AAN in R Assignment

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R Markdown

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
install.packages(c("neuralnet", "keras", "tensorflow"), dependancies = T)
```

```
## Installing packages into '/cloud/lib/x86_64-pc-linux-gnu-library/4.4'
## (as 'lib' is unspecified)
```

```
library(neuralnet)
install.packages("tidyverse")
```

```
## Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.4'
## (as 'lib' is unspecified)
```

```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.1     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.1
## v purrr     1.0.2
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::compute() masks neuralnet::compute()
## x dplyr::filter()  masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
iris <- iris %>%mutate_if(is.character, as.factor)
iris
```

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1            5.1         3.5          1.4         0.2     setosa
## 2            4.9         3.0          1.4         0.2     setosa
## 3            4.7         3.2          1.3         0.2     setosa
## 4            4.6         3.1          1.5         0.2     setosa
## 5            5.0         3.6          1.4         0.2     setosa
## 6            5.4         3.9          1.7         0.4     setosa
## 7            4.6         3.4          1.4         0.3     setosa
## 8            5.0         3.4          1.5         0.2     setosa
## 9            4.4         2.9          1.4         0.2     setosa
```

```
## 10          4.9         3.1          1.5         0.1     setosa
## 11          5.4         3.7          1.5         0.2     setosa
## 12          4.8         3.4          1.6         0.2     setosa
## 13          4.8         3.0          1.4         0.1     setosa
## 14          4.3         3.0          1.1         0.1     setosa
## 15          5.8         4.0          1.2         0.2     setosa
## 16          5.7         4.4          1.5         0.4     setosa
## 17          5.4         3.9          1.3         0.4     setosa
## 18          5.1         3.5          1.4         0.3     setosa
## 19          5.7         3.8          1.7         0.3     setosa
## 20          5.1         3.8          1.5         0.3     setosa
## 21          5.4         3.4          1.7         0.2     setosa
## 22          5.1         3.7          1.5         0.4     setosa
## 23          4.6         3.6          1.0         0.2     setosa
## 24          5.1         3.3          1.7         0.5     setosa
## 25          4.8         3.4          1.9         0.2     setosa
## 26          5.0         3.0          1.6         0.2     setosa
## 27          5.0         3.4          1.6         0.4     setosa
## 28          5.2         3.5          1.5         0.2     setosa
## 29          5.2         3.4          1.4         0.2     setosa
## 30          4.7         3.2          1.6         0.2     setosa
## 31          4.8         3.1          1.6         0.2     setosa
## 32          5.4         3.4          1.5         0.4     setosa
## 33          5.2         4.1          1.5         0.1     setosa
## 34          5.5         4.2          1.4         0.2     setosa
## 35          4.9         3.1          1.5         0.2     setosa
## 36          5.0         3.2          1.2         0.2     setosa
## 37          5.5         3.5          1.3         0.2     setosa
## 38          4.9         3.6          1.4         0.1     setosa
## 39          4.4         3.0          1.3         0.2     setosa
## 40          5.1         3.4          1.5         0.2     setosa
## 41          5.0         3.5          1.3         0.3     setosa
## 42          4.5         2.3          1.3         0.3     setosa
## 43          4.4         3.2          1.3         0.2     setosa
## 44          5.0         3.5          1.6         0.6     setosa
## 45          5.1         3.8          1.9         0.4     setosa
## 46          4.8         3.0          1.4         0.3     setosa
## 47          5.1         3.8          1.6         0.2     setosa
## 48          4.6         3.2          1.4         0.2     setosa
## 49          5.3         3.7          1.5         0.2     setosa
## 50          5.0         3.3          1.4         0.2     setosa
## 51          7.0         3.2          4.7         1.4 versicolor
## 52          6.4         3.2          4.5         1.5 versicolor
