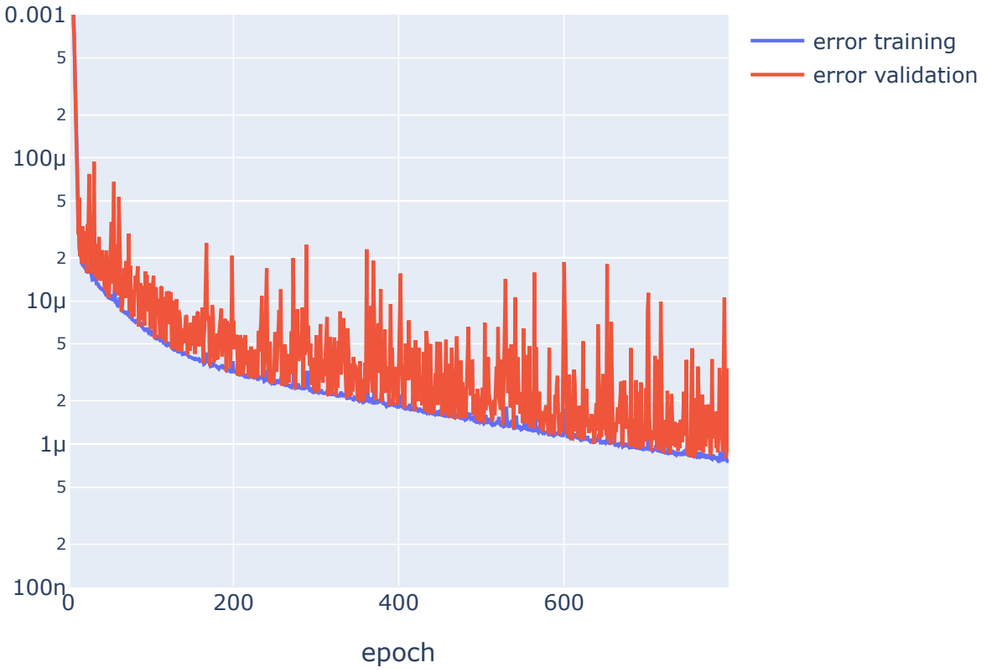
which concatenates together the output of multiple layers.

We can plot the model using

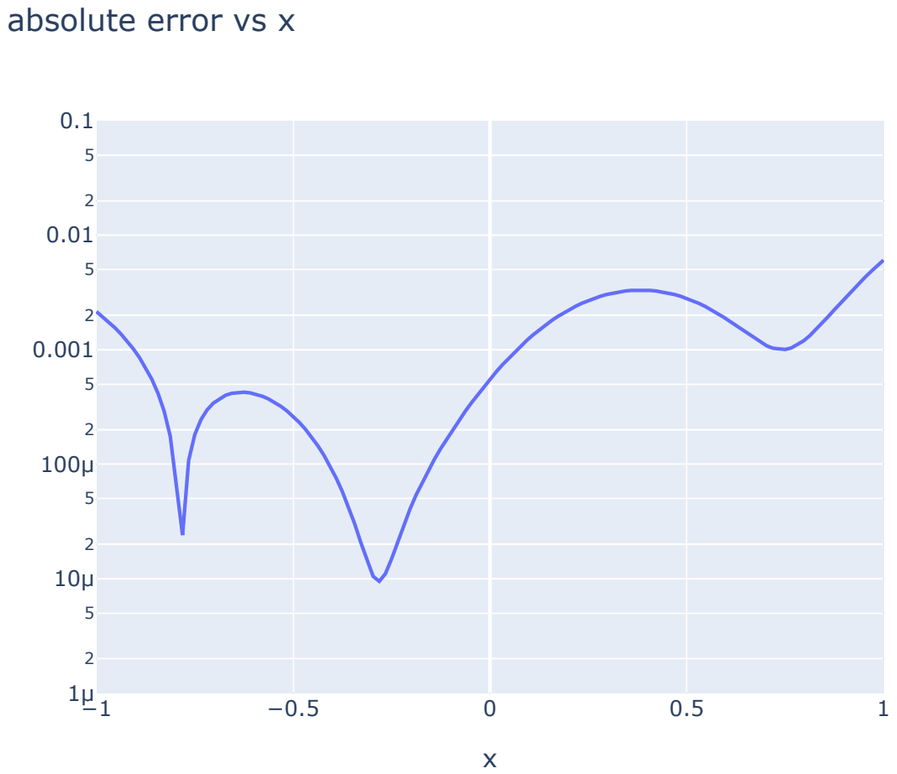
```
keras.utils.plot_model(model)
```


input_3: InputLayer
dense_8: Dense
dense_9: Dense
dense_10: Dense
concatenate: Concatenate
dense_11: Dense

Convergence



Error


absolute error vs x
0.1
5
2
0.01
5
2
0.001
5
2
100μ
5
2
10μ
5
2
1μ
−1
−0.5
0
0.5
1
x