Trabalho da Aula 5

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Treinamento com kFold == 5 utilizando o código fornecido em sala de aula

```r
# Carregando bibliotecas
library(cvTools)
```

```
## Carregando pacotes exigidos: lattice
```

```
## Carregando pacotes exigidos: robustbase
```

```r
library(RSNNS)
```

```
## Carregando pacotes exigidos: Rcpp
```

```r
# Função para calcular a acurácia
calc_acuracia <- function(y_desejado, y_estimado) {
  matriz_confusao <- table(y_desejado, y_estimado)
  acuracia <- sum(diag(matriz_confusao)) / length(y_desejado)
  return(acuracia * 100)
}

# Configurando a validação cruzada
db_iris <- iris
n <- dim(db_iris)[1]
K <- 5
pastas <- cvFolds(n, K, type = "random")

acuracias <- numeric(K)

for (pasta in 1:K) {
  i_treino <- which(pastas$which != pasta)
  i_teste <- which(pastas$which == pasta)

  # Preparando os dados de treino e teste
  X_treino <- db_iris[i_treino, -5]
  X_teste <- db_iris[i_teste, -5]
  classes_bin_treino <- decodeClassLabels(db_iris$Species[i_treino])
  classes_bin_teste <- decodeClassLabels(db_iris$Species[i_teste])

  # Treinando o modelo
  model <- mlp(X_treino, classes_bin_treino, size = c(2, 3), learnFuncParams = c(0.9),
               maxit = 100, learnFunc = "Std_Backpropagation",
               hiddenActFunc = "Act_Logistic", inputsTest = X_teste,
```

```
            targetsTest = classes_bin_teste, linOut = FALSE)

# Fazendo a previsão
y_estimado <- predict(model, X_teste)
y_estimado <- matrix(apply(y_estimado, 1, which.max), ncol = 1)
colnames(y_estimado) <- "Estimado"
y_estimado <- colnames(classes_bin_treino)[y_estimado]

# Calculando a acurácia
acuracias[pasta] <- calc_acuracia(db_iris$Species[i_teste], y_estimado)

# Plotando o gráfico de erro
plotIterativeError(model, main = paste("Erro Iterativo - Fold", pasta))
}
```
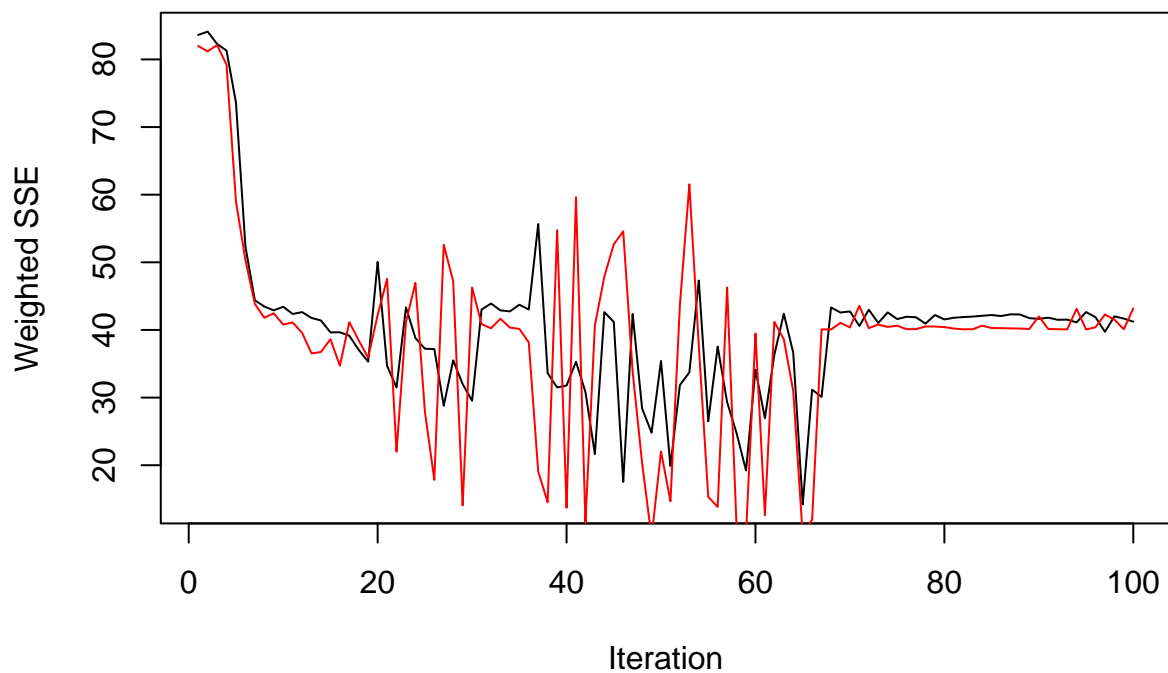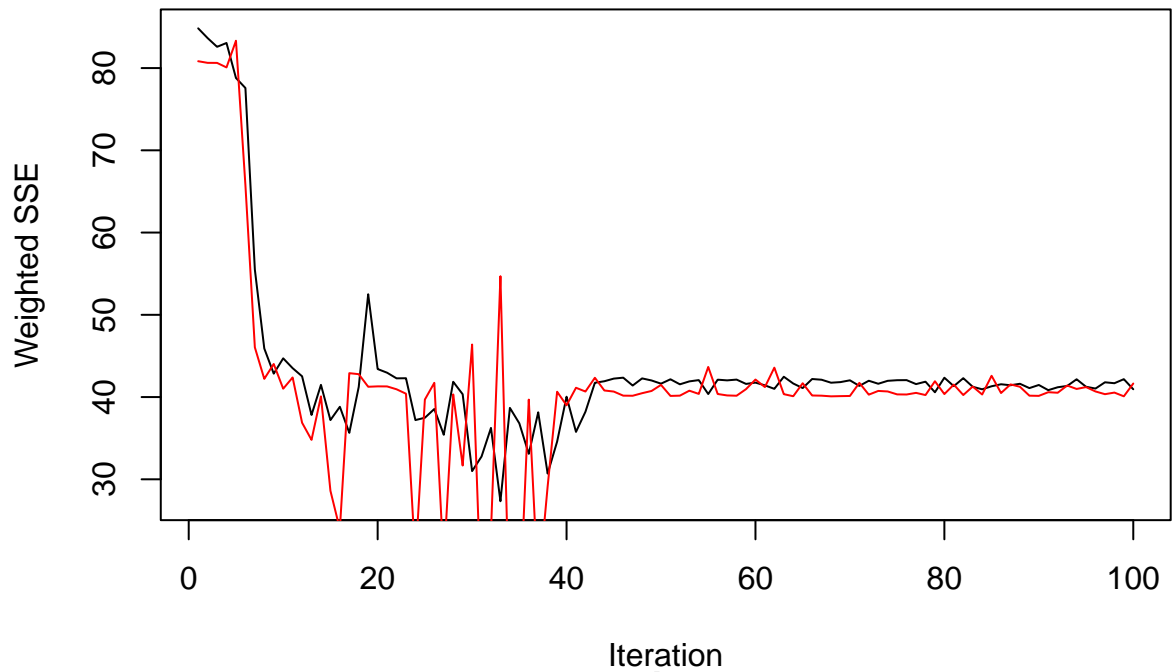
Erro Iterativo – Fold 1

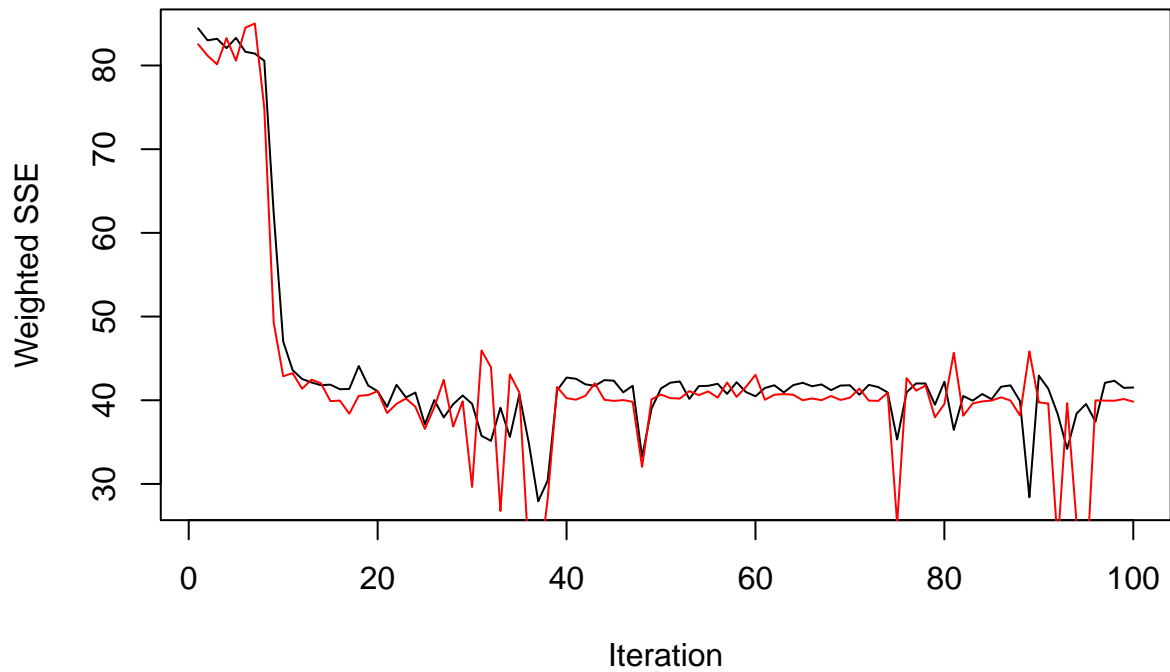# Erro Iterativo – Fold 2
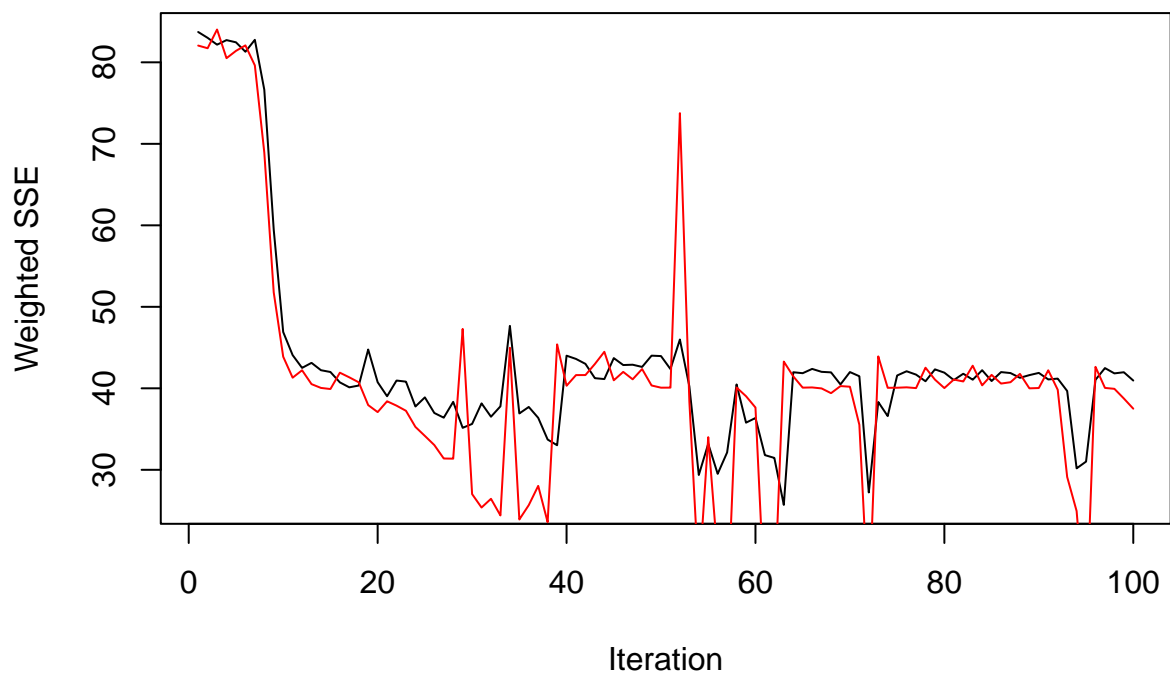

Erro Iterativo – Fold 3
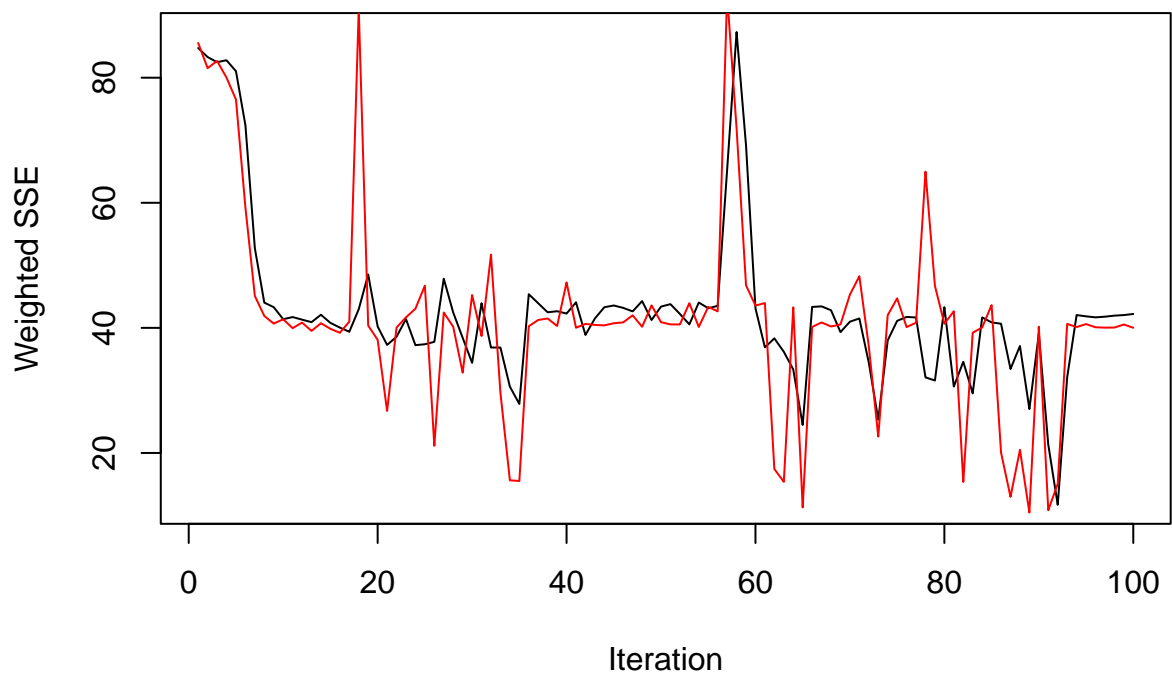
Erro Iterativo – Fold 4

Iteration

Erro Iterativo – Fold 5

Iteration

```r
# Acurácia média
acuracia_media <- mean(acuracias)
print(acuracia_media)
```

```
## [1] 69.33333
```

