Linear Regression & Neural Network Modeling - Seoul Bike Sharing

Dataset from https://archive.ics.uci.edu/ml/datasets/Seoul+Bike+Sharing+Demand

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Data columns:

1 - Date : year-month-day, 2 - Rented Bike count - Count of bikes rented at each hour; 3 - Hour - Hour of the day; 4 - Temperature-Temperature in Celsius; 5 - Humidity - %; 6 - Windspeed - m/s; 7 - Visibility - 10m; 8 - Dew point temperature - Celsius; 9 - Solar radiation - MJ/m2; 10 - Rainfall - mm; 11 - Snowfall - cm; 12 - Seasons - Winter, Spring, Summer, Autumn; 13 - Holiday - Holiday/No holiday, 14 - Functional Day - NoFunc(Non Functional Hours), Fun(Functional hours)

Output variable:

Column 2 (Rented bike count)

```
clear all
close all
```

Read in dataset

```
dataset=readtable('SeoulBikeData.csv');
```

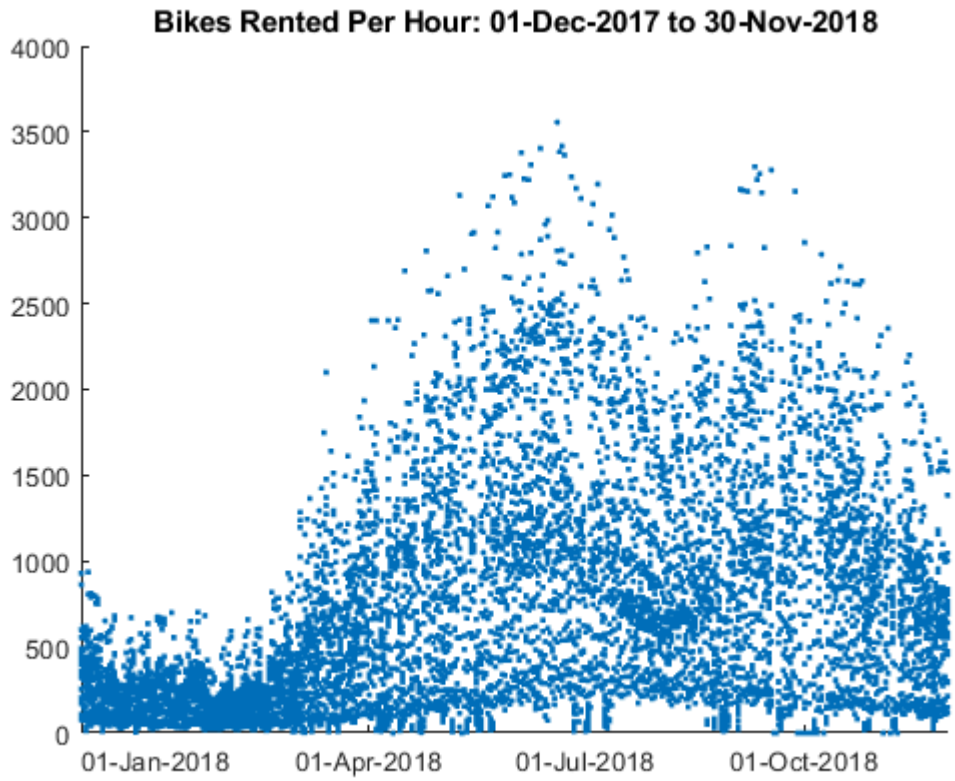
```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers before creating
 variable names for the table. The original column headers are saved in the VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
dataset = convertvars(dataset, "Date", 'datenum');
dataset = convertvars(dataset, "FunctioningDay", 'string');
dataset = convertvars(dataset, "Holiday", 'string');
dataset = convertvars(dataset, "Seasons", 'string');
seasonnum = double(categorical(dataset.Seasons));
fdaynum = double(categorical(dataset.FunctioningDay));
hdaynum = double(categorical(dataset.Holiday));
datamat = table2array(dataset(:,1:11));
% Note: Season, Holiday, and FunctioningDay data have been converted to
% numbers, but those numbers still represent categories.
% Subtract 1 from hdaynum and fdaynum to turn those into booleans (0 or 1)
% Create 3 new columns to hold the season data: Winter Y/N, Spring Y/N,
% Summer Y/N. (Fall will be represented by Winter=Spring=Summer=0)
winter = logical(seasonnum==4);
spring = logical(seasonnum==2);
summer = logical(seasonnum==3);
datamat(:,12:16) = [winter spring summer -1*(hdaynum-2) -1*(fdaynum-2)];
```

Divide dataset into inputs and outputs

```
% inputs are all of datamat except col 2
datasetInputs=datamat;
```

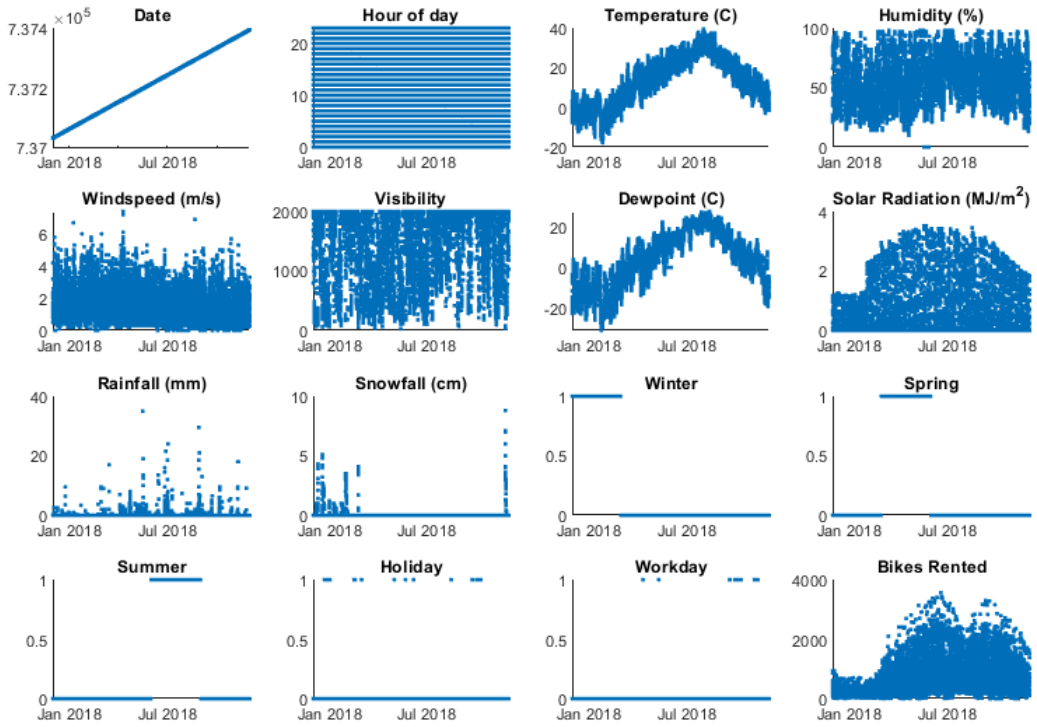
```
datasetInputs(:,2)=[];
datasetOutputs=datamat(:,2);

dateslist = datetime(datamat(:,1),'ConvertFrom','datenum');

figure
scatter(dateslist, datasetOutputs,'.')
xtickformat('dd-MMM-yyyy')
title(['Bikes Rented Per Hour: ' datestr(dateslist(1)) ' to ' datestr(dateslist(end))])
```



Scatter plots of inputs and outputs

```
figure('Renderer', 'painters', 'Position', [10 10 900 600])
subplot(4,4,1)
scatter(dateslist, datasetInputs(:,1),'.')
title('Date')
subplot(4,4,2)
scatter(dateslist, datasetInputs(:,2),'.')
title('Hour of day')
subplot(4,4,3)
scatter(dateslist, datasetInputs(:,3),'.')
title('Temperature (C)')
subplot(4,4,4)
scatter(dateslist, datasetInputs(:,4),'.')
title('Humidity (%)')
subplot(4,4,5)
```

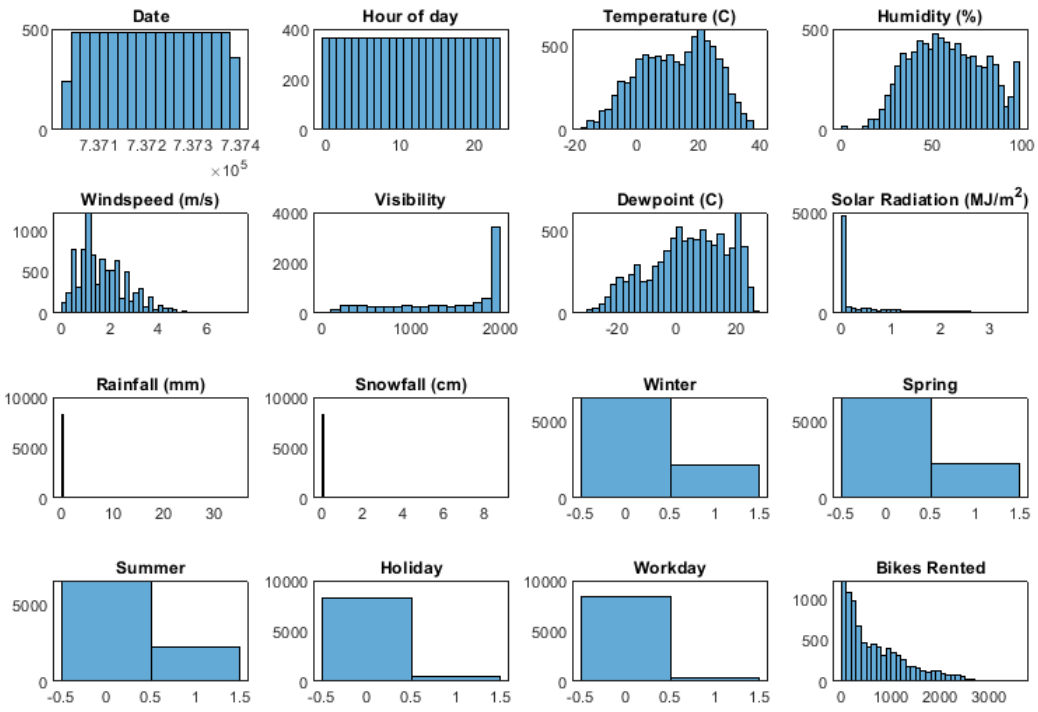
```
scatter(dateslist, datasetInputs(:,5),'.')
title('Windspeed (m/s)')
subplot(4,4,6)
scatter(dateslist, datasetInputs(:,6),'.')
title('Visibility')
subplot(4,4,7)
scatter(dateslist, datasetInputs(:,7),'.')
title('Dewpoint (C)')
subplot(4,4,8)
scatter(dateslist, datasetInputs(:,8),'.')
title('Solar Radiation (MJ/m^2)')
subplot(4,4,9)
scatter(dateslist, datasetInputs(:,9),'.')
title('Rainfall (mm)')
subplot(4,4,10)
scatter(dateslist, datasetInputs(:,10),'.')
title('Snowfall (cm)')
subplot(4,4,11)
scatter(dateslist, datasetInputs(:,11),'.')
title('Winter')
subplot(4,4,12)
scatter(dateslist, datasetInputs(:,12),'.')
title('Spring')
subplot(4,4,13)
scatter(dateslist, datasetInputs(:,13),'.')
title('Summer')
subplot(4,4,14)
scatter(dateslist, datasetInputs(:,14),'.')
title('Holiday')
subplot(4,4,15)
scatter(dateslist, datasetInputs(:,15),'.')
title('Workday')
subplot(4,4,16)
scatter(dateslist, datasetOutputs,'.')
title('Bikes Rented')
```



Histograms of inputs and outputs

```
figure('Renderer', 'painters', 'Position', [10 10 900 600])
subplot(4,4,1)
histogram(datasetInputs(:,1))
title('Date')
subplot(4,4,2)
histogram(datasetInputs(:,2))
title('Hour of day')
subplot(4,4,3)
histogram(datasetInputs(:,3))
title('Temperature (C)')
subplot(4,4,4)
histogram(datasetInputs(:,4))
title('Humidity (%)')
subplot(4,4,5)
histogram(datasetInputs(:,5))
title('Windspeed (m/s)')
subplot(4,4,6)
histogram(datasetInputs(:,6))
title('Visibility')
subplot(4,4,7)
histogram(datasetInputs(:,7))
title('Dewpoint (C)')
subplot(4,4,8)
histogram(datasetInputs(:,8))
title('Solar Radiation (MJ/m^2)')
subplot(4,4,9)
```

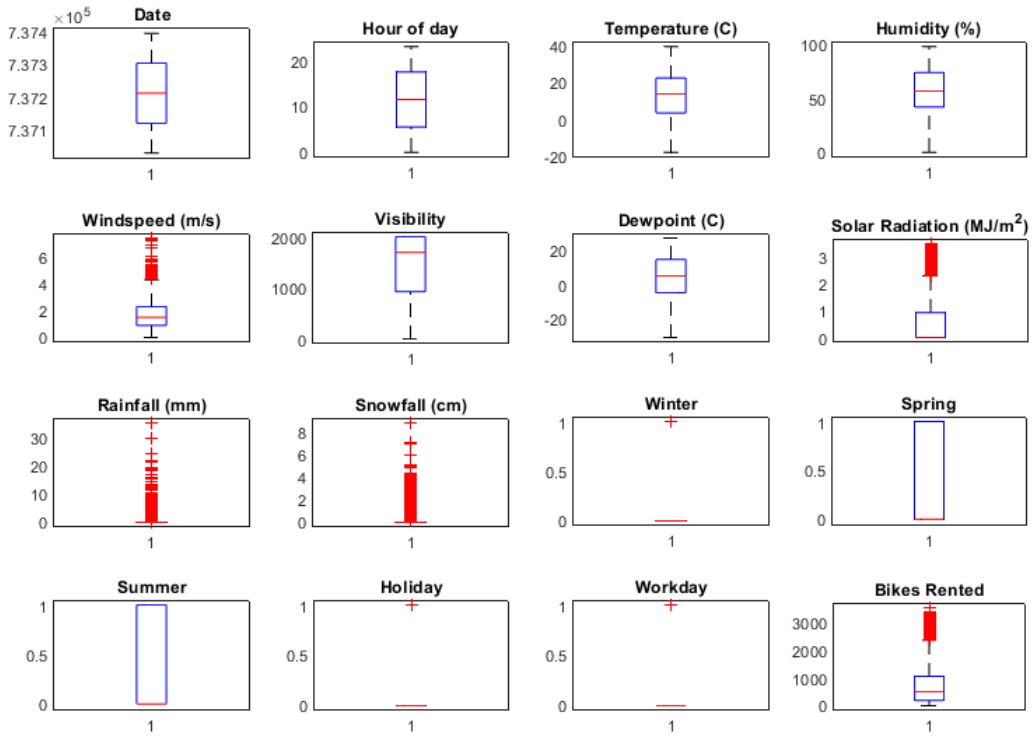
```
histogram(datasetInputs(:,9))
title('Rainfall (mm)')
subplot(4,4,10)
histogram(datasetInputs(:,10))
title('Snowfall (cm)')
subplot(4,4,11)
histogram(datasetInputs(:,11))
title('Winter')
subplot(4,4,12)
histogram(datasetInputs(:,12))
title('Spring')
subplot(4,4,13)
histogram(datasetInputs(:,13))
title('Summer')
subplot(4,4,14)
histogram(datasetInputs(:,14))
title('Holiday')
subplot(4,4,15)
histogram(datasetInputs(:,15))
title('Workday')
subplot(4,4,16)
histogram(datasetOutputs)
title('Bikes Rented')
```



Boxplots of inputs and outputs to check for outliers

```
figure('Renderer', 'painters', 'Position', [10 10 900 600])
```

```
subplot(4,4,1)
boxplot(datasetInputs(:,1))
title('Date')
subplot(4,4,2)
boxplot(datasetInputs(:,2))
title('Hour of day')
subplot(4,4,3)
boxplot(datasetInputs(:,3))
title('Temperature (C)')
subplot(4,4,4)
boxplot(datasetInputs(:,4))
title('Humidity (%)')
subplot(4,4,5)
boxplot(datasetInputs(:,5))
title('Windspeed (m/s)')
subplot(4,4,6)
boxplot(datasetInputs(:,6))
title('Visibility')
subplot(4,4,7)
boxplot(datasetInputs(:,7))
title('Dewpoint (C)')
subplot(4,4,8)
boxplot(datasetInputs(:,8))
title('Solar Radiation (MJ/m^2)')
subplot(4,4,9)
boxplot(datasetInputs(:,9))
title('Rainfall (mm)')
subplot(4,4,10)
boxplot(datasetInputs(:,10))
title('Snowfall (cm)')
subplot(4,4,11)
boxplot(datasetInputs(:,11))
title('Winter')
subplot(4,4,12)
boxplot(datasetInputs(:,12))
title('Spring')
subplot(4,4,13)
boxplot(datasetInputs(:,13))
title('Summer')
subplot(4,4,14)
boxplot(datasetInputs(:,14))
title('Holiday')
subplot(4,4,15)
boxplot(datasetInputs(:,15))
title('Workday')
subplot(4,4,16)
boxplot(datasetOutputs)
title('Bikes Rented')
```



In this case the outliers hold relevant information, so keep them in the dataset.

```
% idx=[];
% for ii=1:11
%     idx = [idx isoutlier(datasetInputs(:,ii),'quartiles')];
% end
% % idx = [idx isoutlier(datasetOutputs(:,1),'quartiles')];
% idx(:,12) = any(idx,2);
% idxremove = find(idx(:,12)==1);
% datasetInputs(idxremove,:)=[];
% datasetOutputs(idxremove,:)=[];
```

Rows and columns of all missing entries

```
[rowmissingIn,colmissingIn]=find(isnan(datasetInputs))
```

```
rowmissingIn =

  0×1 empty double column vector


colmissingIn =

  0×1 empty double column vector
```

```
[rowmissingOut]=find(isnan(datasetOutputs))
```

```
rowmissingOut =
```

```
0×1 empty double column vector
```

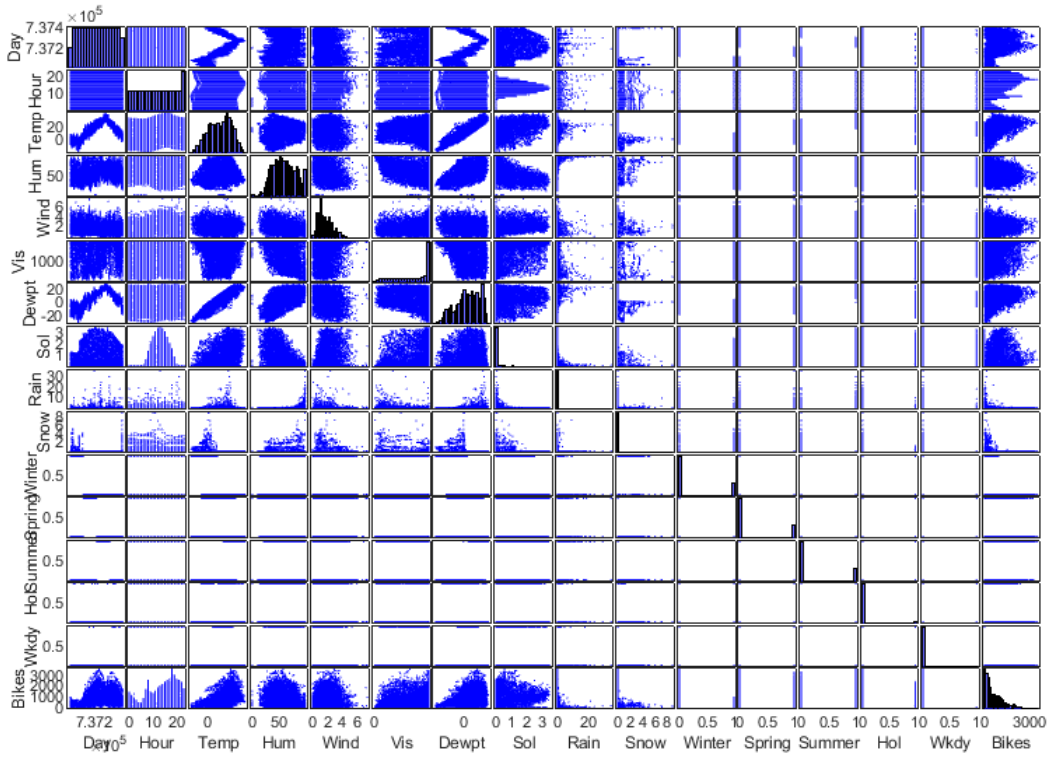
No missing entries.

Scatter plots of all inputs and outputs

```
alldata = [datasetInputs,datasetOutputs];
names = {'Day', 'Hour', 'Temp', 'Hum', 'Wind', 'Vis', 'Dewpt', 'Sol', 'Rain', 'Snow','Winter','
```

```
names = 1×16 cell
'Day'        'Hour'        'Temp'        'Hum'        'Wind'        'Vis'        'D ···
```

```
namesCell = cell(1,16);
namesCell(1:16) = names;
figure('Renderer', 'painters', 'Position', [10 10 900 600])
g=gplotmatrix(alldata,[],[],[],[],[],[], 'hist',namesCell);
```



Relationships among the inputs:

Temperature is strongly linearly correlated with Dewpoint. Day of the Year is strongly correlated with both Temperature and Dewpoint. Hour of the Day is strongly correlated with Solar Radiation Level. Weak linear relationships exist between Humidity and Dewpoin; Temperature and Solar Radiation; and Humidity and Solar Radiation.

Relationships between the inputs and output:

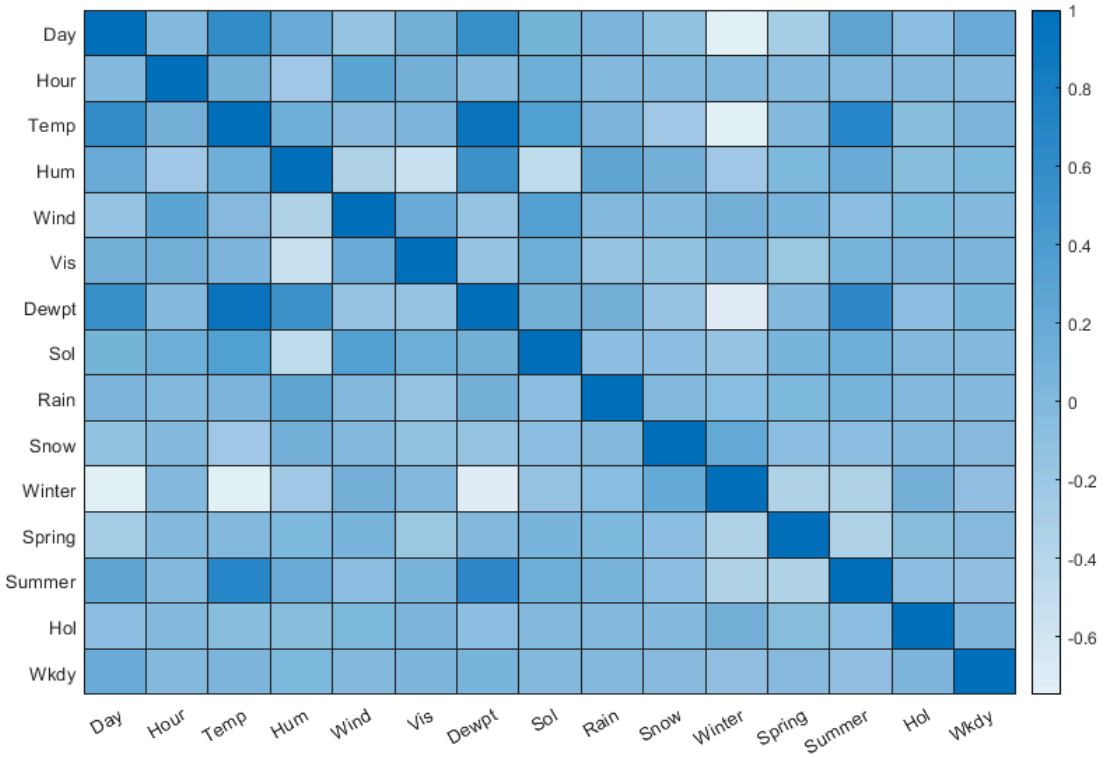
The output (Bikes Rented) is weakly correlated to Day of Year, Hour of Day, Temperature, Dewpoint, and Solar Radiation.

Correlation matrix for the input data

```
corrmat = corrcoef(datasetInputs)
```

```
corrmat = 15×15
    1.0000         0    0.5780    0.1701   -0.1621    0.1075    0.5629    0.0911 ···
         0    1.0000    0.1241   -0.2416    0.2852    0.0988    0.0031    0.1451
    0.5780    0.1241    1.0000    0.1594   -0.0363    0.0348    0.9128    0.3535
    0.1701   -0.2416    0.1594    1.0000   -0.3367   -0.5431    0.5369   -0.4619
   -0.1621    0.2852   -0.0363   -0.3367    1.0000    0.1715   -0.1765    0.3323
    0.1075    0.0988    0.0348   -0.5431    0.1715    1.0000   -0.1766    0.1497
    0.5629    0.0031    0.9128    0.5369   -0.1765   -0.1766    1.0000    0.0944
    0.0911    0.1451    0.3535   -0.4619    0.3323    0.1497    0.0944    1.0000
    0.0380    0.0087    0.0503    0.2364   -0.0197   -0.1676    0.1256   -0.0743
   -0.1370   -0.0215   -0.2184    0.1082   -0.0036   -0.1217   -0.1509   -0.0723
      ⋮
```

```
heatmap(namesCell(1:15), namesCell(1:15), corrmat)
```



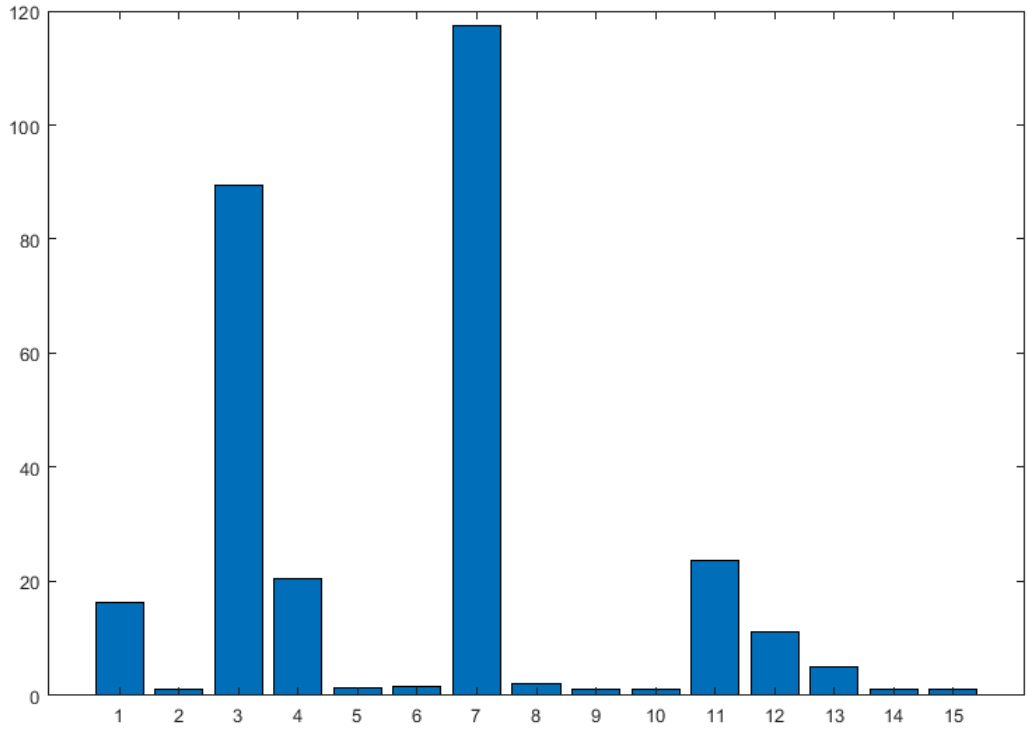
Variance inflation factor for each input factor

```
VIF = diag(inv(corrmat))
```

```
VIF = 15×1
   16.2657
    1.2110
   89.5456
```

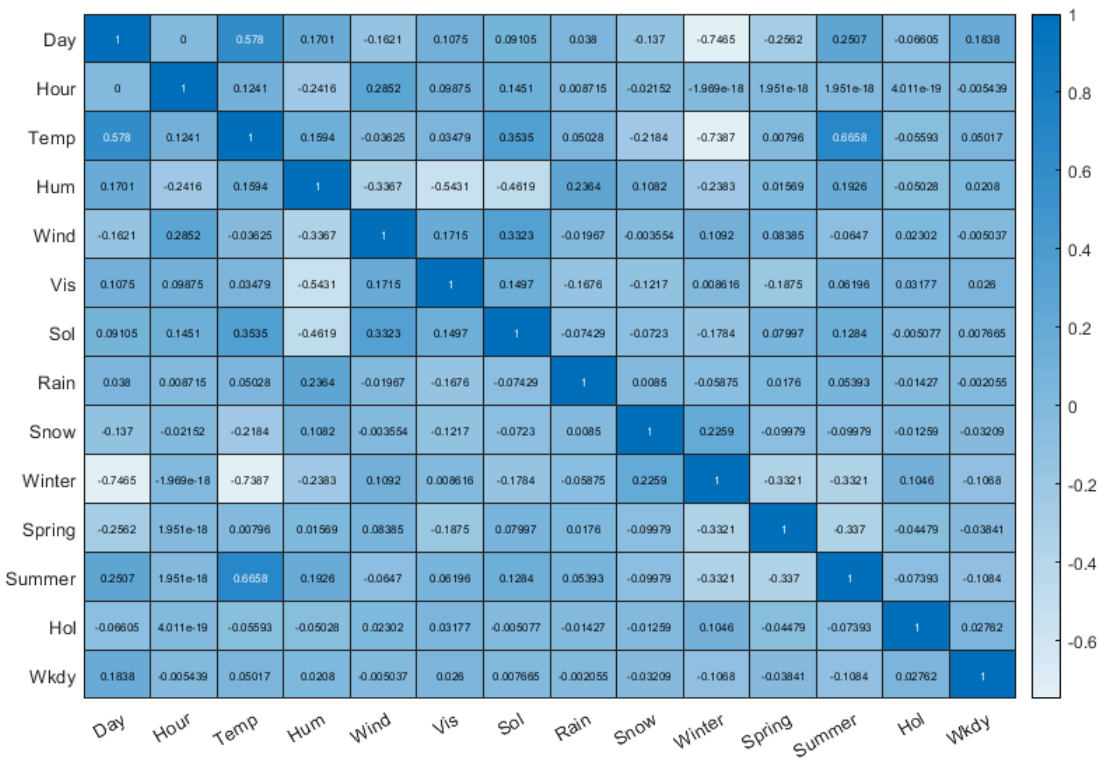
```
   20.5671
    1.3036
    1.6936
  117.3150
    2.0448
    1.0868
    1.1210
      ⋮
      ⋮
```

```
bar(VIF)
```

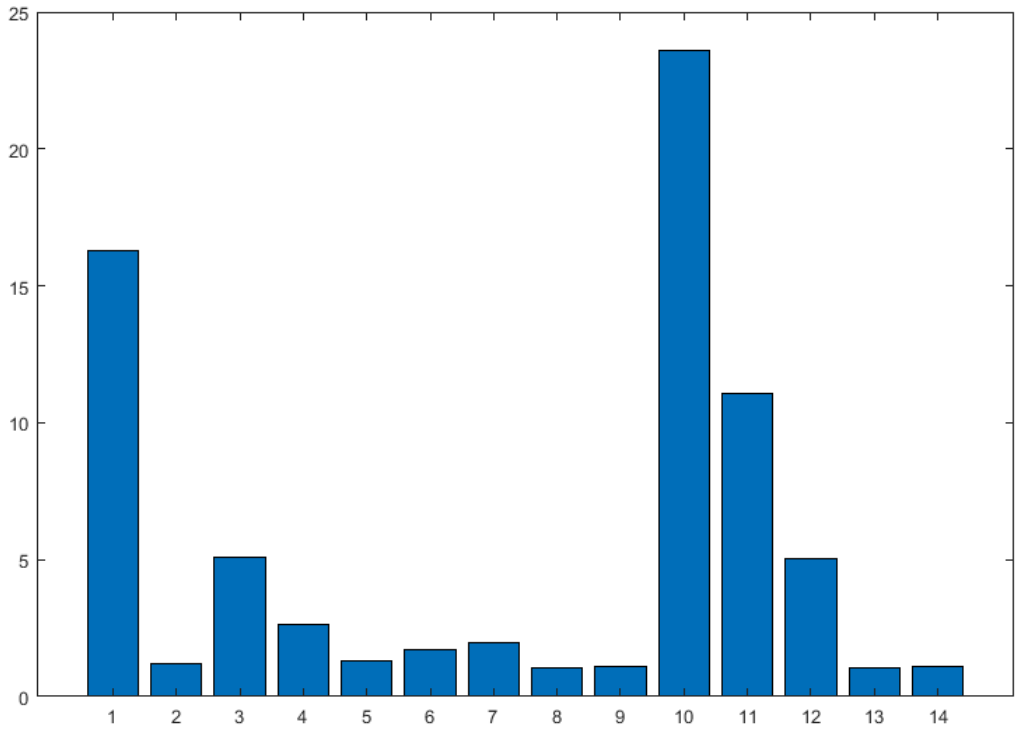


Factors 1, 3, 4, 7, and 11 (Day of Year, Temperature, Humidity, Dew Point, and Winter) have a VIF > 10, indicating that there is strong multicollinearity. The VIF for Dew Point is the highest, so remove Dew Point as an input and re-evaluate the VIFs.

```
datasetInputs2=datasetInputs;
datasetInputs2(:,7)=[];
corrmat2 = corrcoef(datasetInputs2);
namesCell2=namesCell;
namesCell2(7)=[];
heatmap(namesCell2(1:14), namesCell2(1:14), corrmat2)
```

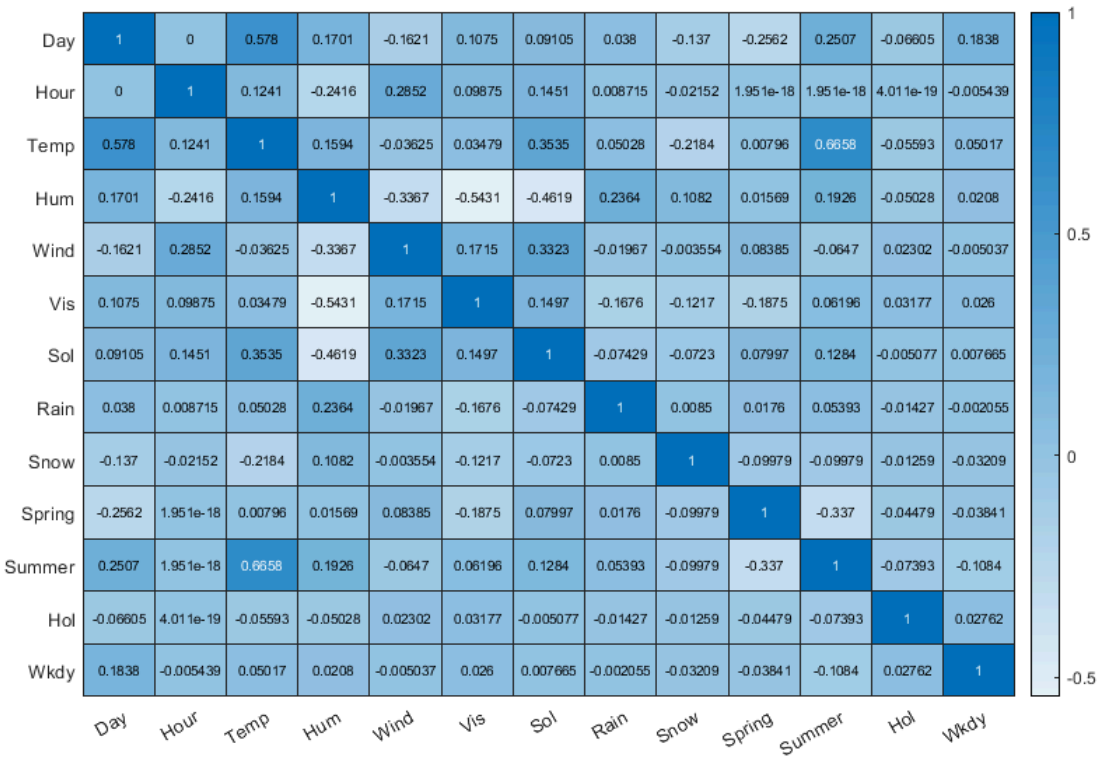



```
VIF2 = diag(inv(corrmat2));
bar(VIF2)
```

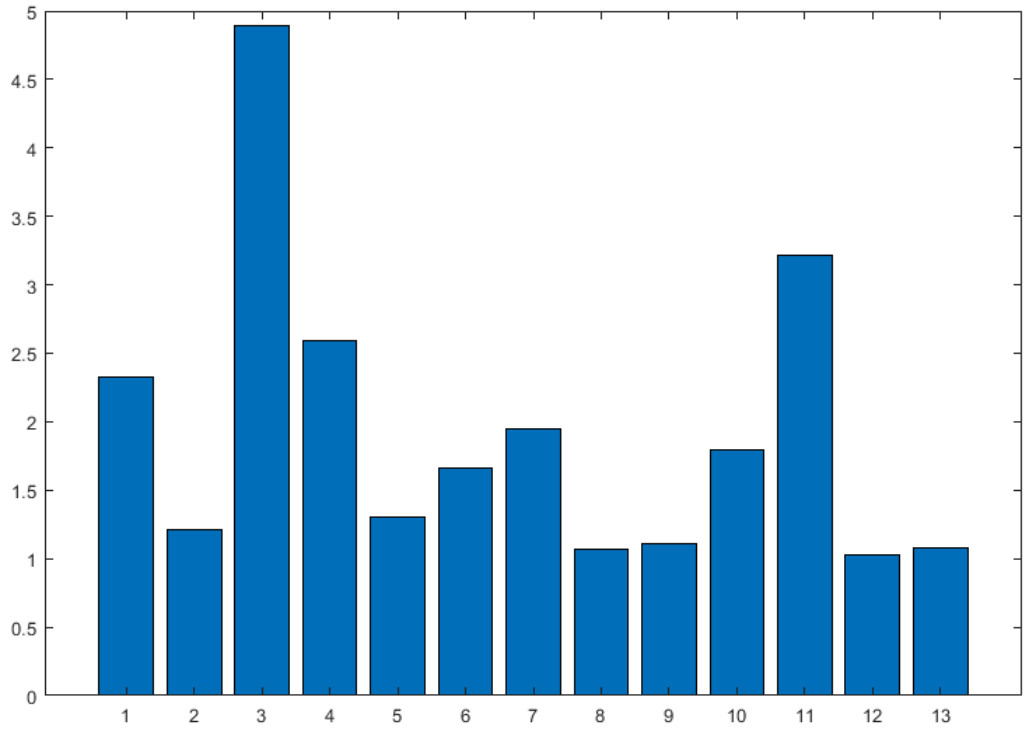


With Dew Point removed, factors 1, 10, and 11 (Day of Year, Winter, and Spring) have a VIF > 10, indicating that there is still strong multicollinearity in the data. The VIF for Winter is the highest, so remove Winter as an input and re-evaluate the VIFs.

```
datasetInputs3=datasetInputs2;
datasetInputs3(:,10)=[];
corrmat3 = corrcoef(datasetInputs3);
namesCell3=namesCell2;
namesCell3(10)=[];
heatmap(namesCell3(1:13), namesCell3(1:13), corrmat3)
```




```
VIF3 = diag(inv(corrmat3));
bar(VIF3)
```



