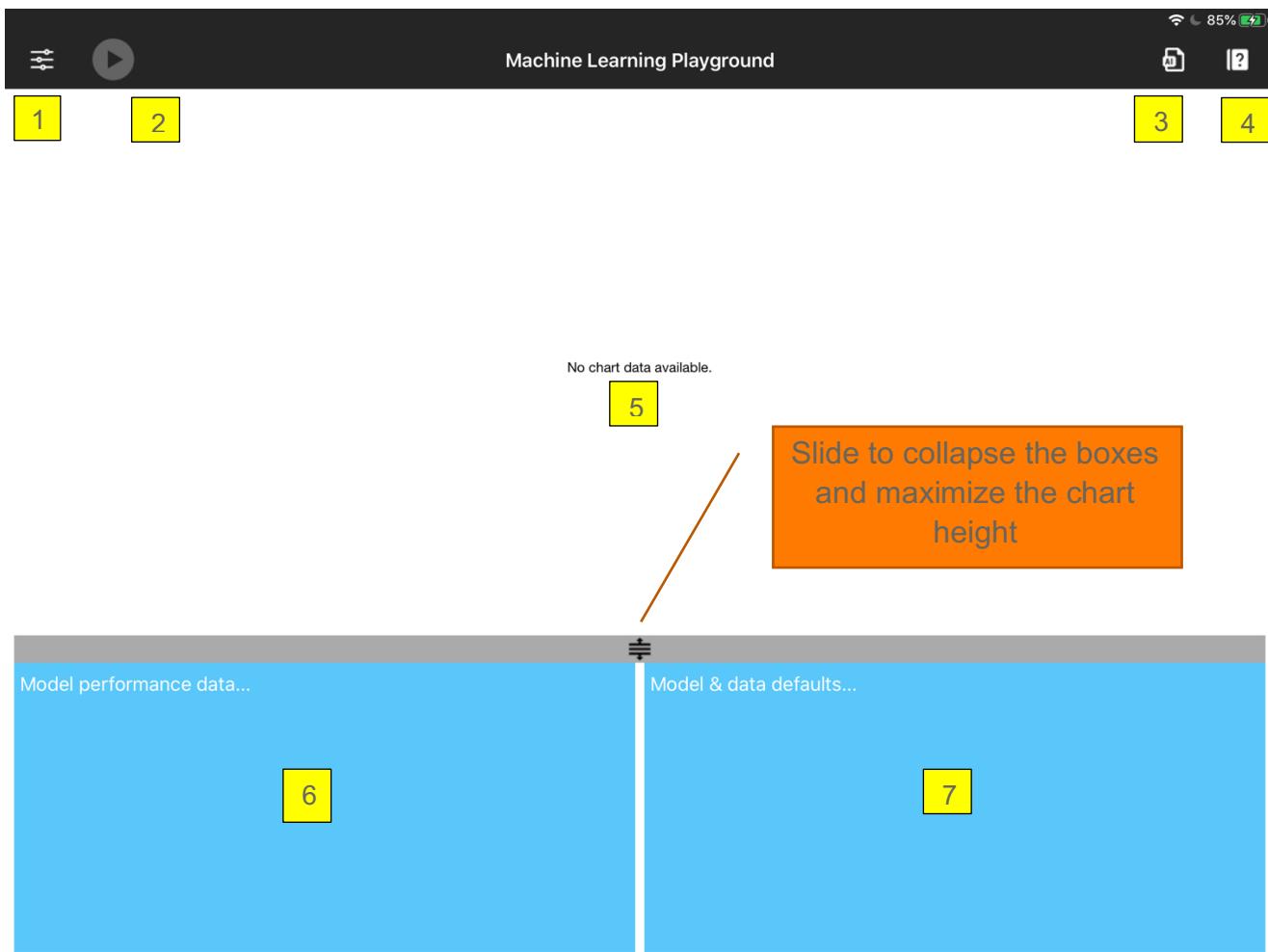




# Machine Learning Playground®

## Home

When the app launches this is the first page.



