Tut6_memo

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Write a code for the following problems:

Q1. Use the package neuralnet and NeuralNetTools. Install it if not installed in your computer. Now consider the mtcars dataset. Create a neural network model to predict the miles per gallon (mpg) of cars in the mtcars dataset based on the displacement (disp) and horsepower (hp) of the cars. Follow the steps below: 1. Call the package. 2. Load the dataset. 3. Scale the dataset. 4. Create a neural network model using the neuralnet() function and save the output in a variable. 5. Print the output using the print() function. 6. Predict the mpg using the compute() function. 7. Then create a neural network plot using the plotnet() function.

Then calculate the mean square error (MSE) for the above model. To calculate the Mean Squared Error (MSE) for the above neural network model, you can use the predict function to generate predictions and then compare these to the actual values.

```
library(neuralnet)
library(NeuralNetTools)
data(mtcars)

# Scale the data
maxs <- apply(mtcars, 2, max)
mins <- apply(mtcars, 2, min)
scaled_mtcars <- as.data.frame(scale(mtcars, center = mins, scale = maxs -
mins))

# Fit the neural network model
set.seed(12345)
nn <- neuralnet(mpg ~ disp + hp, data = scaled_mtcars, hidden = 2)

# Print summary and visualize
print(nn)
```

```
## $call
## neuralnet(formula = mpg ~ disp + hp, data = scaled_mtcars, hidden = 2)
##
## $response
##                           mpg
## Mazda RX4           0.4510638
## Mazda RX4 Wag       0.4510638
## Datsun 710          0.5276596
```

```
## Hornet 4 Drive      0.4680851
## Hornet Sportabout   0.3531915
## Valiant             0.3276596
## Duster 360          0.1659574
## Merc 240D           0.5957447
## Merc 230            0.5276596
## Merc 280            0.3744681
## Merc 280C           0.3148936
## Merc 450SE          0.2553191
## Merc 450SL          0.2936170
## Merc 450SLC         0.2042553
## Cadillac Fleetwood  0.0000000
## Lincoln Continental 0.0000000
## Chrysler Imperial   0.1829787
## Fiat 128            0.9361702
## Honda Civic         0.8510638
## Toyota Corolla      1.0000000
## Toyota Corona       0.4723404
## Dodge Challenger    0.2170213
## AMC Javelin         0.2042553
## Camaro Z28          0.1234043
## Pontiac Firebird    0.3744681
## Fiat X1-9           0.7191489
## Porsche 914-2       0.6638298
## Lotus Europa        0.8510638
## Ford Pantera L      0.2297872
## Ferrari Dino        0.3957447
## Maserati Bora       0.1957447
## Volvo 142E          0.4680851
##
## $covariate
##                           disp         hp
## Mazda RX4           0.22175106 0.20494700
## Mazda RX4 Wag       0.22175106 0.20494700
## Datsun 710          0.09204290 0.14487633
## Hornet 4 Drive      0.46620105 0.20494700
## Hornet Sportabout   0.72062859 0.43462898
## Valiant             0.38388626 0.18727915
## Duster 360          0.72062859 0.68197880
## Merc 240D           0.18857570 0.03533569
## Merc 230            0.17385882 0.15194346
## Merc 280            0.24070841 0.25088339
## Merc 280C           0.24070841 0.25088339
## Merc 450SE          0.51060115 0.45229682
## Merc 450SL          0.51060115 0.45229682
## Merc 450SLC         0.51060115 0.45229682
## Cadillac Fleetwood  1.00000000 0.54063604
## Lincoln Continental 0.97006735 0.57597173
## Chrysler Imperial   0.92017960 0.62897527
## Fiat 128            0.01895735 0.04946996
```

```
## Honda Civic         0.01147418 0.00000000
## Toyota Corolla      0.00000000 0.04593640
## Toyota Corona       0.12222499 0.15901060
## Dodge Challenger    0.61586431 0.34628975
## AMC Javelin         0.58094288 0.34628975
## Camaro Z28          0.69568471 0.68197880
## Pontiac Firebird    0.82040409 0.43462898
## Fiat X1-9           0.01970566 0.04946996
## Porsche 914-2       0.12272387 0.13780919
## Lotus Europa        0.05986530 0.21554770
## Ford Pantera L      0.69817910 0.74911661
## Ferrari Dino        0.18433525 0.43462898
## Maserati Bora       0.57345972 1.00000000
## Volvo 142E          0.12446994 0.20141343
##
## $model.list
## $model.list$response
## [1] "mpg"
##
## $model.list$variables
## [1] "disp" "hp"
##
##
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x000000001fc6c340>
## <environment: 0x000000001fc6ac80>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x000000001fc678a8>
## <environment: 0x000000001fc66fb0>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##                           mpg cyl       disp         hp       drat
wt
## Mazda RX4           0.4510638 0.5 0.22175106 0.20494700 0.52534562
```

```
0.28304781
## Mazda RX4 Wag       0.4510638 0.5 0.22175106 0.20494700 0.52534562
0.34824853
## Datsun 710          0.5276596 0.0 0.09204290 0.14487633 0.50230415
0.20634109
## Hornet 4 Drive      0.4680851 0.5 0.46620105 0.20494700 0.14746544
0.43518282
## Hornet Sportabout   0.3531915 1.0 0.72062859 0.43462898 0.17972350
0.49271286
## Valiant             0.3276596 0.5 0.38388626 0.18727915 0.00000000
0.49782664
## Duster 360          0.1659574 1.0 0.72062859 0.68197880 0.20737327
0.52595244
## Merc 240D           0.5957447 0.0 0.18857570 0.03533569 0.42857143
0.42879059
## Merc 230            0.5276596 0.0 0.17385882 0.15194346 0.53456221
0.41856303
## Merc 280            0.3744681 0.5 0.24070841 0.25088339 0.53456221
0.49271286
## Merc 280C           0.3148936 0.5 0.24070841 0.25088339 0.53456221
0.49271286
## Merc 450SE          0.2553191 1.0 0.51060115 0.45229682 0.14285714
0.65379698
## Merc 450SL          0.2936170 1.0 0.51060115 0.45229682 0.14285714
0.56686269
## Merc 450SLC         0.2042553 1.0 0.51060115 0.45229682 0.14285714
0.57964715
## Cadillac Fleetwood  0.0000000 1.0 1.00000000 0.54063604 0.07834101
0.95551010
## Lincoln Continental 0.0000000 1.0 0.97006735 0.57597173 0.11059908
1.00000000
## Chrysler Imperial   0.1829787 1.0 0.92017960 0.62897527 0.21658986
0.97980056
## Fiat 128            0.9361702 0.0 0.01895735 0.04946996 0.60829493
0.17565840
## Honda Civic         0.8510638 0.0 0.01147418 0.00000000 1.00000000
0.02608029
## Toyota Corolla      1.0000000 0.0 0.00000000 0.04593640 0.67281106
0.08233188
## Toyota Corona       0.4723404 0.0 0.12222499 0.15901060 0.43317972
0.24341601
## Dodge Challenger    0.2170213 1.0 0.61586431 0.34628975 0.00000000
0.51316799
## AMC Javelin         0.2042553 1.0 0.58094288 0.34628975 0.17972350
0.49143442
## Camaro Z28          0.1234043 1.0 0.69568471 0.68197880 0.44700461
0.59498849
## Pontiac Firebird    0.3744681 1.0 0.82040409 0.43462898 0.14746544
0.59626694
## Fiat X1-9           0.7191489 0.0 0.01970566 0.04946996 0.60829493
```

```
0.10790079
## Porsche 914-2       0.6638298 0.0 0.12272387 0.13780919 0.76958525
0.16031705
## Lotus Europa        0.8510638 0.0 0.05986530 0.21554770 0.46543779
0.00000000
## Ford Pantera L      0.2297872 1.0 0.69817910 0.74911661 0.67281106
0.42367681
## Ferrari Dino        0.3957447 0.5 0.18433525 0.43462898 0.39631336
0.32140118
## Maserati Bora       0.1957447 1.0 0.57345972 1.00000000 0.35944700
0.52595244
