Assignment 1

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Exercise 1. Nonlinear Regression

1

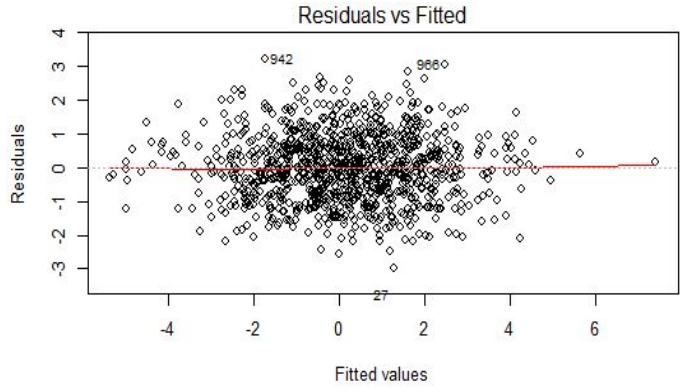
```
Beta = 0.6
n = 1000
X = rnorm(n)
epsilon = rnorm(n)
Y = exp(Beta)*X + epsilon
summary(Y)
```

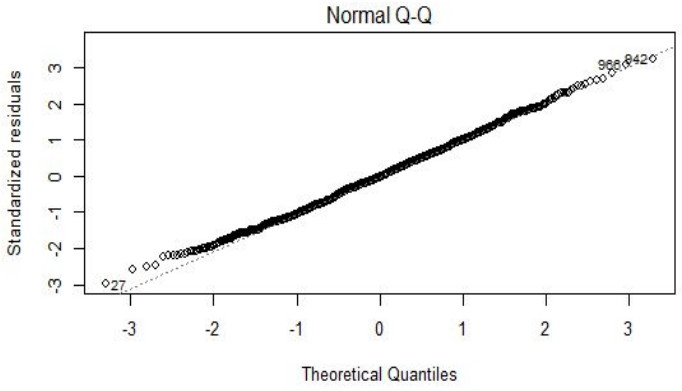
2.

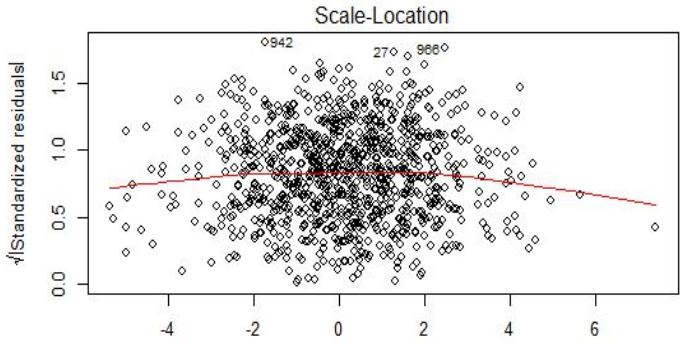
(a) , (b)

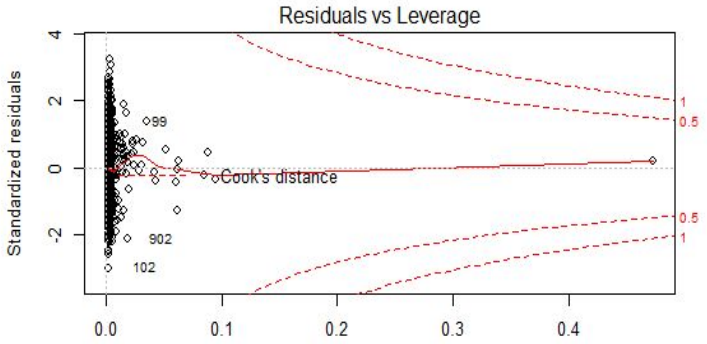
```
lm1.fit = lm(Y~X) #Linear Regression
lm1.fit

par(mfrow=c(2,2))
plot(lm1.fit)

lm2.fit = lm(Y~poly(X,2)) #Quadratic Regression
lm2.fit
par(mfrow=c(2,2))
plot(lm2.fit)

lm3.fit = lm(Y~poly(X,3)) #Cubic Regression
lm3.fit
par(mfrow=c(2,2))
plot(lm3.fit)

plot(X,Y)
abline(lm1.fit, col="Red", lwd=1)
lines(X, predict(lm2.fit), col="blue", lwd=1)
lines(X, predict(lm3.fit), col="green", lwd=1)
```

