

Untitled

2024-12-01

1.) (Use R) Consider the dataset “Homework 6 data.xlsx.” It consists of 5 randomly selected student’s scores on Test 1 and Test 2 in my introductory statistics course. We want to answer 2 questions:

```
setwd("~/Desktop/Personal_save/Stat_405_Module_14/Module_14_Homework")
#setwd("C:/Users/jake pc/Desktop/Personal_save/Stat_405_Module_14/Module_14_Homework")
HW_6 <- read.csv(file="Homework_6.csv",header=TRUE)
HW_6
```

```
## Student Test.1 Test.2
## 1      1      82      90
## 2      2      74      87
## 3      3      65      68
## 4      4      62      83
## 5      5      88      92
```

a. First, we want to see if there is a difference in the two tests. Paired two-tailed t-test

```
t.test(HW_6$Test.1, HW_6$Test.2, paired = TRUE)
```

```
##
## Paired t-test
##
## data: HW_6$Test.1 and HW_6$Test.2
## t = -2.9629, df = 4, p-value = 0.04143
## alternative hypothesis: true mean difference is not equal to 0
## 95 percent confidence interval:
## -18.9832784 -0.6167216
## sample estimates:
## mean difference
## -9.8
```

The p-value is less than 0.05, reject the null hypothesis that the means of Test 1 and Test 2 are equal. Tentatively conclude that the mean of the test scores are different.

b. Second, we want to see if there was improvement over the course of the semester. H_0 : Test1 - Test2 < 0

```
t.test(HW_6$Test.1, HW_6$Test.2, paired = TRUE, alternative = "less")
```

```
##
## Paired t-test
##
## data: HW_6$Test.1 and HW_6$Test.2
## t = -2.9629, df = 4, p-value = 0.02072
## alternative hypothesis: true mean difference is less than 0
## 95 percent confidence interval:
## -Inf -2.748774
## sample estimates:
## mean difference
## -9.8
```

Reject the null hypothesis that the mean difference of Test 1 minus Test 2 is equal to zero. Tentatively conclude that the mean difference of test 1 minus test 2 is less than zero, and therefore that the the grades of the second test were greater (better) than the first.

2.) (Use R) The data called “plasma” from Anderson et al. (1981) consists of measurements of plasma concentrations in micromoles/liter from 10 subjects at times of 8 am, 11am, 2pm, 5 pm, and 8 pm. Analyze the data in a 1-way ANOVA model choosing time as factor.

```
plasma <- read.csv(file="plasma.csv",header=TRUE)
plasma$time <- factor(plasma$time,levels=c("8am", "11am", "2pm", "5pm", "8pm"),
                      labels = c("8am", "11am", "2pm", "5pm", "8pm"))
```

```
plasma
```

```
##      subjects time plasma
## 1          1 8am    93
## 2          2 8am   116
## 3          3 8am   125
## 4          4 8am   144
## 5          5 8am   105
## 6          6 8am   109
## 7          7 8am    89
## 8          8 8am   116
## 9          9 8am   151
## 10         10 8am   137
## 11          1 11am  121
## 12          2 11am  135
## 13          3 11am  137
## 14          4 11am  173
## 15          5 11am  119
## 16          6 11am   83
## 17          7 11am   95
## 18          8 11am  128
## 19          9 11am  149
## 20         10 11am  139
## 21          1 2pm   112
## 22          2 2pm   114
## 23          3 2pm   119
## 24          4 2pm   148
## 25          5 2pm   125
## 26          6 2pm   109
## 27          7 2pm    88
## 28          8 2pm   122
## 29          9 2pm   141
## 30         10 2pm   125
## 31          1 5pm   117
## 32          2 5pm    98
## 33          3 5pm   105
## 34          4 5pm   124
## 35          5 5pm    91
## 36          6 5pm    80
## 37          7 5pm    91
## 38          8 5pm   107
## 39          9 5pm   126
## 40         10 5pm   109
```

```
## 41      1  8pm  121
## 42      2  8pm  135
## 43      3  8pm  102
## 44      4  8pm  122
## 45      5  8pm  133
## 46      6  8pm  104
## 47      7  8pm  116
## 48      8  8pm  119
## 49      9  8pm  138
## 50     10  8pm  107
```

```
plasma_model <- lm(plasma ~ time, data = plasma)
anova(plasma_model)
```

```
## Analysis of Variance Table
##
## Response: plasma
##           Df Sum Sq Mean Sq F value Pr(>F)
## time        4  2803.9   700.98   1.9838 0.1132
## Residuals  45 15901.2   353.36
```

```
summary(plasma_model)
```

```
##
## Call:
## lm(formula = plasma ~ time, data = plasma)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -44.90 -10.85   0.15  11.93  45.10
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   118.500     5.944   19.935 <2e-16 ***
## time11am       9.400     8.407    1.118   0.269
## time2pm        1.800     8.407    0.214   0.831
## time5pm       -13.700     8.407   -1.630   0.110
## time8pm        1.200     8.407    0.143   0.887
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 18.8 on 45 degrees of freedom
## Multiple R-squared:  0.1499, Adjusted R-squared:  0.07434
## F-statistic: 1.984 on 4 and 45 DF,  p-value: 0.1132
```