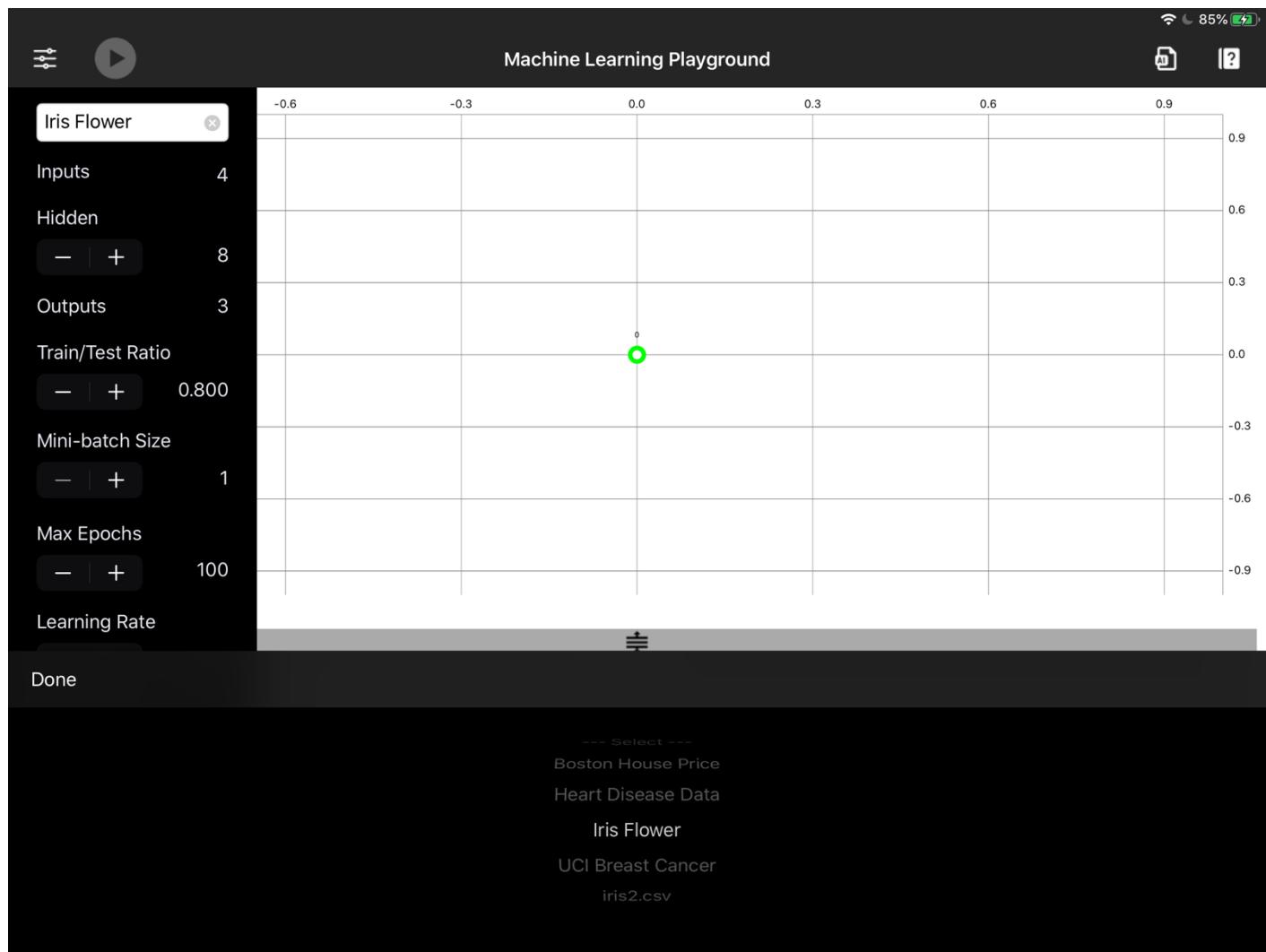
- 1) Hyperparameter menu panel. To open tap the icon or swipe right from the left edge of the screen.
- 2) Run a model. The button is disabled when a model is not selected.
- 3) Custom dataset and model definition page. Here you import your custom dataset and specify the neural network characteristics and save your dataset/model files.
- 4) Hyperparameter definitions page.
- 5) Loss chart for displaying training and test set model loss performance
- 6) Numeric values for training and test set loss values
- 7) Description of the model. The app ships with four built-in datasets. Brief descriptions appear in this space. The descriptions that you write for your custom datasets will also appear here.



# Machine Learning Playground®

## Select a dataset, set the hyperparameters & run

Within this page you select a dataset (either built-in, or custom), and perform your “what-if” analysis with the hyperparameters.



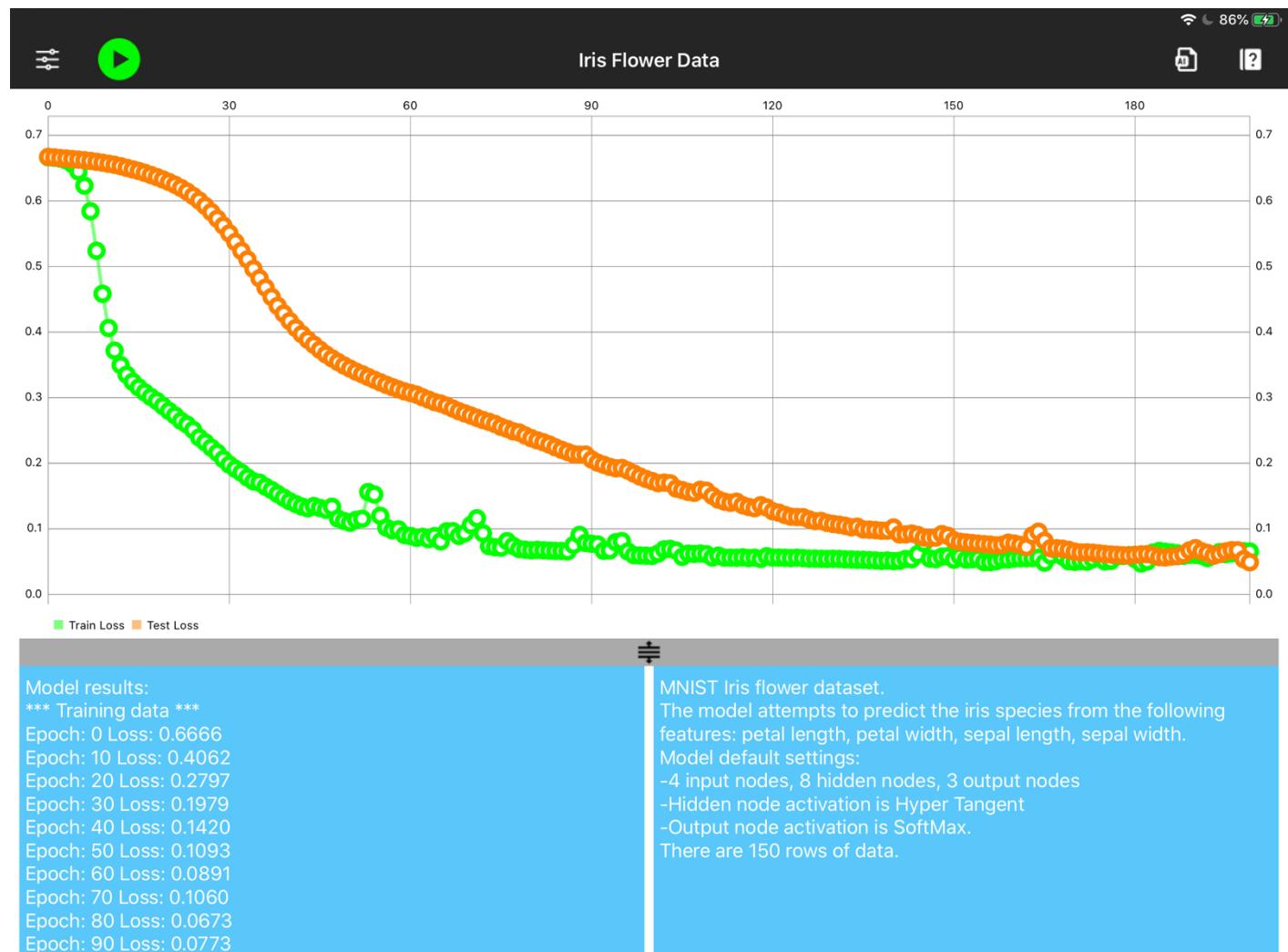
- 1) Tap the hyperparameter menu icon or swipe-right from the left edge to open the hyperparameter menu.
- 2) Then tap the text box at the top and a list of datasets will appear at the bottom
- 3) Tap “Done” to select
- 4) Use the stepper controls to set the hyperparameters
- 5) Tap the play button to run the model



