ANN_Assignment
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```
> 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

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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
```

```
> train_indices<-sample(c(1:nrow(iris)), data_rows)
> train_indices
  [1] 10 40 109 41 82 42 22 46 73 1 107 112 17 84 56 90 12 121 30
 [20] 16 98 127 18 61 97 20 62 123 55 144 129 105 70 59 89 49
67 88

 [39] 130 74 31 32 71 19 76 48 143 72 116 111 8 50 37 77 13
```

```
69 28

 [58] 108 120 102 58 63 4 132 114 149 96 86 39 36 34 79 140 68
150 11

 [77] 66 113 119 52 117 139 53 135 136 93 137 35 78 6 26 21 25
80 126
 [96] 9 60 29 141 5 146 142 85 64 3 44 118 145 15 38 110 94
83 7
[115] 148 81 43 99 131 54
> test_data <- iris[-train_indices, ]
> test_data
    Sepal.Length Sepal.Width Petal.Length Petal.Width  Species
2    4.9   3.0   1.4   0.2   setosa 14   4.3   3.0   1.1   0.1
    setosa
23           4.6      3.6   1.0   0.2   setosa
24           5.1      3.3   1.7   0.5   setosa

27   5.0   3.4   1.6   0.4   setosa
33   5.2   4.1   1.5   0.1    setosa
45   5.1   3.8   1.9   0.4    setosa
47   5.1   3.8   1.6   0.2    setosa 51  7.0   3.2   4.7   1.4
versicolor
57   6.3   3.3   4.7   1.6   versicolor
65   5.6   2.9   3.6   1.3   versicolor
75   6.4   2.9   4.3   1.3   versicolor
87   6.7   3.1   4.7   1.5 versicolor
91           5.5      2.6   4.4   1.2 versicolor
92           6.1      3.0   4.6   1.4 versicolor
95   5.6   2.7   4.2   1.3 versicolor 100     5.7   2.8   4.1   1.3
versicolor 101  6.3   3.3   6.0   2.5 virginica
103          7.1      3.0   5.9   2.1 virginica
104          6.3      2.9   5.6   1.8 virginica
106  7.6   3.0   6.6   2.1 virginica
115  5.8   2.8   5.1   2.4 virginica
122  5.6   2.8   4.9   2.0 virginica
124          6.3      2.7   4.9   1.8 virginica
125          6.7      3.3   5.7   2.1 virginica
128  6.1   3.0   4.9   1.8 virginica
133          6.4      2.8   5.6   2.2 virginica
134          6.3      2.8   5.1   1.5 virginica
138  6.4   3.1   5.5   1.8 virginica
```

```
147  6.3   2.5   5.0   1.9 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      versicolor
setosa virginica
1          FALSE TRUE      FALSE
2          TRUE FALSE      FALSE
3         FALSE FALSE       TRUE
4          FALSE TRUE      FALSE
5          TRUE FALSE      FALSE
6         FALSE FALSE       TRUE
7          TRUE FALSE      FALSE
8          FALSE TRUE      FALSE
```

FALSE

FALSE TRUE
TRUE FALSE FALSE
FALSE TRUE FALSE
TRUE FALSE FALSE 13 FALSE FALSE TRUE
FALSE FALSE TRUE
FALSE FALSE TRUE 16
FALSE FALSE TRUE
FALSE TRUE FALSE
FALSE FALSE TRUE
FALSE FALSE TRUE
TRUE FALSE FALSE
FALSE FALSE TRUE
FALSE FALSE TRUE
FALSE TRUE FALSE
FALSE FALSE TRUE
FALSE FALSE TRUE
FALSE FALSE TRUE
FALSE TRUE FALSE
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FALSE FALSE TRUE
FALSE FALSE TRUE
FALSE FALSE TRUE
TRUE FALSE FALSE
TRUE FALSE FALSE
FALSE TRUE FALSE

FALSE

43 TRUE FALSE FALSE
44 FALSE TRUE FALSE
45 TRUE FALSE FALSE
46 TRUE FALSE FALSE
47 TRUE FALSE FALSE
48 FALSE TRUE FALSE
49 TRUE FALSE FALSE
50 FALSE TRUE FALSE
51 FALSE FALSE TRUE
52 FALSE FALSE TRUE
53 FALSE TRUE FALSE 54 FALSE FALSE TRUE
55 FALSE TRUE FALSE 56 FALSE TRUE
57 TRUE FALSE FALSE
58 TRUE FALSE FALSE
59 TRUE FALSE FALSE
60 FALSE TRUE FALSE
61 FALSE TRUE FALSE
62 FALSE TRUE FALSE 63 TRUE FALSE FALSE
64 FALSE FALSE TRUE
65 TRUE FALSE FALSE
66 FALSE FALSE TRUE
67 FALSE TRUE FALSE
68 TRUE FALSE FALSE
69 TRUE FALSE FALSE
70 FALSE TRUE FALSE
71 FALSE TRUE FALSE
72 TRUE FALSE FALSE
73 FALSE FALSE TRUE
74 TRUE FALSE FALSE
75 FALSE FALSE TRUE
76 FALSE FALSE TRUE
77 FALSE FALSE TRUE
78 TRUE FALSE FALSE
79 TRUE FALSE FALSE
80 FALSE TRUE FALSE
81 FALSE TRUE FALSE

FALSE

82 TRUE FALSE FALSE
83 TRUE FALSE FALSE
84 FALSE TRUE FALSE
85 FALSE FALSE TRUE
86 FALSE FALSE TRUE
87 TRUE FALSE FALSE
88 TRUE FALSE FALSE
89 FALSE FALSE TRUE
90 FALSE TRUE FALSE
91 TRUE FALSE FALSE
92 TRUE FALSE FALSE
93 FALSE TRUE FALSE
94 FALSE TRUE FALSE
95 TRUE FALSE FALSE
96 FALSE TRUE FALSE
97 FALSE FALSE TRUE
98 FALSE TRUE FALSE
99 FALSE TRUE FALSE 100 FALSE FALSE TRUE 101
FALSE TRUE FALSE
102 FALSE TRUE FALSE 103 TRUE FALSE
104 FALSE FALSE TRUE
105 TRUE FALSE FALSE
106 TRUE FALSE FALSE
107 TRUE FALSE FALSE
108 FALSE FALSE TRUE
109 FALSE FALSE TRUE 110 TRUE FALSE FALSE
111 FALSE FALSE TRUE 112 TRUE
FALSE FALSE
113 FALSE TRUE FALSE
114 FALSE TRUE FALSE
115 FALSE TRUE FALSE
116 FALSE TRUE FALSE
117 TRUE FALSE FALSE