The p-value from this test is greater than 0.05, we therefore fail to reject the null hypothesis that the difference of the plasma level means of the groups are equal to zero.

Furthermore, the p-value testing if the mean of the 8am group plasma level is equal to zero is significant, we therefore reject the null hypothesis that the 8am plasma level mean is equal to zero. The remaining t-tests all fail to reject the null hypothesis that the difference of their group mean and the 8am group mean is equal to zero.

Therefore, there is insufficient evidence to suggest that blood plasma levels are different at different times of day.

3.) Two friends play a computer game and each of them repeats the same level 10 times. The scores obtained

are:

```
scores <- read.table(file="scores.txt",header=TRUE)

## Warning in read.table(file = "scores.txt", header = TRUE): incomplete final
## line found by readTableHeader on 'scores.txt'

library(tidyverse)

## -- Attaching core tidyverse packages ----- tidyverse 2.0.0 --
## v dplyr      1.1.4      v readr      2.1.5
## v forcats    1.0.0      v stringr   1.5.1
## v ggplot2    3.5.1      v tibble    3.2.1
## v lubridate  1.9.3      v tidyr     1.3.1
## v purrr      1.0.2
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

long <- scores %>%
  pivot_longer(cols = X1:X10, names_to = "trials", values_to = "scores") %>%
  select(-trials)

long$ID <- factor(long$ID, levels = c("Player1","Player2"), labels = c("Player1","Player2"))

write.csv(long, file="long.csv")
```

- a. Player 2 insists that he is the better player and suggests to compare their mean performance. Use a t-test to test whether there is a difference between their mean performance (alpha = 0.05).

We are testing for difference of mean on two separate individuals —> 2 sample - unpaired - two sided t-test

```
scores <- t(as.matrix(scores))
colnames(scores) <- scores[1,]
scores <- as_tibble(scores[-1,])
library(dplyr)

scores <- scores %>%
  mutate(across(everything(), as.numeric))

scores

## # A tibble: 10 x 2
##   Player1 Player2
##   <dbl>   <dbl>
## 1     91     261
## 2    101     47
## 3    112     40
## 4     99     29
## 5    108     64
## 6     88      6
## 7     99     87
## 8    105     47
## 9    111     98
## 10   104    351
```

```
shapiro.test(scores$Player1)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  scores$Player1
## W = 0.94628, p-value = 0.6247
```

```
shapiro.test(scores$Player2)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  scores$Player2
## W = 0.75335, p-value = 0.00392
```

```
t.test(long$scores ~ long$ID, var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  long$scores by long$ID
## t = -0.033723, df = 9.0898, p-value = 0.9738
## alternative hypothesis: true difference in means between group Player1 and group Player2 is not equal to 0
## 95 percent confidence interval:
##  -81.57617  79.17617
## sample estimates:
## mean in group Player1 mean in group Player2
##                101.8                103.0
```

fail to reject the null hypothesis that the player 1 scores are normally distributed.