(c)

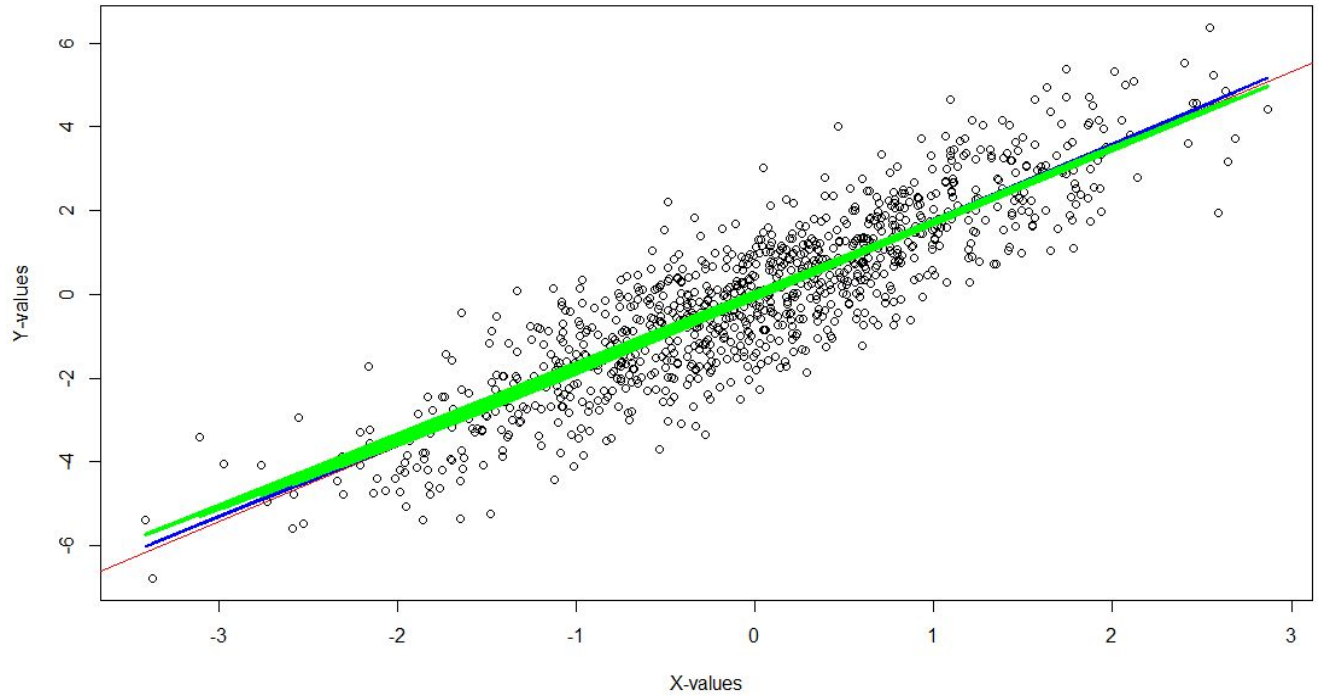






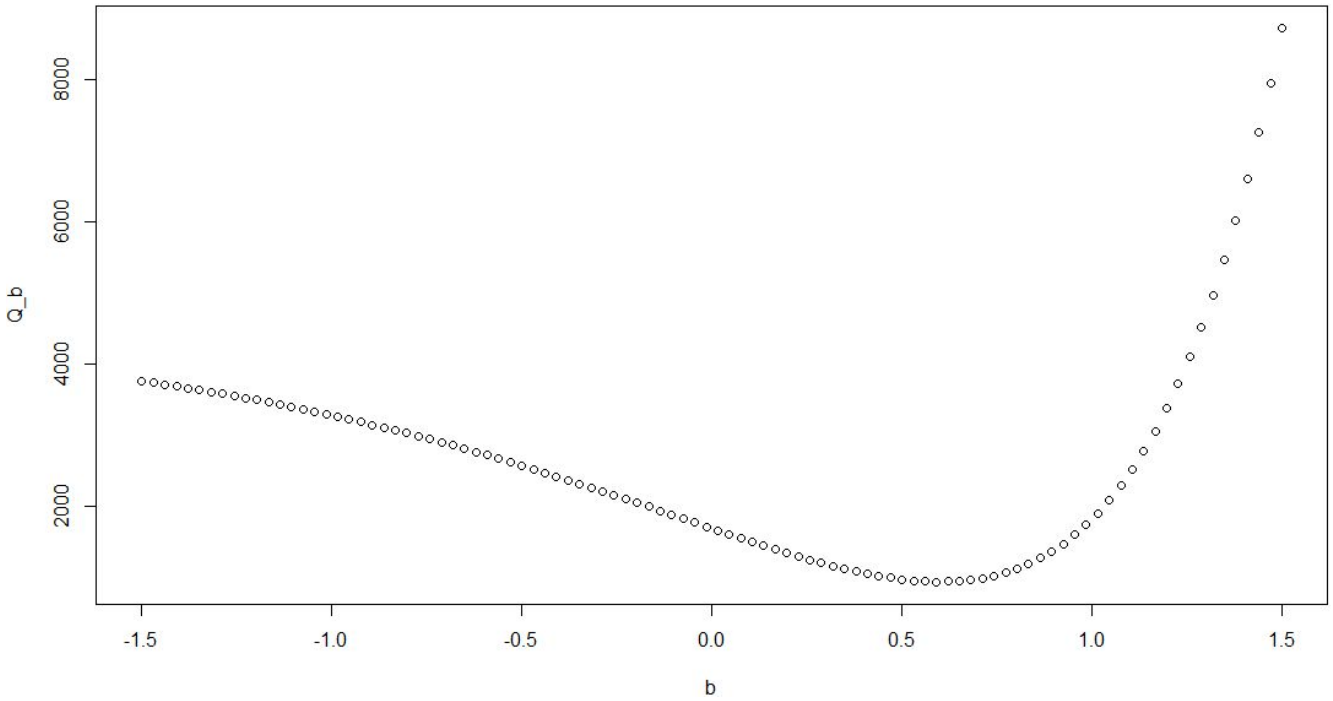


(d) Red Line - linear model, Blue Line - Quadratic