```
FALSE



118       FALSE TRUE FALSE 119 FALSE FALSE TRUE
120   FALSE FALSE      TRUE

$covariate
Sepal.Length Sepal.Width Petal.Length Petal.Width
55 6.5 2.8 4.6 1.5
37    5.5   3.5   1.3   0.2 146     6.7   3.0   5.2
      2.3 70      5.6   2.5   3.9   1.1
45    5.1   3.8   1.9   0.4 124     6.3   2.7   4.9
      1.8 20      5.1   3.8   1.5   0.3
76    6.6   3.0   4.4   1.4 144     6.8   3.2   5.9
      2.3 3       4.7   3.2   1.3   0.2 88      6.3
      2.3   4.4   1.3
10    4.9   3.1   1.5   0.1 136     7.7   3.0   6.1
      2.3
126 7.2 3.2 6.0 1.8
102 5.8 2.7 5.1 1.9
125   6.7   3.3   5.7   2.1 64      6.1   2.9   4.7
      1.4 111     6.5   3.2   5.1   2.0
122   5.6   2.8   4.9   2.0 32      5.4   3.4   1.5
      0.4 147     6.3   2.5   5.0   1.9
123   7.7   2.8   6.7   2.0 95      5.6   2.7   4.2
      1.3 101     6.3   3.3   6.0   2.5 149     6.2
      3.4   5.4   2.3
143 5.8 2.7 5.1 1.9
```

94 5.0 2.3 3.3 1.0 150 5.9 3.0 5.1 1.8
11 5.4 3.7 1.5 0.2
83 5.8 2.7 3.9 1.2
54 5.5 2.3 4.0 1.3
57 6.3 3.3 4.7 1.6
61 5.0 2.0 3.5 1.0
48 4.6 3.2 1.4 0.2
29 5.2 3.4 1.4 0.2
69 6.2 2.2 4.5 1.5 130 7.2 3.0 5.8 1.6
115 5.8 2.8 5.1 2.4
145 6.7 3.3 5.7 2.5 17 5.4 3.9 1.3 0.4
50 5.0 3.3 1.4 0.2
96 5.7 3.0 4.2 1.2
35 4.9 3.1 1.5 0.2
93 5.8 2.6 4.0 1.2
49 5.3 3.7 1.5 0.2
12 4.8 3.4 1.6 0.2
14 4.3 3.0 1.1 0.1
60 5.2 2.7 3.9 1.4
18 5.1 3.5 1.4 0.3
97 5.7 2.9 4.2 1.3 109 6.7 2.5 5.8 1.8
134 6.3 2.8 5.1 1.5 62 5.9 3.0 4.2 1.5
113 6.8 3.0 5.5 2.1 75 6.4 2.9 4.3 1.3
119 7.7 2.6 6.9 2.3 41 5.0 3.5 1.3 0.3
27 5.0 3.4 1.6 0.4
25 4.8 3.4 1.9 0.2
89 5.6 3.0 4.1 1.3 100 5.7 2.8 4.1 1.3
91 5.5 2.6 4.4 1.2
19 5.7 3.8 1.7 0.3 137 6.3 3.4 5.6 2.4
46 4.8 3.0 1.4 0.3
103 7.1 3.0 5.9 2.1 85 5.4 3.0 4.5 1.5
6 5.4 3.9 1.7 0.4 44 5.0 3.5 1.6 0.6
86 6.0 3.4 4.5 1.6
71 5.9 3.2 4.8 1.8 36 5.0 3.2 1.2 0.2
104 6.3 2.9 5.6 1.8 42 4.5 2.3 1.3 0.3 139 6.0 3.0 4.8 1.8
118 7.7 3.8 6.7 2.2
106 7.6 3.0 6.6 2.1 9 4.4 2.9 1.4 0.2
43 4.4 3.2 1.3 0.2
84 6.0 2.7 5.1 1.6
66 6.7 3.1 4.4 1.4
39 4.4 3.0 1.3 0.2 7 4.6 3.4 1.4 0.3
72 6.1 2.8 4.0 1.3 117 6.5 3.0 5.5 1.8

```
108  7.3   2.9   6.3   1.8 4       4.6   3.1   1.5   0.2
38   4.9   3.6   1.4   0.1 138     6.4   3.1   5.5   1.8
65   5.6   2.9   3.6   1.3 5       5.0   3.6   1.4   0.2
2    4.9   3.0   1.4   0.2 87      6.7   3.1   4.7   1.5
82 5.5 2.4 3.7 1.0
40 5.1 3.4 1.5 0.2
77   6.8   2.8   4.8   1.4 128     6.1   3.0   4.9   1.8
67   5.6   3.0   4.5   1.5
92   6.1   3.0   4.6   1.4 131     7.4   2.8   6.1   1.9
74   6.1   2.8   4.7   1.2
56 5.7 2.8 4.5 1.3
59   6.6   2.9   4.6   1.3 120     6.0   2.2   5.0   1.5
23   4.6   3.6   1.0   0.2
13 4.8 3.0 1.4 0.1
33   5.2   4.1   1.5   0.1 107     4.9   2.5   4.5   1.7
127  6.2   2.8   4.8   1.8 24      5.1   3.3   1.7   0.5
116  6.4   3.2   5.3   2.3 34      5.5   4.2   1.4   0.2
68 5.8 2.7 4.1 1.0
58 4.9 2.4 3.3 1.0
73 6.3 2.5 4.9 1.5
80   5.7   2.6   3.5   1.0 8       5.0   3.4   1.5   0.2
99   5.1   2.5   3.0   1.1 121     6.9   3.2   5.7   2.3
133 6.4 2.8 5.6 2.2 $model.list
$model.list$response
[1] "versicolor" "setosa"  "virginica"

$model.list$variables
[1] "Sepal.Length" "Sepal.Width" "Petal.Length" "Petal.Width"


$err.fct
function (x, y)
{
    1/2 * (y - x)^2
}
<bytecode:     0x5774ac69d0d8>
<environment:  0x5774ad1e7bf0>
attr(,"type")
[1] "sse"
$act.fct
function (x)
{
    1/(1 + exp(-x))
}
```