reject the null hypothesis that the player 2 scores are normally distributed, therefore player 1 and 2 could never have equal variances

test results in a p-value of 0.9738, fail to reject the null hypothesis that the difference in means is equal to zero. This test fails to produce sufficient evidence that the difference of players mean scores is not equal to zero.

b. Player 1 insists that he is the better player. He proposes to use the Wilcoxon rank-sum test for the comparison. What are the results ($\alpha = 0.05$)?

```
wilcox.test(long$scores ~ long$ID, alternative = "greater")
```

```
## Warning in wilcox.test.default(x = DATA[[1L]], y = DATA[[2L]], ...): cannot
## compute exact p-value with ties
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  long$scores by long$ID
## W = 78, p-value = 0.01875
## alternative hypothesis: true location shift is greater than 0
```

The resulting p-value is less than 0.05, we therefore reject the null hypothesis that the true location shift is equal to zero and conclude that player 1 is better than player 2.

4.) (Use R)

A random sample of 90 adults is classified according to gender and the number of hours of television watched

during a week:

Use a 0.01 level of significance and test the hypothesis that the time spent watching television is independent of whether the viewer is male or female.

```
table <- matrix(data=c(15,29,27,19),nrow=2,ncol=2,byrow=TRUE,dimnames = list(c("Over 25 hours", "Under 25 hours"), c("Male", "Female")))
table <- t(table)
```

```
##           Over 25 hours Under 25 hours
## Male           15           27
## Female          29           19
```

```
chisq.test(table)
```

```
##
## Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table
## X-squared = 4.5262, df = 1, p-value = 0.03338
```

The p-value obtained is 0.03338 which is greater than 0.01, we therefore fail to reject the null hypothesis that time spent watching television is independent of whether the viewer is male or female.

5.) (Use R)

The data set named “Movies” contains a random sample of 35 movies released in 2008. This sample was collected from the Internet Movie Database (IMDb). The goal of this problem is to explore if the information available soon after a movie’s theatrical release can successfully predict total revenue. All dollar amounts (i.e., variables Budget, Opening, and USRevenue) are measured in millions of dollars. Consider three explanatory variables:

- The movie’s budget (variable named Budget).
- Opening weekend revenue (variable named Opening).
- Number of theaters showing the movie (variable named Theaters).

```
Movies <- read.csv(file="Movies.csv",header=TRUE)
Movies
```

```
##           Title Rating  Genre Budget USRevenue
## 1  Madagascar: Escape 2 Africa    PG Animation   150.0    180.0
## 2           Sex and the City      R   Comedy    65.0    152.6
## 3           The Ruins          R   Horror     8.0     17.4
## 4           Stop-Loss          R    Drama    25.0     10.9
## 5 The Curious Case of Benjamin Button PG-13   Drama   150.0    127.5
## 6           Redbelt          R    Action     7.0      2.3
## 7   The Secret Life of Bees PG-13   Drama    11.0     37.8
## 8           Kung Fu Panda      PG Animation   130.0    215.4
## 9           The Happening      R    Drama    60.0     64.5
## 10 Zach and Miri Make a Porno      R   Comedy    24.0     31.5
## 11           The Strangers      R   Horror    10.0     52.5
## 12           Prom Night PG-13   Horror    20.0     43.8
## 13           The Dark Knight PG-13   Action   185.0    533.3
## 14           Baby Mama PG-13   Comedy    30.0     60.3
## 15           Wanted          R    Action    75.0    134.3
## 16           Changeling      R    Drama    55.0     35.7
```

