Dr. Sudhakar Raju

BUS 209: LINEAR & MULTIVARIATE MODELS

SPRING 2017

**ANSWERS TO ASSIGNMENT 1**

1 a.) *μ* = 15,015, *σ* = 3540



*Prob*(*x* > 18,000) = 1- *P*(*z* ≤ .84) = 1 - .7995 = **.2005**

b.) 

*Prob*(*x* < 10,000) = *P*(*z* < -1.42) = **.0778**

c.) At 18,000, *z* = .84 from part (a)

At 12,000, 

*Prob*(12,000 < *x* < 18,000) = *P*(-.85 < *z* < .84) = .7995 - .1977 = **.6018**

d.) 

*Prob*(*x* ≤ 14,000) = *P*(*z* ≤ -.29) = **.3859**

2 a.) 

*Prob* (*z* ≤ -2) = .0228. So *P*(*x* < 60) = **.0228**

b.) At *x* = 60

 Area to left is .0228

At *x* = 75

 Area to left is .3085

*Prob*(60 ≤ *x* ≤ 75) = .3085 - .0228 = **.2857**

c.)  *P*(*z* ≤ 1) = *P*(*x* ≤ 90) = .1587

Therefore 15.87% of students will not complete on time or (60) (.1587) = 9.52 students. We would expect 9 or 10 students to be unable to complete the exam on time.

3a.) 1% of the worst outcomes implies a Z value of -2.33. Use this Z value to solve for the X value. Thus:





X = $199.81 million

This means that if 1% of the worst, most unexpected events happen (banks attribute probability to events like financial crisis, recession, currency devaluation, etc.) the bank could lose an amount equal to or greater than $199.81 million.

b.) 5%of the worst outcomes implies a Z value of -1.65. Thus:





X = $229 million

This means that if 5% of the worst, most unexpected events happen (financial crisis, recession, currency devaluation, etc.) the bank could lose an amount equal to or greater than $229 million.

4a.) The top 10% of the normal distribution (right tail of the normal distribution) implies that we are looking for a Z value that corresponds to 90% of the distribution (going from left to right). The Z value that corresponds to 90% of the distribution equals +1.28. Use this Z value to solve for the X value. Thus:



X = 88.24 points

Thus, a student needs to score at least 88.24 points to get an A on the course.

b.) The bottom 20% of the class get a “C”. This means that we are looking for a Z value that corresponds to 20% of the left tail of the distribution. The Z value that corresponds to 20% of the distribution equals -.84. Use this Z value to solve for the X value. Thus:



X = 71.28 points

Thus, a student who gets a score of 71.28 points or lower gets a “C”. Students who score between 71.28 and 88.24 points, get a “B” grade.

5.) R CODE FOR QUESTION 3

names(Auto)

attach(Auto)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

REGRESSION1<-lm(mpg~horsepower)

summary(REGRESSION1)

anova(REGRESSION1)

plot(horsepower, mpg)

abline (REGRESSION1)

a.)

Call:

lm(formula = mpg ~ horsepower)

Residuals:

Min 1Q Median 3Q Max

-13.5710 -3.2592 -0.3435 2.7630 16.9240

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 39.935861 0.717499 55.66 <2e-16 \*\*\*

horsepower -0.157845 0.006446 -24.49 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.906 on 390 degrees of freedom

Multiple R-squared: 0.6059, Adjusted R-squared: 0.6049

F-statistic: 599.7 on 1 and 390 DF, p-value: < 2.2e-16

a.) There is a very strong relationship between mpg and horsepower as indicated by the very small p value. The p value indicates that horsepower is statistically significant in explaining mpg.

b.) The strength of the relationship between predictor (horsepower) and response variable (mpg) is indicated by the significant p value as well as the R2  value of .60. The generated equation is given by:

mpg = 39.94 - .1578 horsepower

The relationship above indicates that for every 1 unit increase in horsepower, mpg decreases by .16 miles per gallon.