Now the correlation matrix and VIFs do not show any strong correlations between the remaining input variables. The dataset without Dew Point and Winter will be used moving forward.

```
clear datasetInputs namesCell datasetInputs2 namesCell2
datasetInputs = datasetInputs3;
namesCell = namesCell3;
```

Linear Regression model:

```
mdl_linear = fitlm(datasetInputs,datasetOutputs)
```

```
mdl_linear =
Linear regression model:
    y ~ 1 + x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9 + x10 + x11 + x12 + x13

Estimated Coefficients:
                    Estimate        SE         tStat       pValue
                   ___________    _________    _______    __________

    (Intercept)    -6.9536e+05        49793    -13.965     7.5227e-44
    x1                 0.94388     0.067551     13.973     6.7487e-44
    x2                  27.217      0.74123     36.718    1.2292e-274
    x3                  29.296       0.8638     33.915    5.4468e-237
    x4                 -7.4577      0.36869    -20.228     5.9225e-89
    x5                  16.137       5.1339     3.1431      0.0016772
    x6                0.024644    0.0098973     2.4899       0.012795
    x7                 -81.237       7.5032    -10.827     3.8125e-27
    x8                 -60.691         4.28    -14.18      3.8383e-45
    x9                  24.226       11.261     2.1513       0.031483
    x10                 70.318       14.384     4.8886     1.0337e-06
```

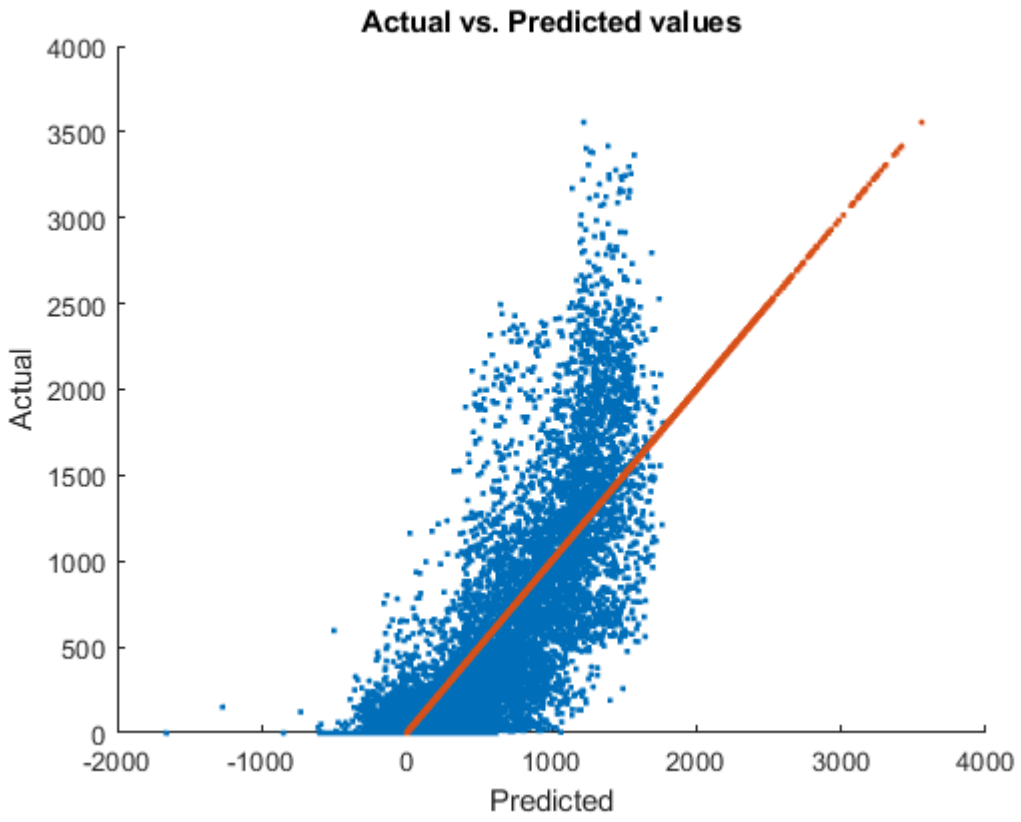
```
x11               -75.906       19.264    -3.9404     8.1983e-05
x12                -123.5       21.817    -5.6605     1.5572e-08
x13                -911.4       26.835    -33.963    1.2902e-237


Number of observations: 8760, Error degrees of freedom: 8746
Root Mean Squared Error: 437
R-squared: 0.542,  Adjusted R-Squared: 0.542
F-statistic vs. constant model: 797, p-value = 0
```

Plot of actual vs predicted values:

```
predicted = predict(mdl_linear,datasetInputs);
RMSE_linearmodel = sqrt(mean((predicted-datasetOutputs).^2))
```

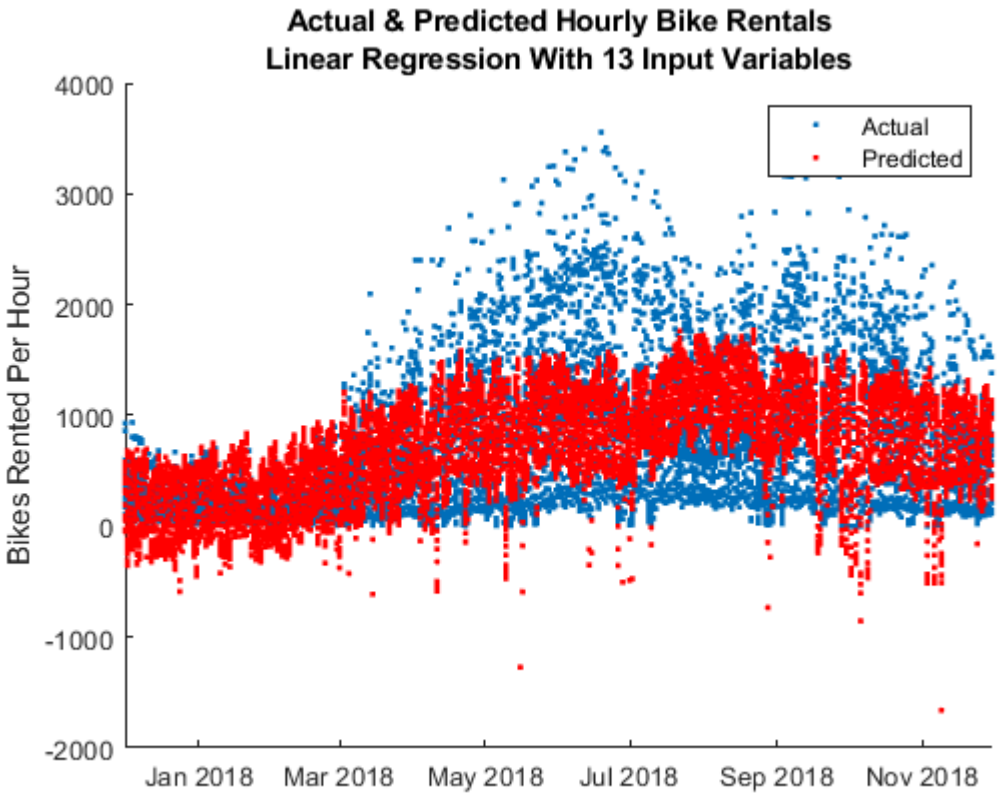
```
RMSE_linearmodel = 436.2951
```

```
figure
scatter(predicted, datasetOutputs,'.')
hold on
plot(datasetOutputs,datasetOutputs,'.')
title('Actual vs. Predicted values')
xlabel('Predicted')
ylabel('Actual')
```



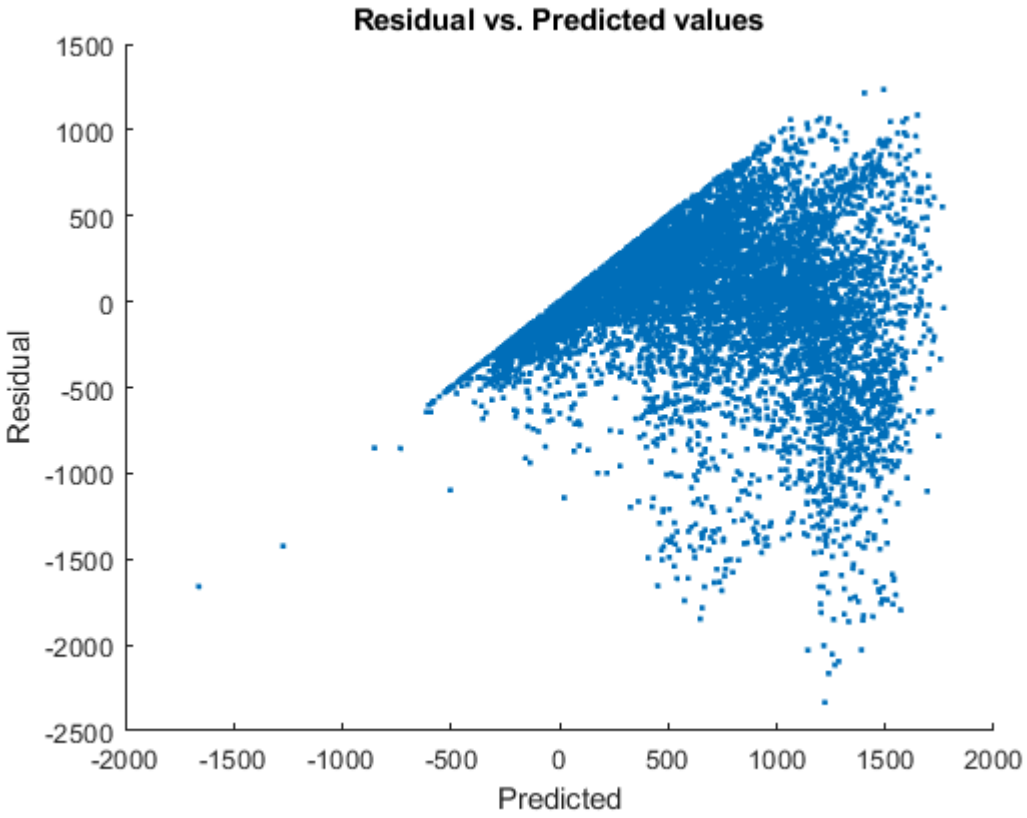

```
figure
scatter(dateslist,datasetOutputs,'.')
hold on
scatter(dateslist,predicted,'.r')
title({'Actual & Predicted Hourly Bike Rentals','Linear Regression With 13 Input Variables'})
```

```
ylabel('Bikes Rented Per Hour')
legend({'Actual','Predicted'})
```



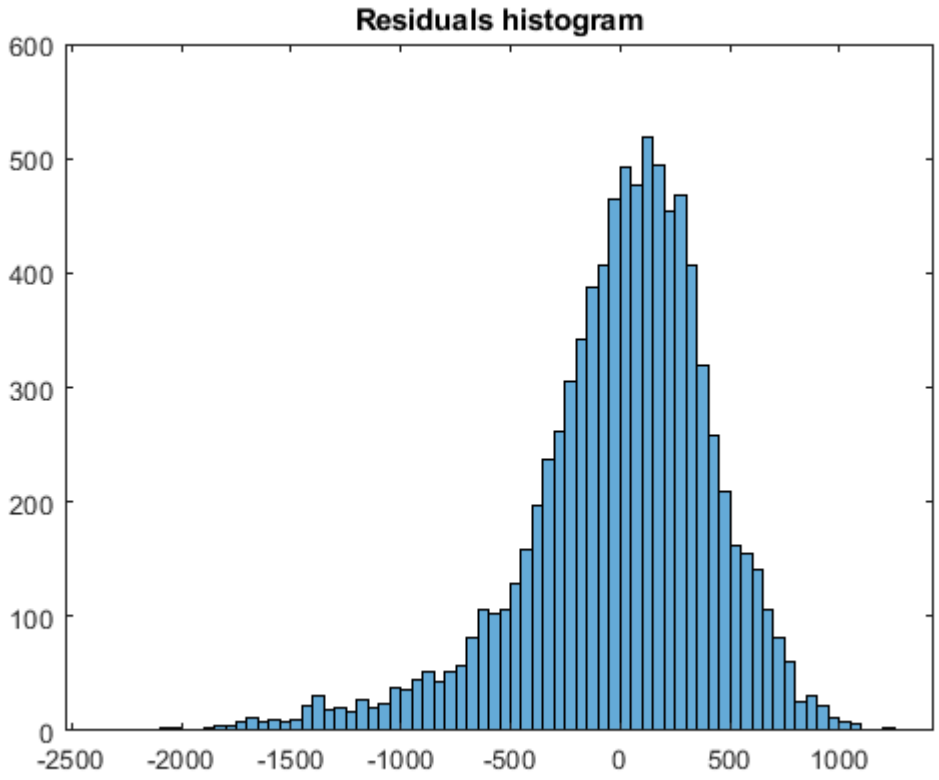
Plot of residual vs. predicted values:

```
residual = predicted-datasetOutputs;
figure
scatter(predicted,residual,'.')
title('Residual vs. Predicted values')
xlabel('Predicted')
ylabel('Residual')
```



Residual histogram:

```
figure
histogram(residual)
title('Residuals histogram')
```

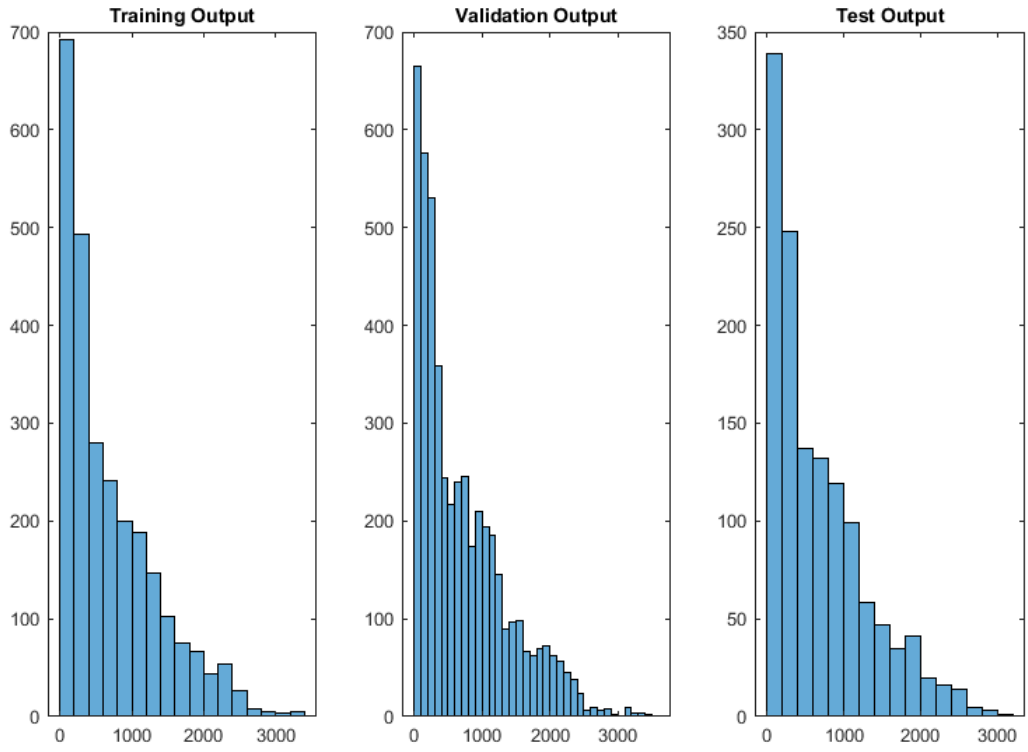


The scatter plot shows poor prediction performance, especially for higher values of Bikes Rented. The predicted values do not trend with the actual values. The ordinary R^2 value of this model is only 0.54. The histogram of the residuals has a wide peak, with most residuals being within the range [-750, 750]. Considering that most of the data points for Bikes Rented are below 1000, these residuals are very large.

Therefore, try a neural network model instead.

```
% Randomize data
nruns = size(datasetOutputs,1);
random_row_ind = randperm(nruns);
randInputs = datasetInputs(random_row_ind,:);
randOutputs = datasetOutputs(random_row_ind);

% 15% of rows
testsize = floor(0.15*nruns);

% Divide the input matrix and output vector into a train (30%), validation
% (55%), and a test set (15%)
input_train = randInputs(1:testsize*2,:);
input_val = randInputs((testsize*2+1):(nruns-testsize),:);
input_test = randInputs((nruns-testsize+1):end,:);
output_train = randOutputs(1:testsize*2,:);
output_val = randOutputs((testsize*2+1):(nruns-testsize),:);
output_test = randOutputs((nruns-testsize+1):end,:);

figure('Renderer', 'painters', 'Position', [10 10 900 600])
```

```
subplot(1,3,1)
h1 = histogram(output_train);
title('Training Output')
subplot(1,3,2)
h2=histogram(output_val);
title('Validation Output')
subplot(1,3,3)
h3=histogram(output_test);
title('Test Output')
```




```
h1.Values
```

```
ans = 1×17
   692   493   280   241   199   188   147   102    75    66    44    54    26 ···
```

```
h2.Values
```

```
ans = 1×36
   665   576   530   359   244   217   240   246   174   209   194   185   146 ···
```

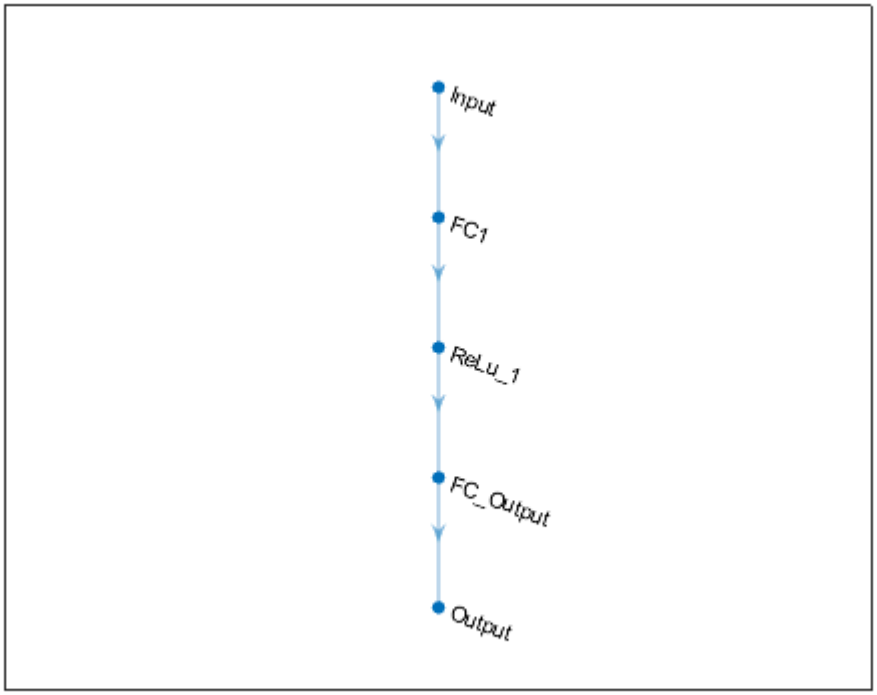
```
h3.Values
```

```
ans = 1×16
   339   248   137   132   119    99    58    47    35    41    20    16    14 ···
```

```
% Step 2: Scale training data using mapstd
% mapstd expects each row to be variable and each column to be sample
[scaled_input_train,SF] = mapstd(input_train');
```

```
scaled_input_train = scaled_input_train';

% Apply these scale factors to validation and test data
scaled_input_val = mapstd('apply',input_val',SF);
scaled_input_test = mapstd('apply',input_test',SF);
scaled_input_val = scaled_input_val';
scaled_input_test = scaled_input_test';

% Output vector does not need to be scaled
```

```
% Neural net models
% Training Algorithm: adam
% Max Epochs: 500 (this should be more than enough to ensure convergence).
% Batch Size: 32
% Initial Learning Rate: 0.01
% Learning Rate Schedule: ‘piecewise’
% Learning Rate Drop Period: 5 epochs
% Learning Rate Drop Factor: 0.5
% Gradient Threshold: 1
% Validation Frequency = floor(size(t_train, 1) / batch_size);
% Validation Patience: 5

% set random seed for result repeatability
rng(42);

% Step 3: Single hidden layer neural network.
% Model 1: A neural network with one hidden layer of 10 nodes.
FC_1 = 10; % number of nodes in the hidden layer

[net_10, RMSE_train_10, RMSE_val_10] = singlehiddenlayer(10, scaled_input_train, output_train,
```




```
Training on single CPU.
|=========================================================================================================================
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnin
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |     Rate
|=========================================================================================================================
|       1 |           1 |       00:00:08 |      1074.80 |       966.47 |  577598.0625 |  467036.6563 |         0.01
|       1 |          50 |       00:00:10 |       773.15 |              |  298881.6875 |              |         0.01
|       1 |          82 |       00:00:11 |      1058.99 |       956.58 |  560732.3125 |  457520.4063 |         0.01
|       2 |         100 |       00:00:12 |      1141.95 |              |  652030.2500 |              |         0.01
|       2 |         150 |       00:00:12 |       774.63 |              |  300025.3438 |              |         0.01
|       2 |         164 |       00:00:13 |       731.25 |       928.92 |  267366.8750 |  431441.8125 |         0.01
|       3 |         200 |       00:00:13 |      1115.55 |              |  622223.0625 |              |         0.01
|       3 |         246 |       00:00:14 |       632.45 |       862.45 |  199993.7969 |  371908.1563 |         0.01
|       4 |         250 |       00:00:15 |      1204.70 |              |  725645.8750 |              |         0.01
|       4 |         300 |       00:00:16 |       761.76 |              |  290139.7500 |              |         0.01
|       4 |         328 |       00:00:17 |       855.66 |       755.59 |  366075.5313 |  285458.5625 |         0.01
|       5 |         350 |       00:00:17 |       893.35 |              |  399037.4688 |              |         0.01
|       5 |         400 |       00:00:19 |       701.98 |              |  246386.0469 |              |         0.01
|       5 |         410 |       00:00:19 |       533.54 |       637.02 |  142331.2656 |  202895.0313 |         0.01
|       6 |         450 |       00:00:19 |       551.43 |              |  152037.6719 |              |         0.00
|       6 |         492 |       00:00:20 |       643.09 |       583.63 |  206783.6875 |  170313.7500 |         0.00
|       7 |         500 |       00:00:21 |       615.59 |              |  189476.1094 |              |         0.00
|       7 |         550 |       00:00:22 |       420.81 |              |   88541.3438 |              |         0.00
|       7 |         574 |       00:00:23 |       416.70 |       538.70 |   86820.9766 |  145101.2813 |         0.00
|       8 |         600 |       00:00:23 |       639.50 |              |  204481.5938 |              |         0.00
|       8 |         650 |       00:00:24 |       412.18 |              |   84945.2266 |              |         0.00
|       8 |         656 |       00:00:24 |       481.25 |       504.44 |  115802.0313 |  127230.0859 |         0.00
|       9 |         700 |       00:00:25 |       485.83 |              |  118017.3047 |              |         0.00
|       9 |         738 |       00:00:25 |       337.04 |       477.81 |   56798.6758 |  114149.7109 |         0.00
|      10 |         750 |       00:00:26 |       418.83 |              |   87708.7578 |              |         0.00
|      10 |         800 |       00:00:26 |       384.01 |              |   73733.5234 |              |         0.00
|      10 |         820 |       00:00:27 |       432.02 |       459.47 |   93321.0469 |  105557.4844 |         0.00
|      11 |         850 |       00:00:27 |       427.55 |              |   91398.0938 |              |         0.00
|      11 |         900 |       00:00:28 |       413.54 |              |   85507.3281 |              |         0.00
|      11 |         902 |       00:00:28 |       317.88 |       452.61 |   50523.0859 |  102429.0078 |         0.00
```

12	950	00:00:29	448.59		100616.8672		0.00
12	984	00:00:29	274.85	446.53	37772.5781	99694.5547	0.00
13	1000	00:00:30	519.24		134805.6875		0.00
13	1050	00:00:31	258.59		33435.1055		0.00
13	1066	00:00:32	345.32	441.77	59623.6758	97582.3359	0.00
14	1100	00:00:33	296.60		43987.1523		0.00
14	1148	00:00:34	482.88	437.58	116586.4766	95736.3594	0.00
15	1150	00:00:34	469.30		110121.8125		0.00
15	1200	00:00:35	456.13		104026.9531		0.00
15	1230	00:00:37	366.58	434.09	67189.1250	94218.4375	0.00
16	1250	00:00:37	401.90		80762.8906		0.00
16	1300	00:00:38	511.12		130620.5781		0.00
16	1312	00:00:38	433.38	432.69	93907.9063	93609.6328	0.00
17	1350	00:00:39	386.80		74806.6094		0.00
17	1394	00:00:39	406.86	431.43	82768.7891	93064.1563	0.00
18	1400	00:00:39	319.84		51147.3438		0.00
18	1450	00:00:40	333.62		55652.7344		0.00
18	1476	00:00:41	510.09	430.22	130095.3906	92546.0000	0.00
19	1500	00:00:41	396.55		78627.1250		0.00
19	1550	00:00:42	428.85		91954.5703		0.00
19	1558	00:00:42	427.04	429.20	91183.1875	92106.0859	0.00
20	1600	00:00:43	422.00		89040.8594		0.00
20	1640	00:00:43	592.40	428.28	175471.1875	91712.6484	0.00
21	1650	00:00:43	377.55		71272.5625		0.00
21	1700	00:00:44	318.75		50800.0313		0.00
21	1722	00:00:44	378.80	427.82	71746.0938	91516.1797	0.00
22	1750	00:00:45	456.63		104257.4375		0.00
22	1800	00:00:45	358.10		64117.8320		0.00
22	1804	00:00:45	503.89	427.38	126954.4922	91328.3750	0.00
23	1850	00:00:46	424.23		89984.7266		0.00
23	1886	00:00:47	410.97	426.99	84450.1484	91160.9297	0.00
24	1900	00:00:47	366.74		67250.0703		0.00
24	1950	00:00:48	373.62		69794.8125		0.00
24	1968	00:00:48	343.17	426.59	58882.5586	90988.8047	0.00
25	2000	00:00:48	463.13		107246.5391		0.00
25	2050	00:00:49	619.73	426.19	192034.5000	90818.5781	0.00
26	2100	00:00:50	371.28		68925.0859		0.00
26	2132	00:00:50	389.88	426.01	76002.0234	90740.3125	0.00
27	2150	00:00:51	378.43		71605.8672		0.00
27	2200	00:00:52	481.98		116153.3281		0.00
27	2214	00:00:52	382.64	425.82	73207.6484	90660.0391	0.00
28	2250	00:00:52	495.41		122713.2188		0.00
28	2296	00:00:53	303.38	425.65	46020.8086	90590.0703	0.00
29	2300	00:00:53	363.02		65893.4063		0.00
29	2350	00:00:54	529.39		140125.0938		0.00
29	2378	00:00:54	320.01	425.49	51204.4023	90518.9375	0.00
30	2400	00:00:55	288.65		41658.6875		0.00
30	2450	00:00:55	438.54		96159.1406		0.00
30	2460	00:00:55	395.38	425.31	78163.0469	90444.4063	0.00
31	2500	00:00:56	500.22		125109.9297		0.00
31	2542	00:00:57	339.51	425.24	57631.9023	90413.8438	0.00
32	2550	00:00:57	338.10		57157.2383		0.00
32	2600	00:00:58	469.06		110008.3750		0.00
32	2624	00:00:58	326.06	425.17	53157.9102	90383.9297	0.00
33	2650	00:00:58	290.20		42107.1445		0.00
33	2700	00:00:59	339.40		57594.5195		0.00
33	2706	00:00:59	328.90	425.09	54086.3750	90350.5234	0.00
34	2750	00:01:00	324.78		52741.4922		0.00
34	2788	00:01:00	353.09	425.01	62335.2344	90317.8438	0.00
35	2800	00:01:01	450.02		101257.8359		0.00
35	2850	00:01:01	524.54		137572.6250		0.00
35	2870	00:01:02	321.46	424.94	51668.5313	90286.8438	0.00
36	2900	00:01:02	483.84		117049.5313		7.8125e-
36	2950	00:01:03	316.91		50215.2656		7.8125e-
36	2952	00:01:03	316.16	424.90	49979.6914	90271.1875	7.8125e-

37	3000	00:01:03	476.28		113421.9766		7.8125e-
37	3034	00:01:04	318.32	424.87	50663.8320	90256.5078	7.8125e-
38	3050	00:01:04	430.80		92795.7188		7.8125e-
38	3100	00:01:05	312.68		48885.5156		7.8125e-
38	3116	00:01:05	434.08	424.83	94212.0625	90241.4375	7.8125e-
39	3150	00:01:06	363.61		66104.8672		7.8125e-
39	3198	00:01:07	328.44	424.80	53934.8477	90225.7656	7.8125e-
40	3200	00:01:07	277.69		38556.1836		7.8125e-
40	3250	00:01:07	360.43		64954.2031		7.8125e-
40	3280	00:01:08	376.75	424.76	70970.1563	90209.7031	7.8125e-
41	3300	00:01:08	334.03		55788.5195		3.9062e-
41	3350	00:01:09	316.00		49926.9727		3.9062e-
41	3362	00:01:09	507.90	424.74	128979.3281	90201.9844	3.9062e-
42	3400	00:01:10	435.72		94926.4844		3.9062e-
42	3444	00:01:11	408.23	424.72	83327.4141	90194.8125	3.9062e-
43	3450	00:01:11	540.97		146323.1875		3.9062e-
43	3500	00:01:12	506.61		128325.8516		3.9062e-
43	3526	00:01:12	390.89	424.70	76397.1094	90187.0938	3.9062e-
44	3550	00:01:13	403.67		81476.6172		3.9062e-
44	3600	00:01:13	505.82		127928.9375		3.9062e-
44	3608	00:01:13	524.81	424.69	137711.2188	90179.6094	3.9062e-
45	3650	00:01:14	352.51		62131.8359		3.9062e-
45	3690	00:01:15	314.08	424.67	49322.0156	90171.7734	3.9062e-
46	3700	00:01:15	387.60		75118.1250		1.9531e-
46	3750	00:01:16	285.26		40687.0859		1.9531e-
46	3772	00:01:16	297.18	424.66	44159.4336	90167.8594	1.9531e-
47	3800	00:01:17	578.26		167190.8438		1.9531e-
47	3850	00:01:17	588.17		172969.7188		1.9531e-
47	3854	00:01:18	448.83	424.65	100723.1953	90164.0234	1.9531e-
48	3900	00:01:18	444.65		98855.5234		1.9531e-
48	3936	00:01:19	451.07	424.64	101731.0547	90160.1094	1.9531e-
49	3950	00:01:19	358.44		64240.7773		1.9531e-
49	4000	00:01:19	307.42		47252.1055		1.9531e-
49	4018	00:01:20	481.50	424.63	115921.3906	90156.3281	1.9531e-
50	4050	00:01:20	503.78		126898.9688		1.9531e-
50	4100	00:01:21	279.75	424.62	39128.7305	90152.4922	1.9531e-
51	4150	00:01:22	547.08		149646.1719		9.7656e-
51	4182	00:01:23	325.26	424.62	52896.0977	90150.7188	9.7656e-
52	4200	00:01:23	351.41		61744.4453		9.7656e-
52	4250	00:01:24	325.44		52955.6250		9.7656e-
52	4264	00:01:24	380.63	424.61	72437.7344	90148.8516	9.7656e-
53	4300	00:01:24	406.17		82487.5703		9.7656e-
53	4346	00:01:25	435.17	424.61	94687.5703	90147.1094	9.7656e-
54	4350	00:01:25	517.63		133968.6563		9.7656e-
54	4400	00:01:26	376.05		70706.6328		9.7656e-
54	4428	00:01:27	341.61	424.61	58348.2813	90145.2891	9.7656e-
55	4450	00:01:27	433.48		93951.9375		9.7656e-
55	4500	00:01:28	376.26		70786.8047		9.7656e-
55	4510	00:01:28	480.42	424.60	115403.5625	90143.3750	9.7656e-
56	4550	00:01:29	269.18		36229.8320		4.8828e-
56	4592	00:01:29	407.47	424.60	83017.8203	90142.4609	4.8828e-
57	4600	00:01:29	360.35		64927.3867		4.8828e-
57	4650	00:01:30	317.75		50482.6563		4.8828e-
57	4674	00:01:30	296.38	424.60	43919.5742	90141.3984	4.8828e-
58	4700	00:01:31	336.56		56636.6172		4.8828e-
58	4750	00:01:32	564.54		159351.7656		4.8828e-
58	4756	00:01:32	352.46	424.59	62114.7344	90140.2109	4.8828e-
59	4800	00:01:33	338.65		57340.6211		4.8828e-
59	4838	00:01:33	420.96	424.59	88601.6641	90139.1875	4.8828e-
60	4850	00:01:33	257.58		33173.1719		4.8828e-
60	4900	00:01:34	390.33		76177.7578		4.8828e-
60	4920	00:01:34	376.11	424.59	70729.4609	90138.2734	4.8828e-
61	4950	00:01:35	288.93		41741.4961		2.4414e-
61	5000	00:01:36	376.28		70794.6484		2.4414e-
61	5002	00:01:36	408.53	424.59	83447.4688	90137.7734	2.4414e-

