

Homework 6

Neural Networks

Group 22

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Problem 1

```
```{r warning=FALSE,message=FALSE}
library(readxl)
Toyota_Corolla<-read_excel("C:/Users/pc/Desktop/Spring2019/DM/Rdown/DataMining/homework5/ToyotaCorolla.xlsx",sheet=2)
|
library(neuralnet)
Toyota_Corolla<-read_excel("C:/Users/pc/Desktop/Spring2019/DM/hw6/ToyotaCorolla.xlsx"
)

normalize<-function(x){
 return((x-min(x))/(max(x)-min(x)))
}

rmse<-function(x,y){
 sqrt(mean(x-y)^2)
}

library(fastDummies)
Toyota_Corolla<-dummy_cols(Toyota_Corolla,select_columns = c("Fuel_Type"))
Toyota_Corolla<-Toyota_Corolla[,-c(1,2,5,6,8,11,41,51)]
```

Splitting the data into train and test(Validation set)

```
35 ```{r}
36 set.seed(90)
37 ss <- sample(1:2,size=nrow(Toyota_Corolla),replace=TRUE,prob=c(0.75,0.25))
38 train_split <- Toyota_Corolla[ss==1,]
39 test_split <- Toyota_Corolla[ss==2,]
40
41 train_split[,c(2,3,4,7,8,9,10,11,12,15)]<- normalize_function(train_split[,c(2,3,4,7,8,9,10,11,12,15)])
42 test_split[,c(2,3,4,7,8,9,10,11,12,15)]<- normalize_function(test_split[,c(2,3,4,7,8,9,10,11,12,15)])
43
44 ..
```

Record the RMS error for the training data and the validation data. Repeat the process, changing the threshold values, 1, 0.1, 0.05, 0.01, 0.005, 0.001, and 0.0001. Set threshold to these values.

(a)

Creating Neural Net with threshold values, 1, 0.1, 0.05, 0.01, 0.005, 0.001, and 0.0001:

```

46+ ```{r}
47 Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
48 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
49 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
50 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
51 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
52 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
53 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 1)
54
55 Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
56 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
57 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
58 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
59 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
60 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
61 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.1)
62
63 Price2 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
64 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
65 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
66 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
67 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
68 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
69 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.05)
70
71 Price3 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
72 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
73 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
74 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
75 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
76 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
77 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.01)
78
79 Price4 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
80 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
81 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
82 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
83 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
84 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
85 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.005)
86
87 Price5 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
88 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
89 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
90 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
91 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
92 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
93 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.001)
94
95 Price6 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
96 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
97 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
98 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
99 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
100 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
101 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.0001)
102
103 ```

```

Getting RMS for models mentioned above:

```

105+ ```{r}
106 results <- compute(Price,train_split[,,-1])
107 train_split<- cbind(train_split,data.frame(results$net.result))
108 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
109
110 train_split$results.net.result <- NULL
111 results <- compute(Price1,train_split[,,-1])
112 train_split<- cbind(train_split,data.frame(results$net.result))
113 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
114
115 train_split$results.net.result <- NULL
116 results <- compute(Price2,train_split[,,-1])
117 train_split<- cbind(train_split,data.frame(results$net.result))
118 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
119
120 train_split$results.net.result <- NULL
121 results <- compute(Price3,train_split[,,-1])
122 train_split<- cbind(train_split,data.frame(results$net.result))
123 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
124
125 train_split$results.net.result <- NULL
126 results <- compute(Price4,train_split[,,-1])
127 train_split<- cbind(train_split,data.frame(results$net.result))
128 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
129

```

```

130 train_split$results.net.result <- NULL
131 results <- compute(Price5,train_split[, -1])
132 train_split<- cbind(train_split,data.frame(results$net.result))
133 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
134
135 train_split$results.net.result <- NULL
136 results <- compute(Price6,train_split[, -1])
137 train_split<- cbind(train_split,data.frame(results$net.result))
138 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
139

```

Output:

```

139
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823

```

Answer: We can see that even though we are increasing the number of hidden layers RMS values across models isn't changing and remains the same.

(b)

Using the neural nets created above we test those against test data(validation data)

```

141 ~~~{r}
142 results <- compute(Price,test_split[, -1])
143 test_split<- cbind(test_split,data.frame(results$net.result))
144 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
145
146 test_split$results.net.result <- NULL
147 results <- compute(Price1,test_split[, -1])
148 test_split<- cbind(test_split,data.frame(results$net.result))
149 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
150
151 test_split$results.net.result <- NULL
152 results <- compute(Price2,test_split[, -1])
153 test_split<- cbind(test_split,data.frame(results$net.result))
154 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
155
156 test_split$results.net.result <- NULL
157 results <- compute(Price3,test_split[, -1])
158 test_split<- cbind(test_split,data.frame(results$net.result))
159 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
160
161 test_split$results.net.result <- NULL
162 results <- compute(Price4,test_split[, -1])
163 test_split<- cbind(test_split,data.frame(results$net.result))
164 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
165
166 test_split$results.net.result <- NULL
167 results <- compute(Price5,test_split[, -1])
168 test_split<- cbind(test_split,data.frame(results$net.result))
169 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
170
171 test_split$results.net.result <- NULL
172 results <- compute(Price6,test_split[, -1])
173 test_split<- cbind(test_split,data.frame(results$net.result))
174 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
175

```

Output:

```

175
[1] 4065.956481
[1] 4065.956537
[1] 4065.956541
[1] 4065.95654
[1] 4065.956541
[1] 4065.956541
[1] 4065.956541

```

Answer: We can see that as we decrease the value of threshold RMSE increases for validation data set.

(c)

Creating models with hidden layers 1,2,4, and 8. Calculating RMSE for train and validation dataset:

```
178 ~~~{r}
179 Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+weight+
180 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
181 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
182 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
183 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
184 Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
185 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split, hidden = 1, threshold = 1)
186
187 Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+weight+
188 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
189 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
190 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
191 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
192 Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
193 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split, hidden = 2, threshold = 1)
194
195 Price2 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+weight+
196 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
197 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
198 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
199 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
200 Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
201 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split, hidden = 4, threshold = 1)
202
203 Price3 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+weight+
204 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
205 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
206 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
207 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
208 Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
209 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split, hidden = 8, threshold = 1)
210 ~~~
```

Testing the models on train and validation datasets:

```
213 ~~~{r}
214 train_split$results.net.result <- NULL
215 results <- compute(Price,train_split[, -1])
216 train_split<- cbind(train_split,data.frame(results$net.result))
217 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
218
219 train_split$results.net.result <- NULL
220 results <- compute(Price1,train_split[, -1])
221 train_split<- cbind(train_split,data.frame(results$net.result))
222 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
223
224 train_split$results.net.result <- NULL
225 results <- compute(Price2,train_split[, -1])
226 train_split<- cbind(train_split,data.frame(results$net.result))
227 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
228
229 train_split$results.net.result <- NULL
230 results <- compute(Price3,train_split[, -1])
231 train_split<- cbind(train_split,data.frame(results$net.result))
232 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
233
```

```

233
234 test_split$results.net.result <- NULL
235 results <- compute(Price,test_split[, -1])
236 test_split<- cbind(test_split,data.frame(results$net.result))
237 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
238
239 test_split$results.net.result <- NULL
240 results <- compute(Price1,test_split[, -1])
241 test_split<- cbind(test_split,data.frame(results$net.result))
242 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
243
244 test_split$results.net.result <- NULL
245 results <- compute(Price2,test_split[, -1])
246 test_split<- cbind(test_split,data.frame(results$net.result))
247 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
248
249 test_split$results.net.result <- NULL
250 results <- compute(Price3,test_split[, -1])
251 test_split<- cbind(test_split,data.frame(results$net.result))
252 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
253

```

Output:

```

253
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 4065.956481
[1] 4065.956537
[1] 4065.956541
[1] 4065.95654
254

```

Ans: For training dataset, as we increase number of hidden layers RMSE doesn't change but for validation dataset (test data) we can see that as number of hidden layers increase RMSE value also increases.

(d)

Creating models:

```

255 ~~~{r}
256 |
257 Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
258 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
259 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
260 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
261 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
262 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
263 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = c(2,1), threshold = 1)
264
265 Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
266 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
267 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
268 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
269 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
270 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
271 Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = 1, threshold = 1)
272

```

Testing the models on train and validation datasets:

```

276 ~~~{r}
277 train_split$results.net.result <- NULL
278 results <- compute(Price,train_split[, -1])
279 train_split<- cbind(train_split,data.frame(results$net.result))
280 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
281
282 train_split$results.net.result <- NULL
283 results <- compute(Price1,train_split[, -1])
284 train_split<- cbind(train_split,data.frame(results$net.result))
285 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
286
287
288 test_split$results.net.result <- NULL
289 results <- compute(Price,test_split[, -1])
290 test_split<- cbind(test_split,data.frame(results$net.result))
291 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
292
293
294
295 test_split$results.net.result <- NULL
296 results <- compute(Price1,test_split[, -1])
297 test_split<- cbind(test_split,data.frame(results$net.result))
298 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
299
300 ~~~

```

Output:

```

300 ~~~
[1] 3468.517823
[1] 3468.517823
[1] 4065.956613
[1] 4065.956488

```

Ans: We can see that, changing the number of layers from 1 to 2 in the network decrease the RMSE for validation dataset (test data) whereas RMSE remains the same for train dataset.

(e)

Create models with learning rate 0.2, 0.7 & 1.2:

```

302 ~~~{r}
303 Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
304 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
305 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
306 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
307 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
308 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
309 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split,
310 hidden = 8, threshold = 1,learningrate = 0.2)
311
312 Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
313 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
314 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
315 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
316 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
317 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
318 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split,
319 hidden = 8, threshold = 1,learningrate = 0.7)
320
321 Price2 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
322 Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_Airco+
323 Boardcomputer+CD_Player+Central_Lock+Powered_windows+Power_Steering+Radio+Mistlamps+
324 Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
325 Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
326 Toyota_Corolla_Green+Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
327 Toyota_Corolla_Violet+Toyota_Corolla_white,train_split,
328 hidden = 8, threshold = 1,learningrate = 1.2)
329 ~~~

```



Testing the models on train and validation datasets:

```
331 {r}
332 train_split$results.net.result <- NULL
333 results <- compute(Price,train_split[, -1])
334 train_split<- cbind(train_split,data.frame(results$net.result))
335 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
336
337 train_split$results.net.result <- NULL
338 results <- compute(Price1,train_split[, -1])
339 train_split<- cbind(train_split,data.frame(results$net.result))
340 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
341
342 train_split$results.net.result <- NULL
343 results <- compute(Price2,train_split[, -1])
344 train_split<- cbind(train_split,data.frame(results$net.result))
345 rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
346
347 test_split$results.net.result <- NULL
348 results <- compute(Price,test_split[, -1])
349 test_split<- cbind(test_split,data.frame(results$net.result))
350 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
351
352
353 test_split$results.net.result <- NULL
354 results <- compute(Price1,test_split[, -1])
355 test_split<- cbind(test_split,data.frame(results$net.result))
356 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
357
358 test_split$results.net.result <- NULL
359 results <- compute(Price1,test_split[, -1])
360 test_split<- cbind(test_split,data.frame(results$net.result))
361 rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
```

Output:

```
363 [1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 4065.956519
[1] 4065.956587
[1] 4065.956587
```

Ans: Changing the learning rate doesn't have effect on RMSE of train dataset but as we increase learning rate RSME value for validation dataset (test data) also increases.