

Ann_R

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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:

```
# Let us install packages
install.packages(c('neuralnet','keras','tensorflow'), dependencies = T)
install.packages(c("neuralnet", "keras", "tensorflow"), dependencies = T)

# Import Packages
library(neuralnet)
install.packages("tidyverse")
library(tidyverse)

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
```

```
summary(iris)
```

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
Min. :4.300	Min. :2.000	Min. :1.000	Min. :0.100	setosa :50
1st Qu.:5.100	1st Qu.:2.800	1st Qu.:1.600	1st Qu.:0.300	versicolor:50
Median :5.800	Median :3.000	Median :4.350	Median :1.300	virginica :50
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	

```
# Let us train and split the data
```

```
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 64 111 122 32 147 123 95 101
```

```
[25] 149 143 94 150 11 83 54 57 61 48 29 69 130 115 145 17 50 96 35 93 49 12 14 60
```

```
[49] 18 97 109 134 62 113 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 5 2 87 82 40 77
```

```
[97] 128 67 92 131 74 56 59 120 23 13 33 107 127 24 116 34 68 58 73 80 8 99 121 133
```

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

```
train_data
```

```
# Below is a sample of the train 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

```

test_data<-iris[-train_indices,]
test_data

# Sample of 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

# Our model

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
9      FALSE  FALSE  TRUE
10     TRUE  FALSE  FALSE
11     FALSE  TRUE  FALSE
12     TRUE  FALSE  FALSE
13     FALSE  FALSE  TRUE
14     FALSE  FALSE  TRUE
15     FALSE  FALSE  TRUE
16     FALSE  FALSE  TRUE
17     FALSE  TRUE  FALSE
18     FALSE  FALSE  TRUE

```

19	FALSE	FALSE	TRUE
20	TRUE	FALSE	FALSE
21	FALSE	FALSE	TRUE
22	FALSE	FALSE	TRUE
23	FALSE	TRUE	FALSE
24	FALSE	FALSE	TRUE
25	FALSE	FALSE	TRUE
26	FALSE	FALSE	TRUE
27	FALSE	TRUE	FALSE
28	FALSE	FALSE	TRUE
29	TRUE	FALSE	FALSE
30	FALSE	TRUE	FALSE
31	FALSE	TRUE	FALSE
32	FALSE	TRUE	FALSE
33	FALSE	TRUE	FALSE
34	TRUE	FALSE	FALSE
35	TRUE	FALSE	FALSE
36	FALSE	TRUE	FALSE
37	FALSE	FALSE	TRUE
38	FALSE	FALSE	TRUE
39	FALSE	FALSE	TRUE
40	TRUE	FALSE	FALSE
41	TRUE	FALSE	FALSE
42	FALSE	TRUE	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	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
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 FALSE 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
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: 0x62a02b9a3178>
<environment: 0x62a02b9a1af0>
attr(,"type")
[1] "sse"

$act.fct
function (x)
{
  1/(1 + exp(-x))
}
<bytecode: 0x62a02b99a0a8>
<environment: 0x62a02b9997b0>
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
\$exclude						
NULL						
\$net.result						
\$net.result[[1]]						
	[,1]	[,2]	[,3]			
55	1.601170e-38	1.000000e+00	1.298708e-30			
37	1.000000e+00	1.987582e-03	1.606099e-61			
146	1.518550e-51	2.454243e-15	1.000000e+00			
70	7.105483e-38	1.000000e+00	1.328137e-33			
45	1.000000e+00	1.987582e-03	1.606099e-61			
124	3.610940e-48	8.137557e-08	1.000000e+00			
20	1.000000e+00	1.987582e-03	1.606099e-61			
76	6.475931e-38	1.000000e+00	2.038987e-33			
144	5.450583e-52	2.504358e-16	1.000000e+00			
3	1.000000e+00	1.987582e-03	1.606099e-61			
88	2.757899e-38	1.000000e+00	1.052913e-31			
10	1.000000e+00	1.987582e-03	1.606099e-61			
136	6.227984e-52	3.370393e-16	1.000000e+00			
126	1.717897e-51	3.230297e-15	1.000000e+00			
102	1.484091e-51	2.331914e-15	1.000000e+00			
125	8.394893e-52	6.554200e-16	1.000000e+00			
64	7.593145e-39	1.000000e+00	4.080085e-29			
111	2.492582e-49	2.110541e-10	1.000000e+00			
122	2.436396e-51	7.035128e-15	1.000000e+00			
32	1.000000e+00	1.987582e-03	1.606099e-61			
147	8.029602e-51	1.002337e-13	1.000000e+00			
123	5.212206e-52	2.266912e-16	1.000000e+00			
95	5.797446e-38	1.000000e+00	3.400220e-33			
101	4.907908e-52	1.982622e-16	1.000000e+00			
149	7.904729e-52	5.732160e-16	1.000000e+00			
143	1.484091e-51	2.331914e-15	1.000000e+00			
94	7.211933e-38	1.000000e+00	1.239945e-33			
150	2.054311e-50	8.124288e-13	1.000000e+00			
11	1.000000e+00	1.987582e-03	1.606099e-61			
83	7.150465e-38	1.000000e+00	1.289968e-33			
54	5.172284e-38	1.000000e+00	5.760756e-33			
57	1.911504e-38	1.000000e+00	5.728107e-31			
61	7.149501e-38	1.000000e+00	1.290772e-33			
48	1.000000e+00	1.987582e-03	1.606099e-61			
29	1.000000e+00	1.987582e-03	1.606099e-61			
69	8.811969e-41	1.000000e+00	3.574382e-20			
130	6.898532e-50	1.206894e-11	1.000000e+00			
115	5.910974e-52	3.000139e-16	1.000000e+00			
145	5.454428e-52	2.508295e-16	1.000000e+00			
17	1.000000e+00	1.987582e-03	1.606099e-61			
50	1.000000e+00	1.987582e-03	1.606099e-61			
96	7.055361e-38	1.000000e+00	1.372297e-33			
35	1.000000e+00	1.987582e-03	1.606099e-61			
93	6.998568e-38	1.000000e+00	1.424514e-33			
49	1.000000e+00	1.987582e-03	1.606099e-61			
12	1.000000e+00	1.987582e-03	1.606099e-61			

14	1.000000e+00	1.987582e-03	1.606099e-61
60	6.671977e-38	1.000000e+00	1.776505e-33
18	1.000000e+00	1.987582e-03	1.606099e-61
97	6.695672e-38	1.000000e+00	1.747641e-33
109	7.228449e-52	4.696742e-16	1.000000e+00
134	1.315433e-45	3.968430e-02	9.985972e-01
62	6.300075e-38	1.000000e+00	2.315585e-33
113	1.190078e-51	1.426019e-15	1.000000e+00
75	6.805633e-38	1.000000e+00	1.620929e-33
119	4.812030e-52	1.897380e-16	1.000000e+00
41	1.000000e+00	1.987582e-03	1.606099e-61
27	1.000000e+00	1.987582e-03	1.606099e-61
25	1.000000e+00	1.987582e-03	1.606099e-61
89	7.049685e-38	1.000000e+00	1.377410e-33
100	6.820959e-38	1.000000e+00	1.604170e-33
91	3.173896e-38	1.000000e+00	5.501326e-32
19	1.000000e+00	1.987582e-03	1.606099e-61
137	5.763454e-52	2.835904e-16	1.000000e+00
46	1.000000e+00	1.987582e-03	1.606099e-61
103	6.792748e-52	4.089350e-16	1.000000e+00
85	4.937381e-39	1.000000e+00	2.981131e-28
6	1.000000e+00	1.987582e-03	1.606099e-61
44	1.000000e+00	1.987582e-03	1.606099e-61
86	5.122704e-38	1.000000e+00	6.022936e-33
71	3.289076e-44	9.817322e-01	2.469511e-04
36	1.000000e+00	1.987582e-03	1.606099e-61
104	1.002050e-51	9.722097e-16	1.000000e+00
42	1.000000e+00	1.987582e-03	1.606099e-61
139	8.203586e-46	1.422956e-02	9.998415e-01
118	5.371473e-52	2.424111e-16	1.000000e+00
106	5.190939e-52	2.246360e-16	1.000000e+00
9	1.000000e+00	1.987582e-03	1.606099e-61
43	1.000000e+00	1.987582e-03	1.606099e-61
84	1.355170e-49	5.430808e-11	1.000000e+00
66	6.766925e-38	1.000000e+00	1.664218e-33
39	1.000000e+00	1.987582e-03	1.606099e-61
7	1.000000e+00	1.987582e-03	1.606099e-61
72	7.097521e-38	1.000000e+00	1.335034e-33
117	3.021557e-51	1.136340e-14	1.000000e+00
108	6.830430e-52	4.140053e-16	1.000000e+00
4	1.000000e+00	1.987582e-03	1.606099e-61
38	1.000000e+00	1.987582e-03	1.606099e-61
138	3.031977e-51	1.145088e-14	1.000000e+00
65	7.210105e-38	1.000000e+00	1.241398e-33
5	1.000000e+00	1.987582e-03	1.606099e-61
2	1.000000e+00	1.987582e-03	1.606099e-61
87	3.410430e-38	1.000000e+00	3.946641e-32
82	7.191884e-38	1.000000e+00	1.255997e-33
40	1.000000e+00	1.987582e-03	1.606099e-61
77	1.605979e-38	1.000000e+00	1.280838e-30
128	4.266711e-47	1.992757e-05	1.000000e+00
67	1.030713e-38	1.000000e+00	9.941174e-30
92	3.057856e-38	1.000000e+00	6.534452e-32
131	8.145444e-52	6.128273e-16	1.000000e+00