## 53          6.9         3.1          4.9         1.5 versicolor
## 54          5.5         2.3          4.0         1.3 versicolor
## 55          6.5         2.8          4.6         1.5 versicolor
## 56          5.7         2.8          4.5         1.3 versicolor
## 57          6.3         3.3          4.7         1.6 versicolor
## 58          4.9         2.4          3.3         1.0 versicolor
## 59          6.6         2.9          4.6         1.3 versicolor
## 60          5.2         2.7          3.9         1.4 versicolor
## 61          5.0         2.0          3.5         1.0 versicolor
## 62          5.9         3.0          4.2         1.5 versicolor
## 63          6.0         2.2          4.0         1.0 versicolor
```

```
## 64          6.1         2.9          4.7         1.4 versicolor
## 65          5.6         2.9          3.6         1.3 versicolor
## 66          6.7         3.1          4.4         1.4 versicolor
## 67          5.6         3.0          4.5         1.5 versicolor
## 68          5.8         2.7          4.1         1.0 versicolor
## 69          6.2         2.2          4.5         1.5 versicolor
## 70          5.6         2.5          3.9         1.1 versicolor
## 71          5.9         3.2          4.8         1.8 versicolor
## 72          6.1         2.8          4.0         1.3 versicolor
## 73          6.3         2.5          4.9         1.5 versicolor
## 74          6.1         2.8          4.7         1.2 versicolor
## 75          6.4         2.9          4.3         1.3 versicolor
## 76          6.6         3.0          4.4         1.4 versicolor
## 77          6.8         2.8          4.8         1.4 versicolor
## 78          6.7         3.0          5.0         1.7 versicolor
## 79          6.0         2.9          4.5         1.5 versicolor
## 80          5.7         2.6          3.5         1.0 versicolor
## 81          5.5         2.4          3.8         1.1 versicolor
## 82          5.5         2.4          3.7         1.0 versicolor
## 83          5.8         2.7          3.9         1.2 versicolor
## 84          6.0         2.7          5.1         1.6 versicolor
## 85          5.4         3.0          4.5         1.5 versicolor
## 86          6.0         3.4          4.5         1.6 versicolor
## 87          6.7         3.1          4.7         1.5 versicolor
## 88          6.3         2.3          4.4         1.3 versicolor
## 89          5.6         3.0          4.1         1.3 versicolor
## 90          5.5         2.5          4.0         1.3 versicolor
## 91          5.5         2.6          4.4         1.2 versicolor
## 92          6.1         3.0          4.6         1.4 versicolor
## 93          5.8         2.6          4.0         1.2 versicolor
## 94          5.0         2.3          3.3         1.0 versicolor
## 95          5.6         2.7          4.2         1.3 versicolor
## 96          5.7         3.0          4.2         1.2 versicolor
## 97          5.7         2.9          4.2         1.3 versicolor
## 98          6.2         2.9          4.3         1.3 versicolor
## 99          5.1         2.5          3.0         1.1 versicolor
## 100         5.7         2.8          4.1         1.3 versicolor
## 101         6.3         3.3          6.0         2.5  virginica
## 102         5.8         2.7          5.1         1.9  virginica
## 103         7.1         3.0          5.9         2.1  virginica
## 104         6.3         2.9          5.6         1.8  virginica
## 105         6.5         3.0          5.8         2.2  virginica
## 106         7.6         3.0          6.6         2.1  virginica
## 107         4.9         2.5          4.5         1.7  virginica
## 108         7.3         2.9          6.3         1.8  virginica
## 109         6.7         2.5          5.8         1.8  virginica
## 110         7.2         3.6          6.1         2.5  virginica
## 111         6.5         3.2          5.1         2.0  virginica
## 112         6.4         2.7          5.3         1.9  virginica
## 113         6.8         3.0          5.5         2.1  virginica
## 114         5.7         2.5          5.0         2.0  virginica
## 115         5.8         2.8          5.1         2.4  virginica
## 116         6.4         3.2          5.3         2.3  virginica
## 117         6.5         3.0          5.5         1.8  virginica
```

```