At a horsepower of 98, predicted mpg is:

mpg = 39.94 - .1578 horsepower

mpg = 39.94 - .1578 (98)

= 24.48

c.) Call:

lm(formula = mpg ~ cylinders + displacement + horsepower)

Residuals:

Min 1Q Median 3Q Max

-11.7144 -3.1391 -0.3149 2.3481 16.5726

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 39.305268 1.324633 29.673 < 2e-16 \*\*\*

cylinders -0.719431 0.434180 -1.657 0.098331 .

displacement -0.029120 0.008623 -3.377 0.000807 \*\*\*

horsepower -0.059935 0.013498 -4.440 1.17e-05 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.523 on 388 degrees of freedom

Multiple R-squared: 0.6667, Adjusted R-squared: 0.6641

F-statistic: 258.7 on 3 and 388 DF, p-value: < 2.2e-16

The negative signs on the coefficients indicate that all 3 variables (cylinders, displacement and horsepower) negatively impact mpg. In other words, higher the number of cylinders, greater the displacement and higher the horsepower, lower the mpg. Notice that except for cylinders, both displacement and horsepower are statistically significant.

6.

> summary(REGMODEL1)

Call:

lm(formula = Sales ~ Price)

Residuals:

Min 1Q Median 3Q Max

-6.5362 -1.8611 -0.1605 1.6351 7.7127

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 13.643692 0.639553 21.333 <2e-16 \*\*\*

Price -0.052970 0.005411 -9.788 <2e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.559 on 398 degrees of freedom

Multiple R-squared: 0.194, Adjusted R-squared: 0.192

F-statistic: 95.81 on 1 and 398 DF, p-value: < 2.2e-16

The regression equation is:

Sales = 13.64 - .0530 Price

For every $1 increase in price, car seat sales decline by .0530 thousand (that is, .0530 x 1000 = 53 car seats. Note that car seats are measured in thousands). In economics, we call this the price elasticity of demand.

b.)

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Thus, a $15 increase in price will decrease car seat sales by about 795 car seats.

c.) > summary(REGMODEL2)

Call:

lm(formula = Sales ~ Price + Competitor\_Price + Income + Advertising)

Residuals:

Min 1Q Median 3Q Max

-5.8643 -1.4553 -0.1867 1.1760 5.9596

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 3.977835 0.920464 4.322 1.96e-05 \*\*\*

Price -0.090824 0.005434 -16.712 < 2e-16 \*\*\*

Competitor\_Price 0.097960 0.008397 11.666 < 2e-16 \*\*\*

Income 0.013528 0.003738 3.619 0.000334 \*\*\*

Advertising 0.132317 0.015723 8.415 7.27e-16 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.079 on 395 degrees of freedom

Multiple R-squared: 0.4721, Adjusted R-squared: 0.4668

F-statistic: 88.32 on 4 and 395 DF, p-value: < 2.2e-16

The above implies that as Price goes up, sales of car seats comes down.

As competitor prices, Income and Advertising go up, sales goes up.

d.) The regression equation is:

Sales = 3.98 - .0908 Price + .0980 Competitor\_Price + .0135 Income + .1323 Advertising

Sales = 3.98 - .0908 ($10) + .0980 (-$15) + .0135 (-$10) + .1323 (-$5)

= 3.98 - .9080 -1.47 - .1350 -.6615

= .8055 (thousands)

Note that both Income and Advertising are measured in thousands. Thus, -$10 implies -$10,000 and -$5 represents -$5000. The effect of all the above changes results in an increase in sales of .8055 thousand or 806 car seats approximately.

R CODE FOR ASSIGNMENT 1

attach(Auto)

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REGRESSION1<-lm(mpg~horsepower)

summary(REGRESSION1)

anova(REGRESSION1)

plot(horsepower, mpg)

abline (REGRESSION1)

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REGRESSION2<-lm(mpg~cylinders+displacement+horsepower)

summary(REGRESSION2)

anova(REGRESSION2)

###########R CODE FOR PROBLEM 4################

attach(carseats\_data)

REGMODEL1<-lm(Sales~Price)

summary(REGMODEL1)

anova(REGMODEL1)

REGMODEL2<-lm(Sales~Price+Competitor\_Price+Income+Advertising)

summary(REGMODEL2)

anova(REGMODEL2)