```

74  2.857764e-38 1.000000e+00 8.933320e-32
56  2.640611e-38 1.000000e+00 1.287069e-31
59  5.419751e-38 1.000000e+00 4.641889e-33
120 1.163945e-49 3.870000e-11 1.000000e+00
23  1.000000e+00 1.987582e-03 1.606099e-61
13  1.000000e+00 1.987582e-03 1.606099e-61
33  1.000000e+00 1.987582e-03 1.606099e-61
107 4.063692e-49 6.269529e-10 1.000000e+00
127 2.179633e-46 7.531395e-04 9.999997e-01
24  1.000000e+00 1.987582e-03 1.606099e-61
116 9.301786e-52 8.236807e-16 1.000000e+00
34  1.000000e+00 1.987582e-03 1.606099e-61
68  7.142415e-38 1.000000e+00 1.296699e-33
58  7.212898e-38 1.000000e+00 1.239178e-33
73  2.329842e-44 9.614361e-01 1.213721e-03
80  7.212812e-38 1.000000e+00 1.239247e-33
8   1.000000e+00 1.987582e-03 1.606099e-61
99  7.213998e-38 1.000000e+00 1.238305e-33
121 6.551611e-52 3.773008e-16 1.000000e+00
133 5.623574e-52 2.684868e-16 1.000000e+00

```

```

$weights
$weights[[1]]
$weights[[1]][[1]]
[,1]      [,2]      [,3]      [,4]
[1,] 1.4234560 -1.1944464 1.2101605 0.9113375579
[2,] -0.2904539 -0.9993736 0.1096572 0.0008651006
[3,] 0.9484971 -0.1330028 0.2551982 0.8731832666
[4,] -0.9615934 1.2684301 -0.4092203 -0.9767699707
[5,] -0.2011001 1.0345903 -1.0699969 -0.9020607328

```

```

$weights[[1]][[2]]
[,1]      [,2]
[1,] -0.4327106 91.2076704
[2,] 23.6738296 -141.5999554
[3,] -8.7599363 145.2574275
[4,] 13.0953007 0.4824887
[5,] 9.7989790 -109.5602592

```

```

$weights[[1]][[3]]
[,1]      [,2]      [,3]
[1,] 4.065277 -78.99574 10.97916
[2,] 32.671524 72.77689 -150.96304
[3,] -122.259002 42.72709 64.21228

```