## 118          7.7         3.8          6.7         2.2  virginica
## 119          7.7         2.6          6.9         2.3  virginica
## 120          6.0         2.2          5.0         1.5  virginica
## 121          6.9         3.2          5.7         2.3  virginica
## 122          5.6         2.8          4.9         2.0  virginica
## 123          7.7         2.8          6.7         2.0  virginica
## 124          6.3         2.7          4.9         1.8  virginica
## 125          6.7         3.3          5.7         2.1  virginica
## 126          7.2         3.2          6.0         1.8  virginica
## 127          6.2         2.8          4.8         1.8  virginica
## 128          6.1         3.0          4.9         1.8  virginica
## 129          6.4         2.8          5.6         2.1  virginica
## 130          7.2         3.0          5.8         1.6  virginica
## 131          7.4         2.8          6.1         1.9  virginica
## 132          7.9         3.8          6.4         2.0  virginica
## 133          6.4         2.8          5.6         2.2  virginica
## 134          6.3         2.8          5.1         1.5  virginica
## 135          6.1         2.6          5.6         1.4  virginica
## 136          7.7         3.0          6.1         2.3  virginica
## 137          6.3         3.4          5.6         2.4  virginica
## 138          6.4         3.1          5.5         1.8  virginica
## 139          6.0         3.0          4.8         1.8  virginica
## 140          6.9         3.1          5.4         2.1  virginica
## 141          6.7         3.1          5.6         2.4  virginica
## 142          6.9         3.1          5.1         2.3  virginica
## 143          5.8         2.7          5.1         1.9  virginica
## 144          6.8         3.2          5.9         2.3  virginica
## 145          6.7         3.3          5.7         2.5  virginica
## 146          6.7         3.0          5.2         2.3  virginica
## 147          6.3         2.5          5.0         1.9  virginica
## 148          6.5         3.0          5.2         2.0  virginica
## 149          6.2         3.4          5.4         2.3  virginica
## 150          5.9         3.0          5.1         1.8  virginica
```

```
summary(iris)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.800   Median :3.000   Median :4.350   Median :1.300
##  Mean   :5.843   Mean   :3.057   Mean   :3.758   Mean   :1.199
##  3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
##        Species
##  setosa    :50
##  versicolor:50
##  virginica :50
##
##
##
```

```
set.seed(254)
data_rows <- floor(0.80 * nrow(iris))
data_rows
```

```
## [1] 120
```

```
train_indices <- sample(c(1:nrow(iris)), data_rows)
train_indices
```

```
##   [1]  55  37 146  70  45 124  20  76 144   3  88  10 136 126 102 125  64 111
##  [19] 122  32 147 123  95 101 149 143  94 150  11  83  54  57  61  48  29  69
##  [37] 130 115 145  17  50  96  35  93  49  12  14  60  18  97 109 134  62 113
##  [55]  75 119  41  27  25  89 100  91  19 137  46 103  85   6  44  86  71  36
##  [73] 104  42 139 118 106   9  43  84  66  39   7  72 117 108   4  38 138  65
##  [91]   5   2  87  82  40  77 128  67  92 131  74  56  59 120  23  13  33 107
## [109] 127  24 116  34  68  58  73  80   8  99 121 133
```

```
train_data <- iris[-train_indices,]
train_data
```

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1            5.1         3.5          1.4         0.2     setosa
## 15           5.8         4.0          1.2         0.2     setosa
## 16           5.7         4.4          1.5         0.4     setosa
## 21           5.4         3.4          1.7         0.2     setosa
## 22           5.1         3.7          1.5         0.4     setosa
## 26           5.0         3.0          1.6         0.2     setosa
## 28           5.2         3.5          1.5         0.2     setosa
## 30           4.7         3.2          1.6         0.2     setosa
## 31           4.8         3.1          1.6         0.2     setosa
## 47           5.1         3.8          1.6         0.2     setosa
## 51           7.0         3.2          4.7         1.4 versicolor
## 52           6.4         3.2          4.5         1.5 versicolor
## 53           6.9         3.1          4.9         1.5 versicolor
## 63           6.0         2.2          4.0         1.0 versicolor
## 78           6.7         3.0          5.0         1.7 versicolor
## 