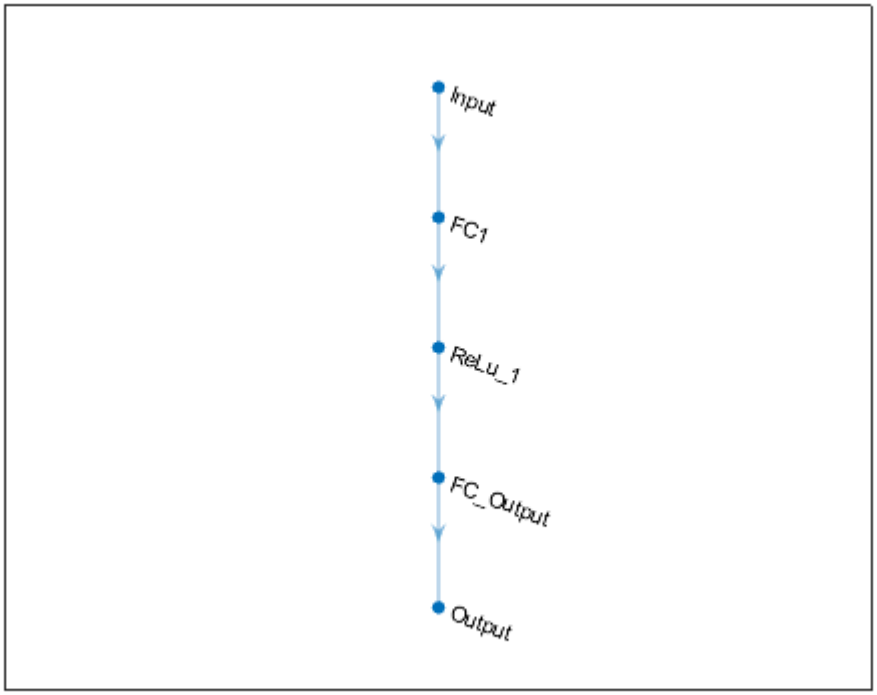
62	5050	00:01:37	415.39		86275.6250		2.4414e-
62	5084	00:01:37	482.84	424.59	116565.8984	90137.2500	2.4414e-
63	5100	00:01:38	371.74		69095.4297		2.4414e-
63	5150	00:01:38	401.36		80543.7656		2.4414e-
63	5166	00:01:39	332.48	424.59	55270.4141	90136.7500	2.4414e-
64	5200	00:01:39	358.99		64435.8516		2.4414e-
64	5248	00:01:40	430.70	424.59	92753.1563	90136.2891	2.4414e-
65	5250	00:01:40	345.10		59546.0820		2.4414e-
65	5300	00:01:41	395.02		78020.3672		2.4414e-
65	5330	00:01:41	320.53	424.58	51368.4258	90135.7969	2.4414e-
66	5350	00:01:42	306.57		46993.0391		1.2207e-
66	5400	00:01:43	296.24		43879.5938		1.2207e-
66	5412	00:01:43	384.96	424.58	74096.0391	90135.5781	1.2207e-
67	5450	00:01:43	349.11		60939.0000		1.2207e-
67	5494	00:01:44	351.51	424.58	61779.4102	90135.3359	1.2207e-
68	5500	00:01:44	530.14		140523.3281		1.2207e-
68	5550	00:01:45	476.79		113662.3203		1.2207e-
68	5576	00:01:45	542.43	424.58	147117.2344	90135.0859	1.2207e-
69	5600	00:01:46	507.41		128731.4531		1.2207e-
69	5650	00:01:47	437.86		95860.5625		1.2207e-
69	5658	00:01:47	353.60	424.58	62515.8320	90134.8750	1.2207e-
70	5700	00:01:47	448.18		100433.6641		1.2207e-
70	5740	00:01:48	401.19	424.58	80475.2813	90134.5859	1.2207e-
71	5750	00:01:48	371.48		68997.8594		6.1035e-
71	5800	00:01:49	347.23		60283.3711		6.1035e-
71	5822	00:01:49	421.30	424.58	88748.6016	90134.5391	6.1035e-
72	5850	00:01:50	494.49		122259.0469		6.1035e-
72	5900	00:01:51	317.45		50385.7617		6.1035e-
72	5904	00:01:51	319.86	424.58	51154.0781	90134.4219	6.1035e-
73	5950	00:01:52	446.49		99676.0547		6.1035e-
73	5986	00:01:52	496.64	424.58	123325.0313	90134.3438	6.1035e-
74	6000	00:01:53	407.86		83175.5547		6.1035e-
74	6050	00:01:53	377.80		71366.3594		6.1035e-
74	6068	00:01:54	333.57	424.58	55634.2852	90134.3047	6.1035e-
75	6100	00:01:54	291.38		42451.1289		6.1035e-
75	6150	00:01:55	431.66	424.58	93167.2656	90134.2266	6.1035e-
76	6200	00:01:56	419.42		87956.2188		3.0518e-
76	6232	00:01:56	333.30	424.58	55544.3516	90134.2109	3.0518e-
77	6250	00:01:57	475.51		113052.5938		3.0518e-
77	6300	00:01:57	370.43		68609.2734		3.0518e-
77	6314	00:01:58	279.27	424.58	38994.8438	90134.1563	3.0518e-
78	6350	00:01:58	435.06		94640.4219		3.0518e-
78	6396	00:01:59	533.47	424.58	142296.2656	90134.1094	3.0518e-
79	6400	00:01:59	565.44		159861.2031		3.0518e-
79	6450	00:02:00	394.15		77675.1484		3.0518e-
79	6478	00:02:00	237.60	424.58	28227.3223	90134.1094	3.0518e-
80	6500	00:02:01	336.85		56735.4648		3.0518e-
80	6550	00:02:02	338.07		57146.0703		3.0518e-
80	6560	00:02:02	402.99	424.58	81200.6797	90134.1172	3.0518e-
81	6600	00:02:03	384.46		73905.1406		1.5259e-
81	6642	00:02:03	412.30	424.58	84993.9844	90134.0859	1.5259e-
82	6650	00:02:03	262.44		34437.5820		1.5259e-
82	6700	00:02:04	454.15		103124.3828		1.5259e-
82	6724	00:02:05	344.39	424.58	59302.9063	90134.1094	1.5259e-
83	6750	00:02:05	549.85		151166.1406		1.5259e-
83	6800	00:02:06	404.93		81984.5547		1.5259e-
83	6806	00:02:06	325.31	424.58	52912.9102	90134.0625	1.5259e-
84	6850	00:02:06	373.75		69844.9453		1.5259e-
84	6888	00:02:07	404.64	424.58	81865.1797	90134.0625	1.5259e-
85	6900	00:02:07	335.72		56355.3320		1.5259e-
85	6950	00:02:08	421.26		88730.3750		1.5259e-
85	6970	00:02:08	479.01	424.58	114727.5391	90134.0391	1.5259e-
86	7000	00:02:09	525.32		137982.9375		7.6294e-
86	7050	00:02:10	387.90		75235.1328		7.6294e-
86	7052	00:02:10	509.16	424.58	129620.8906	90134.0391	7.6294e-

```
|      87 |        7100 |       00:02:11 |       508.82 |              |  129446.5234 |              |      7.6294e-
|      87 |        7134 |       00:02:11 |       396.19 |       424.58 |   78483.1172 |   90134.0625 |      7.6294e-
|      88 |        7150 |       00:02:12 |       348.47 |              |   60715.6172 |              |      7.6294e-
|      88 |        7200 |       00:02:12 |       515.81 |              |  133027.5781 |              |      7.6294e-
|      88 |        7216 |       00:02:12 |       486.85 |       424.58 |  118513.7422 |   90134.0391 |      7.6294e-
|      89 |        7250 |       00:02:13 |       402.56 |              |   81026.1797 |              |      7.6294e-
|      89 |        7298 |       00:02:14 |       392.73 |       424.58 |   77119.3750 |   90134.0234 |      7.6294e-
|      90 |        7300 |       00:02:14 |       375.36 |              |   70449.3203 |              |      7.6294e-
|      90 |        7350 |       00:02:15 |       427.40 |              |   91334.8203 |              |      7.6294e-
|      90 |        7380 |       00:02:15 |       388.37 |       424.58 |   75414.8750 |   90134.0547 |      7.6294e-
|      91 |        7400 |       00:02:16 |       566.21 |              |  160297.1563 |              |      3.8147e-
|      91 |        7450 |       00:02:16 |       489.89 |              |  119995.4375 |              |      3.8147e-
|      91 |        7462 |       00:02:17 |       431.13 |       424.58 |   92935.4375 |   90134.0547 |      3.8147e-
|      92 |        7500 |       00:02:17 |       285.26 |              |   40686.8086 |              |      3.8147e-
|      92 |        7544 |       00:02:18 |       502.66 |       424.58 |  126334.0938 |   90134.0391 |      3.8147e-
|      93 |        7550 |       00:02:18 |       307.34 |              |   47229.5156 |              |      3.8147e-
|      93 |        7600 |       00:02:19 |       365.66 |              |   66854.3828 |              |      3.8147e-
|      93 |        7626 |       00:02:19 |       409.10 |       424.58 |   83679.6094 |   90134.0391 |      3.8147e-
|      94 |        7650 |       00:02:20 |       485.12 |              |  117668.5703 |              |      3.8147e-
|      94 |        7700 |       00:02:20 |       290.63 |              |   42231.5977 |              |      3.8147e-
|      94 |        7708 |       00:02:21 |       532.04 |       424.58 |  141534.8906 |   90134.0078 |      3.8147e-
|      95 |        7750 |       00:02:21 |       335.83 |              |   56389.3594 |              |      3.8147e-
|      95 |        7790 |       00:02:22 |       301.98 |       424.58 |   45595.3867 |   90134.0469 |      3.8147e-
|      96 |        7800 |       00:02:22 |       327.02 |              |   53472.2305 |              |      1.9073e-
|      96 |        7850 |       00:02:23 |       377.37 |              |   71203.8984 |              |      1.9073e-
|      96 |        7872 |       00:02:23 |       433.99 |       424.58 |   94172.5859 |   90134.0391 |      1.9073e-
|      97 |        7900 |       00:02:24 |       426.11 |              |   90783.0391 |              |      1.9073e-
|      97 |        7950 |       00:02:25 |       392.03 |              |   76842.5938 |              |      1.9073e-
|      97 |        7954 |       00:02:25 |       362.00 |       424.58 |   65523.7930 |   90134.0469 |      1.9073e-
|      98 |        8000 |       00:02:25 |       321.19 |              |   51582.7266 |              |      1.9073e-
|      98 |        8036 |       00:02:26 |       451.92 |       424.58 |  102114.5156 |   90134.0391 |      1.9073e-
|      99 |        8050 |       00:02:26 |       308.42 |              |   47561.6719 |              |      1.9073e-
|      99 |        8100 |       00:02:27 |       317.10 |              |   50276.6133 |              |      1.9073e-
|      99 |        8118 |       00:02:27 |       467.96 |       424.58 |  109494.7578 |   90134.0234 |      1.9073e-
|=========================================================================================================================
```

Using a single layer of 10 hidden nodes achieved an RMSE of 425.

```
% Model 2: A neural network with one hidden layer of 50 nodes.

% FC_1 = 50;
% RMSE_train_50 = RMSE_train;
% RMSE_val_50 = RMSE_val;

[net_50, RMSE_train_50, RMSE_val_50] = singlehiddenlayer(50, scaled_input_train, output_train,
```

```
Training on single CPU.
```



Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch RMSE	Validation RMSE	Mini-batch Loss	Validation Loss	Base Learnir Rate
1	1	00:00:05	786.87	966.60	309579.2500	467158.8125	0.01
1	50	00:00:06	917.27		420695.5313		0.01
1	82	00:00:07	899.84	912.97	404855.3125	416755.5938	0.01
2	100	00:00:07	1052.57		553948.6875		0.01
2	150	00:00:08	712.67		253950.3594		0.01
2	164	00:00:08	822.00	751.37	337840.0313	282279.7813	0.01
3	200	00:00:08	824.80		340148.9688		0.01
3	246	00:00:09	703.21	536.62	247254.1563	143978.0000	0.01
4	250	00:00:09	259.00		33540.2617		0.01
4	300	00:00:10	434.73		94492.9141		0.01
4	328	00:00:11	268.28	440.42	35987.5352	96983.2500	0.01
5	350	00:00:11	420.69		88491.6172		0.01
5	400	00:00:12	457.89		104829.4219		0.01
5	410	00:00:12	310.89	423.30	48326.5703	89590.6016	0.01
6	450	00:00:13	436.21		95138.7422		0.00
6	492	00:00:14	398.12	420.41	79249.0859	88372.0078	0.00
7	500	00:00:14	431.90		93267.6328		0.00
7	550	00:00:15	299.84		44950.5234		0.00
7	574	00:00:15	455.86	418.29	103904.9766	87484.3438	0.00
8	600	00:00:15	514.70		132458.6094		0.00
8	650	00:00:16	520.80		135617.0000		0.00
8	656	00:00:16	466.50	416.84	108810.1172	86877.5234	0.00
9	700	00:00:17	463.87		107586.5469		0.00
9	738	00:00:18	408.12	415.70	83282.2188	86401.4141	0.00
10	750	00:00:18	357.01		63727.3203		0.00
10	800	00:00:19	382.55		73173.6641		0.00
10	820	00:00:19	382.24	414.73	73052.7266	86002.1875	0.00
11	850	00:00:19	314.76		49536.3750		0.00
11	900	00:00:20	352.68		62192.1445		0.00
11	902	00:00:20	273.39	413.96	37371.1797	85681.5313	0.00
12	950	00:00:21	443.74		98454.7422		0.00

12	984	00:00:22	427.38	413.23	91324.8828	85378.3203	0.00
13	1000	00:00:22	450.29		101379.6953		0.00
13	1050	00:00:23	409.84		83984.0547		0.00
13	1066	00:00:23	354.27	412.60	62754.1914	85119.2969	0.00
14	1100	00:00:24	281.87		39725.0898		0.00
14	1148	00:00:25	373.70	411.75	69826.3047	84768.6875	0.00
15	1150	00:00:25	413.86		85640.2734		0.00
15	1200	00:00:25	287.55		41342.5859		0.00
15	1230	00:00:26	269.80	411.33	36397.2539	84595.6094	0.00
16	1250	00:00:26	432.03		93322.9766		0.00
16	1300	00:00:27	454.39		103233.4453		0.00
16	1312	00:00:27	373.50	411.02	69751.8438	84469.6484	0.00
17	1350	00:00:28	387.61		75122.4844		0.00
17	1394	00:00:29	311.80	410.56	48610.9688	84280.2656	0.00
18	1400	00:00:29	321.36		51637.1953		0.00
18	1450	00:00:29	478.30		114384.6406		0.00
18	1476	00:00:30	370.34	410.18	68577.1797	84122.5625	0.00
19	1500	00:00:30	318.82		50821.5781		0.00
19	1550	00:00:31	346.58		60060.5156		0.00
19	1558	00:00:31	420.19	409.85	88278.8672	83989.4219	0.00
20	1600	00:00:32	385.16		74172.8359		0.00
20	1640	00:00:33	372.46	409.61	69364.5625	83890.7734	0.00
21	1650	00:00:33	273.00		37264.2930		0.00
21	1700	00:00:34	411.53		84678.8047		0.00
21	1722	00:00:34	492.28	409.45	121168.6953	83823.5703	0.00
22	1750	00:00:34	466.01		108582.5156		0.00
22	1800	00:00:35	521.32		135886.4844		0.00
22	1804	00:00:35	373.90	409.26	69899.4609	83746.7969	0.00
23	1850	00:00:36	464.55		107904.0313		0.00
23	1886	00:00:37	472.17	409.06	111471.9688	83665.3516	0.00
24	1900	00:00:37	441.75		97573.4297		0.00
24	1950	00:00:38	400.26		80102.6563		0.00
24	1968	00:00:38	344.35	408.94	59289.2539	83614.4297	0.00
25	2000	00:00:39	315.87		49887.3359		0.00
25	2050	00:00:39	429.59	408.76	92273.0547	83542.9453	0.00
26	2100	00:00:40	308.01		47435.9609		0.00
26	2132	00:00:41	453.36	408.65	102766.8125	83498.7188	0.00
27	2150	00:00:41	213.64		22821.3867		0.00
27	2200	00:00:42	447.79		100258.7578		0.00
27	2214	00:00:42	267.65	408.57	35819.1875	83465.4766	0.00
28	2250	00:00:43	421.63		88884.5859		0.00
28	2296	00:00:43	425.17	408.48	90382.6875	83429.6328	0.00
29	2300	00:00:44	383.56		73560.7344		0.00
29	2350	00:00:44	286.68		41091.3281		0.00
29	2378	00:00:45	421.52	408.41	88838.7500	83400.4609	0.00
30	2400	00:00:45	424.68		90177.2266		0.00
30	2450	00:00:46	454.50		103285.6719		0.00
30	2460	00:00:46	333.90	408.35	55743.3711	83374.3672	0.00
31	2500	00:00:47	415.93		86498.8984		0.00
31	2542	00:00:47	481.32	408.30	115833.3828	83353.3047	0.00
32	2550	00:00:47	364.78		66531.0703		0.00
32	2600	00:00:48	501.20		125601.5547		0.00
32	2624	00:00:48	323.25	408.27	52244.3398	83341.7266	0.00
33	2650	00:00:49	385.42		74273.2578		0.00
33	2700	00:00:50	328.39		53918.5586		0.00
33	2706	00:00:50	425.91	408.24	90699.9922	83329.4609	0.00
34	2750	00:00:50	515.75		132999.5625		0.00
34	2788	00:00:51	396.85	408.20	78744.4922	83313.2969	0.00
35	2800	00:00:51	439.98		96791.0469		0.00
35	2850	00:00:52	407.09		82860.3281		0.00
35	2870	00:00:52	527.32	408.17	139030.7344	83302.7188	0.00
36	2900	00:00:53	299.90		44968.6953		7.8125e-
36	2950	00:00:54	436.24		95152.8516		7.8125e-
36	2952	00:00:54	297.95	408.16	44387.4922	83295.9453	7.8125e-
37	3000	00:00:55	399.15		79661.1719		7.8125e-

37	3034	00:00:55	399.28	408.13	79710.3828	83286.3594	7.8125e-
38	3050	00:00:56	463.99		107642.8984		7.8125e-
38	3100	00:00:56	356.42		63519.0820		7.8125e-
38	3116	00:00:57	395.50	408.11	78209.0703	83278.4609	7.8125e-
39	3150	00:00:57	344.14		59216.2539		7.8125e-
39	3198	00:00:58	311.45	408.10	48500.6484	83274.1094	7.8125e-
40	3200	00:00:58	315.74		49844.7383		7.8125e-
40	3250	00:00:59	269.54		36324.7188		7.8125e-
40	3280	00:00:59	340.61	408.09	58007.8359	83267.4375	7.8125e-
41	3300	00:01:00	437.49		95697.5703		3.9062e-
41	3350	00:01:00	472.82		111779.2344		3.9062e-
41	3362	00:01:00	404.32	408.08	81735.5625	83263.6250	3.9062e-
42	3400	00:01:01	424.33		90028.5625		3.9062e-
42	3444	00:01:02	385.94	408.07	74476.3672	83260.2031	3.9062e-
43	3450	00:01:02	375.38		70453.2813		3.9062e-
43	3500	00:01:03	351.44		61755.8516		3.9062e-
43	3526	00:01:03	315.14	408.06	49656.4180	83256.7109	3.9062e-
44	3550	00:01:04	267.30		35725.5938		3.9062e-
44	3600	00:01:05	476.94		113735.7031		3.9062e-
44	3608	00:01:05	474.95	408.05	112787.4297	83252.2266	3.9062e-
45	3650	00:01:05	386.32		74621.9688		3.9062e-
45	3690	00:01:06	478.95	408.04	114694.3594	83247.3672	3.9062e-
46	3700	00:01:06	422.25		89148.3125		1.9531e-
46	3750	00:01:07	301.23		45371.0352		1.9531e-
46	3772	00:01:07	441.49	408.03	97457.6016	83245.2578	1.9531e-
47	3800	00:01:08	407.85		83172.4219		1.9531e-
47	3850	00:01:08	367.19		67413.2266		1.9531e-
47	3854	00:01:09	511.11	408.03	130615.2109	83243.9844	1.9531e-
48	3900	00:01:09	297.05		44119.0898		1.9531e-
48	3936	00:01:10	439.28	408.02	96481.5781	83241.5547	1.9531e-
49	3950	00:01:10	383.12		73388.9141		1.9531e-
49	4000	00:01:11	390.68		76315.7656		1.9531e-
49	4018	00:01:11	427.47	408.02	91363.9531	83239.9688	1.9531e-
50	4050	00:01:12	407.52		83034.2500		1.9531e-
50	4100	00:01:13	494.12	408.02	122077.5156	83238.1328	1.9531e-
51	4150	00:01:13	345.68		59748.0703		9.7656e-
51	4182	00:01:14	365.37	408.01	66747.3984	83237.3047	9.7656e-
52	4200	00:01:14	495.56		122791.4453		9.7656e-
52	4250	00:01:15	377.44		71229.7344		9.7656e-
52	4264	00:01:15	472.87	408.01	111802.1016	83236.6016	9.7656e-
53	4300	00:01:16	463.98		107638.1250		9.7656e-
53	4346	00:01:17	308.85	408.01	47695.6406	83236.0625	9.7656e-
54	4350	00:01:17	323.56		52346.4961		9.7656e-
54	4400	00:01:18	358.44		64239.8633		9.7656e-
54	4428	00:01:18	485.20	408.01	117711.0703	83235.3906	9.7656e-
55	4450	00:01:19	229.92		26432.1035		9.7656e-
55	4500	00:01:19	372.66		69436.3438		9.7656e-
55	4510	00:01:20	440.74	408.01	97127.1406	83234.4297	9.7656e-
56	4550	00:01:21	307.55		47294.6289		4.8828e-
56	4592	00:01:21	416.99	408.00	86939.2344	83233.8203	4.8828e-
57	4600	00:01:22	400.93		80371.5469		4.8828e-
57	4650	00:01:23	365.09		66645.2344		4.8828e-
57	4674	00:01:23	517.77	408.00	134042.5781	83233.2031	4.8828e-
58	4700	00:01:24	371.92		69160.7266		4.8828e-
58	4750	00:01:24	348.85		60847.1484		4.8828e-
58	4756	00:01:24	474.88	408.00	112754.5781	83232.9531	4.8828e-
59	4800	00:01:25	441.62		97512.1953		4.8828e-
59	4838	00:01:26	449.58	408.00	101063.0625	83232.5547	4.8828e-
60	4850	00:01:26	442.37		97844.1172		4.8828e-
60	4900	00:01:27	549.48		150966.3281		4.8828e-
60	4920	00:01:28	493.73	408.00	121885.0469	83232.1094	4.8828e-
61	4950	00:01:28	283.74		40254.3555		2.4414e-
61	5000	00:01:29	379.26		71917.8438		2.4414e-
61	5002	00:01:29	478.76	408.00	114604.5781	83231.8281	2.4414e-
62	5050	00:01:30	401.08		80433.7031		2.4414e-

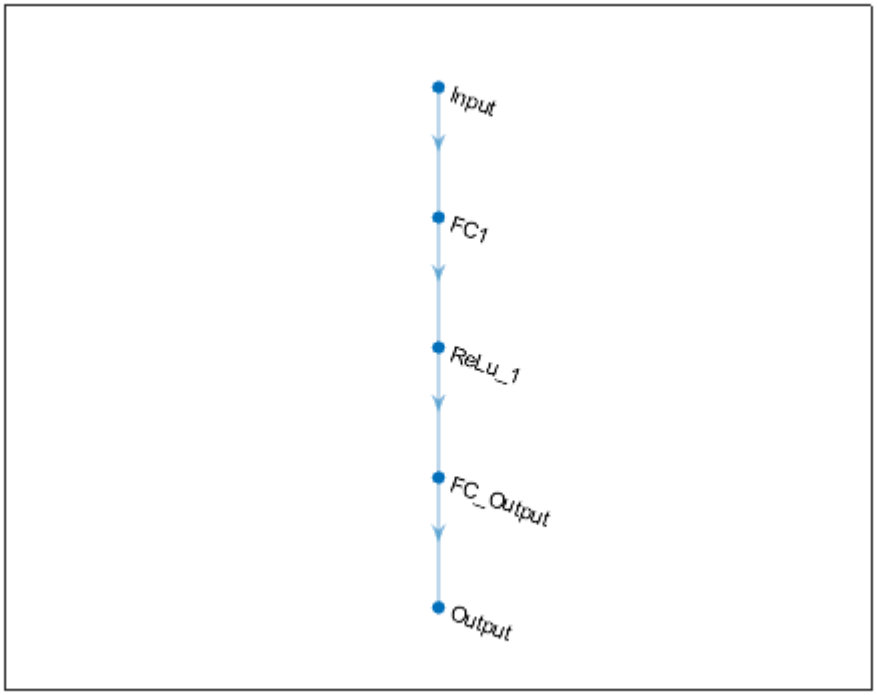
62	5084	00:01:31	334.96	408.00	56097.9453	83231.6641	2.4414e-
63	5100	00:01:31	415.03		86123.1953		2.4414e-
63	5150	00:01:31	332.59		55309.2813		2.4414e-
63	5166	00:01:32	430.19	408.00	92532.8516	83231.4453	2.4414e-
64	5200	00:01:32	369.05		68097.3750		2.4414e-
64	5248	00:01:33	316.75	408.00	50166.4922	83231.2031	2.4414e-
65	5250	00:01:33	419.62		88040.1094		2.4414e-
65	5300	00:01:34	332.35		55228.2344		2.4414e-
65	5330	00:01:35	328.21	408.00	53862.2109	83231.0156	2.4414e-
66	5350	00:01:35	314.58		49479.5000		1.2207e-
66	5400	00:01:36	215.28		23173.3926		1.2207e-
66	5412	00:01:36	400.65	408.00	80260.1484	83230.9219	1.2207e-
67	5450	00:01:37	412.16		84938.6563		1.2207e-
67	5494	00:01:38	353.18	408.00	62369.8164	83230.7500	1.2207e-
68	5500	00:01:38	317.45		50387.1172		1.2207e-
68	5550	00:01:39	471.02		110928.0313		1.2207e-
68	5576	00:01:39	448.81	408.00	100716.8672	83230.6641	1.2207e-
69	5600	00:01:40	373.78		69856.7188		1.2207e-
69	5650	00:01:40	361.14		65210.5273		1.2207e-
69	5658	00:01:40	484.10	408.00	117178.1797	83230.6016	1.2207e-
70	5700	00:01:41	517.66		133983.9219		1.2207e-
70	5740	00:01:42	375.22	408.00	70393.8516	83230.5078	1.2207e-
71	5750	00:01:42	455.97		103956.5547		6.1035e-
71	5800	00:01:43	302.32		45699.7148		6.1035e-
71	5822	00:01:43	419.16	408.00	87846.7656	83230.4375	6.1035e-
72	5850	00:01:44	418.30		87486.3984		6.1035e-
72	5900	00:01:45	367.16		67403.0156		6.1035e-
72	5904	00:01:46	567.66	408.00	161121.3438	83230.4297	6.1035e-
73	5950	00:01:46	467.53		109291.2422		6.1035e-
73	5986	00:01:47	431.27	408.00	92998.8828	83230.3359	6.1035e-
74	6000	00:01:47	356.74		63632.9844		6.1035e-
74	6050	00:01:48	437.69		95786.5234		6.1035e-
74	6068	00:01:48	247.41	408.00	30606.8984	83230.2969	6.1035e-
75	6100	00:01:49	326.32		53243.4648		6.1035e-
75	6150	00:01:49	415.84	408.00	86461.7031	83230.2266	6.1035e-
76	6200	00:01:50	420.01		88202.7344		3.0518e-
76	6232	00:01:51	323.00	408.00	52162.8945	83230.2188	3.0518e-
77	6250	00:01:51	310.94		48342.4922		3.0518e-
77	6300	00:01:52	482.84		116565.2031		3.0518e-
77	6314	00:01:52	378.38	408.00	71585.1016	83230.2031	3.0518e-
78	6350	00:01:53	383.86		73676.1484		3.0518e-
78	6396	00:01:53	396.41	408.00	78568.5938	83230.1797	3.0518e-
79	6400	00:01:53	598.01		178808.5938		3.0518e-
79	6450	00:01:54	380.53		72399.7109		3.0518e-
79	6478	00:01:55	392.39	408.00	76986.1563	83230.1953	3.0518e-
80	6500	00:01:55	403.60		81446.4297		3.0518e-
80	6550	00:01:56	331.92		55084.5391		3.0518e-
80	6560	00:01:56	308.54	408.00	47597.6523	83230.1875	3.0518e-
81	6600	00:01:57	261.52		34195.8438		1.5259e-
81	6642	00:01:58	260.44	408.00	33914.8359	83230.1484	1.5259e-
82	6650	00:01:58	298.35		44507.8516		1.5259e-
82	6700	00:01:59	353.66		62538.1523		1.5259e-
82	6724	00:01:59	457.14	408.00	104489.3984	83230.1563	1.5259e-
83	6750	00:02:00	358.72		64340.9727		1.5259e-
83	6800	00:02:00	328.10		53823.4375		1.5259e-
83	6806	00:02:01	393.29	408.00	77337.5703	83230.1016	1.5259e-
84	6850	00:02:01	487.86		119001.7422		1.5259e-
84	6888	00:02:02	373.93	408.00	69911.8438	83230.1563	1.5259e-
85	6900	00:02:02	439.03		96375.1328		1.5259e-
85	6950	00:02:03	384.24		73818.4922		1.5259e-
85	6970	00:02:03	399.38	408.00	79754.1797	83230.1016	1.5259e-
86	7000	00:02:04	294.47		43357.4414		7.6294e-
86	7050	00:02:05	467.59		109321.7578		7.6294e-
86	7052	00:02:05	444.27	408.00	98688.1328	83230.1250	7.6294e-
87	7100	00:02:05	427.88		91540.8594		7.6294e-

```
|      87 |        7134 |       00:02:06 |       320.75 |       408.00 |   51441.3828 |   83230.1484 |      7.6294e-
|      88 |        7150 |       00:02:06 |       448.02 |              |  100358.9219 |              |      7.6294e-
|      88 |        7200 |       00:02:07 |       374.79 |              |   70232.3984 |              |      7.6294e-
|      88 |        7216 |       00:02:08 |       489.25 |       408.00 |  119681.8984 |   83230.1016 |      7.6294e-
|=========================================================================================================================
```

Using 50 nodes in the single layer achieved a similar RMSE, 408.

```
% Model 3: A neural network with one hidden layer of 100 nodes.
%
% FC_1 = 100;
% RMSE_train_100 = RMSE_train;
% RMSE_val_100 = RMSE_val;

[net_100, RMSE_train_100, RMSE_val_100] = singlehiddenlayer(100, scaled_input_train, output_tra
```

```
Training on single CPU.
```




```
|=========================================================================================================================
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnir
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate
|=========================================================================================================================
|       1 |           1 |       00:00:05 |      1006.08 |       966.03 |  506094.7500 |  466605.4375 |          0.01
|       1 |          50 |       00:00:06 |       903.62 |              |  408267.9063 |              |          0.01
|       1 |          82 |       00:00:07 |       739.90 |       843.70 |  273723.2500 |  355911.6250 |          0.01
|       2 |         100 |       00:00:07 |       860.27 |              |  370033.8438 |              |          0.01
|       2 |         150 |       00:00:08 |       604.24 |              |  182553.3750 |              |          0.01
|       2 |         164 |       00:00:08 |       567.33 |       554.94 |  160929.5938 |  153981.5469 |          0.01
|       3 |         200 |       00:00:09 |       427.88 |              |   91541.8281 |              |          0.01
|       3 |         246 |       00:00:10 |       561.30 |       431.80 |  157530.2500 |   93227.6484 |          0.01
|       4 |         250 |       00:00:10 |       444.99 |              |   99006.8984 |              |          0.01
|       4 |         300 |       00:00:10 |       524.85 |              |  137734.4063 |              |          0.01
|       4 |         328 |       00:00:11 |       485.48 |       419.91 |  117846.7188 |   88161.9609 |          0.01
```

5	350	00:00:11	358.35		64206.8477		0.01
5	400	00:00:12	480.87		115620.2266		0.01
5	410	00:00:12	524.19	416.48	137388.0156	86726.9375	0.01
6	450	00:00:13	378.51		71636.7266		0.00
6	492	00:00:14	502.87	414.25	126440.9922	85802.3203	0.00
7	500	00:00:14	454.17		103133.7109		0.00
7	550	00:00:14	350.79		61528.1484		0.00
7	574	00:00:15	395.46	413.24	78192.3359	85384.7188	0.00
8	600	00:00:15	392.38		76981.7813		0.00
8	650	00:00:16	518.52		134432.0781		0.00
8	656	00:00:16	474.18	411.90	112424.8516	84830.6484	0.00
9	700	00:00:17	318.37		50680.1445		0.00
9	738	00:00:17	534.68	411.33	142940.1250	84597.7422	0.00
10	750	00:00:18	382.05		72981.8125		0.00
10	800	00:00:18	321.96		51828.2031		0.00
10	820	00:00:19	464.59	410.09	107921.4609	84088.7109	0.00
11	850	00:00:19	327.49		53623.9336		0.00
11	900	00:00:20	406.45		82602.0859		0.00
11	902	00:00:20	420.49	409.59	88403.8516	83881.4063	0.00
12	950	00:00:21	358.38		64216.9023		0.00
12	984	00:00:21	472.06	409.05	111422.5078	83662.4453	0.00
13	1000	00:00:22	415.20		86194.3047		0.00
13	1050	00:00:22	421.13		88677.2344		0.00
13	1066	00:00:23	519.79	408.66	135093.3438	83500.6172	0.00
14	1100	00:00:23	426.36		90890.0547		0.00
14	1148	00:00:24	378.08	408.09	71472.7969	83268.8672	0.00
15	1150	00:00:24	417.47		87139.2734		0.00
15	1200	00:00:25	368.70		67968.5469		0.00
15	1230	00:00:25	436.29	407.40	95175.6016	82989.0469	0.00
16	1250	00:00:25	225.69		25468.2441		0.00
16	1300	00:00:26	264.80		35059.0859		0.00
16	1312	00:00:26	472.12	407.19	111447.4609	82900.4453	0.00
17	1350	00:00:27	234.61		27520.9609		0.00
17	1394	00:00:28	323.45	406.82	52311.4258	82752.8516	0.00
18	1400	00:00:28	428.00		91592.0313		0.00
18	1450	00:00:29	262.54		34462.7383		0.00
18	1476	00:00:29	338.97	406.51	57450.0234	82625.9219	0.00
19	1500	00:00:30	496.99		123499.8750		0.00
19	1550	00:00:31	477.78		114136.8516		0.00
19	1558	00:00:31	285.10	406.12	40640.3789	82468.2031	0.00
20	1600	00:00:32	243.59		29668.3516		0.00
20	1640	00:00:32	252.67	405.82	31920.3320	82344.2188	0.00
21	1650	00:00:33	254.76		32451.9023		0.00
21	1700	00:00:33	430.18		92527.7031		0.00
21	1722	00:00:34	434.15	405.68	94245.1016	82289.0391	0.00
22	1750	00:00:34	391.15		76499.5703		0.00
22	1800	00:00:35	394.29		77731.0000		0.00
22	1804	00:00:35	539.33	405.58	145440.4688	82245.9766	0.00
23	1850	00:00:36	406.17		82485.9844		0.00
23	1886	00:00:36	539.80	405.45	145693.4531	82196.6641	0.00
24	1900	00:00:36	491.75		120911.3672		0.00
24	1950	00:00:37	255.41		32616.6152		0.00
24	1968	00:00:38	296.46	405.29	43944.0820	82128.3125	0.00
25	2000	00:00:38	326.70		53367.1719		0.00
25	2050	00:00:39	300.50	405.20	45149.2109	82094.5625	0.00
26	2100	00:00:39	410.54		84270.7500		0.00
26	2132	00:00:40	322.60	405.12	52036.5703	82062.5781	0.00
27	2150	00:00:40	523.57		137065.2344		0.00
27	2200	00:00:41	265.09		35137.1016		0.00
27	2214	00:00:41	356.63	405.05	63592.2578	82033.7031	0.00
28	2250	00:00:42	265.73		35306.9531		0.00
28	2296	00:00:43	530.73	404.99	140839.3438	82009.3906	0.00
29	2300	00:00:43	403.05		81224.9141		0.00
29	2350	00:00:44	346.65		60082.3750		0.00
29	2378	00:00:44	482.65	404.93	116474.2500	81985.0469	0.00

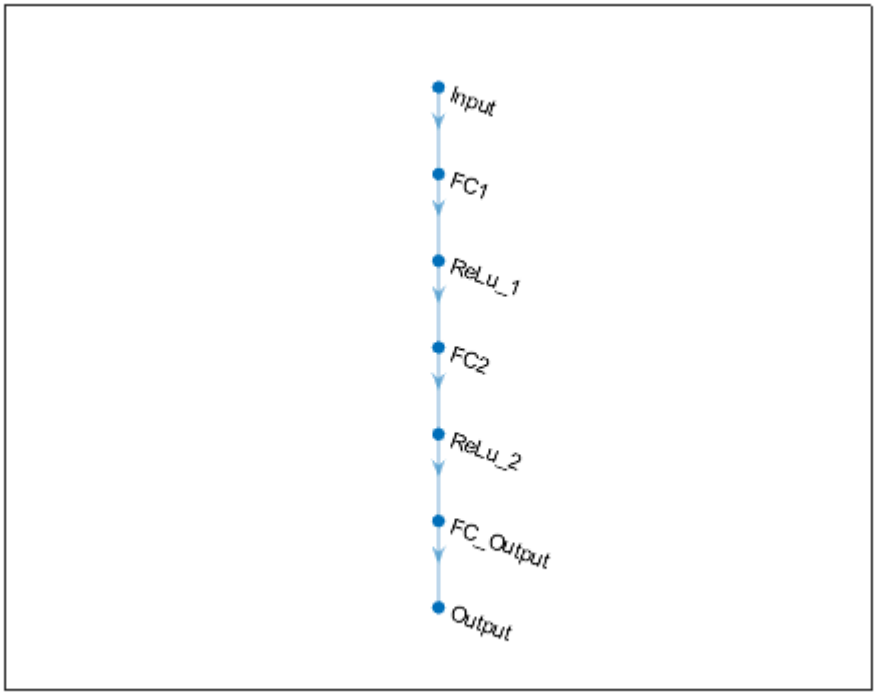
30	2400	00:00:45	487.50		118829.8516		0.00
30	2450	00:00:46	457.08		104461.1875		0.00
30	2460	00:00:46	332.30	404.83	55210.3945	81943.7969	0.00
31	2500	00:00:47	477.81		114149.7109		0.00
31	2542	00:00:47	230.08	404.81	26467.6621	81936.1016	0.00
32	2550	00:00:47	442.97		98109.7109		0.00
32	2600	00:00:48	324.21		52556.7031		0.00
32	2624	00:00:48	464.48	404.78	107870.2188	81924.7188	0.00
33	2650	00:00:49	273.01		37266.9297		0.00
33	2700	00:00:49	314.39		49421.6094		0.00
33	2706	00:00:50	384.55	404.76	73939.8984	81914.6641	0.00
34	2750	00:00:50	321.09		51549.3203		0.00
34	2788	00:00:51	401.20	404.70	80481.5781	81892.1406	0.00
35	2800	00:00:51	393.09		77259.6797		0.00
35	2850	00:00:52	336.02		56455.8750		0.00
35	2870	00:00:52	325.72	404.66	53045.1406	81874.3438	0.00
36	2900	00:00:53	382.36		73101.0078		7.8125e-
36	2950	00:00:54	284.84		40568.0898		7.8125e-
36	2952	00:00:54	437.18	404.64	95563.2266	81867.5625	7.8125e-
37	3000	00:00:54	381.05		72598.7031		7.8125e-
37	3034	00:00:55	331.72	404.63	55019.2148	81863.0234	7.8125e-
38	3050	00:00:55	271.76		36927.6875		7.8125e-
38	3100	00:00:56	344.35		59289.9648		7.8125e-
38	3116	00:00:56	437.02	404.62	95492.2734	81859.6875	7.8125e-
39	3150	00:00:57	397.82		79129.7813		7.8125e-
39	3198	00:00:58	425.09	404.60	90350.1641	81851.4844	7.8125e-
40	3200	00:00:58	579.63		167988.2500		7.8125e-
40	3250	00:00:59	356.17		63427.2617		7.8125e-
40	3280	00:00:59	327.41	404.59	53598.6289	81845.8359	7.8125e-
41	3300	00:00:59	467.27		109171.2656		3.9062e-
41	3350	00:01:00	441.15		97304.7266		3.9062e-
41	3362	00:01:01	393.62	404.59	77467.3672	81844.8984	3.9062e-
42	3400	00:01:01	535.98		143638.3594		3.9062e-
42	3444	00:01:02	254.29	404.58	32331.7402	81842.3828	3.9062e-
43	3450	00:01:02	492.87		121461.5000		3.9062e-
43	3500	00:01:03	493.93		121983.1953		3.9062e-
43	3526	00:01:04	294.74	404.57	43436.2891	81839.3125	3.9062e-
44	3550	00:01:04	344.84		59457.1719		3.9062e-
44	3600	00:01:05	406.83		82755.4063		3.9062e-
44	3608	00:01:05	295.26	404.57	43590.6992	81837.6641	3.9062e-
45	3650	00:01:06	231.63		26826.2754		3.9062e-
45	3690	00:01:06	406.33	404.56	82552.6250	81834.6250	3.9062e-
46	3700	00:01:07	418.73		87665.7891		1.9531e-
46	3750	00:01:07	399.55		79819.7422		1.9531e-
46	3772	00:01:08	380.78	404.56	72497.6563	81833.8516	1.9531e-
47	3800	00:01:08	333.31		55546.5078		1.9531e-
47	3850	00:01:09	399.37		79750.1797		1.9531e-
47	3854	00:01:09	327.85	404.55	53744.0977	81831.5781	1.9531e-
48	3900	00:01:10	372.00		69193.6719		1.9531e-
48	3936	00:01:11	380.39	404.55	72346.6484	81829.3672	1.9531e-
49	3950	00:01:11	415.79		86441.3438		1.9531e-
49	4000	00:01:12	377.87		71391.9766		1.9531e-
49	4018	00:01:12	357.85	404.55	64029.6953	81828.3750	1.9531e-
50	4050	00:01:13	298.07		44423.0273		1.9531e-
50	4100	00:01:14	331.99	404.54	55110.2344	81826.8047	1.9531e-
51	4150	00:01:14	368.67		67960.2813		9.7656e-
51	4182	00:01:15	331.11	404.54	54818.1055	81826.1406	9.7656e-
52	4200	00:01:15	425.33		90453.5391		9.7656e-
52	4250	00:01:16	469.26		110103.4297		9.7656e-
52	4264	00:01:16	574.89	404.54	165246.3906	81825.1719	9.7656e-
53	4300	00:01:17	483.85		117053.7266		9.7656e-
53	4346	00:01:18	474.21	404.54	112435.8672	81824.4219	9.7656e-
54	4350	00:01:18	350.81		61533.9141		9.7656e-
54	4400	00:01:18	336.41		56587.2852		9.7656e-
54	4428	00:01:19	377.27	404.53	71166.3828	81823.1250	9.7656e-