## Volvo 142E          0.4680851 0.0 0.12446994 0.20141343 0.62211982
0.32395807
##                           qsec vs am gear      carb
## Mazda RX4           0.23333333  0  1  0.5 0.4285714
## Mazda RX4 Wag       0.30000000  0  1  0.5 0.4285714
## Datsun 710          0.48928571  1  1  0.5 0.0000000
## Hornet 4 Drive      0.58809524  1  0  0.0 0.0000000
## Hornet Sportabout   0.30000000  0  0  0.0 0.1428571
## Valiant             0.68095238  1  0  0.0 0.0000000
## Duster 360          0.15952381  0  0  0.0 0.4285714
## Merc 240D           0.65476190  1  0  0.5 0.1428571
## Merc 230            1.00000000  1  0  0.5 0.1428571
## Merc 280            0.45238095  1  0  0.5 0.4285714
## Merc 280C           0.52380952  1  0  0.5 0.4285714
## Merc 450SE          0.34523810  0  0  0.0 0.2857143
## Merc 450SL          0.36904762  0  0  0.0 0.2857143
## Merc 450SLC         0.41666667  0  0  0.0 0.2857143
## Cadillac Fleetwood  0.41428571  0  0  0.0 0.4285714
## Lincoln Continental 0.39523810  0  0  0.0 0.4285714
## Chrysler Imperial   0.34761905  0  0  0.0 0.4285714
## Fiat 128            0.59166667  1  1  0.5 0.0000000
## Honda Civic         0.47857143  1  1  0.5 0.1428571
## Toyota Corolla      0.64285714  1  1  0.5 0.0000000
## Toyota Corona       0.65595238  1  0  0.0 0.0000000
## Dodge Challenger    0.28214286  0  0  0.0 0.1428571
## AMC Javelin         0.33333333  0  0  0.0 0.1428571
## Camaro Z28          0.10833333  0  0  0.0 0.4285714
## Pontiac Firebird    0.30357143  0  0  0.0 0.1428571
## Fiat X1-9           0.52380952  1  1  0.5 0.0000000
## Porsche 914-2       0.26190476  0  1  1.0 0.1428571
## Lotus Europa        0.28571429  1  1  1.0 0.1428571
## Ford Pantera L      0.00000000  0  1  1.0 0.4285714
## Ferrari Dino        0.11904762  0  1  1.0 0.7142857
## Maserati Bora       0.01190476  0  1  1.0 1.0000000
## Volvo 142E          0.48809524  1  1  0.5 0.1428571
##
## $exclude
## NULL
##
```

```
## $net.result
## $net.result[[1]]
##                           [,1]
## Mazda RX4           0.42184184
## Mazda RX4 Wag       0.42184184
## Datsun 710          0.64380473
## Hornet 4 Drive      0.33444979
## Hornet Sportabout   0.22461018
## Valiant             0.35629309
## Duster 360          0.18061349
## Merc 240D           0.48147148
## Merc 230            0.48026018
## Merc 280            0.40296401
## Merc 280C           0.40296401
## Merc 450SE          0.29154665
## Merc 450SL          0.29154665
## Merc 450SLC         0.29154665
## Cadillac Fleetwood  0.09933257
## Lincoln Continental 0.10423581
## Chrysler Imperial   0.11353670
## Fiat 128            0.86649834
## Honda Civic         0.89709715
## Toyota Corolla      0.91077284
## Toyota Corona       0.56879390
## Dodge Challenger    0.27457060
## AMC Javelin         0.28539310
## Camaro Z28          0.19014274
## Pontiac Firebird    0.18741204
## Fiat X1-9           0.86468489
## Porsche 914-2       0.57322128
## Lotus Europa        0.70740127
## Ford Pantera L      0.17698460
## Ferrari Dino        0.42076475
## Maserati Bora       0.17912652
## Volvo 142E          0.55330749
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##           [,1]      [,2]
## [1,] -1.085499 -3.082977
## [2,] 15.493586  2.767810
## [3,]  1.591692  1.315673
##
## $weights[[1]][[2]]
##            [,1]
## [1,]  1.1195829
## [2,] -0.6861368
## [3,] -0.5589443
```

```
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##                           [,1]       [,2]
## Mazda RX4             -3.195287 -0.5405825
## Mazda RX4 Wag         -3.195287 -0.5405825
## Datsun 710           -11.113565 -1.2983304
## Hornet 4 Drive        -1.095704 -0.4931870
## Hornet Sportabout     -2.080202 -0.9883427
## Valiant               -1.099463 -0.4246247
## Duster 360            -2.590689 -1.2310997
## Merc 240D             -5.275380 -0.7018338
## Merc 230              -5.472189 -0.7380027
## Merc 280              -2.550942 -0.4973866
## Merc 280C             -2.550942 -0.4973866
## Merc 450SE            -1.448330 -0.6783357
## Merc 450SL            -1.448330 -0.6783357
## Merc 450SLC           -1.448330 -0.6783357
## Cadillac Fleetwood    -4.157807 -1.9763950
## Lincoln Continental   -4.011069 -1.9066386
## Chrysler Imperial     -3.762422 -1.7884321
## Fiat 128             -20.908481 -2.3802481
## Honda Civic          -24.310542 -2.7667736
## Toyota Corolla       -26.414790 -3.0276333
## Toyota Corona         -8.706789 -1.0543361
## Dodge Challenger      -1.587232 -0.7520523
## AMC Javelin           -1.488953 -0.7036861
## Camaro Z28            -2.471040 -1.1740678
## Pontiac Firebird      -2.503631 -1.1899795
## Fiat X1-9            -20.751803 -2.3619493
## Porsche 914-2         -8.824009 -1.0631969
## Lotus Europa         -13.197839 -1.5299421
## Ford Pantera L        -2.638560 -1.2537440
## Ferrari Dino          -3.822807 -0.6408806
## Maserati Bora         -2.615145 -1.2408561
## Volvo 142E            -8.249625 -1.0147210
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##            [,1]       [,2]
## [1,]  0.5855288 -0.4534972
## [2,]  0.7094660  0.6058875
## [3,] -0.1093033 -1.8179560
##
## $startweights[[1]][[2]]
##            [,1]
```

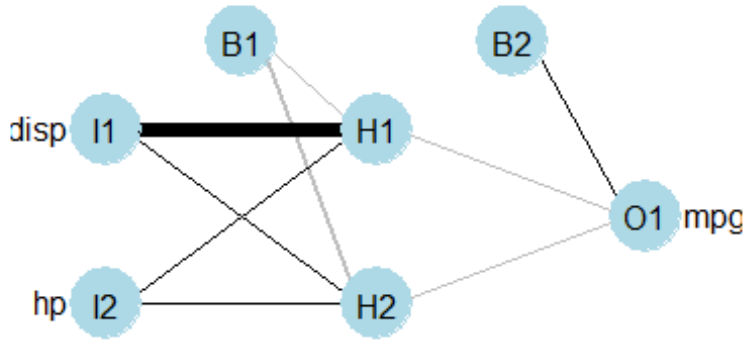
```
## [1,]  0.6300986
## [2,] -0.2761841
## [3,] -0.2841597
##
##
##
## $result.matrix
##                                 [,1]
## error                    0.121773974
## reached.threshold        0.008093771
## steps                  260.000000000
## Intercept.to.1layhid1   -1.085498971
## disp.to.1layhid1        15.493586009
## hp.to.1layhid1           1.591692173
## Intercept.to.1layhid2   -3.082977358
## disp.to.1layhid2         2.767810494
## hp.to.1layhid2           1.315673187
## Intercept.to.mpg         1.119582852
## 1layhid1.to.mpg         -0.686136820
## 1layhid2.to.mpg         -0.558944306
##
## attr(,"class")
## [1] "nn"
```

Now we are going to predict mpg values using the neural net model we have constructed.

```
# Predict the mpg value
predictions <- compute(nn, scaled_mtcars[,c('disp', 'hp')])

# Train the neural network
set.seed(12345)
nn <- neuralnet(mpg ~ disp + hp, data = scaled_mtcars, hidden = 2)

# Plot the neural network with NeuralNetTools
plotnet(nn)
```



The plotnet function from the NeuralNetTools package produces a visualization of a neural network model trained using the neuralnet package. This diagram provides a schematic representation of the architecture and weights of the model. Here's how to interpret the output:

Layers: The diagram consists of three types of layers: an input layer on the left, hidden layers in the middle, and an output layer on the right. Each circle (also known as a node or a neuron) represents a variable (in the input layer) or a computation (in the hidden and output layers).

Nodes: Each node in the input layer represents a feature that the model uses to make its prediction. Each node in the hidden layer represents a transformation of the input features, and the node in the output layer represents the predicted outcome.