Testes com outras bibliotecas e abordagens

Treinamento com kFold == 5 utilizando a biblioteca nnet

```r
# Instalação da biblioteca cross-validation
# install.packages("cvTools")
library(cvTools)
library(nnet)

# Função para calcular a acurácia
calcular_acuracia <- function(valores_reais, valores_preditos) {
  return(mean(valores_reais == valores_preditos))
}

# Exemplo para a base iris
db_iris <- iris
n <- dim(db_iris)[1]
K <- 5
pastas <- cvFolds(n, K, type = "random")

# Inicializando variáveis para armazenar as acurácias
acuracia_kfold <- numeric(K)
acuracia_mlp <- numeric(K)

for (pasta in 1:K) {
  # Separando os índices para treino e teste
  i_treino <- which(pastas$which != pasta)
  i_teste <- which(pastas$which == pasta)

  # Criando os conjuntos de treino e teste
  db_treino <- db_iris[i_treino, ]
  db_teste <- db_iris[i_teste, ]

  # Treinando o modelo de regressão logística
  modelo_logistico <- multinom(Species ~ ., data = db_treino)

  # Treinando o modelo MLP
  modelo_mlp <- nnet(Species ~ ., data = db_treino, size = 10, MaxNWts = 1000, maxit = 200, trace = FALS

  # Realizando as predições com os modelos treinados
  predicoes_logistico <- predict(modelo_logistico, newdata = db_teste)
  predicoes_mlp <- predict(modelo_mlp, newdata = db_teste, type = "class")

  # Calculando a acurácia dos modelos
  acuracia_kfold[pasta] <- calcular_acuracia(db_teste$Species, predicoes_logistico)
  acuracia_mlp[pasta] <- calcular_acuracia(db_teste$Species, predicoes_mlp)
}
```

```
## # weights:  18 (10 variable)
## initial  value 131.833475
## iter  10 value 14.641515
## iter  20 value 5.743636
## iter  30 value 5.252989
## iter  40 value 5.090219
```

```
## iter  50 value 5.079198
## iter  60 value 5.073897
## iter  70 value 5.072414
## iter  80 value 5.071820
## iter  90 value 5.071543
## iter 100 value 5.071426
## final  value 5.071426
## stopped after 100 iterations
## # weights:  18 (10 variable)
## initial  value 131.833475
## iter  10 value 14.942936
## iter  20 value 5.947230
## iter  30 value 5.709551
## iter  40 value 5.492410
## iter  50 value 5.483572
## iter  60 value 5.475925
## iter  70 value 5.474264
## iter  80 value 5.473020
## final  value 5.473003
## converged
## # weights:  18 (10 variable)
## initial  value 131.833475
## iter  10 value 12.371811
## iter  20 value 5.589745
## iter  30 value 5.083009
## iter  40 value 4.896981
## iter  50 value 4.883934
## iter  60 value 4.877370
## iter  70 value 4.875567
## iter  80 value 4.873933
## iter  90 value 4.873882
## iter 100 value 4.873860
## final  value 4.873860
## stopped after 100 iterations
## # weights:  18 (10 variable)
## initial  value 131.833475
## iter  10 value 13.539674
## iter  20 value 2.057272
## iter  30 value 1.303208
## iter  40 value 1.009991
## iter  50 value 0.417583
## iter  60 value 0.362668
## iter  70 value 0.307475
## iter  80 value 0.263228
## iter  90 value 0.233302
## iter 100 value 0.160500
## final  value 0.160500
## stopped after 100 iterations
## # weights:  18 (10 variable)
## initial  value 131.833475
## iter  10 value 13.420210
## iter  20 value 6.069190
## iter  30 value 5.795209
## iter  40 value 5.701119
```

```
## iter   50 value 5.680581
## iter   60 value 5.673828
## iter   70 value 5.672708
## iter   80 value 5.671748
## final   value 5.671695
## converged
```

```r
# Calculando a acurácia média dos modelos
acuracia_media_kfold <- mean(acuracia_kfold)
acuracia_media_mlp <- mean(acuracia_mlp)

cat("Acurácia média do modelo de regressão logística com K-fold cross-validation:", acuracia_media_kfol
```

```
## Acurácia média do modelo de regressão logística com K-fold cross-validation: 0.9733333
```

```r
cat("Acurácia média do modelo MLP:", acuracia_media_mlp, "\n")
```

```
## Acurácia média do modelo MLP: 0.96
```

```r
# Medida de Desempenho
y_estimado <- c(1, 1, 1, 2, 2, 2, 2, 3, 3, 3)
y_desejado <- c(1, 1, 1, 1, 2, 2, 2, 1, 2, 3)

matriz_confusao <- table(y_desejado, y_estimado)

acuracia <- sum(diag(matriz_confusao)) / length(y_desejado)
print(acuracia * 100)
```

```
## [1] 70
```

```r
# Instalar a biblioteca RSNNS
# install.packages("RSNNS")


# Curva ROC
y_desejado <- c(0, 0, 0, 0, 1, 1, 1, 1, 1)
y_estimado <- c(0, 0, 0, 1, 1, 0, 1, 1, 1)

# Converter as classes para probabilidades
y_estimado_prob <- ifelse(y_estimado == 1, 1, 0)

# Instalar a biblioteca pROC
# install.packages("pROC")
library("pROC")
```

```
## Type 'citation("pROC")' for a citation.
```

```
##
## Attaching package: 'pROC'
```

```
## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```r
# Criar a curva ROC
roc_obj <- roc(y_desejado, y_estimado_prob)
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```
```r
# Plotar a curva ROC
plot(roc_obj, main = "Curva ROC")
```

Curva ROC
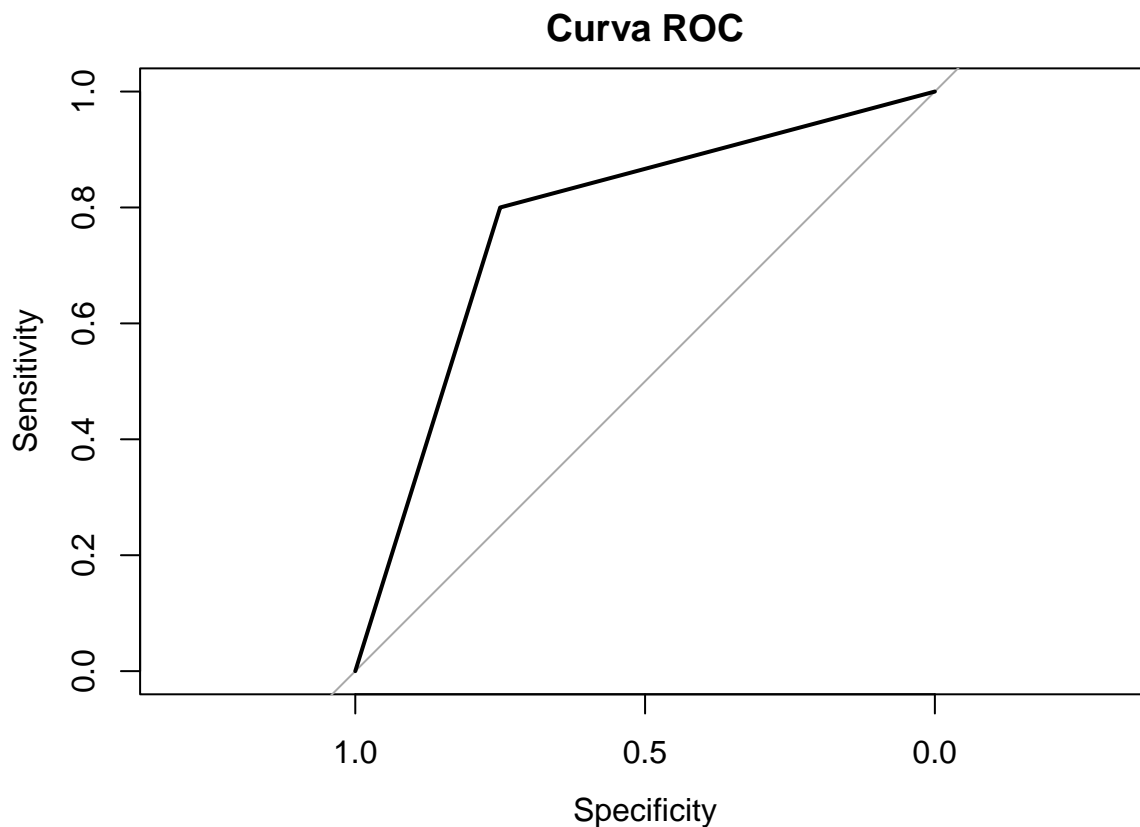
Treinamento com kFold == 5 e os Plots das redes neurais com neuralnet

```r
# Carregando as bibliotecas necessárias
library(neuralnet)
library(mltools)
library(data.table)
library(caret)
```

```
## Carregando pacotes exigidos: ggplot2

##
## Attaching package: 'caret'

## The following objects are masked from 'package:RSNNS':
##
##     confusionMatrix, train
```

```r
library(pROC)

# Carregando o dataset iris e normalizando os dados das colunas numéricas
iris2 = scale(iris[,1:4])
iris2 = as.data.frame(iris2)
iris2$Species = iris$Species
```

```r
# Definindo a semente aleatória
set.seed(1234)

# Definindo o número de folds e criando a lista de folds
k <- 5
folds <- createFolds(iris2$Species, k = k)

# Inicializando os vetores de acurácia e de curvas ROC
accuracy <- vector(mode = "numeric", length = k)
roc_list <- list()

# Loop principal que realiza o processo de treinamento e teste para cada fold
for(i in 1:k) {
  # Dividindo o dataset em conjunto de treinamento e teste
  iristreino <- iris2[folds[[i]], ]
  iristeste <- iris2[-folds[[i]], ]

  # Transformando a variável Species em one-hot encoding para utilização na rede neural
  iristreino <- cbind(iristreino[,1:4], one_hot(as.data.table(iristreino[,5])))

  # Treinando a rede neural com a função neuralnet, com duas camadas ocultas
  modelo <- neuralnet(V1_setosa + V1_versicolor + V1_virginica ~ Sepal.Length + Sepal.Width + Petal.Len

  # Plotando a rede neural treinada
  print(modelo)

  # Testando a rede neural no conjunto de teste e obtendo as predições
  teste <- compute(modelo, iristeste[,1:4])
  resultado <- as.data.frame(teste$net.result)

  # Renomeando as colunas das predições para as espécies de iris
  names(resultado)[1] <- 'setosa'
  names(resultado)[2] <- 'versicolor'
  names(resultado)[3] <- 'virginica'

  # Atribuindo a espécie com maior probabilidade como a predição final
  resultado$class <- colnames(resultado[,1:3])[max.col(resultado[,1:3], ties.method = 'first')]

  # Criando a tabela de confusão e imprimindo no console
  confusao <- table(resultado$class, iristeste$Species)
  print(confusao)

  # Calculando a acurácia do modelo para o fold atual e adicionando à lista de acurácias
  accuracy[i] <- sum(diag(confusao) * 100 / sum(confusao))
}
```

