Homework 6

Neural Networks

Group 22

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Problem 1

```r
```{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)

```r
```{r}
set.seed(90)
ss <- sample(1:2,size=nrow(Toyota_Corolla),replace=TRUE,prob=c(0.75,0.25))
train_split <- Toyota_Corolla[ss==1,]
test_split <- Toyota_Corolla[ss==2,]

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)])
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)])
```
```

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:
```

```r
Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 1)

Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.1)

Price2 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                    Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                    Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                    Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                    Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                    Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                    Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.05)

Price3 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                    Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                    Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                    Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                    Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                    Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                    Toyota_Corolla_Violet+Toyota_Corolla_White,train_split,  threshold = 0.01)

Price4 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                    Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                    Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                    Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                    Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                    Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                    Toyota_Corolla_Violet+Toyota_Corolla_White,train_split,  threshold = 0.005)

Price5 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                    Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                    Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                    Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                    Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                    Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                    Toyota_Corolla_Violet+Toyota_Corolla_White,train_split,  threshold = 0.001)

Price6 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                    Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                    Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                    Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                    Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                    Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                    Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, threshold = 0.0001)

```
```

Getting RMS for models mentioned above:

```r
results <- compute(Price,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price1,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price2,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price3,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price4,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
```
```

```
train_split$results.net.result <- NULL
results <- compute(Price5,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price6,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
```

Output:

```
[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)

```{r}
results <- compute(Price,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price1,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price2,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price3,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price4,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price5,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price6,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
```

Output:

```
[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:

```r
Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = 1, threshold = 1)

Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = 2, threshold = 1)

Price2 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = 4, threshold = 1)
```

```r
Price3 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = 8, threshold = 1)
```

Testing the models on train and validation datasets:

```r
train_split$results.net.result <- NULL
results <- compute(Price,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price1,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price2,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price3,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))
```

```
test_split$results.net.result <- NULL
results <- compute(Price,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price1,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price2,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price3,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
```

Output:

```
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 3468.517823
[1] 4065.956481
[1] 4065.956537
[1] 4065.956541
[1] 4065.95654
```

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:

```
```{r}

Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = c(2,1), threshold = 1)

Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split, hidden = 1, threshold = 1)
```
```

Testing the models on train and validation datasets:

```r
train_split$results.net.result <- NULL
results <- compute(Price,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price1,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))


test_split$results.net.result <- NULL
results <- compute(Price,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))



test_split$results.net.result <- NULL
results <- compute(Price1,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

```

Output:

```
[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:

```r
Price <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split,
                   hidden = 8, threshold = 1,learningrate = 0.2)

Price1 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split,
                   hidden = 8, threshold = 1,learningrate = 0.7)

Price2 <- neuralnet(Price~Age_08_04+KM++HP+Met_Color+Automatic+cc+Doors+Cylinders++Gears+Quarterly_Tax+Weight+
                   Mfr_Guarantee+BOVAG_Guarantee+Guarantee_Period+ABS+Airbag_1+Airbag_2+Airco+Automatic_airco+
                   Boardcomputer+CD_Player+Central_Lock+Powered_Windows+Power_Steering+Radio+Mistlamps+
                   Sport_Model+Backseat_Divider+Metallic_Rim+Radio_cassette+Tow_Bar+Toyota_Corolla_CNG+
                   Toyota_Corolla_Diesel+Toyota_Corolla_Beige+Toyota_Corolla_Black+Toyota_Corolla_Blue+
                   Toyota_Corolla_Green++Toyota_Corolla_Grey+Toyota_Corolla_Red+Toyota_Corolla_Silver+
                   Toyota_Corolla_Violet+Toyota_Corolla_White,train_split,
                   hidden = 8, threshold = 1,learningrate = 1.2)
```

Testing the models on train and validation datasets:

```r
train_split$results.net.result <- NULL
results <- compute(Price,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price1,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

train_split$results.net.result <- NULL
results <- compute(Price2,train_split[,-1])
train_split<- cbind(train_split,data.frame(results$net.result))
rmse(as.numeric(train_split$Price),as.numeric(train_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))


test_split$results.net.result <- NULL
results <- compute(Price1,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))

test_split$results.net.result <- NULL
results <- compute(Price1,test_split[,-1])
test_split<- cbind(test_split,data.frame(results$net.result))
rmse(as.numeric(test_split$Price),as.numeric(test_split$results.net.result))
```

Output:

```
[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.