79           6.0         2.9          4.5         1.5 versicolor
## 81           5.5         2.4          3.8         1.1 versicolor
## 90           5.5         2.5          4.0         1.3 versicolor
## 98           6.2         2.9          4.3         1.3 versicolor
## 105          6.5         3.0          5.8         2.2  virginica
## 110          7.2         3.6          6.1         2.5  virginica
## 112          6.4         2.7          5.3         1.9  virginica
## 114          5.7         2.5          5.0         2.0  virginica
## 129          6.4         2.8          5.6         2.1  virginica
## 132          7.9         3.8          6.4         2.0  virginica
## 135          6.1         2.6          5.6         1.4  virginica
## 140          6.9         3.1          5.4         2.1  virginica
## 141          6.7         3.1          5.6         2.4  virginica
## 142          6.9         3.1          5.1         2.3  virginica
## 148          6.5         3.0          5.2         2.0  virginica
```

```
test_data <- iris[-train_indices, ]
test_data
```

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1            5.1         3.5          1.4         0.2     setosa
## 15           5.8         4.0          1.2         0.2     setosa
## 16           5.7         4.4          1.5         0.4     setosa
## 21           5.4         3.4          1.7         0.2     setosa
```

```
## 22           5.1         3.7          1.5         0.4     setosa
## 26           5.0         3.0          1.6         0.2     setosa
## 28           5.2         3.5          1.5         0.2     setosa
## 30           4.7         3.2          1.6         0.2     setosa
## 31           4.8         3.1          1.6         0.2     setosa
## 47           5.1         3.8          1.6         0.2     setosa
## 51           7.0         3.2          4.7         1.4 versicolor
## 52           6.4         3.2          4.5         1.5 versicolor
## 53           6.9         3.1          4.9         1.5 versicolor
## 63           6.0         2.2          4.0         1.0 versicolor
## 78           6.7         3.0          5.0         1.7 versicolor
## 79           6.0         2.9          4.5         1.5 versicolor
## 81           5.5         2.4          3.8         1.1 versicolor
## 90           5.5         2.5          4.0         1.3 versicolor
## 98           6.2         2.9          4.3         1.3 versicolor
## 105          6.5         3.0          5.8         2.2  virginica
## 110          7.2         3.6          6.1         2.5  virginica
## 112          6.4         2.7          5.3         1.9  virginica
## 114          5.7         2.5          5.0         2.0  virginica
## 129          6.4         2.8          5.6         2.1  virginica
## 132          7.9         3.8          6.4         2.0  virginica
## 135          6.1         2.6          5.6         1.4  virginica
## 140          6.9         3.1          5.4         2.1  virginica
## 141          6.7         3.1          5.6         2.4  virginica
## 142          6.9         3.1          5.1         2.3  virginica
## 148          6.5         3.0          5.2         2.0  virginica
```

```
model <- neuralnet(Species ~ Sepal.Length + Sepal.Width + Petal.Length +
Petal.Width, data = train_data, hidden = c(4,2), linear.output = FALSE)
model
```

```
## $call
## neuralnet(formula = Species ~ Sepal.Length + Sepal.Width + Petal.Length +
##     Petal.Width, data = train_data, hidden = c(4, 2), linear.output = FALSE)
##
## $response
##    setosa versicolor virginica
## 1    TRUE      FALSE     FALSE
## 2    TRUE      FALSE     FALSE
## 3    TRUE      FALSE     FALSE
## 4    TRUE      FALSE     FALSE
## 5    TRUE      FALSE     FALSE
## 6    TRUE      FALSE     FALSE
## 7    TRUE      FALSE     FALSE
## 8    TRUE      FALSE     FALSE
## 9    TRUE      FALSE     FALSE
## 10   TRUE      FALSE     FALSE
## 11  FALSE       TRUE     FALSE
## 12  FALSE       TRUE     FALSE
## 13  FALSE       TRUE     FALSE
## 14  FALSE       TRUE     FALSE
## 15  FALSE       TRUE     FALSE
## 16  FALSE       TRUE     FALSE
## 17  FALSE       TRUE     FALSE
## 18  FALSE       TRUE     FALSE
```

```