Edges: The lines connecting the nodes (also known as edges) represent the weights of the model. These weights determine the importance of the corresponding input or transformation in predicting the outcome. In some visualizations, the thickness and color of the line might indicate the size and sign of the weight (a thicker line for a larger absolute value, a red line for a negative weight, and a blue line for a positive weight).

Calculation of MSE:

```
# Generate predictions using the neural network model
predictions <- compute(nn, scaled_mtcars[,c('disp', 'hp')])

# The predictions are on the same scale as the training data. So we need to
```

```
convert them back.
actuals <- mtcars$mpg
predicted <- predictions$net.result * (maxs["mpg"] - mins["mpg"]) +
mins["mpg"]

# Calculate the mean squared error
mse <- mean((predicted - actuals)^2)
print(mse)
```

```
## [1] 4.203105
```

Q2. Predict the species of iris flowers based on four input variables: Sepal.Length, Sepal.Width, Petal.Length, and Petal.Width. Also create a neural network plot using the plotnet() function.

```
library(neuralnet)
library(NeuralNetTools)

# Load the iris dataset
data(iris)

# Convert the Species to numerical values
iris$Species <- as.numeric(iris$Species)

# Scale the dataset
maxs <- apply(iris, 2, max)
mins <- apply(iris, 2, min)
scaled_iris <- as.data.frame(scale(iris, center = mins, scale = maxs - mins))

# Create a neural network model
set.seed(12345)
nn <- neuralnet(Species ~ Sepal.Length + Sepal.Width + Petal.Length +
Petal.Width,
                data = scaled_iris, hidden = 5)

# Print the output
print(nn)
```

```
## $call
## neuralnet(formula = Species ~ Sepal.Length + Sepal.Width + Petal.Length +
##     Petal.Width, data = scaled_iris, hidden = 5)
##
## $response
##     Species
## 1       0.0
## 2       0.0
## 3       0.0
## 4       0.0
## 5       0.0
## 6       0.0
```

```
## 7       0.0
## 8       0.0
## 9       0.0
## 10      0.0
## 11      0.0
## 12      0.0
## 13      0.0
## 14      0.0
## 15      0.0
## 16      0.0
## 17      0.0
## 18      0.0
## 19      0.0
## 20      0.0
## 21      0.0
## 22      0.0
## 23      0.0
## 24      0.0
## 25      0.0
## 26      0.0
## 27      0.0
## 28      0.0
## 29      0.0
## 30      0.0
## 31      0.0
## 32      0.0
## 33      0.0
## 34      0.0
## 35      0.0
## 36      0.0
## 37      0.0
## 38      0.0
## 39      0.0
## 40      0.0
## 41      0.0
## 42      0.0
## 43      0.0
## 44      0.0
## 45      0.0
## 46      0.0
## 47      0.0
## 48      0.0
## 49      0.0
## 50      0.0
## 51      0.5
## 52      0.5
## 53      0.5
## 54      0.5
## 55      0.5
## 56      0.5
```

```
## 57      0.5
## 58      0.5
## 59      0.5
## 60      0.5
## 61      0.5
## 62      0.5
## 63      0.5
## 64      0.5
## 65      0.5
## 66      0.5
## 67      0.5
## 68      0.5
## 69      0.5
## 70      0.5
## 71      0.5
## 72      0.5
## 73      0.5
## 74      0.5
## 75      0.5
## 76      0.5
## 77      0.5
## 78      0.5
## 79      0.5
## 80      0.5
## 81      0.5
## 82      0.5
## 83      0.5
## 84      0.5
## 85      0.5
## 86      0.5
## 87      0.5
## 88      0.5
## 89      0.5
## 90      0.5
## 91      0.5
## 92      0.5
## 93      0.5
## 94      0.5
## 95      0.5
## 96      0.5
## 97      0.5
## 98      0.5
## 99      0.5
## 100     0.5
## 101     1.0
## 102     1.0
## 103     1.0
## 104     1.0
## 105     1.0
## 106     1.0
```

```
## 107     1.0
## 108     1.0
## 109     1.0
## 110     1.0
## 111     1.0
## 112     1.0
## 113     1.0
## 114     1.0
## 115     1.0
## 116     1.0
## 117     1.0
## 118     1.0
## 119     1.0
## 120     1.0
## 121     1.0
## 122     1.0
## 123     1.0
## 124     1.0
## 125     1.0
## 126     1.0
## 127     1.0
## 128     1.0
## 129     1.0
## 130     1.0
## 131     1.0
## 132     1.0
## 133     1.0
## 134     1.0
## 135     1.0
## 136     1.0
## 137     1.0
## 138     1.0
## 139     1.0
## 140     1.0
## 141     1.0
## 142     1.0
## 143     1.0
## 144     1.0
## 145     1.0
## 146     1.0
## 147     1.0
## 148     1.0
## 149     1.0
## 150     1.0
##
## $covariate
##        Sepal.Length Sepal.Width Petal.Length Petal.Width
##   [1,]   0.22222222  0.62500000   0.06779661  0.04166667
##   [2,]   0.16666667  0.41666667   0.06779661  0.04166667
##   [3,]   0.11111111  0.50000000   0.05084746  0.04166667
```

```
##   [4,]   0.08333333  0.45833333   0.08474576  0.04166667
##   [5,]   0.19444444  0.66666667   0.06779661  0.04166667
##   [6,]   0.30555556  0.79166667   0.11864407  0.12500000
##   [7,]   0.08333333  0.58333333   0.06779661  0.08333333
##   [8,]   0.19444444  0.58333333   0.08474576  0.04166667
##   [9,]   0.02777778  0.37500000   0.06779661  0.04166667
##  [10,]   0.16666667  0.45833333   0.08474576  0.00000000
##  [11,]   0.30555556  0.70833333   0.08474576  0.04166667
##  [12,]   0.13888889  0.58333333   0.10169492  0.04166667
##  [13,]   0.13888889  0.41666667   0.06779661  0.00000000
##  [14,]   0.00000000  0.41666667   0.01694915  0.00000000
##  [15,]   0.41666667  0.83333333   0.03389831  0.04166667
##  [16,]   0.38888889  1.00000000   0.08474576  0.12500000
##  [17,]   0.30555556  0.79166667   0.05084746  0.12500000
##  [18,]   0.22222222  0.62500000   0.06779661  0.08333333
##  [19,]   0.38888889  0.75000000   0.11864407  0.08333333
##  [20,]   0.22222222  0.75000000   0.08474576  0.08333333
##  [21,]   0.30555556  0.58333333   0.11864407  0.04166667
##  [22,]   0.22222222  0.70833333   0.08474576  0.12500000
##  [23,]   0.08333333  0.66666667   0.00000000  0.04166667
##  [24,]   0.22222222  0.54166667   0.11864407  0.16666667
##  [25,]   0.13888889  0.58333333   0.15254237  0.04166667
##  [26,]   0.19444444  0.41666667   0.10169492  0.04166667
##  [27,]   0.19444444  0.58333333   0.10169492  0.12500000
##  [28,]   0.25000000  0.62500000   0.08474576  0.04166667
##  [29,]   0.25000000  0.58333333   0.06779661  0.04166667
##  [30,]   0.11111111  0.50000000   0.10169492  0.04166667
##  [31,]   0.13888889  0.45833333   0.10169492  0.04166667
##  [32,]   0.30555556  0.58333333   0.08474576  0.12500000
##  [33,]   0.25000000  0.87500000   0.08474576  0.00000000
##  [34,]   0.33333333  0.91666667   0.06779661  0.04166667
##  [35,]   0.16666667  0.45833333   0.08474576  0.04166667
##  [36,]   0.19444444  0.50000000   0.03389831  0.04166667
##  [37,]   0.33333333  0.62500000   0.05084746  0.04166667
##  [38,]   0.16666667  0.66666667   0.06779661  0.00000000
##  [39,]   0.02777778  0.41666667   0.05084746  0.04166667
##  [40,]   0.22222222  0.58333333   0.08474576  0.04166667
##  [41,]   0.19444444  0.62500000   0.05084746  0.08333333
##  [42,]   0.05555556  0.12500000   0.05084746  0.08333333
##  [43,]   0.02777778  0.50000000   0.05084746  0.04166667
##  [44,]   0.19444444  0.62500000   0.10169492  0.20833333
##  [45,]   0.22222222  0.75000000   0.15254237  0.12500000
##  [46,]   0.13888889  0.41666667   0.06779661  0.08333333
##  [47,]   0.22222222  0.75000000   0.10169492  0.04166667
##  [48,]   0.08333333  0.50000000   0.06779661  0.04166667
##  [49,]   0.27777778  0.70833333   0.08474576  0.04166667
##  [50,]   0.19444444  0.54166667   0.06779661  0.04166667
##  [51,]   0.75000000  0.50000000   0.62711864  0.54166667
##  [52,]   0.58333333  0.50000000   0.59322034  0.58333333
##  [53,]   0.72222222  0.45833333   0.66101695  0.58333333
```