```
<bytecode:     0x5774ac6aa000>
<environment:  0x5774ad1e7758>
attr(,"type")
[1] "logistic"

$linear.output
[1] FALSE

$data
 Sepal.Length Sepal.Width Petal.Length Petal.Width Species
55  6.5 2.8 4.6 1.5 versicolor 37  5.5 3.5 1.3 0.2 setosa 146  6.7
3.0 5.2 2.3 virginica
70  5.6 2.5 3.9 1.1 versicolor 45  5.1 3.8 1.9 0.4 setosa 124  6.3
2.7 4.9 1.8 virginica
20  5.1    3.8    1.5    0.3    setosa 76  6.6    3.0    4.4    1.4
versicolor 144  6.8   3.2   5.9   2.3   virginica
3    4.7    3.2   1.3   0.2   setosa
88  6.3   2.3   4.4   1.3   versicolor 10  4.9   3.1   1.5   0.1
setosa
136  7.7    3.0   6.1   2.3   virginica 126  7.2  3.2  6.0  1.8   virginica
102  5.8   2.7   5.1   1.9   virginica 125    6.7   3.3   5.7   2.1
virginica 64    6.1   2.9   4.7   1.4   versicolor 111   6.5   3.2
    5.1   2.0   virginica
122  5.6  2.8  4.9  2.0   virginica
32   5.4   3.4   1.5   0.4    setosa 147      6.3   2.5   5.0   1.9
virginica
123  7.7  2.8  6.7  2.0  virginica
95  5.6  2.7  4.2  1.3  versicolor
101  6.3  3.3  6.0  2.5  virginica
149  6.2  3.4  5.4  2.3  virginica
143  5.8  2.7  5.1  1.9  virginica
94  5.0  2.3  3.3  1.0  versicolor
150  5.9   3.0   5.1   1.8 virginica 11  5.4   3.7   1.5   0.2
    setosa 83   5.8   2.7   3.9   1.2 versicolor
54  5.5  2.3  4.0  1.3  versicolor
57  6.3  3.3  4.7  1.6  versicolor
61   5.0   2.0   3.5   1.0 versicolor 48      4.6   3.2   1.4   0.2
    setosa
29   5.2   3.4   1.4   0.2   setosa 69   6.2   2.2   4.5   1.5
versicolor
130  7.2  3.0  5.8  1.6  virginica
115  5.8  2.8  5.1  2.4  virginica
145  6.7   3.3   5.7   2.5 virginica 17  5.4   3.9   1.3   0.4
    setosa
```

```
50  5.0  3.3  1.4  0.2  setosa 96  5.7  3.0  4.2  1.2
versicolor 35  4.9  3.1  1.5  0.2  setosa 93  5.8  2.6  4.0
    1.2 versicolor 49      5.3  3.7  1.5  0.2  setosa
12 4.8 3.4 1.6 0.2 setosa
14  4.3  3.0  1.1  0.1  setosa 60  5.2  2.7  3.9  1.4
versicolor 18  5.1  3.5  1.4  0.3  setosa 97  5.7  2.9  4.2
    1.3 versicolor
109 6.7 2.5 5.8 1.8 virginica
134 6.3  2.8  5.1  1.5 virginica 62 5.9  3.0  4.2  1.5
versicolor
113 6.8  3.0  5.5  2.1  virginica 75     6.4  2.9  4.3  1.3
versicolor 119  7.7  2.6  6.9  2.3  virginica
41 5.0 3.5 1.3 0.3  setosa
27  5.0  3.4  1.6  0.4   setosa 25 4.8  3.4  1.9  0.2
setosa 89 5.6  3.0  4.1  1.3  versicolor 100 5.7 2.8 4.1 1.3
versicolor
91  5.5  2.6  4.4  1.2  versicolor 19    5.7  3.8  1.7  0.3
     setosa 137      6.3  3.4  5.6  2.4  virginica
46  4.8  3.0  1.4  0.3   setosa 103      7.1  3.0  5.9  2.1
virginica 85    5.4  3.0  4.5  1.5  versicolor 6     5.4  3.9
    1.7  0.4   setosa
44  5.0  3.5  1.6  0.6  setosa 86  6.0  3.4  4.5  1.6
versicolor
71  5.9  3.2  4.8  1.8 versicolor 36      5.0  3.2  1.2  0.2
    setosa 104  6.3  2.9  5.6  1.8 virginica 42 4.5  2.3  1.3
    0.3  setosa 139  6.0  3.0  4.8  1.8 virginica
118 7.7 3.8 6.7 2.2 virginica
106 7.6  3.0  6.6  2.1 virginica 9  4.4  2.9  1.4  0.2
    setosa 43  4.4  3.2  1.3  0.2  setosa 84  6.0  2.7  5.1
    1.6 versicolor
66  6.7  3.1  4.4  1.4 versicolor 39      4.4  3.0  1.3  0.2
    setosa 7   4.6  3.4  1.4  0.3  setosa 72  6.1  2.8  4.0
    1.3 versicolor
117 6.5 3.0 5.5 1.8 virginica
108 7.3  2.9  6.3  1.8 virginica 4  4.6  3.1  1.5  0.2
    setosa 38  4.9  3.6  1.4  0.1  setosa 138 6.4  3.1  5.5
    1.8 virginica
65  5.6  2.9  3.6  1.3 versicolor 5 5.0  3.6  1.4  0.2
    setosa
2   4.9  3.0  1.4  0.2  setosa 87  6.7  3.1  4.7  1.5
versicolor
82  5.5  2.4  3.7  1.0 versicolor 40      5.1  3.4  1.5  0.2
    setosa 77  6.8  2.8  4.8  1.4 versicolor
128 6.1 3.0 4.9 1.8 virginica
67 5.6 3.0 4.5 1.5 versicolor
```