55	4450	00:01:19	333.32		55550.5820		9.7656e-
55	4500	00:01:20	387.12		74931.6641		9.7656e-
55	4510	00:01:21	344.54	404.53	59352.1875	81822.7266	9.7656e-
56	4550	00:01:21	425.31		90443.7969		4.8828e-
56	4592	00:01:22	522.63	404.53	136573.5000	81822.4531	4.8828e-
57	4600	00:01:22	240.35		28883.1387		4.8828e-
57	4650	00:01:23	378.18		71510.6875		4.8828e-
57	4674	00:01:23	368.59	404.53	67928.0000	81822.0625	4.8828e-
58	4700	00:01:24	282.14		39801.8086		4.8828e-
58	4750	00:01:24	290.62		42230.3359		4.8828e-
58	4756	00:01:25	331.02	404.53	54788.5000	81821.8750	4.8828e-
59	4800	00:01:25	438.49		96134.7969		4.8828e-
59	4838	00:01:26	493.76	404.53	121898.5391	81821.3750	4.8828e-
60	4850	00:01:26	438.62		96193.6797		4.8828e-
60	4900	00:01:27	463.26		107305.3594		4.8828e-
60	4920	00:01:27	475.68	404.53	113133.9375	81820.9688	4.8828e-
61	4950	00:01:28	462.92		107148.8203		2.4414e-
61	5000	00:01:29	284.93		40592.9727		2.4414e-
61	5002	00:01:29	304.60	404.53	46390.6172	81820.6563	2.4414e-
62	5050	00:01:29	298.61		44583.0781		2.4414e-
62	5084	00:01:30	452.94	404.53	102576.5938	81820.3828	2.4414e-
63	5100	00:01:31	332.60		55312.5430		2.4414e-
63	5150	00:01:32	313.29		49076.6484		2.4414e-
63	5166	00:01:32	279.83	404.52	39152.0313	81820.2031	2.4414e-
64	5200	00:01:33	338.06		57140.7969		2.4414e-
64	5248	00:01:33	399.76	404.52	79903.5547	81819.9766	2.4414e-
65	5250	00:01:33	254.43		32367.4648		2.4414e-
65	5300	00:01:34	363.89		66206.5625		2.4414e-
65	5330	00:01:35	325.58	404.52	53002.5430	81819.8047	2.4414e-
66	5350	00:01:35	330.59		54645.7813		1.2207e-
66	5400	00:01:36	375.23		70397.0156		1.2207e-
66	5412	00:01:36	307.72	404.52	47346.1914	81819.7266	1.2207e-
67	5450	00:01:37	432.66		93595.5703		1.2207e-
67	5494	00:01:38	433.46	404.52	93942.9922	81819.5625	1.2207e-
68	5500	00:01:38	415.85		86465.0703		1.2207e-
68	5550	00:01:39	359.50		64621.7422		1.2207e-
68	5576	00:01:39	354.08	404.52	62687.2891	81819.6328	1.2207e-
69	5600	00:01:39	385.82		74427.0234		1.2207e-
69	5650	00:01:40	275.62		37984.1719		1.2207e-
69	5658	00:01:41	290.00	404.52	42049.1016	81819.4219	1.2207e-
70	5700	00:01:42	350.40		61388.8359		1.2207e-
70	5740	00:01:42	392.52	404.52	77035.2891	81819.3125	1.2207e-
71	5750	00:01:43	443.90		98524.6719		6.1035e-
71	5800	00:01:43	289.75		41976.8555		6.1035e-
71	5822	00:01:44	308.09	404.52	47461.1758	81819.2813	6.1035e-
72	5850	00:01:44	298.30		44492.3633		6.1035e-
72	5900	00:01:45	398.97		79588.5156		6.1035e-
72	5904	00:01:45	298.97	404.52	44691.1758	81819.2500	6.1035e-
73	5950	00:01:46	409.73		83938.1094		6.1035e-
73	5986	00:01:47	345.60	404.52	59718.6211	81819.1953	6.1035e-
74	6000	00:01:47	466.99		109040.3047		6.1035e-
74	6050	00:01:48	557.83		155585.8906		6.1035e-
74	6068	00:01:48	399.66	404.52	79865.6250	81819.1641	6.1035e-
75	6100	00:01:49	367.71		67606.3125		6.1035e-
75	6150	00:01:50	338.46	404.52	57277.6484	81819.0781	6.1035e-
76	6200	00:01:51	510.73		130421.9063		3.0518e-
76	6232	00:01:52	398.26	404.52	79303.8984	81819.0859	3.0518e-
77	6250	00:01:52	335.75		56364.8086		3.0518e-
77	6300	00:01:53	363.74		66153.6953		3.0518e-
77	6314	00:01:53	384.04	404.52	73743.8359	81819.0625	3.0518e-
78	6350	00:01:54	571.24		163158.0781		3.0518e-
78	6396	00:01:55	458.11	404.52	104933.2422	81819.0078	3.0518e-
79	6400	00:01:55	314.71		49519.8359		3.0518e-
79	6450	00:01:56	495.75		122884.1875		3.0518e-
79	6478	00:01:56	404.83	404.52	81944.0234	81819.0391	3.0518e-

```
|      80 |        6500 |       00:01:57 |       374.70 |              |   70201.7344 |              |      3.0518e-
|      80 |        6550 |       00:01:58 |       355.41 |              |   63159.4102 |              |      3.0518e-
|      80 |        6560 |       00:01:58 |       298.72 |       404.52 |   44618.0898 |   81819.0547 |      3.0518e-
|      81 |        6600 |       00:01:59 |       468.43 |              |  109711.0000 |              |      1.5259e-
|      81 |        6642 |       00:01:59 |       492.54 |       404.52 |  121297.3750 |   81819.0000 |      1.5259e-
|      82 |        6650 |       00:02:00 |       443.83 |              |   98493.5234 |              |      1.5259e-
|      82 |        6700 |       00:02:00 |       323.92 |              |   52463.0781 |              |      1.5259e-
|      82 |        6724 |       00:02:01 |       350.42 |       404.52 |   61397.1094 |   81819.0156 |      1.5259e-
|      83 |        6750 |       00:02:01 |       295.61 |              |   43693.6797 |              |      1.5259e-
|      83 |        6800 |       00:02:02 |       412.56 |              |   85102.3047 |              |      1.5259e-
|      83 |        6806 |       00:02:02 |       506.36 |       404.52 |  128201.8594 |   81819.0313 |      1.5259e-
|      84 |        6850 |       00:02:03 |       403.00 |              |   81204.7813 |              |      1.5259e-
|      84 |        6888 |       00:02:04 |       497.90 |       404.52 |  123954.5859 |   81819.0156 |      1.5259e-
|      85 |        6900 |       00:02:04 |       373.99 |              |   69936.0781 |              |      1.5259e-
|      85 |        6950 |       00:02:05 |       415.99 |              |   86525.5234 |              |      1.5259e-
|      85 |        6970 |       00:02:05 |       392.26 |       404.52 |   76932.0469 |   81818.9922 |      1.5259e-
|      86 |        7000 |       00:02:06 |       200.42 |              |   20084.3672 |              |      7.6294e-
|      86 |        7050 |       00:02:07 |       476.78 |              |  113660.7266 |              |      7.6294e-
|      86 |        7052 |       00:02:07 |       430.15 |       404.52 |   92515.4219 |   81818.9922 |      7.6294e-
|      87 |        7100 |       00:02:08 |       450.88 |              |  101648.3359 |              |      7.6294e-
|      87 |        7134 |       00:02:08 |       401.49 |       404.52 |   80595.9844 |   81819.0469 |      7.6294e-
|      88 |        7150 |       00:02:09 |       401.70 |              |   80682.1250 |              |      7.6294e-
|      88 |        7200 |       00:02:09 |       265.06 |              |   35128.3164 |              |      7.6294e-
|      88 |        7216 |       00:02:10 |       303.65 |       404.52 |   46102.5781 |   81819.0000 |      7.6294e-
|      89 |        7250 |       00:02:10 |       326.79 |              |   53397.2070 |              |      7.6294e-
|      89 |        7298 |       00:02:12 |       487.93 |       404.52 |  119039.4297 |   81818.9922 |      7.6294e-
|      90 |        7300 |       00:02:12 |       380.66 |              |   72451.8594 |              |      7.6294e-
|      90 |        7350 |       00:02:13 |       463.95 |              |  107622.5547 |              |      7.6294e-
|      90 |        7380 |       00:02:13 |       442.49 |       404.52 |   97899.1484 |   81819.0078 |      7.6294e-
|=========|=============|================|==============|==============|==============|==============|==============
```

Again a similar RMSE, 405, using 100 nodes in the single hidden layer.

```
% Step 4: Deeper network: two hidden layers; 1st has 100 nodes and 2nd has 50
% nodes. ReLu activation after each hidden layer. Same training options as
% before.

[net_twohiddenlayers, RMSE_train_twohiddenlayers, RMSE_val_twohiddenlayers] = twohiddenlayers(1
```




```
Training on single CPU.
|=========================================================================================================================
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnir
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |     Rate
|=========================================================================================================================
|       1 |           1 |       00:00:07 |       970.15 |       965.62 |  470593.6875 |  466206.5938 |          0.01
|       1 |          41 |       00:00:08 |       613.25 |       601.24 |  188040.1719 |  180743.6250 |          0.01
|       2 |          50 |       00:00:08 |       523.30 |              |  136921.9375 |              |          0.01
|       2 |          82 |       00:00:09 |       340.89 |       426.64 |   58104.2773 |   91011.7188 |          0.01
|       3 |         100 |       00:00:10 |       511.58 |              |  130856.2266 |              |          0.01
|       3 |         123 |       00:00:10 |       419.28 |       413.44 |   87899.3281 |   85467.3438 |          0.01
|       4 |         150 |       00:00:11 |       391.79 |              |   76751.4375 |              |          0.01
|       4 |         164 |       00:00:11 |       428.11 |       409.11 |   91640.7188 |   83684.9375 |          0.01
|       5 |         200 |       00:00:12 |       359.30 |              |   64546.4531 |              |          0.01
|       5 |         205 |       00:00:12 |       394.20 |       405.16 |   77695.8359 |   82075.9922 |          0.01
|       6 |         246 |       00:00:13 |       397.88 |       404.59 |   79155.8984 |   81846.2266 |          0.01
|       7 |         250 |       00:00:13 |       485.74 |              |  117972.0781 |              |          0.01
|       7 |         287 |       00:00:14 |       438.77 |       396.56 |   96257.5313 |   78629.0859 |          0.01
|       8 |         300 |       00:00:15 |       457.51 |              |  104658.8984 |              |          0.01
|       8 |         328 |       00:00:15 |       413.57 |       397.84 |   85519.9375 |   79140.1563 |          0.01
|       9 |         350 |       00:00:15 |       386.43 |              |   74665.6172 |              |          0.01
|       9 |         369 |       00:00:16 |       313.14 |       393.78 |   49028.8047 |   77533.2734 |          0.01
|      10 |         400 |       00:00:17 |       451.56 |              |  101955.1094 |              |          0.01
|      10 |         410 |       00:00:18 |       361.47 |       390.89 |   65331.1797 |   76396.2109 |          0.01
|      11 |         450 |       00:00:19 |       445.26 |              |   99128.3125 |              |          0.01
|      11 |         451 |       00:00:19 |       442.20 |       392.22 |   97769.4844 |   76918.2891 |          0.01
|      12 |         492 |       00:00:20 |       429.15 |       388.63 |   92086.3438 |   75518.1406 |          0.01
|      13 |         500 |       00:00:20 |       390.53 |              |   76256.9766 |              |          0.01
|      13 |         533 |       00:00:21 |       315.01 |       385.26 |   49614.5820 |   74211.9688 |          0.01
|      14 |         550 |       00:00:21 |       362.37 |              |   65654.2969 |              |          0.01
|      14 |         574 |       00:00:22 |       347.29 |       384.84 |   60306.3906 |   74049.1797 |          0.01
|      15 |         600 |       00:00:22 |       328.48 |              |   53950.6133 |              |          0.01
|      15 |         615 |       00:00:23 |       338.10 |       381.51 |   57155.3984 |   72776.6641 |          0.01
|      16 |         650 |       00:00:24 |       324.23 |              |   52562.5391 |              |          0.01
|      16 |         656 |       00:00:24 |       327.84 |       378.99 |   53739.6016 |   71816.8906 |          0.01
```

17	697	00:00:25	316.44	380.15	50068.6992	72257.8203	0.01
18	700	00:00:25	402.47		80990.9531		0.01
18	738	00:00:26	478.44	375.27	114451.6328	70412.6797	0.01
19	750	00:00:26	366.02		66984.3438		0.01
19	779	00:00:27	309.11	371.52	47774.2188	69012.5078	0.01
20	800	00:00:27	411.00		84461.0625		0.01
20	820	00:00:28	284.75	367.18	40541.2266	67409.4453	0.01
21	850	00:00:28	308.85		47693.1719		0.01
21	861	00:00:29	400.47	364.94	80186.1406	66590.7813	0.01
22	900	00:00:30	342.11		58517.9805		0.01
22	902	00:00:30	284.63	362.60	40507.0313	65740.2578	0.01
23	943	00:00:31	449.53	366.51	101040.4609	67164.5313	0.01
24	950	00:00:31	240.15		28835.8457		0.01
24	984	00:00:32	218.50	356.09	23871.1094	63401.3789	0.01
25	1000	00:00:32	249.74		31185.9258		0.01
25	1025	00:00:33	389.19	353.17	75734.5859	62362.8242	0.01
26	1050	00:00:33	444.39		98739.9219		0.01
26	1066	00:00:34	431.47	349.66	93084.6250	61131.7109	0.01
27	1100	00:00:35	336.61		56652.1055		0.01
27	1107	00:00:35	335.47	347.94	56270.9883	60529.5078	0.01
28	1148	00:00:36	330.19	348.32	54511.4492	60664.5078	0.01
29	1150	00:00:36	251.54		31635.1387		0.01
29	1189	00:00:36	310.13	347.68	48089.3828	60441.2383	0.01
30	1200	00:00:37	294.37		43327.0313		0.01
30	1230	00:00:37	293.08	342.96	42949.1758	58809.3320	0.01
31	1250	00:00:38	286.55		41055.5039		0.00
31	1271	00:00:38	326.38	344.96	53263.5313	59497.0586	0.00
32	1300	00:00:39	303.48		46050.5938		0.00
32	1312	00:00:39	312.51	347.08	48831.0547	60230.8125	0.00
33	1350	00:00:40	347.02		60209.7617		0.00
33	1353	00:00:41	245.92	344.37	30238.7734	59294.4648	0.00
34	1394	00:00:42	264.02	339.94	34853.2188	57780.6445	0.00
35	1400	00:00:42	318.00		50562.7148		0.00
35	1435	00:00:43	329.95	336.99	54434.8594	56781.7031	0.00
36	1450	00:00:43	298.03		44412.1250		0.00
36	1476	00:00:44	345.65	336.14	59737.1680	56495.8320	0.00
37	1500	00:00:45	316.75		50166.5000		0.00
37	1517	00:00:45	270.41	341.68	36561.2813	58373.3477	0.00
38	1550	00:00:46	336.94		56765.5703		0.00
38	1558	00:00:46	251.61	337.66	31654.2695	57005.9023	0.00
39	1599	00:00:47	291.62	336.28	42519.9883	56542.4180	0.00
40	1600	00:00:47	329.24		54198.9688		0.00
40	1640	00:00:48	250.48	334.52	31369.6543	55950.5664	0.00
41	1650	00:00:48	234.74		27550.4316		0.00
41	1681	00:00:49	245.35	338.33	30097.4297	57232.3789	0.00
42	1700	00:00:49	322.76		52087.7266		0.00
42	1722	00:00:50	254.41	333.15	32361.9375	55494.4414	0.00
43	1750	00:00:51	204.68		20946.7617		0.00
43	1763	00:00:51	300.72	332.54	45217.6211	55292.8711	0.00
44	1800	00:00:52	354.63		62881.0703		0.00
44	1804	00:00:52	343.61	335.21	59032.8594	56181.4922	0.00
45	1845	00:00:53	286.85	336.78	41142.7305	56710.9414	0.00
46	1850	00:00:53	243.78		29715.2031		0.00
46	1886	00:00:54	278.55	332.79	38795.7578	55375.1445	0.00
47	1900	00:00:55	279.70		39114.6680		0.00
47	1927	00:00:55	378.90	332.23	71781.6094	55189.1680	0.00
48	1950	00:00:56	178.62		15952.8242		0.00
48	1968	00:00:56	322.12	332.22	51881.0938	55186.6289	0.00
49	2000	00:00:57	278.56		38796.7969		0.00
49	2009	00:00:57	308.44	330.23	47568.2305	54525.9297	0.00
50	2050	00:00:58	309.65	327.82	47941.5195	53732.9141	0.00
51	2091	00:00:59	291.60	326.92	42516.2891	53438.1992	0.00
52	2100	00:00:59	295.22		43577.6250		0.00
52	2132	00:01:00	172.60	328.42	14895.7861	53929.9219	0.00
53	2150	00:01:00	285.70		40812.3672		0.00

53	2173	00:01:01	183.00	326.99	16744.2500	53459.8867	0.00
54	2200	00:01:02	210.74		22205.8652		0.00
54	2214	00:01:02	392.52	323.01	77035.2578	52168.2383	0.00
55	2250	00:01:03	320.65		51407.3359		0.00
55	2255	00:01:03	308.24	323.41	47506.6875	52296.0352	0.00
56	2296	00:01:04	327.12	325.18	53502.3750	52870.4609	0.00
57	2300	00:01:04	261.06		34075.7344		0.00
57	2337	00:01:05	306.64	322.13	47013.0117	51884.3789	0.00
58	2350	00:01:05	322.62		52041.8867		0.00
58	2378	00:01:06	333.12	326.56	55485.1797	53320.4336	0.00
59	2400	00:01:07	341.21		58212.7578		0.00
59	2419	00:01:07	251.02	318.02	31505.7246	50567.8711	0.00
60	2450	00:01:08	255.32		32593.8262		0.00
60	2460	00:01:08	231.42	325.47	26778.7559	52965.3516	0.00
61	2500	00:01:09	284.67		40518.0703		0.00
61	2501	00:01:09	278.01	316.86	38645.1914	50198.8828	0.00
62	2542	00:01:10	317.56	315.09	50420.6680	49641.6719	0.00
63	2550	00:01:10	273.42		37379.1836		0.00
63	2583	00:01:11	340.29	317.50	57900.2500	50402.8281	0.00
64	2600	00:01:11	288.01		41475.7578		0.00
64	2624	00:01:13	326.54	316.40	53315.1484	50053.1406	0.00
65	2650	00:01:13	307.36		47234.2188		0.00
65	2665	00:01:13	271.18	315.53	36769.0781	49778.5859	0.00
66	2700	00:01:14	300.33		45098.6914		0.00
66	2706	00:01:15	222.29	313.27	24705.7734	49069.7070	0.00
67	2747	00:01:16	326.23	312.34	53212.8828	48777.3047	0.00
68	2750	00:01:16	228.48		26100.7012		0.00
68	2788	00:01:17	219.87	317.45	24171.0898	50386.7617	0.00
69	2800	00:01:17	296.47		43946.8125		0.00
69	2829	00:01:18	271.61	311.91	36884.9297	48643.3477	0.00
70	2850	00:01:18	260.28		33871.5742		0.00
70	2870	00:01:19	328.08	314.22	53819.2734	49365.5742	0.00
71	2900	00:01:20	251.05		31513.8867		0.00
71	2911	00:01:20	259.03	311.42	33549.1719	48492.1406	0.00
72	2950	00:01:21	222.64		24783.8242		0.00
72	2952	00:01:21	236.00	308.82	27847.0273	47684.8555	0.00
73	2993	00:01:22	286.40	308.04	41012.2891	47442.8555	0.00
74	3000	00:01:22	223.30		24931.6309		0.00
74	3034	00:01:23	295.31	309.48	43603.3359	47889.5195	0.00
75	3050	00:01:23	222.28		24704.4395		0.00
75	3075	00:01:24	293.58	309.00	43094.0938	47739.9766	0.00
76	3100	00:01:25	240.93		29024.6406		0.00
76	3116	00:01:25	318.09	313.22	50589.0977	49054.5156	0.00
77	3150	00:01:26	278.02		38648.8672		0.00
77	3157	00:01:26	255.36	307.60	32603.1875	47310.2148	0.00
78	3198	00:01:27	192.29	305.31	18487.8281	46606.6836	0.00
79	3200	00:01:27	266.92		35623.9297		0.00
79	3239	00:01:28	213.32	307.74	22752.5352	47351.3477	0.00
80	3250	00:01:28	229.55		26347.4551		0.00
80	3280	00:01:29	306.37	302.77	46929.8906	45835.8477	0.00
81	3300	00:01:29	242.98		29519.7813		0.00
81	3321	00:01:30	252.90	303.46	31980.2402	46043.6016	0.00
82	3350	00:01:31	270.72		36643.7266		0.00
82	3362	00:01:31	244.08	300.62	29788.2031	45184.7500	0.00
83	3400	00:01:32	281.80		39704.9688		0.00
83	3403	00:01:32	250.70	307.44	31424.1406	47261.1641	0.00
84	3444	00:01:33	208.55	303.87	21745.9844	46168.0000	0.00
85	3450	00:01:33	281.70		39677.2578		0.00
85	3485	00:01:34	227.55	300.70	25888.7773	45209.2305	0.00
86	3500	00:01:34	234.67		27533.9941		0.00
86	3526	00:01:35	255.98	299.67	32761.8555	44901.4570	0.00
87	3550	00:01:35	202.94		20591.8086		0.00
87	3567	00:01:36	260.52	298.35	33935.9727	44507.4375	0.00
88	3600	00:01:36	299.25		44775.5586		0.00
88	3608	00:01:36	221.06	298.61	24434.0410	44583.0078	0.00

89	3649	00:01:37	252.87	296.06	31971.2480	43824.3516	0.00
90	3650	00:01:37	229.64		26368.1191		0.00
90	3690	00:01:38	223.24	296.18	24917.9160	43860.2227	0.00
91	3700	00:01:38	278.53		38788.7070		0.00
91	3731	00:01:39	255.26	295.04	32578.6289	43523.1445	0.00
92	3750	00:01:39	230.19		26494.1465		0.00
92	3772	00:01:40	248.99	293.60	30997.0723	43100.4570	0.00
93	3800	00:01:41	287.87		41434.8203		0.00
93	3813	00:01:41	230.45	294.67	26553.8750	43414.4609	0.00
94	3850	00:01:42	244.42		29871.6992		0.00
94	3854	00:01:42	135.49	291.59	9179.3975	42511.8672	0.00
95	3895	00:01:43	278.95	293.90	38907.1836	43187.3398	0.00
96	3900	00:01:43	255.81		32718.9375		0.00
96	3936	00:01:44	255.35	293.60	32601.9395	43101.8008	0.00
97	3950	00:01:45	273.90		37511.1445		0.00
97	3977	00:01:45	237.86	292.34	28289.1094	42732.1289	0.00
98	4000	00:01:46	255.71		32693.7949		0.00
98	4018	00:01:46	264.15	293.10	34887.8281	42955.1367	0.00
99	4050	00:01:47	278.25		38712.4727		0.00
99	4059	00:01:47	254.76	290.57	32450.3145	42214.8594	0.00
100	4100	00:01:48	239.97	291.85	28793.0996	42589.2305	0.00
101	4141	00:01:49	236.56	295.72	27979.9805	43724.7734	0.00
102	4150	00:01:49	270.44		36567.6328		0.00
102	4182	00:01:50	274.49	294.14	37672.6445	43258.3203	0.00
103	4200	00:01:50	235.60		27753.0684		0.00
103	4223	00:01:51	207.19	288.44	21463.8203	41597.5430	0.00
104	4250	00:01:51	231.09		26701.9414		0.00
104	4264	00:01:51	296.50	290.24	43955.7617	42118.7734	0.00
105	4300	00:01:52	247.66		30667.6035		0.00
105	4305	00:01:52	207.64	289.23	21556.7363	41827.2695	0.00
106	4346	00:01:53	233.99	287.61	27376.4141	41359.9531	0.00
107	4350	00:01:53	258.20		33334.3906		0.00
107	4387	00:01:54	178.13	291.47	15864.5195	42478.4844	0.00
108	4400	00:01:55	238.76		28502.3281		0.00
108	4428	00:01:55	298.43	288.19	44529.8750	41527.7266	0.00
109	4450	00:01:56	244.95		30000.8008		0.00
109	4469	00:01:56	318.52	287.64	50727.5547	41367.0352	0.00
110	4500	00:01:57	225.57		25441.0586		0.00
110	4510	00:01:57	271.90	286.98	36964.4063	41177.8281	0.00
111	4550	00:01:58	221.92		24624.3164		0.00
111	4551	00:01:58	180.63	289.03	16313.7197	41768.1172	0.00
112	4592	00:01:59	198.26	285.40	19654.1914	40727.5273	0.00
113	4600	00:01:59	216.04		23336.1758		0.00
113	4633	00:02:00	258.39	285.74	33383.8164	40822.3242	0.00
114	4650	00:02:01	234.33		27455.8535		0.00
114	4674	00:02:01	200.37	284.38	20073.2266	40435.4844	0.00
115	4700	00:02:02	208.09		21650.7539		0.00
115	4715	00:02:02	220.31	285.38	24269.1680	40720.4219	0.00
116	4750	00:02:03	211.51		22369.1914		0.00
116	4756	00:02:03	258.39	283.97	33383.6953	40320.8828	0.00
117	4797	00:02:05	235.66	286.31	27767.0449	40985.9219	0.00
118	4800	00:02:05	182.58		16667.8086		0.00
118	4838	00:02:06	322.28	287.32	51932.4727	41277.3828	0.00
119	4850	00:02:06	206.96		21417.1719		0.00
119	4879	00:02:07	181.04	284.06	16388.6055	40345.8359	0.00
120	4900	00:02:07	235.18		27655.7051		0.00
120	4920	00:02:08	236.49	284.18	27963.8438	40377.7383	0.00
121	4950	00:02:08	206.62		21346.8984		0.00
121	4961	00:02:08	228.60	283.12	26128.9063	40078.2656	0.00
122	5000	00:02:09	214.48		22999.8555		0.00
122	5002	00:02:09	290.10	284.80	42079.5625	40556.3594	0.00
123	5043	00:02:10	201.83	283.03	20368.0566	40052.3711	0.00
124	5050	00:02:10	167.58		14041.5430		0.00
124	5084	00:02:11	232.34	285.35	26991.9316	40711.0469	0.00
125	5100	00:02:11	202.02		20406.9922		0.00

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|     125 |        5125 |       00:02:12 |       246.76 |       283.29 |   30446.0234 |   40126.0508 |          0.00
|     126 |        5150 |       00:02:12 |       246.53 |              |   30387.3906 |              |          0.00
|     126 |        5166 |       00:02:13 |       245.88 |       281.45 |   30228.2793 |   39607.7109 |          0.00
|     127 |        5200 |       00:02:14 |       257.25 |              |   33089.2500 |              |          0.00
|     127 |        5207 |       00:02:14 |       286.85 |       281.72 |   41141.3594 |   39683.5625 |          0.00
|     128 |        5248 |       00:02:16 |       194.76 |       280.43 |   18965.1875 |   39321.6172 |          0.00
|     129 |        5250 |       00:02:16 |       172.58 |              |   14892.6348 |              |          0.00
|     129 |        5289 |       00:02:17 |       220.49 |       286.12 |   24307.8242 |   40932.8242 |          0.00
|     130 |        5300 |       00:02:17 |       215.46 |              |   23211.0313 |              |          0.00
|     130 |        5330 |       00:02:18 |       218.97 |       281.07 |   23973.1758 |   39500.0469 |          0.00
|     131 |        5350 |       00:02:18 |       243.15 |              |   29560.6680 |              |          0.00
|     131 |        5371 |       00:02:19 |       195.96 |       283.36 |   19199.5898 |   40147.2031 |          0.00
|     132 |        5400 |       00:02:19 |       191.84 |              |   18401.8613 |              |          0.00
|     132 |        5412 |       00:02:20 |       232.11 |       282.59 |   26936.4277 |   39929.9023 |          0.00
|     133 |        5450 |       00:02:20 |       216.88 |              |   23517.8203 |              |          0.00
|     133 |        5453 |       00:02:20 |       200.96 |       280.40 |   20191.6094 |   39311.5273 |          0.00
|     134 |        5494 |       00:02:21 |       195.04 |       281.16 |   19019.6094 |   39526.7891 |          0.00
|     135 |        5500 |       00:02:21 |       278.91 |              |   38895.2539 |              |          0.00
|     135 |        5535 |       00:02:22 |       188.01 |       282.68 |   17674.1113 |   39954.7852 |          0.00
|     136 |        5550 |       00:02:22 |       194.46 |              |   18907.5293 |              |          0.00
|     136 |        5576 |       00:02:23 |       273.28 |       280.18 |   37340.8750 |   39251.4180 |          0.00
|     137 |        5600 |       00:02:24 |       201.74 |              |   20348.8887 |              |          0.00
|     137 |        5617 |       00:02:24 |       216.50 |       280.18 |   23436.6211 |   39250.0859 |          0.00
|     138 |        5650 |       00:02:25 |       151.74 |              |   11512.6650 |              |          0.00
|     138 |        5658 |       00:02:25 |       218.69 |       277.80 |   23913.4375 |   38586.6758 |          0.00
|     139 |        5699 |       00:02:26 |       244.94 |       278.53 |   29998.7520 |   38789.2578 |          0.00
|     140 |        5700 |       00:02:26 |       189.87 |              |   18025.1484 |              |          0.00
|     140 |        5740 |       00:02:27 |       173.30 |       280.44 |   15016.3486 |   39324.6250 |          0.00
|     141 |        5750 |       00:02:27 |       243.58 |              |   29665.1895 |              |          0.00
|     141 |        5781 |       00:02:28 |       233.22 |       280.88 |   27195.4961 |   39446.5859 |          0.00
|     142 |        5800 |       00:02:29 |       207.87 |              |   21604.9336 |              |          0.00
|     142 |        5822 |       00:02:29 |       281.68 |       279.21 |   39671.1406 |   38979.2344 |          0.00
|     143 |        5850 |       00:02:30 |       253.52 |              |   32137.0371 |              |          0.00
|     143 |        5863 |       00:02:31 |       200.84 |       282.67 |   20168.8926 |   39951.0742 |          0.00
|=========================================================================================================================
```

Using a two hidden layer neural net achieved an RMSE of 283.

```
% Step 5: Explore effect of batch size and learning rate drop factor
% Batch sizes: 32, 128, 256
% Learning rate drop factors: 1, 0.9, 0.5
% Learning rate drop period: 10
% All 9 combos

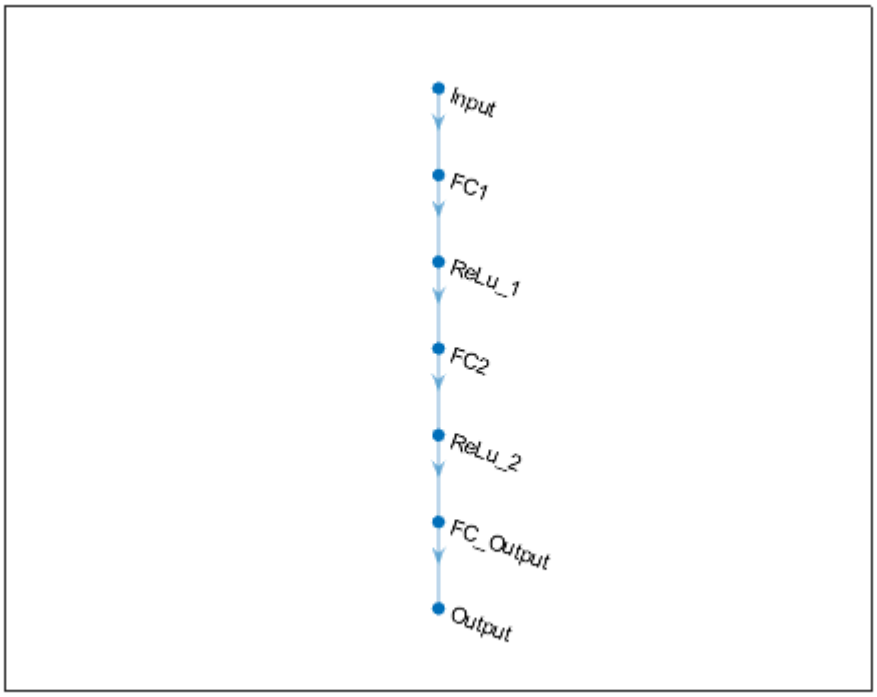
% twohiddenlayers_varybatchanddropfac(FC_1, FC_2, batch_size, LearnRateDropFactor, scaled_input

batchSizes = [32, 128, 256];
dropFactors= [1, 0.9, 0.5];

Step5nets = {};
for i=1:3
    for j=1:3
    sprintf('%d, %d start',i,j)
    [this_net, this_RMSE_train, this_RMSE_val] = twohiddenlayers_varybatchanddropfac(100, 50, b
    Step5nets{i,j} = this_net;
    Step5RMSE_train(i,j) = this_RMSE_train;
    Step5RMSE_val(i,j) = this_RMSE_val;
    sprintf('%d, %d end',i,j)
    end
```