```
##  [54,]   0.33333333  0.12500000   0.50847458  0.50000000
##  [55,]   0.61111111  0.33333333   0.61016949  0.58333333
##  [56,]   0.38888889  0.33333333   0.59322034  0.50000000
##  [57,]   0.55555556  0.54166667   0.62711864  0.62500000
##  [58,]   0.16666667  0.16666667   0.38983051  0.37500000
##  [59,]   0.63888889  0.37500000   0.61016949  0.50000000
##  [60,]   0.25000000  0.29166667   0.49152542  0.54166667
##  [61,]   0.19444444  0.00000000   0.42372881  0.37500000
##  [62,]   0.44444444  0.41666667   0.54237288  0.58333333
##  [63,]   0.47222222  0.08333333   0.50847458  0.37500000
##  [64,]   0.50000000  0.37500000   0.62711864  0.54166667
##  [65,]   0.36111111  0.37500000   0.44067797  0.50000000
##  [66,]   0.66666667  0.45833333   0.57627119  0.54166667
##  [67,]   0.36111111  0.41666667   0.59322034  0.58333333
##  [68,]   0.41666667  0.29166667   0.52542373  0.37500000
##  [69,]   0.52777778  0.08333333   0.59322034  0.58333333
##  [70,]   0.36111111  0.20833333   0.49152542  0.41666667
##  [71,]   0.44444444  0.50000000   0.64406780  0.70833333
##  [72,]   0.50000000  0.33333333   0.50847458  0.50000000
##  [73,]   0.55555556  0.20833333   0.66101695  0.58333333
##  [74,]   0.50000000  0.33333333   0.62711864  0.45833333
##  [75,]   0.58333333  0.37500000   0.55932203  0.50000000
##  [76,]   0.63888889  0.41666667   0.57627119  0.54166667
##  [77,]   0.69444444  0.33333333   0.64406780  0.54166667
##  [78,]   0.66666667  0.41666667   0.67796610  0.66666667
##  [79,]   0.47222222  0.37500000   0.59322034  0.58333333
##  [80,]   0.38888889  0.25000000   0.42372881  0.37500000
##  [81,]   0.33333333  0.16666667   0.47457627  0.41666667
##  [82,]   0.33333333  0.16666667   0.45762712  0.37500000
##  [83,]   0.41666667  0.29166667   0.49152542  0.45833333
##  [84,]   0.47222222  0.29166667   0.69491525  0.62500000
##  [85,]   0.30555556  0.41666667   0.59322034  0.58333333
##  [86,]   0.47222222  0.58333333   0.59322034  0.62500000
##  [87,]   0.66666667  0.45833333   0.62711864  0.58333333
##  [88,]   0.55555556  0.12500000   0.57627119  0.50000000
##  [89,]   0.36111111  0.41666667   0.52542373  0.50000000
##  [90,]   0.33333333  0.20833333   0.50847458  0.50000000
##  [91,]   0.33333333  0.25000000   0.57627119  0.45833333
##  [92,]   0.50000000  0.41666667   0.61016949  0.54166667
##  [93,]   0.41666667  0.25000000   0.50847458  0.45833333
##  [94,]   0.19444444  0.12500000   0.38983051  0.37500000
##  [95,]   0.36111111  0.29166667   0.54237288  0.50000000
##  [96,]   0.38888889  0.41666667   0.54237288  0.45833333
##  [97,]   0.38888889  0.37500000   0.54237288  0.50000000
##  [98,]   0.52777778  0.37500000   0.55932203  0.50000000
##  [99,]   0.22222222  0.20833333   0.33898305  0.41666667
## [100,]   0.38888889  0.33333333   0.52542373  0.50000000
## [101,]   0.55555556  0.54166667   0.84745763  1.00000000
## [102,]   0.41666667  0.29166667   0.69491525  0.75000000
## [103,]   0.77777778  0.41666667   0.83050847  0.83333333
```

```
## [104,]   0.55555556  0.37500000   0.77966102  0.70833333
## [105,]   0.61111111  0.41666667   0.81355932  0.87500000
## [106,]   0.91666667  0.41666667   0.94915254  0.83333333
## [107,]   0.16666667  0.20833333   0.59322034  0.66666667
## [108,]   0.83333333  0.37500000   0.89830508  0.70833333
## [109,]   0.66666667  0.20833333   0.81355932  0.70833333
## [110,]   0.80555556  0.66666667   0.86440678  1.00000000
## [111,]   0.61111111  0.50000000   0.69491525  0.79166667
## [112,]   0.58333333  0.29166667   0.72881356  0.75000000
## [113,]   0.69444444  0.41666667   0.76271186  0.83333333
## [114,]   0.38888889  0.20833333   0.67796610  0.79166667
## [115,]   0.41666667  0.33333333   0.69491525  0.95833333
## [116,]   0.58333333  0.50000000   0.72881356  0.91666667
## [117,]   0.61111111  0.41666667   0.76271186  0.70833333
## [118,]   0.94444444  0.75000000   0.96610169  0.87500000
## [119,]   0.94444444  0.25000000   1.00000000  0.91666667
## [120,]   0.47222222  0.08333333   0.67796610  0.58333333
## [121,]   0.72222222  0.50000000   0.79661017  0.91666667
## [122,]   0.36111111  0.33333333   0.66101695  0.79166667
## [123,]   0.94444444  0.33333333   0.96610169  0.79166667
## [124,]   0.55555556  0.29166667   0.66101695  0.70833333
## [125,]   0.66666667  0.54166667   0.79661017  0.83333333
## [126,]   0.80555556  0.50000000   0.84745763  0.70833333
## [127,]   0.52777778  0.33333333   0.64406780  0.70833333
## [128,]   0.50000000  0.41666667   0.66101695  0.70833333
## [129,]   0.58333333  0.33333333   0.77966102  0.83333333
## [130,]   0.80555556  0.41666667   0.81355932  0.62500000
## [131,]   0.86111111  0.33333333   0.86440678  0.75000000
## [132,]   1.00000000  0.75000000   0.91525424  0.79166667
## [133,]   0.58333333  0.33333333   0.77966102  0.87500000
## [134,]   0.55555556  0.33333333   0.69491525  0.58333333
## [135,]   0.50000000  0.25000000   0.77966102  0.54166667
## [136,]   0.94444444  0.41666667   0.86440678  0.91666667
## [137,]   0.55555556  0.58333333   0.77966102  0.95833333
## [138,]   0.58333333  0.45833333   0.76271186  0.70833333
## [139,]   0.47222222  0.41666667   0.64406780  0.70833333
## [140,]   0.72222222  0.45833333   0.74576271  0.83333333
## [141,]   0.66666667  0.45833333   0.77966102  0.95833333
## [142,]   0.72222222  0.45833333   0.69491525  0.91666667
## [143,]   0.41666667  0.29166667   0.69491525  0.75000000
## [144,]   0.69444444  0.50000000   0.83050847  0.91666667
## [145,]   0.66666667  0.54166667   0.79661017  1.00000000
## [146,]   0.66666667  0.41666667   0.71186441  0.91666667
## [147,]   0.55555556  0.20833333   0.67796610  0.75000000
## [148,]   0.61111111  0.41666667   0.71186441  0.79166667
## [149,]   0.52777778  0.58333333   0.74576271  0.91666667
## [150,]   0.44444444  0.41666667   0.69491525  0.70833333
##
## $model.list
## $model.list$response
```