```
92   6.1   3.0   4.6   1.4 versicolor 131     7.4   2.8   6.1   1.9
virginica
74 6.1 2.8 4.7 1.2   versicolor
56 5.7 2.8 4.5 1.3   versicolor
59   6.6   2.9   4.6   1.3   versicolor 120   6.0   2.2   5.0   1.5
virginica
23   4.6   3.6   1.0   0.2    setosa 13  4.8   3.0   1.4   0.1
setosa
33 5.2 4.1 1.5 0.1   setosa 107 4.9 2.5 4.5   1.7 virginica
127 6.2 2.8 4.8   1.8 virginica
24   5.1   3.3   1.7    0.5  setosa 116  6.4   3.2   5.3    2.3
virginica
34   5.5   4.2   1.4    0.2  setosa 68   5.8   2.7   4.1    1.0
versicolor
58 4.9 2.4 3.3   1.0 versicolor
73 6.3 2.5 4.9   1.5 versicolor
80   5.7   2.6   3.5   1.0 versicolor 8 5.0   3.4   1.5   0.2
     setosa 99   5.1   2.5   3.0   1.1 versicolor
121 6.9 3.2 5.7 2.3 virginica
133 6.4 2.8 5.6 2.2 virginica

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146 1.118932e-73 2.935025e-19 1.000000e+00
70 2.605431e-61 1.000000e+00 3.863890e-38
45 1.000000e+00 2.377365e-03 1.120145e-81
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20 1.000000e+00 2.381823e-03 1.116163e-81
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144 1.463396e-74 5.437448e-22 1.000000e+00
3 1.000000e+00 2.380866e-03 1.117016e-81 88
3.457192e-62 1.000000e+00 5.382853e-33
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111 3.434009e-69 2.210669e-05 1.000000e+00
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95 3.240998e-62 1.000000e+00 7.861003e-33
101 6.144976e-75 3.714824e-23 1.000000e+00
149 4.892277e-74 2.272109e-20 1.000000e+00
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94 3.999636e-61 1.000000e+00 3.129118e-39
150 5.530746e-72 5.088361e-14 1.000000e+00
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83 3.727793e-61 1.000000e+00 4.728126e-39
54 1.533889e-62 1.000000e+00 6.320193e-31
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48 1.000000e+00 2.379590e-03 1.118155e-81
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1.009941e-73 2.137785e-19 1.000000e+00
134 3.958197e-68 4.073568e-02 9.973322e-01
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113 3.010026e-73 6.262526e-18 1.000000e+00
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92 2.493843e-62 1.000000e+00 3.655124e-32 131 4.621612e-73 2.358749e-17 1.000000e+00
74 5.468321e-63 1.000000e+00 2.676857e-28
56 1.085553e-63 1.000000e+00 3.512515e-24

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1.475580e-71 1.058328e-12 1.000000e+00
23 1.000000e+00 2.382464e-03 1.115592e-81
13 1.000000e+00 2.381590e-03 1.116371e-81
33 1.000000e+00 2.384281e-03 1.113977e-81 107
3.782582e-73 1.269407e-17 1.000000e+00
127  3.178755e-68  2.109730e-02  9.992613e-01
24  1.000000e+00  2.375779e-03  1.121566e-81
116 5.121451e-74 2.617690e-20 1.000000e+00
34 1.000000e+00 2.384853e-03 1.113469e-81
68 3.018805e-61 1.000000e+00 1.629166e-38 58
3.956279e-61   1.000000e+00 3.335658e-39
73 2.990162e-67   9.566758e-01 2.639065e-03
80 4.889727e-61   1.000000e+00 9.631498e-40
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99 8.423283e-46   1.000000e+00 4.222135e-48
121 3.158893e-74   5.873416e-21 1.000000e+00
133 1.159636e-74   2.647944e-22 1.000000e+00 $weights
$weights[[1]]
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     [,1]  [,2]  [,3]  [,4]
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[2,] 3.632602 -1.2922141 -0.3148418 -0.5708703
[3,] 4.266830 0.2061764 0.6226494 -1.5850129
[4,] 5.528042 1.4646955 0.6562208 1.9048024
[5,] 3.716274 0.5999010 -2.4618863 0.1547923

$weights[[1]][[2]]
     [,1]   [,2]
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[2,] 1.081212   -8.107311
[3,] -6.425414   348.463875
[4,] 7.201311   -136.626766
[5,] -5.840216   350.993181

$weights[[1]][[3]]
     [,1]  [,2]  [,3]
[1,]       4.167595 -106.7679     4.606187
[2,] 32.574117 100.7418 -191.027388
[3,] -175.539255 53.5948 96.154620
```

```
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146 5.7349465 7.6354918 -9.1360788 -15.8227539 1.773645e+01 70 1.7985531
1.5684620 -3.1994660 -1.5530637 NaN
45   NaN   NaN   NaN   NaN 4.707113e-03
124 17.3387736 16.1886914 -27.5197672 -29.8777340 5.362356e+01
20   NaN   NaN   NaN   NaN 1.994012e-03
76 0.8292691 0.8124906 -1.4807435 -0.9333301 NaN 144 1.2699087 2.1265668 -
1.8537187 -5.2766376 3.927442e+00
3    NaN   NaN   NaN   NaN 2.157148e-03
88   5.9501457   5.3600832 -10.2007922  -6.9866782  NaN
10   NaN   NaN   NaN   NaN 2.153037e-03
136 3.2077081 3.0536206 -3.9755415 -9.7330155 9.920467e+00 126 10.3374634
6.8133408 -15.2883909 -14.3305554 3.197063e+01 102 3.7804899 4.5575405 -
5.8671922 -9.7295641 1.169191e+01 125 5.0236544 6.4081259 -8.2977439 -
12.0451017 1.553664e+01
64   12.3112844 10.0010233 -21.2064443 -11.1964723 3.807506e+01 111
17.3826314 20.1175837 -29.9764659 -31.6228434 5.375920e+01 122 3.8433524
5.8401720 -6.5656191 -10.9181296 1.188632e+01
32 NaN NaN NaN NaN 9.333903e-04
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2.3035792  1.2641637  -2.4149915  -6.1181178  7.124271e+00  95  6.9693328
5.8722325 -12.1480644 -6.3784046 NaN 101 0.1395644 0.7648629 -0.2059326
-1.9836847  4.316304e-01  149  2.8117543  5.7344743  -5.3915607  -9.7380844
8.695902e+00
143  3.7804899   4.5575405   -5.8671922  -9.7295641 1.169191e+01 94
     0.6549725   0.5734253   -1.1528904  -0.6159937  NaN
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11 NaN NaN NaN NaN 1.076333e-03
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     7.2869798 -14.2166918  -9.1867425 2.560744e+01 57   6.0118262
     5.3337244 -10.4554758  -6.3007409  NaN 61      3.2343471   2.8558036   -
5.7258883 -2.9871684  NaN
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69 15.3648873 12.7835851 -24.1240422 -23.2781667 4.751893e+01
130 16.8286316 8.8192754 -24.6211262 -18.2593139 5.204585e+01 115
0.4385983 1.0514374 -0.6965604 -2.4604753 1.356451e+00
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76 NaN NaN NaN -4.863159e+00 -4.764764e+00 144 6.576825e+00 -5.732989e+00 -16.319037312 NaN NaN

