Untitled

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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:

```r
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)
```

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

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

```r
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
```

```r
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
```

2

```
## 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
```

```r
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
##
##
##
```

```r
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
```

```r
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: 0x60c2bf0b29f8>
## <environment: 0x60c2bf0b0448>
## attr(,"type")
## [1] "sse"
##
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <bytecode: 0x60c2bf0bae58>
## <environment: 0x60c2bf0b7990>
## 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"
```

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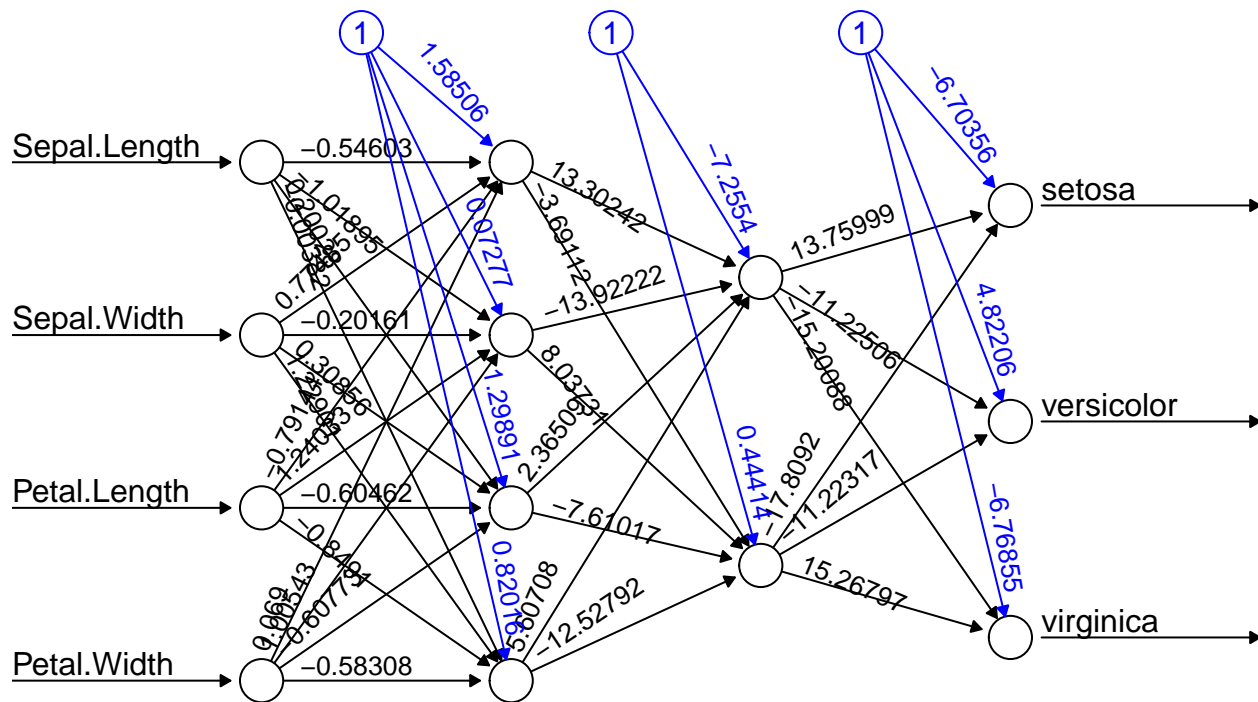

Error: 0.004401   Steps: 169

```r
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
```

```r
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
```

```r
check = as.numeric(test_data$Species) == max.col(pred)
check
```
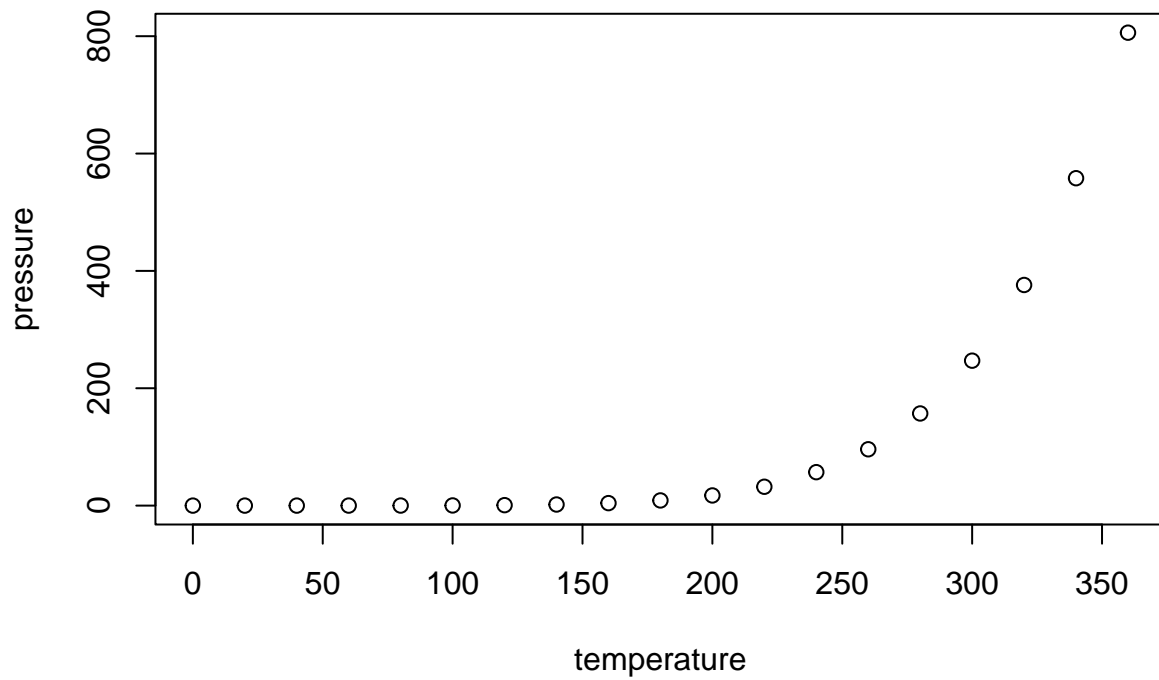
```
##  [1] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
## [16] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```r
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.