## 19  FALSE       TRUE     FALSE
## 20  FALSE      FALSE      TRUE
## 21  FALSE      FALSE      TRUE
## 22  FALSE      FALSE      TRUE
## 23  FALSE      FALSE      TRUE
## 24  FALSE      FALSE      TRUE
## 25  FALSE      FALSE      TRUE
## 26  FALSE      FALSE      TRUE
## 27  FALSE      FALSE      TRUE
## 28  FALSE      FALSE      TRUE
## 29  FALSE      FALSE      TRUE
## 30  FALSE      FALSE      TRUE
##
## $covariate
##     Sepal.Length Sepal.Width Petal.Length Petal.Width
## 1            5.1         3.5          1.4         0.2
## 15           5.8         4.0          1.2         0.2
## 16           5.7         4.4          1.5         0.4
## 21           5.4         3.4          1.7         0.2
## 22           5.1         3.7          1.5         0.4
## 26           5.0         3.0          1.6         0.2
## 28           5.2         3.5          1.5         0.2
## 30           4.7         3.2          1.6         0.2
## 31           4.8         3.1          1.6         0.2
## 47           5.1         3.8          1.6         0.2
## 51           7.0         3.2          4.7         1.4
## 52           6.4         3.2          4.5         1.5
## 53           6.9         3.1          4.9         1.5
## 63           6.0         2.2          4.0         1.0
## 78           6.7         3.0          5.0         1.7
## 79           6.0         2.9          4.5         1.5
## 81           5.5         2.4          3.8         1.1
## 90           5.5         2.5          4.0         1.3
## 98           6.2         2.9          4.3         1.3
## 105          6.5         3.0          5.8         2.2
## 110          7.2         3.6          6.1         2.5
## 112          6.4         2.7          5.3         1.9
## 114          5.7         2.5          5.0         2.0
## 129          6.4         2.8          5.6         2.1
## 132          7.9         3.8          6.4         2.0
## 135          6.1         2.6          5.6         1.4
## 140          6.9         3.1          5.4         2.1
## 141          6.7         3.1          5.6         2.4
## 142          6.9         3.1          5.1         2.3
## 148          6.5         3.0          5.2         2.0
##
## $model.list
## $model.list$response
## [1] "setosa"     "versicolor" "virginica"
##
## $model.list$variables
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Width"
##
##
```

```
## $err.fct
## function (x, y)
## {
##     1/2 * (y - x)^2
## }
## <bytecode: 0x5e62f5da73e8>
## <environment: 0x5e62f5da4c78>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x5e62f5dad880>
## <environment: 0x5e62f5daa348>
## attr(,"type")
## [1] "logistic"
##
## $linear.output
## [1] FALSE
##
## $data
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1            5.1         3.5          1.4         0.2     setosa
## 15           5.8         4.0          1.2         0.2     setosa
## 16           5.7         4.4          1.5         0.4     setosa
## 21           5.4         3.4          1.7         0.2     setosa
## 22           5.1         3.7          1.5         0.4     setosa
## 26           5.0         3.0          1.6         0.2     setosa
## 28           5.2         3.5          1.5         0.2     setosa
## 30           4.7         3.2          1.6         0.2     setosa
## 31           4.8         3.1          1.6         0.2     setosa
## 47           5.1         3.8          1.6         0.2     setosa
## 51           7.0         3.2          4.7         1.4 versicolor
## 52           6.4         3.2          4.5         1.5 versicolor
## 53           6.9         3.1          4.9         1.5 versicolor
## 63           6.0         2.2          4.0         1.0 versicolor
## 78           6.7         3.0          5.0         1.7 versicolor
## 79           6.0         2.9          4.5         1.5 versicolor
## 81           5.5         2.4          3.8         1.1 versicolor
## 90           5.5         2.5          4.0         1.3 versicolor
## 98           6.2         2.9          4.3         1.3 versicolor
## 105          6.5         3.0          5.8         2.2  virginica
## 110          7.2         3.6          6.1         2.5  virginica
## 112          6.4         2.7          5.3         1.9  virginica
## 114          5.7         2.5          5.0         2.0  virginica
## 129          6.4         2.8          5.6         2.1  virginica
## 132          7.9         3.8          6.4         2.0  virginica
## 135          6.1         2.6          5.6         1.4  virginica
## 140          6.9         3.1          5.4         2.1  virginica
## 141          6.7         3.1          5.6         2.4  virginica
## 142          6.9         3.1          5.1         2.3  virginica
```