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50 9.695645e-04 -1.534557e-03 -0.005016434 -3.035941e-03 -1.838495e-03

96 NaN NaN NaN -1.432373e+01 -1.105308e+01

35 1.176482e-03 -2.442609e-03 -0.005662212 -4.321589e-03 -2.230854e-03

93 NaN NaN NaN -9.853405e+00 -8.886490e+00

49 6.589273e-04 -1.200844e-03 -0.003875175 -2.457178e-03 -1.249462e-03

12 6.713689e-04 -3.819302e-03 -0.005197065 -6.548292e-03 -1.273054e-03

14 8.990175e-04 -2.737468e-03 -0.005332578 -4.881867e-03 -1.704723e-03

60 NaN NaN NaN -3.774525e+01 -3.396659e+01

18 1.075849e-03 -1.226111e-03 -0.005710599 -2.767607e-03 -2.040032e-03

97 NaN NaN NaN -2.155743e+01 -1.776448e+01 109 6.938713e+00 -1.441137e+01 -26.544716481 NaN NaN

134 3.977682e+01 -9.101422e+01 -60.685716211 -1.081491e+02 -7.542509e+01

62 NaN NaN NaN -1.666440e+01 -1.474111e+01 113 2.198118e+01 -3.033532e+01 -49.052405932 NaN NaN 75 NaN NaN NaN -5.116085e+00 -4.830818e+00 119 1.689036e+00 -5.900465e-01 -7.924212183 NaN NaN

41 1.099612e-03 -1.121071e-03 -0.005863358 -2.657050e-03 -2.085091e-03

27 1.386876e-03 -2.765358e-03 -0.007767670 -5.351737e-03 -2.629805e-03

25 6.069873e-04 -7.262199e-03 -0.006199536 -1.173003e-02 -1.150974e-03

89 NaN NaN NaN -1.439327e+01 -1.135313e+01 100 NaN NaN NaN -1.691687e+01 -1.432653e+01

91 3.549715e+01 -8.032998e+01 -37.940536637 -8.913948e+01 -6.730994e+01 19 8.473310e-04 -8.124062e-04 -0.004389938 -1.928052e-03 -1.606715e-03

137 8.613416e+00 -6.562622e+00 -16.569915164 NaN NaN

46 1.722257e-03 -2.221704e-03 -0.007870390 -4.304795e-03 -3.265756e-03

103 1.149796e+01 -1.629797e+01 -31.820870814 NaN NaN

85 5.177895e+01 -9.452398e+01 -52.962999570 -9.795855e+01 -9.818360e+01 6 8.669698e-04 -1.781121e-03 -0.005493665 -3.659431e-03 -1.643954e-03 44 2.309409e-03 -2.794839e-03 -0.012541803 -6.272468e-03 -4.379118e-03

86 NaN NaN NaN -2.517108e+01 -2.147477e+01

71 6.203293e+01 -9.900950e+01 -77.644941291 -1.031547e+02 -1.176273e+02 36 1.197004e-03 -6.481656e-04 -0.005536143 -1.784254e-03 -2.269767e-03

104 1.195632e+01 -2.019897e+01 -26.285260526 NaN NaN

42 4.138874e-03 -3.577416e-03 -0.013156511 -5.738994e-03 -7.848162e-03 139 6.039790e+01 -9.788193e+01 -86.055930109 -1.064388e+02 -1.145269e+02

118 1.076359e+01 -1.466207e+01 -22.392591340 NaN NaN

106 4.519600e+00 -6.514578e+00 -17.915968692 NaN NaN

9 1.386678e-03 -4.841721e-03 -0.007284916 -8.025702e-03 -2.629429e-03 43 8.472447e-04 -3.886149e-03 -0.006161523 -6.828643e-03 -1.606551e-03

84 2.723094e+01 -5.583565e+01 -49.093281052 NaN NaN 66 NaN NaN NaN -2.960295e+00 -2.880700e+00

39 1.176524e-03 -3.812804e-03 -0.006753081 -6.620212e-03 -2.230933e-03

7 9.118833e-04 -3.644098e-03 -0.006721129 -6.642613e-03 -1.729119e-03

[,11] [,12]