```

$generalized.weights
$generalized.weights[[1]]
[,1]      [,2]      [,3]      [,4]      [,5]      [,6]      [,7]
55  2.570045e+00 4.449909e+00 -8.383053e+00 -8.496462e+00 5.724859e+00 9.912319e+00 -1.867352e+01
37  -3.827141e-55 2.092267e-54 -2.261010e-54 -1.011602e-54 1.337510e-55 -7.312057e-55 7.901782e-55
146 2.094269e+00 1.995211e+00 -4.821397e+00 -4.598664e+00 4.665052e+00 4.444398e+00 -1.073982e+01

```

70	1.829449e-02	7.402118e-02	-1.131720e-01	-1.045990e-01	4.075158e-02	1.648846e-01	-2.520943e-01
45	-1.039886e-50	1.000389e-49	-1.154937e-49	-5.878932e-50	3.634195e-51	-3.496160e-50	4.036275e-50
124	1.340702e+01	1.475084e+01	-3.322092e+01	-3.330245e+01	2.986457e+01	3.285798e+01	-7.400069e+01
20	-3.487610e-56	2.630487e-55	-2.967091e-55	-1.444183e-55	1.218850e-56	-9.193031e-56	1.036939e-55
76	1.380522e-01	4.237958e-01	-6.822552e-01	-6.676449e-01	3.075159e-01	9.440191e-01	-1.519746e+00
144	2.035659e-01	1.836956e-01	-4.540396e-01	-4.645912e-01	4.534497e-01	4.091879e-01	-1.011388e+00
3	-1.754236e-53	1.291711e-52	-1.451139e-52	-7.085894e-53	6.130705e-54	-4.514272e-53	5.071442e-53
88	1.624133e+00	2.673452e+00	-5.102217e+00	-5.470123e+00	3.617810e+00	5.955201e+00	-1.136536e+01
10	-8.473241e-50	5.492175e-49	-6.077036e-49	-2.876448e-49	2.961229e-50	-1.919406e-49	2.123803e-49
136	5.421045e-01	2.724234e-01	-9.326524e-01	-9.717239e-01	1.207555e+00	6.068320e-01	-2.077514e+00
126	2.528982e+00	1.783007e+00	-4.977940e+00	-5.431110e+00	5.633391e+00	3.971706e+00	-1.108852e+01
102	1.719681e+00	2.210018e+00	-4.673348e+00	-4.661159e+00	3.830645e+00	4.922887e+00	-1.041004e+01
125	9.228636e-01	9.291387e-01	-2.180171e+00	-2.198775e+00	2.055709e+00	2.069687e+00	-4.856403e+00
64	4.051848e+00	7.052544e+00	-1.328852e+01	-1.311314e+01	9.025624e+00	1.570977e+01	-2.960061e+01
111	9.724523e+00	1.231041e+01	-2.622486e+01	-2.495814e+01	2.166169e+01	2.742184e+01	-5.841675e+01
122	2.201719e+00	3.710243e+00	-7.131353e+00	-6.658974e+00	4.904401e+00	8.264689e+00	-1.588532e+01
32	-1.275675e-50	7.976436e-50	-8.753260e-50	-4.185352e-50	4.458231e-51	-2.787606e-50	3.059091e-50
147	5.249164e+00	4.753187e+00	-1.171256e+01	-1.195117e+01	1.169269e+01	1.058788e+01	-2.609011e+01
123	1.716294e-01	7.955928e-02	-2.853011e-01	-3.253931e-01	3.823102e-01	1.772209e-01	-6.355174e-01
95	3.569958e-01	9.556343e-01	-1.596742e+00	-1.476532e+00	7.952199e-01	2.128707e+00	-3.556795e+00
101	3.346389e-02	5.397628e-02	-1.051899e-01	-1.048873e-01	7.454192e-02	1.202339e-01	-2.343139e-01
149	6.182052e-01	1.045944e+00	-2.011993e+00	-1.832803e+00	1.377072e+00	2.329874e+00	-4.481780e+00
143	1.719681e+00	2.210018e+00	-4.673348e+00	-4.661159e+00	3.830645e+00	4.922887e+00	-1.041004e+01
94	1.901273e-04	1.919935e-03	-2.638832e-03	-2.200412e-03	4.235148e-04	4.276719e-03	-5.878084e-03
150	5.589057e+00	8.211676e+00	-1.649878e+01	-1.605247e+01	1.244981e+01	1.829178e+01	-3.675158e+01
11	-3.483668e-55	2.077581e-54	-2.276197e-54	-1.042859e-54	1.217473e-55	-7.260732e-55	7.954856e-55
83	9.170934e-03	4.562285e-02	-6.754402e-02	-6.101483e-02	2.042856e-02	1.016264e-01	-1.504565e-01
54	5.512548e-01	1.318854e+00	-2.264699e+00	-2.157437e+00	1.227938e+00	2.937790e+00	-5.044691e+00
57	2.259959e+00	4.934036e+00	-8.706790e+00	-8.062695e+00	5.034133e+00	1.099073e+01	-1.939466e+01
61	1.070219e-02	4.619764e-02	-6.996898e-02	-6.346230e-02	2.383948e-02	1.029068e-01	-1.558582e-01
48	-2.136170e-52	1.754311e-51	-1.995127e-51	-9.920704e-52	7.465490e-53	-6.130969e-52	6.972573e-52
29	-1.521801e-53	9.243837e-53	-1.013856e-52	-4.713217e-53	5.318391e-54	-3.230537e-53	3.543224e-53
69	1.088913e+01	1.304295e+01	-2.818504e+01	-2.981068e+01	2.425589e+01	2.905360e+01	-6.278309e+01
130	9.487971e+00	6.725585e+00	-1.868282e+01	-2.079396e+01	2.113477e+01	1.498146e+01	-4.161659e+01
115	2.485156e-01	3.979500e-01	-7.808608e-01	-7.155382e-01	5.535767e-01	8.864468e-01	-1.739393e+00
145	1.896218e-01	2.069754e-01	-4.705987e-01	-4.502224e-01	4.223887e-01	4.610446e-01	-1.048274e+00
17	-4.609645e-58	3.006831e-57	-3.326813e-57	-1.582558e-57	1.610979e-58	-1.050827e-57	1.162655e-57
50	-8.264910e-53	5.395649e-52	-5.973447e-52	-2.837816e-52	2.888422e-53	-1.885672e-52	2.087601e-52
96	3.010537e-02	1.159674e-01	-1.793794e-01	-1.598711e-01	6.706070e-02	2.583211e-01	-3.995734e-01
35	-4.197433e-49	2.863029e-48	-3.183843e-48	-1.538768e-48	1.466919e-49	-1.000572e-48	1.112690e-48
93	3.821312e-02	1.406222e-01	-2.187471e-01	-2.042928e-01	8.512097e-02	3.132406e-01	-4.872663e-01
49	-2.292363e-55	1.425368e-54	-1.570864e-54	-7.280948e-55	8.011354e-56	-4.981379e-55	5.489857e-55
12	-8.981889e-52	7.240046e-51	-8.225274e-51	-4.056998e-51	3.138992e-52	-2.530252e-51	2.874570e-51
14	-6.233351e-55	5.071463e-54	-5.766432e-54	-2.850213e-54	2.178432e-55	-1.772376e-54	2.015253e-54
60	1.137853e-01	4.138518e-01	-6.504578e-01	-5.563614e-01	2.534605e-01	9.218684e-01	-1.448916e+00
18	-2.804299e-54	1.902871e-53	-2.115796e-53	-1.017669e-53	9.800467e-55	-6.650154e-54	7.394287e-54
97	1.106987e-01	3.598072e-01	-5.757247e-01	-5.191662e-01	2.465850e-01	8.014824e-01	-1.282446e+00
109	7.759290e-01	4.962862e-01	-1.462423e+00	-1.640036e+00	1.728407e+00	1.105494e+00	-3.257595e+00
134	1.720948e+01	1.923284e+01	-4.284598e+01	-4.488344e+01	3.833469e+01	4.284178e+01	-9.544082e+01
62	1.983088e-01	6.372544e-01	-1.024036e+00	-9.098890e-01	4.417394e-01	1.419505e+00	-2.281073e+00
113	1.697583e+00	1.411904e+00	-3.631978e+00	-3.682994e+00	3.781422e+00	3.145063e+00	-8.090350e+00
75	7.195983e-02	2.421277e-01	-3.822714e-01	-3.711013e-01	1.602929e-01	5.393475e-01	-8.515220e-01
119	3.219124e-02	1.459828e-02	-5.311446e-02	-6.104411e-02	7.170705e-02	3.251814e-02	-1.183142e-01
41	-1.451087e-55	1.015797e-54	-1.133892e-54	-5.488761e-55	5.071262e-56	-3.550009e-55	3.962728e-55

27	-4.954460e-50	3.950473e-49	-4.467125e-49	-2.242598e-49	1.731485e-50	-1.380612e-49	1.561171e-49
25	-2.877408e-47	2.687367e-46	-3.098117e-46	-1.561230e-46	1.005597e-47	-9.391814e-47	1.082730e-46
89	3.065437e-02	1.251632e-01	-1.920530e-01	-1.667415e-01	6.828360e-02	2.788051e-01	-4.278044e-01
100	7.927736e-02	2.707278e-01	-4.286959e-01	-3.874006e-01	1.765929e-01	6.030550e-01	-9.549343e-01
91	1.492787e+00	3.098780e+00	-5.530944e+00	-5.339181e+00	3.325231e+00	6.902634e+00	-1.232036e+01
19	-8.051320e-53	4.706625e-52	-5.134533e-52	-2.358220e-52	2.813776e-53	-1.644872e-52	1.794417e-52
137	2.161865e-01	3.451631e-01	-6.769339e-01	-6.297083e-01	4.815625e-01	7.688622e-01	-1.507893e+00
46	-9.875936e-49	7.164772e-48	-8.012143e-48	-3.965524e-48	3.451443e-49	-2.503945e-48	2.800085e-48
103	6.577671e-01	4.393164e-01	-1.267788e+00	-1.342001e+00	1.465198e+00	9.785916e-01	-2.824040e+00