# Machine Learning Playground®

## Model results

The model's training and test losses by epoch.



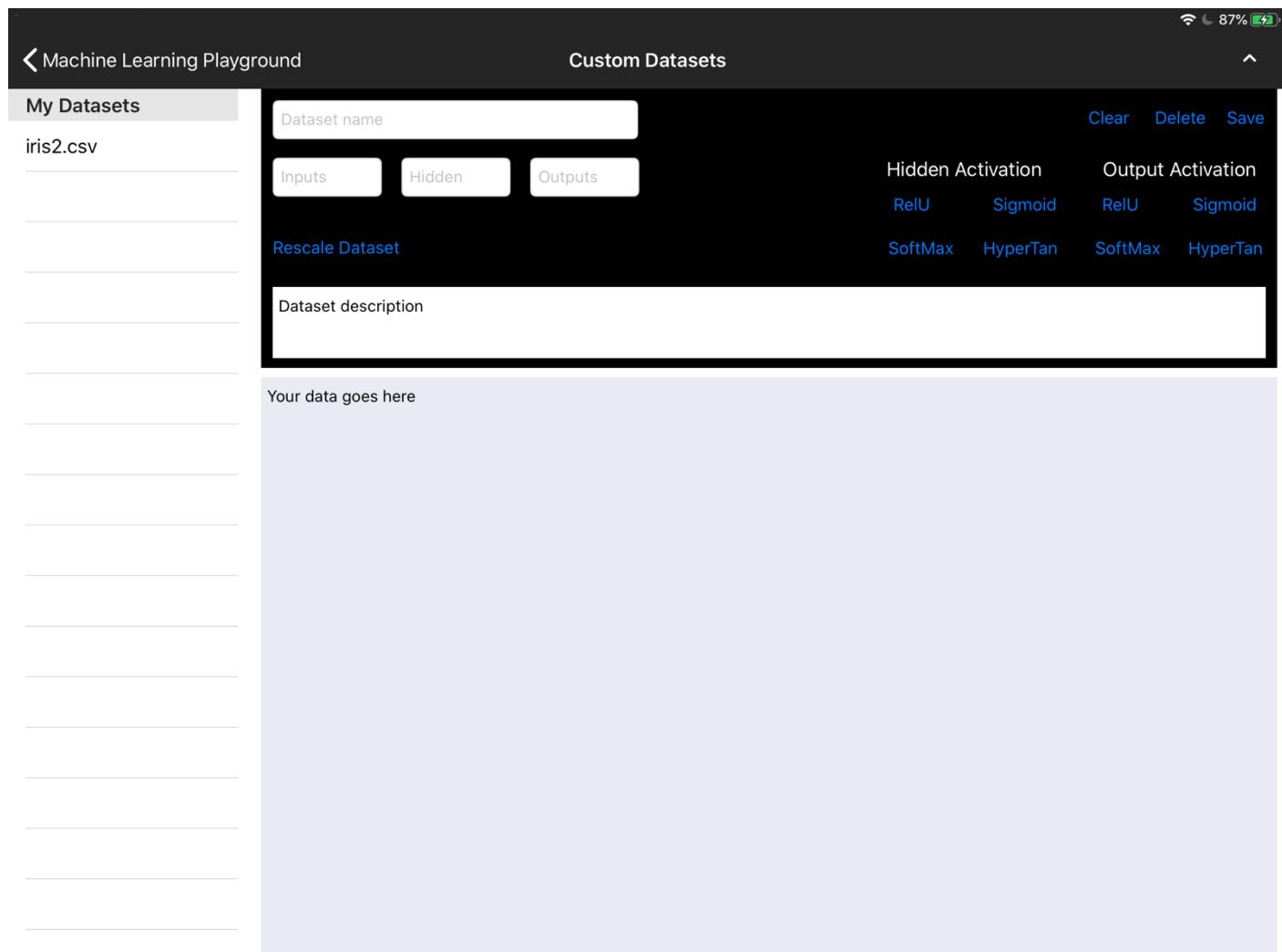
- 1) Scroll to view the model's training and test loss values in the "Model results" box.
- 2) Pull the slider down to collapse the boxes and maximize the height of the chart.
- 3) Pinch the chart to zoom in and out