55 5.544851e+01 3.743625e+01

37 1.177538e-04 8.721742e-03

146 NaN NaN

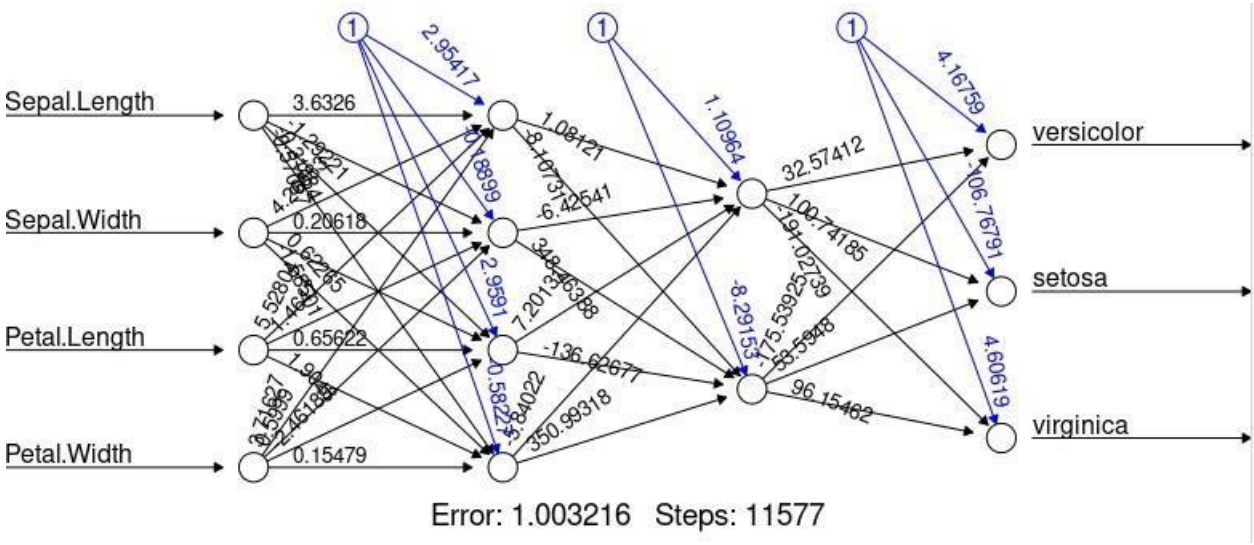
70 1.876292e+01 9.107774e+00

```
45 9.676800e-03 1.262730e-02  124 1.613867e+02 1.752147e+02
20 3.644713e-03 9.181184e-03
76 8.683660e+00 5.473414e+00
144  NaN   NaN
3 4.113511e-03 1.061065e-02  88 5.982144e+01 4.097262e+01
10 4.565238e-03 8.481731e-03
136  NaN   NaN
126  NaN   NaN
102  NaN   NaN
125  NaN   NaN
64 1.243629e+02 6.566050e+01  111 1.757937e+02 1.854487e+02
122  NaN   NaN
32 7.907373e-04 1.453838e-02
147  NaN   NaN
123  NaN   NaN
95 7.124101e+01 3.740546e+01
101  NaN   NaN
149  NaN   NaN
143  NaN   NaN
94 6.761001e+00 3.612429e+00
150  NaN   NaN
11 1.777718e-03 7.277819e-03
83 8.612393e+00 4.786619e+00
54 8.337225e+01 5.387466e+01
57 6.131501e+01 3.695001e+01
61 3.357885e+01 1.751793e+01
48 6.440402e-03 1.104621e-02
29 1.814911e-03 8.847673e-03           69 1.414728e+02
1.365123e+02
130 1.443879e+02 1.070798e+02
115  NaN   NaN 145    NaN   NaN
17 3.078671e-04 1.145222e-02
50 2.909838e-03 9.512197e-03
96 2.481420e+01 1.096496e+01
35 4.631692e-03 1.073673e-02
93 1.751136e+01 9.350578e+00
49 2.277048e-03 7.348133e-03
12 7.242186e-03 9.854710e-03
14 5.190805e-03 1.011167e-02
60 6.565023e+01 4.081180e+01
18 2.324961e-03 1.082848e-02
97 3.751656e+01 1.888441e+01
```

```
109  NaN   NaN
134 1.725818e+02 1.150727e+02 62
2.852912e+01 1.899281e+01
113  NaN   NaN
75 9.164206e+00 5.170006e+00
119  NaN   NaN
41 2.125783e-03 1.111814e-02
27 5.243690e-03 1.472911e-02
25 1.377063e-02 1.175560e-02
89  2.468547e+01  1.257764e+01
100  2.944131e+01  1.584282e+01
91 1.523223e+02 7.194311e+01
19 1.540490e-03 8.324230e-03
137  NaN   NaN
46 4.212811e-03 1.492389e-02
103  NaN   NaN
85  1.792370e+02 1.004288e+02
    6 3.377374e-03 1.041713e-
    02 44 5.299593e-03
    2.378185e-02
86  4.308382e+01 2.661608e+01
71 1.877425e+02 1.472309e+02
36 1.229056e-03 1.049767e-02
104  NaN   NaN
42 6.783520e-03 2.494747e-02 139
1.856044e+02 1.631798e+02
118  NaN   NaN
106  NaN   NaN
9 9.180905e-03 1.381371e-02 43
7.368942e-03 1.168352e-02
84   NaN   NaN
66 5.254030e+00 3.395110e+00
39 7.229866e-03 1.280524e-02
7 6.909964e-03 1.274465e-02
 [ reached getOption("max.print") -- omitted 37 rows ] $startweights
$startweights[[1]]
$startweights[[1]][[1]]
 [,1] [,2] [,3] [,4]
[1,]  -1.0458348  0.77423195  -0.9602864  0.6787051
[2,] -0.3673978 -1.68289827 -1.1898026 -0.7665335
[3,]  0.2668296  0.06191503  -0.7462531  -0.2843683
[4,] 1.5280424 0.75299000 1.2208441 0.7467765
[5,] -0.2837257 -0.83605244 -0.3181927 -1.6039578
```

```
$startweights[[1]][[2]]
     [,1]  [,2]
[1,] 0.00651497 -0.5233031 [2,]
-0.02191388 -0.3390795
[3,] -0.74364067 -1.2128671
[4,] 1.51092366 -1.0569400
[5,] -1.13580406 0.8177532

$startweights[[1]][[3]]
     [,1]  [,2]  [,3]
[1,] 0.3348667 -1.020637 0.4856726
[2,] 1.8163913 2.275452 0.1071237
[3,] 0.3894724 1.425514 0.9289246



$result.matrix
                                    [,1]
error     1.003216e+00 reached.threshold
9.744090e-03 steps    1.157700e+04
Intercept.to.1layhid1      2.954165e+00
Sepal.Length.to.1layhid1 3.632602e+00
Sepal.Width.to.1layhid1 4.266830e+00
Petal.Length.to.1layhid1 5.528042e+00
Petal.Width.to.1layhid1 3.716274e+00 Intercept.to.1layhid2
-1.889898e-01 Sepal.Length.to.1layhid2 -1.292214e+00
Sepal.Width.to.1layhid2 2.061764e-01
Petal.Length.to.1layhid2 1.464695e+00
Petal.Width.to.1layhid2 5.999010e-01 Intercept.to.1layhid3
     2.959099e+00 Sepal.Length.to.1layhid3 -3.148418e-01
Sepal.Width.to.1layhid3 6.226494e-01
Petal.Length.to.1layhid3 6.562208e-01 Petal.Width.to.1layhid3 -
2.461886e+00 Intercept.to.1layhid4 -5.822692e-01 Sepal.Length.to.1layhid4
-5.708703e-01 Sepal.Width.to.1layhid4 -1.585013e+00
Petal.Length.to.1layhid4 1.904802e+00 Petal.Width.to.1layhid4 1.547923e-01
Intercept.to.2layhid1     1.109641e+00
1layhid1.to.2layhid1      1.081212e+00
1layhid2.to.2layhid1     -6.425414e+00
1layhid3.to.2layhid1      7.201311e+00
1layhid4.to.2layhid1     -5.840216e+00
Intercept.to.2layhid2    -8.291534e+00
1layhid1.to.2layhid2     -8.107311e+00
1layhid2.to.2layhid2      3.484639e+02
1layhid3.to.2layhid2     -1.366268e+02
1layhid4.to.2layhid2      3.509932e+02
```

```
Intercept.to.versicolor 4.167595e+00
2layhid1.to.versicolor 3.257412e+01
2layhid2.to.versicolor -1.755393e+02 Intercept.to.setosa
    -1.067679e+02
2layhid1.to.setosa    1.007418e+02
2layhid2.to.setosa    5.359480e+01 Intercept.to.virginica
4.606187e+00 2layhid1.to.virginica -1.910274e+02
2layhid2.to.virginica   9.615462e+01
attr(,"class")
[1] "nn"
```




```
> pred <- predict(model, test_data)
> pred
                            [,1]  [,2]  [,3]
2 1.000000e+00 2.380773e-03 1.117099e-81 14 1.000000e+00 2.380630e-03
1.117227e-81
23  1.000000e+00 2.382464e-03 1.115592e-81
24  1.000000e+00 2.375779e-03 1.121566e-81
27 1.000000e+00 2.378303e-03 1.119306e-81
33 1.000000e+00 2.384281e-03 1.113977e-81
45 1.000000e+00 2.377365e-03 1.120145e-81
47 1.000000e+00 2.382340e-03 1.115703e-81
51 3.841502e-61 1.000000e+00 3.964263e-39
57 4.629354e-62 1.000000e+00 9.714613e-34
65 4.536115e-61 1.000000e+00 1.495731e-39
75 3.644473e-61 1.000000e+00 5.398333e-39
87 1.820233e-61 1.000000e+00 3.165331e-37
91  2.555245e-64 1.000000e+00 1.697219e-20
92  2.493843e-62 1.000000e+00 3.655124e-32
```