85	4.149705e+00	1.040751e+01	-1.775469e+01	-1.586162e+01	9.243604e+00	2.318307e+01	-3.954916e+01
6	-5.747882e-54	4.119227e-53	-4.612336e-53	-2.240662e-53	2.008771e-54	-1.439588e-53	1.611920e-53
44	-6.759697e-50	6.542118e-49	-7.519924e-49	-3.932676e-49	2.362380e-50	-2.286340e-49	2.628064e-49
86	5.355918e-01	1.616508e+00	-2.638488e+00	-2.291283e+00	1.193048e+00	3.600824e+00	-5.877318e+00
71	1.405819e+01	2.730675e+01	-5.008734e+01	-4.536365e+01	3.131507e+01	6.082669e+01	-1.115712e+02
36	-4.079819e-54	2.510147e-53	-2.755600e-53	-1.292217e-53	1.425816e-54	-8.772466e-54	9.630273e-54
104	1.222666e+00	1.198344e+00	-2.835814e+00	-3.032005e+00	2.723528e+00	2.669351e+00	-6.316869e+00
42	-2.147186e-14	1.381963e-13	-1.535647e-13	-1.019779e-13	-4.782928e-14	3.078369e-13	-3.420703e-13
139	1.501229e+01	2.391654e+01	-4.673081e+01	-4.384251e+01	3.344037e+01	5.327488e+01	-1.040944e+02
118	2.010692e-01	1.391463e-01	-3.931320e-01	-4.253780e-01	4.478882e-01	3.099529e-01	-8.757143e-01
106	1.589132e-01	8.184782e-02	-2.747274e-01	-3.082347e-01	3.539843e-01	1.823187e-01	-6.119644e-01
9	-6.409029e-49	5.663239e-48	-6.479521e-48	-3.282908e-48	2.239828e-49	-1.979189e-48	2.264464e-48
43	-5.402324e-54	5.152326e-53	-5.946720e-53	-3.015123e-53	1.888005e-54	-1.800636e-53	2.078260e-53
84	9.150238e+00	1.038343e+01	-2.302350e+01	-2.386096e+01	2.038246e+01	2.312944e+01	-5.128560e+01
66	7.394816e-02	2.621785e-01	-4.095765e-01	-3.976378e-01	1.647220e-01	5.840113e-01	-9.123451e-01
39	-1.102955e-51	9.638438e-51	-1.102118e-50	-5.558786e-51	3.854609e-52	-3.368442e-51	3.851684e-51
7	-4.678772e-54	4.557316e-53	-5.265713e-53	-2.687756e-53	1.635138e-54	-1.592691e-53	1.840262e-53
	[,8]	[,9]	[,10]	[,11]	[,12]		
55	-1.892615e+01	-1.187523e+01	-2.056139e+01	3.873499e+01	3.925901e+01		
37	3.535349e-55	2.010072e-55	-1.098890e-54	1.187517e-54	5.313089e-55		
146	-1.024367e+01	NaN	NaN	NaN	NaN		
70	-2.329978e-01	-8.453209e-02	-3.420245e-01	5.229259e-01	4.833135e-01		
45	2.054570e-50	5.461639e-51	-5.254193e-50	6.065904e-50	3.087704e-50		
124	-7.418230e+01	-6.194887e+01	-6.815817e+01	1.535016e+02	1.538783e+02		
20	5.047131e-56	1.831745e-56	-1.381572e-55	1.558361e-55	7.585066e-56		
76	-1.487201e+00	-6.378884e-01	-1.958204e+00	3.152449e+00	3.084940e+00		
144	-1.034892e+00	NaN	NaN	NaN	NaN		
3	2.476379e-53	9.213511e-54	-6.784260e-53	7.621601e-53	3.721619e-53		
88	-1.218488e+01	-7.504520e+00	-1.235303e+01	2.357546e+01	2.527542e+01		
10	1.005261e-49	4.450274e-50	-2.884573e-49	3.191751e-49	1.510754e-49		
136	-2.164547e+00	NaN	NaN	NaN	NaN		
126	-1.209798e+01	NaN	NaN	NaN	NaN		
102	-1.038288e+01	NaN	NaN	NaN	NaN		
125	-4.897843e+00	NaN	NaN	NaN	NaN		
64	-2.920995e+01	-1.872209e+01	-3.258720e+01	6.140134e+01	6.059098e+01		
111	-5.559507e+01	NaN	NaN	NaN	NaN		
122	-1.483308e+01	NaN	NaN	NaN	NaN		
32	1.462697e-50	6.700038e-51	-4.189345e-50	4.597345e-50	2.198210e-50		
147	-2.662163e+01	NaN	NaN	NaN	NaN		
123	-7.248238e-01	NaN	NaN	NaN	NaN		
95	-3.289024e+00	-1.649546e+00	-4.415633e+00	7.377955e+00	6.822510e+00		
101	-2.336399e-01	NaN	NaN	NaN	NaN		
149	-4.082630e+00	NaN	NaN	NaN	NaN		
143	-1.038288e+01	NaN	NaN	NaN	NaN		
94	-4.901489e-03	-8.785081e-04	-8.871313e-03	1.219307e-02	1.016729e-02		

150	-3.575740e+01	NaN	NaN	NaN	NaN
11	3.644583e-55	1.829675e-55	-1.091177e-54	1.195493e-54	5.477251e-55
83	-1.359125e-01	-4.237550e-02	-2.108064e-01	3.120960e-01	2.819270e-01
54	-4.805762e+00	-2.547145e+00	-6.093936e+00	1.046434e+01	9.968720e+00
57	-1.795992e+01	-1.044244e+01	-2.279836e+01	4.023086e+01	3.725474e+01
61	-1.413643e-01	-4.945087e-02	-2.134622e-01	3.233008e-01	2.932358e-01
48	3.467089e-52	1.121949e-52	-9.213907e-52	1.047871e-51	5.210504e-52
29	1.647176e-53	7.992728e-54	-4.855003e-53	5.324923e-53	2.475453e-53
69	-6.640426e+01	-5.031463e+01	-6.026667e+01	1.302326e+02	1.377441e+02
130	-4.631923e+01	NaN	NaN	NaN	NaN
115	-1.593885e+00	NaN	NaN	NaN	NaN
145	-1.002885e+00	NaN	NaN	NaN	NaN
17	5.530725e-58	2.421055e-58	-1.579233e-57	1.747292e-57	8.311832e-58
50	9.917604e-53	4.340856e-53	-2.833877e-52	3.137345e-52	1.490464e-52
96	-3.561180e-01	-1.391058e-01	-5.358424e-01	8.288458e-01	7.387051e-01
35	5.377689e-49	2.204555e-49	-1.503706e-48	1.672203e-48	8.081843e-49
93	-4.550688e-01	-1.765687e-01	-6.497633e-01	1.010749e+00	9.439614e-01
49	2.544547e-55	1.203984e-55	-7.486250e-55	8.250415e-55	3.824064e-55
12	1.417840e-51	4.717424e-52	-3.802582e-51	4.320038e-51	2.130797e-51
14	9.960929e-55	3.273850e-55	-2.663609e-54	3.028617e-54	1.496975e-54
60	-1.239313e+00	-5.257599e-01	-1.912256e+00	3.005525e+00	2.570741e+00
18	3.556550e-54	1.472860e-54	-9.994164e-54	1.111248e-53	5.344951e-54
97	-1.156460e+00	-5.114979e-01	-1.662536e+00	2.660211e+00	2.398875e+00
109	-3.653234e+00	NaN	NaN	NaN	NaN
134	-9.997933e+01	-7.951867e+01	-8.886784e+01	1.979754e+02	2.073898e+02
62	-2.026807e+00	-9.163118e-01	-2.944517e+00	4.731690e+00	4.204261e+00
113	-8.203990e+00	NaN	NaN	NaN	NaN
75	-8.266404e-01	-3.324998e-01	-1.118783e+00	1.766335e+00	1.714722e+00
119	-1.359778e-01	NaN	NaN	NaN	NaN
41	1.918213e-55	7.621330e-56	-5.335121e-55	5.955374e-55	2.882780e-55
27	7.837435e-50	2.602157e-50	-2.074848e-49	2.346201e-49	1.177847e-49
25	5.456190e-47	1.511258e-47	-1.411446e-46	1.627178e-46	8.199818e-47
89	-3.714223e-01	-1.416425e-01	-5.783328e-01	8.874060e-01	7.704511e-01
100	-8.629475e-01	-3.663114e-01	-1.250933e+00	1.980846e+00	1.790035e+00
91	-1.189320e+01	-6.897616e+00	-1.431832e+01	2.555645e+01	2.467038e+01
19	8.241509e-53	4.228675e-53	-2.471991e-52	2.696735e-52	1.238573e-52
137	-1.402696e+00	NaN	NaN	NaN	NaN
46	1.385872e-48	5.186991e-49	-3.763047e-48	4.208098e-48	2.082753e-48
103	-2.989351e+00	NaN	NaN	NaN	NaN
85	-3.533229e+01	-1.917425e+01	-4.808926e+01	8.203787e+01	7.329071e+01
6	7.830670e-54	3.018875e-54	-2.163480e-53	2.422469e-53	1.176830e-53
44	1.374392e-49	3.550295e-50	-3.436019e-49	3.949578e-49	2.065501e-49
86	-5.103909e+00	-2.474772e+00	-7.469285e+00	1.219148e+01	1.058717e+01
71	-1.010490e+02	-6.495768e+01	-1.261744e+02	2.314351e+02	2.096087e+02
36	4.516042e-54	2.142783e-54	-1.318367e-53	1.447283e-53	6.786920e-54
104	-6.753892e+00	NaN	NaN	NaN	NaN
42	-2.271592e-13	9.921356e-14	-6.385543e-13	7.095656e-13	4.712024e-13
139	-9.766063e+01	-6.936625e+01	-1.105095e+02	2.159258e+02	2.025800e+02
118	-9.475435e-01	NaN	NaN	NaN	NaN
106	-6.866030e-01	NaN	NaN	NaN	NaN
9	1.147311e-48	3.366119e-49	-2.974419e-48	3.403143e-48	1.724233e-48
43	1.053726e-53	2.837382e-54	-2.706080e-53	3.123307e-53	1.583588e-53
84	-5.315107e+01	NaN	NaN	NaN	NaN
66	-8.857512e-01	-3.416871e-01	-1.211430e+00	1.892502e+00	1.837337e+00