```
## $call
## neuralnet(formula = V1_setosa + V1_versicolor + V1_virginica ~
##     Sepal.Length + Sepal.Width + Petal.Length + Petal.Width,
##     data = iristreino, hidden = c(5, 4))
##
## $response
##     V1_setosa V1_versicolor V1_virginica
## 2           1             0            0
```

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```
## 14          1          0          0
## 15          1          0          0
## 22          1          0          0
## 24          1          0          0
## 27          1          0          0
## 30          1          0          0
## 40          1          0          0
## 47          1          0          0
## 48          1          0          0
## 52          0          1          0
## 56          0          1          0
## 58          0          1          0
## 63          0          1          0
## 67          0          1          0
## 72          0          1          0
## 80          0          1          0
## 87          0          1          0
## 90          0          1          0
## 99          0          1          0
## 104         0          0          1
## 106         0          0          1
## 107         0          0          1
## 108         0          0          1
## 110         0          0          1
## 112         0          0          1
## 123         0          0          1
## 141         0          0          1
## 147         0          0          1
## 150         0          0          1
##
## $covariate
##      Sepal.Length Sepal.Width Petal.Length Petal.Width
## 2     -1.13920048 -0.13153881   -1.3357516  -1.3110521
## 14    -1.86378030 -0.13153881   -1.5056946  -1.4422448
## 15    -0.05233076  2.16274279   -1.4490469  -1.3110521
## 22    -0.89767388  1.47445831   -1.2791040  -1.0486668
## 24    -0.89767388  0.55674567   -1.1658087  -0.9174741
## 27    -1.01843718  0.78617383   -1.2224563  -1.0486668
## 30    -1.38072709  0.32731751   -1.2224563  -1.3110521
## 40    -0.89767388  0.78617383   -1.2791040  -1.3110521
## 47    -0.89767388  1.70388647   -1.2224563  -1.3110521
## 48    -1.50149039  0.32731751   -1.3357516  -1.3110521
## 52     0.67224905  0.32731751    0.4203256   0.3944526
## 56    -0.17309407 -0.59039513    0.4203256   0.1320673
## 58    -1.13920048 -1.50810778   -0.2594462  -0.2615107
## 63     0.18919584 -1.96696410    0.1370873  -0.2615107
## 67    -0.29385737 -0.13153881    0.4203256   0.3944526
## 72     0.30995914 -0.59039513    0.1370873   0.1320673
## 80    -0.17309407 -1.04925145   -0.1461509  -0.2615107
## 87     1.03453895  0.09788935    0.5336209   0.3944526
## 90    -0.41462067 -1.27867961    0.1370873   0.1320673
## 99    -0.89767388 -1.27867961   -0.4293892  -0.1303181
## 104    0.55148575 -0.36096697    1.0434497   0.7880307
## 106    2.12140867 -0.13153881    1.6099263   1.1816087
```

```
## 107  -1.13920048 -1.27867961    0.4203256    0.6568380
## 108   1.75911877 -0.36096697    1.4399833    0.7880307
## 110   1.63835547  1.24503015    1.3266880    1.7063794
## 112   0.67224905 -0.81982329    0.8735068    0.9192234
## 123   2.24217198 -0.59039513    1.6665739    1.0504160
## 141   1.03453895  0.09788935    1.0434497    1.5751867
## 147   0.55148575 -1.27867961    0.7035638    0.9192234
## 150   0.06843254 -0.13153881    0.7602115    0.7880307
##
## $model.list
## $model.list$response
## [1] "V1_setosa"     "V1_versicolor" "V1_virginica"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
##
##
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x55b77bb58270>
## <environment: 0x55b77bb5a7b0>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x55b77bb522e0>
## <environment: 0x55b77bb55770>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##     Sepal.Length Sepal.Width Petal.Length Petal.Width V1_setosa V1_versicolor
## 2    -1.13920048 -0.13153881   -1.3357516  -1.3110521         1             0
## 14   -1.86378030 -0.13153881   -1.5056946  -1.4422448         1             0
## 15   -0.05233076  2.16274279   -1.4490469  -1.3110521         1             0
## 22   -0.89767388  1.47445831   -1.2791040  -1.0486668         1             0
## 24   -0.89767388  0.55674567   -1.1658087  -0.9174741         1             0
## 27   -1.01843718  0.78617383   -1.2224563  -1.0486668         1             0
## 30   -1.38072709  0.32731751   -1.2224563  -1.3110521         1             0
## 40   -0.89767388  0.78617383   -1.2791040  -1.3110521         1             0
## 47   -0.89767388  1.70388647   -1.2224563  -1.3110521         1             0
## 48   -1.50149039  0.32731751   -1.3357516  -1.3110521         1             0
## 52    0.67224905  0.32731751    0.4203256   0.3944526         0             1
## 56   -0.17309407 -0.59039513    0.4203256   0.1320673         0             1
```

```
## 58     -1.13920048 -1.50810778  -0.2594462  -0.2615107       0           1
## 63      0.18919584 -1.96696410   0.1370873  -0.2615107       0           1
## 67     -0.29385737 -0.13153881   0.4203256   0.3944526       0           1
## 72      0.30995914 -0.59039513   0.1370873   0.1320673       0           1
## 80     -0.17309407 -1.04925145  -0.1461509  -0.2615107       0           1
## 87      1.03453895  0.09788935   0.5336209   0.3944526       0           1
## 90     -0.41462067 -1.27867961   0.1370873   0.1320673       0           1
## 99     -0.89767388 -1.27867961  -0.4293892  -0.1303181       0           1
## 104     0.55148575 -0.36096697   1.0434497   0.7880307       0           0
## 106     2.12140867 -0.13153881   1.6099263   1.1816087       0           0
## 107    -1.13920048 -1.27867961   0.4203256   0.6568380       0           0
## 108     1.75911877 -0.36096697   1.4399833   0.7880307       0           0
## 110     1.63835547  1.24503015   1.3266880   1.7063794       0           0
## 112     0.67224905 -0.81982329   0.8735068   0.9192234       0           0
## 123     2.24217198 -0.59039513   1.6665739   1.0504160       0           0
## 141     1.03453895  0.09788935   1.0434497   1.5751867       0           0
## 147     0.55148575 -1.27867961   0.7035638   0.9192234       0           0
## 150     0.06843254 -0.13153881   0.7602115   0.7880307       0           0
##      V1_virginica
## 2               0
## 14              0
## 15              0
## 22              0
## 24              0
## 27              0
## 30              0
## 40              0
## 47              0
## 48              0
## 52              0
## 56              0
## 58              0
## 63              0
## 67              0
## 72              0
## 80              0
## 87              0
## 90              0
## 99              0
## 104             1
## 106             1
## 107             1
## 108             1
## 110             1
## 112             1
## 123             1
## 141             1
## 147             1
## 150             1
##
## $exclude
## NULL
##
## $net.result
```

```
## $net.result[[1]]
##               [,1]            [,2]            [,3]
## 2     0.9983360751   0.0002968086  -0.0001137420
## 14    0.9894133666   0.0031357666  -0.0006279109
## 15    1.0208769958  -0.0071023552   0.0012927539
## 22    1.0055576807  -0.0020381419   0.0003200919
## 24    0.9951281150   0.0013195807  -0.0002991455
## 27    0.9976853322   0.0005047072  -0.0001516177
## 30    0.9885757071   0.0033991962  -0.0006746135
## 40    1.0051920673  -0.0019187983   0.0002975485
## 47    1.0067600210  -0.0024296100   0.0003935570
## 48    0.9914847036   0.0024811898  -0.0005107241
## 52    0.0007765890   1.0117650564  -0.0181121086
## 56   -0.0096223862   1.0007159004  -0.0082742113
## 58   -0.0038856263   0.9946634631   0.0030394698
## 63    0.0044696048   0.9983173943   0.0099631191
## 67   -0.0105833748   0.9807097371   0.0112801562
## 72    0.0065789256   1.0060378423   0.0009350136
## 80    0.0117825297   1.0054895553  -0.0149686825
## 87    0.0007961207   0.9858616387   0.0154454297
## 90   -0.0071891504   0.9998172224  -0.0046847387
## 99    0.0053122498   1.0046977328  -0.0099998615
## 104  -0.0028782863  -0.0219362366   1.0197030756
## 106   0.0014133636  -0.0030316835   1.0057634493
## 107  -0.0071103704  -0.0033400453   0.9969451838
## 108   0.0031753765   0.0185166032   0.9863998854
## 110   0.0028023744   0.0097406571   0.9946555147
## 112   0.0006956241  -0.0022426441   1.0041709978
## 123   0.0010833133  -0.0058740234   1.0082094234
## 141  -0.0007125770  -0.0201091809   1.0202788356
## 147   0.0021311866   0.0105600679   0.9930844930
## 150  -0.0003236623   0.0245702659   0.9765715382
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##             [,1]       [,2]       [,3]       [,4]       [,5]
## [1,]   1.5759304 -0.9061128 -8.1267072 -3.034730 -4.126777
## [2,]   0.8268200 -1.6353893  0.1363777  0.339520 -1.214996
## [3,]   0.1789453 -4.2818750 -1.1160758 -1.018054 -1.129891
## [4,]  -1.5919588  8.5226626  1.7905775  2.045641  4.493194
## [5,]  -0.4053111  4.9718668 12.4956650  4.709414 10.037525
##
## $weights[[1]][[2]]
##             [,1]       [,2]       [,3]       [,4]
## [1,]  -1.0034327 -0.9211473  0.5732014  0.1162771
## [2,]  -3.7260860  1.2506680 -1.9584403  0.6291244
## [3,]  -0.4141908 -6.0254267 -0.6662233  0.9624586
## [4,]   2.6676290 -0.6933613  1.9513427  0.5153213
## [5,]   2.3572821 -0.1823520  1.0921791  0.3518738
## [6,]   0.2326597  0.3915714 -0.8266362 -0.8851566
##
## $weights[[1]][[3]]
```

```
##              [,1]       [,2]       [,3]
## [1,] -0.1464342  1.4481961 -0.5954577
## [2,]  0.4224612 -0.5775787  1.1036202
## [3,]  1.8722017 -1.8032468  0.1743794
## [4,] -0.6241608 -0.9660941  0.1750978
## [5,]  0.3042919 -0.3100967  0.6651170
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##               [,1]        [,2]        [,3]        [,4]        [,5]        [,6]
## 2      14.1452111   3.06241319 -27.2371836  -6.9369925 -25.4216471  -5.50217552
## 14      2.8980807   0.62727602  -5.5800685  -1.4208009  -3.0611589  -0.66254739
## 15     -0.2606338  -0.05641254   0.5018357   0.1277846   0.2606062   0.05639109
## 22     -3.1930288  -0.69118647   6.1481824   1.5658269   2.8456380   0.61558180
## 24      5.3578724   1.16066800 -10.3185364  -2.6307067  -6.2874596  -1.35869452
## 27     10.3933482   2.25014015 -20.0131431  -5.0980366 -15.2538493  -3.29898882
## 30      2.7441980   0.59401283  -5.2838754  -1.3455225  -2.8789564  -0.62305125
## 40     -3.4744331  -0.75204323   6.6898804   1.7035563   3.0696128   0.66417244
## 47     -2.4824759  -0.53730009   4.7798269   1.2170463   2.2645710   0.49004946
## 48      3.4083901   0.73774753  -6.5626928  -1.6711013  -3.6806196  -0.79649798
## 52      1.8885276  -7.33251890  -2.1146272 -46.2492577   3.3922947  -0.25639009
## 56     -1.6815248  -0.52876643   3.6588293  -2.7715234   3.3094784 -23.22588804
## 58     -7.6851526  -0.62232942  13.8424384   3.6372559   8.4090148   1.38936613
## 63      5.1922662   2.88119210 -14.3977043  -9.7793093  18.0591100  16.75968777
## 67     -1.4361460  -0.55830143   3.0961550   4.2614940   1.9099229   6.21562818
## 72      1.4992072  -0.19491876  -3.4426321  -1.1059698   0.5486228  -0.25480347
## 80      2.0780849   0.73724762  -4.5887083  -1.8795643   2.5627857  17.47390543
## 87      1.4090224   4.19545320 -14.1797820 -74.6852434  -1.7648792   4.74228474
## 90     -2.1334841  -0.89674805   5.1152608  -2.9366352 -26.8477268  96.02082628
## 99      3.7045736  -1.95892277  -3.7535556   0.1931390  -1.5700208  11.49882849
## 104    -5.8354053  -1.70533585  11.9930869   8.0199523  -5.0424456  -2.15245389
## 106    10.0924040   2.17631782 -19.4104649  -4.9286066 -40.8018249  -9.01989205
## 107    -2.2302276  -1.57172475   6.1874569  13.5566201 -26.5672751 -39.52672989
## 108     3.7904608   0.92248753  -7.4371271  -3.3730895   7.0164739   2.04149912
## 110     4.5564930   0.97841272  -8.7566140  -2.2073938  13.1583109   2.88894367
## 112    20.6214269   4.49175710 -39.5681918 -12.1637223 -54.5467406 -15.55801251
## 123    13.4697983   2.91222926 -25.9206986  -6.6507115 -20.8782626  -4.62403176
## 141   -22.7017080  -4.90375250  43.6869042  11.0889844  -5.8198382  -1.28269125
## 147     6.0361252   1.26936896 -11.4768323  -3.2833198  12.0338362   3.35897181
## 150   -39.5775965 -11.90448487  78.8659952  87.5750369   4.9798688   3.62343857
##              [,7]       [,8]        [,9]       [,10]       [,11]      [,12]
## 2      48.9444595  12.453663 -12.1833093  -2.63223199  23.4460684   5.9507165
## 14      5.8939203   1.500387  -2.7143048  -0.58720339   5.2254912   1.3293897
## 15     -0.5017442  -0.127702   0.2831794   0.06124101  -0.5451188  -0.1386089
## 22     -5.4782758  -1.393653   3.4132742   0.73730798  -6.5684213  -1.6668915
## 24     12.1000111   3.070628  -5.0354906  -1.08080509   9.6728933   2.4277128
## 27     29.3636885   7.466200  -9.3043864  -2.00718850  17.8984839   4.5317857
## 30      5.5429222   1.410697  -2.5671649  -0.55502109   4.9413457   1.2557292
## 40     -5.9097971  -1.503943   3.7241666   0.80511790  -7.1683083  -1.8216264
## 47     -4.3600492  -1.109824   2.6441280   0.57196136  -5.0902694  -1.2948398
## 48      7.0863640   1.803599  -3.2007104  -0.69212294   6.1611545   1.5662800
## 52     -1.7936479   9.995716  -1.0631356   3.42205487  -4.6392286  -7.4115290
```

```
## 56     50.7974589 -187.680898  -2.3699853   1.35463682    0.2025419   11.6024923
## 58    -16.5124397   -5.180572  -3.6687610  -3.20884772   11.1958618    5.4218021
## 63    -66.7055974  -59.185497  -0.3251974  -1.27230549    3.5725438    4.6104316
## 67    -16.5656261  -37.186997  -1.7984404  -9.97027437   24.9345372   58.1517236
## 72      2.8420805   -3.151677   7.4825736 -21.96919926   28.6035296   -9.1135085
## 80    -27.0625304  -16.429986   1.4003530   3.42640368   -7.1599145   -4.4944749
## 87     -8.1047961  -30.409126   1.3202018  -4.75525677    8.0575362   23.9857773
## 90   -187.4734404  664.042593  -4.5607403   2.15566210    1.4148927   19.4513580
## 99    -12.0808849   -9.786408   1.7976245   4.06065834   -8.7358007   -5.0990254
## 104    12.0103515   10.279851   4.6144281   2.09381318  -11.2957270   -9.9831545
## 106    79.0208610   20.914160  18.4507530   4.09410818  -35.7713894   -9.5252672
## 107   121.7701670  286.936599 -22.9393262 -38.62276068  115.6495090  273.6591923
## 108   -14.6162707   -7.544910  -8.4385980  -2.49966037   17.6951332    9.2152299
## 110   -25.4378103   -6.637639 -21.0092102  -4.62640407   40.6473893   10.6535297
## 112   113.7641584   48.616386  25.1610994   7.43701298  -53.1248535  -23.5582964
## 123    40.4496952   10.800229  12.7858097   2.84230708  -24.7975440   -6.6604233
## 141    11.2627037    2.956585   4.8256420   1.06753306   -9.3484802   -2.4691311
## 147   -24.9369374  -10.202981 -16.0727098  -4.63163364   33.6690127   14.2520325
## 150   -15.1511194  -20.788778  -4.5501392  -3.57206510   14.4954226   20.1070947
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##               [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] -0.47471847 -0.89626463 -0.64906975 -1.24428785 -0.78190665
## [2,]  0.06599349  0.16818539 -1.10976723  0.16902641  2.05816199
## [3,] -0.50247778  0.35496826  0.84927420  0.67316631  0.75050145
## [4,] -0.82599859 -0.05210512  0.02236253 -0.02627638  1.82420830
## [5,]  0.16698928 -0.19593462  0.83114062 -0.19139217  0.08005964
##
## $startweights[[1]][[2]]
##            [,1]       [,2]       [,3]      [,4]
## [1,] -0.6314093 -1.1719483  0.9200575 0.5137628
## [2,] -1.5132881  0.6687143 -0.6228716 0.3992718
## [3,] -0.6360998 -1.6501009 -0.3340366 1.6628564
## [4,]  0.2263015 -0.3658522  1.3951479 0.2758934
## [5,]  1.0136903 -0.3161183  0.6366744 0.5062726
## [6,]  0.2527501 -1.9482460 -0.1084317 0.3475520
##
## $startweights[[1]][[3]]
##            [,1]       [,2]       [,3]
## [1,] -0.37723765  1.3621307 -0.8473501
## [2,]  0.09761946 -0.2346211 -0.2606394
## [3,]  1.63874465 -1.0533828 -0.4144197
## [4,] -0.87559247 -0.8697836 -0.1830508
## [5,]  0.12176000 -0.3901270  0.4070561
##
##
##
## $result.matrix
##                                  [,1]
## error                    0.003728005
## reached.threshold        0.009667820
```

```
## steps                    264.000000000
## Intercept.to.1layhid1        1.575930428
## Sepal.Length.to.1layhid1     0.826820047
## Sepal.Width.to.1layhid1      0.178945270
## Petal.Length.to.1layhid1    -1.591958831
## Petal.Width.to.1layhid1     -0.405311097
## Intercept.to.1layhid2       -0.906112810
## Sepal.Length.to.1layhid2    -1.635389318
## Sepal.Width.to.1layhid2     -4.281875019
## Petal.Length.to.1layhid2     8.522662613
## Petal.Width.to.1layhid2      4.971866795
## Intercept.to.1layhid3       -8.126707243
## Sepal.Length.to.1layhid3     0.136377707
## Sepal.Width.to.1layhid3     -1.116075775
## Petal.Length.to.1layhid3     1.790577526
## Petal.Width.to.1layhid3     12.495665013
## Intercept.to.1layhid4       -3.034729674
## Sepal.Length.to.1layhid4     0.339520014
## Sepal.Width.to.1layhid4     -1.018053703
## Petal.Length.to.1layhid4     2.045641072
## Petal.Width.to.1layhid4      4.709414388
## Intercept.to.1layhid5       -4.126776683
## Sepal.Length.to.1layhid5    -1.214995982
## Sepal.Width.to.1layhid5     -1.129891249
## Petal.Length.to.1layhid5     4.493193542
## Petal.Width.to.1layhid5     10.037525313
## Intercept.to.2layhid1       -1.003432695
## 1layhid1.to.2layhid1        -3.726085991
## 1layhid2.to.2layhid1        -0.414190751
## 1layhid3.to.2layhid1         2.667628995
## 1layhid4.to.2layhid1         2.357282064
## 1layhid5.to.2layhid1         0.232659694
## Intercept.to.2layhid2       -0.921147311
## 1layhid1.to.2layhid2         1.250668005
## 1layhid2.to.2layhid2        -6.025426705
## 1layhid3.to.2layhid2        -0.693361280
## 1layhid4.to.2layhid2        -0.182351971
## 1layhid5.to.2layhid2         0.391571351
## Intercept.to.2layhid3        0.573201378
## 1layhid1.to.2layhid3        -1.958440315
## 1layhid2.to.2layhid3        -0.666223283
## 1layhid3.to.2layhid3         1.951342714
## 1layhid4.to.2layhid3         1.092179118
## 1layhid5.to.2layhid3        -0.826636247
## Intercept.to.2layhid4        0.116277086
## 1layhid1.to.2layhid4         0.629124417
## 1layhid2.to.2layhid4         0.962458648
## 1layhid3.to.2layhid4         0.515321279
## 1layhid4.to.2layhid4         0.351873778
## 1layhid5.to.2layhid4        -0.885156620
## Intercept.to.V1_setosa      -0.146434224
## 2layhid1.to.V1_setosa        0.422461186
## 2layhid2.to.V1_setosa        1.872201726
## 2layhid3.to.V1_setosa       -0.624160831
```

```
## 2layhid4.to.V1_setosa         0.304291938
## Intercept.to.V1_versicolor    1.448196093
## 2layhid1.to.V1_versicolor    -0.577578731
## 2layhid2.to.V1_versicolor    -1.803246752
## 2layhid3.to.V1_versicolor    -0.966094064
## 2layhid4.to.V1_versicolor    -0.310096693
## Intercept.to.V1_virginica    -0.595457707
## 2layhid1.to.V1_virginica     1.103620184
## 2layhid2.to.V1_virginica     0.174379390
## 2layhid3.to.V1_virginica     0.175097787
## 2layhid4.to.V1_virginica     0.665117001
##
## attr(,"class")
## [1] "nn"
##
##               setosa versicolor virginica
##    setosa         40          0         0
##    versicolor      0         37         2
##    virginica       0          3        38
## $call
## neuralnet(formula = V1_setosa + V1_versicolor + V1_virginica ~
##     Sepal.Length + Sepal.Width + Petal.Length + Petal.Width,
##     data = iristreino, hidden = c(5, 4))
##
## $response
##     V1_setosa V1_versicolor V1_virginica
## 3           1             0            0
## 4           1             0            0
## 21          1             0            0
## 31          1             0            0
## 33          1             0            0
## 34          1             0            0
## 35          1             0            0
## 37          1             0            0
## 45          1             0            0
## 49          1             0            0
## 54          0             1            0
## 57          0             1            0
## 59          0             1            0
## 60          0             1            0
## 61          0             1            0
## 69          0             1            0
## 79          0             1            0
## 83          0             1            0
## 91          0             1            0
## 96          0             1            0
## 102         0             0            1
## 103         0             0            1
## 114         0             0            1
## 117         0             0            1
## 124         0             0            1
## 127         0             0            1
## 128         0             0            1
## 133         0             0            1
```

```
## 136          0            0            1
## 149          0            0            1
##
## $covariate
##      Sepal.Length Sepal.Width Petal.Length   Petal.Width
## 3    -1.38072709  0.32731751  -1.39239929 -1.3110521482
## 4    -1.50149039  0.09788935  -1.27910398 -1.3110521482
## 21   -0.53538397  0.78617383  -1.16580868 -1.3110521482
## 31   -1.25996379  0.09788935  -1.22245633 -1.3110521482
## 33   -0.77691058  2.39217095  -1.27910398 -1.4422448248
## 34   -0.41462067  2.62159911  -1.33575163 -1.3110521482
## 35   -1.13920048  0.09788935  -1.27910398 -1.3110521482
## 37   -0.41462067  1.01560199  -1.39239929 -1.3110521482
## 45   -0.89767388  1.70388647  -1.05251337 -1.0486667950
## 49   -0.65614727  1.47445831  -1.27910398 -1.3110521482
## 54   -0.41462067 -1.73753594   0.13708732  0.1320672944
## 57    0.55148575  0.55674567   0.53362088  0.5256453243
## 59    0.91377565 -0.36096697   0.47697323  0.1320672944
## 60   -0.77691058 -0.81982329   0.08043967  0.2632599711
## 61   -1.01843718 -2.42582042  -0.14615094 -0.2615107354
## 69    0.43072244 -1.96696410   0.42032558  0.3944526477
## 79    0.18919584 -0.36096697   0.42032558  0.3944526477
## 83   -0.05233076 -0.81982329   0.08043967  0.0008746178
## 91   -0.41462067 -1.04925145   0.36367793  0.0008746178
## 96   -0.17309407 -0.13153881   0.25038262  0.0008746178
## 102  -0.05233076 -0.81982329   0.76021149  0.9192233541
## 103   1.51759216 -0.13153881   1.21339271  1.1816087073
## 114  -0.17309407 -1.27867961   0.70356384  1.0504160307
## 117   0.79301235 -0.13153881   0.98680210  0.7880306775
## 124   0.55148575 -0.81982329   0.64691619  0.7880306775
## 127   0.43072244 -0.59039513   0.59026853  0.7880306775
## 128   0.30995914 -0.13153881   0.64691619  0.7880306775
## 133   0.67224905 -0.59039513   1.04344975  1.3128013839
## 136   2.24217198 -0.13153881   1.32668801  1.4439940605
## 149   0.43072244  0.78617383   0.93015445  1.4439940605
##
## $model.list
## $model.list$response
## [1] "V1_setosa"     "V1_versicolor" "V1_virginica"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
##
##
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x55b77bb58270>
## <environment: 0x55b7771bb480>
## attr(,"type")
## [1] "sse"
##
```

```
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x55b77bb522e0>
## <environment: 0x55b7771bafe8>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##      Sepal.Length Sepal.Width Petal.Length  Petal.Width V1_setosa V1_versicolor
## 3    -1.38072709  0.32731751  -1.39239929 -1.3110521482         1             0
## 4    -1.50149039  0.09788935  -1.27910398 -1.3110521482         1             0
## 21   -0.53538397  0.78617383  -1.16580868 -1.3110521482         1             0
## 31   -1.25996379  0.09788935  -1.22245633 -1.3110521482         1             0
## 33   -0.77691058  2.39217095  -1.27910398 -1.4422448248         1             0
## 34   -0.41462067  2.62159911  -1.33575163 -1.3110521482         1             0
## 35   -1.13920048  0.09788935  -1.27910398 -1.3110521482         1             0
## 37   -0.41462067  1.01560199  -1.39239929 -1.3110521482         1             0
## 45   -0.89767388  1.70388647  -1.05251337 -1.0486667950         1             0
## 49   -0.65614727  1.47445831  -1.27910398 -1.3110521482         1             0
## 54   -0.41462067 -1.73753594   0.13708732  0.1320672944         0             1
## 57    0.55148575  0.55674567   0.53362088  0.5256453243         0             1
## 59    0.91377565 -0.36096697   0.47697323  0.1320672944         0             1
## 60   -0.77691058 -0.81982329   0.08043967  0.2632599711         0             1
## 61   -1.01843718 -2.42582042  -0.14615094 -0.2615107354         0             1
## 69    0.43072244 -1.96696410   0.42032558  0.3944526477         0             1
## 79    0.18919584 -0.36096697   0.42032558  0.3944526477         0             1
## 83   -0.05233076 -0.81982329   0.08043967  0.0008746178         0             1
## 91   -0.41462067 -1.04925145   0.36367793  0.0008746178         0             1
## 96   -0.17309407 -0.13153881   0.25038262  0.0008746178         0             1
## 102  -0.05233076 -0.81982329   0.76021149  0.9192233541         0             0
## 103   1.51759216 -0.13153881   1.21339271  1.1816087073         0             0
## 114  -0.17309407 -1.27867961   0.70356384  1.0504160307         0             0
## 117   0.79301235 -0.13153881   0.98680210  0.7880306775         0             0
## 124   0.55148575 -0.81982329   0.64691619  0.7880306775         0             0
## 127   0.43072244 -0.59039513   0.59026853  0.7880306775         0             0
## 128   0.30995914 -0.13153881   0.64691619  0.7880306775         0             0
## 133   0.67224905 -0.59039513   1.04344975  1.3128013839         0             0
## 136   2.24217198 -0.13153881   1.32668801  1.4439940605         0             0
## 149   0.43072244  0.78617383   0.93015445  1.4439940605         0             0
##      V1_virginica
## 3               0
## 4               0
## 21              0
## 31              0
## 33              0
## 34              0
## 35              0
## 37              0
```

```
## 45             0
## 49             0
## 54             0
## 57             0
## 59             0
## 60             0
## 61             0
## 69             0
## 79             0
## 83             0
## 91             0
## 96             0
## 102            1
## 103            1
## 114            1
## 117            1
## 124            1
## 127            1
## 128            1
## 133            1
## 136            1
## 149            1
##
## $exclude
## NULL
##
## $net.result
## $net.result[[1]]
##               [,1]            [,2]            [,3]
## 3      1.0021176587  0.0024770972  0.001333362
## 4      1.0057805727  0.0063912185  0.001379148
## 21     0.9974437220 -0.0023923006  0.001262190
## 31     1.0057514480  0.0064329693  0.001378838
## 33     0.9939986088 -0.0067225157  0.001202754
## 34     0.9936966184 -0.0065848175  0.001191821
## 35     1.0057595189  0.0065578591  0.001378961
## 37     0.9960127060 -0.0035529018  0.001236599
## 45     0.9943182632 -0.0061528183  0.001209137
## 49     0.9948493467 -0.0055951572  0.001217746
## 54    -0.0076575836  0.9743049091  0.014699892
## 57    -0.0018683520  0.9854923540  0.036661231
## 59    -0.0233463679  1.0056489293 -0.029403670
## 60    -0.0180739245  1.0019530424 -0.012577491
## 61     0.0246382075  1.0069309933 -0.006987285
## 69    -0.0095513022  1.0126340475 -0.008192879
## 79    -0.0102217286  0.9007257257  0.020585641
## 83    -0.0234983420  1.0563995718 -0.018511365
## 91     0.0118282906  0.9788873421 -0.010718390
## 96     0.0538526273  1.0546668361 -0.005248557
## 102    0.0069212951 -0.0190078085  1.020378493
## 103   -0.0046405892  0.0080965151  0.997748081
## 114    0.0054856445  0.0325702829  0.997465572
## 117   -0.0001528566 -0.0027853397  0.998972351
## 124    0.0002554732  0.0170268921  1.000672453
```