```
## [1] "Species"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
##
##
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x000000001fc6c340>
## <environment: 0x00000000158b6698>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x000000001fc678a8>
## <environment: 0x00000000158b6200>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##     Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1     0.22222222  0.62500000   0.06779661  0.04166667     0.0
## 2     0.16666667  0.41666667   0.06779661  0.04166667     0.0
## 3     0.11111111  0.50000000   0.05084746  0.04166667     0.0
## 4     0.08333333  0.45833333   0.08474576  0.04166667     0.0
## 5     0.19444444  0.66666667   0.06779661  0.04166667     0.0
## 6     0.30555556  0.79166667   0.11864407  0.12500000     0.0
## 7     0.08333333  0.58333333   0.06779661  0.08333333     0.0
## 8     0.19444444  0.58333333   0.08474576  0.04166667     0.0
## 9     0.02777778  0.37500000   0.06779661  0.04166667     0.0
## 10    0.16666667  0.45833333   0.08474576  0.00000000     0.0
## 11    0.30555556  0.70833333   0.08474576  0.04166667     0.0
## 12    0.13888889  0.58333333   0.10169492  0.04166667     0.0
## 13    0.13888889  0.41666667   0.06779661  0.00000000     0.0
## 14    0.00000000  0.41666667   0.01694915  0.00000000     0.0
## 15    0.41666667  0.83333333   0.03389831  0.04166667     0.0
## 16    0.38888889  1.00000000   0.08474576  0.12500000     0.0
## 17    0.30555556  0.79166667   0.05084746  0.12500000     0.0
## 18    0.22222222  0.62500000   0.06779661  0.08333333     0.0
## 19    0.38888889  0.75000000   0.11864407  0.08333333     0.0
```

```
## 20    0.22222222  0.75000000   0.08474576  0.08333333     0.0
## 21    0.30555556  0.58333333   0.11864407  0.04166667     0.0
## 22    0.22222222  0.70833333   0.08474576  0.12500000     0.0
## 23    0.08333333  0.66666667   0.00000000  0.04166667     0.0
## 24    0.22222222  0.54166667   0.11864407  0.16666667     0.0
## 25    0.13888889  0.58333333   0.15254237  0.04166667     0.0
## 26    0.19444444  0.41666667   0.10169492  0.04166667     0.0
## 27    0.19444444  0.58333333   0.10169492  0.12500000     0.0
## 28    0.25000000  0.62500000   0.08474576  0.04166667     0.0
## 29    0.25000000  0.58333333   0.06779661  0.04166667     0.0
## 30    0.11111111  0.50000000   0.10169492  0.04166667     0.0
## 31    0.13888889  0.45833333   0.10169492  0.04166667     0.0
## 32    0.30555556  0.58333333   0.08474576  0.12500000     0.0
## 33    0.25000000  0.87500000   0.08474576  0.00000000     0.0
## 34    0.33333333  0.91666667   0.06779661  0.04166667     0.0
## 35    0.16666667  0.45833333   0.08474576  0.04166667     0.0
## 36    0.19444444  0.50000000   0.03389831  0.04166667     0.0
## 37    0.33333333  0.62500000   0.05084746  0.04166667     0.0
## 38    0.16666667  0.66666667   0.06779661  0.00000000     0.0
## 39    0.02777778  0.41666667   0.05084746  0.04166667     0.0
## 40    0.22222222  0.58333333   0.08474576  0.04166667     0.0
## 41    0.19444444  0.62500000   0.05084746  0.08333333     0.0
## 42    0.05555556  0.12500000   0.05084746  0.08333333     0.0
## 43    0.02777778  0.50000000   0.05084746  0.04166667     0.0
## 44    0.19444444  0.62500000   0.10169492  0.20833333     0.0
## 45    0.22222222  0.75000000   0.15254237  0.12500000     0.0
## 46    0.13888889  0.41666667   0.06779661  0.08333333     0.0
## 47    0.22222222  0.75000000   0.10169492  0.04166667     0.0
## 48    0.08333333  0.50000000   0.06779661  0.04166667     0.0
## 49    0.27777778  0.70833333   0.08474576  0.04166667     0.0
## 50    0.19444444  0.54166667   0.06779661  0.04166667     0.0
## 51    0.75000000  0.50000000   0.62711864  0.54166667     0.5
## 52    0.58333333  0.50000000   0.59322034  0.58333333     0.5
## 53    0.72222222  0.45833333   0.66101695  0.58333333     0.5
## 54    0.33333333  0.12500000   0.50847458  0.50000000     0.5
## 55    0.61111111  0.33333333   0.61016949  0.58333333     0.5
## 56    0.38888889  0.33333333   0.59322034  0.50000000     0.5
## 57    0.55555556  0.54166667   0.62711864  0.62500000     0.5
## 58    0.16666667  0.16666667   0.38983051  0.37500000     0.5
## 59    0.63888889  0.37500000   0.61016949  0.50000000     0.5
## 60    0.25000000  0.29166667   0.49152542  0.54166667     0.5
## 61    0.19444444  0.00000000   0.42372881  0.37500000     0.5
## 62    0.44444444  0.41666667   0.54237288  0.58333333     0.5
## 63    0.47222222  0.08333333   0.50847458  0.37500000     0.5
## 64    0.50000000  0.37500000   0.62711864  0.54166667     0.5
## 65    0.36111111  0.37500000   0.44067797  0.50000000     0.5
## 66    0.66666667  0.45833333   0.57627119  0.54166667     0.5
## 67    0.36111111  0.41666667   0.59322034  0.58333333     0.5
## 68    0.41666667  0.29166667   0.52542373  0.37500000     0.5
## 69    0.52777778  0.08333333   0.59322034  0.58333333     0.5
```

```
## 70    0.36111111  0.20833333   0.49152542  0.41666667     0.5
## 71    0.44444444  0.50000000   0.64406780  0.70833333     0.5
## 72    0.50000000  0.33333333   0.50847458  0.50000000     0.5
## 73    0.55555556  0.20833333   0.66101695  0.58333333     0.5
## 74    0.50000000  0.33333333   0.62711864  0.45833333     0.5
## 75    0.58333333  0.37500000   0.55932203  0.50000000     0.5
## 76    0.63888889  0.41666667   0.57627119  0.54166667     0.5
## 77    0.69444444  0.33333333   0.64406780  0.54166667     0.5
## 78    0.66666667  0.41666667   0.67796610  0.66666667     0.5
## 79    0.47222222  0.37500000   0.59322034  0.58333333     0.5
## 80    0.38888889  0.25000000   0.42372881  0.37500000     0.5
## 81    0.33333333  0.16666667   0.47457627  0.41666667     0.5
## 82    0.33333333  0.16666667   0.45762712  0.37500000     0.5
## 83    0.41666667  0.29166667   0.49152542  0.45833333     0.5
## 84    0.47222222  0.29166667   0.69491525  0.62500000     0.5
## 85    0.30555556  0.41666667   0.59322034  0.58333333     0.5
## 86    0.47222222  0.58333333   0.59322034  0.62500000     0.5
## 87    0.66666667  0.45833333   0.62711864  0.58333333     0.5
## 88    0.55555556  0.12500000   0.57627119  0.50000000     0.5
## 89    0.36111111  0.41666667   0.52542373  0.50000000     0.5
## 90    0.33333333  0.20833333   0.50847458  0.50000000     0.5
## 91    0.33333333  0.25000000   0.57627119  0.45833333     0.5
## 92    0.50000000  0.41666667   0.61016949  0.54166667     0.5
## 93    0.41666667  