```
end
```

```
ans =
'1, 1 start'
Training on single CPU.
```



Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch RMSE	Validation RMSE	Mini-batch Loss	Validation Loss	Base Learnir Rate
1	1	00:00:07	1005.34	965.65	505353.0625	466242.0313	0.01
1	41	00:00:08	546.08	531.74	149102.6563	141372.0625	0.01
2	50	00:00:08	472.98		111853.9219		0.01
2	82	00:00:09	462.83	421.03	107105.9375	88633.3203	0.01
3	100	00:00:10	328.92		54093.4805		0.01
3	123	00:00:10	353.80	415.92	62588.1914	86494.6953	0.01
4	150	00:00:11	408.06		83255.3672		0.01
4	164	00:00:11	413.63	405.27	85545.7031	82120.4844	0.01
5	200	00:00:12	403.56		81429.7969		0.01
5	205	00:00:12	395.64	401.40	78264.9531	80559.9609	0.01
6	246	00:00:13	466.77	397.30	108935.5781	78925.5156	0.01
7	250	00:00:14	374.55		70142.5547		0.01
7	287	00:00:14	445.07	398.81	99044.7422	79524.5703	0.01
8	300	00:00:15	487.28		118720.0313		0.01
8	328	00:00:15	319.45	394.86	51023.4727	77958.6016	0.01
9	350	00:00:16	319.32		50982.9531		0.01
9	369	00:00:17	328.52	396.71	53964.3281	78689.5781	0.01
10	400	00:00:18	312.58		48854.5781		0.01
10	410	00:00:18	311.28	393.64	48448.1055	77474.5703	0.01
11	450	00:00:19	301.80		45542.7813		0.01
11	451	00:00:19	334.45	389.57	55927.7227	75883.9609	0.01
12	492	00:00:20	386.21	389.22	74580.7656	75744.7500	0.01
13	500	00:00:20	489.26		119687.5625		0.01
13	533	00:00:21	363.80	385.04	66176.8984	74127.7031	0.01
14	550	00:00:21	406.82		82751.9688		0.01
14	574	00:00:22	296.72	385.97	44022.5938	74486.8047	0.01

15	600	00:00:23	342.46		58638.9609		0.01
15	615	00:00:23	344.09	382.28	59197.9297	73070.3594	0.01
16	650	00:00:24	326.15		53188.0430		0.01
16	656	00:00:24	357.73	380.51	63985.5234	72394.5859	0.01
17	697	00:00:25	392.34	381.60	76963.9297	72810.0234	0.01
18	700	00:00:25	284.93		40593.0508		0.01
18	738	00:00:27	336.67	378.47	56672.4922	71618.5781	0.01
19	750	00:00:27	386.37		74642.0469		0.01
19	779	00:00:28	388.61	373.10	75509.1875	69603.5000	0.01
20	800	00:00:29	371.13		68868.0156		0.01
20	820	00:00:29	247.15	368.53	30542.1836	67906.0625	0.01
21	850	00:00:30	327.02		53469.4844		0.01
21	861	00:00:30	299.45	366.70	44836.0977	67232.7813	0.01
22	900	00:00:31	434.32		94317.6250		0.01
22	902	00:00:31	320.52	363.75	51367.9531	66158.7031	0.01
23	943	00:00:32	336.27	360.16	56537.9805	64859.3555	0.01
24	950	00:00:32	390.10		76088.5391		0.01
24	984	00:00:33	315.59	354.46	49799.6953	62820.0859	0.01
25	1000	00:00:34	321.73		51754.7734		0.01
25	1025	00:00:35	329.66	353.29	54338.3984	62406.6289	0.01
26	1050	00:00:35	341.75		58397.0273		0.01
26	1066	00:00:36	382.77	350.79	73257.6406	61526.6367	0.01
27	1100	00:00:36	302.22		45668.6250		0.01
27	1107	00:00:37	314.38	351.51	49418.7539	61778.3047	0.01
28	1148	00:00:38	311.68	346.39	48573.4922	59992.4531	0.01
29	1150	00:00:38	315.30		49708.2578		0.01
29	1189	00:00:39	304.25	342.50	46283.6563	58653.8203	0.01
30	1200	00:00:39	247.59		30649.5859		0.01
30	1230	00:00:40	291.53	340.63	42495.1797	58013.8008	0.01
31	1250	00:00:41	264.54		34991.3242		0.00
31	1271	00:00:41	314.57	338.46	49476.8359	57279.0039	0.00
32	1300	00:00:42	235.87		27817.8672		0.00
32	1312	00:00:42	352.05	338.79	61970.5156	57387.7344	0.00
33	1350	00:00:43	354.36		62785.1484		0.00
33	1353	00:00:43	306.93	340.07	47102.5547	57824.7773	0.00
34	1394	00:00:44	214.87	336.94	23084.5430	56764.6641	0.00
35	1400	00:00:44	327.41		53600.0469		0.00
35	1435	00:00:46	383.83	337.52	73663.4531	56960.4531	0.00
36	1450	00:00:46	253.17		32048.6836		0.00
36	1476	00:00:47	309.19	335.51	47799.0078	56283.5586	0.00
37	1500	00:00:48	321.50		51680.4453		0.00
37	1517	00:00:48	311.05	332.97	48376.7461	55434.0273	0.00
38	1550	00:00:49	277.32		38453.9375		0.00
38	1558	00:00:49	317.19	332.05	50303.7422	55128.4336	0.00
39	1599	00:00:50	318.56	334.50	50740.2461	55945.9961	0.00
40	1600	00:00:50	283.99		40324.6563		0.00
40	1640	00:00:51	261.68	329.94	34237.2969	54430.7930	0.00
41	1650	00:00:51	310.35		48158.1094		0.00
41	1681	00:00:52	232.94	329.21	27131.1387	54189.2617	0.00
42	1700	00:00:52	272.20		37046.8438		0.00
42	1722	00:00:53	311.18	333.71	48417.4922	55680.6094	0.00
43	1750	00:00:54	342.87		58778.3359		0.00
43	1763	00:00:55	269.77	328.36	36388.1445	53910.8398	0.00
44	1800	00:00:55	267.02		35648.9375		0.00
44	1804	00:00:55	315.01	331.98	49616.5078	55106.1875	0.00
45	1845	00:00:56	312.28	329.04	48758.0625	54132.3281	0.00
46	1850	00:00:56	348.68		60787.6328		0.00
46	1886	00:00:58	332.39	326.28	55240.0117	53228.9102	0.00
47	1900	00:00:58	278.25		38711.7617		0.00
47	1927	00:00:58	262.76	323.67	34520.5430	52381.5352	0.00
48	1950	00:00:59	236.81		28039.1426		0.00
48	1968	00:00:59	375.90	322.69	70651.5547	52062.8516	0.00
49	2000	00:01:00	292.05		42646.4258		0.00
49	2009	00:01:00	261.73	328.05	34251.2266	53806.8789	0.00
50	2050	00:01:01	244.24	323.56	29826.2578	52345.2188	0.00

51	2091	00:01:02	256.81	321.92	32974.5234	51816.9453	0.00
52	2100	00:01:02	241.82		29238.8574		0.00
52	2132	00:01:03	318.45	319.46	50704.9531	51027.2891	0.00
53	2150	00:01:04	350.95		61582.5664		0.00
53	2173	00:01:05	253.14	317.75	32040.0371	50482.0938	0.00
54	2200	00:01:06	363.06		65906.5781		0.00
54	2214	00:01:06	296.17	317.46	43859.3359	50390.8711	0.00
55	2250	00:01:07	270.90		36694.1641		0.00
55	2255	00:01:07	242.92	317.65	29505.9629	50451.0039	0.00
56	2296	00:01:08	331.77	316.47	55037.0313	50075.2266	0.00
57	2300	00:01:08	295.76		43736.3594		0.00
57	2337	00:01:09	330.75	314.13	54699.0156	49340.3008	0.00
58	2350	00:01:09	264.39		34951.9102		0.00
58	2378	00:01:10	234.42	316.46	27476.6426	50072.8516	0.00
59	2400	00:01:10	202.78		20559.4961		0.00
59	2419	00:01:11	251.31	314.22	31577.5273	49366.3086	0.00
60	2450	00:01:11	312.32		48772.3633		0.00
60	2460	00:01:11	338.08	314.36	57149.5234	49410.6563	0.00
61	2500	00:01:12	250.54		31385.3711		0.00
61	2501	00:01:12	248.89	312.17	30973.4023	48725.7461	0.00
62	2542	00:01:13	266.63	314.95	35544.5156	49596.5586	0.00
63	2550	00:01:13	237.99		28318.9844		0.00
63	2583	00:01:14	290.28	311.06	42130.6836	48377.8359	0.00
64	2600	00:01:14	270.24		36515.9883		0.00
64	2624	00:01:16	310.09	315.99	48077.9453	49925.3477	0.00
65	2650	00:01:16	344.18		59230.6641		0.00
65	2665	00:01:17	271.62	312.43	36887.9219	48806.6523	0.00
66	2700	00:01:18	278.21		38699.4805		0.00
66	2706	00:01:18	328.52	313.02	53964.0195	48989.3320	0.00
67	2747	00:01:19	250.91	307.91	31479.1387	47405.7969	0.00
68	2750	00:01:19	213.02		22688.0137		0.00
68	2788	00:01:20	241.88	308.10	29252.3027	47462.9766	0.00
69	2800	00:01:20	255.44		32625.5977		0.00
69	2829	00:01:21	177.86	307.55	15817.3154	47293.7305	0.00
70	2850	00:01:21	302.18		45656.2383		0.00
70	2870	00:01:22	268.67	307.01	36090.9219	47129.0625	0.00
71	2900	00:01:22	317.90		50530.4414		0.00
71	2911	00:01:23	253.43	304.65	32112.7480	46406.7031	0.00
72	2950	00:01:24	301.23		45368.8555		0.00
72	2952	00:01:24	177.78	304.97	15802.8516	46503.2930	0.00
73	2993	00:01:25	204.95	304.69	21003.0547	46416.8320	0.00
74	3000	00:01:25	238.38		28413.5879		0.00
74	3034	00:01:26	308.53	303.70	47596.2109	46115.4023	0.00
75	3050	00:01:27	253.52		32136.3945		0.00
75	3075	00:01:28	243.82	307.18	29724.5078	47179.1172	0.00
76	3100	00:01:28	272.91		37241.1289		0.00
76	3116	00:01:29	313.62	303.32	49179.2188	46001.8594	0.00
77	3150	00:01:29	297.15		44148.2344		0.00
77	3157	00:01:30	308.35	304.24	47538.3477	46281.7383	0.00
78	3198	00:01:31	323.66	300.65	52377.5586	45195.4570	0.00
79	3200	00:01:31	189.51		17956.2441		0.00
79	3239	00:01:32	315.12	304.79	49650.2969	46447.6406	0.00
80	3250	00:01:32	310.73		48275.0820		0.00
80	3280	00:01:33	365.20	301.50	66686.0000	45451.4961	0.00
81	3300	00:01:33	243.61		29671.7188		0.00
81	3321	00:01:34	278.92	300.93	38898.0977	45279.4844	0.00
82	3350	00:01:34	313.77		49225.5352		0.00
82	3362	00:01:35	172.04	299.96	14798.6953	44987.5352	0.00
83	3400	00:01:35	235.13		27644.0215		0.00
83	3403	00:01:35	261.38	308.07	34159.0469	47452.7969	0.00
84	3444	00:01:36	251.48	309.97	31620.7207	48041.2695	0.00
85	3450	00:01:36	203.98		20803.4219		0.00
85	3485	00:01:38	237.87	301.14	28290.1367	45342.2539	0.00
86	3500	00:01:38	249.02		31005.4570		0.00
86	3526	00:01:39	287.33	300.27	41278.3164	45081.1523	0.00

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|      87 |        3550 |       00:01:40 |       296.16 |              |   43856.6641 |              |          0.00
|      87 |        3567 |       00:01:40 |       253.40 |       298.19 |   32106.3398 |   44458.2266 |          0.00
|      88 |        3600 |       00:01:41 |       193.38 |              |   18697.7461 |              |          0.00
|      88 |        3608 |       00:01:41 |       254.80 |       299.14 |   32460.4160 |   44741.3984 |          0.00
|      89 |        3649 |       00:01:42 |       296.73 |       299.04 |   44025.2031 |   44711.6641 |          0.00
|      90 |        3650 |       00:01:42 |       163.23 |              |   13322.3105 |              |          0.00
|      90 |        3690 |       00:01:43 |       215.50 |       297.36 |   23219.3516 |   44212.3906 |          0.00
|      91 |        3700 |       00:01:43 |       246.91 |              |   30482.2402 |              |          0.00
|      91 |        3731 |       00:01:44 |       273.03 |       296.30 |   37272.7656 |   43896.9258 |          0.00
|      92 |        3750 |       00:01:44 |       239.26 |              |   28623.2188 |              |          0.00
|      92 |        3772 |       00:01:45 |       254.64 |       295.52 |   32421.1250 |   43664.5859 |          0.00
|      93 |        3800 |       00:01:46 |       203.84 |              |   20775.3125 |              |          0.00
|      93 |        3813 |       00:01:46 |       187.38 |       296.87 |   17554.8828 |   44066.0703 |          0.00
|      94 |        3850 |       00:01:47 |       257.09 |              |   33048.5078 |              |          0.00
|      94 |        3854 |       00:01:47 |       183.37 |       296.39 |   16811.5664 |   43922.5234 |          0.00
|      95 |        3895 |       00:01:48 |       278.77 |       296.28 |   38856.0078 |   43890.8867 |          0.00
|      96 |        3900 |       00:01:48 |       199.13 |              |   19825.8926 |              |          0.00
|      96 |        3936 |       00:01:49 |       275.61 |       295.95 |   37980.8789 |   43792.9570 |          0.00
|      97 |        3950 |       00:01:50 |       220.92 |              |   24402.6680 |              |          0.00
|      97 |        3977 |       00:01:50 |       310.53 |       296.80 |   48213.4844 |   44045.0117 |          0.00
|=========================================================================================================================================
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    246.3051
this_RMSE_val = single

    296.7996
ans =
'1, 1 end'
ans =
'1, 2 start'
```

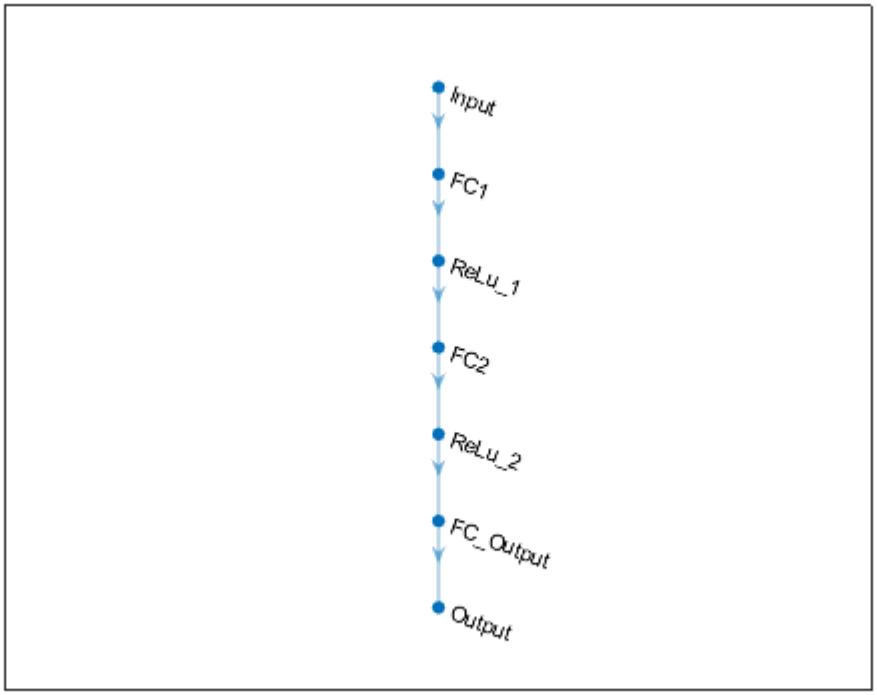


```
Training on single CPU.
|=========================================================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnin|
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate    |
|=========================================================================================================================|
|       1 |           1 |       00:00:06 |       860.62 |       965.74 |  370331.0625 |  466330.5000 |         0.01 |
|       1 |          41 |       00:00:08 |       428.92 |       536.77 |   91986.5000 |  144062.7969 |         0.01 |
|       2 |          50 |       00:00:09 |       491.07 |              |  120577.1797 |              |         0.01 |
|       2 |          82 |       00:00:10 |       391.13 |       422.43 |   76493.1797 |   89223.0156 |         0.01 |
|       3 |         100 |       00:00:11 |       427.86 |              |   91533.8594 |              |         0.01 |
|       3 |         123 |       00:00:11 |       338.76 |       409.97 |   57378.6523 |   84038.5703 |         0.01 |
|       4 |         150 |       00:00:12 |       354.20 |              |   62728.2813 |              |         0.01 |
|       4 |         164 |       00:00:12 |       264.12 |       403.18 |   34878.9297 |   81275.3516 |         0.01 |
|       5 |         200 |       00:00:13 |       298.17 |              |   44452.9102 |              |         0.01 |
|       5 |         205 |       00:00:13 |       338.34 |       400.87 |   57238.6250 |   80348.5000 |         0.01 |
|       6 |         246 |       00:00:14 |       362.87 |       402.39 |   65837.9688 |   80957.8047 |         0.01 |
|       7 |         250 |       00:00:15 |       363.06 |              |   65906.1797 |              |         0.01 |
|       7 |         287 |       00:00:16 |       285.60 |       395.25 |   40782.4336 |   78111.5313 |         0.01 |
|       8 |         300 |       00:00:16 |       374.98 |              |   70306.7031 |              |         0.01 |
|       8 |         328 |       00:00:17 |       401.93 |       392.74 |   80774.3828 |   77120.4375 |         0.01 |
|       9 |         350 |       00:00:18 |       391.79 |              |   76748.2813 |              |         0.01 |
|       9 |         369 |       00:00:18 |       506.75 |       393.79 |  128397.2344 |   77534.0859 |         0.01 |
|      10 |         400 |       00:00:20 |       284.54 |              |   40482.3125 |              |         0.01 |
|      10 |         410 |       00:00:20 |       287.79 |       389.20 |   41411.0234 |   75739.8359 |         0.01 |
|      11 |         450 |       00:00:21 |       373.21 |              |   69643.0859 |              |         0.01 |
|      11 |         451 |       00:00:21 |       335.98 |       386.92 |   56442.6211 |   74855.3594 |         0.01 |
|      12 |         492 |       00:00:22 |       345.56 |       385.23 |   59704.3125 |   74200.1563 |         0.01 |
|      13 |         500 |       00:00:22 |       334.98 |              |   56106.0859 |              |         0.01 |
|      13 |         533 |       00:00:23 |       287.07 |       383.09 |   41204.0156 |   73379.2969 |         0.01 |
|      14 |         550 |       00:00:24 |       372.43 |              |   69351.9531 |              |         0.01 |
|      14 |         574 |       00:00:25 |       366.96 |       384.00 |   67330.9609 |   73726.9688 |         0.01 |
|      15 |         600 |       00:00:25 |       337.72 |              |   57026.4219 |              |         0.01 |
|      15 |         615 |       00:00:26 |       358.53 |       379.13 |   64272.3438 |   71871.3203 |         0.01 |
|      16 |         650 |       00:00:26 |       289.30 |              |   41847.8359 |              |         0.01 |
|      16 |         656 |       00:00:26 |       409.75 |       390.94 |   83948.3906 |   76418.4609 |         0.01 |
```

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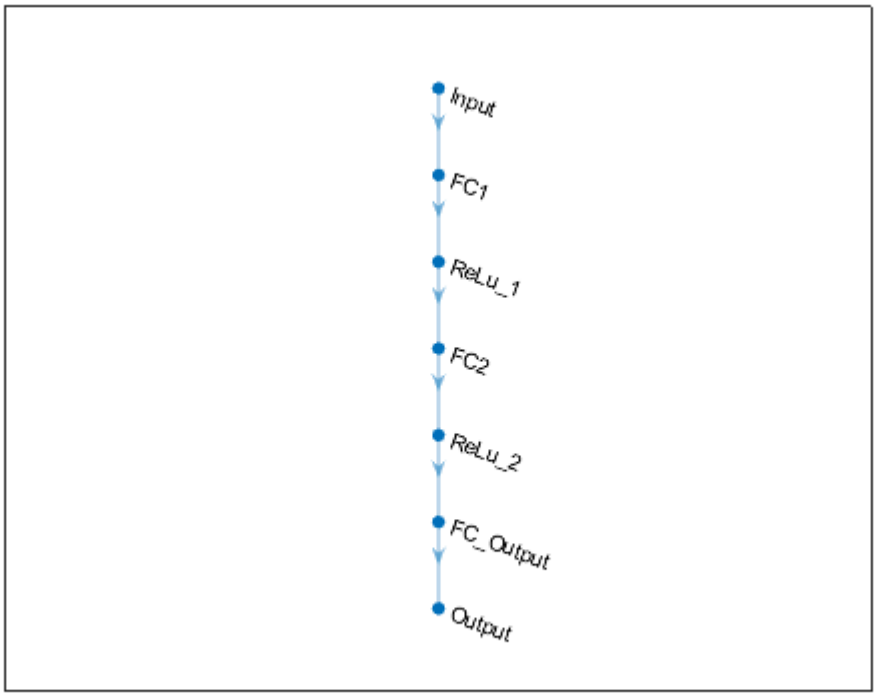
|      17 |         697 |       00:00:28 |       502.21 |       376.88 |  126109.2031 |   71018.1250 |          0.01
|      18 |         700 |       00:00:28 |       378.75 |              |   71725.1719 |              |          0.01
|      18 |         738 |       00:00:29 |       360.58 |       374.33 |   65007.4063 |   70059.7188 |          0.01
|      19 |         750 |       00:00:30 |       375.46 |              |   70483.7734 |              |          0.01
|      19 |         779 |       00:00:30 |       394.77 |       372.45 |   77920.8906 |   69361.0156 |          0.01
|      20 |         800 |       00:00:31 |       326.14 |              |   53183.0898 |              |          0.01
|      20 |         820 |       00:00:31 |       271.73 |       370.62 |   36918.7852 |   68680.4453 |          0.01
|      21 |         850 |       00:00:32 |       340.78 |              |   58065.6836 |              |          0.01
|      21 |         861 |       00:00:32 |       279.74 |       366.23 |   39127.9727 |   67063.1016 |          0.01
|      22 |         900 |       00:00:33 |       317.06 |              |   50264.5547 |              |          0.01
|      22 |         902 |       00:00:33 |       310.17 |       366.45 |   48104.2500 |   67142.4531 |          0.01
|      23 |         943 |       00:00:34 |       305.18 |       363.66 |   46566.9766 |   66125.4141 |          0.01
|      24 |         950 |       00:00:34 |       377.90 |              |   71405.2813 |              |          0.01
|      24 |         984 |       00:00:36 |       339.44 |       357.24 |   57610.3398 |   63810.5898 |          0.01
|      25 |        1000 |       00:00:36 |       347.20 |              |   60275.4375 |              |          0.01
|      25 |        1025 |       00:00:37 |       284.70 |       354.35 |   40527.4063 |   62781.9297 |          0.01
|      26 |        1050 |       00:00:38 |       305.41 |              |   46636.9219 |              |          0.01
|      26 |        1066 |       00:00:38 |       397.74 |       350.44 |   79097.7188 |   61404.9063 |          0.01
|      27 |        1100 |       00:00:39 |       410.11 |              |   84096.4922 |              |          0.01
|      27 |        1107 |       00:00:40 |       240.68 |       343.81 |   28964.2266 |   59102.5508 |          0.01
|      28 |        1148 |       00:00:40 |       299.89 |       340.78 |   44968.2031 |   58063.9727 |          0.01
|      29 |        1150 |       00:00:41 |       314.43 |              |   49433.7578 |              |          0.01
|      29 |        1189 |       00:00:42 |       248.82 |       343.21 |   30954.5977 |   58896.7383 |          0.01
|      30 |        1200 |       00:00:42 |       322.15 |              |   51890.1211 |              |          0.01
|      30 |        1230 |       00:00:43 |       291.81 |       334.23 |   42575.8359 |   55856.5117 |          0.01
|      31 |        1250 |       00:00:43 |       306.03 |              |   46827.2227 |              |          0.00
|      31 |        1271 |       00:00:44 |       272.31 |       330.71 |   37075.5859 |   54684.4883 |          0.00
|      32 |        1300 |       00:00:44 |       357.34 |              |   63844.6328 |              |          0.00
|      32 |        1312 |       00:00:44 |       239.04 |       330.58 |   28569.0371 |   54640.8398 |          0.00
|      33 |        1350 |       00:00:45 |       273.31 |              |   37349.2695 |              |          0.00
|      33 |        1353 |       00:00:45 |       293.27 |       326.51 |   43003.3516 |   53304.5703 |          0.00
|      34 |        1394 |       00:00:47 |       326.37 |       330.90 |   53260.1953 |   54747.1328 |          0.00
|      35 |        1400 |       00:00:47 |       312.95 |              |   48968.3633 |              |          0.00
|      35 |        1435 |       00:00:48 |       348.14 |       327.02 |   60600.1445 |   53471.0781 |          0.00
|      36 |        1450 |       00:00:48 |       191.16 |              |   18271.2969 |              |          0.00
|      36 |        1476 |       00:00:50 |       306.08 |       325.80 |   46842.9766 |   53071.2031 |          0.00
|      37 |        1500 |       00:00:50 |       257.67 |              |   33197.9688 |              |          0.00
|      37 |        1517 |       00:00:51 |       225.92 |       322.10 |   25519.3496 |   51873.7070 |          0.00
|      38 |        1550 |       00:00:52 |       292.33 |              |   42727.3320 |              |          0.00
|      38 |        1558 |       00:00:52 |       245.48 |       319.35 |   30131.3555 |   50992.8594 |          0.00
|      39 |        1599 |       00:00:53 |       257.16 |       319.02 |   33066.0352 |   50885.7852 |          0.00
|      40 |        1600 |       00:00:53 |       241.12 |              |   29068.8984 |              |          0.00
|      40 |        1640 |       00:00:55 |       223.21 |       317.38 |   24912.0586 |   50366.4961 |          0.00
|      41 |        1650 |       00:00:55 |       283.66 |              |   40230.7852 |              |          0.00
|      41 |        1681 |       00:00:56 |       274.53 |       315.49 |   37684.1484 |   49767.2813 |          0.00
|      42 |        1700 |       00:00:56 |       260.86 |              |   34024.1680 |              |          0.00
|      42 |        1722 |       00:00:57 |       235.79 |       316.76 |   27798.4824 |   50169.1211 |          0.00
|      43 |        1750 |       00:00:57 |       264.61 |              |   35009.1367 |              |          0.00
|      43 |        1763 |       00:00:58 |       216.70 |       309.34 |   23480.3008 |   47846.7031 |          0.00
|      44 |        1800 |       00:00:58 |       213.12 |              |   22710.8438 |              |          0.00
|      44 |        1804 |       00:00:58 |       260.85 |       310.97 |   34020.8828 |   48351.1914 |          0.00
|      45 |        1845 |       00:01:00 |       293.13 |       314.26 |   42964.0508 |   49379.0273 |          0.00
|      46 |        1850 |       00:01:00 |       355.83 |              |   63309.2617 |              |          0.00
|      46 |        1886 |       00:01:01 |       308.10 |       314.33 |   47461.2852 |   49402.0820 |          0.00
|      47 |        1900 |       00:01:02 |       329.54 |              |   54297.3047 |              |          0.00
|      47 |        1927 |       00:01:02 |       247.27 |       310.72 |   30570.1621 |   48272.8008 |          0.00
|      48 |        1950 |       00:01:03 |       244.32 |              |   29845.8867 |              |          0.00
|      48 |        1968 |       00:01:03 |       249.14 |       309.88 |   31035.7109 |   48013.7031 |          0.00
|=========================================================================================================================================
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
```

```
this_RMSE_train = single

    269.8378
this_RMSE_val = single

    309.8829
ans =
'1, 2 end'
ans =
'1, 3 start'
```




```
Training on single CPU.
```

Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch RMSE	Validation RMSE	Mini-batch Loss	Validation Loss	Base Learnir Rate
1	1	00:00:10	827.78	965.81	342609.9688	466393.9063	0.01
1	41	00:00:12	459.64	559.34	105635.1328	156428.6406	0.01
2	50	00:00:12	422.64		89311.7500		0.01
2	82	00:00:14	462.49	425.68	106948.5625	90602.9453	0.01
3	100	00:00:15	443.27		98242.4141		0.01
3	123	00:00:16	327.49	413.42	53625.8359	85456.6875	0.01
4	150	00:00:17	337.39		56917.0938		0.01
4	164	00:00:17	493.19	411.09	121619.8125	84497.6641	0.01
5	200	00:00:19	389.24		75753.6406		0.01
5	205	00:00:19	401.95	405.65	80783.6328	82274.9844	0.01
6	246	00:00:21	430.66	407.29	92736.0313	82942.9766	0.01
7	250	00:00:21	376.38		70831.4531		0.01
7	287	00:00:23	424.57	399.37	90130.0625	79749.1172	0.01
8	300	00:00:23	416.08		86561.9375		0.01
8	328	00:00:25	448.35	402.25	100509.6406	80903.1484	0.01
9	350	00:00:25	398.62		79447.7188		0.01
9	369	00:00:26	406.18	395.82	82492.7813	78336.5156	0.01
10	400	00:00:28	339.03		57471.7539		0.01
10	410	00:00:28	385.32	395.44	74234.1797	78185.5000	0.01
11	450	00:00:30	363.19		65954.5391		0.01

11	451	00:00:30	442.97	392.33	98109.2813	76959.6250	0.01
12	492	00:00:32	414.98	391.30	86103.2656	76557.3672	0.01
13	500	00:00:32	370.62		68678.1875		0.01
13	533	00:00:34	378.07	388.09	71469.2266	75307.8047	0.01
14	550	00:00:34	364.25		66338.1250		0.01
14	574	00:00:36	379.30	391.26	71935.6719	76543.3516	0.01
15	600	00:00:36	353.75		62570.3906		0.01
15	615	00:00:36	388.07	385.87	75298.3438	74447.9375	0.01
16	650	00:00:38	365.25		66702.1094		0.01
16	656	00:00:38	445.67	387.51	99310.1094	75083.1172	0.01
17	697	00:00:40	390.97	384.90	76430.6484	74073.5000	0.01
18	700	00:00:40	353.50		62480.7695		0.01
18	738	00:00:42	422.37	384.77	89196.3750	74024.8359	0.01
19	750	00:00:42	348.85		60848.0273		0.01
19	779	00:00:43	367.56	382.76	67550.0000	73254.1250	0.01
20	800	00:00:45	350.95		61582.0313		0.01
20	820	00:00:45	463.35	382.13	107347.6094	73011.4688	0.01
21	850	00:00:46	325.85		53089.3477		0.01
21	861	00:00:47	293.24	382.10	42994.9922	72998.7891	0.01
22	900	00:00:48	328.23		53865.9258		0.01
22	902	00:00:48	435.89	379.26	95002.0469	71919.6563	0.01
23	943	00:00:50	450.72	381.24	101574.5625	72671.4297	0.01
24	950	00:00:50	374.18		70004.4531		0.01
24	984	00:00:51	336.85	376.68	56735.5391	70944.1094	0.01
25	1000	00:00:51	335.40		56245.4063		0.01
25	1025	00:00:53	462.42	378.85	106916.3906	71762.0625	0.01
26	1050	00:00:53	375.05		70331.0469		0.01
26	1066	00:00:55	362.15	380.52	65575.7656	72398.9063	0.01
27	1100	00:00:55	440.49		97014.6094		0.01
27	1107	00:00:56	456.98	379.33	104414.6719	71946.5938	0.01
28	1148	00:00:57	296.49	374.68	43951.7305	70194.0938	0.01
29	1150	00:00:58	329.24		54200.6602		0.01
29	1189	00:00:59	313.64	375.15	49183.6797	70366.9531	0.01
30	1200	00:01:00	359.48		64611.8359		0.01
30	1230	00:01:01	406.62	371.96	82669.5859	69176.5469	0.01
31	1250	00:01:02	389.45		75835.6641		0.00
31	1271	00:01:03	287.46	373.81	41315.9141	69865.8203	0.00
32	1300	00:01:04	251.34		31586.9453		0.00
32	1312	00:01:04	302.19	371.01	45660.0547	68822.5000	0.00
33	1350	00:01:05	415.81		86447.2031		0.00
33	1353	00:01:05	290.64	367.03	42235.3906	67355.2188	0.00
34	1394	00:01:07	277.59	365.93	38529.1211	66952.3516	0.00
35	1400	00:01:07	310.93		48339.0625		0.00
35	1435	00:01:09	392.96	365.97	77208.9375	66968.7500	0.00
36	1450	00:01:09	306.97		47115.7422		0.00
36	1476	00:01:10	354.62	363.83	62876.9063	66186.1328	0.00
37	1500	00:01:11	323.91		52460.2188		0.00
37	1517	00:01:13	357.65	360.72	63955.3516	65060.3242	0.00
38	1550	00:01:13	277.71		38560.8281		0.00
38	1558	00:01:14	321.67	355.15	51735.8438	63064.5469	0.00
39	1599	00:01:15	255.88	355.93	32737.7246	63343.2773	0.00
40	1600	00:01:16	274.14		37575.3906		0.00
40	1640	00:01:16	397.35	350.96	78945.3047	61586.0313	0.00
41	1650	00:01:18	243.48		29640.0742		0.00
41	1681	00:01:18	325.07	348.59	52834.5469	60758.4219	0.00
42	1700	00:01:20	327.09		53494.8086		0.00
42	1722	00:01:21	336.09	352.57	56479.7266	62152.7813	0.00
43	1750	00:01:22	330.44		54596.1367		0.00
43	1763	00:01:22	269.62	347.19	36346.2461	60270.7109	0.00
44	1800	00:01:24	383.85		73670.8906		0.00
44	1804	00:01:24	262.49	343.20	34450.7930	58893.1367	0.00
45	1845	00:01:26	279.15	343.42	38961.9141	58968.1445	0.00
46	1850	00:01:26	289.53		41913.5391		0.00
46	1886	00:01:28	222.59	338.16	24772.4199	57176.1211	0.00
47	1900	00:01:28	273.12		37298.5195		0.00

47	1927	00:01:29	293.14	335.50	42964.3086	56280.3750	0.00
48	1950	00:01:30	274.38		37640.9063		0.00
48	1968	00:01:31	298.85	334.87	44654.9453	56070.1953	0.00
49	2000	00:01:32	339.61		57666.7148		0.00
49	2009	00:01:33	307.31	332.36	47219.5664	55230.7266	0.00
50	2050	00:01:33	253.50	328.14	32132.1836	53839.4922	0.00
51	2091	00:01:35	251.36	328.02	31591.3594	53799.4180	0.00
52	2100	00:01:37	294.50		43363.8945		0.00
52	2132	00:01:37	306.06	325.74	46836.2188	53054.5234	0.00
53	2150	00:01:40	286.33		40993.1172		0.00
53	2173	00:01:40	323.42	328.95	52299.8281	54102.9922	0.00
54	2200	00:01:42	293.96		43207.1484		0.00
54	2214	00:01:42	297.64	324.44	44294.4961	52629.1602	0.00
55	2250	00:01:44	311.99		48668.2266		0.00
55	2255	00:01:44	264.70	320.79	35032.4375	51453.7148	0.00
56	2296	00:01:49	253.98	320.18	32253.3750	51256.8398	0.00
57	2300	00:01:49	314.69		49515.4922		0.00
57	2337	00:01:51	247.71	321.13	30680.8711	51562.3555	0.00
58	2350	00:01:52	279.83		39151.5352		0.00
58	2378	00:01:53	278.14	320.45	38680.0586	51344.8516	0.00
59	2400	00:01:54	253.10		32030.9180		0.00
59	2419	00:01:54	342.06	317.70	58503.7109	50466.1367	0.00
60	2450	00:01:56	312.24		48746.3281		0.00
60	2460	00:01:56	345.93	316.38	59834.1641	50047.3828	0.00
61	2500	00:01:58	314.29		49388.3359		0.00
61	2501	00:01:58	247.52	312.87	30632.1875	48942.7383	0.00
62	2542	00:02:00	256.84	312.86	32983.1367	48940.6797	0.00
63	2550	00:02:00	269.91		36426.6836		0.00
63	2583	00:02:02	313.95	312.12	49283.2969	48708.3398	0.00
64	2600	00:02:02	323.16		52216.8125		0.00
64	2624	00:02:03	229.41	310.63	26315.5195	48244.8438	0.00
65	2650	00:02:04	248.81		30952.1172		0.00
65	2665	00:02:05	327.74	310.55	53706.5391	48221.0703	0.00
66	2700	00:02:07	268.07		35931.9336		0.00
66	2706	00:02:07	290.89	312.07	42307.8477	48692.3047	0.00
67	2747	00:02:09	342.80	307.33	58755.6250	47225.2617	0.00
68	2750	00:02:09	261.65		34229.3867		0.00
68	2788	00:02:11	222.12	307.32	24669.5742	47222.2422	0.00
69	2800	00:02:11	267.13		35678.9727		0.00
69	2829	00:02:13	276.02	307.31	38092.4609	47218.2383	0.00
70	2850	00:02:14	282.02		39767.9844		0.00
70	2870	00:02:15	218.81	304.94	23937.9258	46495.7227	0.00
71	2900	00:02:16	253.51		32133.8223		0.00
71	2911	00:02:17	211.41	306.31	22347.3125	46913.8789	0.00
72	2950	00:02:19	231.39		26771.0781		0.00
72	2952	00:02:19	282.79	304.22	39983.9766	46274.7422	0.00
73	2993	00:02:21	235.79	303.92	27798.4180	46182.2070	0.00
74	3000	00:02:21	294.19		43273.3789		0.00
74	3034	00:02:21	218.58	303.76	23889.2305	46134.6797	0.00
75	3050	00:02:23	225.45		25413.7578		0.00
75	3075	00:02:23	168.52	303.49	14200.1904	46053.5938	0.00
76	3100	00:02:25	307.08		47148.6445		0.00
76	3116	00:02:25	285.67	302.54	40804.9102	45765.0313	0.00
77	3150	00:02:27	310.20		48110.5898		0.00
77	3157	00:02:27	260.13	303.06	33834.7109	45923.2813	0.00
78	3198	00:02:29	191.84	300.86	18401.2266	45257.7695	0.00
79	3200	00:02:29	164.49		13527.9395		0.00
79	3239	00:02:31	271.75	303.52	36924.8828	46062.7773	0.00
80	3250	00:02:32	308.47		47575.5820		0.00
80	3280	00:02:33	267.98	300.50	35907.6641	45149.2852	0.00
81	3300	00:02:33	254.11		32286.6992		0.00
81	3321	00:02:35	287.24	299.49	41253.1211	44846.9023	0.00
82	3350	00:02:35	188.01		17674.1816		0.00
82	3362	00:02:37	269.02	300.39	36186.1328	45118.2109	0.00
83	3400	00:02:39	281.53		39629.4922		0.00

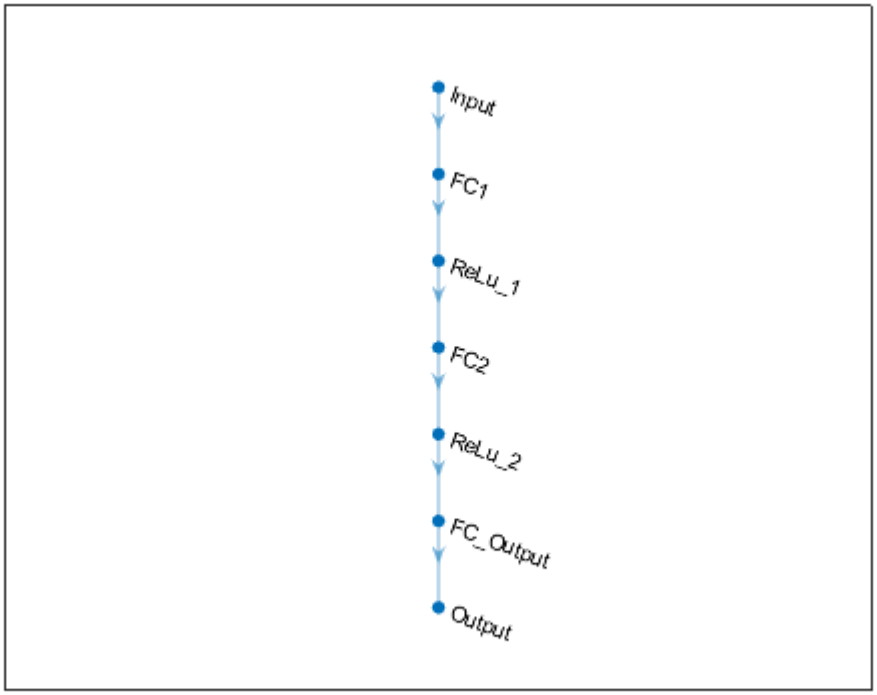
83	3403	00:02:39	230.12	298.40	26477.1484	44522.0742	0.00
84	3444	00:02:41	242.02	298.58	29287.9746	44576.4375	0.00
85	3450	00:02:41	304.67		46410.4141		0.00
85	3485	00:02:41	309.01	298.97	47742.9453	44690.8906	0.00
86	3500	00:02:42	291.82		42580.6602		0.00
86	3526	00:02:43	256.78	298.50	32966.9023	44551.1172	0.00
87	3550	00:02:44	187.64		17605.2227		0.00
87	3567	00:02:44	261.68	296.50	34237.0781	43956.5156	0.00
88	3600	00:02:46	250.50		31376.3516		0.00
88	3608	00:02:46	260.70	298.90	33981.0000	44670.7305	0.00
89	3649	00:02:48	275.94	294.77	38070.0703	43445.4883	0.00
90	3650	00:02:48	196.81		19367.8047		0.00
90	3690	00:02:50	296.57	297.45	43977.0273	44238.8477	0.00
91	3700	00:02:50	236.88		28057.0605		0.00
91	3731	00:02:52	242.53	293.83	29410.9355	43167.9648	0.00
92	3750	00:02:52	232.47		27021.7656		0.00
92	3772	00:02:54	218.16	297.22	23796.4375	44169.6055	0.00
93	3800	00:02:54	305.13		46552.5547		0.00
93	3813	00:02:55	317.51	293.23	50407.8320	42992.0156	0.00
94	3850	00:02:56	218.43		23856.0449		0.00
94	3854	00:02:56	235.58	291.09	27749.0039	42366.6133	0.00
95	3895	00:02:58	325.49	290.39	52972.9766	42162.6250	0.00
96	3900	00:02:58	254.68		32431.3281		0.00
96	3936	00:03:00	209.19	292.26	21879.9941	42707.4805	0.00
97	3950	00:03:01	306.51		46975.3906		0.00
97	3977	00:03:01	257.12	291.37	33055.4531	42448.5430	0.00
98	4000	00:03:03	196.06		19220.4180		0.00
98	4018	00:03:03	319.86	290.77	51156.5898	42274.4922	0.00
99	4050	00:03:05	298.27		44483.0781		0.00
99	4059	00:03:05	234.31	291.96	27450.3672	42621.5195	0.00
100	4100	00:03:07	233.10	289.93	27167.8145	42031.1445	0.00
101	4141	00:03:09	245.07	289.82	30029.4023	41996.8711	0.00
102	4150	00:03:09	247.52		30631.9844		0.00
102	4182	00:03:10	174.35	291.65	15199.2559	42529.6289	0.00
103	4200	00:03:11	213.31		22750.3906		0.00
103	4223	00:03:12	263.84	290.59	34806.9414	42221.4375	0.00
104	4250	00:03:12	235.23		27665.9609		0.00
104	4264	00:03:14	228.93	289.81	26203.5215	41994.0352	0.00
105	4300	00:03:15	191.80		18393.3164		0.00
105	4305	00:03:16	246.49	289.26	30377.7207	41836.6641	0.00
106	4346	00:03:18	300.40	288.89	45119.5352	41727.8320	0.00
107	4350	00:03:18	255.78		32711.9063		0.00
107	4387	00:03:18	260.45	290.21	33918.3594	42109.9141	0.00
108	4400	00:03:19	252.90		31979.7891		0.00
108	4428	00:03:20	213.31	289.86	22749.6328	42009.9453	0.00
109	4450	00:03:21	232.13		26941.4609		0.00
109	4469	00:03:21	219.30	288.09	24045.9629	41498.5469	0.00
110	4500	00:03:23	220.47		24303.5430		0.00
110	4510	00:03:23	181.82	287.39	16529.7793	41296.9805	0.00
111	4550	00:03:25	276.85		38322.3008		0.00
111	4551	00:03:25	212.27	286.10	22529.5742	40926.7930	0.00
112	4592	00:03:26	298.02	289.02	44406.7891	41767.3164	0.00
113	4600	00:03:26	232.28		26977.4707		0.00
113	4633	00:03:28	204.79	286.38	20970.3770	41005.5938	0.00
114	4650	00:03:28	218.71		23917.3926		0.00
114	4674	00:03:30	273.43	292.04	37381.9844	42642.3594	0.00
115	4700	00:03:31	261.75		34256.9102		0.00
115	4715	00:03:32	299.53	286.30	44860.5586	40984.3359	0.00
116	4750	00:03:34	252.62		31907.4355		0.00
116	4756	00:03:34	309.09	285.08	47767.6719	40634.6875	0.00
117	4797	00:03:36	252.12	289.92	31783.0820	42026.5977	0.00
118	4800	00:03:36	240.68		28962.3320		0.00
118	4838	00:03:37	219.87	286.74	24170.7793	41110.3750	0.00
119	4850	00:03:38	212.17		22507.6133		0.00
119	4879	00:03:39	293.17	287.68	42973.7227	41381.1523	0.00