```

39   1.942685e-51  5.792888e-52 -5.062253e-51  5.788491e-51  2.919558e-51
7    9.393173e-54  2.457362e-54 -2.393571e-53  2.765632e-53  1.411650e-53
[ reached getOption("max.print") -- omitted 37 rows ]

$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          1.001880e+00
reached.threshold 9.913458e-03
steps          6.171000e+03
Intercept.to.1layhid1 1.423456e+00
Sepal.Length.to.1layhid1 -2.904539e-01
Sepal.Width.to.1layhid1  9.484971e-01
Petal.Length.to.1layhid1 -9.615934e-01
Petal.Width.to.1layhid1 -2.011001e-01
Intercept.to.1layhid2 -1.194446e+00
Sepal.Length.to.1layhid2 -9.993736e-01
Sepal.Width.to.1layhid2 -1.330028e-01
Petal.Length.to.1layhid2  1.268430e+00
Petal.Width.to.1layhid2  1.034590e+00
Intercept.to.1layhid3  1.210161e+00
Sepal.Length.to.1layhid3 1.096572e-01
Sepal.Width.to.1layhid3  2.551982e-01
Petal.Length.to.1layhid3 -4.092203e-01
Petal.Width.to.1layhid3 -1.069997e+00
Intercept.to.1layhid4  9.113376e-01
Sepal.Length.to.1layhid4 8.651006e-04
Sepal.Width.to.1layhid4  8.731833e-01

```

```

Petal.Length.to.1layhid4 -9.767700e-01
Petal.Width.to.1layhid4 -9.020607e-01
Intercept.to.2layhid1 -4.327106e-01
1layhid1.to.2layhid1 2.367383e+01
1layhid2.to.2layhid1 -8.759936e+00
1layhid3.to.2layhid1 1.309530e+01
1layhid4.to.2layhid1 9.798979e+00
Intercept.to.2layhid2 9.120767e+01
1layhid1.to.2layhid2 -1.416000e+02
1layhid2.to.2layhid2 1.452574e+02
1layhid3.to.2layhid2 4.824887e-01
1layhid4.to.2layhid2 -1.095603e+02
Intercept.to.versicolor 4.065277e+00
2layhid1.to.versicolor 3.267152e+01
2layhid2.to.versicolor -1.222590e+02
Intercept.to.setosa -7.899574e+01
2layhid1.to.setosa 7.277689e+01
2layhid2.to.setosa 4.272709e+01
Intercept.to.virginica 1.097916e+01
2layhid1.to.virginica -1.509630e+02
2layhid2.to.virginica 6.421228e+01

attr("class")
[1] "nn"

plot(model, rep = 'best')

knitr::include_graphics("Rplot(4,2).png")