0.25000000   0.50847458  0.45833333     0.5
## 94    0.19444444  0.12500000   0.38983051  0.37500000     0.5
## 95    0.36111111  0.29166667   0.54237288  0.50000000     0.5
## 96    0.38888889  0.41666667   0.54237288  0.45833333     0.5
## 97    0.38888889  0.37500000   0.54237288  0.50000000     0.5
## 98    0.52777778  0.37500000   0.55932203  0.50000000     0.5
## 99    0.22222222  0.20833333   0.33898305  0.41666667     0.5
## 100   0.38888889  0.33333333   0.52542373  0.50000000     0.5
## 101   0.55555556  0.54166667   0.84745763  1.00000000     1.0
## 102   0.41666667  0.29166667   0.69491525  0.75000000     1.0
## 103   0.77777778  0.41666667   0.83050847  0.83333333     1.0
## 104   0.55555556  0.37500000   0.77966102  0.70833333     1.0
## 105   0.61111111  0.41666667   0.81355932  0.87500000     1.0
## 106   0.91666667  0.41666667   0.94915254  0.83333333     1.0
## 107   0.16666667  0.20833333   0.59322034  0.66666667     1.0
## 108   0.83333333  0.37500000   0.89830508  0.70833333     1.0
## 109   0.66666667  0.20833333   0.81355932  0.70833333     1.0
## 110   0.80555556  0.66666667   0.86440678  1.00000000     1.0
## 111   0.61111111  0.50000000   0.69491525  0.79166667     1.0
## 112   0.58333333  0.29166667   0.72881356  0.75000000     1.0
## 113   0.69444444  0.41666667   0.76271186  0.83333333     1.0
## 114   0.38888889  0.20833333   0.67796610  0.79166667     1.0
## 115   0.41666667  0.33333333   0.69491525  0.95833333     1.0
## 116   0.58333333  0.50000000   0.72881356  0.91666667     1.0
## 117   0.61111111  0.41666667   0.76271186  0.70833333     1.0
## 118   0.94444444  0.75000000   0.96610169  0.87500000     1.0
## 119   0.94444444  0.25000000   1.00000000  0.91666667     1.0
```

```
## 120   0.47222222  0.08333333   0.67796610  0.58333333     1.0
## 121   0.72222222  0.50000000   0.79661017  0.91666667     1.0
## 122   0.36111111  0.33333333   0.66101695  0.79166667     1.0
## 123   0.94444444  0.33333333   0.96610169  0.79166667     1.0
## 124   0.55555556  0.29166667   0.66101695  0.70833333     1.0
## 125   0.66666667  0.54166667   0.79661017  0.83333333     1.0
## 126   0.80555556  0.50000000   0.84745763  0.70833333     1.0
## 127   0.52777778  0.33333333   0.64406780  0.70833333     1.0
## 128   0.50000000  0.41666667   0.66101695  0.70833333     1.0
## 129   0.58333333  0.33333333   0.77966102  0.83333333     1.0
## 130   0.80555556  0.41666667   0.81355932  0.62500000     1.0
## 131   0.86111111  0.33333333   0.86440678  0.75000000     1.0
## 132   1.00000000  0.75000000   0.91525424  0.79166667     1.0
## 133   0.58333333  0.33333333   0.77966102  0.87500000     1.0
## 134   0.55555556  0.33333333   0.69491525  0.58333333     1.0
## 135   0.50000000  0.25000000   0.77966102  0.54166667     1.0
## 136   0.94444444  0.41666667   0.86440678  0.91666667     1.0
## 137   0.55555556  0.58333333   0.77966102  0.95833333     1.0
## 138   0.58333333  0.45833333   0.76271186  0.70833333     1.0
## 139   0.47222222  0.41666667   0.64406780  0.70833333     1.0
## 140   0.72222222  0.45833333   0.74576271  0.83333333     1.0
## 141   0.66666667  0.45833333   0.77966102  0.95833333     1.0
## 142   0.72222222  0.45833333   0.69491525  0.91666667     1.0
## 143   0.41666667  0.29166667   0.69491525  0.75000000     1.0
## 144   0.69444444  0.50000000   0.83050847  0.91666667     1.0
## 145   0.66666667  0.54166667   0.79661017  1.00000000     1.0
## 146   0.66666667  0.41666667   0.71186441  0.91666667     1.0
## 147   0.55555556  0.20833333   0.67796610  0.75000000     1.0
## 148   0.61111111  0.41666667   0.71186441  0.79166667     1.0
## 149   0.52777778  0.58333333   0.74576271  0.91666667     1.0
## 150   0.44444444  0.41666667   0.69491525  0.70833333     1.0
##
## $exclude
## NULL
##
## $net.result
## $net.result[[1]]
##                 [,1]
##   [1,] -0.0086914078
##   [2,] -0.0030266962
##   [3,]  0.0009198357
##   [4,]  0.0192867055
##   [5,] -0.0057320049
##   [6,]  0.0150618527
##   [7,]  0.0192488469
##   [8,]  0.0018135313
##   [9,]  0.0216968943
##  [10,] -0.0049541760
##  [11,] -0.0135699572
##  [12,]  0.0157314226
```

```
##  [13,] -0.0084953308
##  [14,] -0.0059459207
##  [15,] -0.0439319947
##  [16,] -0.0093306517
##  [17,] -0.0085438099
##  [18,]  0.0008031175
##  [19,] -0.0028171096
##  [20,]  0.0043618200
##  [21,] -0.0012892842
##  [22,]  0.0146495593
##  [23,] -0.0169625505
##  [24,]  0.0429608332
##  [25,]  0.0359237417
##  [26,]  0.0060841244
##  [27,]  0.0283388358
##  [28,] -0.0060162978
##  [29,] -0.0126687461
##  [30,]  0.0215056271
##  [31,]  0.0176136317
##  [32,]  0.0053641369
##  [33,] -0.0182387092
##  [34,] -0.0242343767
##  [35,]  0.0056662284
##  [36,] -0.0188616423
##  [37,] -0.0308721149
##  [38,] -0.0115646434
##  [39,]  0.0141469753
##  [40,] -0.0020606610
##  [41,] -0.0019750056
##  [42,] -0.0057591566
##  [43,]  0.0124288409
##  [44,]  0.0469661835
##  [45,]  0.0379741515
##  [46,]  0.0134646114
##  [47,]  0.0014432943
##  [48,]  0.0116593663
##  [49,] -0.0101677715
##  [50,] -0.0047178757
##  [51,]  0.4897162979
##  [52,]  0.5173818139
##  [53,]  0.6086299664
##  [54,]  0.6322536966
##  [55,]  0.6458168152
##  [56,]  0.6051544704
##  [57,]  0.5641748953
##  [58,]  0.3920117803
##  [59,]  0.5325658585
##  [60,]  0.5588264786
##  [61,]  0.4949951215
##  [62,]  0.5352291990
```

```
##  [63,]  0.4076146555
##  [64,]  0.6367323472
##  [65,]  0.3913019513
##  [66,]  0.4706256701
##  [67,]  0.6101539926
##  [68,]  0.4243325035
##  [69,]  0.6861636758
##  [70,]  0.4763251527
##  [71,]  0.7016530511
##  [72,]  0.4635469430
##  [73,]  0.7773112214
##  [74,]  0.5883203679
##  [75,]  0.4823305166
##  [76,]  0.5024579632
##  [77,]  0.6128640923
##  [78,]  0.7535017356
##  [79,]  0.6328210048
##  [80,]  0.3253857444
##  [81,]  0.4829836276
##  [82,]  0.4193928699
##  [83,]  0.4526431151
##  [84,]  0.8674095152
##  [85,]  0.6137158132
##  [86,]  0.4955283500
##  [87,]  0.5765688300
##  [88,]  0.5748542913
##  [89,]  0.4599129653
##  [90,]  0.5891611210
##  [91,]  0.6177232122
##  [92,]  0.5808848406
##  [93,]  0.4975668070
##  [94,]  0.4027550956
##  [95,]  0.5722672006
##  [96,]  0.4452615340
##  [97,]  0.5058928700
##  [98,]  0.4991416317
##  [99,]  0.3317874736
## [100,]  0.5138604316
## [101,]  1.1224092578
## [102,]  0.9763355882
## [103,]  1.0228754671
## [104,]  0.9681402514
## [105,]  1.0797064766
## [106,]  1.0565964964
## [107,]  0.8873992850
## [108,]  0.9765856535
## [109,]  0.9534591008
## [110,]  1.0421926562
## [111,]  0.8321799858
## [112,]  0.9629750362
```