```
|     120 |        4900 |       00:03:40 |       226.99 |              |   25762.1055 |              |          0.00
|     120 |        4920 |       00:03:41 |       228.73 |       286.26 |   26158.4219 |   40973.5313 |          0.00
|     121 |        4950 |       00:03:42 |       172.31 |              |   14844.5615 |              |          0.00
|     121 |        4961 |       00:03:42 |       242.24 |       284.25 |   29340.2285 |   40398.6719 |          0.00
|     122 |        5000 |       00:03:44 |       237.07 |              |   28101.5508 |              |          0.00
|     122 |        5002 |       00:03:44 |       334.70 |       284.58 |   56012.0859 |   40492.3984 |          0.00
|     123 |        5043 |       00:03:46 |       270.72 |       285.38 |   36645.9063 |   40719.6875 |          0.00
|     124 |        5050 |       00:03:46 |       230.44 |              |   26550.6191 |              |          0.00
|     124 |        5084 |       00:03:48 |       181.43 |       285.00 |   16457.6602 |   40613.6719 |          0.00
|     125 |        5100 |       00:03:48 |       186.62 |              |   17413.0039 |              |          0.00
|     125 |        5125 |       00:03:50 |       236.88 |       285.22 |   28055.3320 |   40675.3125 |          0.00
|     126 |        5150 |       00:03:50 |       210.64 |              |   22184.3242 |              |          0.00
|     126 |        5166 |       00:03:52 |       286.51 |       284.69 |   41043.8750 |   40522.9375 |          0.00
|=========|=============|================|==============|==============|==============|==============|==============
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    234.4111
this_RMSE_val = single

    284.6856
ans =
'1, 3 end'
ans =
'2, 1 start'
```




```
Training on single CPU.
|=========|=============|================|==============|==============|==============|==============|==============
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnin
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate
|=========|=============|================|==============|==============|==============|==============|==============
```

1	1	00:00:15	797.13	965.86	317711.6250	466440.7813	0.01
1	41	00:00:17	646.05	569.87	208691.0000	162378.0938	0.01
2	50	00:00:17	590.33		174246.5469		0.01
2	82	00:00:19	486.69	422.58	118432.2266	89287.4141	0.01
3	100	00:00:20	412.41		85040.8906		0.01
3	123	00:00:21	433.28	412.92	93865.1328	85251.1094	0.01
4	150	00:00:23	360.26		64894.1523		0.01
4	164	00:00:24	300.66	408.22	45197.0313	83321.5469	0.01
5	200	00:00:26	349.79		61176.9961		0.01
5	205	00:00:26	426.44	408.16	90925.1719	83296.7344	0.01
6	246	00:00:29	384.39	401.31	73876.6953	80523.7109	0.01
7	250	00:00:29	372.24		69282.1719		0.01
7	287	00:00:31	344.64	398.72	59388.6094	79489.3125	0.01
8	300	00:00:32	439.02		96367.8125		0.01
8	328	00:00:33	446.26	399.94	99572.4453	79975.5625	0.01
9	350	00:00:34	323.89		52453.3477		0.01
9	369	00:00:35	418.01	397.67	87365.1719	79069.1094	0.01
10	400	00:00:36	348.42		60696.5781		0.01
10	410	00:00:38	330.13	394.18	54493.9336	77689.2891	0.01
11	450	00:00:40	313.81		49236.8203		0.01
11	451	00:00:40	385.15	394.94	74169.8594	77988.4531	0.01
12	492	00:00:43	284.21	388.85	40386.8516	75602.9141	0.01
13	500	00:00:43	317.31		50344.3711		0.01
13	533	00:00:43	346.16	389.68	59913.5078	75925.0313	0.01
14	550	00:00:46	442.27		97802.5703		0.01
14	574	00:00:46	367.81	387.71	67642.0078	75157.9609	0.01
15	600	00:00:48	382.97		73332.3281		0.01
15	615	00:00:48	372.74	383.35	69466.7031	73480.1953	0.01
16	650	00:00:51	352.50		62127.0156		0.01
16	656	00:00:51	322.45	384.90	51987.4609	74075.5938	0.01
17	697	00:00:53	390.95	385.54	76420.1953	74318.8672	0.01
18	700	00:00:53	299.31		44793.6250		0.01
18	738	00:00:55	363.29	385.59	65990.5703	74339.5469	0.01
19	750	00:00:55	315.26		49695.9531		0.01
19	779	00:00:57	384.29	378.65	73838.5156	71689.7656	0.01
20	800	00:00:57	348.88		60859.6250		0.01
20	820	00:00:59	351.33	377.68	61714.8672	71322.5156	0.01
21	850	00:01:01	371.84		69132.8281		0.01
21	861	00:01:02	330.00	376.19	54449.9766	70758.4141	0.01
22	900	00:01:03	387.79		75190.1094		0.01
22	902	00:01:03	362.40	375.46	65665.3750	70485.1172	0.01
23	943	00:01:06	332.97	378.28	55433.2734	71547.9375	0.01
24	950	00:01:06	419.87		88144.7188		0.01
24	984	00:01:08	400.42	365.48	80169.5000	66788.8203	0.01
25	1000	00:01:08	234.03		27385.4063		0.01
25	1025	00:01:08	401.25	367.10	80502.0938	67381.5859	0.01
26	1050	00:01:11	345.95		59839.6133		0.01
26	1066	00:01:11	338.71	356.82	57361.4961	63661.5938	0.01
27	1100	00:01:13	281.19		39533.9609		0.01
27	1107	00:01:13	368.26	353.76	67806.6797	62572.5547	0.01
28	1148	00:01:16	379.30	353.31	71933.0547	62414.4727	0.01
29	1150	00:01:16	445.20		99103.6328		0.01
29	1189	00:01:19	397.62	346.63	79050.2344	60074.6406	0.01
30	1200	00:01:20	341.49		58306.1914		0.01
30	1230	00:01:21	260.19	342.28	33848.2891	58576.4570	0.01
31	1250	00:01:23	379.92		72168.9375		0.00
31	1271	00:01:23	364.47	338.54	66418.8594	57303.6992	0.00
32	1300	00:01:26	280.76		39411.8008		0.00
32	1312	00:01:26	303.98	338.77	46201.4102	57382.3359	0.00
33	1350	00:01:28	284.63		40507.9688		0.00
33	1353	00:01:28	319.19	338.43	50940.3906	57268.1758	0.00
34	1394	00:01:30	303.50	332.83	46055.1563	55387.8359	0.00
35	1400	00:01:30	341.54		58324.8398		0.00
35	1435	00:01:33	329.25	329.92	54204.3594	54422.2344	0.00
36	1450	00:01:33	327.38		53588.2656		0.00

36	1476	00:01:35	303.81	329.95	46149.9961	54432.7852	0.00
37	1500	00:01:35	378.23		71529.6172		0.00
37	1517	00:01:37	362.55	331.46	65722.8203	54931.6328	0.00
38	1550	00:01:38	249.07		31017.4355		0.00
38	1558	00:01:39	286.78	323.31	41122.4297	52264.7891	0.00
39	1599	00:01:42	317.42	323.76	50379.1328	52408.9102	0.00
40	1600	00:01:42	315.05		49628.0391		0.00
40	1640	00:01:44	234.82	318.89	27569.7637	50844.7266	0.00
41	1650	00:01:44	188.85		17832.1074		0.00
41	1681	00:01:46	263.88	317.83	34815.5781	50506.6055	0.00
42	1700	00:01:46	339.86		57751.9297		0.00
42	1722	00:01:48	266.16	317.40	35420.8711	50370.7031	0.00
43	1750	00:01:48	286.04		40910.2578		0.00
43	1763	00:01:48	347.71	313.63	60449.4258	49181.2031	0.00
44	1800	00:01:51	290.83		42291.3906		0.00
44	1804	00:01:51	284.20	312.98	40385.2188	48976.9844	0.00
45	1845	00:01:54	257.84	315.77	33241.9531	49855.6172	0.00
46	1850	00:01:54	278.89		38890.1445		0.00
46	1886	00:01:56	266.74	310.82	35575.5313	48304.4766	0.00
47	1900	00:01:59	265.78		35319.9414		0.00
47	1927	00:02:00	289.77	307.44	41983.5000	47260.4180	0.00
48	1950	00:02:02	262.36		34415.2227		0.00
48	1968	00:02:02	288.36	308.44	41575.7461	47566.3594	0.00
49	2000	00:02:04	309.30		47833.2734		0.00
49	2009	00:02:05	235.85	304.66	27811.5313	46407.9844	0.00
50	2050	00:02:07	243.02	307.51	29529.7070	47282.2500	0.00
51	2091	00:02:10	306.44	305.99	46951.6016	46815.1211	0.00
52	2100	00:02:10	251.53		31633.1992		0.00
52	2132	00:02:12	257.02	306.27	33028.4844	46899.6133	0.00
53	2150	00:02:12	223.30		24930.9473		0.00
53	2173	00:02:14	224.48	303.16	25195.0703	45953.7188	0.00
54	2200	00:02:15	323.09		52192.4258		0.00
54	2214	00:02:17	240.21	297.85	28850.1934	44356.7539	0.00
55	2250	00:02:19	284.19		40383.1016		0.00
55	2255	00:02:19	194.15	302.96	18847.0645	45890.9492	0.00
56	2296	00:02:22	219.86	300.35	24168.4336	45104.9375	0.00
57	2300	00:02:22	221.14		24452.2910		0.00
57	2337	00:02:24	267.25	305.50	35712.3203	46663.9922	0.00
58	2350	00:02:24	279.46		39049.2656		0.00
58	2378	00:02:27	270.37	298.77	36549.9414	44632.7305	0.00
59	2400	00:02:27	290.00		42051.0938		0.00
59	2419	00:02:29	270.24	297.69	36514.3945	44311.0430	0.00
60	2450	00:02:32	232.89		27118.3281		0.00
60	2460	00:02:32	251.61	296.19	31654.2031	43863.5859	0.00
61	2500	00:02:35	205.07		21026.9141		0.00
61	2501	00:02:35	281.86	295.25	39723.3164	43587.5586	0.00
62	2542	00:02:37	298.11	296.10	44433.6250	43836.3789	0.00
63	2550	00:02:37	322.82		52105.3398		0.00
63	2583	00:02:38	300.54	298.09	45161.7656	44428.2656	0.00
64	2600	00:02:40	315.88		49888.8516		0.00
64	2624	00:02:40	311.96	300.82	48658.2813	45247.2852	0.00
65	2650	00:02:42	264.91		35088.1563		0.00
65	2665	00:02:42	228.67	296.09	26144.8711	43833.4063	0.00
66	2700	00:02:44	268.80		36127.0078		0.00
66	2706	00:02:44	253.87	293.93	32224.1641	43197.0117	0.00
67	2747	00:02:47	257.06	292.03	33039.2188	42639.8789	0.00
68	2750	00:02:47	316.25		50006.8008		0.00
68	2788	00:02:49	233.12	294.84	27172.4199	43466.1602	0.00
69	2800	00:02:49	211.14		22289.2910		0.00
69	2829	00:02:51	257.23	295.46	33082.6016	43647.5117	0.00
70	2850	00:02:51	232.94		27130.4297		0.00
70	2870	00:02:54	219.38	293.36	24063.4805	43030.1836	0.00
71	2900	00:02:54	272.84		37221.0234		0.00
71	2911	00:02:56	227.25	291.54	25821.4375	42498.3164	0.00
72	2950	00:02:56	247.76		30691.3789		0.00

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|      72 |        2952 |       00:02:57 |       235.52 |       292.79 |   27733.7207 |   42863.0742 |          0.00
|      73 |        2993 |       00:02:59 |       289.56 |       293.17 |   41921.7031 |   42975.2383 |          0.00
|      74 |        3000 |       00:03:01 |       241.45 |              |   29149.4375 |              |          0.00
|      74 |        3034 |       00:03:02 |       314.98 |       292.18 |   49606.0586 |   42684.0078 |          0.00
|      75 |        3050 |       00:03:04 |       269.27 |              |   36252.2109 |              |          0.00
|      75 |        3075 |       00:03:05 |       188.48 |       291.03 |   17761.5938 |   42347.9219 |          0.00
|      76 |        3100 |       00:03:07 |       280.78 |              |   39417.9063 |              |          0.00
|      76 |        3116 |       00:03:07 |       212.10 |       289.96 |   22492.2422 |   42037.6641 |          0.00
|      77 |        3150 |       00:03:09 |       233.21 |              |   27194.5469 |              |          0.00
|      77 |        3157 |       00:03:09 |       269.93 |       290.66 |   36431.6836 |   42240.2930 |          0.00
|      78 |        3198 |       00:03:12 |       266.12 |       289.03 |   35410.9727 |   41768.0352 |          0.00
|      79 |        3200 |       00:03:12 |       280.35 |              |   39298.7852 |              |          0.00
|      79 |        3239 |       00:03:14 |       278.08 |       290.83 |   38663.0859 |   42290.4102 |          0.00
|      80 |        3250 |       00:03:15 |       297.65 |              |   44297.8242 |              |          0.00
|      80 |        3280 |       00:03:17 |       227.89 |       288.97 |   25965.8789 |   41751.1055 |          0.00
|      81 |        3300 |       00:03:17 |       236.69 |              |   28010.7227 |              |          0.00
|      81 |        3321 |       00:03:17 |       232.52 |       289.35 |   27033.1602 |   41861.9844 |          0.00
|      82 |        3350 |       00:03:19 |       327.63 |              |   53670.0078 |              |          0.00
|      82 |        3362 |       00:03:19 |       223.11 |       289.25 |   24887.9668 |   41831.7539 |          0.00
|      83 |        3400 |       00:03:21 |       253.87 |              |   32225.9258 |              |          0.00
|      83 |        3403 |       00:03:21 |       229.59 |       290.20 |   26356.1289 |   42106.8242 |          0.00
|      84 |        3444 |       00:03:23 |       231.86 |       289.57 |   26878.8477 |   41925.4258 |          0.00
|      85 |        3450 |       00:03:23 |       216.65 |              |   23469.6172 |              |          0.00
|      85 |        3485 |       00:03:25 |       220.77 |       295.20 |   24370.1211 |   43571.3438 |          0.00
|=========================================================================================================================
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    250.3109
this_RMSE_val = single

    295.1994
ans =
'2, 1 end'
ans =
'2, 2 start'
```

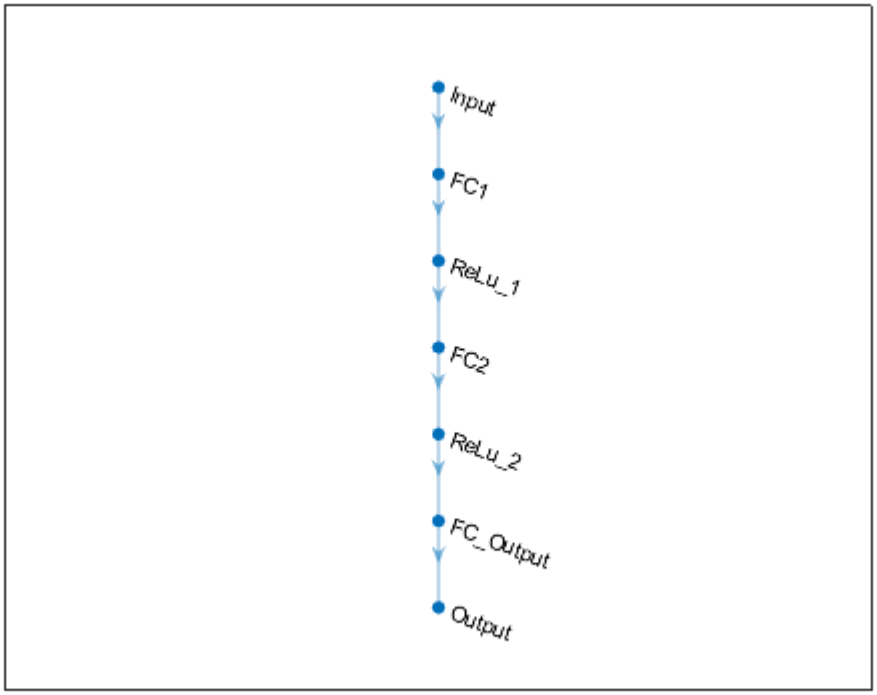


```
Training on single CPU.
|=========================================================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnin|
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate    |
|=========================================================================================================================|
|       1 |           1 |       00:00:17 |       958.35 |       965.69 |  459221.4688 |  466275.3125 |         0.01 |
|       1 |          41 |       00:00:21 |       449.79 |       488.25 |  101155.9531 |  119192.1094 |         0.01 |
|       2 |          50 |       00:00:24 |       492.00 |              |  121029.9297 |              |         0.01 |
|       2 |          82 |       00:00:25 |       386.77 |       421.78 |   74796.5469 |   88949.7031 |         0.01 |
|       3 |         100 |       00:00:27 |       446.28 |              |   99585.0156 |              |         0.01 |
|       3 |         123 |       00:00:27 |       531.77 |       413.18 |  141389.0781 |   85360.4297 |         0.01 |
|       4 |         150 |       00:00:30 |       412.64 |              |   85134.8906 |              |         0.01 |
|       4 |         164 |       00:00:30 |       422.53 |       405.86 |   89265.8906 |   82361.0313 |         0.01 |
|       5 |         200 |       00:00:33 |       430.47 |              |   92650.6406 |              |         0.01 |
|       5 |         205 |       00:00:33 |       462.77 |       402.50 |  107076.9609 |   81003.8594 |         0.01 |
|       6 |         246 |       00:00:36 |       464.56 |       400.13 |  107910.1328 |   80052.8359 |         0.01 |
|       7 |         250 |       00:00:36 |       410.70 |              |   84338.0000 |              |         0.01 |
|       7 |         287 |       00:00:39 |       366.61 |       394.07 |   67203.0781 |   77645.9609 |         0.01 |
|       8 |         300 |       00:00:39 |       419.04 |              |   87797.2813 |              |         0.01 |
|       8 |         328 |       00:00:42 |       439.13 |       393.23 |   96419.7500 |   77314.8281 |         0.01 |
|       9 |         350 |       00:00:42 |       323.66 |              |   52376.5000 |              |         0.01 |
|       9 |         369 |       00:00:44 |       404.06 |       384.73 |   81630.4844 |   74007.0078 |         0.01 |
|      10 |         400 |       00:00:45 |       391.53 |              |   76648.0469 |              |         0.01 |
|      10 |         410 |       00:00:45 |       315.02 |       382.70 |   49619.7344 |   73230.6016 |         0.01 |
|      11 |         450 |       00:00:47 |       426.62 |              |   91002.7109 |              |         0.01 |
|      11 |         451 |       00:00:47 |       383.27 |       375.18 |   73448.6875 |   70381.2578 |         0.01 |
|      12 |         492 |       00:00:50 |       416.67 |       370.90 |   86808.0078 |   68783.2109 |         0.01 |
|      13 |         500 |       00:00:50 |       344.90 |              |   59476.3164 |              |         0.01 |
|      13 |         533 |       00:00:53 |       328.58 |       367.99 |   53983.2344 |   67709.3281 |         0.01 |
|      14 |         550 |       00:00:53 |       282.66 |              |   39947.8047 |              |         0.01 |
|      14 |         574 |       00:00:56 |       336.80 |       361.01 |   56717.3047 |   65165.8828 |         0.01 |
|      15 |         600 |       00:00:59 |       305.98 |              |   46811.3672 |              |         0.01 |
|      15 |         615 |       00:00:59 |       359.72 |       358.00 |   64698.7891 |   64081.9609 |         0.01 |
|      16 |         650 |       00:01:02 |       294.12 |              |   43252.9102 |              |         0.01 |
|      16 |         656 |       00:01:02 |       365.98 |       356.95 |   66969.3906 |   63705.9844 |         0.01 |
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17	697	00:01:05	370.02	354.86	68459.2422	62962.5234	0.01
18	700	00:01:05	250.86		31465.2695		0.01
18	738	00:01:08	357.07	350.73	63749.6641	61507.3203	0.01
19	750	00:01:08	351.37		61730.1289		0.01
19	779	00:01:10	282.42	348.05	39880.4922	60569.7891	0.01
20	800	00:01:11	355.04		63025.9453		0.01
20	820	00:01:13	410.41	348.42	84216.4141	60699.0195	0.01
21	850	00:01:14	334.48		55936.7617		0.01
21	861	00:01:16	404.34	351.35	81745.7656	61722.3477	0.01
22	900	00:01:19	318.29		50654.5313		0.01
22	902	00:01:19	242.67	351.61	29444.5684	61814.7148	0.01
23	943	00:01:22	281.03	342.84	39489.6914	58769.7461	0.01
24	950	00:01:22	317.03		50254.7773		0.01
24	984	00:01:24	323.37	345.32	52284.4375	59624.1211	0.01
25	1000	00:01:24	327.43		53603.6250		0.01
25	1025	00:01:27	252.57	340.23	31896.7148	57878.5742	0.01
26	1050	00:01:27	380.93		72553.7109		0.01
26	1066	00:01:29	336.64	339.59	56664.1406	57659.1719	0.01
27	1100	00:01:30	378.11		71483.3359		0.01
27	1107	00:01:32	300.43	338.07	45128.9648	57144.0352	0.01
28	1148	00:01:35	328.90	333.93	54089.1797	55753.2188	0.01
29	1150	00:01:35	375.94		70664.5625		0.01
29	1189	00:01:35	262.62	331.36	34484.7109	54901.2422	0.01
30	1200	00:01:38	266.79		35587.8477		0.01
30	1230	00:01:38	229.14	339.88	26252.3867	57759.5352	0.01
31	1250	00:01:40	225.84		25502.3633		0.00
31	1271	00:01:40	359.75	333.29	64709.9297	55541.4688	0.00
32	1300	00:01:43	266.38		35480.0352		0.00
32	1312	00:01:43	293.39	329.84	43040.2070	54396.4297	0.00
33	1350	00:01:46	311.62		48553.8086		0.00
33	1353	00:01:46	311.13	332.28	48399.6563	55203.6719	0.00
34	1394	00:01:49	234.90	333.98	27588.5156	55772.7578	0.00
35	1400	00:01:49	304.98		46505.0000		0.00
35	1435	00:01:52	351.58	327.79	61804.5039	53722.5859	0.00
36	1450	00:01:54	431.73		93195.1563		0.00
36	1476	00:01:55	263.31	331.97	34665.1328	55103.6758	0.00
37	1500	00:01:57	353.41		62449.8281		0.00
37	1517	00:01:58	255.50	325.41	32641.3242	52944.7500	0.00
38	1550	00:02:00	265.32		35196.2695		0.00
38	1558	00:02:01	216.01	326.80	23330.6602	53399.8320	0.00
39	1599	00:02:03	328.48	324.03	53949.9219	52496.3867	0.00
40	1600	00:02:03	260.25		33866.1563		0.00
40	1640	00:02:06	303.01	334.66	45906.3203	55999.6797	0.00
41	1650	00:02:08	315.03		49621.2813		0.00
41	1681	00:02:09	308.78	328.66	47672.2383	54007.1016	0.00
42	1700	00:02:11	344.50		59338.4609		0.00
42	1722	00:02:12	287.05	320.74	41199.8984	51436.4922	0.00
43	1750	00:02:14	305.40		46634.5391		0.00
43	1763	00:02:15	247.69	320.50	30676.2695	51360.0938	0.00
44	1800	00:02:17	274.48		37668.6602		0.00
44	1804	00:02:18	264.08	319.41	34869.0469	51010.5820	0.00
45	1845	00:02:21	310.52	319.93	48212.1016	51176.3867	0.00
46	1850	00:02:21	199.83		19966.5781		0.00
46	1886	00:02:23	371.81	325.16	69121.8516	52863.3789	0.00
47	1900	00:02:24	301.47		45442.2383		0.00
47	1927	00:02:26	294.52	317.56	43370.4609	50423.4375	0.00
48	1950	00:02:29	221.11		24445.2129		0.00
48	1968	00:02:29	271.98	316.59	36987.7344	50113.6992	0.00
49	2000	00:02:32	190.96		18232.5059		0.00
49	2009	00:02:32	252.69	311.83	31925.6367	48617.7305	0.00
50	2050	00:02:35	234.15	314.28	27413.2891	49387.4453	0.00
51	2091	00:02:38	304.34	313.29	46311.0273	49076.7031	0.00
52	2100	00:02:38	285.26		40686.6797		0.00
52	2132	00:02:41	342.11	312.74	58520.8281	48904.1914	0.00
53	2150	00:02:41	243.53		29652.6914		0.00

53	2173	00:02:44	269.00	309.39	36179.3867	47861.5117	0.00
54	2200	00:02:44	250.61		31403.5586		0.00
54	2214	00:02:47	215.18	311.02	23151.2305	48368.1797	0.00
55	2250	00:02:50	247.26		30568.7422		0.00
55	2255	00:02:50	267.83	307.37	35866.3125	47238.5273	0.00
56	2296	00:02:53	204.24	306.66	20857.9414	47021.0703	0.00
57	2300	00:02:53	251.71		31678.7813		0.00
57	2337	00:02:55	293.10	305.42	42953.0469	46640.6055	0.00
58	2350	00:02:56	241.95		29269.0234		0.00
58	2378	00:02:59	232.63	307.95	27057.6641	47417.6680	0.00
59	2400	00:02:59	233.76		27320.9961		0.00
59	2419	00:03:02	218.43	303.11	23855.0234	45936.3867	0.00
60	2450	00:03:02	284.29		40411.4063		0.00
60	2460	00:03:02	298.29	307.42	44488.7344	47254.2031	0.00
61	2500	00:03:05	293.36		43030.0977		0.00
61	2501	00:03:05	292.66	304.06	42826.2617	46226.8945	0.00
62	2542	00:03:08	239.61	305.84	28707.2285	46769.8516	0.00
63	2550	00:03:08	281.01		39483.3125		0.00
63	2583	00:03:10	205.35	301.29	21083.9746	45388.5742	0.00
64	2600	00:03:10	228.45		26095.8242		0.00
64	2624	00:03:13	233.52	300.50	27265.5723	45150.8438	0.00
65	2650	00:03:16	259.24		33601.4375		0.00
65	2665	00:03:16	238.65	303.02	28477.8418	45909.2813	0.00
66	2700	00:03:19	281.56		39636.6992		0.00
66	2706	00:03:19	241.71	300.05	29211.0742	45015.0703	0.00
67	2747	00:03:22	293.25	299.43	42997.6953	44830.6406	0.00
68	2750	00:03:22	267.40		35750.4922		0.00
68	2788	00:03:25	310.01	300.73	48051.8047	45218.2461	0.00
69	2800	00:03:25	250.99		31498.6094		0.00
69	2829	00:03:28	360.29	300.39	64905.9141	45116.7148	0.00
70	2850	00:03:29	270.34		36542.3789		0.00
70	2870	00:03:31	262.00	300.06	34322.7695	45018.8555	0.00
71	2900	00:03:32	198.07		19616.5469		0.00
71	2911	00:03:34	275.65	297.60	37991.7461	44283.8984	0.00
72	2950	00:03:35	227.26		25823.5742		0.00
72	2952	00:03:37	222.96	296.18	24855.5508	43861.5781	0.00
73	2993	00:03:39	180.44	300.22	16280.0264	45064.5273	0.00
74	3000	00:03:39	293.16		42971.4766		0.00
74	3034	00:03:40	319.99	298.67	51197.2070	44602.3281	0.00
75	3050	00:03:42	270.88		36687.4414		0.00
75	3075	00:03:42	240.55	293.34	28931.6680	43025.1875	0.00
76	3100	00:03:45	284.09		40352.7109		0.00
76	3116	00:03:45	275.01	294.10	37815.3203	43247.1680	0.00
77	3150	00:03:48	199.17		19833.5664		0.00
77	3157	00:03:48	258.13	298.38	33316.7031	44514.8398	0.00
78	3198	00:03:51	235.62	299.30	27759.5352	44790.8359	0.00
79	3200	00:03:51	290.36		42155.9180		0.00
79	3239	00:03:54	221.59	292.89	24550.9531	42892.2578	0.00
80	3250	00:03:54	200.51		20101.5820		0.00
80	3280	00:03:57	275.15	290.39	37853.3203	42162.8945	0.00
81	3300	00:03:59	170.63		14557.7432		0.00
81	3321	00:04:00	229.07	295.93	26236.5977	43787.3867	0.00
82	3350	00:04:02	235.25		27671.6758		0.00
82	3362	00:04:03	300.14	290.12	45042.8281	42085.3828	0.00
83	3400	00:04:05	207.94		21620.3848		0.00
83	3403	00:04:05	258.55	289.99	33423.9297	42047.5352	0.00
84	3444	00:04:08	197.95	292.86	19592.3867	42882.2383	0.00
85	3450	00:04:08	247.90		30726.1445		0.00
85	3485	00:04:11	196.11	295.94	19229.4688	43789.6133	0.00
86	3500	00:04:11	244.52		29895.9668		0.00
86	3526	00:04:14	258.73	292.06	33470.3828	42650.1367	0.00
87	3550	00:04:14	265.13		35148.1328		0.00
87	3567	00:04:17	245.55	290.00	30146.6211	42050.4375	0.00
88	3600	00:04:21	243.16		29562.3555		0.00
88	3608	00:04:21	222.75	288.98	24808.4883	41754.0352	0.00

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|      89 |        3649 |       00:04:24 |       246.05 |       288.70 |   30269.9883 |   41672.4961 |          0.00
|      90 |        3650 |       00:04:24 |       187.35 |              |   17549.5859 |              |          0.00
|      90 |        3690 |       00:04:28 |       275.90 |       289.59 |   38059.4805 |   41931.2695 |          0.00
|      91 |        3700 |       00:04:30 |       218.78 |              |   23933.2578 |              |          0.00
|      91 |        3731 |       00:04:34 |       269.93 |       286.90 |   36431.1641 |   41154.4922 |          0.00
|      92 |        3750 |       00:04:34 |       224.68 |              |   25239.9258 |              |          0.00
|      92 |        3772 |       00:04:37 |       260.92 |       290.08 |   34039.1641 |   42073.0078 |          0.00
|      93 |        3800 |       00:04:39 |       208.31 |              |   21696.1719 |              |          0.00
|      93 |        3813 |       00:04:40 |       216.40 |       289.56 |   23414.7383 |   41922.2461 |          0.00
|      94 |        3850 |       00:04:43 |       239.55 |              |   28693.0020 |              |          0.00
|      94 |        3854 |       00:04:43 |       238.04 |       291.16 |   28332.1797 |   42387.5469 |          0.00
|      95 |        3895 |       00:04:47 |       193.89 |       290.29 |   18796.5371 |   42133.9063 |          0.00
|      96 |        3900 |       00:04:47 |       265.61 |              |   35274.7266 |              |          0.00
|      96 |        3936 |       00:04:50 |       173.82 |       287.31 |   15106.1602 |   41273.3320 |          0.00
|=========|=============|================|==============|==============|==============|==============|==============
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    234.5800
this_RMSE_val = single

    287.3093
ans =
'2, 2 end'
ans =
'2, 3 start'
```
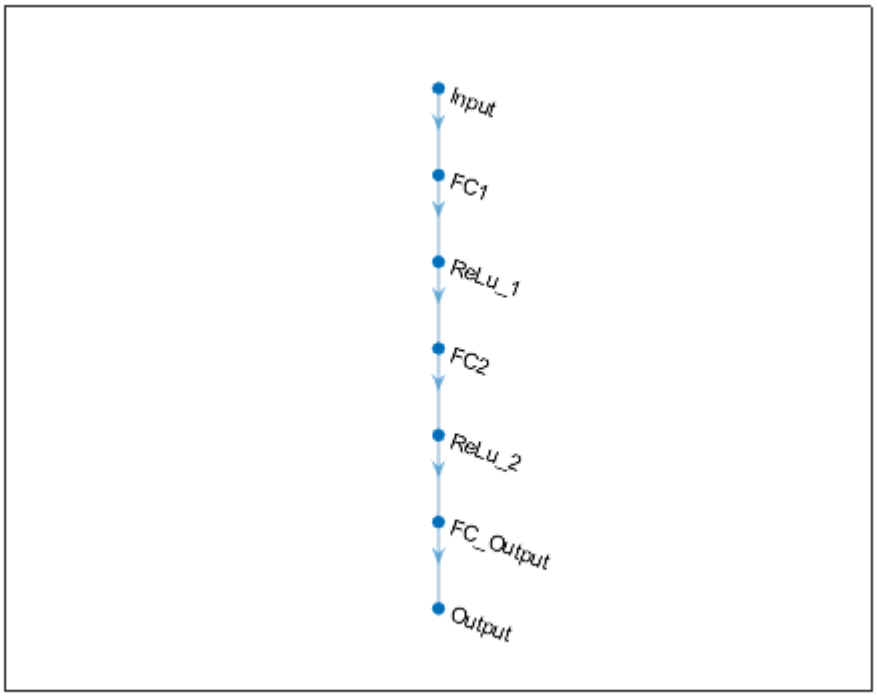



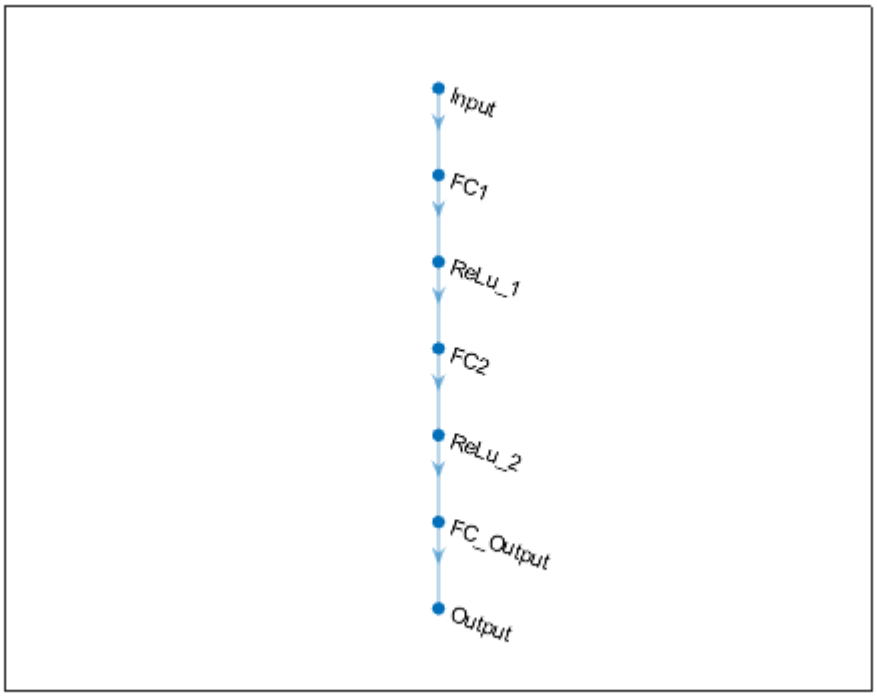

```
Training on single CPU.
|=========|=============|================|==============|==============|==============|==============|==============
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnir
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate
```

1	1	00:00:19	999.16	965.38	499160.3750	465979.3125	0.01
1	41	00:00:24	467.87	484.88	109449.3438	117554.6797	0.01
2	50	00:00:27	358.10		64117.2656		0.01
2	82	00:00:27	527.06	421.76	138897.1719	88940.4844	0.01
3	100	00:00:30	371.55		69023.6484		0.01
3	123	00:00:31	447.60	423.15	100171.3438	89526.4063	0.01
4	150	00:00:34	363.97		66237.3281		0.01
4	164	00:00:34	457.45	404.80	104628.2813	81929.8438	0.01
5	200	00:00:36	500.15		125074.2188		0.01
5	205	00:00:36	415.34	401.07	86253.8281	80429.1172	0.01
6	246	00:00:40	337.23	404.56	56861.4375	81836.2656	0.01
7	250	00:00:40	464.97		108099.1719		0.01
7	287	00:00:43	437.77	397.20	95819.5625	78884.1250	0.01
8	300	00:00:46	469.85		110378.2344		0.01
8	328	00:00:46	425.76	392.44	90636.4531	77006.4297	0.01
9	350	00:00:49	381.98		72952.5156		0.01
9	369	00:00:49	328.67	391.57	54012.7969	76662.7422	0.01
10	400	00:00:53	344.75		59427.8672		0.01
10	410	00:00:53	418.08	390.43	87393.8281	76217.3750	0.01
11	450	00:00:56	412.27		84982.7734		0.01
11	451	00:00:56	396.73	386.30	78696.3516	74614.0469	0.01
12	492	00:00:59	365.18	384.77	66679.4922	74022.6406	0.01
13	500	00:00:59	481.78		116055.3672		0.01
13	533	00:01:02	321.66	384.94	51732.8555	74088.4453	0.01
14	550	00:01:02	387.66		75138.2734		0.01
14	574	00:01:05	381.49	387.32	72768.7188	75009.3984	0.01
15	600	00:01:05	426.31		90870.4531		0.01
15	615	00:01:08	367.68	386.18	67594.7813	74568.8594	0.01
16	650	00:01:09	390.87		76388.8438		0.01
16	656	00:01:09	336.30	384.46	56550.4531	73903.0859	0.01
17	697	00:01:12	368.14	378.96	67764.6875	71803.6094	0.01
18	700	00:01:12	374.11		69979.5781		0.01
18	738	00:01:15	252.06	378.53	31766.9180	71643.7734	0.01
19	750	00:01:15	330.98		54774.1172		0.01
19	779	00:01:18	265.29	378.30	35188.0898	71554.6797	0.01
20	800	00:01:18	401.58		80634.4609		0.01
20	820	00:01:22	389.68	378.03	75924.9453	71452.9375	0.01
21	850	00:01:26	349.36		61026.7734		0.01
21	861	00:01:26	396.47	375.39	78593.4609	70457.9609	0.01
22	900	00:01:29	267.04		35656.1211		0.01
22	902	00:01:29	332.25	370.94	55194.4102	68799.7266	0.01
23	943	00:01:32	286.67	371.51	41091.1602	69009.2422	0.01
24	950	00:01:32	280.61		39370.7930		0.01
24	984	00:01:36	364.59	369.27	66463.5078	68180.6563	0.01
25	1000	00:01:36	344.51		59343.8906		0.01
25	1025	00:01:39	359.15	363.40	64494.7734	66031.2969	0.01
26	1050	00:01:40	283.70		40242.6992		0.01
26	1066	00:01:43	256.57	360.98	32914.6133	65154.4766	0.01
27	1100	00:01:45	287.03		41194.4336		0.01
27	1107	00:01:46	334.66	361.83	55999.2422	65458.7969	0.01
28	1148	00:01:49	341.55	352.45	58326.8984	62111.9883	0.01
29	1150	00:01:49	357.72		63982.4570		0.01
29	1189	00:01:52	302.21	354.45	45665.6875	62818.1914	0.01
30	1200	00:01:52	307.68		47332.0273		0.01
30	1230	00:01:55	316.70	349.60	50150.6211	61109.2422	0.01
31	1250	00:01:55	324.73		52726.0391		0.00
31	1271	00:01:58	261.85	344.03	34281.5000	59179.2773	0.00
32	1300	00:01:58	281.19		39534.7070		0.00
32	1312	00:01:58	259.74	344.36	33732.3789	59291.8672	0.00
33	1350	00:02:01	387.73		75165.6719		0.00
33	1353	00:02:02	290.18	342.10	42101.4336	58516.8477	0.00
34	1394	00:02:05	305.80	338.25	46757.5117	57206.5039	0.00
35	1400	00:02:07	338.02		57129.5625		0.00
35	1435	00:02:08	266.27	337.27	35450.8125	56877.1758	0.00