# Model evaluation
# predict categories - test dataset
# list of category names
# dataframe
# table - actual and predicated
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

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

```
# below is the predicted
```

	[,1]	[,2]	[,3]
1	1.000000e+00	1.987582e-03	1.606099e-61
15	1.000000e+00	1.987582e-03	1.606099e-61
16	1.000000e+00	1.987582e-03	1.606099e-61
21	1.000000e+00	1.987582e-03	1.606099e-61
22	1.000000e+00	1.987582e-03	1.606099e-61
26	1.000000e+00	1.987582e-03	1.606099e-61
28	1.000000e+00	1.987582e-03	1.606099e-61
30	1.000000e+00	1.987582e-03	1.606099e-61
31	1.000000e+00	1.987582e-03	1.606099e-61
47	1.000000e+00	1.987582e-03	1.606099e-61
51	5.976903e-38	1.000000e+00	2.953469e-33
52	5.723452e-38	1.000000e+00	3.608146e-33
53	1.384220e-38	1.000000e+00	2.544987e-30
63	6.966252e-38	1.000000e+00	1.455306e-33
78	5.834333e-43	9.999693e-01	4.187287e-10
79	1.736209e-38	1.000000e+00	8.933657e-31
81	7.119429e-38	1.000000e+00	1.316157e-33
90	6.249596e-38	1.000000e+00	2.403280e-33
98	6.688873e-38	1.000000e+00	1.755865e-33
105	5.423696e-52	2.476923e-16	1.000000e+00
110	5.316714e-52	2.369408e-16	1.000000e+00
112	1.893062e-51	4.010254e-15	1.000000e+00
114	9.329015e-52	8.290613e-16	1.000000e+00
129	6.037474e-52	3.145041e-16	1.000000e+00
132	1.404842e-51	2.063591e-15	1.000000e+00
135	2.891381e-51	1.030162e-14	1.000000e+00
140	3.342740e-51	1.423096e-14	1.000000e+00
141	5.820653e-52	2.898980e-16	1.000000e+00
142	1.001202e-50	1.638601e-13	1.000000e+00
148	7.647401e-51	8.991549e-14	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      10         0        0
versicolor     0         9        0
virginica     0         0       11

test_data.shape
summary(test_data)

  Sepal.Length   Sepal.Width   Petal.Length   Petal.Width   Species
Min.    :4.700   Min.    :2.200   Min.    :1.200   Min.    :0.200   setosa    :10
1st Qu.:5.425  1st Qu.:2.900  1st Qu.:1.600  1st Qu.:0.250  versicolor: 9
Median  :6.050  Median  :3.100  Median  :4.500  Median  :1.400  virginica :11
Mean    :6.043  Mean    :3.143  Mean    :3.867  Mean    :1.253
3rd Qu.:6.650  3rd Qu.:3.475  3rd Qu.:5.275  3rd Qu.:2.000
Max.    :7.900  Max.    :4.400  Max.    :6.400  Max.    :2.500

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

[1] TRUE TRUE
[18] TRUE TRUE

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

[1] 100

# Let us look at (30, 20)
model<-neuralnet( Species ~ Sepal.Length +Sepal.Width+Petal.Length +Petal.Width,
data = train_data, hidden = c(30,20), linear.output = FALSE)
model

$startweights
$startweights[[1]]
$startweights[[1]][[1]]
[,1]      [,2]      [,3]      [,4]      [,5]      [,6]      [,7]
[1,] -0.3964162 -1.1948629 -0.9563154  0.10474138  0.03043331  1.1649010  0.6741629
[2,]  0.5617638 -0.3681083 -1.4700479  1.18608678  1.12006546  0.2731169 -0.5782839
[3,] -1.9379269  0.8910686 -0.1595232  0.01497661 -2.18109368 -2.1901225  1.2176358
[4,]  0.3142828  0.4059390 -0.8901412  0.44123261 -1.49638101 -0.7037991  1.1580760
[5,] -1.5587669  0.9899401 -0.2152458 -0.80929964  1.00208789 -0.1048053 -0.5751086
[,8]      [,9]      [,10]     [,11]     [,12]     [,13]     [,14]
[1,]  0.60708579 -1.10158144 -1.9823526  1.2975168  1.2826801  1.6797544 -0.3721804
[2,] -0.29797754 -0.45296662 -0.6579730 -1.1988129 -0.1600673 -0.8082663  2.0415971

```

```

[3,]  0.70336119 -1.35783168  0.6124200 -0.1682078  0.8455583  0.2211513 -0.2278503
[4,] -0.03720223 -0.55857941  0.2790416  1.9153882  0.9099621  0.5235187 -1.4996566
[5,]  0.97586934  0.04700967  0.7028444  0.0613362 -1.1818996 -0.1686357 -0.8111803
      [,15]      [,16]      [,17]      [,18]      [,19]      [,20]      [,21]
[1,]  1.2803130  0.378699465 -1.0673757  0.2123884 -0.9487461  1.14438821  0.45773445
[2,] -0.2974152 -0.518472922  0.7651243 -0.1595385  0.5293638  0.03730723 -0.43781974
[3,] -0.8930151 -0.776836681 -1.3232125 -0.8498832  0.3449820  0.24848432 -0.08193491
[4,] -0.8481645  0.007490124 -0.5061534  1.0879398  0.6278463  1.55034240  0.72133193
[5,]  0.6611543  0.657666994  0.9559471 -0.5596530  0.5736615 -0.31655744 -1.56244677
      [,22]      [,23]      [,24]      [,25]      [,26]      [,27]      [,28]
[1,]  1.1384278 -1.2186451 -0.8488603 -0.848354131  0.0700866  0.89379554  0.4710505
[2,]  0.5049542 -0.1311861 -1.1793249  0.006112086 -0.3907774 -1.64391899 -1.1335714
[3,]  1.2383853  1.1873155  1.2369896 -1.366567846  1.6883891  0.18043651  1.7046001
[4,]  0.1441805  0.4823775 -0.5097379  1.674911405 -0.3979383  0.38114647 -0.4263409
[5,]  1.5548026  0.3120183 -0.6114136  0.395916550  1.7111356  0.02093069  1.3723676
      [,29]      [,30]
[1,] -0.1511982 -1.0279958
[2,] -0.2620271  1.7594795
[3,]  1.0408982 -0.5658039
[4,]  2.4324545  0.7427029
[5,] -0.4754496  0.6979811

```