```
## 148          6.5         3.0          5.2         2.0  virginica
##
## $exclude
## NULL
##
## $net.result
## $net.result[[1]]
##             [,1]        [,2]         [,3]
## 1   9.991355e-01 0.001659219 2.888748e-10
## 15  9.991374e-01 0.001656208 2.881641e-10
## 16  9.991378e-01 0.001655553 2.880095e-10
## 21  9.991203e-01 0.001682876 2.944759e-10
## 22  9.991360e-01 0.001658348 2.886692e-10
## 26  9.991141e-01 0.001692545 2.967733e-10
## 28  9.991335e-01 0.001662327 2.896091e-10
## 30  9.991297e-01 0.001668198 2.909975e-10
## 31  9.991249e-01 0.001675776 2.927920e-10
## 47  9.991361e-01 0.001658264 2.886495e-10
## 51  1.193086e-03 0.991841402 1.173366e-03
## 52  1.161553e-03 0.991731584 1.201323e-03
## 53  8.680128e-04 0.990089810 1.542250e-03
## 63  1.151139e-03 0.991662037 1.210063e-03
## 78  4.176569e-05 0.936557818 2.041222e-02
## 79  6.882928e-04 0.988550031 1.881375e-03
## 81  1.186391e-03 0.991822512 1.179286e-03
## 90  9.992943e-04 0.990924100 1.366906e-03
## 98  1.180271e-03 0.991803859 1.184722e-03
## 105 2.978676e-11 0.001970871 9.997422e-01
## 110 3.726085e-11 0.002268828 9.996876e-01
## 112 8.684217e-11 0.003860900 9.993550e-01
## 114 4.650096e-11 0.002607858 9.996223e-01
## 129 3.229135e-11 0.002073528 9.997237e-01
## 132 4.964612e-10 0.011494713 9.971312e-01
## 135 6.020337e-11 0.003067363 9.995288e-01
## 140 5.744430e-10 0.012587730 9.967502e-01
## 141 3.729272e-11 0.002270048 9.996874e-01
## 142 5.238735e-09 0.048828764 9.787701e-01
## 148 1.252679e-09 0.020411292 9.936789e-01
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##            [,1]        [,2]       [,3]         [,4]
## [1,]  1.5850607  0.07276711  1.2989067  0.820164988
## [2,] -0.5460290 -1.01895101  0.2002771 -0.003823878
## [3,]  0.7748516 -0.20160588  0.3085626  1.229014294
## [4,] -0.7914394  1.24033480 -0.6046214 -0.849104820
## [5,]  0.0689953  1.00543305 -0.6077275 -0.583076099
##
## $weights[[1]][[2]]
##            [,1]        [,2]
## [1,]  -7.255405   0.4441351
## [2,]  13.302418  -3.6911194
```

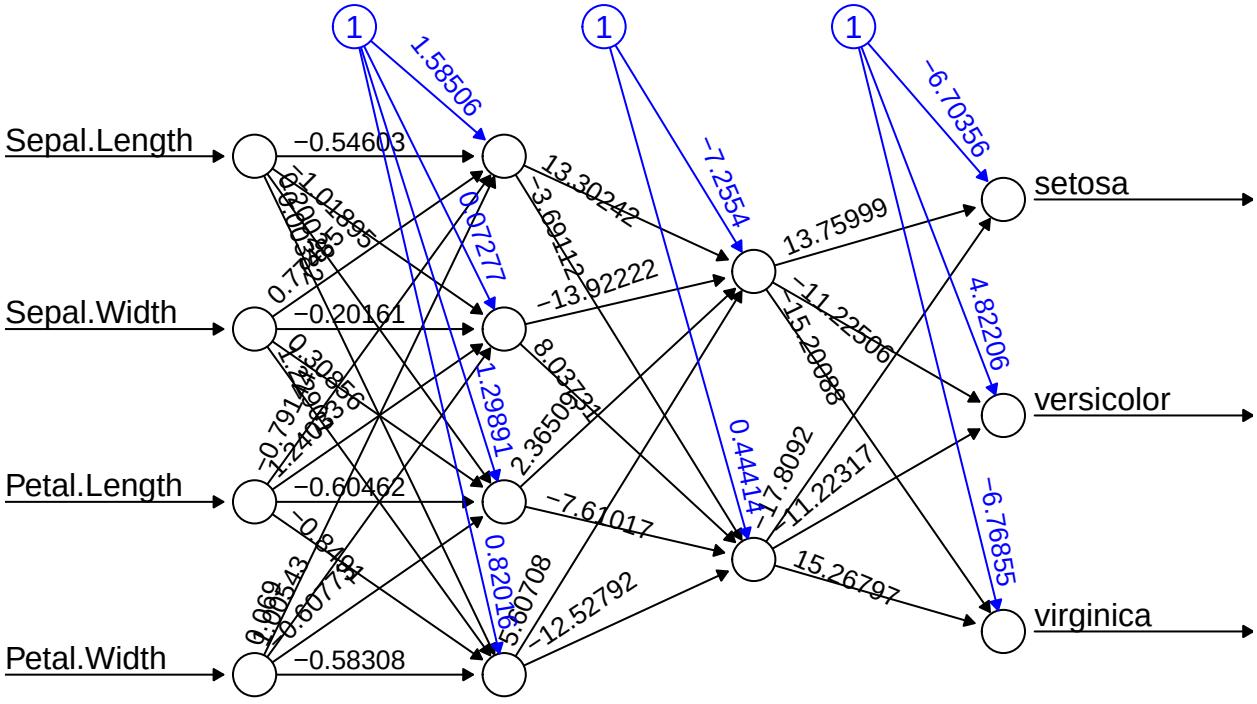
```
## [3,] -13.922219   8.0373052
## [4,]   2.365087  -7.6101736
## [5,]   5.607081 -12.5279189
##
## $weights[[1]][[3]]
##            [,1]       [,2]       [,3]
## [1,]  -6.703558   4.822063  -6.768551
## [2,]  13.759986 -11.225064 -15.200882
## [3,] -17.809196 -11.223174  15.267968
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##             [,1]         [,2]          [,3]          [,4]         [,5]
## 1   -0.005685301  0.010861959  -0.012227302 -9.228596e-04 0.004637927
## 15  -0.002720428  0.004389956  -0.004682075  1.120169e-05 0.002219256
## 16  -0.001771065  0.003065011  -0.003386790 -1.150891e-04 0.001444789
## 21  -0.031429623  0.062039050  -0.069646516 -6.193651e-03 0.025639519
## 22  -0.004347101  0.008996646  -0.010458119 -1.102484e-03 0.003546257
## 26  -0.038074132  0.086018039  -0.099084295 -1.342101e-02 0.031059950
## 28  -0.009172052  0.017580883  -0.019765557 -1.519396e-03 0.007482333
## 30  -0.012717459  0.031402218  -0.037776711 -5.988049e-03 0.010374594
## 31  -0.020357092  0.048693528  -0.057624622 -8.692756e-03 0.016606821
## 47  -0.004402584  0.008760877  -0.010094442 -9.164908e-04 0.003591518
## 51   0.077848382  0.155948674  -0.206713989 -1.606611e-01 0.033188241
## 52   0.128711976  0.272924195  -0.355484391 -2.747692e-01 0.076236632
## 53   0.799175435  1.604466118  -2.116109619 -1.659425e+00 0.501925805
## 63   0.152099317  0.315226384  -0.414650787 -3.218353e-01 0.082583721
## 78   6.010937870 11.919084762 -15.843896607 -1.244767e+01 3.787893504
## 79   1.232104935  2.707606028  -3.478557945 -2.691667e+00 0.775960339
## 81   0.085752552  0.182049599  -0.240240241 -1.827583e-01 0.042596309
## 90   0.456457070  1.001007571  -1.297041674 -9.956993e-01 0.285934196
## 98   0.095778373  0.200424563  -0.262964139 -2.027670e-01 0.051520438
## 105  0.250031258  0.693430548  -0.825212107 -6.518235e-01 0.157566885
## 110  0.492433921  1.455023585  -1.668518562 -1.304675e+00 0.310326380
## 112  1.851636707  3.829323668  -5.066983590 -4.021626e+00 1.166880213
## 114  0.763987727  2.045091743  -2.489599190 -1.949609e+00 0.481456558
## 129  0.370016152  0.901346244  -1.125636307 -8.934018e-01 0.233179980
## 132  4.394138000  9.177165589 -11.842156515 -9.365144e+00 2.769134591
## 135  