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```
## 127  0.0029191820 -0.0101600612  1.012148625
## 128  0.0084040532  0.0185275257  0.953721041
## 133 -0.0034186766 -0.0160473753  1.031882810
## 136 -0.0046043747  0.0038841818  1.001206974
## 149 -0.0006389511 -0.0005476318  0.986219580
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##             [,1]        [,2]       [,3]        [,4]       [,5]
## [1,]   1.652190 -4.0412359   2.929088 -2.55580014 -9.068444
## [2,]   2.630721  4.7808859  -1.442603  0.01715896  4.257276
## [3,]  -1.692355  0.3451255   3.633206 -1.80376461  1.730150
## [4,]  -2.791903 -1.3214770  -0.159821 -0.06607537  1.959214
## [5,]   8.739499  2.8391343  -5.675086 -0.57685031 12.023766
##
## $weights[[1]][[2]]
##             [,1]        [,2]        [,3]        [,4]
## [1,]  -0.2071041  0.1749067 -0.49735128 -0.5734452
## [2,]  -4.4954617 -1.4632796  0.54711320 -0.5461697
## [3,]  -0.7053793 -0.2759244  0.07366498  0.4924756
## [4,]   0.8401239 -4.7781242  1.53659154 -3.7742390
## [5,]   0.3692577 -0.5965535  0.72980028  0.6082486
## [6,]   1.2382166  1.6931886 -0.29468575 -0.5672535
##
## $weights[[1]][[3]]
##             [,1]        [,2]         [,3]
## [1,]   0.16104550 -0.1209425 -0.139117662
## [2,]   1.61378183 -1.6743774  0.007823021
## [3,]  -0.12588865 -1.6364414  2.486528298
## [4,]  -0.29900755  1.6383630  0.167625078
## [5,]   0.06145687  1.0603988 -1.040175187
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##               [,1]         [,2]          [,3]          [,4]          [,5]
## 3     0.024615911  6.44759957   0.148454744   2.36018029   0.14160702
## 4    -0.006642439  3.24186917   0.093923798   1.12164573   0.05515763
## 21   -0.231959094 -2.52767719   0.099459189  -1.42466135  -0.34098072
## 31    0.008773038  3.25000166   0.078682936   1.17705436   0.07052621
## 33   -0.018847060 -0.07313640   0.003560681  -0.03761208  -0.02056422
## 34   -0.174386888 -0.05084735   0.051783220  -0.13500633  -0.19105253
## 35    0.033199393  3.24467209   0.053871819   1.25879653   0.09392720
## 37   -0.332022477 -1.06057894   0.192698694  -1.06452208  -0.45043028
## 45   -0.059989175 -0.17984187   0.042831638  -0.21814235  -0.06642901
## 49   -0.061372103 -0.38936590   0.022659258  -0.23475107  -0.07202616
## 54    0.204485189 -0.96001371  -0.631261503  -0.05346790  -0.25862714
## 57   -2.004434401  1.19568296 -21.469523753 -67.45921901 -14.51850963
## 59   -0.640048094  2.62937341  -0.524167492  -4.52758194  13.09057427
## 60   -0.438127041  2.26589550  -1.120686533  -2.47447241  68.27841077
## 61   -5.176865323  3.24049424   5.605965281 -17.10969754 -36.67006417
```

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```
## 69    0.278645715  -1.03878214  -0.134010934  -0.23041130   -6.70278221
## 79   -1.923199628   4.49020009  -0.734193890  -8.70274303   -2.28860092
## 83    0.200312201   1.30585584  -1.315725135  -0.18191503    1.65840035
## 91   -9.122761318   3.97681810  11.286450622 -29.18439194    2.50031994
## 96   -6.526229561   4.22868649   6.837447160 -21.60234038   -6.73439585
## 102   0.353400983   1.02068762   0.727951277   2.69170985   22.72250687
## 103   0.074197508  -0.33812192  -0.029489395  -0.04232118    0.72075326
## 114   0.770695635   1.49555707   0.939424255   4.12718956  -12.36078370
## 117 113.486046434 -26.09190328 -29.258788115  93.80967886  -56.20757046
## 124 -70.168502090  15.94084806  24.992787190 -23.01884917    1.50366405
## 127  -5.686682537   1.48504281   2.264150615  -1.52163735    8.28196618
## 128  -2.281017804   1.39351019   0.802433050  -1.92788356  -11.85732161
## 133   2.785851091  -0.61080829  -0.796192475   1.40493458  -12.40561527
## 136   0.004342542  -0.29059297  -0.010870199  -0.09010692    0.07810878
## 149  19.806277224  -4.62987646  -4.648887197  18.92550240 -191.61920387
##               [,6]         [,7]          [,8]          [,9]         [,10]
## 3     -6.14458148  -0.310238462  -1.677044e+00 -2.056757e-04 -1.403441e-01
## 4     -3.19021297  -0.142550996  -9.334898e-01  4.205889e-04 -1.554907e-01
## 21     3.24806171   0.350597959   2.972690e-01 -1.186597e-02 -8.468953e-02
## 31    -3.17980416  -0.157759961  -8.776331e-01 -3.344807e-04 -1.552087e-01
## 33     0.07282196   0.008997238   8.885967e-03 -4.236639e-03 -6.807222e-03
## 34     0.03772445   0.059779899  -1.170277e-01 -4.123566e-02 -6.810723e-03
## 35    -3.14646655  -0.180519343  -7.859369e-01 -1.517610e-03 -1.547972e-01
## 37     1.59766904   0.351438811  -4.049945e-01 -3.014668e-02 -6.110285e-02
## 45     0.24205475   0.060021226  -8.868120e-02 -6.282050e-03 -1.617245e-02
## 49     0.43244811   0.054129958   2.424251e-02 -8.762686e-03 -2.982824e-02
## 54    -6.67256067  -1.185435137  -4.850166e+00  6.360898e-01  4.988794e+00
## 57    24.05344304  -8.396198221  -6.865492e+01  2.701458e+00 -3.325181e+00
## 59   -57.91294685  14.603919100   1.195636e+02  1.250127e+00  5.685837e-01
## 60  -159.15757928  33.534111694   3.003844e+02 -1.748047e+00  3.827225e+00
## 61    26.07440693  46.750474205  -1.128193e+02  1.551931e+01 -7.284875e+00
## 69    16.49421597   3.412463806   4.471975e+00  9.290783e+00 -1.441355e+01
## 79     4.44002609  -0.725683884  -9.943252e+00  5.174701e+00 -9.047536e+00
## 83    -4.47837405   1.342877809   7.868338e+00  2.347674e-01 -5.670115e-01
## 91     7.39856322 -12.287791186   1.077115e+00 -1.974942e-02  3.158177e+00
## 96     3.85643772   7.644050948  -2.182181e+01  4.047137e-01 -1.081236e+00
## 102   15.95888767  12.676819940   7.407195e+01 -2.557027e+01 -1.406083e+01
## 103   -5.09485446  -0.579580793  -3.044827e+00 -2.297262e+00  1.074170e+01
## 114  -12.73880825  -7.002442082  -4.061661e+01  1.849454e+02  1.432319e+02
## 117  -67.71476707  33.867222190   9.864267e+01 -1.330904e+02 -2.439765e+02
## 124  -13.04508915 -12.531895365  -3.947601e+01 -4.301122e+01 -2.724528e+02
## 127   14.27732560  22.037722390   8.809426e+01 -1.249459e+01 -9.616159e+00
## 128   19.49475133 -10.021597852  -7.090815e+01  6.710660e+00 -1.003631e+01
## 133    4.79051844   3.658768259  -5.225584e+00  6.193239e+00 -1.480587e+00
## 136  -11.18135064  -0.434839335  -3.883184e+00  1.056503e-01 -2.478469e+01
## 149 -506.33949296 129.521107581   5.466496e+02 -6.411550e+00 -2.432696e+01
##              [,11]        [,12]
## 3    -3.655865e-03 -4.980992e-02
## 4    -4.633935e-03 -5.323864e-02
## 21    3.077836e-03 -4.455442e-02
## 31   -3.945789e-03 -5.536662e-02
## 33    9.941890e-04 -4.801823e-03
## 34    1.155608e-02 -2.685772e-02
## 35   -2.855091e-03 -5.879645e-02
```

```
## 37    1.112811e-02 -5.571182e-02
## 45    2.887807e-03 -1.539750e-02
## 49    2.310394e-03 -1.812138e-02
## 54    1.329355e+00  6.341490e+00
## 57    1.281793e+00  1.111771e+01
## 59   -1.350101e+00 -3.248611e+00
## 60   -1.004129e+00 -7.957467e+00
## 61   -2.363184e+01  4.494759e+01
## 69   -4.677093e+00 -4.166142e+00
## 79    2.033497e+00  2.260935e+01
## 83   -3.736087e-01  1.641629e-01
## 91   -3.863196e+00 -3.203938e+00
## 96    2.215470e-01  1.619785e+00
## 102 -1.364798e+01 -8.066501e+01
## 103  1.882804e+00  9.869593e+00
## 114  9.989020e+01  5.827711e+02
## 117  9.494665e+01  3.387428e+02
## 124 -3.420760e+02 -1.180167e+03
## 127 -2.049034e+01 -8.832489e+01
## 128  4.588602e+00  3.483928e+01
## 133 -1.798949e+00  2.877968e+00
## 136 -9.983674e-01 -9.115006e+00
## 149  5.421949e+00  2.767292e+01
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##              [,1]        [,2]        [,3]        [,4]        [,5]
## [1,]  0.62463313  1.70432940 -0.83758243 -2.73221952  1.9837322
## [2,]  1.67820574  0.04324404 -1.12376279 -0.09979059  1.1691085
## [3,] -0.06869365 -0.33265732  3.04376589  0.97603173 -0.5087370
## [4,] -0.32083991 -1.82223542  0.23502131  0.41386892  0.7041802
## [5,]  1.47100572  1.41126240 -0.03325861  0.91232216 -0.1984163
##
## $startweights[[1]][[2]]
##            [,1]       [,2]      [,3]        [,4]
## [1,] -0.5380708  0.6202102 0.1855139  0.03266396
## [2,] -2.8557587 -0.9659032 0.7007335 -1.11444896
## [3,] -0.7896469  0.1626547 0.3116810  0.41805782
## [4,]  0.4878146 -2.0782375 0.7604624 -0.40023524
## [5,]  2.1680325  0.4852268 1.8424636  1.49349310
## [6,]  0.5006946  0.6967688 1.1123628 -1.60708094
##
## $startweights[[1]][[3]]
##            [,1]      [,2]       [,3]
## [1,] -0.4157518 0.6295361  0.2877097
## [2,]  0.4220084 0.8951720 -0.6597701
## [3,] -0.1517365 0.6602126  2.9191401
## [4,] -0.6061511 2.2734835  0.6774155
## [5,] -0.3047211 1.1734976 -0.6843203
##
##
##
```

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```
## $result.matrix
##                                    [,1]
## error                       0.016874197
## reached.threshold           0.009396770
## steps                     321.000000000
## Intercept.to.1layhid1       1.652190013
## Sepal.Length.to.1layhid1    2.630720979
## Sepal.Width.to.1layhid1    -1.692355454
## Petal.Length.to.1layhid1   -2.791902994
## Petal.Width.to.1layhid1     8.739498802
## Intercept.to.1layhid2      -4.041235875
## Sepal.Length.to.1layhid2    4.780885909
## Sepal.Width.to.1layhid2     0.345125465
## Petal.Length.to.1layhid2   -1.321476962
## Petal.Width.to.1layhid2     2.839134349
## Intercept.to.1layhid3       2.929088424
## Sepal.Length.to.1layhid3   -1.442603036
## Sepal.Width.to.1layhid3     3.633206257
## Petal.Length.to.1layhid3   -0.159821029
## Petal.Width.to.1layhid3    -5.675086303
## Intercept.to.1layhid4      -2.555800144
## Sepal.Length.to.1layhid4    0.017158956
## Sepal.Width.to.1layhid4    -1.803764610
## Petal.Length.to.1layhid4   -0.066075372
## Petal.Width.to.1layhid4    -0.576850309
## Intercept.to.1layhid5      -9.068444214
## Sepal.Length.to.1layhid5    4.257275992
## Sepal.Width.to.1layhid5     1.730149600
## Petal.Length.to.1layhid5    1.959213537
## Petal.Width.to.1layhid5    12.023766472
## Intercept.to.2layhid1      -0.207104147
## 1layhid1.to.2layhid1       -4.495461699
## 1layhid2.to.2layhid1       -0.705379323
## 1layhid3.to.2layhid1        0.840123860
## 1layhid4.to.2layhid1        0.369257748
## 1layhid5.to.2layhid1        1.238216574
## Intercept.to.2layhid2       0.174906721
## 1layhid1.to.2layhid2       -1.463279571
## 1layhid2.to.2layhid2       -0.275924350
## 1layhid3.to.2layhid2       -4.778124178
## 1layhid4.to.2layhid2       -0.596553464
## 1layhid5.to.2layhid2        1.693188592
## Intercept.to.2layhid3      -0.497351279
## 1layhid1.to.2layhid3        0.547113203
## 1layhid2.to.2layhid3        0.073664977
## 1layhid3.to.2layhid3        1.536591544
## 1layhid4.to.2layhid3        0.729800278
## 1layhid5.to.2layhid3       -0.294685754
## Intercept.to.2layhid4      -0.573445157
## 1layhid1.to.2layhid4       -0.546169744
## 1layhid2.to.2layhid4        0.492475604
## 1layhid3.to.2layhid4       -3.774238986
## 1layhid4.to.2layhid4        0.608248572
## 1layhid5.to.2layhid4       -0.567253502
```

```
## Intercept.to.V1_setosa        0.161045499
## 2layhid1.to.V1_setosa         1.613781826
## 2layhid2.to.V1_setosa        -0.125888651
## 2layhid3.to.V1_setosa        -0.299007555
## 2layhid4.to.V1_setosa         0.061456866
## Intercept.to.V1_versicolor   -0.120942455
## 2layhid1.to.V1_versicolor    -1.674377424
## 2layhid2.to.V1_versicolor    -1.636441365
## 2layhid3.to.V1_versicolor     1.638362959
## 2layhid4.to.V1_versicolor     1.060398780
## Intercept.to.V1_virginica    -0.139117662
## 2layhid1.to.V1_virginica      0.007823021
## 2layhid2.to.V1_virginica      2.486528298
## 2layhid3.to.V1_virginica      0.167625078
## 2layhid4.to.V1_virginica     -1.040175187
##
## attr(,"class")
## [1] "nn"
##
##               setosa versicolor virginica
##    setosa         40          0         0
##    versicolor      0         39         5
##    virginica       0          1        35
## $call
## neuralnet(formula = V1_setosa + V1_versicolor + V1_virginica ~
##     Sepal.Length + Sepal.Width + Petal.Length + Petal.Width,
##     data = iristreino, hidden = c(5, 4))
##
## $response
##     V1_setosa V1_versicolor V1_virginica
## 1           1             0            0
## 8           1             0            0
## 13          1             0            0
## 25          1             0            0
## 28          1             0            0
## 36          1             0            0
## 41          1             0            0
## 42          1             0            0
## 43          1             0            0
## 46          1             0            0
## 51          0             1            0
## 55          0             1            0
## 64          0             1            0
## 71          0             1            0
## 75          0             1            0
## 81          0             1            0
## 84          0             1            0
## 92          0             1            0
## 94          0             1            0
## 97          0             1            0
## 101         0             0            1
## 105         0             0            1
## 111         0             0            1
## 113         0             0            1
```