## 17	Yes Man	PG-13	Comedy	70.0	97.7
## 18	The Express	PG	Drama	40.0	9.6
## 19	W.	PG-13	Drama	25.1	25.5
## 20	The Mummy: Tomb of the Dragon Emporer	PG-13	Action	145.0	102.2
## 21	Eagle Eye	PG-13	Action	80.0	101.1
## 22	Burn After Reading	R	Comedy	37.0	60.3
## 23	Saw V	R	Horror	10.8	56.7
## 24	Miracle and St Anna	R	Action	45.0	7.9
## 25	The Day the Earth Stood Still	PG-13	Drama	80.0	79.4
## 26	Be Kind Rewind	PG-13	Comedy	20.0	11.2
## 27	Jumper	PG-13	Action	85.0	80.2
## 28	Hancock	PG-13	Action	150.0	227.9
## 29	Speed Racer	PG	Action	120.0	43.9
## 30	The Eye	R	Drama	12.0	31.4
## 31	Death Race	R	Action	45.0	36.1
## 32	College	R	Comedy	6.5	4.7
## 33	Blindness	R	Drama	25.0	3.1
## 34	Iron Man	PG-13	Action	140.0	318.3
## 35	Lakeview Terrace	PG-13	Drama	22.0	39.3
##	Opening Theaters				
## 1	63.1	4056			
## 2	56.8	3285			
## 3	8.0	2812			
## 4	4.6	1291			
## 5	26.9	2988			
## 6	1.1	1379			
## 7	10.5	1591			
## 8	60.2	4114			
## 9	30.5	2986			
## 10	10.1	2735			
## 11	21.0	2466			
## 12	20.8	2700			
## 13	158.4	4366			
## 14	17.4	2543			
## 15	50.9	3175			
## 16	10.0	1850			
## 17	18.3	3434			
## 18	4.6	2808			
## 19	10.5	2030			
## 20	40.5	3760			
## 21	29.2	3510			
## 22	19.1	2651			
## 23	30.1	3060			
## 24	3.5	1185			
## 25	30.5	3560			
## 26	4.1	808			
## 27	32.1	3428			
## 28	62.6	3965			
## 29	18.6	3606			
## 30	12.4	2436			
## 31	12.6	2532			
## 32	2.6	2123			
## 33	2.0	1690			
## 34	102.1	4105			