# Machine Learning Playground®

## Custom datasets and models

Within this page you create, edit and delete datasets and their associated neural network models.



- 1) Tap the  icon on the Home page menu to open the Custom Datasets view and then tap the  icon to expand the custom neural network model parameters menu.
- 2) The easiest way to import data onto your iPad is to go to Files → Locations and select a .txt file from either your iCloud Drive, Google Drive, Dropbox, Pages, etc. The dataset file should be in a comma separated format such that each line looks something like the following:



# Machine Learning Playground®

## Custom datasets and models, continued

Copying data from external files.

[Copy](#) [Look Up](#) [Share...](#)

```
14.23,1.71,2.43,15.6,127,2.8,3.06,0.28,2.29,5.64,1.04,3.92,1065,1,0,0
13.2,1.78,2.14,11.2,100,2.65,2.76,0.26,1.28,4.38,1.05,3.4,1050,1,0,0
13.16,2.36,2.67,18.6,101,2.8,3.24,0.3,2.81,5.68,1.03,3.17,1185,1,0,0
14.37,1.95,2.5,16.8,113,3.85,3.49,0.24,2.18,7.8,0.86,3.45,1480,1,0,0
13.24,2.59,2.87,21,118,2.8,2.69,0.39,1.82,4.32,1.04,2.93,735,1,0,0
14.2,1.76,2.45,15.2,112,3.27,3.39,0.34,1.97,6.75,1.05,2.85,1450,1,0,0
14.39,1.87,2.45,14.6,96,2.5,2.52,0.3,1.98,5.25,1.02,3.58,1290,1,0,0
14.06,2.15,2.61,17.6,121,2.6,2.51,0.31,1.25,5.05,1.06,3.58,1295,1,0,0
14.83,1.64,2.17,14,97,2.8,2.98,0.29,1.98,5.2,1.08,2.85,1045,1,0,0
13.86,1.35,2.27,16,98,2.98,3.15,0.22,1.85,7.22,1.01,3.55,1045,1,0,0
14.1,2.16,2.3,18,105,2.95,3.32,0.22,2.38,5.75,1.25,3.17,1510,1,0,0
14.12,1.48,2.32,16.8,95,2.2,2.43,0.26,1.57,5,1.17,2.82,1280,1,0,0
13.75,1.73,2.41,16,89,2.6,2.76,0.29,1.81,5.6,1.15,2.9,1320,1,0,0
14.75,1.73,2.39,11.4,91,3.1,3.69,0.43,2.81,5.4,1.25,2.73,1150,1,0,0
14.38,1.87,2.38,12,102,3.3,3.64,0.29,2.96,7.5,1.2,3,1547,1,0,0
13.63,1.81,2.7,17.2,112,2.85,2.91,0.3,1.46,7.3,1.28,2.88,1310,1,0,0
14.3,1.92,2.72,20,120,2.8,3.14,0.33,1.97,6.2,1.07,2.65,1280,1,0,0
13.83,1.57,2.62,20,115,2.95,3.4,0.4,1.72,6.6,1.13,2.57,1130,1,0,0
14.19,1.59,2.48,16.5,108,3.3,3.93,0.32,1.86,8.7,1.23,2.82,1680,1,0,0
13.64,3.1,2.56,15.2,116,2.7,3.03,0.17,1.66,5.1,0.96,3.36,845,1,0,0
14.06,1.63,2.28,16,126,3,3.17,0.24,2.1,5.65,1.09,3.71,780,1,0,0
12.93,3.8,2.65,18.6,102,2.41,2.41,0.25,1.98,4.5,1.03,3.52,770,1,0,0
13.71,1.86,2.36,16.6,101,2.61,2.88,0.27,1.69,3.8,1.11,4,1035,1,0,0
12.85,1.6,2.52,17.8,95,2.48,2.37,0.26,1.46,3.93,1.09,3.63,1015,1,0,0
13.5,1.81,2.61,20,96,2.53,2.61,0.28,1.66,3.52,1.12,3.82,845,1,0,0
13.05,2.05,3.22,25,124,2.63,2.68,0.47,1.92,3.58,1.13,3.2,830,1,0,0
13.39,1.77,2.62,16.1,93,2.85,2.94,0.34,1.45,4.8,0.92,3.22,1195,1,0,0
13.3,1.72,2.14,17,94,2.4,2.19,0.27,1.35,3.95,1.02,2.77,1285,1,0,0
13.87,1.9,2.8,19.4,107,2.95,2.97,0.37,1.76,4.5,1.25,3.4,915,1,0,0
14.02,1.68,2.21,16,96,2.65,2.33,0.26,1.98,4.7,1.04,3.59,1035,1,0,0
13.73,1.5,2.7,22.5,101,3,3.25,0.29,2.38,5.7,1.19,2.71,1285,1,0,0
13.58,1.66,2.36,19.1,106,2.86,3.19,0.22,1.95,6.9,1.09,2.88,1515,1,0,0
13.68,1.83,2.36,17.2,104,2.42,2.69,0.42,1.97,3.84,1.23,2.87,990,1,0,0
13.76,1.53,2.7,19.5,132,2.95,2.74,0.5,1.35,5.4,1.25,3,1235,1,0,0
13.51,1.8,2.65,19,110,2.35,2.53,0.29,1.54,4.2,1.1,2.87,1095,1,0,0
```