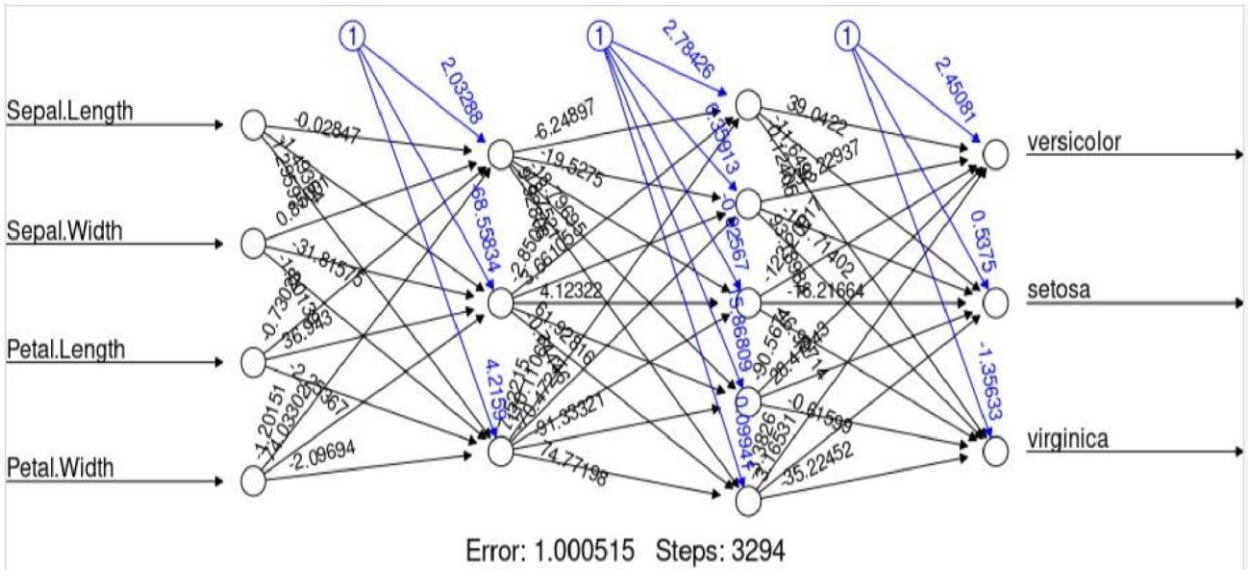
```
95 3.240998e-62 1.000000e+00 7.861003e-33 100
1.742567e-61 1.000000e+00 4.087682e-37
101 6.144976e-75 3.714824e-23 1.000000e+00
103 7.521713e-74 8.593353e-20 1.000000e+00
104 1.885182e-73 1.473200e-18 1.000000e+00
106 2.782045e-74 3.965194e-21 1.000000e+00
115 6.244517e-75 3.904102e-23 1.000000e+00
122 9.005676e-74 1.499720e-19 1.000000e+00
124 1.773171e-69 2.862667e-06 1.000000e+00
125 2.102869e-73 2.065557e-18 1.000000e+00
    128 9.652789e-69 5.400823e-04 9.999993e-
    01 133 1.159636e-74 2.647944e-22
    1.000000e+00 134 3.958197e-68 4.073568e-
    02 9.973322e-01 138 2.946197e-72
    7.255337e-15 1.000000e+00
147 1.438490e-72 7.901908e-16 1.000000e+00

> labels<-c("setosa", "versicolor", "virginica")
> labels
[1] "setosa"    "versicolor" "virginica"
> prediction_label <- data.frame(max.col(pred)) %>%
+    mutate(pred=labels[max.col.pred.]) %>%
+    select(2) %>%
+    unlist()
> table(test_data$Species, prediction_label) prediction_label
     setosa versicolor virginica
  setosa    8                 0     0
  versicolor      0           9     0
  virginica       0           0     13
> prediction_label
       pred1      pred2             pred3       pred4          pred5
     "setosa"    "setosa"       "setosa"   "setosa"        "setosa"
       pred6      pred7             pred8       pred9        pred10
    "setosa"   "setosa"    "setosa" "versicolor" "versicolor" pred11
      pred12 pred13 pred14 pred15
"versicolor" "versicolor" "versicolor" "versicolor" "versicolor"
     pred16 pred17 pred18 pred19 pred20
"versicolor" "versicolor"  "virginica"  "virginica"  "virginica"
      pred21    pred22     pred23     pred24     pred25
 "virginica" "virginica" "virginica" "virginica" "virginica" pred26
      pred27 pred28 pred29 pred30
 "virginica" "virginica" "virginica" "virginica" "virginica"
>
> check = as.numeric(test_data$Species) == max.col(pred)
```