```

$startweights[[1]][[2]]
      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]      [,7]
[1,]  1.2225065 -0.4326136 -0.37945348 -1.82940937  0.60226221  0.17583083 -0.993206403
[2,] -0.3136112 -0.7281993 -0.02246692  1.24362174  0.85877810  0.85359589  0.044610972
[3,] -0.2641362  0.2978334  0.09040222  1.38139927  0.91159154 -0.37453945 -1.041431242
[4,]  1.6141228  0.9098199  0.04030704  1.17157192  0.53027058  0.45268126  0.688288944
[5,] -0.3480718  0.3925999  0.58319090  0.68879380  0.48426562 -0.84357625 -0.892074579
[6,] -0.7885068  0.7451535  1.34784350  1.91952013  2.40120201 -0.11604844  1.525447716
[7,]  0.8535937  0.5513101 -0.32535131  0.39493131  0.58672814  1.12005063 -1.223951365
[8,]  1.5084190  1.8301770 -0.58551865 -0.74589185 -0.83654539 -2.21305894  0.404897443
[9,]  0.4587302  0.2772518 -0.15606493  0.30630342 -0.24882052 -0.71516999  0.684960903
[10,] 1.3558616  0.8294237  1.00453339 -0.31764189 -0.56221161  0.28394682 -0.399344338
[11,] 0.2936335 -0.7042802 -0.82245075  1.37278309 -0.39414397  0.21390311 -1.553295976
[12,] -0.4258596 -0.6144982  0.95747521 -0.85263205  1.90844404  1.07072375 -0.573038879
[13,]  0.6534223 -0.2696542  1.21616430 -0.14986843  1.02208847  1.62387533 -0.293418683
[14,] -0.7156545 -0.6551549 -0.67547465  0.86500561 -0.18730903 -0.82866652 -0.578430654
[15,] -0.5702158  0.7590120 -0.92335226  0.20854731  0.98026010 -0.62647006  0.484295091
[16,]  1.2066423  0.1910448  0.67335313 -0.34378459  0.21986640  1.19301171 -0.073774307
[17,] -2.7573081 -0.1623868  0.13413175  0.44324936  2.19773567  0.56667287  0.426072681
[18,] -1.2289189 -0.2748075 -0.82606194 -1.22554572  1.84747752 -0.45847609 -0.486183347
[19,] -1.4055309 -0.6274473 -0.30915086 -0.45953159 -0.41597130  1.01731457  2.058884767
[20,]  1.1532463 -1.2616068 -0.41297571 -1.14292417 -0.27963541 -0.81169968  2.416149774
[21,] -1.2624432 -1.5438610 -0.89317343  1.02307599 -0.29751743  0.80630450 -1.992529874
[22,] -0.7876786 -0.7258904 -0.03868748  0.80677786  0.41066164  0.13381629  1.181499326
[23,] -0.9859500  0.1122953  0.45498487 -1.39482255 -0.09868400  1.33271720 -1.546346342
[24,] -1.1246888  1.9795811  1.21061710 -1.07378250 -2.03421043  2.07981840  1.154038944
[25,]  1.2657002 -2.1279129  2.37914178  0.99166806 -1.16172275  1.29434438 -0.152043930
[26,] -0.6699691  1.5197783  2.09128234  0.51600191  1.98663702  2.59900053 -0.124981022
[27,]  1.1481540 -0.2401596  0.42764718  1.49877175 -1.64243421  0.04965431 -0.246569458
[28,]  0.9532777 -0.3257640  0.79300781 -0.04112103  0.46188466 -0.95719441  0.005994843
[29,]  0.5615729 -0.3144222  2.20783459 -0.50868327  0.44138669 -0.27565401  0.465503814
[30,] -1.7207718 -1.6229682 -1.91548624 -0.04223595 -0.79764450  1.58059300  0.345490362

```

[31,]	-0.7935486	-0.5691359	1.14612865	-0.36255881	-0.06279204	-1.68019486	0.050845815
[,8]	[,9]	[,10]	[,11]	[,12]	[,13]	[,14]	
[1,]	0.2049496	-0.4577685	0.679727787	0.55783705	-1.97606198	-0.01999830	-0.42082310
[2,]	1.2268267	-0.5926119	0.333912824	-0.17963757	0.48240178	0.61783656	-0.49368329
[3,]	-2.6433113	-0.2053826	-0.238646153	0.83572871	1.48479237	-0.13069356	-0.36030399
[4,]	-0.6316012	-1.1826015	-0.361551831	1.64512975	0.14987509	-1.03189728	-0.11368977
[5,]	0.3263707	-0.1373477	-0.548145798	0.25915013	-0.49189289	-0.76079398	-0.91556292
[6,]	-0.5356129	-1.1485113	0.550651593	-0.38956694	1.19255166	-0.03769899	-2.08858155
[7,]	2.8020699	0.7419872	0.106904979	1.62731030	-0.94961631	1.51217464	0.19888846
[8,]	0.6388118	0.8120344	1.735899503	-0.53130070	-0.13027076	-1.27053830	2.00878348
[9,]	0.5816125	1.4213686	1.844315085	-1.39038705	0.47780422	0.50254746	-0.37370856
[10,]	1.4858212	-2.2964087	-2.246078584	1.32357839	-0.19031154	1.32768377	-1.17652807
[11,]	1.2925667	-1.4029168	0.585518030	-0.31172679	-0.04345282	-0.61817912	1.24975454
[12,]	-0.3188229	-1.0471999	0.059983431	1.36604234	0.54944445	-0.51270180	0.24257516
[13,]	-0.6551841	0.4129340	0.755635241	1.15207319	0.79442504	-1.59995279	1.44658934
[14,]	-0.9769859	1.0690519	-1.357534714	0.54411816	-0.87703697	1.57983527	1.76890141
[15,]	1.6560306	0.9856600	-0.663041688	-0.21531233	1.42333778	0.95811015	0.19414378
[16,]	-1.8325377	-0.6604393	0.686132999	0.15702523	0.90829058	0.48384338	0.06192005
[17,]	0.2526088	-0.5179764	1.068674757	-1.94526328	0.10278463	-0.36871722	0.32298275
[18,]	0.3179573	1.6282446	0.867422295	0.56396119	0.42317529	-0.05671579	1.25045258
[19,]	1.5871239	-0.7817818	0.506785215	1.37380863	-1.79362486	-0.87108138	0.18696039
[20,]	-1.7158558	0.3712726	-0.014142759	-0.19343870	0.90745828	0.30796299	-0.37151835
[21,]	0.5279628	0.7529672	-0.007371249	-0.06932985	-0.37938636	-0.49856832	0.54196445
[22,]	-1.9498217	1.1523565	-0.959715500	0.57954230	-0.13973097	0.89632755	0.55817566
[23,]	-0.4123682	0.2810194	-0.059716470	-1.20922898	-0.80362494	-0.17797993	0.05217745
[24,]	0.5324786	-1.0408815	-1.474326143	-0.21249761	0.30011884	-1.05715036	-0.58960026
[25,]	-0.1827301	-0.5154578	-1.113853266	-1.62837520	-1.47931336	-0.95091743	1.02398395
[26,]	-0.5929932	0.7010077	0.511968561	0.72538945	0.10532462	0.67419248	-0.55490471
[27,]	1.2484942	0.4455226	0.269921000	-0.89125027	-0.42158702	-0.09523589	-0.50473696
[28,]	-0.9328145	1.6771847	-0.645475084	1.31063572	1.37868221	0.69935391	0.42986032
[29,]	0.7842364	-0.5005257	-2.236058711	-1.18404708	0.43564250	0.96005080	1.49959010
[30,]	1.6956249	-0.1062607	-0.248396344	-1.01728835	-0.19257824	0.21402764	1.19125303
[31,]	1.1958241	-0.4083588	-0.029798463	1.21972589	-1.18660471	-1.52506565	-0.49212763
	[,15]	[,16]	[,17]	[,18]	[,19]	[,20]	
[1,]	-1.04855463	-1.43658859	-1.015051786	-0.03876683	0.7053795	-0.56682153	
[2,]	-0.01282796	-0.71000013	-0.596257588	3.77950638	0.9042990	-0.87960439	
[3,]	-0.47447458	-1.08597312	0.574336659	-0.58325923	1.1882075	0.23837907	
[4,]	-1.38322898	0.63581746	-2.573433417	0.16791603	-1.2229392	1.04880528	
[5,]	-2.19645309	-0.37733145	-0.016017365	1.36344484	0.1071586	0.16216249	
[6,]	-0.50450586	-0.13900757	1.328821791	-0.08394112	0.4995525	0.76876801	
[7,]	0.59225073	0.44512626	0.272687892	-0.74693726	-1.7115244	2.43715829	
[8,]	-2.22390073	0.50514819	-0.188053294	0.16531486	0.8705587	0.13531135	
[9,]	0.59989640	-0.10694256	-0.116019943	-0.34326191	-1.6806814	-0.18337305	
[10,]	0.36069869	-0.31053500	-0.608984047	1.31121563	-1.8273135	1.60070819	
[11,]	-0.83934097	-0.44929361	0.122904836	0.40499695	-0.2764109	0.94193522	
[12,]	1.31415863	-0.96602112	-0.507603720	-1.48227937	0.9177562	-0.54202754	
[13,]	-1.57756919	-1.06125284	1.352626789	2.96383814	0.2944137	-0.48386285	
[14,]	-0.31707993	0.33967354	0.738777808	-0.82627363	0.8920893	1.19103753	
[15,]	-0.88784269	0.79134807	0.132207881	-0.79348865	1.6856208	1.46854466	
[16,]	-1.40446724	-0.05961412	-1.586110592	0.96786290	-0.1816690	0.04367113	
[17,]	-0.10927209	1.21037827	0.495154326	0.48430478	0.4947295	-0.86783970	
[18,]	3.42626281	0.27673363	1.310908163	-0.04776644	-1.7743210	0.54865771	
[19,]	1.14195016	-0.26564584	0.480452489	0.27316804	-0.9249815	2.08969565	
[20,]	0.84874016	2.29411454	1.202662487	-0.72588496	-0.9634380	-0.96858231	

