Create Simple Sequence Classification Network Using Deep Network Designer

This example shows how to create a simple long short-term memory (LSTM) classification network using Deep Network Designer.

To train a deep neural network to classify sequence data, you can use an LSTM network. An LSTM network is a type of recurrent neural network (RNN) that learns long-term dependencies between time steps of sequence data.

The example demonstrates how to:

- Load sequence data.
- Construct the network architecture.
- Specify training options.
- Train the network.
- Predict the labels of new data and calculate the classification accuracy.

Load Data

Load the Japanese Vowels data set, as described in [1] and [2]. The predictors are cell arrays containing sequences of varying length with a feature dimension of 12. The labels are categorical vectors of labels 1,2,...,9.

```
load JapaneseVowelsTrainData
```

```
Error using load
JapaneseVowelsTrainData is not found in the current folder or on the MATLAB path, but exists in:
    /MATLAB Drive/Examples/R2023b/nnet/
CreateSequenceClassificationNetworkInDeepNetworkDesignerExample

Change the MATLAB current folder or add its folder to the MATLAB path.
```

```
load JapaneseVowelsTestData
```

View the sizes of the first few training sequences. The sequences are matrices with 12 rows (one row for each feature) and a varying number of columns (one column for each time step).

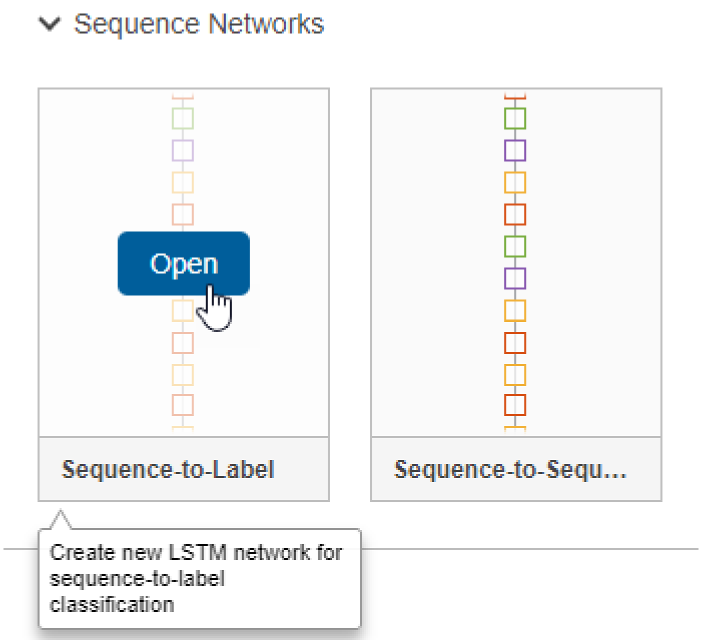
```
XTrain(1:5)
```

Define Network Architecture

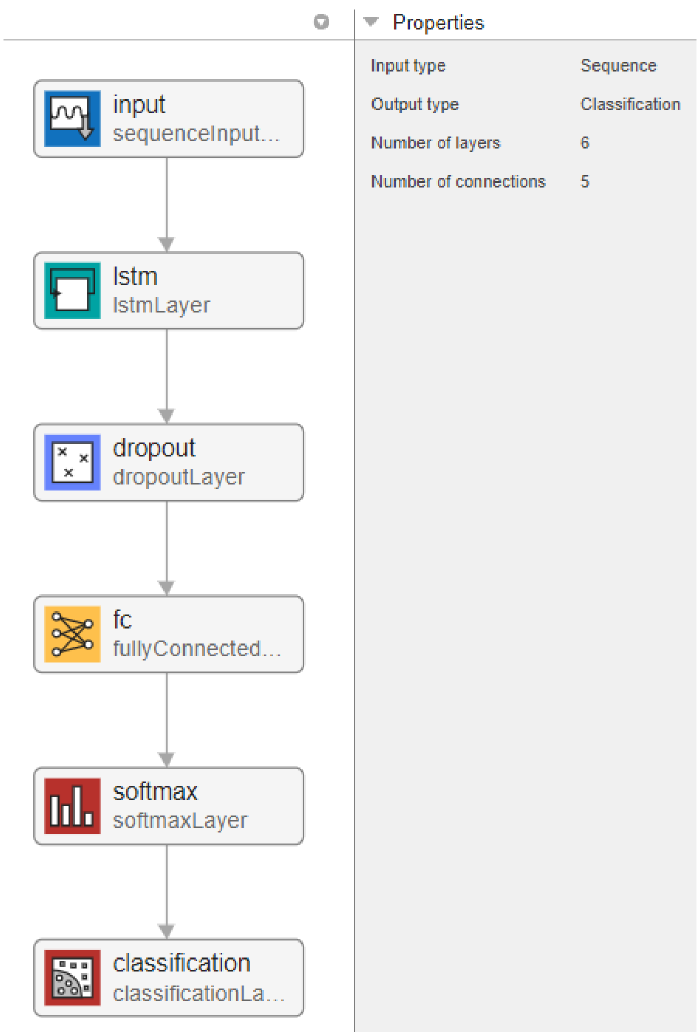
Open Deep Network Designer.

```
deepNetworkDesigner
```