Model, Green Line - Cubic model



3

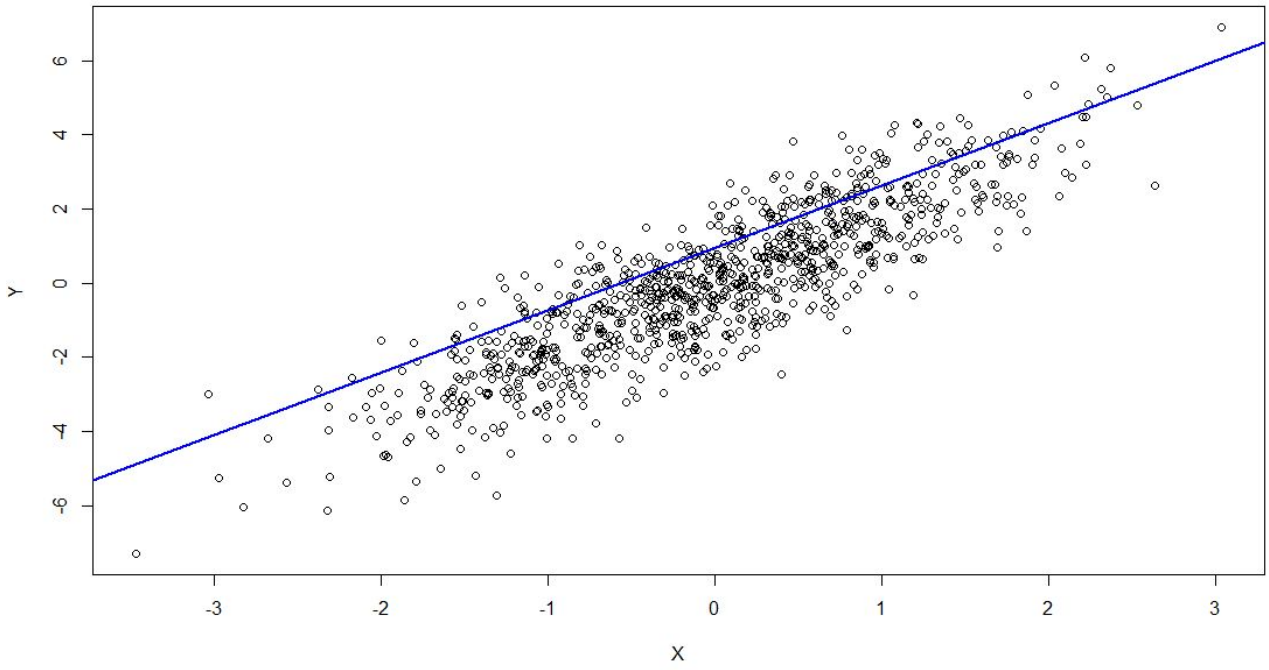
(a) x-axis has the values b and y-axis has the values of Q