```

[21,]  0.62668631 -0.07433255  1.044176755  0.59574658 -0.6125074 -0.14384516
[22,]  0.44877064  1.21854669 -1.997433566  0.17708707 -1.0581848  0.68152627
[23,] -1.61988431  1.09064561 -0.098726923 -0.81035704 -1.0651442 -0.69604797
[24,] -0.68282978  0.50527948 -0.004356259  0.79973524  0.6247836  0.73564612
[25,] -0.73557013 -0.91489089  0.248965599 -1.04401755  1.6326361 -0.95331596
[26,]  0.21884798  1.44387726  0.337701164 -0.12153606  0.9521616  0.79625258
[27,] -1.14747094  1.56071649 -0.581481557 -1.07266779  0.1965400  2.18159680

plot(model, rep = 'best')

# Model evaluation
#predict categories - test dataset
#list of category names
#dataframe
# table - actual and predicated
test_data

> 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

pred<-predict(model, test_data)
pred

[,1]      [,2]      [,3]
1  1.000000e+00 5.046337e-06 1.037863e-19
15 1.000000e+00 3.433053e-05 1.209322e-20
16 1.000000e+00 1.801635e-06 3.248098e-19
21 1.000000e+00 4.089601e-04 7.954519e-22
22 1.000000e+00 1.889218e-06 3.010986e-19
26 1.000000e+00 2.762146e-03 9.242709e-23
28 1.000000e+00 7.858440e-06 6.602595e-20
30 1.000000e+00 2.623395e-06 2.108522e-19
31 1.000000e+00 2.865046e-05 1.450709e-20
47 1.000000e+00 1.788209e-06 3.171373e-19
51 1.901208e-25 1.000000e+00 8.953821e-09
52 1.401630e-26 9.999914e-01 3.670733e-06
53 5.570076e-29 9.999827e-01 7.507990e-06
63 3.405007e-26 1.000000e+00 1.157291e-10
78 4.256534e-34 3.733246e-01 6.921986e-01
79 1.413398e-29 9.994468e-01 3.951338e-04
81 2.954811e-25 1.000000e+00 2.214912e-10
90 2.319032e-27 9.999998e-01 5.664436e-08
98 9.158248e-26 9.999999e-01 2.884110e-08
105 1.494080e-43 6.941063e-12 1.000000e+00
110 9.557100e-43 2.832602e-11 1.000000e+00
112 1.678671e-41 1.039140e-08 1.000000e+00
114 6.459941e-42 4.286006e-10 1.000000e+00

```

```

129 1.932463e-43 1.703112e-11 1.000000e+00
132 4.543800e-40 3.403758e-08 1.000000e+00
135 1.204906e-39 1.374394e-06 9.999995e-01
140 9.860584e-41 1.346394e-08 1.000000e+00
141 6.293611e-43 1.970762e-11 1.000000e+00
142 4.086513e-39 1.998238e-06 9.999993e-01
148 9.630661e-40 7.749590e-08 1.000000e+00

labels<-c("setosa", "versicolor","virginica")
labels

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        8        1
  virginica      0        0       11

test_data.shape
summary(test_data)

  Sepal.Length   Sepal.Width   Petal.Length   Petal.Width      Species
Min.    :4.700   Min.    :2.200   Min.    :1.200   Min.    :0.200   setosa    :10
1st Qu.:5.425  1st Qu.:2.900  1st Qu.:1.600  1st Qu.:0.250  versicolor: 9
Median  :6.050  Median  :3.100  Median  :4.500  Median  :1.400  virginica :11
Mean    :6.043  Mean    :3.143  Mean    :3.867  Mean    :1.253
3rd Qu.:6.650  3rd Qu.:3.475  3rd Qu.:5.275  3rd Qu.:2.000
Max.    :7.900  Max.    :4.400  Max.    :6.400  Max.    :2.500

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

> check
[1] TRUE  TRUE
[15] FALSE TRUE  TRUE
[29] TRUE  TRUE

accuracy<-(sum(check)/nrow(test_data))*100
print(accuracy)
[1] 96.66667

# From the tow here is its accuracy
| Number of Nodes | Accurace |
|-----|-----|
| (4, 2)          | 100    |
| (30, 20)         | 96.66667 |
|                   |         |

```