```
## [113,]  0.9833684920
## [114,]  1.0258278447
## [115,]  1.0859237684
## [116,]  0.9745592677
## [117,]  0.9128068125
## [118,]  0.9998359289
## [119,]  0.9957785080
## [120,]  0.8304066995
## [121,]  1.0303098453
## [122,]  0.9500359579
## [123,]  0.9778422132
## [124,]  0.8664418936
## [125,]  0.9542964304
## [126,]  0.9209820537
## [127,]  0.8338357824
## [128,]  0.7996252388
## [129,]  1.0572072760
## [130,]  0.8404113291
## [131,]  0.9373669373
## [132,]  0.8681247296
## [133,]  1.0807356832
## [134,]  0.7838279914
## [135,]  0.9088925910
## [136,]  1.0169016562
## [137,]  0.9965445594
## [138,]  0.8889332602
## [139,]  0.7796489070
## [140,]  0.9392606939
## [141,]  1.0681259369
## [142,]  0.9422437029
## [143,]  0.9763355882
## [144,]  1.0686288399
## [145,]  1.0656209361
## [146,]  0.9931629412
## [147,]  0.9280548815
## [148,]  0.9160829209
## [149,]  0.9254856336
## [150,]  0.8506341337
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##            [,1]       [,2]       [,3]       [,4]       [,5]
## [1,]  1.2118446 -1.7329851 -0.6269448  3.6976994  0.5834111
## [2,]  0.3571057  4.6067043  0.5741632 -0.7837544  0.9161600
## [3,]  1.0413444 -6.2172964 -1.0809956  5.5128476 -1.2208272
## [4,] -1.4887963 -0.6877557  1.2307358 -5.2359423 -0.7973437
## [5,] -1.0778383 -1.2384032 -0.4820558 -3.6042089 -1.2517228
##
```

```
## $weights[[1]][[2]]
##            [,1]
## [1,]  1.4211563
## [2,] -0.7918154
## [3,] -0.9813023
## [4,]  0.5249991
## [5,] -0.6354708
## [6,] -0.4949521
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##                [,1]          [,2]        [,3]        [,4]
##   [1,]   14.9887916  7.009057e-01  -42.658671  -25.794512
##   [2,]   66.1921664 -1.652502e+01 -142.096815  -87.552197
##   [3,] -158.8399216 -6.309122e+00  432.860547  263.357040
##   [4,]   -8.0381218 -7.238172e-01   22.112080   13.373229
##   [5,]   20.6590134  3.008434e+00  -63.021904  -38.190239
##   [6,]   -7.3141933 -2.040435e+00   23.993065   14.471409
##   [7,]   -6.4125730 -1.880334e+00   20.327694   12.386860
##   [8,]  -75.5708758 -5.256969e+00  214.213885  129.013661
##   [9,]   -8.0296692 -1.319226e-01   20.586576   12.568563
##  [10,]   35.9681161 -6.243744e+00  -83.813740  -50.750008
##  [11,]    9.0408419  3.446807e-01  -26.253238  -15.796455
##  [12,]   -8.2202841 -1.768203e+00   25.209196   15.122423
##  [13,]   22.4437831 -5.185643e+00  -49.489334  -30.215714
##  [14,]   25.2262479  5.041341e-01  -67.277401  -41.073085
##  [15,]    2.5246335 -2.439236e-01   -7.118580   -4.367308
##  [16,]    9.9939191  1.593381e+00  -32.567083  -20.175718
##  [17,]   12.8282389  1.741867e+00  -39.521064  -24.395666
##  [18,] -162.7993734 -1.538414e+01  470.647076  286.105218
##  [19,]   44.3925201  2.304813e+00 -129.323286  -77.385556
##  [20,]  -25.0582932 -6.145331e+00   81.122049   49.350887
##  [21,]  125.3653957 -1.532037e+01 -311.015520 -186.727470
##  [22,]   -7.9020463 -2.115205e+00   25.284579   15.404293
##  [23,]    6.4553538  1.043452e+00  -19.979531  -12.456239
##  [24,]   -3.6359131 -6.239101e-01   10.330510    6.281178
##  [25,]   -3.6277164 -1.177796e+00   11.664895    6.911045
##  [26,]  -34.9949022  9.308500e+00   73.458636   45.186750
##  [27,]   -4.8699331 -1.028817e+00   14.556142    8.815740
##  [28,]   22.4071066  5.193535e-01  -62.647533  -37.706205
##  [29,]   11.6288874 -9.462225e-01  -30.053160  -18.201283
##  [30,]   -6.8407637 -9.558498e-01   19.580200   11.772937
##  [31,]   -9.6123433  1.568078e-01   24.621157   14.891122
##  [32,]  -29.8553907  2.292501e+00   75.184203   45.940908
##  [33,]    5.2951777  8.293882e-01  -17.335092  -10.575897
##  [34,]    3.9881442  3.607865e-01  -12.675015   -7.804814
##  [35,]  -31.3077076  3.750025e+00   74.986525   45.636682
##  [36,]    8.7761640 -1.592862e+00  -20.654425  -12.671440
```

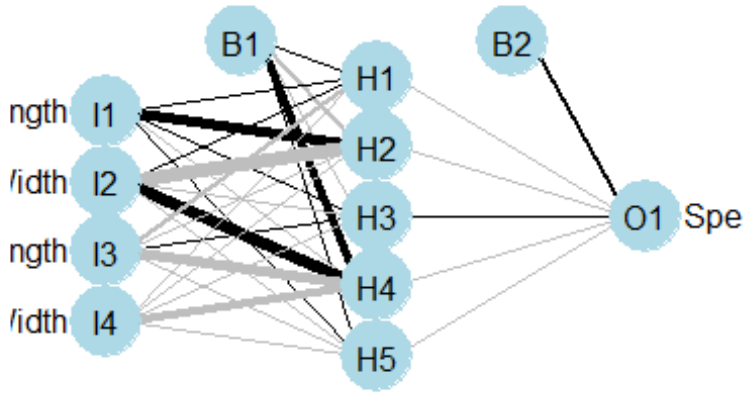
```
##  [37,]    4.8982165 -1.037090e+00  -11.756769   -7.159338
##  [38,]    9.9523353  1.441336e+00  -30.712810  -18.534581
##  [39,]  -11.0919871 -8.047751e-01   29.994283   18.293449
##  [40,]   68.8935512  7.009541e-01 -188.298754 -113.453041
##  [41,]   64.2441375  7.251976e+00 -188.233783 -115.030763
##  [42,]   74.2293261 -4.590795e+01  -99.015388  -67.350426
##  [43,]  -10.6902828 -2.267238e+00   32.171358   19.576615
##  [44,]   -2.7502841 -1.065503e+00    8.884213    5.419576
##  [45,]   -2.9180411 -1.310937e+00   10.167251    6.075756
##  [46,]  -13.9961417  1.683623e+00   32.764450   20.194154
##  [47,]  -75.2932345 -1.773744e+01  245.136442  147.638725
##  [48,]  -12.1297537 -1.617414e+00   34.834061   21.099183
##  [49,]   11.7503214  1.009934e+00  -35.071926  -21.119557
##  [50,]   31.7290418 -1.184081e+00  -83.200666  -50.421081
##  [51,]   -1.2223146 -2.223776e+00    5.330691    3.558080
##  [52,]   -0.5840944 -2.963387e+00    5.059166    3.263004
##  [53,]   -1.3005300 -2.615524e+00    5.952949    3.984498
##  [54,]   -2.0677119 -1.635227e+00    6.157799    4.259499
##  [55,]   -1.7818603 -2.126839e+00    6.242673    4.255081
##  [56,]   -0.7347850 -3.305557e+00    5.770500    3.771794
##  [57,]   -0.3383166 -3.434529e+00    5.173723    3.289325
##  [58,]   -1.1402809 -2.064347e+00    5.017546    3.333696
##  [59,]   -1.6024082 -1.966079e+00    5.700983    3.883556
##  [60,]   -0.5163653 -3.302399e+00    5.345315    3.465304
##  [61,]   -2.4737626 -8.477047e-01    5.903247    4.181658
##  [62,]   -0.5324707 -3.134173e+00    5.167448    3.337701
##  [63,]   -3.7978906  8.375717e-01    6.247555    4.622147
##  [64,]   -0.8908903 -3.303460e+00    6.060501    3.982862
##  [65,]   -0.7257238 -2.282412e+00    4.522255    2.916777
##  [66,]   -1.1501090 -2.246349e+00    5.228615    3.478742
##  [67,]   -0.3159280 -3.783101e+00    5.568894    3.556193
##  [68,]   -1.3515596 -1.917672e+00    5.216762    3.500749
##  [69,]   -4.3662283  2.292881e+00    5.555976    4.162523
##  [70,]   -1.5555424 -1.909045e+00    5.551371    3.781896
##  [71,]   -0.1672610 -4.747407e+00    6.489547    4.106686
##  [72,]   -1.2725569 -2.144807e+00    5.326763    3.575740
##  [73,]   -3.6143484 -8.989569e-02    7.215733    5.088460
##  [74,]   -1.2205622 -2.631771e+00    5.832416    3.900189
##  [75,]   -1.3511792 -2.104647e+00    5.419127    3.649306
##  [76,]   -1.2620457 -2.258706e+00    5.440222    3.647759
##  [77,]   -2.3800563 -1.115511e+00    6.078818    4.254380
##  [78,]   -1.5290478 -3.372783e+00    7.387477    4.899363
##  [79,]   -0.7554176 -3.452676e+00    5.987087    3.914177
##  [80,]   -1.8459982 -1.254384e+00    5.359081    3.647750
##  [81,]   -1.7363634 -1.734736e+00    5.661978    3.890947
##  [82,]   -1.8989815 -1.447397e+00    5.623520    3.881179
##  [83,]   -1.2255043 -2.158788e+00    5.263908    3.524002
##  [84,]   -2.4539679 -4.610774e+00   10.902395    7.171985
##  [85,]   -0.2274406 -3.887405e+00    5.529194    3.511774
##  [86,]   -0.2219831 -3.038590e+00    4.462218    2.782214
```