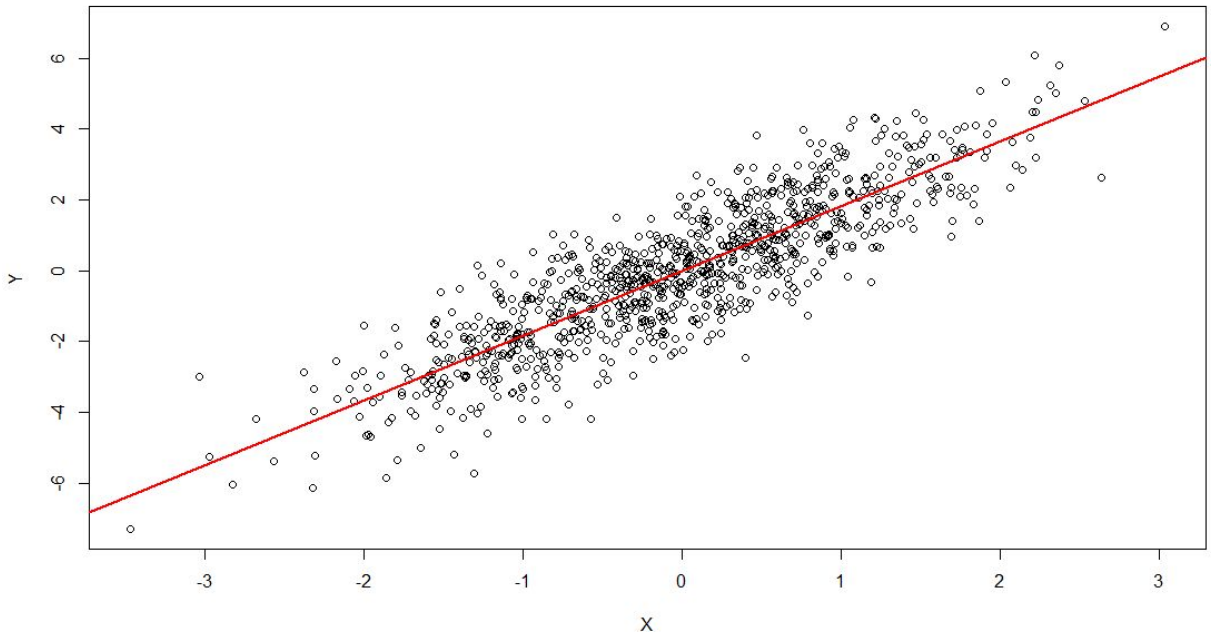
(b)

beta = 0.5909091

(c) Black circles are the actual data points and **blue line** is our predicted data Y for given X.



(d) Black circles are the actual data points and **red line** is the predicted data Y from linear model (lm())



Yes it is possible to estimate this model using lm(), in fact if we estimate this model by lm() then the mean squared error is less as compared to when we estimate the model by, y = exp(b)*x.

4

(a)

	Actual Model	Linear Model	Quadratic Model	Cubic Model
Training MSE	1.027601	1.026994	2.79261	2.844443

(b)

	Actual Model	Linear Model	Quadratic Model	Cubic Model
Test MSE	7.683429	7.78773	37.89978	38.73074

(c)

Based on the result it is clear that Linear Model generalizes well on the test data, so we will choose the Linear Model.

Exercise 2. KNN

```
X1 = c(1,1,-3,2,3,4,4)
X2 = c(2,3,1,2,2,1,3)
Y = c(0,0,0,1,1,1,1)

predicty = function(a,b){
  d = rep(0,7) #Distance
  for (i in 1:7) {
    X1hat = (X1[i] - a)^2
    X2hat = (X2[i] - b)^2
    d[i] = (X1hat + X2hat)^0.5
  }

  y = Y[which.min(d)]


  return(y)
}
```

#Testing on 3 random points

```
predicty(490,3)
     -    1
predicty(4,398)
     -    1
predicty(-400000000000000,-9999999999993)
     -    0
```