```
## 132          0              0              1
## 137          0              0              1
## 138          0              0              1
## 139          0              0              1
## 142          0              0              1
## 144          0              0              1
##
## $covariate
##      Sepal.Length Sepal.Width Petal.Length Petal.Width
## 1    -0.89767388  1.01560199  -1.33575163  -1.3110521
## 8    -1.01843718  0.78617383  -1.27910398  -1.3110521
## 13   -1.25996379 -0.13153881  -1.33575163  -1.4422448
## 25   -1.25996379  0.78617383  -1.05251337  -1.3110521
## 28   -0.77691058  1.01560199  -1.27910398  -1.3110521
## 36   -1.01843718  0.32731751  -1.44904694  -1.3110521
## 41   -1.01843718  1.01560199  -1.39239929  -1.1798595
## 42   -1.62225369 -1.73753594  -1.39239929  -1.1798595
## 43   -1.74301699  0.32731751  -1.39239929  -1.3110521
## 46   -1.25996379 -0.13153881  -1.33575163  -1.1798595
## 51    1.39682886  0.32731751   0.53362088   0.2632600
## 55    0.79301235 -0.59039513   0.47697323   0.3944526
## 64    0.30995914 -0.36096697   0.53362088   0.2632600
## 71    0.06843254  0.32731751   0.59026853   0.7880307
## 75    0.67224905 -0.36096697   0.30703027   0.1320673
## 81   -0.41462067 -1.50810778   0.02379201  -0.1303181
## 84    0.18919584 -0.81982329   0.76021149   0.5256453
## 92    0.30995914 -0.13153881   0.47697323   0.2632600
## 94   -1.01843718 -1.73753594  -0.25944625  -0.2615107
## 97   -0.17309407 -0.36096697   0.25038262   0.1320673
## 101   0.55148575  0.55674567   1.27004036   1.7063794
## 105   0.79301235 -0.13153881   1.15674505   1.3128014
## 111   0.79301235  0.32731751   0.76021149   1.0504160
## 113   1.15530226 -0.13153881   0.98680210   1.1816087
## 132   2.48369858  1.70388647   1.49663097   1.0504160
## 137   0.55148575  0.78617383   1.04344975   1.5751867
## 138   0.67224905  0.09788935   0.98680210   0.7880307
## 139   0.18919584 -0.13153881   0.59026853   0.7880307
## 142   1.27606556  0.09788935   0.76021149   1.4439941
## 144   1.15530226  0.32731751   1.21339271   1.4439941
##
## $model.list
## $model.list$response
## [1] "V1_setosa"     "V1_versicolor" "V1_virginica"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
##
##
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x55b77bb58270>
```

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```
## <environment: 0x55b77b3b29a0>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x55b77bb522e0>
## <environment: 0x55b77b3b2e38>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##      Sepal.Length Sepal.Width Petal.Length Petal.Width V1_setosa V1_versicolor
## 1     -0.89767388  1.01560199  -1.33575163  -1.3110521         1             0
## 8     -1.01843718  0.78617383  -1.27910398  -1.3110521         1             0
## 13    -1.25996379 -0.13153881  -1.33575163  -1.4422448         1             0
## 25    -1.25996379  0.78617383  -1.05251337  -1.3110521         1             0
## 28    -0.77691058  1.01560199  -1.27910398  -1.3110521         1             0
## 36    -1.01843718  0.32731751  -1.44904694  -1.3110521         1             0
## 41    -1.01843718  1.01560199  -1.39239929  -1.1798595         1             0
## 42    -1.62225369 -1.73753594  -1.39239929  -1.1798595         1             0
## 43    -1.74301699  0.32731751  -1.39239929  -1.3110521         1             0
## 46    -1.25996379 -0.13153881  -1.33575163  -1.1798595         1             0
## 51     1.39682886  0.32731751   0.53362088   0.2632600         0             1
## 55     0.79301235 -0.59039513   0.47697323   0.3944526         0             1
## 64     0.30995914 -0.36096697   0.53362088   0.2632600         0             1
## 71     0.06843254  0.32731751   0.59026853   0.7880307         0             1
## 75     0.67224905 -0.36096697   0.30703027   0.1320673         0             1
## 81    -0.41462067 -1.50810778   0.02379201  -0.1303181         0             1
## 84     0.18919584 -0.81982329   0.76021149   0.5256453         0             1
## 92     0.30995914 -0.13153881   0.47697323   0.2632600         0             1
## 94    -1.01843718 -1.73753594  -0.25944625  -0.2615107         0             1
## 97    -0.17309407 -0.36096697   0.25038262   0.1320673         0             1
## 101    0.55148575  0.55674567   1.27004036   1.7063794         0             0
## 105    0.79301235 -0.13153881   1.15674505   1.3128014         0             0
## 111    0.79301235  0.32731751   0.76021149   1.0504160         0             0
## 113    1.15530226 -0.13153881   0.98680210   1.1816087         0             0
## 132    2.48369858  1.70388647   1.49663097   1.0504160         0             0
## 137    0.55148575  0.78617383   1.04344975   1.5751867         0             0
## 138    0.67224905  0.09788935   0.98680210   0.7880307         0             0
## 139    0.18919584 -0.13153881   0.59026853   0.7880307         0             0
## 142    1.27606556  0.09788935   0.76021149   1.4439941         0             0
## 144    1.15530226  0.32731751   1.21339271   1.4439941         0             0
##      V1_virginica
## 1               0
## 8               0
## 13              0
## 25              0
```

```
## 28              0
## 36              0
## 41              0
## 42              0
## 43              0
## 46              0
## 51              0
## 55              0
## 64              0
## 71              0
## 75              0
## 81              0
## 84              0
## 92              0
## 94              0
## 97              0
## 101             1
## 105             1
## 111             1
## 113             1
## 132             1
## 137             1
## 138             1
## 139             1
## 142             1
## 144             1
##
## $exclude
## NULL
##
## $net.result
## $net.result[[1]]
##              [,1]           [,2]          [,3]
## 1     0.999401056 -0.0034919885 -5.364269e-05
## 8     0.999389971 -0.0033233643 -2.584594e-04
## 13    0.999368112 -0.0029908001 -6.624248e-04
## 25    0.999351874 -0.0027437362 -9.625484e-04
## 28    0.999402095 -0.0035077806 -3.446165e-05
## 36    0.999389312 -0.0033133284 -2.706514e-04
## 41    0.999389638 -0.0033182911 -2.646219e-04
## 42    0.998704381  0.0071332309 -1.297381e-02
## 43    0.999319756 -0.0022549539 -1.556350e-03
## 46    0.999295459 -0.0018850908 -2.005735e-03
## 51   -0.006923102  0.9852973524 -1.997598e-02
## 55   -0.036432862  0.9750249610 -1.869913e-02
## 64    0.005908723  1.0344308803 -1.543206e-02
## 71   -0.019666990  0.9560905502  3.365691e-03
## 75    0.017745744  1.0042813421  2.332616e-02
## 81    0.014167197  1.0165707081  1.044129e-02
## 84   -0.032939767  0.9599246007 -2.261571e-02
## 92    0.010579073  1.0228751507  1.921571e-03
## 94    0.014092608  1.0141715602  1.610829e-02
## 97    0.013672715  1.0155461942  1.362596e-02
## 101  -0.002235199  0.0007479239  9.959760e-01
```

```
## 105 -0.002163097  0.0005533761  9.963266e-01
## 111  0.002619844 -0.0101889479  1.017070e+00
## 113 -0.001913280  0.0004169415  9.960957e-01
## 132 -0.004843379 -0.0035331449  1.007844e+00
## 137 -0.001553113 -0.0006406982  9.984775e-01
## 138  0.011708324 -0.0155294569  1.050540e+00
## 139  0.028503224  0.0579330966  9.676887e-01
## 142 -0.001918268  0.0008075597  9.950766e-01
## 144 -0.002243777  0.0008083034  9.957618e-01
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##              [,1]       [,2]       [,3]        [,4]        [,5]
## [1,]   6.1778731  0.1518730 -21.676775 -6.27951893 -13.1717152
## [2,]  -2.5057740  1.5333300  -1.884842  2.11959563   1.7766174
## [3,]   2.5715478  0.8494816  19.424971 -2.61367807  34.3963873
## [4,]  -0.2362832 -2.1567250 -35.450818 -0.09408862   0.1769555
## [5,]  -7.0725668 -3.4381761 -33.686871  7.27394872  35.2169584
##
## $weights[[1]][[2]]
##               [,1]       [,2]       [,3]        [,4]
## [1,]  -0.13327187  1.3879775 -0.081388 -0.03306385
## [2,]   2.60846419 -0.3452341 -7.466768  0.44634229
## [3,]  -0.08666798 -0.2187653  0.819274 -0.60431190
## [4,]  26.68016322 -4.8687964  6.183641 -1.86965262
## [5,]   0.75686575 -0.4226917  3.348461  1.85516735
## [6,]   0.71641987  0.3338133  3.552476  1.44140828
##
## $weights[[1]][[3]]
##              [,1]       [,2]       [,3]
## [1,]   0.41163809  1.0288310 -1.0663173
## [2,]   0.56558006 -0.6127789  0.6422088
## [3,]  -1.31538740  0.2881325  1.6983036
## [4,]   0.09910312 -1.3395635  1.4793007
## [5,]   0.07498754  0.5914164 -1.3075126
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##              [,1]        [,2]        [,3]        [,4]         [,5]         [,6]
## 1     0.04355419  0.02412732 -0.06125981 -0.09765427   0.11316878   0.06269224
## 8     0.07056946  0.03909329 -0.09925783 -0.15822800   0.19628007   0.10873477
## 13    0.12096602  0.06700964 -0.17014044 -0.27121947   0.38744141   0.21462959
## 25    0.15610778  0.08648380 -0.21957401 -0.35003433   0.55922311   0.30981113
## 28    0.04097159  0.02269581 -0.05762659 -0.09186098   0.10579273   0.05860432
## 36    0.07215116  0.03996294 -0.10147691 -0.16175347   0.20150542   0.11161511
## 41    0.07136762  0.03953581 -0.10037935 -0.16001214   0.19891316   0.11019427
## 42    0.81044146  0.44838098 -1.13942144 -1.81529541  -2.26369897  -1.25282650
## 43    0.22048210  0.12214787 -0.31012055 -0.49438043   1.00935384   0.55918738
## 46    0.26514579  0.14685329 -0.37290980 -0.59440594   1.50459927   0.83338626
## 51   -2.81741961 -0.23016757  4.19435091  2.28796855 -37.50330183  32.12554544
```

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```
## 55    0.26943765 -0.02534784  0.94566676   0.14124204 -37.39389571  37.14800562
## 64   -1.78951638  3.30425515 -2.71070129  -9.93927453  -0.47504021   1.44261527
## 71   -2.17378140  2.69885649  0.41307344  -7.46521316 -21.61993427  22.93024358
## 75   -0.18221848  1.43692080 -1.54671147  -4.57524364   1.21823469  13.34659534
## 81    0.63504922  0.44477416 -1.11564322  -1.74337423   0.89388120   1.40752291
## 84    0.12352678  0.60024197  0.63783562  -1.77040272 -27.01732247  28.92420478
## 92   -0.04847845  1.29700623 -1.59922727  -4.35553111   0.09840359   1.45901274
## 94    0.72898983  0.37788967 -1.02826240  -1.55576492   1.49023422   1.03171786
## 97    0.63635330  0.48550897 -1.09856760  -1.86541763   1.14757680   1.20058388
## 101   0.22566495 -0.15784841  0.12487486   0.42843186   1.25848475  -1.21373524
## 105   0.21568758 -0.16904204  0.27750286   0.49031624   2.40325651  -2.41330659
## 111  -5.62453225  4.02585353 -3.20097960 -10.97217636  -2.41458303   2.36454331
## 113  -0.14345438 -0.20022995  0.72746948   0.77456931   2.65728133  -3.43934623
## 132  -4.60408214  3.34289553  3.45761123  -8.15215935  -0.68791886   2.22158426
## 137   1.72605172 -1.22440915  0.77115635   3.29957924  -7.04471189   6.76280470
## 138  -3.17559898  2.05201303 -1.46647551  -5.46564767   4.96456621  -5.66680177
## 139  -0.09028210 -0.48771496 -0.56051364   1.42949573 -12.23893071  13.21022725
## 142  -0.29758267 -0.22298743  0.55864117   0.86715912   0.04511708  -0.56487217
## 144  -0.04565910 -0.03496370  0.25061255   0.16177172   0.68272847  -0.80586688
##            [,7]         [,8]         [,9]        [,10]        [,11]
## 1    -0.1591750   -0.2537431  -8.978747376  -4.97401122  12.628891278
## 8    -0.2760745   -0.4400967  -3.074977698  -1.70348173   4.325069790
## 13   -0.5449456   -0.8687025  -2.129839868  -1.17987237   2.995681010
## 25   -0.7865784   -1.2539278  -1.939907538  -1.07471610   2.728589483
## 28   -0.1487988   -0.2371989 -13.124785643  -7.27061961  18.460246098
## 36   -0.2834115   -0.4517670  -3.005453217  -1.66477961   4.227116048
## 41   -0.2797756   -0.4459887  -3.038977099  -1.68354774   4.274401087
## 42    3.1829237    5.0717693  -1.484946178  -0.82195165   2.088039202
## 43   -1.4197147   -2.2632496  -1.777969657  -0.98500600   2.500818465
## 46   -2.1161578   -3.3731845  -1.717925578  -0.95157290   2.416214728
## 51    4.1306756  -85.4111273 -29.354486816  25.09356393   2.366264639
## 55    0.7681248 -101.1091624 -48.001459250  45.19811093  -0.143015408
## 64   -0.7431955   -4.3686184   1.976767066  -5.29431506   1.649522567
## 71   -0.9516033  -63.1158516 291.434394934 -304.49027615  16.888080007
## 75  -12.2177368  -43.0995812  -0.007448456   3.71602360  -2.523622754
## 81   -1.9931518   -4.9073795   1.128482255   3.69831424  -3.789248432
## 84   -1.1925830  -79.6957866 -45.884835229  47.41870253  -3.133308698
## 92   -1.3958943   -5.1757127  -1.711868235  27.21639731 -18.711772390
## 94   -2.2601947   -3.9970639   1.523561937   1.28287468  -2.463536442
## 97   -2.0726827   -4.3709732   1.414900940   2.04526084  -2.880898376
## 101   0.2370943    3.3336072  -0.413490914   0.44729314   0.009213247
## 105   0.6194991    6.6842854  -0.770684531   0.78439711   0.065028479
## 111  -0.5018156   -6.5128698   2.673737803  -2.94507574  -0.082458393
## 113   1.6207187    9.8943743  -0.963544179   0.76092678   0.272859843
## 132  -2.6045340   -6.9755960   6.275336516  -5.72813247  -1.435099947
## 137  -1.2228313  -18.5481598  -4.958258968   5.44703256   0.036219260
## 138  -0.2549664   15.6425943  -0.870731695   0.72432049  -0.177350051
## 139  -0.4869738  -36.4506137  22.553616424 -23.70933484   1.443840542
## 142   0.5712203    1.8013189  -0.285094787   0.06048918   0.217615154
## 144   0.3463588    2.2934134  -0.417817492   0.36051039   0.093629044
##             [,12]
## 1    20.13197658
## 8     6.89471684
## 13    4.77546381
```

```
## 25      4.34979795
## 28     29.42750745
## 36      6.73823224
## 41      6.81384040
## 42      3.32737167
## 43      3.98670248
## 46      3.85152938
## 51    -66.82760709
## 55   -122.37736965
## 64     15.78381958
## 71    837.38162506
## 75    -11.74639976
## 81    -12.26499618
## 84   -130.32474030
## 92    -94.80916119
## 94     -4.80724093
## 97     -7.16618647
## 101    -1.22941253
## 105    -2.13329631
## 111     8.10710627
## 113    -1.96554778
## 132    15.21394072
## 137   -15.00879235
## 138    -1.95617521
## 139    65.33004099
## 142    -0.05696861
## 144    -0.94954198
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##              [,1]        [,2]        [,3]      [,4]      [,5]
## [1,]  0.1864921  0.31916024  0.59427377 0.7188887 0.2680439
## [2,] -0.3243933 -1.07754212  0.05913517 0.2516511 0.4369306
## [3,] -0.2747042 -3.23315213  0.41339889 1.3572744 1.0601239
## [4,] -0.9335033 -0.25487465 -1.09777217 0.4044685 0.4521904
## [5,]  0.1168453  0.02951783  0.71117526 0.2643643 0.6631986
##
## $startweights[[1]][[2]]
##              [,1]       [,2]       [,3]       [,4]
## [1,] -1.1363736  0.9758033 -0.2386466  0.6705594
## [2,] -0.3704975 -0.3488767 -1.1877653  0.9486326
## [3,]  1.4769696  0.1586254  0.3849353  2.0494030
## [4,] -1.2239038 -1.7632551  0.6665795 -0.6511136
## [5,]  0.2580684  0.3385960 -0.3046139  0.8086193
## [6,]  0.4050028 -0.6665650  1.8250111  0.9865806
##
## $startweights[[1]][[3]]
##               [,1]       [,2]       [,3]
## [1,] -0.006170796  0.8136829 -1.5528590
## [2,]  0.319052358 -0.8114308  0.1284340
## [3,] -1.011821903  0.3193975  0.9854434
## [4,]  0.470167548 -0.8465227  0.1832475
```