- 3) The most important thing is that file should have a .txt extension. If you give it a .csv extension iPad will try to open the file using Excel. If you copy from Excel you will lose the comma separation.
- 4) After selecting the data tap the Copy tab.



# Machine Learning Playground®

## Custom datasets and models, continued

Set the file name and specify the neural network's parameters.

testdata.txt

13 17 3

Hidden Activation: ReLU, SoftMax  
Output Activation: Sigmoid, ReLU, SoftMax

HyperTan

Dataset description

12.37,1.21,2.56,18.1,98,2.42,2.65,0.37,2.08,4.6,1.19,2.3,6780,1,0  
13.11,0.01,1.715,78,2.98,3.18,0.26,2.28,5.3,112,3,19,502,0,1,0  
12.37,1.17,1.92,19.6,78,2.11,2,0.27,1.04,4.68,1.12,3.48,510,0,1,0  
13.34,0.94,2.36,17,110,2.53,1.3,0.55,0.42,3.17,1.02,1.93,750,0,1,0  
12.21,1.19,1.75,16.8,151,1.85,1.28,0.14,2.5,2.85,1.28,3.07,713,0,1,0  
12.29,1.61,2.21,20.4,103,1.1,1.02,0.37,1.46,3.05,0.906,1.82,870,0,1,0  
13.86,1.51,2.67,25,86,2.95,2.86,0.21,1.87,3.38,1.36,3.16,410,0,1,0  
13.49,1.66,2.24,24,87,1.88,1.84,0.27,1.03,3.74,0.98,2.78,472,0,1,0  
12.99,1.67,2.6,30,139,3.3,2.89,0.21,1.96,3.35,1.31,3.5,985,0,1,0  
11.96,1.09,2.3,21,101,3.38,2.14,0.13,1.65,3.21,0.99,3.13,886,0,1,0  
11.66,1.88,1.92,16,97,1.61,1.57,0.34,1.15,3.8,1.23,2.14,428,0,1,0  
13.03,0.9,1.71,16,86,1.95,2.03,0.24,1.46,4.6,1.19,2.48,392,0,1,0  
11.84,2.89,2.23,18,112,1.72,1.32,0.43,0.95,2.65,0.96,2.52,500,0,1,0  
12.33,0.99,1.95,14.8,136,1.9,1.85,0.35,2.76,3.4,1.06,2.31,750,0,1,0  
12.7,3.87,2.4,23,101,2.83,2.55,0.43,1.95,2.57,1.19,3.13,463,0,1,0  
12,0.92,2,19,86,2.42,2.26,0.3,1.43,2.5,1.38,3.12,278,0,1,0  
12.72,1.81,2,2,18,8,86,2,2,2.53,0.26,1.77,3.9,1.16,3.14,714,0,1,0  
12.08,1.13,2,51,24,78,2,1.58,0.4,1.4,2.2,1.31,2.72,630,0,1,0  
13.05,3.86,2.32,22,5.85,1.65,1.59,0.61,1.62,4.8,0.84,2.01,515,0,1,0  
11.84,0.89,2.58,18,94,2.2,2.21,0.22,2.35,3.05,0.79,3.08,520,0,1,0  
12.67,0.98,2.24,18,99,2.2,1.94,0.3,1.46,2.62,1.23,3.16,450,0,1,0  
12.16,1.61,2,31,22,8,90,1.78,1.69,0.43,1.56,2.45,1.33,2.26,495,0,1,0  
11.65,1.67,2.62,26,88,1.92,1.61,0.4,1.34,2.6,1.36,3.21,562,0,1,0  
11.64,2.06,2.46,21,6,84,1.95,1.69,0.48,1.35,2.8,1.2,75,680,0,1,0  
12.08,1.33,2.3,23,6,70,2.2,1.59,0.42,1.38,1.74,1.07,3.21,625,0,1,0  
12.08,1.83,2,32,18,5,81,1.6,1.5,0.52,1.64,2.4,1.08,2.27,480,0,1,0  
12,1.51,2,42,22,86,1.45,1.25,0.5,1.63,3.6,1.05,2.65,450,0,1,0  
12.69,1.53,2,26,20,7,80,1.38,1.46,0.58,1.62,3.05,0.96,2.06,495,0,1,0  
12.29,2.83,2.22,18,88,2.45,2.25,0.25,1.99,2.15,1.15,3.3,290,0,1,0  
11.62,1.99,2.28,18,98,3.02,2.26,0.17,1.35,3.25,1.16,2.96,345,0,1,0  
10.47,1.55,2.2,21,10,2,5,2.25,0.25,1.99,2.15,1.15,3.3,290,0,1,0  
10.47,1.55,2.2,21,10,2,5,2.25,0.25,1.99,2.15,1.15,3.3,290,0,1,0