36	1450	00:02:11	348.96		60886.5391		0.00
36	1476	00:02:11	282.65	335.41	39946.0547	56248.6953	0.00
37	1500	00:02:14	309.96		48036.7500		0.00
37	1517	00:02:14	313.86	334.19	49252.9688	55842.0703	0.00
38	1550	00:02:17	311.09		48389.1250		0.00
38	1558	00:02:18	346.24	332.50	59940.6211	55277.1836	0.00
39	1599	00:02:21	309.99	349.27	48046.1016	60993.1094	0.00
40	1600	00:02:21	344.76		59428.9453		0.00
40	1640	00:02:24	276.25	333.79	38156.8516	55708.6133	0.00
41	1650	00:02:24	272.82		37216.0156		0.00
41	1681	00:02:27	220.56	329.27	24322.4082	54207.8398	0.00
42	1700	00:02:27	273.21		37322.9609		0.00
42	1722	00:02:30	298.66	330.05	44598.5430	54467.1719	0.00
43	1750	00:02:30	214.28		22957.3477		0.00
43	1763	00:02:33	268.94	331.88	36164.5195	55072.0742	0.00
44	1800	00:02:36	245.23		30068.8828		0.00
44	1804	00:02:36	257.33	331.58	33109.2813	54973.1523	0.00
45	1845	00:02:39	260.82	328.34	34012.6563	53902.6523	0.00
46	1850	00:02:39	294.99		43510.1484		0.00
46	1886	00:02:42	247.58	327.85	30648.0000	53743.3945	0.00
47	1900	00:02:43	265.91		35354.0234		0.00
47	1927	00:02:43	357.19	323.88	63793.5547	52447.7305	0.00
48	1950	00:02:46	200.20		20040.1055		0.00
48	1968	00:02:46	243.44	323.32	29630.9590	52266.9922	0.00
49	2000	00:02:49	352.19		62017.1641		0.00
49	2009	00:02:50	240.60	331.84	28943.0254	55059.4453	0.00
50	2050	00:02:53	283.90	325.90	40299.3281	53105.4297	0.00
51	2091	00:02:56	254.62	323.69	32414.9258	52388.1094	0.00
52	2100	00:02:56	299.62		44885.8203		0.00
52	2132	00:02:59	207.12	320.23	21449.3066	51274.3164	0.00
53	2150	00:02:59	320.25		51281.4531		0.00
53	2173	00:03:02	310.91	320.26	48332.4727	51284.6953	0.00
54	2200	00:03:05	233.72		27313.0313		0.00
54	2214	00:03:05	348.95	320.09	60884.4844	51229.2148	0.00
55	2250	00:03:08	286.60		41069.5781		0.00
55	2255	00:03:08	301.21	318.43	45363.0938	50699.1641	0.00
56	2296	00:03:11	414.94	322.51	86085.8906	52007.3594	0.00
57	2300	00:03:11	280.33		39293.7031		0.00
57	2337	00:03:15	192.01	316.72	18433.9492	50156.1289	0.00
58	2350	00:03:15	167.21		13978.9814		0.00
58	2378	00:03:18	255.17	317.30	32557.0039	50340.3125	0.00
59	2400	00:03:18	295.28		43595.8711		0.00
59	2419	00:03:20	292.99	330.54	42922.3984	54629.2617	0.00
60	2450	00:03:21	285.73		40819.4688		0.00
60	2460	00:03:23	276.26	322.62	38158.8828	52042.8867	0.00
61	2500	00:03:27	299.60		44879.6016		0.00
61	2501	00:03:27	244.84	316.93	29972.3984	50221.6992	0.00
62	2542	00:03:30	313.46	313.72	49129.7773	49210.1914	0.00
63	2550	00:03:30	213.22		22730.4805		0.00
63	2583	00:03:33	281.05	313.40	39495.3125	49109.4375	0.00
64	2600	00:03:33	305.36		46622.4570		0.00
64	2624	00:03:36	183.01	315.03	16746.2559	49622.1055	0.00
65	2650	00:03:37	211.90		22450.5156		0.00
65	2665	00:03:37	256.38	313.94	32865.6406	49280.4063	0.00
66	2700	00:03:40	245.71		30186.7520		0.00
66	2706	00:03:40	298.00	312.93	44401.1094	48963.2266	0.00
67	2747	00:03:42	317.36	310.41	50359.6875	48176.1914	0.00
68	2750	00:03:42	318.28		50651.3789		0.00
68	2788	00:03:46	345.97	311.61	59846.2891	48551.8945	0.00
69	2800	00:03:46	196.95		19394.8613		0.00
69	2829	00:03:48	297.24	312.22	44174.3242	48739.1133	0.00
70	2850	00:03:49	201.43		20287.2695		0.00
70	2870	00:03:51	253.49	310.65	32128.8242	48253.1289	0.00
71	2900	00:03:54	272.73		37192.1641		0.00
71	2911	00:03:54	286.82	307.72	41134.0156	47344.4492	0.00

```
|      72 |        2950 |       00:03:57 |       290.49 |              |   42191.5742 |              |          0.00
|      72 |        2952 |       00:03:57 |       215.31 |       310.44 |   23178.7734 |   48185.8633 |          0.00
|      73 |        2993 |       00:03:58 |       220.17 |       305.98 |   24236.6738 |   46810.3672 |          0.00
|      74 |        3000 |       00:04:01 |       186.52 |              |   17394.2637 |              |          0.00
|      74 |        3034 |       00:04:01 |       259.60 |       309.93 |   33697.0391 |   48027.8008 |          0.00
|      75 |        3050 |       00:04:05 |       235.24 |              |   27669.5215 |              |          0.00
|      75 |        3075 |       00:04:05 |       275.77 |       305.36 |   38023.7617 |   46622.9492 |          0.00
|      76 |        3100 |       00:04:07 |       265.12 |              |   35144.1797 |              |          0.00
|      76 |        3116 |       00:04:08 |       251.29 |       304.54 |   31573.8633 |   46370.8906 |          0.00
|      77 |        3150 |       00:04:10 |       221.46 |              |   24522.7480 |              |          0.00
|      77 |        3157 |       00:04:10 |       201.43 |       305.25 |   20287.1406 |   46587.5586 |          0.00
|      78 |        3198 |       00:04:14 |       230.65 |       306.29 |   26598.6309 |   46907.3359 |          0.00
|      79 |        3200 |       00:04:14 |       249.72 |              |   31180.4805 |              |          0.00
|      79 |        3239 |       00:04:17 |       272.30 |       306.77 |   37072.3516 |   47055.2305 |          0.00
|      80 |        3250 |       00:04:17 |       257.87 |              |   33249.2578 |              |          0.00
|      80 |        3280 |       00:04:20 |       265.79 |       308.11 |   35322.6289 |   47466.0273 |          0.00
|      81 |        3300 |       00:04:20 |       258.74 |              |   33472.7305 |              |          0.00
|      81 |        3321 |       00:04:23 |       254.41 |       303.38 |   32363.3828 |   46018.6133 |          0.00
|      82 |        3350 |       00:04:27 |       318.33 |              |   50668.3672 |              |          0.00
|      82 |        3362 |       00:04:27 |       191.66 |       306.76 |   18367.5898 |   47051.7227 |          0.00
|      83 |        3400 |       00:04:30 |       281.10 |              |   39508.6719 |              |          0.00
|      83 |        3403 |       00:04:30 |       195.50 |       301.62 |   19110.8691 |   45486.3281 |          0.00
|      84 |        3444 |       00:04:33 |       263.52 |       309.43 |   34721.7109 |   47873.2539 |          0.00
|      85 |        3450 |       00:04:33 |       265.28 |              |   35186.7461 |              |          0.00
|      85 |        3485 |       00:04:36 |       309.52 |       301.76 |   47900.5547 |   45529.7891 |          0.00
|      86 |        3500 |       00:04:36 |       308.80 |              |   47679.7539 |              |          0.00
|      86 |        3526 |       00:04:39 |       244.78 |       301.87 |   29957.7715 |   45562.5742 |          0.00
|      87 |        3550 |       00:04:40 |       334.06 |              |   55797.0039 |              |          0.00
|      87 |        3567 |       00:04:42 |       264.73 |       301.82 |   35040.0391 |   45548.8086 |          0.00
|      88 |        3600 |       00:04:46 |       287.56 |              |   41346.6484 |              |          0.00
|      88 |        3608 |       00:04:46 |       268.57 |       300.72 |   36063.8203 |   45215.6016 |          0.00
|      89 |        3649 |       00:04:49 |       254.58 |       301.14 |   32406.6523 |   45342.4180 |          0.00
|      90 |        3650 |       00:04:49 |       291.60 |              |   42513.8633 |              |          0.00
|      90 |        3690 |       00:04:53 |       254.56 |       301.20 |   32399.9258 |   45361.6797 |          0.00
|      91 |        3700 |       00:04:53 |       253.53 |              |   32137.5703 |              |          0.00
|      91 |        3731 |       00:04:56 |       283.53 |       301.22 |   40193.9922 |   45367.7891 |          0.00
|      92 |        3750 |       00:04:56 |       252.45 |              |   31866.2852 |              |          0.00
|      92 |        3772 |       00:04:58 |       299.31 |       298.08 |   44792.9609 |   44424.7383 |          0.00
|      93 |        3800 |       00:04:59 |       272.08 |              |   37014.9375 |              |          0.00
|      93 |        3813 |       00:05:01 |       238.86 |       297.68 |   28527.1191 |   44305.3477 |          0.00
|      94 |        3850 |       00:05:01 |       336.59 |              |   56644.8750 |              |          0.00
|      94 |        3854 |       00:05:04 |       235.67 |       302.35 |   27770.7813 |   45708.3594 |          0.00
|      95 |        3895 |       00:05:07 |       258.46 |       298.07 |   33399.6836 |   44424.0273 |          0.00
|      96 |        3900 |       00:05:07 |       282.29 |              |   39844.0625 |              |          0.00
|      96 |        3936 |       00:05:08 |       315.43 |       298.95 |   49748.9766 |   44685.3320 |          0.00
|      97 |        3950 |       00:05:10 |       222.13 |              |   24671.1875 |              |          0.00
|      97 |        3977 |       00:05:10 |       237.72 |       297.62 |   28254.9863 |   44290.2930 |          0.00
|      98 |        4000 |       00:05:12 |       254.62 |              |   32416.5508 |              |          0.00
|      98 |        4018 |       00:05:13 |       248.34 |       297.77 |   30835.5469 |   44332.9922 |          0.00
|      99 |        4050 |       00:05:16 |       221.70 |              |   24575.8066 |              |          0.00
|      99 |        4059 |       00:05:16 |       243.70 |       300.64 |   29693.7949 |   45192.6133 |          0.00
|     100 |        4100 |       00:05:19 |       288.54 |       299.97 |   41626.9375 |   44992.1836 |          0.00
|     101 |        4141 |       00:05:22 |       242.71 |       299.49 |   29454.4863 |   44848.5391 |          0.00
|     102 |        4150 |       00:05:22 |       255.59 |              |   32663.9648 |              |          0.00
|     102 |        4182 |       00:05:26 |       255.01 |       297.92 |   32515.6172 |   44378.6328 |          0.00
|=========================================================================================================================================
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    244.3523
```

```
this_RMSE_val = single

    297.9216
ans =
'2, 3 end'
ans =
'3, 1 start'
```




```
Training on single CPU.
```

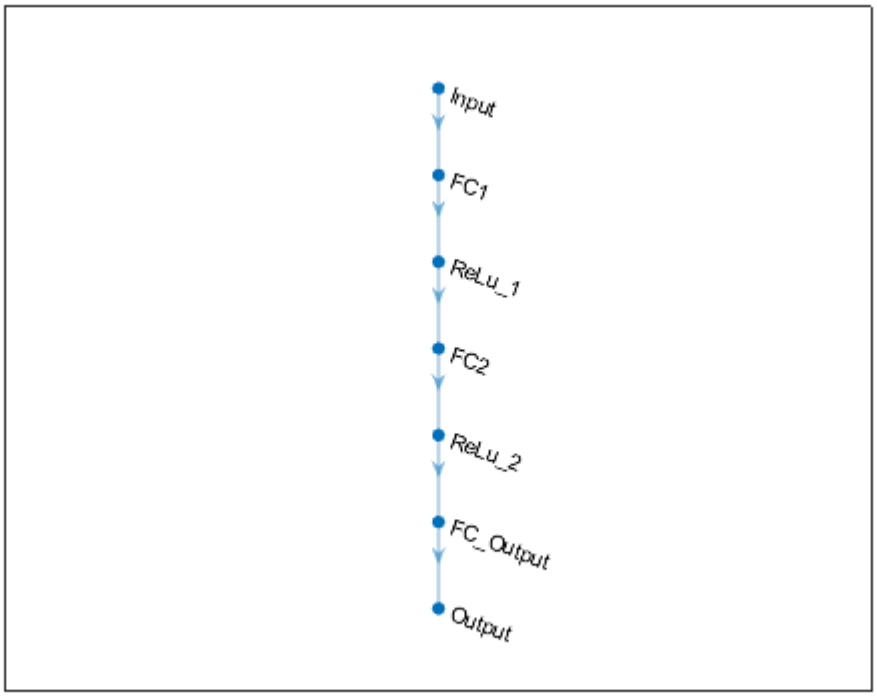
Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch RMSE	Validation RMSE	Mini-batch Loss	Validation Loss	Base Learnir Rate
1	1	00:00:20	997.55	965.83	497557.5313	466411.0625	0.01
1	41	00:00:24	441.54	544.52	97479.5938	148248.8906	0.01
2	50	00:00:24	509.52		129807.2500		0.01
2	82	00:00:28	429.47	421.85	92223.2109	88978.8047	0.01
3	100	00:00:30	448.24		100460.7266		0.01
3	123	00:00:31	402.62	412.10	81050.0000	84912.9063	0.01
4	150	00:00:34	393.55		77441.6953		0.01
4	164	00:00:34	459.31	409.57	105483.5781	83873.8828	0.01
5	200	00:00:37	429.70		92320.5078		0.01
5	205	00:00:37	388.26	402.32	75371.2188	80928.8047	0.01
6	246	00:00:41	422.35	399.09	89188.3125	79635.6875	0.01
7	250	00:00:41	377.67		71317.6953		0.01
7	287	00:00:44	417.31	396.95	87073.2813	78784.0703	0.01
8	300	00:00:44	366.93		67319.0469		0.01
8	328	00:00:47	493.13	393.22	121590.9219	77310.2188	0.01
9	350	00:00:47	332.70		55344.3828		0.01
9	369	00:00:51	351.53	390.70	61785.5234	76323.2891	0.01
10	400	00:00:54	407.53		83040.3984		0.01
10	410	00:00:54	365.06	387.78	66633.3594	75186.5078	0.01
11	450	00:00:57	264.33		34935.7734		0.01
11	451	00:00:57	410.65	385.01	84317.4531	74115.7031	0.01
12	492	00:01:01	437.59	383.87	95741.1875	73679.5469	0.01
13	500	00:01:01	360.18		64866.1563		0.01

13	533	00:01:04	358.29	382.87	64184.8359	73294.6250	0.01
14	550	00:01:05	283.32		40135.2578		0.01
14	574	00:01:07	223.52	377.46	24979.8750	71239.1797	0.01
15	600	00:01:07	363.66		66124.9375		0.01
15	615	00:01:11	246.84	373.02	30464.8164	69573.0313	0.01
16	650	00:01:11	274.35		37633.5352		0.01
16	656	00:01:11	376.05	374.00	70705.9141	69938.7266	0.01
17	697	00:01:15	325.38	369.66	52937.4922	68325.3828	0.01
18	700	00:01:15	295.43		43640.0977		0.01
18	738	00:01:18	340.06	375.05	57821.1953	70331.7656	0.01
19	750	00:01:21	355.23		63095.8125		0.01
19	779	00:01:21	324.54	363.16	52663.6523	65942.3516	0.01
20	800	00:01:23	398.29		79318.4766		0.01
20	820	00:01:24	333.25	358.08	55529.1484	64112.3242	0.01
21	850	00:01:27	266.30		35456.8398		0.01
21	861	00:01:27	300.21	353.98	45063.7031	62649.8711	0.01
22	900	00:01:30	314.38		49417.0547		0.01
22	902	00:01:30	394.77	357.30	77923.5859	63831.2852	0.01
23	943	00:01:34	321.89	349.30	51805.3203	61005.6680	0.01
24	950	00:01:34	322.80		52100.7773		0.01
24	984	00:01:37	303.20	350.49	45966.4883	61423.3477	0.01
25	1000	00:01:37	310.02		48055.5898		0.01
25	1025	00:01:41	348.71	344.66	60799.8477	59394.3633	0.01
26	1050	00:01:41	347.26		60295.8633		0.01
26	1066	00:01:45	287.87	344.21	41433.7344	59239.1914	0.01
27	1100	00:01:48	332.56		55297.1094		0.01
27	1107	00:01:48	326.07	334.97	53160.5547	56102.4766	0.01
28	1148	00:01:51	239.78	333.62	28747.8887	55650.8906	0.01
29	1150	00:01:51	258.03		33288.9922		0.01
29	1189	00:01:54	323.70	341.36	52389.6914	58262.2891	0.01
30	1200	00:01:54	276.34		38183.1406		0.01
30	1230	00:01:57	348.65	331.52	60779.3828	54953.6289	0.01
31	1250	00:01:58	303.91		46180.4844		0.00
31	1271	00:02:00	324.79	328.02	52743.0625	53799.3984	0.00
32	1300	00:02:03	296.21		43871.1797		0.00
32	1312	00:02:03	399.98	327.78	79991.8750	53721.1172	0.00
33	1350	00:02:06	299.88		44962.7539		0.00
33	1353	00:02:06	321.70	330.60	51744.9805	54649.8008	0.00
34	1394	00:02:10	361.48	325.50	65334.3594	52976.5352	0.00
35	1400	00:02:10	363.58		66095.0781		0.00
35	1435	00:02:13	378.49	324.89	71626.0156	52776.1523	0.00
36	1450	00:02:13	264.40		34954.0078		0.00
36	1476	00:02:14	282.56	322.35	39919.8516	51953.3164	0.00
37	1500	00:02:17	267.02		35649.7852		0.00
37	1517	00:02:17	338.77	322.10	57381.6133	51873.3398	0.00
38	1550	00:02:20	292.81		42867.4336		0.00
38	1558	00:02:20	286.40	319.74	41013.5469	51116.4805	0.00
39	1599	00:02:24	210.94	322.21	22247.6035	51908.1719	0.00
40	1600	00:02:24	270.89		36690.3047		0.00
40	1640	00:02:26	335.91	320.08	56419.1680	51224.9023	0.00
41	1650	00:02:26	302.70		45813.2578		0.00
41	1681	00:02:30	250.81	315.48	31452.6934	49763.5352	0.00
42	1700	00:02:30	347.56		60398.4141		0.00
42	1722	00:02:33	282.34	316.06	39858.1992	49945.7188	0.00
43	1750	00:02:33	288.70		41674.4844		0.00
43	1763	00:02:37	270.90	316.10	36693.6719	49959.2461	0.00
44	1800	00:02:40	308.42		47562.5039		0.00
44	1804	00:02:40	214.39	315.55	22982.2695	49786.1289	0.00
45	1845	00:02:43	301.91	312.23	45574.7578	48743.4219	0.00
46	1850	00:02:43	287.91		41445.9609		0.00
46	1886	00:02:46	258.50	314.19	33410.4297	49357.1914	0.00
47	1900	00:02:46	253.69		32178.7930		0.00
47	1927	00:02:49	246.66	311.47	30421.5195	48505.7539	0.00
48	1950	00:02:50	261.14		34097.6758		0.00
48	1968	00:02:53	257.34	312.92	33110.7891	48959.5000	0.00

49	2000	00:02:53	292.43		42756.7188		0.00
49	2009	00:02:53	321.34	308.18	51631.0820	47487.4063	0.00
50	2050	00:02:57	214.26	306.49	22954.7031	46967.5234	0.00
51	2091	00:03:00	209.96	305.06	22041.7734	46529.6680	0.00
52	2100	00:03:02	195.59		19128.4941		0.00
52	2132	00:03:02	245.72	303.85	30188.3770	46162.0117	0.00
53	2150	00:03:05	227.79		25944.4180		0.00
53	2173	00:03:06	324.18	302.75	52547.8047	45827.8047	0.00
54	2200	00:03:09	173.88		15117.4043		0.00
54	2214	00:03:09	246.90	299.98	30480.1348	44992.6523	0.00
55	2250	00:03:13	290.25		42123.2617		0.00
55	2255	00:03:13	217.12	303.29	23571.1973	45992.7383	0.00
56	2296	00:03:16	184.78	298.02	17071.6582	44409.3867	0.00
57	2300	00:03:16	191.18		18274.2207		0.00
57	2337	00:03:19	267.88	297.94	35879.5469	44382.9453	0.00
58	2350	00:03:20	239.83		28759.7422		0.00
58	2378	00:03:23	233.79	302.96	27329.6621	45893.3320	0.00
59	2400	00:03:23	239.72		28731.7832		0.00
59	2419	00:03:26	231.97	298.91	26904.7266	44674.1484	0.00
60	2450	00:03:26	212.76		22633.0898		0.00
60	2460	00:03:29	256.15	295.97	32805.1797	43797.6484	0.00
61	2500	00:03:32	224.25		25145.0000		0.00
61	2501	00:03:33	266.34	293.34	35467.5742	43023.4492	0.00
62	2542	00:03:36	245.90	298.39	30233.9141	44517.7930	0.00
63	2550	00:03:36	168.14		14135.6201		0.00
63	2583	00:03:36	245.35	294.34	30099.3945	43317.3906	0.00
64	2600	00:03:39	269.41		36290.5938		0.00
64	2624	00:03:40	274.54	295.53	37686.6094	43668.2500	0.00
65	2650	00:03:43	283.01		40046.3555		0.00
65	2665	00:03:43	289.85	290.71	42007.2461	42255.5664	0.00
66	2700	00:03:47	257.97		33275.3477		0.00
66	2706	00:03:47	263.54	295.72	34726.4141	43724.3359	0.00
67	2747	00:03:50	244.04	291.89	29778.5254	42599.2813	0.00
68	2750	00:03:50	294.32		43313.3789		0.00
68	2788	00:03:54	211.08	289.36	22277.6719	41863.5352	0.00
69	2800	00:03:57	258.99		33536.6523		0.00
69	2829	00:03:57	264.39	288.95	34951.6016	41746.5781	0.00
70	2850	00:04:00	300.30		45089.1445		0.00
70	2870	00:04:00	256.02	288.48	32771.9805	41610.0313	0.00
71	2900	00:04:04	267.92		35890.7734		0.00
71	2911	00:04:04	313.90	289.59	49267.3906	41932.1992	0.00
72	2950	00:04:07	227.76		25937.5117		0.00
72	2952	00:04:07	236.48	287.57	27961.7461	41348.3984	0.00
73	2993	00:04:10	209.66	289.34	21979.5664	41859.1992	0.00
74	3000	00:04:10	234.94		27597.4688		0.00
74	3034	00:04:14	267.72	288.49	35836.9492	41612.0234	0.00
75	3050	00:04:14	232.33		26987.7266		0.00
75	3075	00:04:17	260.11	285.07	33829.1211	40632.5820	0.00
76	3100	00:04:17	263.34		34673.2461		0.00
76	3116	00:04:20	250.61	286.26	31401.8984	40973.5000	0.00
77	3150	00:04:21	233.99		27375.3496		0.00
77	3157	00:04:24	237.34	285.21	28164.6016	40671.2969	0.00
78	3198	00:04:27	222.81	284.21	24821.0898	40386.9961	0.00
79	3200	00:04:27	213.56		22803.4570		0.00
79	3239	00:04:30	266.59	288.61	35534.2852	41648.1836	0.00
80	3250	00:04:31	241.08		29059.1172		0.00
80	3280	00:04:34	248.89	287.39	30973.7734	41296.9258	0.00
81	3300	00:04:34	263.14		34622.4688		0.00
81	3321	00:04:34	197.96	288.39	19593.5254	41585.2500	0.00
82	3350	00:04:38	213.48		22786.2285		0.00
82	3362	00:04:38	270.58	287.92	36607.6250	41447.8711	0.00
83	3400	00:04:40	270.32		36535.8203		0.00
83	3403	00:04:41	233.73	287.96	27314.1602	41460.6758	0.00

this_net =

```
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    235.4986
this_RMSE_val = single

    287.9607
ans =
'3, 1 end'
ans =
'3, 2 start'
```



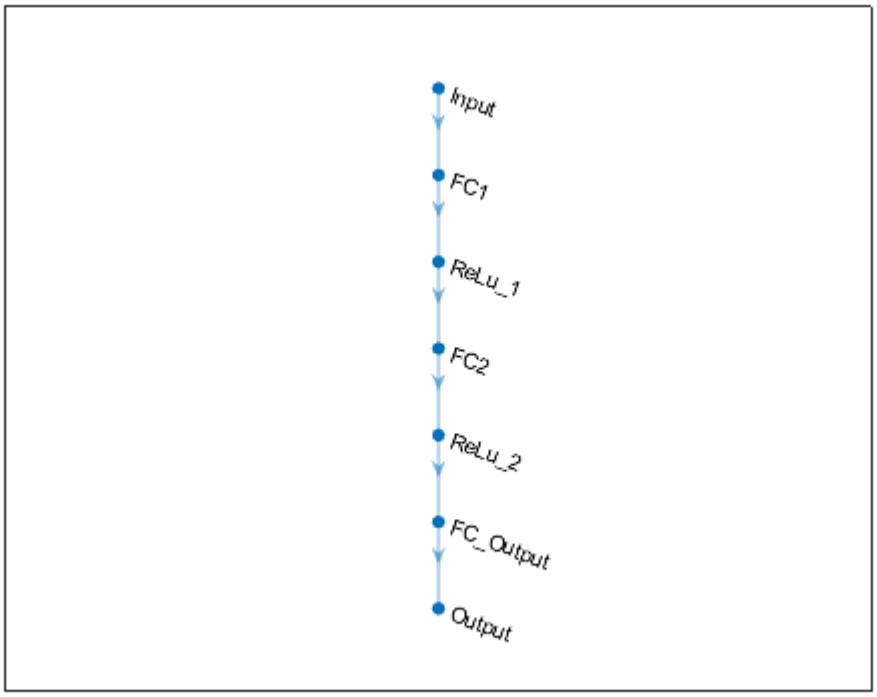

```
Training on single CPU.
|=========================================================================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnin |
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate     |
|=========================================================================================================================================|
|       1 |           1 |       00:00:21 |      1150.44 |       965.43 |  661757.3125 |  466023.8750 |          0.01 |
|       1 |          41 |       00:00:26 |       393.54 |       498.68 |   77438.7266 |  124340.0313 |          0.01 |
|       2 |          50 |       00:00:29 |       467.21 |              |  109141.6406 |              |          0.01 |
|       2 |          82 |       00:00:30 |       514.16 |       421.68 |  132182.7656 |   88908.6250 |          0.01 |
|       3 |         100 |       00:00:33 |       284.48 |              |   40464.0391 |              |          0.01 |
|       3 |         123 |       00:00:33 |       386.16 |       411.76 |   74560.1641 |   84774.3516 |          0.01 |
|       4 |         150 |       00:00:37 |       437.41 |              |   95663.6016 |              |          0.01 |
|       4 |         164 |       00:00:37 |       416.65 |       404.84 |   86799.0469 |   81947.4609 |          0.01 |
|       5 |         200 |       00:00:41 |       385.11 |              |   74154.0469 |              |          0.01 |
|       5 |         205 |       00:00:41 |       491.35 |       407.54 |  120711.3906 |   83045.6797 |          0.01 |
|       6 |         246 |       00:00:45 |       328.49 |       397.86 |   53954.1680 |   79144.9141 |          0.01 |
|       7 |         250 |       00:00:45 |       314.41 |              |   49427.4141 |              |          0.01 |
|       7 |         287 |       00:00:48 |       420.61 |       394.99 |   88454.4922 |   78008.0156 |          0.01 |
|       8 |         300 |       00:00:49 |       347.01 |              |   60207.3359 |              |          0.01 |
|       8 |         328 |       00:00:52 |       434.87 |       393.68 |   94557.8984 |   77490.6797 |          0.01 |
```

9	350	00:00:55	305.93		46796.8125		0.01
9	369	00:00:56	298.90	391.68	44670.1875	76708.4609	0.01
10	400	00:00:59	356.02		63374.9609		0.01
10	410	00:00:59	397.10	387.47	78842.3125	75067.5938	0.01
11	450	00:01:03	340.49		57966.3789		0.01
11	451	00:01:03	335.26	388.23	56198.3203	75361.2813	0.01
12	492	00:01:06	312.50	387.67	48828.6953	75142.1875	0.01
13	500	00:01:06	431.01		92886.1250		0.01
13	533	00:01:10	321.78	382.35	51770.9375	73095.0313	0.01
14	550	00:01:10	332.04		55125.6094		0.01
14	574	00:01:13	419.41	383.01	87951.2578	73347.9531	0.01
15	600	00:01:14	277.71		38562.5156		0.01
15	615	00:01:17	360.63	381.64	65026.1094	72823.6719	0.01
16	650	00:01:20	354.01		62661.0000		0.01
16	656	00:01:21	391.21	379.61	76523.7656	72050.7813	0.01
17	697	00:01:24	316.03	378.14	49937.1875	71496.1641	0.01
18	700	00:01:24	359.48		64613.0859		0.01
18	738	00:01:27	390.61	377.92	76286.2813	71411.6953	0.01
19	750	00:01:27	422.25		89149.4844		0.01
19	779	00:01:30	304.92	376.52	46489.4141	70885.3828	0.01
20	800	00:01:30	418.07		87389.3516		0.01
20	820	00:01:31	349.73	374.07	61156.8398	69964.5938	0.01
21	850	00:01:34	333.59		55639.8633		0.01
21	861	00:01:34	318.87	371.31	50838.8281	68934.0938	0.01
22	900	00:01:37	336.50		56615.9844		0.01
22	902	00:01:38	365.12	368.12	66655.0000	67756.6250	0.01
23	943	00:01:41	350.34	367.09	61370.6953	67378.9063	0.01
24	950	00:01:41	353.25		62391.0547		0.01
24	984	00:01:45	317.77	360.14	50488.3555	64850.7695	0.01
25	1000	00:01:45	318.14		50605.0195		0.01
25	1025	00:01:49	434.99	357.67	94607.8594	63964.7070	0.01
26	1050	00:01:52	332.37		55235.9063		0.01
26	1066	00:01:53	326.94	358.85	53445.0820	64385.7070	0.01
27	1100	00:01:56	327.06		53482.6563		0.01
27	1107	00:01:56	367.68	350.54	67594.8750	61437.5547	0.01
28	1148	00:02:00	358.36	349.34	64209.3438	61020.9297	0.01
29	1150	00:02:00	318.72		50789.9141		0.01
29	1189	00:02:03	304.59	344.82	46387.2500	59449.1133	0.01
30	1200	00:02:04	323.84		52436.0273		0.01
30	1230	00:02:07	287.09	350.80	41209.1719	61528.7930	0.01
31	1250	00:02:07	392.90		77186.5781		0.00
31	1271	00:02:10	336.20	345.82	56515.0078	59797.2930	0.00
32	1300	00:02:11	353.97		62647.3281		0.00
32	1312	00:02:14	354.89	343.30	62972.5469	58928.7656	0.00
33	1350	00:02:18	318.93		50857.3672		0.00
33	1353	00:02:18	288.42	344.54	41592.7227	59355.5234	0.00
34	1394	00:02:21	365.24	341.56	66699.2578	58332.2148	0.00
35	1400	00:02:21	317.42		50378.3242		0.00
35	1435	00:02:22	366.33	339.73	67098.2813	57707.2891	0.00
36	1450	00:02:25	302.18		45657.0234		0.00
36	1476	00:02:25	332.53	340.46	55286.9492	57956.4570	0.00
37	1500	00:02:29	315.55		49784.7031		0.00
37	1517	00:02:29	379.95	339.49	72181.9297	57625.9766	0.00
38	1550	00:02:32	318.28		50651.4063		0.00
38	1558	00:02:32	264.12	338.53	34880.7422	57301.1133	0.00
39	1599	00:02:36	349.18	337.35	60962.5508	56901.9766	0.00
40	1600	00:02:36	297.00		44104.3711		0.00
40	1640	00:02:39	311.80	338.03	48610.3711	57131.9492	0.00
41	1650	00:02:39	348.76		60817.9180		0.00
41	1681	00:02:43	321.35	337.33	51631.6523	56896.0117	0.00
42	1700	00:02:43	360.16		64856.6289		0.00
42	1722	00:02:46	307.23	333.89	47196.5547	55740.5859	0.00
43	1750	00:02:47	342.52		58658.3945		0.00
43	1763	00:02:50	370.24	332.36	68537.0391	55230.7773	0.00
44	1800	00:02:50	299.48		44845.2891		0.00