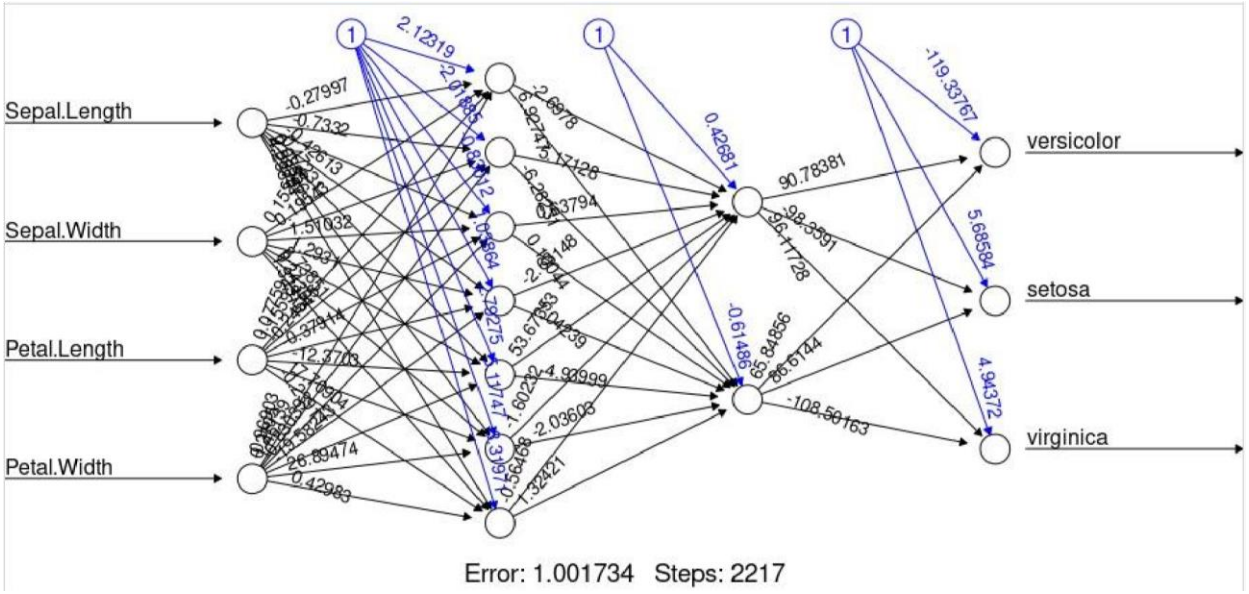
```
> check
 [1] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
[13] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
[25] TRUE TRUE TRUE TRUE TRUE TRUE
> accuracy <- (sum(check)/nrow(test_data))*100
> print(accuracy)
[1] 100
```

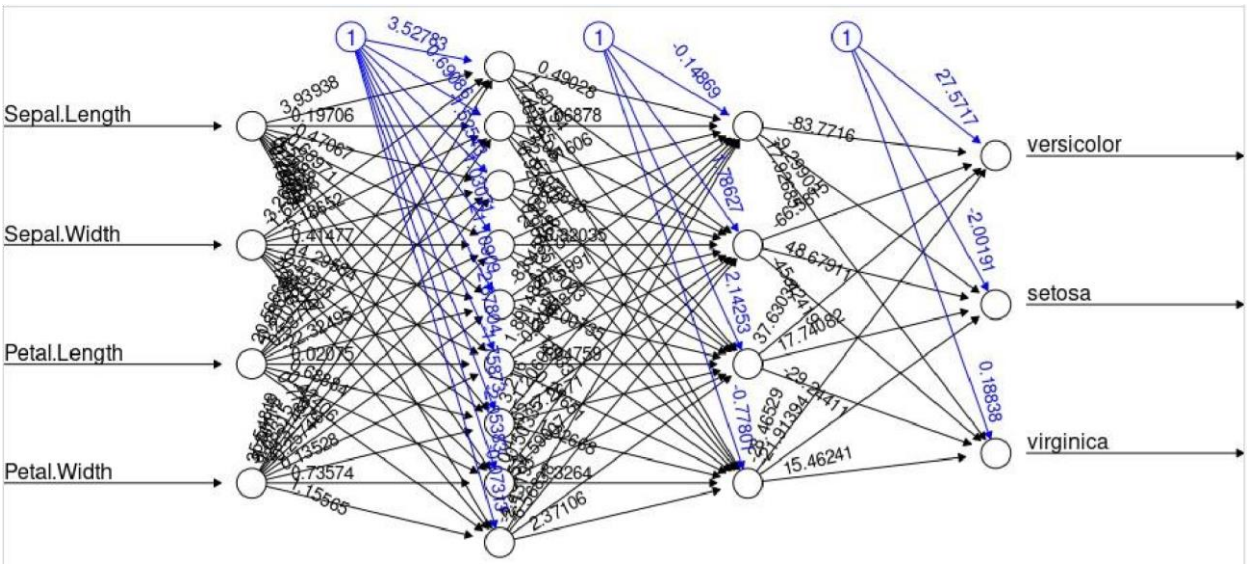
TABLE ANALYSIS

The table below i tried for different other layers and the accuracy it gives

layers	accuracy
4-2	100
3-5	100
7-2	100
9-4	100


Sepal.Length
Sepal.Width
Petal.Length
Petal.Width
versicolor
setosa
virginica
Error: 1.000515 Steps: 3294


Sepal.Length
Sepal.Width
Petal.Length
Petal.Width
versicolor
setosa
virginica
Error: 1.001734 Steps: 2217



ANALYSIS

I noticed this analysis of the iris dataset …since it's a simple dataset,the results I got were 100 % accurate because simple models achieve high accuracy.

The iris dataset is also deemed to be balanced which means that the classes in the dataset iris are well distributed hence the reason I get 100% in all types of hidden layers.