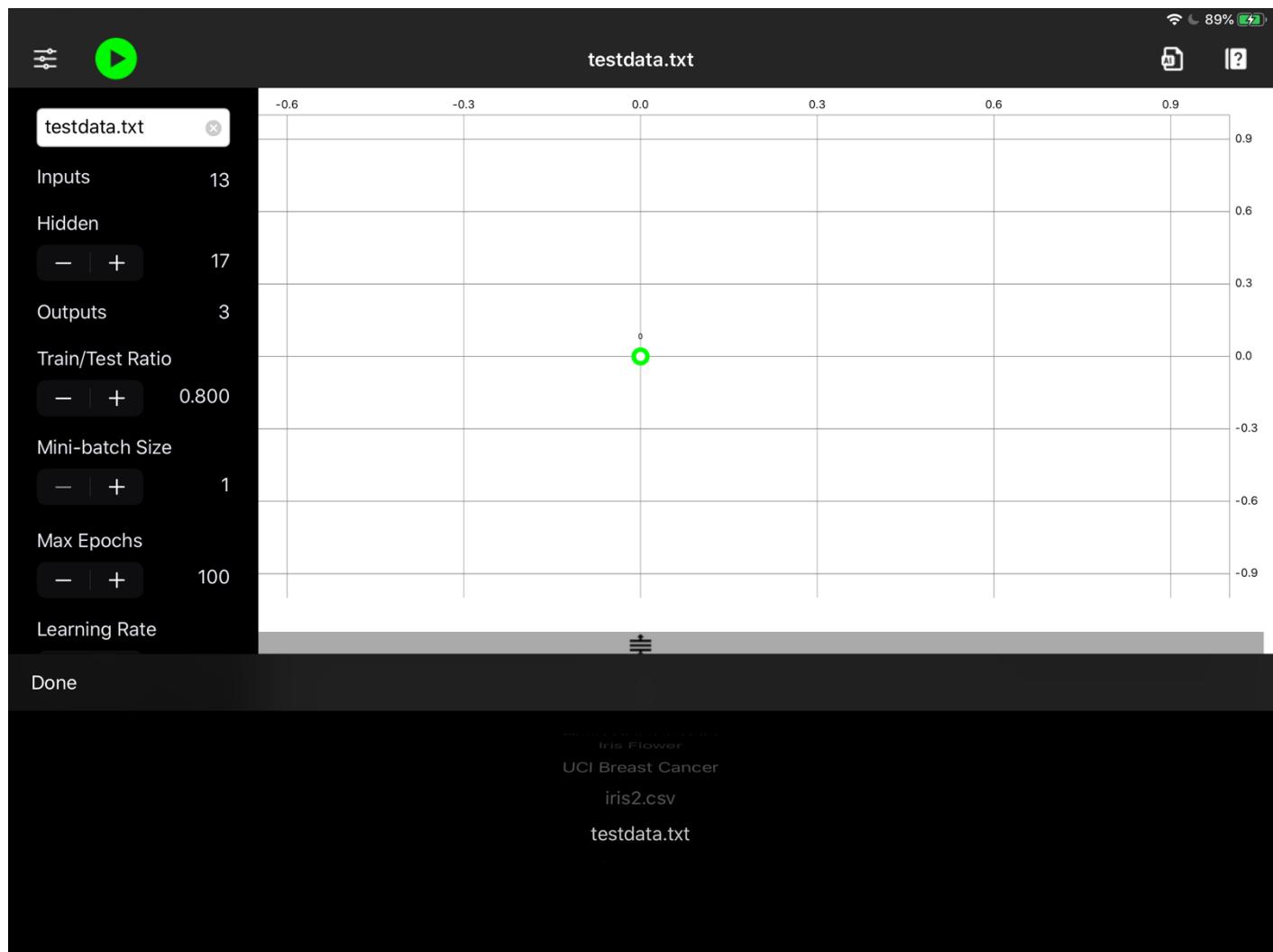
- 1) Paste the data into the text area and give the dataset a name.
- 2) Specify the number of input nodes based on the number of features in the dataset. If they do not match, an error will be displayed when you run the model.
- 3) Specify the number of hidden nodes. Remember, there is only a single layer of hidden nodes.
- 4) Specify the number of output nodes based on the number of outputs in the dataset. If they do not match, an error will be displayed when you run the model.
- 5) Specify the activation function for the hidden and output nodes. Enter a file name and tap the SAVE button. Your file will then appear in the list to the left.



# Machine Learning Playground®

## Custom datasets and models, continued

Select your custom dataset on the Home page.



- 1) Open the hyperparameters menu pane and tap the text box at the top.
- 2) Scroll through the list of dataset files at the bottom and locate your file.
- 3) Tap done to load the data from the file.
- 4) Tap the play button to train the model.