Pause on **Sequence-to-Label** and click **Open**. This opens a prebuilt network suitable for sequence classification problems.

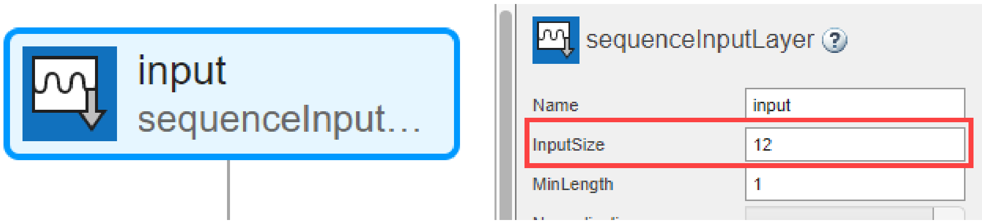


Deep Network Designer displays the prebuilt network.

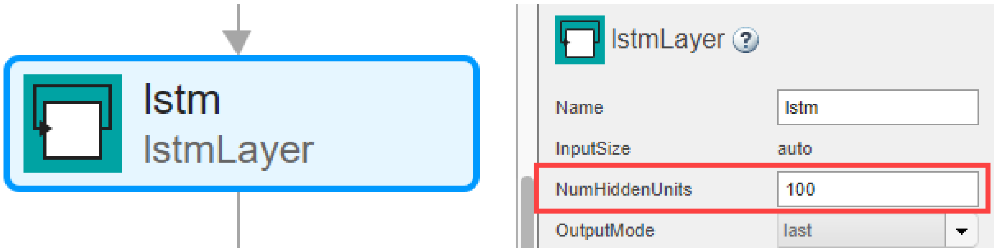


You can easily adapt this sequence network for the Japanese Vowels data set.

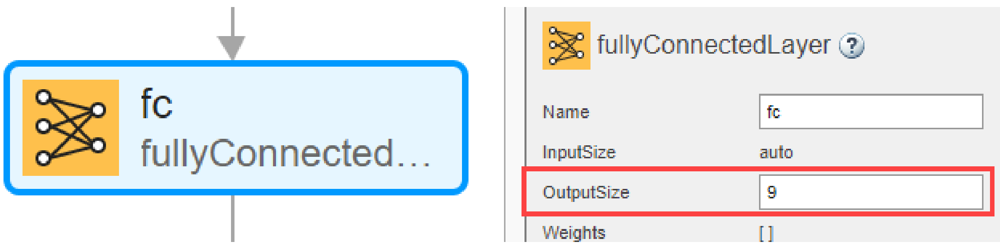
Select **sequenceInputLayer** and check that **InputSize** is set to 12 to match the feature dimension.



Select **lstmLayer** and set **NumHiddenUnits** to 100.