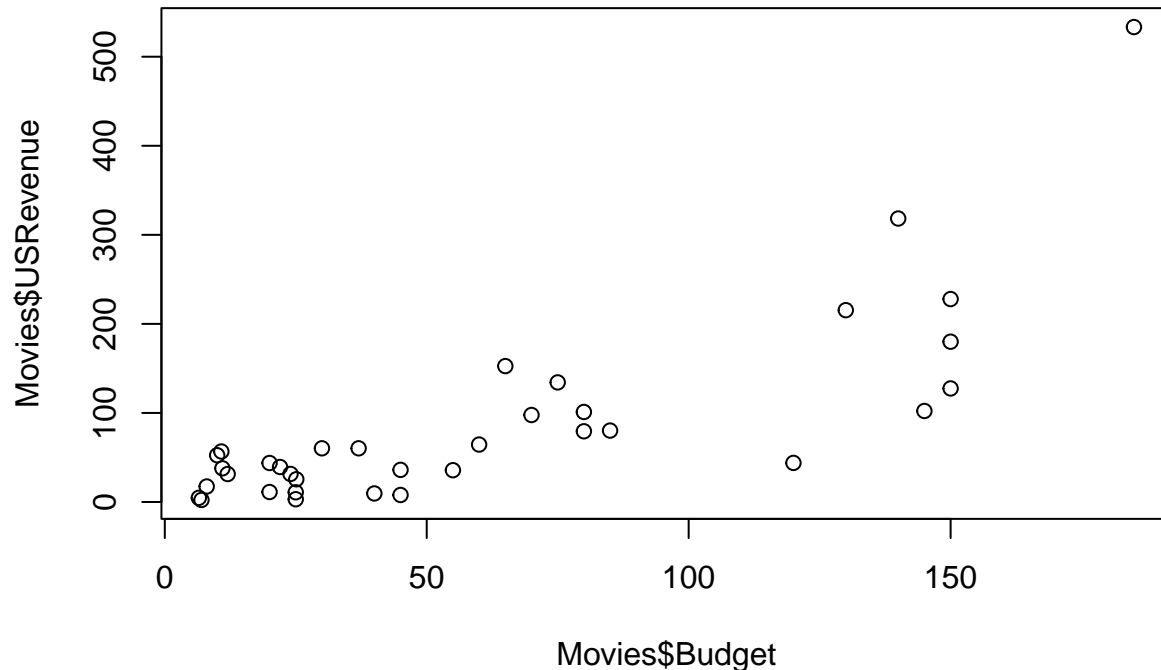
```
## 35      15.0      2464
```

This problem considers using each of these explanatory variables to attempt to predict a movie's total US revenue (variable named USRevenue).

a. Investigate the relationship between the explanatory variable Budget and response variable USRevenue by doing the following:

i) Make a scatterplot.

```
plot(x = Movies$Budget, y = Movies$USRevenue)
```



ii) Calculate the correlation coefficient.

```
cor(x = Movies$Budget, y = Movies$USRevenue)
```

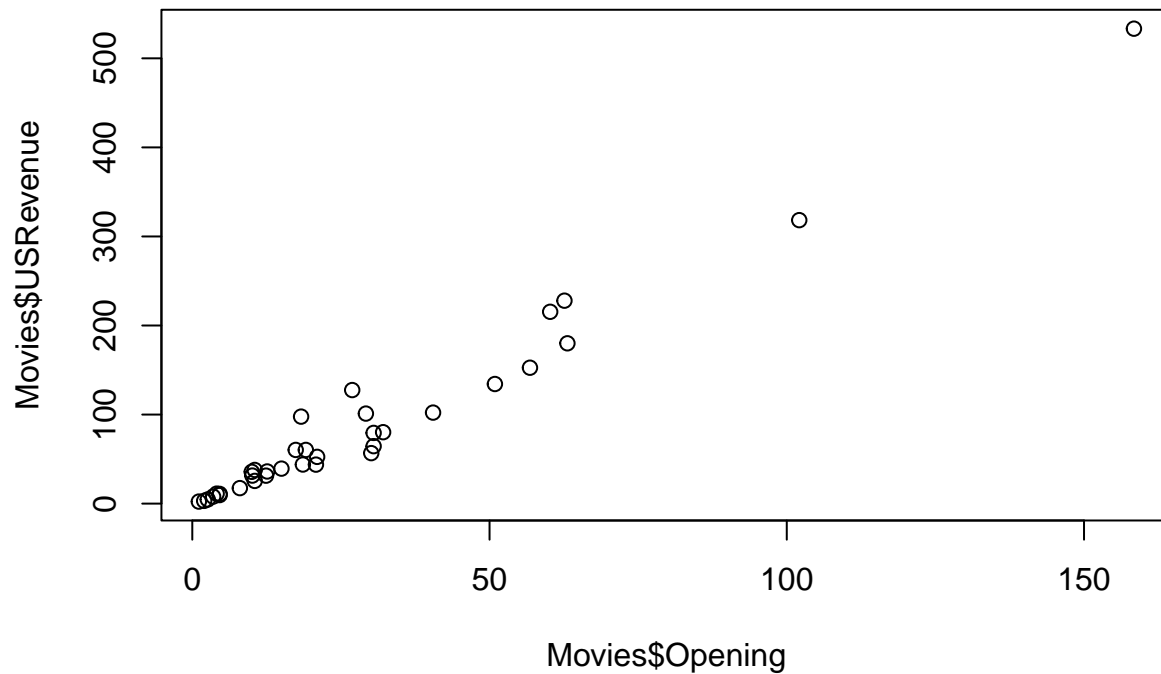
```
## [1] 0.7918636
```

iii) Interpret the scatterplot and correlation coefficient in terms of trend, strength, and shape.