```
## [5,] -0.700970332 -0.2457632 -1.7662292
##
##
##
## $result.matrix
##                                       [,1]
## error                          0.011200749
## reached.threshold              0.009403416
## steps                        607.000000000
## Intercept.to.1layhid1          6.177873051
## Sepal.Length.to.1layhid1      -2.505773990
## Sepal.Width.to.1layhid1        2.571547778
## Petal.Length.to.1layhid1      -0.236283201
## Petal.Width.to.1layhid1       -7.072566769
## Intercept.to.1layhid2          0.151872990
## Sepal.Length.to.1layhid2       1.533329981
## Sepal.Width.to.1layhid2        0.849481603
## Petal.Length.to.1layhid2      -2.156724957
## Petal.Width.to.1layhid2       -3.438176147
## Intercept.to.1layhid3        -21.676774512
## Sepal.Length.to.1layhid3      -1.884841740
## Sepal.Width.to.1layhid3       19.424970580
## Petal.Length.to.1layhid3     -35.450818413
## Petal.Width.to.1layhid3      -33.686870981
## Intercept.to.1layhid4         -6.279518926
## Sepal.Length.to.1layhid4       2.119595632
## Sepal.Width.to.1layhid4       -2.613678065
## Petal.Length.to.1layhid4      -0.094088615
## Petal.Width.to.1layhid4        7.273948724
## Intercept.to.1layhid5        -13.171715244
## Sepal.Length.to.1layhid5       1.776617379
## Sepal.Width.to.1layhid5       34.396387266
## Petal.Length.to.1layhid5       0.176955464
## Petal.Width.to.1layhid5       35.216958441
## Intercept.to.2layhid1         -0.133271871
## 1layhid1.to.2layhid1           2.608464191
## 1layhid2.to.2layhid1          -0.086667983
## 1layhid3.to.2layhid1          26.680163222
## 1layhid4.to.2layhid1           0.756865750
## 1layhid5.to.2layhid1           0.716419873
## Intercept.to.2layhid2          1.387977464
## 1layhid1.to.2layhid2          -0.345234124
## 1layhid2.to.2layhid2          -0.218765310
## 1layhid3.to.2layhid2          -4.868796437
## 1layhid4.to.2layhid2          -0.422691710
## 1layhid5.to.2layhid2           0.333813334
## Intercept.to.2layhid3         -0.081387996
## 1layhid1.to.2layhid3          -7.466767682
## 1layhid2.to.2layhid3           0.819274003
## 1layhid3.to.2layhid3           6.183640682
## 1layhid4.to.2layhid3           3.348461044
## 1layhid5.to.2layhid3           3.552475543
## Intercept.to.2layhid4         -0.033063853
## 1layhid1.to.2layhid4           0.446342291
```

```
## 1layhid2.to.2layhid4        -0.604311900
## 1layhid3.to.2layhid4        -1.869652619
## 1layhid4.to.2layhid4         1.855167347
## 1layhid5.to.2layhid4         1.441408284
## Intercept.to.V1_setosa        0.411638093
## 2layhid1.to.V1_setosa         0.565580056
## 2layhid2.to.V1_setosa        -1.315387405
## 2layhid3.to.V1_setosa         0.099103120
## 2layhid4.to.V1_setosa         0.074987535
## Intercept.to.V1_versicolor   1.028830999
## 2layhid1.to.V1_versicolor   -0.612778929
## 2layhid2.to.V1_versicolor    0.288132545
## 2layhid3.to.V1_versicolor   -1.339563485
## 2layhid4.to.V1_versicolor    0.591416419
## Intercept.to.V1_virginica   -1.066317264
## 2layhid1.to.V1_virginica     0.642208823
## 2layhid2.to.V1_virginica     1.698303552
## 2layhid3.to.V1_virginica     1.479300701
## 2layhid4.to.V1_virginica    -1.307512622
##
## attr(,"class")
## [1] "nn"
##
##              setosa versicolor virginica
##   setosa         40          0         0
##   versicolor      0         36         3
##   virginica       0          4        37
## $call
## neuralnet(formula = V1_setosa + V1_versicolor + V1_virginica ~
##     Sepal.Length + Sepal.Width + Petal.Length + Petal.Width,
##     data = iristreino, hidden = c(5, 4))
##
## $response
##     V1_setosa V1_versicolor V1_virginica
## 5           1             0            0
## 6           1             0            0
## 9           1             0            0
## 10          1             0            0
## 11          1             0            0
## 12          1             0            0
## 17          1             0            0
## 20          1             0            0
## 23          1             0            0
## 39          1             0            0
## 53          0             1            0
## 70          0             1            0
## 73          0             1            0
## 76          0             1            0
## 78          0             1            0
## 88          0             1            0
## 89          0             1            0
## 93          0             1            0
## 98          0             1            0
## 100         0             1            0
```

```
## 115             0               0               1
## 116             0               0               1
## 118             0               0               1
## 119             0               0               1
## 125             0               0               1
## 126             0               0               1
## 130             0               0               1
## 131             0               0               1
## 143             0               0               1
## 148             0               0               1
##
## $covariate
##      Sepal.Length Sepal.Width Petal.Length   Petal.Width
## 5     -1.01843718  1.24503015  -1.33575163 -1.3110521482
## 6     -0.53538397  1.93331463  -1.16580868 -1.0486667950
## 9     -1.74301699 -0.36096697  -1.33575163 -1.3110521482
## 10    -1.13920048  0.09788935  -1.27910398 -1.4422448248
## 11    -0.53538397  1.47445831  -1.27910398 -1.3110521482
## 12    -1.25996379  0.78617383  -1.22245633 -1.3110521482
## 17    -0.53538397  1.93331463  -1.39239929 -1.0486667950
## 20    -0.89767388  1.70388647  -1.27910398 -1.1798594716
## 23    -1.50149039  1.24503015  -1.56234224 -1.3110521482
## 39    -1.74301699 -0.13153881  -1.39239929 -1.3110521482
## 53     1.27606556  0.09788935   0.64691619  0.3944526477
## 70    -0.29385737 -1.27867961   0.08043967 -0.1303180588
## 73     0.55148575 -1.27867961   0.64691619  0.3944526477
## 76     0.91377565 -0.13153881   0.36367793  0.2632599711
## 78     1.03453895 -0.13153881   0.70356384  0.6568380009
## 88     0.55148575 -1.73753594   0.36367793  0.1320672944
## 89    -0.29385737 -0.13153881   0.19373497  0.1320672944
## 93    -0.05233076 -1.04925145   0.13708732  0.0008746178
## 98     0.43072244 -0.36096697   0.30703027  0.1320672944
## 100   -0.17309407 -0.59039513   0.19373497  0.1320672944
## 115   -0.05233076 -0.59039513   0.76021149  1.5751867371
## 116    0.67224905  0.32731751   0.87350679  1.4439940605
## 118    2.24217198  1.70388647   1.66657392  1.3128013839
## 119    2.24217198 -1.04925145   1.77986923  1.4439940605
## 125    1.03453895  0.55674567   1.10009740  1.1816087073
## 126    1.63835547  0.32731751   1.27004036  0.7880306775
## 130    1.63835547 -0.13153881   1.15674505  0.5256453243
## 131    1.87988207 -0.59039513   1.32668801  0.9192233541
## 143   -0.05233076 -0.81982329   0.76021149  0.9192233541
## 148    0.79301235 -0.13153881   0.81685914  1.0504160307
##
## $model.list
## $model.list$response
## [1] "V1_setosa"     "V1_versicolor" "V1_virginica"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
##
##
## $err.fct
## function (x, y)
```

```
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x55b77bb58270>
## <environment: 0x55b77b16e5b8>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x55b77bb522e0>
## <environment: 0x55b77b16ea88>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##     Sepal.Length Sepal.Width Petal.Length  Petal.Width V1_setosa V1_versicolor
## 5     -1.01843718  1.24503015  -1.33575163 -1.3110521482         1             0
## 6     -0.53538397  1.93331463  -1.16580868 -1.0486667950         1             0
## 9     -1.74301699 -0.36096697  -1.33575163 -1.3110521482         1             0
## 10    -1.13920048  0.09788935  -1.27910398 -1.4422448248         1             0
## 11    -0.53538397  1.47445831  -1.27910398 -1.3110521482         1             0
## 12    -1.25996379  0.78617383  -1.22245633 -1.3110521482         1             0
## 17    -0.53538397  1.93331463  -1.39239929 -1.0486667950         1             0
## 20    -0.89767388  1.70388647  -1.27910398 -1.1798594716         1             0
## 23    -1.50149039  1.24503015  -1.56234224 -1.3110521482         1             0
## 39    -1.74301699 -0.13153881  -1.39239929 -1.3110521482         1             0
## 53     1.27606556  0.09788935   0.64691619  0.3944526477         0             1
## 70    -0.29385737 -1.27867961   0.08043967 -0.1303180588         0             1
## 73     0.55148575 -1.27867961   0.64691619  0.3944526477         0             1
## 76     0.91377565 -0.13153881   0.36367793  0.2632599711         0             1
## 78     1.03453895 -0.13153881   0.70356384  0.6568380009         0             1
## 88     0.55148575 -1.73753594   0.36367793  0.1320672944         0             1
## 89    -0.29385737 -0.13153881   0.19373497  0.1320672944         0             1
## 93    -0.05233076 -1.04925145   0.13708732  0.0008746178         0             1
## 98     0.43072244 -0.36096697   0.30703027  0.1320672944         0             1
## 100   -0.17309407 -0.59039513   0.19373497  0.1320672944         0             1
## 115   -0.05233076 -0.59039513   0.76021149  1.5751867371         0             0
## 116    0.67224905  0.32731751   0.87350679  1.4439940605         0             0
## 118    2.24217198  1.70388647   1.66657392  1.3128013839         0             0
## 119    2.24217198 -1.04925145   1.77986923  1.4439940605         0             0
## 125    1.03453895  0.55674567   1.10009740  1.1816087073         0             0
## 126    1.63835547  0.32731751   1.27004036  0.7880306775         0             0
## 130    1.63835547 -0.13153881   1.15674505  0.5256453243         0             0
## 131    1.87988207 -0.59039513   1.32668801  0.9192233541         0             0
## 143   -0.05233076 -0.81982329   0.76021149  0.9192233541         0             0
## 148    0.79301235 -0.13153881   0.81685914  1.0504160307         0             0
##     V1_virginica
```

```
## 5                  0
## 6                  0
## 9                  0
## 10                 0
## 11                 0
## 12                 0
## 17                 0
## 20                 0
## 23                 0
## 39                 0
## 53                 0
## 70                 0
## 73                 0
## 76                 0
## 78                 0
## 88                 0
## 89                 0
## 93                 0
## 98                 0
## 100                0
## 115                1
## 116                1
## 118                1
## 119                1
## 125                1
## 126                1
## 130                1
## 131                1
## 143                1
## 148                1
##
## $exclude
## NULL
##
## $net.result
## $net.result[[1]]
##               [,1]           [,2]           [,3]
## 5     1.0024693325  -0.0068821403   7.668132e-03
## 6     0.9972166835   0.0055799730  -9.909782e-04
## 9     0.9919798579   0.0069653480  -2.116884e-02
## 10    1.0052984024  -0.0160809465   9.763445e-03
## 11    1.0055395374  -0.0090789849   1.778072e-02
## 12    0.9998956564  -0.0092500905  -5.498116e-03
## 17    0.9968948532   0.0145848095   6.874778e-03
## 20    0.9990157322   0.0002428372   8.754684e-04
## 23    0.9981377204   0.0043025147   1.500653e-03
## 39    0.9927933890   0.0073725779  -1.733495e-02
## 53    0.0011718073   1.0097390511  -1.288936e-02
## 70    0.0168892277   0.9793107278   3.085789e-03
## 73   -0.0375173891   1.0141849106   1.724608e-02
## 76    0.0259024460   0.9873650924  -1.027789e-02
## 78   -0.0436267668   1.0078505965   3.036156e-02
## 88    0.0151020147   0.9988477637  -1.338899e-02
## 89   -0.0010925332   1.0007860789   1.067192e-02
```

```
## 93    0.0131948829  0.9941781971 -7.595781e-03
## 98    0.0129273644  1.0066363861 -1.896039e-02
## 100  -0.0098047254  1.0074346010 -7.318493e-05
## 115  -0.0060776830 -0.0019991026  1.004456e+00
## 116  -0.0141252368 -0.0080440139  1.006991e+00
## 118   0.0046871265  0.0038217698  1.001505e+00
## 119  -0.0036185787 -0.0008990864  1.004423e+00
## 125  -0.0110289891 -0.0070269290  1.006783e+00
## 126   0.0003822702 -0.0052790752  1.004353e+00
## 130   0.0158339008  0.0040414980  9.878257e-01
## 131  -0.0025480811 -0.0063398517  1.005845e+00
## 143   0.0204183367  0.0025740008  9.935777e-01
## 148   0.0198111805  0.0054669091  9.908775e-01
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##            [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] -4.8118189  0.90150482 -10.4596860   0.7975252 -1.45290679
## [2,] -4.6050953  0.39145102  -0.1915810   1.5359713 -0.69087859
## [3,] -0.8193431 -0.05278162  -0.3727062  -4.7751747  0.01218062
## [4,]  2.2622689 -1.09188659   8.5655948  11.0412510  1.18398034
## [5,]  6.6685907  0.27782661   3.4259843  -0.2936900  0.90297862
##
## $weights[[1]][[2]]
##            [,1]        [,2]        [,3]        [,4]
## [1,] -0.4104623 -0.2408015  0.01855302  0.6102034
## [2,] -0.3661230 -3.7786466  0.05660582  0.3750416
## [3,]  0.3641556  1.0457344 -0.63983070  0.5577866
## [4,] -0.5764512 -8.0027762 -2.14807880  1.2983468
## [5,] -1.7005753  1.3620743 -0.51307251  5.0359482
## [6,]  0.9687092  1.3578627 -4.93229025 -1.8086606
##
## $weights[[1]][[3]]
##            [,1]        [,2]        [,3]
## [1,]  0.7963976 -1.4594697 -0.78719822
## [2,]  1.1287174  0.4340208 -0.05773041
## [3,] -0.2306707  1.3776455 -1.27088919
## [4,]  1.4734263 -2.0489499  0.98765269
## [5,] -0.9366203  1.4144870  1.80042080
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##            [,1]         [,2]        [,3]         [,4]        [,5]
## 5    -2.6200884  -0.67417165  -2.12080095   15.8203009 -0.17773367
## 6     3.2899198   0.56453322   0.07506097  -15.0121133 -0.86694599
## 9     1.9442222   0.21626427  -1.03495036   -6.8640958 -2.18189416
## 10   -1.1257629  -0.33510728  -1.32350546    7.5729749 -0.19001305
## 11   -0.5388139  -0.28756996  -1.80283492    5.8158784 -0.82062090
## 12  104.6846509  17.40963828  -2.69265284 -468.2137656  0.68343036
## 17    2.0570688   0.43288563   0.78021202  -10.7614033 -0.08046128
```

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```
## 20      8.7646764   1.65588558    1.59426004  -42.6086675  -13.60839532
## 23      4.4838874   0.83978186    0.74885756  -21.6753661   -0.75007549
## 39      1.9980435   0.23527579   -0.93995275   -7.2807011   -1.82038231
## 53     56.3616075   0.94540260 -121.25840107  -93.8466596   11.90683517
## 70      3.6515522  -0.05652592   -6.71757901   -5.4853647   -0.65474846
## 73     -0.5390485   0.13692440    2.02478736    0.8899066  -14.64541245
## 76      2.6889728   0.06718919   -4.73418257   -4.0628301   -9.43625170
## 78     -0.7467298   0.05241077    1.42881511    1.0629976   -2.43614606
## 88      4.4597598  -0.05583076   -7.66911191   -6.6697986  -77.46617989
## 89     -7.4978211 -68.92052887  252.32287100   41.5171896 -282.97296718
## 93      4.8090860  -0.02283177   -8.64492022   -7.1675426   -7.55541999
## 98      5.2388677   0.15401647   -9.31449350   -7.8456740   16.09958965
## 100    -3.9890229  -0.32579050   11.38493086    6.1928967  -19.14198240
## 115     1.4020027  -0.56699238   11.49062241    2.1271670    3.03359268
## 116     0.2091945  -0.30786934    4.90039124    1.4567204    0.89982347
## 118    -1.9679138   0.08537956    3.28519610    4.0746379   -2.20714503
## 119    -8.7078568  -2.09047256    1.25706683   11.0384176  -15.04586310
## 125    -3.1075055  -0.84935800    4.36603932    5.3997278   -1.48344792
## 126   -10.2359349   4.99162261  -90.41305876  -11.4914343    2.72699307
## 130     0.4588863   0.35542995   -9.11611535   -3.5243728   -5.46248784
## 131     1.4441864  -0.38547779    2.11672432   -2.2037569    1.92869652
## 143     0.1333211   0.39050637   -8.55491023   -3.1225091   -4.46992250
## 148     1.7488141   0.67359194   -9.80302296   -5.6096145   18.48026105
##              [,6]          [,7]        [,8]          [,9]         [,10]
## 5      0.78907492    7.51828154  -13.297305     3.6329504    0.15612041
## 6     -0.93785739   -7.26202148   17.537586   -32.9259865   -1.05168296
## 9     -0.81189710   -4.16915631   18.105408    -2.2220438   -0.03273404
## 10     0.35607326    3.56177674   -5.823851     2.8582059    0.13249816
## 11     0.56542075    6.46252498   -8.408073     1.1053220    0.07031790
## 12     0.64533778    4.86605052  -12.230256    -7.1098867   -0.21009317
## 17    -0.30764653   -2.69858073    5.424103     3.5543031    0.13843239
## 20   -22.18599959 -182.51566816  403.850371    36.6840552    1.25864227
## 23    -1.20389625   -9.89370192   21.976917    20.5040911    0.69940781
## 39    -0.75634087   -4.19181414   16.379173    -2.5589288   -0.04494004
## 53    -0.57183562   -4.76934674  -15.604169    -4.4894096    0.49132946
## 70     0.91458856    6.60150633    2.797248   -11.4144404   -5.36842846
## 73    -5.17950286   28.93265536   29.411227   -13.5954159   -4.07734174
## 76    -0.06638872   14.22863285   16.042585    -5.6767842   -0.05930935
## 78    -7.88000049  114.63898532   45.654667    -1.8851790   -2.04209610
## 88     5.28187160  139.26322386  137.567085    -2.4344213    0.40068289
## 89    -7.67917229 -188.00494072  333.319023   -23.1003832   -0.98982270
## 93     2.27289148   25.83090456   16.929496     1.0043572    1.52729500
## 98    -0.16004147  -26.89325407  -28.158587    -2.5510130    0.05306020
## 100   -5.66364285   -9.08621609   22.677312  2382.7792532  522.24934919
## 115   -0.36433633    5.01762432   -2.355909    -0.6563243    0.09613419
## 116   -0.10425573   -0.36641003   -1.125171    -0.5112238    0.05213793
## 118    0.10486570    3.85396174    4.190634    -2.3639469    0.21337087
## 119   -4.34705264   -2.20261415   18.322668     1.1932598    0.38139877
## 125   -0.56977985    0.17243518    2.130378     0.4630627    0.23749295
## 126   -0.26066028   -0.03966793   -3.022407    -1.4099675    0.28986731
## 130    4.08077875  -82.33452952  -24.134057     0.5702842   -1.38159260
## 131   -0.12090654   -2.60324898   -3.021657    -0.8693769    0.10048733
## 143    4.81068888  -86.89332686  -27.517876     0.2569911   -1.94084149
## 148    6.84878980  -68.84475160  -49.753382   -10.2013964   -3.68704718
```

```
##             [,11]         [,12]
## 5      -4.2043091    -8.5426930
## 6      41.4433686    71.1428448
## 9       3.1071746     4.3645627
## 10     -3.2159537    -6.8955011
## 11     -1.0700240    -2.9901960
## 12      9.0974560    15.1120533
## 17     -4.2452779    -8.1077691
## 20    -45.3707212   -80.7876858
## 23    -25.3728793   -45.2205759
## 39      3.5235727     5.0913826
## 53     -4.8858686     4.0159167
## 70    -14.7796329     7.7058699
## 73     28.5263454    27.2272741
## 76      8.0045911    10.1063201
## 78     32.8255225    14.2114645
## 88      4.9155541     4.9380273
## 89     -4.6932054    29.0638183
## 93      7.7681932     1.8076191
## 98      4.4212678     4.8568427
## 100  -173.1664433 -3060.7123113
## 115    -0.8577069     0.1897464
## 116     0.3879642     0.5101575
## 118     4.7770795     3.8193235
## 119     0.4430431    -1.7047892
## 125     0.0368121    -0.8692578
## 126    -2.5267349     0.3756504
## 130    29.7492766    10.3261316
## 131     0.9223182     1.0801750
## 143    38.0230110    14.1806859
## 148    42.4584218    28.9591101
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##             [,1]       [,2]        [,3]       [,4]        [,5]
## [1,] -0.6205337  0.3536254  1.00980821 -0.4469598 -0.04000163
## [2,]  1.6560430  0.3191562  0.02362661  0.7631768 -0.49227997
## [3,]  1.8098054 -0.5799570 -0.64902822  1.4717187  1.22771712
## [4,] -1.1750368 -0.9532787 -0.50437422  0.4436649 -0.14955357
## [5,] -0.3667033 -0.1794286  1.61439150 -0.4217219  1.54998338
##
## $startweights[[1]][[2]]
##             [,1]        [,2]        [,3]        [,4]
## [1,] -0.56161254  0.03006642  0.29247008 -0.27007961
## [2,] -0.64711725 -0.71657670  0.89870272  1.61978988
## [3,]  0.14313216  1.08261096 -0.51874236 -0.21413117
## [4,]  0.02418865 -0.95268545  0.55443855 -0.81778246
## [5,] -0.50445152  1.12648273 -0.08797367 -0.05402292
## [6,] -1.58139681 -0.64904302 -1.13521293  0.33014161
##
## $startweights[[1]][[3]]
##             [,1]       [,2]       [,3]
```