1.250325387  2.705246180  -3.526617029 -2.814858e+00 0.787941021
## 140  4.505154698  9.402278037 -12.271166859 -9.680679e+00 2.839095870
## 141  0.531576805  1.390076916  -1.679261011 -1.320174e+00 0.334993713
## 142  6.920754508 14.386460597 -18.803122405 -1.476195e+01 4.361374603
## 148  5.086318176 11.589299969 -14.655322154 -1.149146e+01 3.205339328
##             [,6]          [,7]          [,8]         [,9]          [,10]
## 1   -0.008860897   0.009974705  7.528333e-04  0.006280644  -0.011999379
## 15  -0.003581208   0.003819510 -9.141895e-06  0.003005301  -0.004849654
## 16  -0.002500351   0.002762848  9.388204e-05  0.001956524  -0.003385966
## 21  -0.050609897   0.056815874  5.052600e-03  0.034720818  -0.068535544
## 22  -0.007339218   0.008531445  8.993639e-04  0.004802313  -0.009938737
## 26  -0.070171333   0.080830452  1.094848e-02  0.042061116  -0.095025518
## 28  -0.014342026   0.016124224  1.239470e-03  0.010132515  -0.019421883
## 30  -0.025617102   0.030817243  4.884864e-03  0.014049185  -0.034690532
```

```
## 31  -0.039722920   0.047008672  7.091291e-03  0.022488813  -0.053792523
## 47  -0.007146888   0.008234772  7.476384e-04  0.004863606  -0.009678280
## 51   0.084101471  -0.101036782 -7.940404e-02 -0.069455622  -0.136121581
## 52   0.167376828  -0.214569995 -1.663083e-01 -0.111180179  -0.234770153
## 53   1.009735580  -1.330548698 -1.043481e+00 -0.685431582  -1.375758445
## 63   0.186359836  -0.236019522 -1.842950e-01 -0.132666122  -0.272349444
## 78   7.511174111  -9.984418502 -7.844213e+00 -5.153249671 -10.218347579
## 79   1.705819917  -2.191169897 -1.695552e+00 -1.056379088  -2.321335831
## 81   0.102508712  -0.127264288 -9.835483e-02 -0.075474470  -0.158162978
## 90   0.629035691  -0.813813812 -6.249753e-01 -0.391618730  -0.858478062
## 98   0.117829957  -0.148460364 -1.153100e-01 -0.083623803  -0.173275800
## 105  0.436992552  -0.520039700 -4.107721e-01 -0.214353880  -0.594483712
## 110  0.916940502  -1.051482452 -8.221919e-01 -0.422167691  -1.247403665
## 112  2.413198728  -3.193157112 -2.534385e+00 -1.587423640  -3.282910726
## 114  1.288795073  -1.568918410 -1.228623e+00 -0.654973026  -1.753273968
## 129  0.568018776  -0.709363680 -5.630121e-01 -0.317217935  -0.772731554
## 132  5.783351298  -7.462795578 -5.901810e+00 -3.767131403  -7.867659674
## 135  1.704817428  -2.222435729 -1.773893e+00 -1.071914363  -2.319229787
## 140  5.925214224  -7.733152361 -6.100656e+00 -3.862306977  -8.060650520
## 141  0.876011684  -1.058252016 -8.319595e-01 -0.455725223  -1.191724372
## 142  9.066188703 -11.849510211 -9.302810e+00 -5.933221683 -12.333631963
## 148  7.303452613  -9.235622283 -7.241793e+00 -4.360543134  -9.935602335
##            [,11]         [,12]
## 1    0.013507695  1.019496e-03
## 15   0.005172362 -1.237534e-05
## 16   0.003741440  1.271400e-04
## 21   0.076939635  6.842223e-03
## 22   0.011553249  1.217929e-03
## 26   0.109460022  1.482640e-02
## 28   0.021835327  1.678499e-03
## 30   0.041732537  6.615089e-03
## 31   0.063658846  9.603022e-03
## 47   0.011151490  1.012460e-03
## 51   0.182219298  1.414734e-01
## 52   0.306377035  2.367336e-01
## 53   1.814671670  1.423027e+00
## 63   0.359810537  2.790812e-01
## 78  13.583143342  1.067152e+01
## 79   2.982364068  2.307710e+00
## 81   0.210089073  1.595577e-01
## 90   1.112574997  8.540496e-01
## 98   0.228394006  1.759678e-01
## 105  0.707461159  5.588137e-01
## 110  1.430434718  1.118508e+00
## 112  4.343967053  3.447774e+00
## 114  2.134353949  1.671416e+00
## 129  0.965017323  7.659208e-01
## 132 10.152379107  8.028816e+00
## 135  3.023397919  2.413201e+00
## 140 10.520173370  8.299326e+00
## 141  1.439644345  1.131796e+00
## 142 16.120074469  1.265554e+01
## 148 12.564129206  9.851726e+00
##
```

```
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