# Machine Learning Playground®

## Custom dataset Feature Scaling

Convert the data so that the feature values have a similar scale. This step is optional, but it can be used as part of your “what-if” analysis to see how feature scaling improves model-training performance.

testdata.txt

13 17 3

Rescale Dataset

Dataset description

Hidden Activation: Sigmoid  
Output Activation: HyperTan

12.37,1.21,2.56,18.1,98,2.42,2.65,0.37,2.08,4.6,1.19,2.3,678,0,1,0  
13.11,1.01,1.7,15,78,2.98,3.18,0,7  
12.37,1.17,1.92,19.6,78,2.11,2.0,3.34,0.94,2.36,17,110,2.53,1.3,1.2  
12.21,1.19,1.75,16.8,151,1.85,1.2  
12.29,1.61,2.21,20.4,103,1.1,1.0  
13.86,1.51,2.67,25,86,2.95,2.86  
13.49,1.66,2.24,24,87,1.88,1.84  
12.99,1.67,2.6,30,139,3.3,2.89,0  
11.96,1.09,2.3,21,101,3.38,2.14  
11.66,1.88,1.92,16,97,1.61,1.57,0  
13.03,0.9,1.71,16,86,1.95,2.03,0  
11.84,2.89,2.23,18,112,1.72,1.32,0.43,0.95,2.65,0.96,2.52,500,0,1,0  
12.33,0.99,1.95,14.8,136,1.9,1.85,0.35,2.76,3.4,1.06,2.31,750,0,1,0  
12.7,3.87,2.4,23,101,2.83,2.55,0.43,1.95,2.57,1.19,3.13,463,0,1,0  
12.0,92,2,19,86,2.42,2.26,0.3,1.43,2.5,1.38,3.12,278,0,1,0  
12.72,1.81,2.2,18.8,86,2.2,2.53,0.26,1.77,3.9,1.16,3.14,714,0,1,0  
12.08,1.13,2.51,24,78,2,1.58,0.4,1.4,2.2,1.31,2.72,630,0,1,0  
13.05,3.86,2.32,22,5.85,1.65,1.59,0.61,1.62,4.8,0.84,2.01,515,0,1,0  
11.84,0.89,2.58,18,94,2.2,2.21,0.22,2.35,3.05,0.79,3.08,520,0,1,0  
12.67,0.98,2.24,18,99,2.2,1.94,0.3,1.46,2.62,1.23,3.16,450,0,1,0  
12.16,1.61,2.31,22,8,90,1.78,1.69,0.43,1.56,2.45,1.33,2.26,495,0,1,0  
11.65,1.67,2.62,26,88,1.92,1.61,0.4,1.34,2.6,1.36,3.21,562,0,1,0  
11.64,2.06,2.46,21.6,84,1.95,1.69,0.48,1.35,2.8,1.2,75,680,0,1,0  
12.08,1.33,2.3,23.6,70,2.2,1.59,0.42,1.38,1.74,1.07,3.21,625,0,1,0  
12.08,1.83,2.32,18.5,81,1.6,1.5,0.52,1.64,2.4,1.08,2.27,480,0,1,0  
12,1.51,2.42,22,86,1.45,1.25,0.5,1.63,3.6,1.05,2.65,450,0,1,0  
12.69,1.53,2.26,20.7,80,1.38,1.46,0.58,1.62,3.05,0.96,2.06,495,0,1,0  
12.29,2.83,2.22,18,88,2.45,2.25,0.25,1.99,2.15,1.15,3.3,290,0,1,0  
11.62,1.99,2.28,18,98,3.02,2.26,0.17,1.35,3.25,1.16,2.96,345,0,1,0  
12,1.71,52,0,2,10,100,0,5,0,270,0,20,0,20,0,210,0,20,0,20,0,1,0

- 1) **\*\*\* This is a one-way conversion. There is no “undo”. \*\*\***
- 2) Each feature value is scaled by subtracting its corresponding column mean and dividing by its corresponding column standard deviation.
- 3) The number of inputs and outputs must be specified in order to rescale the data
- 4) Tap the Rescale Dataset button.
- 5) When prompted tap Yes to rescale, or No to cancel.



# Machine Learning Playground®

## Custom dataset Feature Scaling, continued

Converted data is displayed. The output values always remain unchanged.