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```
## [1,]  0.9553246 -2.3445134 -0.7837751
## [2,]  1.1439599 -0.4716834 -0.2260540
## [3,]  0.1005224 -0.5158555 -1.5871030
## [4,]  1.1645752 -2.3160362  0.5475242
## [5,] -0.7642599  0.5624718  1.8912270
##
##
##
## $result.matrix
##                                    [,1]
## error                      0.006372854
## reached.threshold          0.009594578
## steps                    410.000000000
## Intercept.to.1layhid1     -4.811818928
## Sepal.Length.to.1layhid1  -4.605095286
## Sepal.Width.to.1layhid1   -0.819343124
## Petal.Length.to.1layhid1   2.262268859
## Petal.Width.to.1layhid1    6.668590716
## Intercept.to.1layhid2      0.901504825
## Sepal.Length.to.1layhid2   0.391451023
## Sepal.Width.to.1layhid2   -0.052781619
## Petal.Length.to.1layhid2  -1.091886586
## Petal.Width.to.1layhid2    0.277826607
## Intercept.to.1layhid3    -10.459685952
## Sepal.Length.to.1layhid3  -0.191580985
## Sepal.Width.to.1layhid3   -0.372706219
## Petal.Length.to.1layhid3   8.565594825
## Petal.Width.to.1layhid3    3.425984301
## Intercept.to.1layhid4      0.797525213
## Sepal.Length.to.1layhid4   1.535971285
## Sepal.Width.to.1layhid4   -4.775174698
## Petal.Length.to.1layhid4  11.041250958
## Petal.Width.to.1layhid4   -0.293689992
## Intercept.to.1layhid5     -1.452906787
## Sepal.Length.to.1layhid5  -0.690878589
## Sepal.Width.to.1layhid5    0.012180622
## Petal.Length.to.1layhid5   1.183980335
## Petal.Width.to.1layhid5    0.902978625
## Intercept.to.2layhid1     -0.410462349
## 1layhid1.to.2layhid1      -0.366122974
## 1layhid2.to.2layhid1       0.364155611
## 1layhid3.to.2layhid1      -0.576451222
## 1layhid4.to.2layhid1      -1.700575296
## 1layhid5.to.2layhid1       0.968709159
## Intercept.to.2layhid2     -0.240801454
## 1layhid1.to.2layhid2      -3.778646551
## 1layhid2.to.2layhid2       1.045734394
## 1layhid3.to.2layhid2      -8.002776179
## 1layhid4.to.2layhid2       1.362074265
## 1layhid5.to.2layhid2       1.357862707
## Intercept.to.2layhid3      0.018553018
## 1layhid1.to.2layhid3       0.056605823
## 1layhid2.to.2layhid3      -0.639830702
## 1layhid3.to.2layhid3      -2.148078798
```

```
## 1layhid4.to.2layhid3        -0.513072508
## 1layhid5.to.2layhid3        -4.932290248
## Intercept.to.2layhid4        0.610203382
## 1layhid1.to.2layhid4         0.375041551
## 1layhid2.to.2layhid4         0.557786583
## 1layhid3.to.2layhid4         1.298346771
## 1layhid4.to.2layhid4         5.035948246
## 1layhid5.to.2layhid4        -1.808660604
## Intercept.to.V1_setosa        0.796397632
## 2layhid1.to.V1_setosa         1.128717365
## 2layhid2.to.V1_setosa        -0.230670704
## 2layhid3.to.V1_setosa         1.473426276
## 2layhid4.to.V1_setosa        -0.936620326
## Intercept.to.V1_versicolor  -1.459469710
## 2layhid1.to.V1_versicolor     0.434020822
## 2layhid2.to.V1_versicolor     1.377645522
## 2layhid3.to.V1_versicolor    -2.048949889
## 2layhid4.to.V1_versicolor     1.414486991
## Intercept.to.V1_virginica    -0.787198219
## 2layhid1.to.V1_virginica     -0.057730408
## 2layhid2.to.V1_virginica     -1.270889192
## 2layhid3.to.V1_virginica      0.987652694
## 2layhid4.to.V1_virginica      1.800420797
##
## attr(,"class")
## [1] "nn"
##
##              setosa versicolor virginica
##   setosa         40          0         0
##   versicolor      0         36         1
##   virginica       0          4        39
## $call
## neuralnet(formula = V1_setosa + V1_versicolor + V1_virginica ~
##     Sepal.Length + Sepal.Width + Petal.Length + Petal.Width,
##     data = iristreino, hidden = c(5, 4))
##
## $response
##     V1_setosa V1_versicolor V1_virginica
## 7           1             0            0
## 16          1             0            0
## 18          1             0            0
## 19          1             0            0
## 26          1             0            0
## 29          1             0            0
## 32          1             0            0
## 38          1             0            0
## 44          1             0            0
## 50          1             0            0
## 62          0             1            0
## 65          0             1            0
## 66          0             1            0
## 68          0             1            0
## 74          0             1            0
## 77          0             1            0
```

```
## 82            0           1           0
## 85            0           1           0
## 86            0           1           0
## 95            0           1           0
## 109           0           0           1
## 120           0           0           1
## 121           0           0           1
## 122           0           0           1
## 129           0           0           1
## 134           0           0           1
## 135           0           0           1
## 140           0           0           1
## 145           0           0           1
## 146           0           0           1
##
## $covariate
##      Sepal.Length Sepal.Width Petal.Length   Petal.Width
## 7     -1.50149039  0.78617383  -1.33575163 -1.1798594716
## 16    -0.17309407  3.08045544  -1.27910398 -1.0486667950
## 18    -0.89767388  1.01560199  -1.33575163 -1.1798594716
## 19    -0.17309407  1.70388647  -1.16580868 -1.1798594716
## 26    -1.01843718 -0.13153881  -1.22245633 -1.3110521482
## 29    -0.77691058  0.78617383  -1.33575163 -1.3110521482
## 32    -0.53538397  0.78617383  -1.27910398 -1.0486667950
## 38    -1.13920048  1.24503015  -1.33575163 -1.4422448248
## 44    -1.01843718  1.01560199  -1.22245633 -0.7862814418
## 50    -1.01843718  0.55674567  -1.33575163 -1.3110521482
## 62     0.06843254 -0.13153881   0.25038262  0.3944526477
## 65    -0.29385737 -0.36096697  -0.08950329  0.1320672944
## 66     1.03453895  0.09788935   0.36367793  0.2632599711
## 68    -0.05233076 -0.81982329   0.19373497 -0.2615107354
## 74     0.30995914 -0.59039513   0.53362088  0.0008746178
## 77     1.15530226 -0.59039513   0.59026853  0.2632599711
## 82    -0.41462067 -1.50810778  -0.03285564 -0.2615107354
## 85    -0.53538397 -0.13153881   0.42032558  0.3944526477
## 86     0.18919584  0.78617383   0.42032558  0.5256453243
## 95    -0.29385737 -0.81982329   0.25038262  0.1320672944
## 109    1.03453895 -1.27867961   1.15674505  0.7880306775
## 120    0.18919584 -1.96696410   0.70356384  0.3944526477
## 121    1.27606556  0.32731751   1.10009740  1.4439940605
## 122   -0.29385737 -0.59039513   0.64691619  1.0504160307
## 129    0.67224905 -0.59039513   1.04344975  1.1816087073
## 134    0.55148575 -0.59039513   0.76021149  0.3944526477
## 135    0.30995914 -1.04925145   1.04344975  0.2632599711
## 140    1.27606556  0.09788935   0.93015445  1.1816087073
## 145    1.03453895  0.55674567   1.10009740  1.7063794137
## 146    1.03453895 -0.13153881   0.81685914  1.4439940605
##
## $model.list
## $model.list$response
## [1] "V1_setosa"     "V1_versicolor" "V1_virginica"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
```

```
##
##
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x55b77bb58270>
## <environment: 0x55b775330358>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x55b77bb522e0>
## <environment: 0x55b77532fe88>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] TRUE
##
## $data
##       Sepal.Length Sepal.Width Petal.Length   Petal.Width V1_setosa V1_versicolor
## 7      -1.50149039  0.78617383  -1.33575163 -1.1798594716         1             0
## 16     -0.17309407  3.08045544  -1.27910398 -1.0486667950         1             0
## 18     -0.89767388  1.01560199  -1.33575163 -1.1798594716         1             0
## 19     -0.17309407  1.70388647  -1.16580868 -1.1798594716         1             0
## 26     -1.01843718 -0.13153881  -1.22245633 -1.3110521482         1             0
## 29     -0.77691058  0.78617383  -1.33575163 -1.3110521482         1             0
## 32     -0.53538397  0.78617383  -1.27910398 -1.0486667950         1             0
## 38     -1.13920048  1.24503015  -1.33575163 -1.4422448248         1             0
## 44     -1.01843718  1.01560199  -1.22245633 -0.7862814418         1             0
## 50     -1.01843718  0.55674567  -1.33575163 -1.3110521482         1             0
## 62      0.06843254 -0.13153881   0.25038262  0.3944526477         0             1
## 65     -0.29385737 -0.36096697  -0.08950329  0.1320672944         0             1
## 66      1.03453895  0.09788935   0.36367793  0.2632599711         0             1
## 68     -0.05233076 -0.81982329   0.19373497 -0.2615107354         0             1
## 74      0.30995914 -0.59039513   0.53362088  0.0008746178         0             1
## 77      1.15530226 -0.59039513   0.59026853  0.2632599711         0             1
## 82     -0.41462067 -1.50810778  -0.03285564 -0.2615107354         0             1
## 85     -0.53538397 -0.13153881   0.42032558  0.3944526477         0             1
## 86      0.18919584  0.78617383   0.42032558  0.5256453243         0             1
## 95     -0.29385737 -0.81982329   0.25038262  0.1320672944         0             1
## 109     1.03453895 -1.27867961   1.15674505  0.7880306775         0             0
## 120     0.18919584 -1.96696410   0.70356384  0.3944526477         0             0
## 121     1.27606556  0.32731751   1.10009740  1.4439940605         0             0
## 122    -0.29385737 -0.59039513   0.64691619  1.0504160307         0             0
## 129     0.67224905 -0.59039513   1.04344975  1.1816087073         0             0
## 134     0.55148575 -0.59039513   0.76021149  0.3944526477         0             0
## 135     0.30995914 -1.04925145   1.04344975  0.2632599711         0             0
```

```
## 140    1.27606556  0.09788935   0.93015445  1.1816087073          0            0
## 145    1.03453895  0.55674567   1.10009740  1.7063794137          0            0
## 146    1.03453895 -0.13153881   0.81685914  1.4439940605          0            0
##      V1_virginica
## 7               0
## 16              0
## 18              0
## 19              0
## 26              0
## 29              0
## 32              0
## 38              0
## 44              0
## 50              0
## 62              0
## 65              0
## 66              0
## 68              0
## 74              0
## 77              0
## 82              0
## 85              0
## 86              0
## 95              0
## 109             1
## 120             1
## 121             1
## 122             1
## 129             1
## 134             1
## 135             1
## 140             1
## 145             1
## 146             1
##
## $exclude
## NULL
##
## $net.result
## $net.result[[1]]
##              [,1]          [,2]          [,3]
## 7    1.0005400775 -0.0046274075  6.038082e-03
## 16   1.0013517724 -0.0029826060  1.187469e-05
## 18   1.0000252952 -0.0026760819  1.053904e-03
## 19   0.9974536439  0.0048321093 -1.678212e-02
## 26   0.9894580473  0.0027399739  1.866803e-03
## 29   0.9987510601 -0.0008253376 -2.431667e-03
## 32   0.9962340859  0.0039658449 -1.269405e-02
## 38   1.0011883012 -0.0043756464  4.310547e-03
## 44   0.9995538259 -0.0029484036  2.444910e-03
## 50   0.9986693649 -0.0021822411  1.676010e-03
## 62  -0.0220155419  0.9738770425  8.122712e-03
## 65   0.0208025397  1.0110463770  3.322094e-03
## 66   0.0173566153  1.0078150529  4.042241e-03
```