##            [,1]        [,2]        [,3]        [,4]
## [1,]  0.1784364  0.03180517  1.02430425  0.86798143
## [2,] -1.5608613 -1.07548182 -0.07104261  0.04399257
## [3,] -0.7420118 -0.25677290 -0.69559296  1.28046684
## [4,] -1.5417923  1.18186111 -0.55477281 -0.67644125
## [5,]  0.6627263  0.89462278 -0.48677958 -0.19119685
##
## $startweights[[1]][[2]]
##             [,1]       [,2]
## [1,]  1.38259854  0.5498319
## [2,]  0.74860902  0.3447832
## [3,]  2.34618058  1.5688060
## [4,]  0.21910371  1.1177046
## [5,] -0.02222762 -2.2190741
##
## $startweights[[1]][[3]]
##            [,1]       [,2]       [,3]
## [1,] -0.6102503 -0.3899154 -0.2255378
## [2,] -0.2183231 -0.1562910 -0.2408516
## [3,] -1.0091955 -0.5116348  1.4387121
##
##
##
## $result.matrix
##                                    [,1]
## error                       0.004401359
## reached.threshold           0.009244609
## steps                     169.000000000
## Intercept.to.1layhid1       1.585060688
## Sepal.Length.to.1layhid1   -0.546029023
## Sepal.Width.to.1layhid1     0.774851604
## Petal.Length.to.1layhid1   -0.791439362
## Petal.Width.to.1layhid1     0.068995300
## Intercept.to.1layhid2       0.072767109
## Sepal.Length.to.1layhid2   -1.018951007
## Sepal.Width.to.1layhid2    -0.201605879
## Petal.Length.to.1layhid2    1.240334805
## Petal.Width.to.1layhid2     1.005433051
## Intercept.to.1layhid3       1.298906684
## Sepal.Length.to.1layhid3    0.200277124
## Sepal.Width.to.1layhid3     0.308562585
## Petal.Length.to.1layhid3   -0.604621396
## Petal.Width.to.1layhid3    -0.607727533
## Intercept.to.1layhid4       0.820164988
## Sepal.Length.to.1layhid4   -0.003823878
## Sepal.Width.to.1layhid4     1.229014294
## Petal.Length.to.1layhid4   -0.849104820
## Petal.Width.to.1layhid4    -0.583076099
## Intercept.to.2layhid1      -7.255404980
## 1layhid1.to.2layhid1       13.302418227
```

```
## 1layhid2.to.2layhid1     -13.922219420
## 1layhid3.to.2layhid1       2.365086708
## 1layhid4.to.2layhid1       5.607080502
## Intercept.to.2layhid2      0.444135101
## 1layhid1.to.2layhid2      -3.691119418
## 1layhid2.to.2layhid2       8.037305200
## 1layhid3.to.2layhid2      -7.610173637
## 1layhid4.to.2layhid2     -12.527918866
## Intercept.to.setosa       -6.703558292
## 2layhid1.to.setosa        13.759986212
## 2layhid2.to.setosa       -17.809195535
## Intercept.to.versicolor    4.822063224
## 2layhid1.to.versicolor   -11.225064330
## 2layhid2.to.versicolor   -11.223173824
## Intercept.to.virginica    -6.768551046
## 2layhid1.to.virginica    -15.200882084
## 2layhid2.to.virginica     15.267968382
##
## attr(,"class")
## [1] "nn"
```

```
plot(model, rep = 'best')
```



Error: 0.004401 Steps: 169

```
pred <- predict(model, test_data)
pred
```

```
##             [,1]        [,2]         [,3]
## 1   9.991355e-01 0.001659219 2.888748e-10
## 15  9.991374e-01 0.001656208 2.881641e-10
## 16  9.991378e-01 0.001655553 2.880095e-10
```

```
## 21  9.991203e-01 0.001682876 2.944759e-10
## 22  9.991360e-01 0.001658348 2.886692e-10
## 26  9.991141e-01 0.001692545 2.967733e-10
## 28  9.991335e-01 0.001662327 2.896091e-10
## 30  9.991297e-01 0.001668198 2.909975e-10
## 31  9.991249e-01 0.001675776 2.927920e-10
## 47  9.991361e-01 0.001658264 2.886495e-10
## 51  1.193086e-03 0.991841402 1.173366e-03
## 52  1.161553e-03 0.991731584 1.201323e-03
## 53  8.680128e-04 0.990089810 1.542250e-03
## 63  1.151139e-03 0.991662037 1.210063e-03
## 78  4.176569e-05 0.936557818 2.041222e-02
## 79  6.882928e-04 0.988550031 1.881375e-03
## 81  1.186391e-03 0.991822512 1.179286e-03
## 90  9.992943e-04 0.990924100 1.366906e-03
## 98  1.180271e-03 0.991803859 1.184722e-03
## 105 2.978676e-11 0.001970871 9.997422e-01
## 110 3.726085e-11 0.002268828 9.996876e-01
## 112 8.684217e-11 0.003860900 9.993550e-01
## 114 4.650096e-11 0.002607858 9.996223e-01
## 129 3.229135e-11 0.002073528 9.997237e-01
## 132 4.964612e-10 0.011494713 9.971312e-01
## 135 6.020337e-11 0.003067363 9.995288e-01
## 140 5.744430e-10 0.012587730 9.967502e-01
## 141 3.729272e-11 0.002270048 9.996874e-01
## 142 5.238735e-09 0.048828764 9.787701e-01
## 148 1.252679e-09 0.020411292 9.936789e-01
```

```
labels <- c("setosa", "versicolor", "virginica")
prediction_label <- data.frame(max.col(pred)) %>%
mutate(pred=labels[max.col.pred.]) %>%
select(2) %>%
unlist()
table(test_data$Species, prediction_label)
```

```
##             prediction_label
##              setosa versicolor virginica
##   setosa         10          0         0
##   versicolor      0          9         0
##   virginica       0          0        11
```

```
check = as.numeric(test_data$Species) == max.col(pred)
check
```

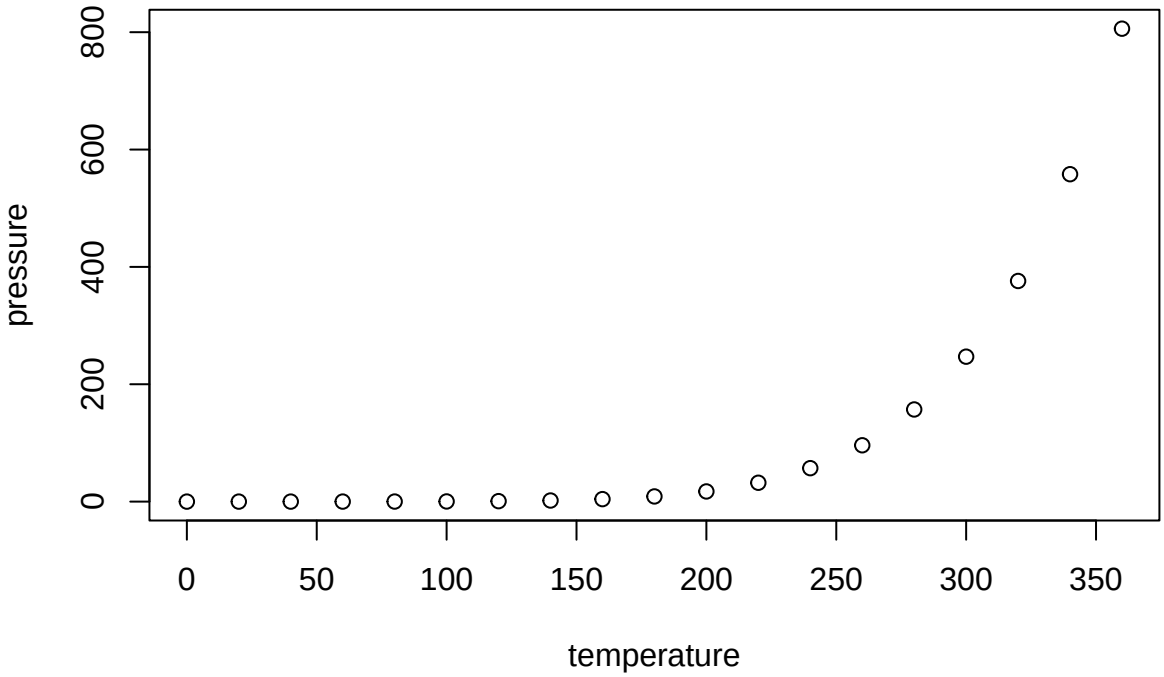
```
##  [1] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
## [16] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```
accuracy <- (sum(check)/nrow(test_data))*100
print(accuracy)
```

```
## [1] 100
```

Including Plots

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.