```
##  [87,]   -1.0305091 -2.801356e+00    5.681412    3.762253
##  [88,]   -3.7092638  1.194062e+00    5.648530    4.184394
##  [89,]   -0.4843928 -2.732868e+00    4.606793    2.937416
##  [90,]   -1.2723022 -2.593117e+00    5.871277    3.947121
##  [91,]   -1.0260541 -3.031442e+00    5.974114    3.961332
##  [92,]   -0.6747016 -3.224296e+00    5.552374    3.613083
##  [93,]   -1.4593965 -2.063207e+00    5.561185    3.772756
##  [94,]   -1.5067339 -1.811722e+00    5.364300    3.638524
##  [95,]   -0.8599996 -3.001194e+00    5.618458    3.702395
##  [96,]   -0.5756016 -2.579684e+00    4.600328    2.942233
##  [97,]   -0.6167264 -2.896058e+00    5.044132    3.266500
##  [98,]   -1.0792904 -2.437971e+00    5.330884    3.542653
##  [99,]   -1.2698764 -1.757451e+00    4.912817    3.263818
## [100,]   -0.7825430 -2.803788e+00    5.233352    3.429268
## [101,]    0.4228866  4.366131e+00   -6.671950   -3.877665
## [102,]   -8.9454284 -2.254795e+01   47.752975   30.391801
## [103,]   16.8636558  4.795941e+00  -40.413026  -26.401587
## [104,]   -7.3161146 -1.661409e+01   36.561679   23.389554
## [105,]    2.3269195  4.501352e+00  -10.767418   -6.612050
## [106,]   10.2763614 -5.476188e+00  -13.504910   -9.329768
## [107,]   -1.1600533 -7.925123e+00   12.679520    8.090836
## [108,]  -27.5876390  1.074581e+01   41.011181   28.722980
## [109,]  -17.6454204  1.172621e+01   19.859328   14.495532
## [110,]    1.5307979  1.594868e+01  -24.000071  -14.411603
## [111,]   -0.7161159 -6.224932e+00    9.499130    6.042821
## [112,]  -11.3532430 -4.828017e+00   29.153588   19.352498
## [113,]  -17.4911232 -2.233783e+01   64.557419   41.513018
## [114,]   11.4104964  9.742431e+00  -36.208391  -23.232778
## [115,]    1.5202919  4.984988e+00   -9.771282   -5.906001
## [116,]   -3.3377253 -3.037202e+01   46.366027   28.667465
## [117,]   -2.7049864 -7.553467e+00   15.276090    9.839565
## [118,] -460.1673550 -4.668772e+03 7024.242883 4288.821634
## [119,] -252.8325124  2.576452e+02  165.931578  133.321630
## [120,]   -5.8462165  3.132644e+00    7.466149    5.491805
## [121,]    5.7248134  1.594782e+01  -32.619992  -20.207973
## [122,]   -2.3263614 -1.541684e+01   24.860807   15.618965
## [123,]  -42.5504867  3.685825e+01   36.387814   27.749939
## [124,]   -3.2354657 -3.081432e+00   10.440023    6.978629
## [125,]   -2.2495658 -1.749275e+01   27.356054   17.035396
## [126,]   -4.0333938 -6.315497e+00   16.283239   10.627034
## [127,]   -1.8561965 -4.333949e+00    9.318442    6.118249
## [128,]   -0.7451923 -5.363788e+00    8.445843    5.420314
## [129,]    5.0099790  3.694401e+00  -15.154633   -9.619456
## [130,]   -3.7426175 -1.365524e+00    9.151814    6.281812
## [131,]  -13.4890661  8.655240e+00   15.486495   11.303227
## [132,]   -0.9260738 -7.396983e+00   11.442180    7.212963
## [133,]    3.3726874  2.297612e+00   -9.998688   -6.279434
## [134,]   -1.8775642 -3.264375e+00    7.949296    5.301240
## [135,]   -5.1642368 -2.757391e+00   13.904249    9.385939
## [136,]   37.4681080 -2.013768e+01  -48.738930  -33.876126
```

```
## [137,]   -6.1727694 -2.472809e+02  334.259792  202.785532
## [138,]   -1.3762223 -7.797653e+00   12.915419    8.219947
## [139,]   -0.5922691 -5.216190e+00    7.945859    5.091856
## [140,]   -4.2949914 -8.799727e+00   20.091875   12.919943
## [141,]    2.5022124  5.877509e+00  -12.906484   -7.895857
## [142,]   -4.2367907 -9.400476e+00   20.742161   13.282048
## [143,]   -8.9454284 -2.254795e+01   47.752975   30.391801
## [144,]    2.1903158  6.551363e+00  -13.153720   -8.016785
## [145,]    1.3808694  8.565478e+00  -14.110261   -8.470737
## [146,]  -35.4346108 -6.219419e+01  153.148376   97.206180
## [147,]   -8.4434915  1.285844e+00   15.185836   10.482381
## [148,]   -2.6256506 -7.933713e+00   15.604990   10.009472
## [149,]   -0.1063037 -1.386358e+01   18.157416   11.176735
## [150,]   -0.6757035 -6.958702e+00   10.400511    6.597885
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##            [,1]       [,2]       [,3]       [,4]       [,5]
## [1,]  0.5855288 -1.8179560 -0.1162478  0.8168998  0.7796219
## [2,]  0.7094660  0.6300986  1.8173120 -0.8863575  1.4557851
## [3,] -0.1093033 -0.2761841  0.3706279 -0.3315776 -0.6443284
## [4,] -0.4534972 -0.2841597  0.5202165  1.1207127 -1.5531374
## [5,]  0.6058875 -0.9193220 -0.7505320  0.2987237 -1.5977095
##
## $startweights[[1]][[2]]
##            [,1]
## [1,]  1.8050975
## [2,] -0.4816474
## [3,]  0.6203798
## [4,]  0.6121235
## [5,] -0.1623110
## [6,]  0.8118732
##
##
##
## $result.matrix
##                                    [,1]
## error                       0.570312030
## reached.threshold           0.009159972
## steps                     802.000000000
## Intercept.to.1layhid1       1.211844619
## Sepal.Length.to.1layhid1    0.357105651
## Sepal.Width.to.1layhid1     1.041344392
## Petal.Length.to.1layhid1   -1.488796330
## Petal.Width.to.1layhid1    -1.077838284
## Intercept.to.1layhid2      -1.732985090
## Sepal.Length.to.1layhid2    4.606704293
## Sepal.Width.to.1layhid2    -6.217296399
```

```
## Petal.Length.to.1layhid2  -0.687755695
## Petal.Width.to.1layhid2   -1.238403234
## Intercept.to.1layhid3     -0.626944842
## Sepal.Length.to.1layhid3   0.574163190
## Sepal.Width.to.1layhid3   -1.080995645
## Petal.Length.to.1layhid3   1.230735761
## Petal.Width.to.1layhid3   -0.482055805
## Intercept.to.1layhid4      3.697699399
## Sepal.Length.to.1layhid4  -0.783754443
## Sepal.Width.to.1layhid4    5.512847618
## Petal.Length.to.1layhid4  -5.235942255
## Petal.Width.to.1layhid4   -3.604208945
## Intercept.to.1layhid5      0.583411127
## Sepal.Length.to.1layhid5   0.916160010
## Sepal.Width.to.1layhid5   -1.220827165
## Petal.Length.to.1layhid5  -0.797343731
## Petal.Width.to.1layhid5   -1.251722800
## Intercept.to.Species       1.421156257
## 1layhid1.to.Species       -0.791815427
## 1layhid2.to.Species       -0.981302336
## 1layhid3.to.Species        0.524999113
## 1layhid4.to.Species       -0.635470818
## 1layhid5.to.Species       -0.494952064
##
## attr(,"class")
## [1] "nn"
```

```
# Plot the neural network
plotnet(nn)
```


B1
B2
H1
H2
H3
H4
H5
ngth
I1
/idth
I2
ngth
I3
/idth
I4
O1
Spe