```
## 68   0.0308761736  1.0137075040  1.043659e-02
## 74  -0.0187218450  0.9937038602 -5.077900e-03
## 77  -0.0213072332  0.9914862151 -3.077578e-03
## 82   0.0122498042  1.0061925599  4.011237e-03
## 85   0.0083505905  1.0002608663  4.790436e-03
## 86   0.0168568661  1.0122263030 -4.761118e-05
## 95  -0.0374122796  0.9879932396 -1.817956e-02
## 109 -0.0061764821 -0.0151026169  1.010569e+00
## 120 -0.0064462703  0.0006896930  9.944738e-01
## 121 -0.0011332994 -0.0060580407  1.005434e+00
## 122  0.0249927543  0.0247391716  9.943331e-01
## 129 -0.0029268207 -0.0135596334  1.011516e+00
## 134 -0.0041994130  0.0304062932  9.664742e-01
## 135 -0.0027184845 -0.0082343209  1.006291e+00
## 140 -0.0009720594 -0.0014385110  1.000934e+00
## 145  0.0024852748 -0.0034942863  1.005663e+00
## 146 -0.0007038587 -0.0021105412  1.001803e+00
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##              [,1]        [,2]        [,3]        [,4]        [,5]
## [1,]  -1.87913132 -0.1787003  1.3794840  0.5452198  0.9846323
## [2,] -15.20806817  0.3285523 -1.4202192  2.5849589  2.0406131
## [3,]   0.02740786 -1.5657714  0.9503682 -0.9713524  1.5379152
## [4,]  10.42812044  2.6217312 -3.7230584  0.8534935 -8.2226704
## [5,]  18.62117137  0.2514075 -1.3642071  0.2563581 -7.3899942
##
## $weights[[1]][[2]]
##            [,1]       [,2]       [,3]         [,4]
## [1,] -0.9824500 -1.5822262  0.6460543 -1.55689812
## [2,]  0.2341516  2.3895916 51.4778463 -0.94594198
## [3,]  0.4321983  1.8356426 10.3899452  0.08815906
## [4,]  1.4947031 -6.8371206 -1.1114020 -0.48743625
## [5,]  0.6740586 -0.4935564 -2.1567781  0.67553623
## [6,] -1.2965053  7.0045485 -2.4414094 -0.14286569
##
## $weights[[1]][[3]]
##             [,1]        [,2]       [,3]
## [1,]  1.36686390 -0.05241796  0.2367706
## [2,] -0.84283046  0.52151003 -1.1792917
## [3,] -0.03743581 -1.58447935  1.5548129
## [4,] -0.76531582  0.93379807  0.3472126
## [5,] -0.52824506  1.43413844 -1.8141921
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##             [,1]        [,2]        [,3]         [,4]        [,5]
## 7     2.25075917  -5.2217508   8.36004177  0.903712648  -0.41032581
## 16    1.94857593  -0.8173608   0.78499291  0.203068831  -2.25494062
## 18  123.40287694 -124.2670990 175.86180410 23.772997412  -2.62749818
```

```
## 19    -4.29880150    2.1032550   -2.25205597   -0.492331586    5.42813102
## 26    -0.85096187    1.8508713   -2.94428997   -0.314554240    5.81626676
## 29    -4.03705420    3.7785379   -5.25814637   -0.736345503  -13.93067700
## 32    -2.68134762    1.9851848   -2.57572323   -0.408227420    5.89389036
## 38     1.13342542   -1.4334602    2.12469233    0.262876177   -0.65435444
## 44    -6.62292062    8.8789878  -13.27158525   -1.682244221   -2.08410428
## 50    -2.81899432    3.9233134   -5.90861253   -0.708239941   -3.55493224
## 62     0.05385168   -0.7812644   -3.64106212   -1.404172764  -27.64782928
## 65     2.58294081    6.1133480  -20.04427285  -17.894446539   88.53323040
## 66     4.49877631    4.2233398  -13.81963146  -11.869922190  150.15865472
## 68     3.82840365    3.3165535  -12.18715836  -12.858857165  117.59161152
## 74     2.85844825   -0.5991134   -3.50043724   -3.671377167  407.68165842
## 77    -0.33964785   -0.4971639    0.87078667    0.654702804  -21.97353024
## 82     6.26084192    8.2959194  -30.01012517  -30.455944491 -190.01157492
## 85    -2.91516185    1.6264034   15.24205609    7.330084304 2057.75166977
## 86    -1.05682232    1.4698275    5.63499463    2.776345615   44.99476155
## 95     0.20580429   -0.2268080   -2.46921065   -0.756561145  -58.00555562
## 109    0.21820163   -0.1657831    0.09176966   -0.025614973   -0.07244317
## 120    0.78059003   -0.1570512   -1.80895531   -0.777365154  -22.02774822
## 121    3.95156823   -7.2526550   10.22454446    0.748291934    0.17486758
## 122   -2.52901640    1.0720425    0.59170175    0.482726006   -0.43122072
## 129    2.45537341   -1.6741393    1.35988970    0.008672637   -0.38335262
## 134    1.47083049   -1.3207267   -2.94391603   -1.916420877    0.53752940
## 135    4.18487520   -1.7389941   -1.34610786   -0.935771391   -0.26133122
## 140    3.94963743   -8.9868175   11.54570325    0.231595836    3.92256033
## 145   -3.67575647    5.0779214   -7.02126578   -0.634491397   -0.92353382
## 146    7.59658931  -12.6156992   14.79469258    0.068033356    2.01404878
##              [,6]         [,7]           [,8]           [,9]          [,10]
## 7      0.2439346   -0.2738275    -0.04809655  -6.390221e-01  -1.674887e-01
## 16     0.8477877   -0.7134241    -0.20906565  -1.313558e+03   4.818378e+02
## 18     1.0975063   -0.9981806    -0.24915220  -1.515917e+01   3.727945e+00
## 19    -2.0510997    1.7192344     0.49745613   3.401509e+00  -1.195970e+00
## 26    -3.6635809    4.3014337     0.71188184  -1.857589e+01  -1.520541e+00
## 29     5.7402469   -5.2347762    -1.34551264   1.067296e+01  -2.795493e+00
## 32    -2.3197880    2.0017807     0.54205446   4.062823e+00  -1.220952e+00
## 38     0.2891696   -0.2765189    -0.06459915  -1.493360e+00   2.692663e-01
## 44     0.9337405   -0.8317296    -0.18551938  -5.714092e+00   9.148548e-01
## 50     1.6341489   -1.6114485    -0.36013474  -1.031476e+01   1.518502e+00
## 62    21.6809263  -74.1723070   -18.21412550   8.734808e+01  -6.683829e+01
## 65    33.2388601 -222.9841054  -252.06964027   3.114005e+02   1.412398e+02
## 66    11.6116774 -186.3598656  -275.27683578   3.086516e+02   3.044645e+01
## 68    26.4808598 -192.1464288  -249.24042529   1.633699e+02   4.219467e+01
## 74    42.3860960 -474.7988354  -605.66542356   5.045973e+02   5.035156e+01
## 77     8.7893958  -12.8845778    15.88202511  -6.201616e+01   2.152319e+01
## 82    76.0401864 -186.7597301   -43.06168605  -2.778977e+02   1.378616e+02
## 85 -1975.5351887 7418.5800296  2468.98683576   1.089574e+02  -1.060479e+02
## 86   -41.5916240  145.6187988    41.63012767  -1.143795e+04   1.042567e+04
## 95    39.9590471 -146.4734437   -34.78363346  -3.691211e+01   2.527334e+01
## 109   -0.1183329    0.4807686     0.19148144   1.997697e-01   9.582901e-02
## 120   26.0832358 -124.3085216   -44.71303742   2.083980e+00  -3.144391e+00
## 121   -2.6721341    5.6145616     0.87849300   4.334864e-01   1.813562e+00
## 122    3.1027711  -15.7290654    -5.28978787  -6.467225e+00  -9.760146e+00
## 129   -0.3733496    1.5288091     0.38634744   9.240196e-01   1.162590e-01
## 134    1.7715011   -7.8823419    -4.51826835  -6.163434e-01  -1.482628e+00
```

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```
## 135    -1.1991143     6.9870701    2.46844441  1.705789e+00  1.006376e+00
## 140   -15.2827608    34.8600687    7.01450908 -2.912231e+00  1.629671e+01
## 145    -6.1283987    13.1959417    1.90835379  1.794593e+00  2.061669e+00
## 146    -9.9856811    24.5090029    5.16070172 -1.024365e-01  7.885729e+00
##              [,11]         [,12]
## 7     5.161984e-01  7.675768e-03
## 16   -4.041208e+02 -1.243117e+02
## 18   -1.398084e+00 -1.123475e+00
## 19    9.502187e-01  3.112741e-01
## 26    9.003800e+00 -4.037269e-01
## 29    1.312310e+00  8.308314e-01
## 32    7.643816e-01  3.362037e-01
## 38    3.290513e-02 -9.585548e-02
## 44    4.324533e-01 -2.897570e-01
## 50    8.239362e-01 -6.094434e-01
## 62    2.423118e+02  6.063449e+01
## 65   -8.478148e+02 -9.358710e+02
## 66   -3.957797e+02 -5.721269e+02
## 68   -2.809335e+02 -3.587491e+02
## 74   -5.903428e+02 -7.493081e+02
## 77   -3.096053e+01  4.684207e+01
## 82   -3.634661e+02 -1.425211e+02
## 85    4.269206e+02  1.451452e+02
## 86   -3.940783e+04 -1.158458e+04
## 95   -9.798316e+01 -2.355781e+01
## 109 -6.498144e-01 -2.862402e-01
## 120  1.728865e+01  6.334103e+00
## 121 -4.618111e+00 -8.611984e-01
## 122  6.947330e+01  2.431981e+01
## 129 -1.542709e+00 -4.559469e-01
## 134  7.472068e+00  4.293818e+00
## 135 -9.641990e+00 -3.559269e+00
## 140 -4.440729e+01 -1.063425e+01
## 145 -5.757581e+00 -9.633436e-01
## 146 -2.424474e+01 -6.034175e+00
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##              [,1]          [,2]         [,3]        [,4]        [,5]
## [1,] -0.8780771 -0.005234058  0.30731422  0.2326318 -0.6787586
## [2,] -0.1125589 -0.152260049 -0.04631853 -0.0396487  0.5008359
## [3,]  1.9487131 -0.509631657  2.25184180 -0.8391251 -0.3316623
## [4,]  0.9338163  1.434573703 -0.60803373  0.1322911 -1.8349803
## [5,]  1.9130594 -1.285838532 -1.50928817 -0.2755247 -2.6517412
##
## $startweights[[1]][[2]]
##              [,1]        [,2]        [,3]        [,4]
## [1,] -0.5805822 -1.5070626  0.52874502 -1.22681509
## [2,]  1.4541869  0.2055698  0.78939440  0.03615287
## [3,]  0.8381294  1.5972281  0.45709951 -0.42139311
## [4,]  1.2150536 -3.3960635  0.53883312 -0.89936441
## [5,]  0.9825054 -0.7813523  0.01464312  0.41744132
```

```
## [6,]   0.3157640   1.1024646  -0.91648914   0.15344474
##
## $startweights[[1]][[3]]
##                [,1]          [,2]        [,3]
## [1,]   1.46328305  -0.2847059   1.1330102
## [2,]  -1.12150250  -0.7081712  -0.6040689
## [3,]  -0.51778808  -2.1476390   0.5575116
## [4,]  -0.07494709  -0.2838372   0.1426293
## [5,]  -1.40779008  -0.5340722  -1.2368602
##
##
##
## $result.matrix
##                                      [,1]
## error                         0.006056711
## reached.threshold             0.008672822
## steps                       673.000000000
## Intercept.to.1layhid1        -1.879131323
## Sepal.Length.to.1layhid1    -15.208068174
## Sepal.Width.to.1layhid1       0.027407860
## Petal.Length.to.1layhid1     10.428120444
## Petal.Width.to.1layhid1      18.621171374
## Intercept.to.1layhid2        -0.178700334
## Sepal.Length.to.1layhid2      0.328552337
## Sepal.Width.to.1layhid2      -1.565771359
## Petal.Length.to.1layhid2      2.621731162
## Petal.Width.to.1layhid2       0.251407470
## Intercept.to.1layhid3         1.379483981
## Sepal.Length.to.1layhid3     -1.420219156
## Sepal.Width.to.1layhid3       0.950368238
## Petal.Length.to.1layhid3     -3.723058432
## Petal.Width.to.1layhid3      -1.364207070
## Intercept.to.1layhid4         0.545219846
## Sepal.Length.to.1layhid4      2.584958874
## Sepal.Width.to.1layhid4      -0.971352354
## Petal.Length.to.1layhid4      0.853493545
## Petal.Width.to.1layhid4       0.256358099
## Intercept.to.1layhid5         0.984632288
## Sepal.Length.to.1layhid5      2.040613079
## Sepal.Width.to.1layhid5       1.537915199
## Petal.Length.to.1layhid5     -8.222670366
## Petal.Width.to.1layhid5      -7.389994203
## Intercept.to.2layhid1        -0.982450005
## 1layhid1.to.2layhid1          0.234151623
## 1layhid2.to.2layhid1          0.432198348
## 1layhid3.to.2layhid1          1.494703097
## 1layhid4.to.2layhid1          0.674058588
## 1layhid5.to.2layhid1         -1.296505258
## Intercept.to.2layhid2        -1.582226156
## 1layhid1.to.2layhid2          2.389591563
## 1layhid2.to.2layhid2          1.835642604
## 1layhid3.to.2layhid2         -6.837120599
## 1layhid4.to.2layhid2         -0.493556426
## 1layhid5.to.2layhid2          7.004548521
```

```
## Intercept.to.2layhid3         0.646054312
## 1layhid1.to.2layhid3         51.477846277
## 1layhid2.to.2layhid3         10.389945176
## 1layhid3.to.2layhid3         -1.111401998
## 1layhid4.to.2layhid3         -2.156778082
## 1layhid5.to.2layhid3         -2.441409432
## Intercept.to.2layhid4         -1.556898123
## 1layhid1.to.2layhid4         -0.945941981
## 1layhid2.to.2layhid4          0.088159056
## 1layhid3.to.2layhid4         -0.487436245
## 1layhid4.to.2layhid4          0.675536225
## 1layhid5.to.2layhid4         -0.142865687
## Intercept.to.V1_setosa        1.366863903
## 2layhid1.to.V1_setosa        -0.842830461
## 2layhid2.to.V1_setosa        -0.037435806
## 2layhid3.to.V1_setosa        -0.765315816
## 2layhid4.to.V1_setosa        -0.528245058
## Intercept.to.V1_versicolor   -0.052417959
## 2layhid1.to.V1_versicolor     0.521510028
## 2layhid2.to.V1_versicolor    -1.584479348
## 2layhid3.to.V1_versicolor     0.933798066
## 2layhid4.to.V1_versicolor     1.434138442
## Intercept.to.V1_virginica     0.236770598
## 2layhid1.to.V1_virginica     -1.179291655
## 2layhid2.to.V1_virginica      1.554812933
## 2layhid3.to.V1_virginica      0.347212568
## 2layhid4.to.V1_virginica     -1.814192144
##
## attr(,"class")
## [1] "nn"
##
##               setosa versicolor virginica
##    setosa         40          0         0
##    versicolor      0         30         2
##    virginica       0         10        38
```
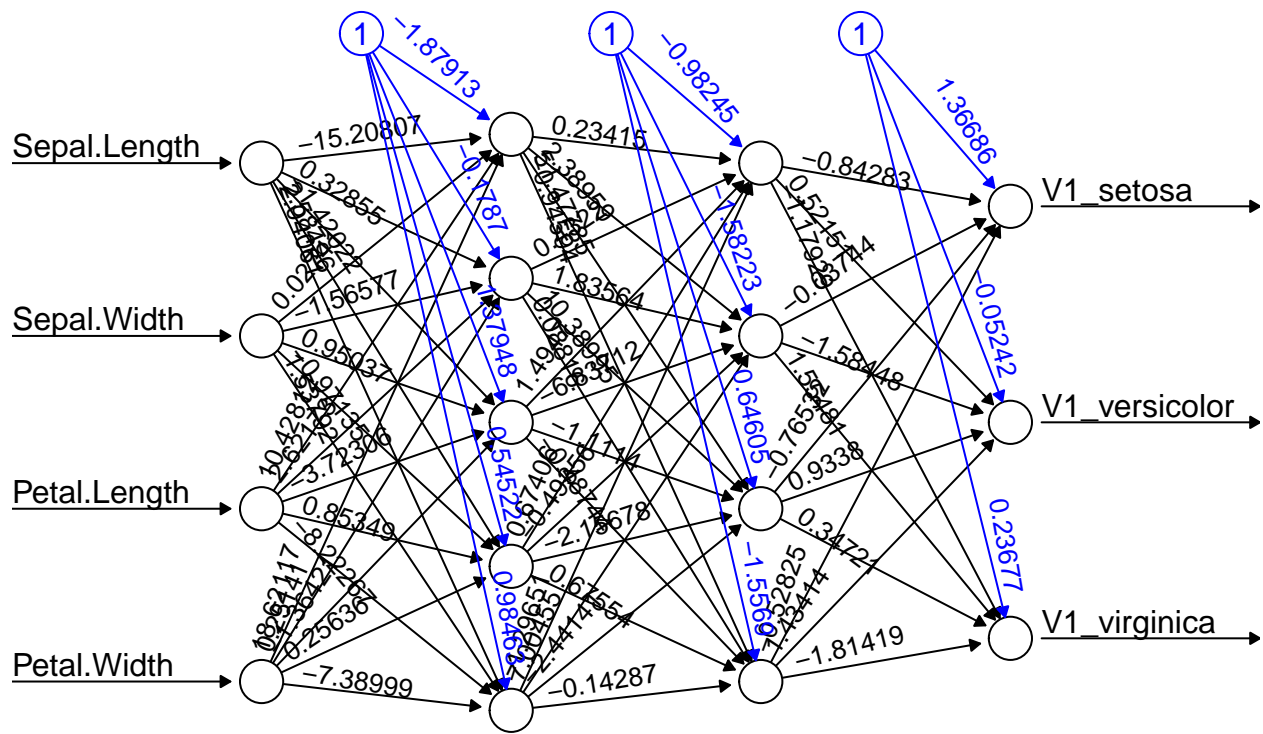
```r
# Calculando a acurácia média do modelo em todos os folds
mean(accuracy)
```

```
## [1] 94.16667
```

```r
# Definindo a disposição dos plots em uma janela gráfica
par(mfrow=c(2,2))

# Plotando todas as redes neurais treinadas em uma única janela gráfica
for(i in 1:length(modelo$weights)) {
  plot(modelo, rep = "best", show.weights = i)
}
```

Error: 0.006057   Steps: 673