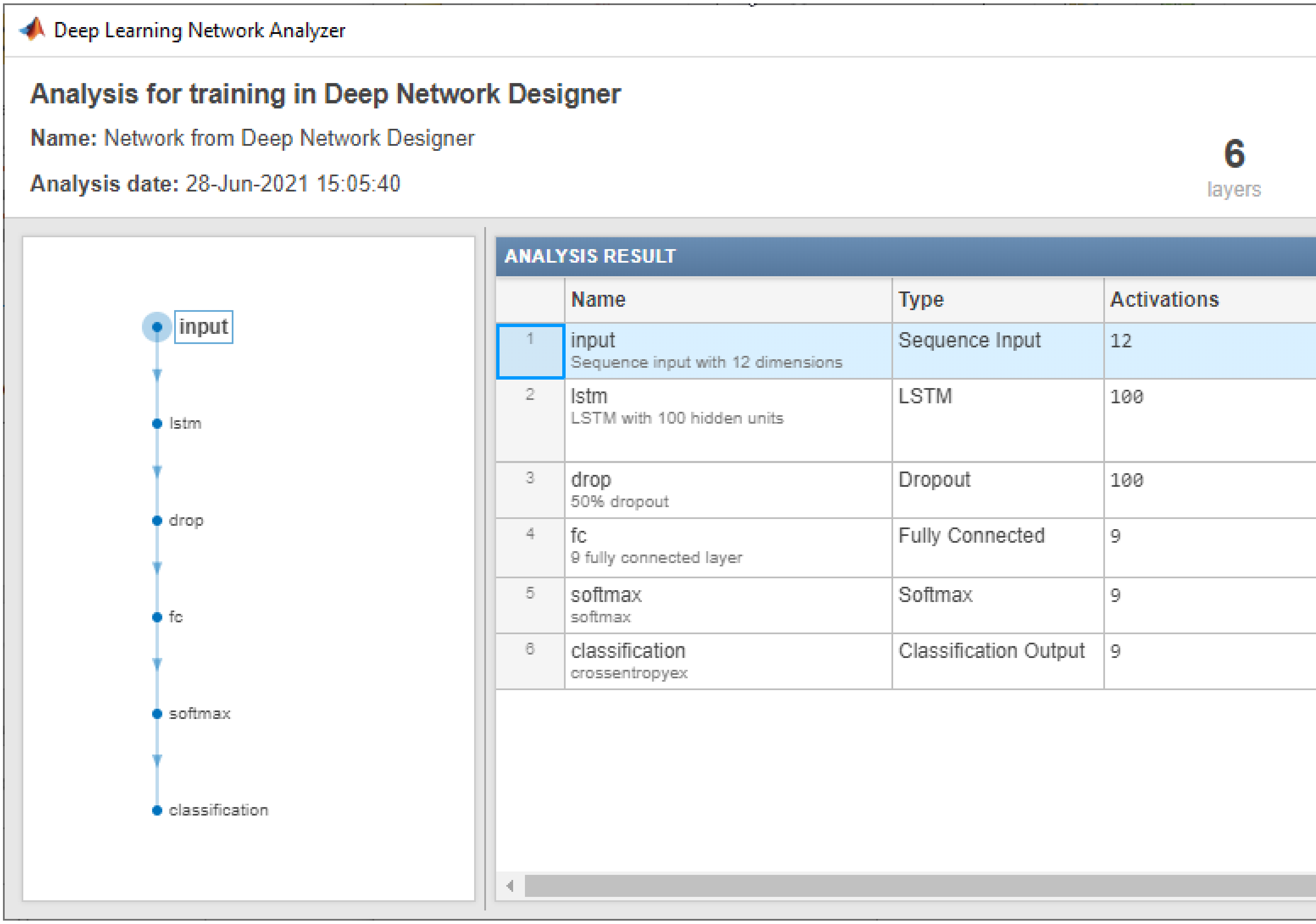


Select **fullyConnectedLayer** and check that **OutputSize** is set to 9, the number of classes.



Check Network Architecture

To check the network and examine more details of the layers, click **Analyze**.



	Name	Type	Activations
1	input Sequence input with 12 dimensions	Sequence Input	12
2	lstm LSTM with 100 hidden units	LSTM	100
3	drop 50% dropout	Dropout	100
4	fc 9 fully connected layer	Fully Connected	9
5	softmax softmax	Softmax	9
6	classification crossentropyex	Classification Output	9

Export Network Architecture

To export the network architecture to the workspace, on the **Designer** tab, click **Export**. Deep Network Designer saves the network as the variable `layers_1`.

You can also generate code to construct the network architecture by selecting **Export** > **Generate Network Code Without Parameters**.

Train Network

Specify the training options and train the network.