The screenshot shows the 'Custom Datasets' screen of the app. At the top, there is a file input field containing 'testdata.txt' with a clear button. Below it are three input fields for '13', '17', and '3', each with a clear button. To the right, there are buttons for 'Hidden Activation' (ReLU, Sigmoid, SoftMax, HyperTan) and 'Output Activation' (ReLU, Sigmoid, SoftMax, HyperTan). The 'HyperTan' button is highlighted in red. Below these are buttons for 'Rescale Dataset' and 'Dataset description'. The main area contains a large block of numerical data representing the converted dataset.

```
1.5186125409891542,-0.562249798328623,0.23205254099473993,-1.1695931750229027,1.9139052175708111,0.80899739463203  
99,1.0348189581307379,-0.6595631143050651,1.2248839840604513,0.2517168498188532,0.3621772757786129,1.847919566506  
6535,1.013008926747691,1.0,0.0,0.0  
0.24628962701506343,-0.4994133781369049,-0.827996323266203,-2.4908471410952195,0.018145020611759512,0.5686476623  
890727,0.7336289414294712,-0.8207192355765842,-0.5447209874470079,-0.2933213287130479,0.40605066293567893,1.11344  
93025258236,0.965241206686006,1.0,0.0,0.0  
0.19687902841412896,0.0212312463087589,1.1093343596934504,-0.2687381981554134,0.08835836123987253,0.80899739463  
203991,1.215532968151498,-0.4984069930335465,2.135967731767262,0.2690196491373263,0.31830388862154685,0.788587454  
9958412,1.3951481753804142,1.0,0.0,0.0  
1.6915496360924271,-0.3468106433855897,0.48792640478186344,-0.8092511842759068,0.9309184487772288,2.49144552033  
28116,1.4665246487358865,-0.9818753568481032,1.032154729737857,1.1860680130163983,-0.42754369304857526,1.18407144  
32932113,2.3345738282691917,1.0,0.0,0.0  
0.29570022561600007,0.2276937697958325,1.840402541942377,0.4519457833385771,1.2819851519177938,0.808997394632039  
9.0.6633512708658426,0.2267955526882888,0.4014044428639109,-0.3192755276907573,0.3621772757786129,0.449601179312  
3816,-0.03787400699229762,1.0,0.0,0.0  
1.4815545920384512,-0.5173666410488243,0.3051593592196326,-1.2897071719385678,0.8607051081491157,1.56209322232667  
12,1.366127976502131,-0.1760947504905084,0.6642170623947216,0.7318695309064807,0.40605066293567893,0.33660575408  
45615,2.23903901611101,1.0,0.0,0.0  
1.7162549353928964,-0.4186236950332673,0.3051593592196326,-1.4698781673120656,-0.2627083419006926,0.328297930146  
10553,0.4926769280684583,-0.4984069930335465,0.6817379036967756,0.08301455646374108,0.27443050146448084,1.36768  
90092884186,1.7295200179340469,1.0,0.0,0.0  
1.3086174969351785,-0.16727801426639524,0.8900139050187723,-0.5690231904445763,1.492625173802133,0.4885310849747  
506,0.4826372608450825,-0.41782893239778696,-0.5972835113531701,-0.003499440128624266,0.44992405009274494,1.3676  
890092884186,1.745442486627077,1.0,0.0,0.0  
2.2597715200031865,-0.6250862185203412,-0.7183360959288647,-1.6500491626855631,-0.19249500127257954,0.8089973946  
320399,0.9545016203437334,-0.5789850536693061,0.6817379036967756,0.06138605731564984,0.5376708244068771,0.33660  
57540845615,0.949319051955705,1.0,0.0,0.0  
1.0615645039304995,-0.8854085307431729,-0.35280200480440144,-1.0494791781072375,-0.12228166064446654,1.097417073  
323601,1.1251759631411176,-1.143031478119622,0.45396696677007314,0.9351774228985389,0.2305571143074148,1.3253157248  
279859,0.949319051955705,1.0,0.0,0.0
```

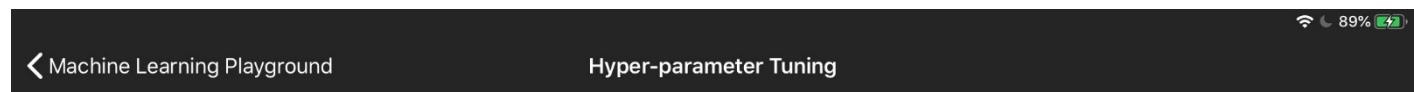
If you are happy with the conversion, tap SAVE to update the file.



# Machine Learning Playground®

## Hyperparameter definitions

A set of definitions for the available hyperparameters.



### Inputs

Number of Inputs corresponds to the number of features in the dataset. This parameter is only editable if you are working with a custom dataset.

### Hidden

Number of Hidden corresponds to the number of nodes in the hidden layer. In this version of the app a model will contain only one hidden layer. When working with the built-in datasets this value can be changed to gauge its effect on the model's performance.

### Outputs

Number of Outputs corresponds to the number of values to be predicted by the model. This parameter is only editable if you are working with a custom dataset.

### Train/Test Ratio

The Train/Test ratio is the percentage of your dataset that is used for training the model vs the percentage used for testing. 80% is a typical starting point and is appropriate for the datasets in this app. If your dataset is small you should consider increasing this value to help improve the accuracy of the model.

### Max Epochs

An epoch is the number of times that gradient descent is performed on the mini-batch set of training data. Max Epochs is typically used to set a stopping point during the model's training step. As a general rule increasing the number of epochs improves the model's accuracy.

### Dataset Rescaling

Dataset scaling or Feature Scaling is a technique to normalize the range of independent variables or features of your data. Do this when the range of



- 1) Navigate to this view by tapping the  icon on the Home page.
- 2) The page scrolls vertically.

### Mini-batch Size

Mini-batch is the number of the data items to use at a time for the training step. During mini-batch training the gradients are accumulated over the size of the mini-batch prior to applying the gradients to the weights.

### Learning Rate

The learning rate controls the step size taken along the loss curve during gradient descent. Reducing the learning rate can increase the number of epochs necessary to train the model. Increasing the learning rate too much can cause the model to skip over the local minimum and oscillate between a range of loss values.

### Momentum

Momentum is a parameter used to help accelerate the gradients in a direction towards the local minimum. It is applied to the prior weight gradient that has been adjusted by the learning rate and is added to the current weight increment.

### Loss Target

Loss target defines the desired accuracy of the model. In this app Loss will be either Mean Squared Error or Cross-entropy. The Accuracy of a model is the % of calculated outputs that match their associated target values.

### Cross-Entropy

When the Cross-Entropy switch is off, the model's loss is calculated as Mean Squared Error. When it is on, the model's loss is calculated as  $-1.0 * \log(\text{predicted value})$ . Use Cross-Entropy loss when the model's outputs are a probability between 0 and 1.