44	1804	00:02:54	281.61	333.57	39652.9922	55635.1680	0.00
45	1845	00:02:57	202.49	331.33	20501.3867	54888.4453	0.00
46	1850	00:02:57	260.01		33802.8477		0.00
46	1886	00:03:01	350.33	331.29	61363.8867	54875.3516	0.00
47	1900	00:03:01	252.62		31908.3711		0.00
47	1927	00:03:04	298.28	335.70	44484.6484	56348.7070	0.00
48	1950	00:03:05	236.85		28049.1387		0.00
48	1968	00:03:05	313.52	334.00	49147.1953	55778.6914	0.00
49	2000	00:03:08	315.61		49805.2266		0.00
49	2009	00:03:09	283.17	327.80	40093.3555	53726.5000	0.00
50	2050	00:03:12	318.41	327.81	50691.5195	53730.9688	0.00
51	2091	00:03:15	371.01	329.12	68823.3906	54158.4375	0.00
52	2100	00:03:15	274.26		37608.5000		0.00
52	2132	00:03:19	270.06	327.06	36466.0859	53485.6367	0.00
53	2150	00:03:19	230.61		26590.8984		0.00
53	2173	00:03:23	288.13	328.18	41510.1875	53852.6016	0.00
54	2200	00:03:23	244.74		29949.5000		0.00
54	2214	00:03:26	296.01	328.57	43812.0938	53979.4141	0.00
55	2250	00:03:30	358.29		64187.4688		0.00
55	2255	00:03:30	282.57	326.52	39923.9258	53308.9219	0.00
56	2296	00:03:30	282.12	326.55	39796.0195	53318.6133	0.00
57	2300	00:03:33	316.11		49963.4531		0.00
57	2337	00:03:34	301.92	324.25	45577.7266	52567.9531	0.00
58	2350	00:03:37	253.97		32250.7168		0.00
58	2378	00:03:38	316.45	323.82	50069.6719	52430.9258	0.00
59	2400	00:03:41	268.28		35986.5742		0.00
59	2419	00:03:41	299.54	326.65	44860.7617	53349.9102	0.00
60	2450	00:03:44	348.08		60578.5391		0.00
60	2460	00:03:45	298.98	325.51	44695.4297	52977.3633	0.00
61	2500	00:03:47	365.35		66739.8125		0.00
61	2501	00:03:47	275.93	319.38	38069.3359	51001.8281	0.00
62	2542	00:03:51	300.99	324.78	45296.8008	52740.1445	0.00
63	2550	00:03:51	288.59		41641.6406		0.00
63	2583	00:03:54	317.38	319.67	50365.0430	51094.7109	0.00
64	2600	00:03:55	228.98		26216.1582		0.00
64	2624	00:03:58	297.47	319.04	44244.4531	50894.6953	0.00
65	2650	00:04:02	251.68		31670.3613		0.00
65	2665	00:04:02	266.71	319.24	35566.1367	50957.5508	0.00
66	2700	00:04:06	270.80		36666.9883		0.00
66	2706	00:04:06	230.32	325.09	26523.5664	52841.8320	0.00
67	2747	00:04:10	256.91	318.52	33001.9180	50726.5703	0.00
68	2750	00:04:10	341.12		58181.5430		0.00
68	2788	00:04:12	268.63	317.44	36080.6016	50384.4727	0.00
69	2800	00:04:12	249.67		31167.4512		0.00
69	2829	00:04:16	281.24	320.47	39548.0000	51351.4141	0.00
70	2850	00:04:16	247.45		30615.1914		0.00
70	2870	00:04:20	271.42	317.70	36835.2500	50467.1758	0.00
71	2900	00:04:20	288.04		41483.5859		0.00
71	2911	00:04:23	382.73	318.15	73241.4375	50610.8711	0.00
72	2950	00:04:27	273.32		37351.5742		0.00
72	2952	00:04:27	271.53	314.60	36863.5703	49486.1445	0.00
73	2993	00:04:30	255.92	315.55	32748.2539	49784.7539	0.00
74	3000	00:04:30	331.87		55069.5391		0.00
74	3034	00:04:31	276.49	317.05	38224.7305	50261.0430	0.00
75	3050	00:04:34	208.04		21640.8066		0.00
75	3075	00:04:34	320.45	316.09	51342.9531	49957.2930	0.00
76	3100	00:04:38	238.22		28375.4023		0.00
76	3116	00:04:38	278.77	314.26	38855.6445	49378.6367	0.00
77	3150	00:04:41	285.47		40747.4453		0.00
77	3157	00:04:42	254.59	315.22	32408.4883	49682.8789	0.00
78	3198	00:04:45	281.35	313.54	39579.2266	49152.4258	0.00
79	3200	00:04:45	270.46		36574.3125		0.00
79	3239	00:04:48	288.08	314.65	41493.8281	49503.8672	0.00
80	3250	00:04:48	248.68		30921.8496		0.00
80	3280	00:04:52	228.92	314.61	26202.2910	49489.5820	0.00

```
|      81 |        3300 |       00:04:55 |       186.92 |              |   17470.2852 |              |          0.00
|      81 |        3321 |       00:04:56 |       356.41 |       315.89 |   63513.3867 |   49892.9531 |          0.00
|      82 |        3350 |       00:04:59 |       243.80 |              |   29718.4707 |              |          0.00
|      82 |        3362 |       00:04:59 |       269.18 |       310.78 |   36229.2500 |   48290.8281 |          0.00
|      83 |        3400 |       00:05:03 |       286.64 |              |   41082.0547 |              |          0.00
|      83 |        3403 |       00:05:03 |       246.14 |       313.17 |   30291.7715 |   49037.0781 |          0.00
|      84 |        3444 |       00:05:07 |       272.98 |       312.74 |   37258.6172 |   48902.8125 |          0.00
|      85 |        3450 |       00:05:07 |       313.31 |              |   49081.7734 |              |          0.00
|      85 |        3485 |       00:05:10 |       230.49 |       310.03 |   26562.8242 |   48057.8711 |          0.00
|      86 |        3500 |       00:05:11 |       345.27 |              |   59604.2891 |              |          0.00
|      86 |        3526 |       00:05:14 |       255.42 |       311.83 |   32619.2617 |   48619.6211 |          0.00
|      87 |        3550 |       00:05:14 |       256.72 |              |   32953.7969 |              |          0.00
|      87 |        3567 |       00:05:18 |       302.06 |       310.37 |   45619.1406 |   48165.0117 |          0.00
|      88 |        3600 |       00:05:18 |       288.29 |              |   41555.9180 |              |          0.00
|      88 |        3608 |       00:05:18 |       171.64 |       311.86 |   14730.7891 |   48627.7930 |          0.00
|      89 |        3649 |       00:05:22 |       281.55 |       320.78 |   39635.6563 |   51450.1953 |          0.00
|      90 |        3650 |       00:05:22 |       290.69 |              |   42249.6289 |              |          0.00
|      90 |        3690 |       00:05:25 |       245.14 |       309.38 |   30045.7441 |   47858.0781 |          0.00
|      91 |        3700 |       00:05:28 |       348.65 |              |   60777.4766 |              |          0.00
|      91 |        3731 |       00:05:29 |       290.14 |       307.49 |   42091.7930 |   47276.4375 |          0.00
|      92 |        3750 |       00:05:32 |       276.38 |              |   38193.7266 |              |          0.00
|      92 |        3772 |       00:05:33 |       246.48 |       309.87 |   30375.0645 |   48009.9063 |          0.00
|      93 |        3800 |       00:05:35 |       235.83 |              |   27807.2227 |              |          0.00
|      93 |        3813 |       00:05:36 |       254.27 |       309.67 |   32325.5293 |   47948.4648 |          0.00
|      94 |        3850 |       00:05:39 |       289.11 |              |   41793.4102 |              |          0.00
|      94 |        3854 |       00:05:40 |       244.87 |       311.39 |   29980.4922 |   48483.1016 |          0.00
|      95 |        3895 |       00:05:42 |       264.03 |       311.20 |   34855.0664 |   48423.9414 |          0.00
|      96 |        3900 |       00:05:42 |       283.70 |              |   40243.7695 |              |          0.00
|      96 |        3936 |       00:05:46 |       303.07 |       306.12 |   45927.0703 |   46853.9297 |          0.00
|      97 |        3950 |       00:05:46 |       294.35 |              |   43320.7344 |              |          0.00
|      97 |        3977 |       00:05:50 |       264.85 |       305.97 |   35072.2578 |   46808.0977 |          0.00
|      98 |        4000 |       00:05:50 |       273.20 |              |   37318.5078 |              |          0.00
|      98 |        4018 |       00:05:53 |       290.21 |       308.88 |   42110.5859 |   47703.5352 |          0.00
|      99 |        4050 |       00:05:57 |       279.89 |              |   39169.5781 |              |          0.00
|      99 |        4059 |       00:05:57 |       249.55 |       310.45 |   31136.9570 |   48189.0703 |          0.00
|     100 |        4100 |       00:06:00 |       303.15 |       310.42 |   45950.0820 |   48179.5781 |          0.00
|     101 |        4141 |       00:06:03 |       235.70 |       306.03 |   27777.5039 |   46827.1602 |          0.00
|     102 |        4150 |       00:06:03 |       250.61 |              |   31401.5469 |              |          0.00
|     102 |        4182 |       00:06:06 |       306.36 |       304.83 |   46928.6602 |   46459.9883 |          0.00
|     103 |        4200 |       00:06:06 |       262.36 |              |   34417.4258 |              |          0.00
|     103 |        4223 |       00:06:09 |       272.36 |       303.95 |   37091.0586 |   46193.6563 |          0.00
|     104 |        4250 |       00:06:10 |       301.62 |              |   45488.5078 |              |          0.00
|     104 |        4264 |       00:06:10 |       174.87 |       303.65 |   15290.0166 |   46101.8633 |          0.00
|     105 |        4300 |       00:06:13 |       220.51 |              |   24311.7773 |              |          0.00
|     105 |        4305 |       00:06:13 |       243.57 |       305.57 |   29662.8887 |   46686.0156 |          0.00
|     106 |        4346 |       00:06:16 |       344.77 |       304.02 |   59432.2656 |   46215.3633 |          0.00
|     107 |        4350 |       00:06:16 |       261.30 |              |   34138.3438 |              |          0.00
|     107 |        4387 |       00:06:19 |       255.74 |       305.97 |   32702.3418 |   46809.4688 |          0.00
|     108 |        4400 |       00:06:19 |       249.04 |              |   31010.8301 |              |          0.00
|     108 |        4428 |       00:06:22 |       246.52 |       306.70 |   30386.7070 |   47032.8281 |          0.00
|     109 |        4450 |       00:06:25 |       272.70 |              |   37183.4414 |              |          0.00
|     109 |        4469 |       00:06:25 |       255.11 |       312.41 |   32541.2871 |   48798.7070 |          0.00
|=========================================================================================================================================
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single

    261.5881
this_RMSE_val = single

    312.4059
```

```
ans =
'3, 2 end'
ans =
'3, 3 start'
```




```
Training on single CPU.
|=========================================================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learnin|
|         |             |   (hh:mm:ss)   |     RMSE     |     RMSE     |     Loss     |     Loss     |      Rate    |
|=========================================================================================================================|
|       1 |           1 |       00:00:22 |       872.19 |       965.72 |  380353.7500 |  466303.4063 |         0.01 |
|       1 |          41 |       00:00:26 |       487.99 |       547.97 |  119068.2813 |  150135.7969 |         0.01 |
|       2 |          50 |       00:00:31 |       603.60 |              |  182164.5000 |              |         0.01 |
|       2 |          82 |       00:00:31 |       363.62 |       422.66 |   66111.0313 |   89319.6172 |         0.01 |
|       3 |         100 |       00:00:34 |       448.78 |              |  100703.8438 |              |         0.01 |
|       3 |         123 |       00:00:35 |       340.75 |       412.49 |   58056.8867 |   85074.7891 |         0.01 |
|       4 |         150 |       00:00:38 |       371.43 |              |   68981.8125 |              |         0.01 |
|       4 |         164 |       00:00:38 |       401.89 |       407.71 |   80757.0391 |   83113.9766 |         0.01 |
|       5 |         200 |       00:00:41 |       471.03 |              |  110936.3438 |              |         0.01 |
|       5 |         205 |       00:00:41 |       440.34 |       405.28 |   96948.3203 |   82125.0078 |         0.01 |
|       6 |         246 |       00:00:45 |       375.21 |       402.50 |   70392.7266 |   81001.2266 |         0.01 |
|       7 |         250 |       00:00:45 |       377.01 |              |   71066.7344 |              |         0.01 |
|       7 |         287 |       00:00:48 |       401.50 |       397.92 |   80599.6406 |   79169.7031 |         0.01 |
|       8 |         300 |       00:00:49 |       351.31 |              |   61709.5391 |              |         0.01 |
|       8 |         328 |       00:00:52 |       315.52 |       395.51 |   49774.8594 |   78212.6641 |         0.01 |
|       9 |         350 |       00:00:52 |       363.61 |              |   66105.9297 |              |         0.01 |
|       9 |         369 |       00:00:56 |       372.95 |       397.29 |   69546.1641 |   78920.5313 |         0.01 |
|      10 |         400 |       00:00:56 |       422.13 |              |   89098.6563 |              |         0.01 |
|      10 |         410 |       00:01:00 |       372.37 |       387.48 |   69328.0391 |   75071.7578 |         0.01 |
|      11 |         450 |       00:01:03 |       331.31 |              |   54881.7891 |              |         0.01 |
|      11 |         451 |       00:01:03 |       430.00 |       386.48 |   92448.9219 |   74683.6641 |         0.01 |
|      12 |         492 |       00:01:07 |       383.82 |       387.27 |   73660.5156 |   74989.3594 |         0.01 |
|      13 |         500 |       00:01:07 |       434.83 |              |   94540.4531 |              |         0.01 |
|      13 |         533 |       00:01:11 |       363.06 |       389.38 |   65905.9141 |   75807.7578 |         0.01 |
|      14 |         550 |       00:01:11 |       291.21 |              |   42400.5156 |              |         0.01 |
|      14 |         574 |       00:01:15 |       313.34 |       376.08 |   49090.6445 |   70718.2969 |         0.01 |
```

```
|      15 |         600 |       00:01:15 |       283.09 |              |   40069.4258 |              |          0.01
|      15 |         615 |       00:01:19 |       317.70 |       370.66 |   50466.2773 |   68694.8750 |          0.01
|      16 |         650 |       00:01:22 |       478.64 |              |  114548.8281 |              |          0.01
|      16 |         656 |       00:01:23 |       292.04 |       368.74 |   42644.5195 |   67984.0234 |          0.01
|      17 |         697 |       00:01:26 |       273.25 |       362.43 |   37331.8164 |   65679.2500 |          0.01
|      18 |         700 |       00:01:27 |       330.06 |              |   54470.8125 |              |          0.01
|      18 |         738 |       00:01:31 |       366.86 |       362.53 |   67291.5625 |   65714.9453 |          0.01
|      19 |         750 |       00:01:31 |       351.65 |              |   61830.5078 |              |          0.01
|      19 |         779 |       00:01:35 |       372.67 |       357.90 |   69439.7422 |   64045.3086 |          0.01
|      20 |         800 |       00:01:35 |       348.56 |              |   60747.7891 |              |          0.01
|      20 |         820 |       00:01:38 |       311.87 |       355.67 |   48632.5664 |   63250.6484 |          0.01
|      21 |         850 |       00:01:38 |       325.61 |              |   53010.9883 |              |          0.01
|      21 |         861 |       00:01:42 |       377.06 |       353.75 |   71087.0859 |   62568.1836 |          0.01
|      22 |         900 |       00:01:45 |       289.93 |              |   42029.4805 |              |          0.01
|      22 |         902 |       00:01:45 |       360.80 |       352.10 |   65087.2578 |   61985.7188 |          0.01
|      23 |         943 |       00:01:49 |       351.45 |       353.49 |   61757.5469 |   62477.9141 |          0.01
|      24 |         950 |       00:01:49 |       288.52 |              |   41621.4570 |              |          0.01
|      24 |         984 |       00:01:53 |       359.92 |       347.76 |   64772.8633 |   60468.7695 |          0.01
|      25 |        1000 |       00:01:53 |       316.68 |              |   50141.9766 |              |          0.01
|      25 |        1025 |       00:01:57 |       344.21 |       346.42 |   59240.0156 |   60003.8594 |          0.01
|      26 |        1050 |       00:01:57 |       266.08 |              |   35399.8008 |              |          0.01
|      26 |        1066 |       00:02:01 |       308.04 |       340.28 |   47444.0234 |   57896.4141 |          0.01
|      27 |        1100 |       00:02:02 |       262.41 |              |   34429.2578 |              |          0.01
|      27 |        1107 |       00:02:02 |       376.94 |       347.63 |   71041.0078 |   60423.8633 |          0.01
|      28 |        1148 |       00:02:06 |       235.82 |       340.66 |   27806.6172 |   58024.7734 |          0.01
|      29 |        1150 |       00:02:06 |       288.37 |              |   41577.5469 |              |          0.01
|      29 |        1189 |       00:02:11 |       274.78 |       341.44 |   37752.4922 |   58291.5117 |          0.01
|      30 |        1200 |       00:02:15 |       280.64 |              |   39380.6875 |              |          0.01
|      30 |        1230 |       00:02:15 |       286.07 |       331.55 |   40917.4727 |   54962.3398 |          0.01
|      31 |        1250 |       00:02:19 |       253.28 |              |   32074.2500 |              |          0.00
|      31 |        1271 |       00:02:20 |       254.67 |       331.94 |   32428.0625 |   55092.9141 |          0.00
|      32 |        1300 |       00:02:23 |       280.85 |              |   39439.5664 |              |          0.00
|      32 |        1312 |       00:02:23 |       273.97 |       331.02 |   37529.7578 |   54785.5625 |          0.00
|      33 |        1350 |       00:02:27 |       318.69 |              |   50781.0039 |              |          0.00
|      33 |        1353 |       00:02:27 |       350.35 |       330.15 |   61373.2734 |   54501.0430 |          0.00
|      34 |        1394 |       00:02:31 |       316.76 |       330.49 |   50168.4922 |   54613.2734 |          0.00
|      35 |        1400 |       00:02:31 |       286.34 |              |   40994.3125 |              |          0.00
|      35 |        1435 |       00:02:35 |       432.63 |       327.52 |   93583.0313 |   53633.4961 |          0.00
|      36 |        1450 |       00:02:38 |       306.28 |              |   46902.3984 |              |          0.00
|      36 |        1476 |       00:02:38 |       348.77 |       328.54 |   60819.3008 |   53968.8750 |          0.00
|      37 |        1500 |       00:02:41 |       263.33 |              |   34671.6875 |              |          0.00
|      37 |        1517 |       00:02:41 |       276.58 |       325.65 |   38246.8789 |   53023.6875 |          0.00
|      38 |        1550 |       00:02:45 |       264.11 |              |   34878.1094 |              |          0.00
|      38 |        1558 |       00:02:45 |       308.89 |       325.73 |   47706.9609 |   53050.0742 |          0.00
|      39 |        1599 |       00:02:49 |       292.55 |       320.25 |   42792.8672 |   51281.4219 |          0.00
|      40 |        1600 |       00:02:49 |       306.39 |              |   46936.6797 |              |          0.00
|      40 |        1640 |       00:02:53 |       249.97 |       318.61 |   31241.2715 |   50755.6797 |          0.00
|      41 |        1650 |       00:02:53 |       311.57 |              |   48537.3438 |              |          0.00
|      41 |        1681 |       00:02:56 |       252.65 |       320.63 |   31916.3945 |   51403.3242 |          0.00
|      42 |        1700 |       00:02:59 |       281.11 |              |   39512.6758 |              |          0.00
|      42 |        1722 |       00:03:00 |       228.00 |       320.41 |   25991.5430 |   51331.0820 |          0.00
|      43 |        1750 |       00:03:03 |       242.23 |              |   29337.5898 |              |          0.00
|      43 |        1763 |       00:03:03 |       243.17 |       320.42 |   29565.2578 |   51335.2461 |          0.00
|      44 |        1800 |       00:03:07 |       299.54 |              |   44862.7422 |              |          0.00
|      44 |        1804 |       00:03:07 |       313.89 |       320.97 |   49262.2734 |   51509.7656 |          0.00
|      45 |        1845 |       00:03:11 |       261.94 |       319.64 |   34307.2578 |   51083.6797 |          0.00
|=========================================================================================================================================
this_net =
  SeriesNetwork with properties:

         Layers: [7×1 nnet.cnn.layer.Layer]
     InputNames: {'Input'}
    OutputNames: {'Output'}
this_RMSE_train = single
```

```
    281.1486
this_RMSE_val = single

    319.6363
ans =
'3, 3 end'
```

```
Step5RMSE_val
```

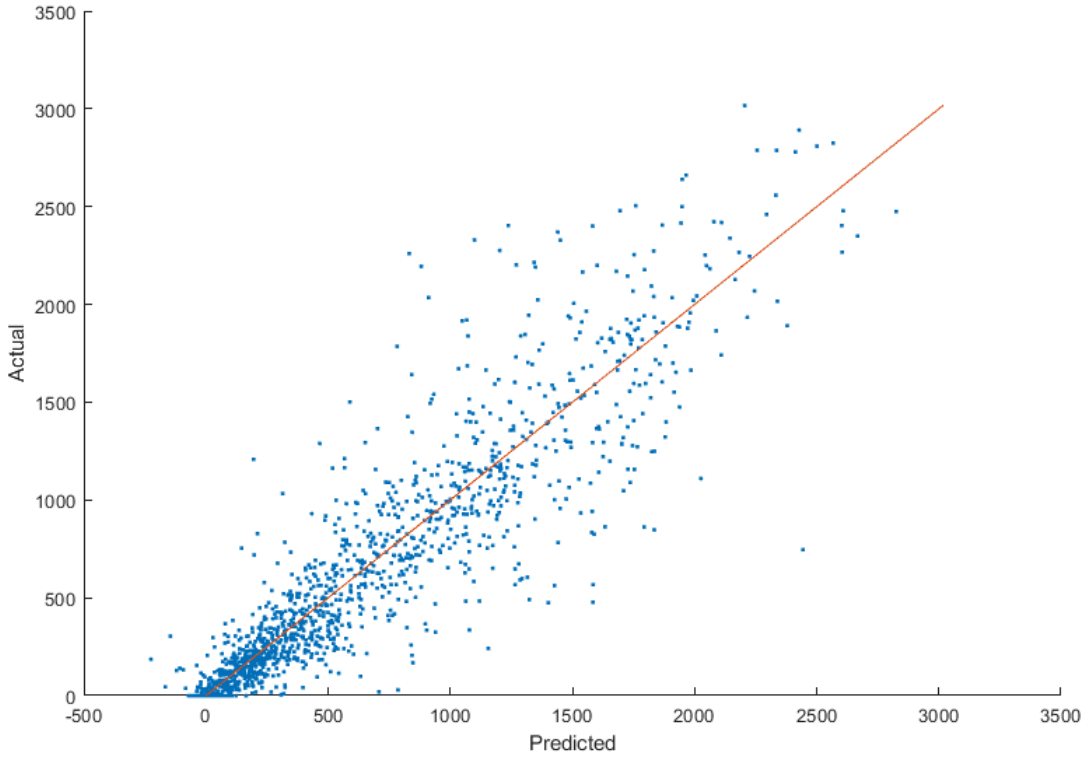
```
Step5RMSE_val = 3×3 single matrix
  296.7996  309.8829  284.6856
  295.1994  287.3093  297.9216
  287.9607  312.4059  319.6363
```

```
RMSE_val_twohiddenlayers
```

```
RMSE_val_twohiddenlayers = single

    282.6697
```

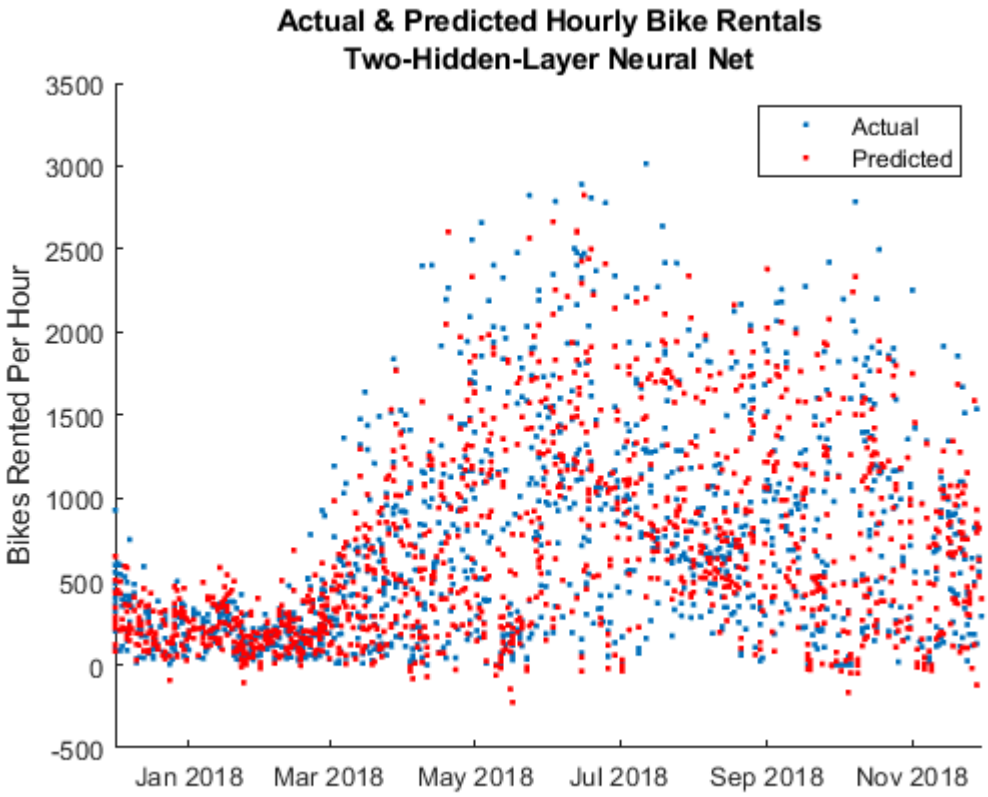
The first two-hidden-layer model achieved the lowest RMSE.

```
% Step 6: Select best model and calculate RMSE of test set

% best model = net_twohiddenlayers
y_hat_test_best = predict(net_twohiddenlayers, scaled_input_test);

RMSE_test_best = sqrt(mean((output_test-y_hat_test_best).^2));

figure('Renderer', 'painters', 'Position', [10 10 900 600])
scatter(y_hat_test_best, output_test,'.')
hold on
plot(output_test,output_test)
xlabel('Predicted')
ylabel('Actual')
```



This model is a marked improvement from the linear regression model, though the high values of Bikes Rented remain harder to predict than the lower values.

```
dateslist_test = datetime(input_test(:,1),'ConvertFrom','datenum');

figure
scatter(dateslist_test,output_test,'.')
hold on
scatter(dateslist_test,y_hat_test_best,'.r')
title({'Actual & Predicted Hourly Bike Rentals','Two-Hidden-Layer Neural Net'})
ylabel('Bikes Rented Per Hour')
legend({'Actual','Predicted'})
```

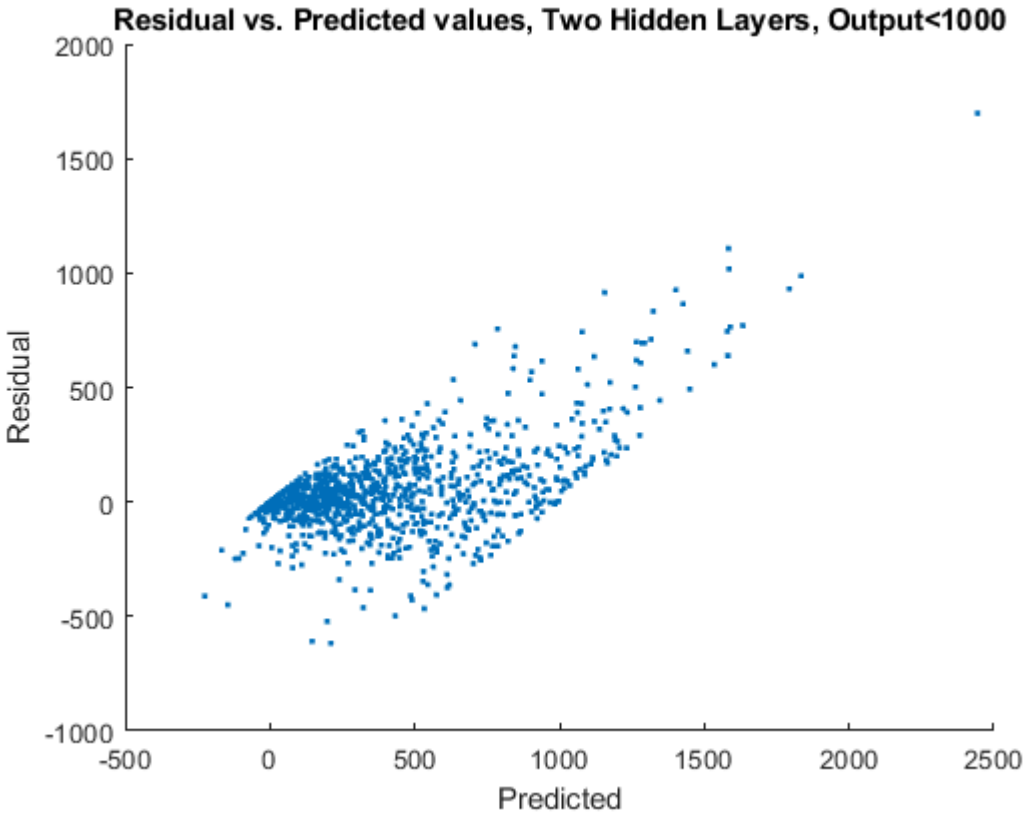



```
output_test_lt1000 = output_test;
y_hat_test_best_lt1000 = y_hat_test_best;
output_test_gt1000_idx = find(output_test>1000);
output_test_lt1000(output_test_gt1000_idx,:)=[]; % keep only data for which the true output is
y_hat_test_best_lt1000(output_test_gt1000_idx,:)=[];
RMSE_test_best_lt1000 = sqrt(mean((output_test_lt1000-y_hat_test_best_lt1000).^2))
```

```
RMSE_test_best_lt1000 = single

    211.0835
```

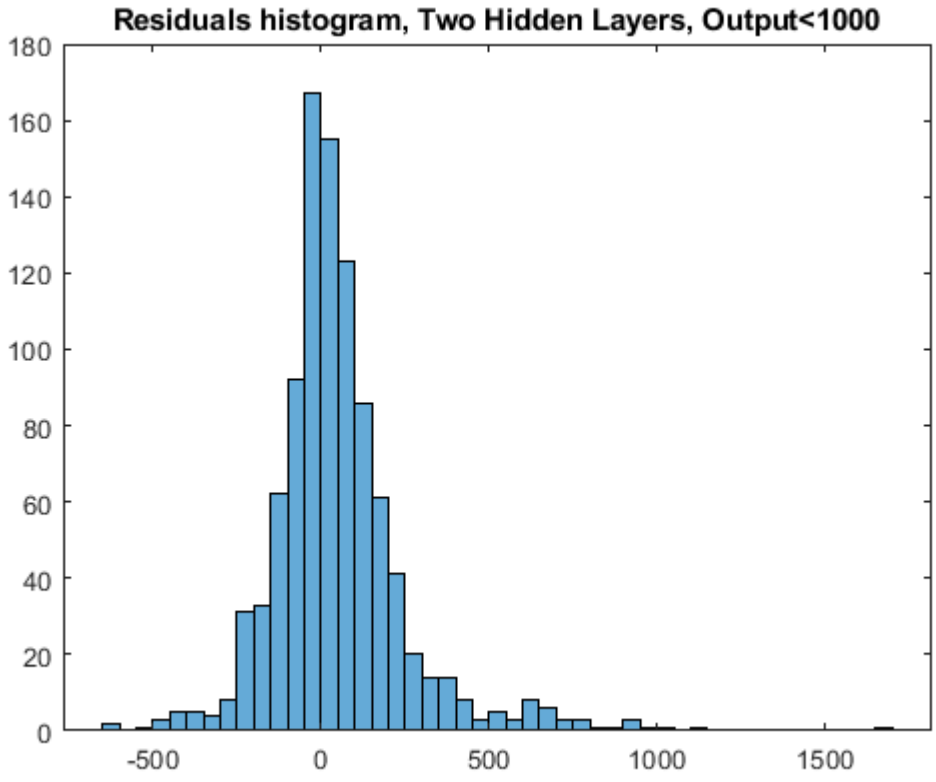
For the data where the true output was less than 1000 Bikes Rented, the RMSE of this model is 211 (compared to 283 when all of the data is included).

```
residual_2layer_lt1000 = y_hat_test_best_lt1000-output_test_lt1000;
figure
scatter(y_hat_test_best_lt1000,residual_2layer_lt1000,'.')
title('Residual vs. Predicted values, Two Hidden Layers, Output<1000')
xlabel('Predicted')
ylabel('Residual')
```

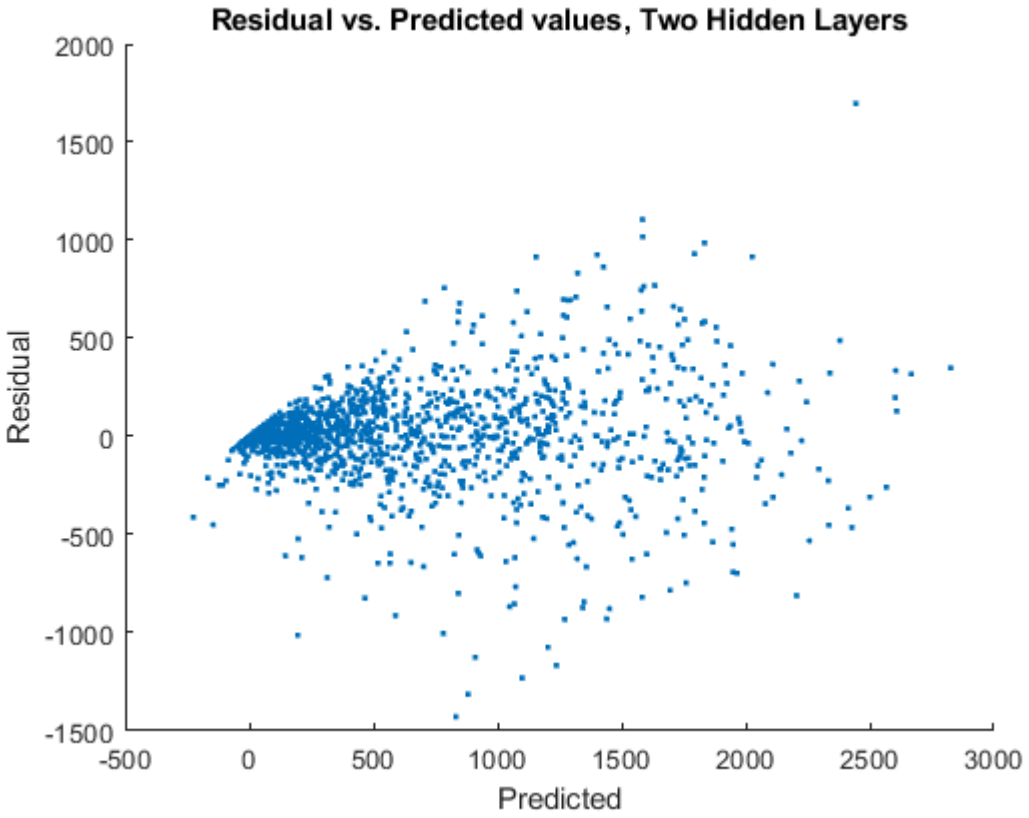


For the data where the true output was less than 1000, the residuals are linearly correlated with the predicted number of Bikes Rented.

```
figure
histogram(residual_2layer_lt1000)
title('Residuals histogram, Two Hidden Layers, Output<1000')
```

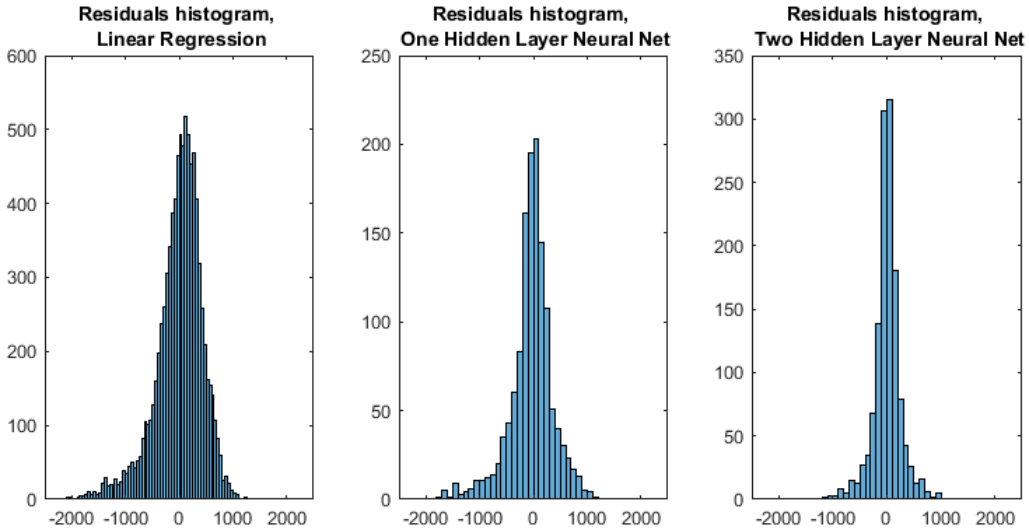



```
residual_2layer = y_hat_test_best-output_test;
figure
scatter(y_hat_test_best,residual_2layer,'.')
title('Residual vs. Predicted values, Two Hidden Layers')
xlabel('Predicted')
ylabel('Residual')
```



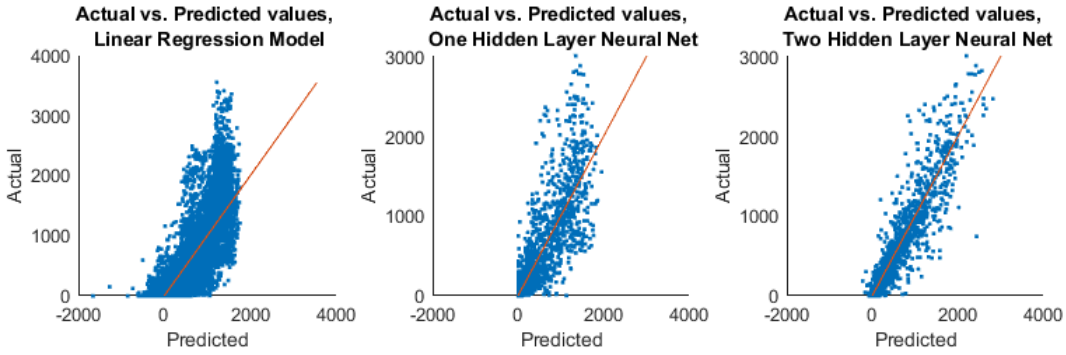
The scatter plot of residuals vs. predicted shows a cone pattern, i.e. heteroscedasticity, i.e. there is room for improvement.

```
y_hat_test_1layer = predict(net_10, scaled_input_test);
RMSE_test_1layer = sqrt(mean((output_test-y_hat_test_1layer).^2));
residual_1layer = y_hat_test_1layer-output_test;

figure('Renderer', 'painters', 'Position', [10 10 900 400])
subplot(1,3,1)
histogram(residual)
xlim([-2500 2500])
title(sprintf('Residuals histogram, \n Linear Regression'))
subplot(1,3,2)
histogram(residual_1layer)
xlim([-2500 2500])
title(sprintf('Residuals histogram, \n One Hidden Layer Neural Net'))
subplot(1,3,3)
histogram(residual_2layer)
xlim([-2500 2500])
title(sprintf('Residuals histogram, \n Two Hidden Layer Neural Net'))
```

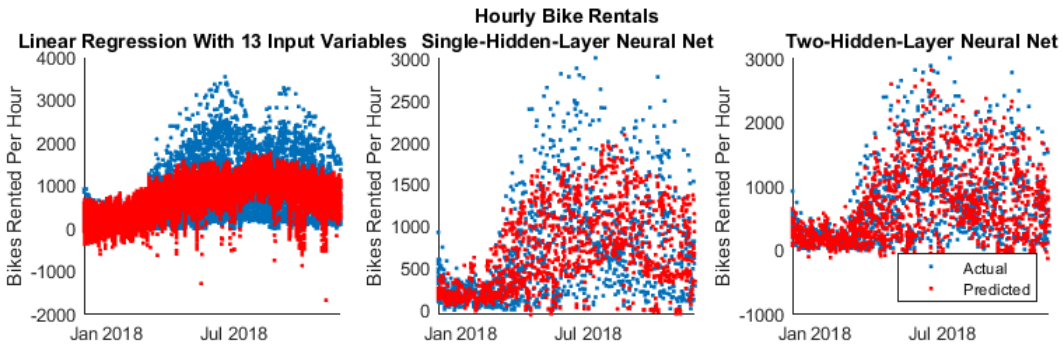


Although the best two-hidden-layer neural net achieved here is not as accurate as desired, improvement from the linear regression model is still evident. The histogram of the residuals gets narrower as the model becomes more complex.

```
figure('Renderer', 'painters', 'Position', [10 10 900 250])
subplot(1,3,1)
scatter(predicted, datasetOutputs,'.')
hold on
plot(datasetOutputs,datasetOutputs)
title(sprintf('Actual vs. Predicted values, \n Linear Regression Model'))
xlabel('Predicted')
ylabel('Actual')
xlim([-2000 4000])
subplot(1,3,2)
scatter(y_hat_test_1layer, output_test,'.')
hold on
plot(output_test,output_test)
title(sprintf('Actual vs. Predicted values, \n One Hidden Layer Neural Net'))
xlabel('Predicted')
ylabel('Actual')
xlim([-2000 4000])
subplot(1,3,3)
scatter(y_hat_test_best, output_test,'.')
hold on
plot(output_test,output_test)
title(sprintf('Actual vs. Predicted values, \n Two Hidden Layer Neural Net'))
xlabel('Predicted')
ylabel('Actual')
xlim([-2000 4000])
```




```
y_hat_test_best_sgl = predict(net_100, scaled_input_test);

figure('Renderer', 'painters', 'Position', [10 10 900 250])
subplot(1,3,1)
scatter(dateslist,datasetOutputs,'.')
hold on
scatter(dateslist,predicted,'.r')
title({'Linear Regression With 13 Input Variables'})
ylabel('Bikes Rented Per Hour')
%legend({'Actual','Predicted'})
subplot(1,3,2)
scatter(dateslist_test,output_test,'.')
hold on
scatter(dateslist_test,y_hat_test_best_sgl,'.r')
title({'Hourly Bike Rentals','Single-Hidden-Layer Neural Net'})
ylabel('Bikes Rented Per Hour')
%legend({'Actual','Predicted'})
subplot(1,3,3)
scatter(dateslist_test,output_test,'.')
hold on
scatter(dateslist_test,y_hat_test_best,'.r')
title({'Two-Hidden-Layer Neural Net'})
ylabel('Bikes Rented Per Hour')
legend({'Actual','Predicted'},'Location','Southeast')
```



The two-hidden-layer model is much better at predicting the trend in the number of Bikes Rented, as compared to the linear regression model and one-hidden-layer model. To further improve the model, the number of nodes per layer could be increased or a different type of activation layer could be used.