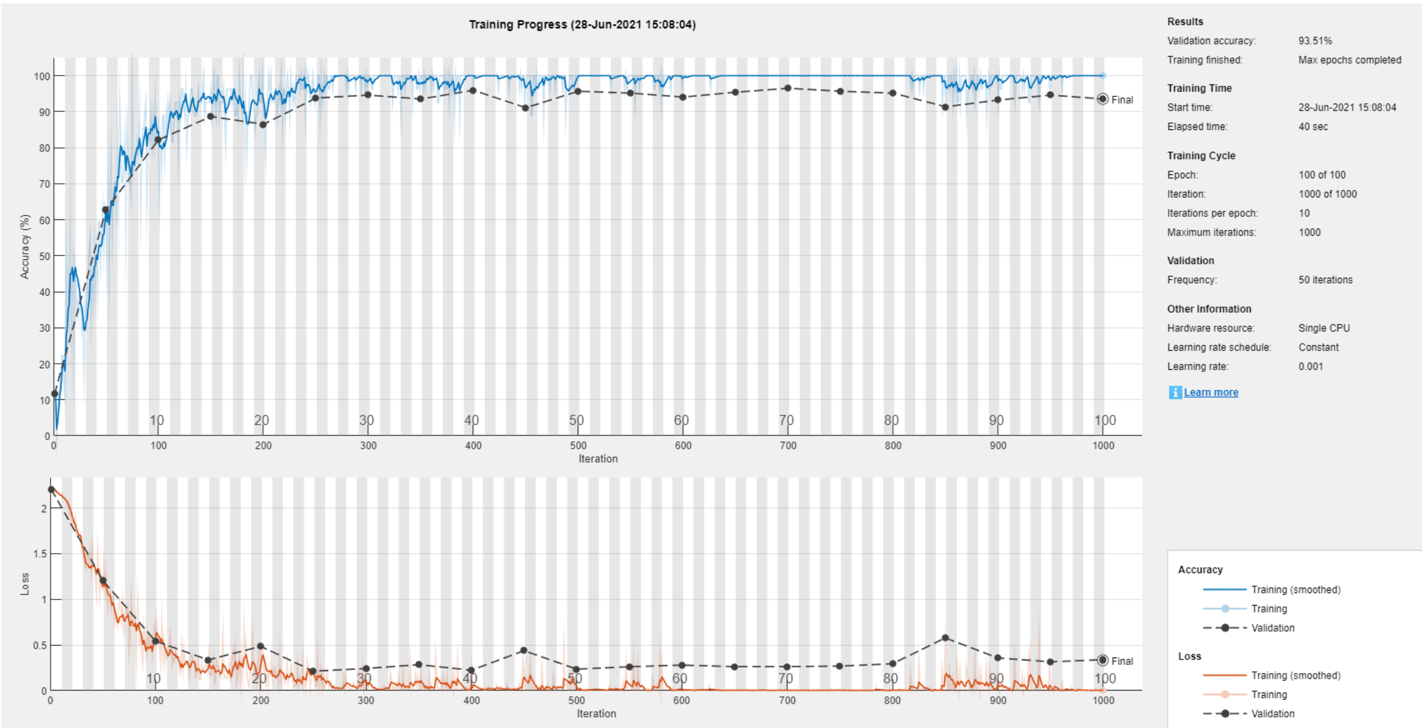
Because the mini-batches are small with short sequences, the CPU is better suited for training. Set `'ExecutionEnvironment'` to `'cpu'`. To train on a GPU, if available, set `'ExecutionEnvironment'` to `'auto'` (the default value).

```
miniBatchSize = 27;
options = trainingOptions('adam', ...
    'ExecutionEnvironment','cpu', ...
```

```
    'MaxEpochs',100, ...
    'MiniBatchSize',miniBatchSize, ...
    'ValidationData',{XValidation,TValidation}, ...
    'GradientThreshold',2, ...
    'Shuffle','every-epoch', ...
    'Verbose',false, ...
    'Plots','training-progress');
```

Train the network.

```
net = trainNetwork(XTrain,TTrain,layers_1,options);
```



You can also train this network using Deep Network Designer and datastore objects. For an example showing how to train a sequence-to-sequence regression network in Deep Network Designer, see Time Series Forecasting Using Deep Network Designer.

Test Network

Classify the test data and calculate the classification accuracy. Specify the same mini-batch size as for training.

```
YPred = classify(net,XValidation,'MiniBatchSize',miniBatchSize);
acc = mean(YPred == TValidation)
```

```
acc = 0.9405
```

For next steps, you can try improving the accuracy by using bidirectional LSTM (BiLSTM) layers or by creating a deeper network. For more information, see Long Short-Term Memory Networks.

For an example showing how to use convolutional networks to classify sequence data, see Speech Command Recognition Using Deep Learning.

References

[1] Kudo, Mineichi, Jun Toyama, and Masaru Shimbo. “Multidimensional Curve Classification Using Passing-through Regions.” Pattern Recognition Letters 20, no. 11–13 (November 1999): 1103–11. https://doi.org/10.1016/S0167-8655(99)00077-X.

[2] Kudo, Mineichi, Jun Toyama, and Masaru Shimbo. Japanese Vowels Data Set. Distributed by UCI Machine Learning Repository. https://archive.ics.uci.edu/ml/datasets/Japanese+Vowels