The correlation coefficient is in the moderate strength range but just below the strong threshold of plus/minus 0.8, the trend is positive such that as budget increases US revenue increases. The scatter plot has a wedge shape such that as budget increases the USRevenue becomes more variable, this is a problem and will produce a “wedge shape” in the residuals plot.

b. Repeat part (a) for the explanatory variable Opening.

```
plot(x = Movies$Opening, y = Movies$USRevenue)
```

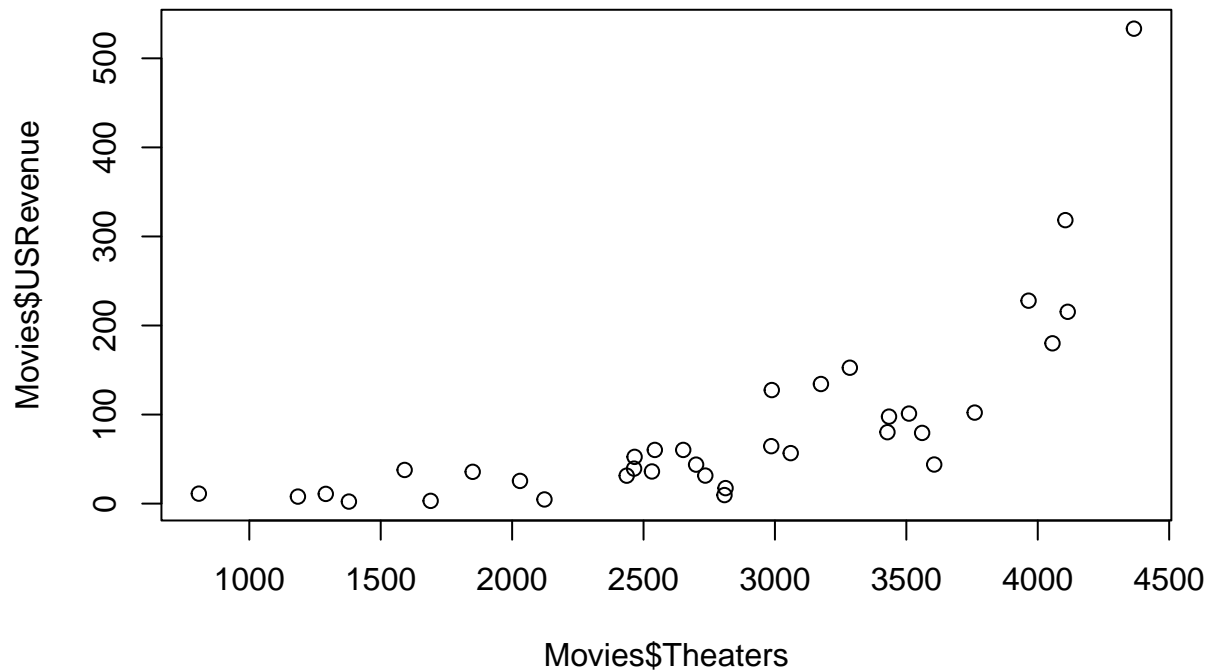
```
cor(x = Movies$Opening, y = Movies$USRevenue)
```

```
## [1] 0.9840177
```

The trend is positive such that as the variable opening increase so the variable USRevenue. The variables have a correlation coefficient of 0.9840177 which is classified as a strong correlation but it is almost perfect. The relationship between these variables has pattern other than a linear relationship between predictor and response, and has no disturbing patters of increasing variability as the predictor variable increases as the last one did.

c. Repeat part (a) for the explanatory variable Theaters.

```
plot(x = Movies$Theaters, y = Movies$USRevenue)
```



```
cor(x = Movies$Theaters, y = Movies$USRevenue)
```

```
## [1] 0.7153432
```

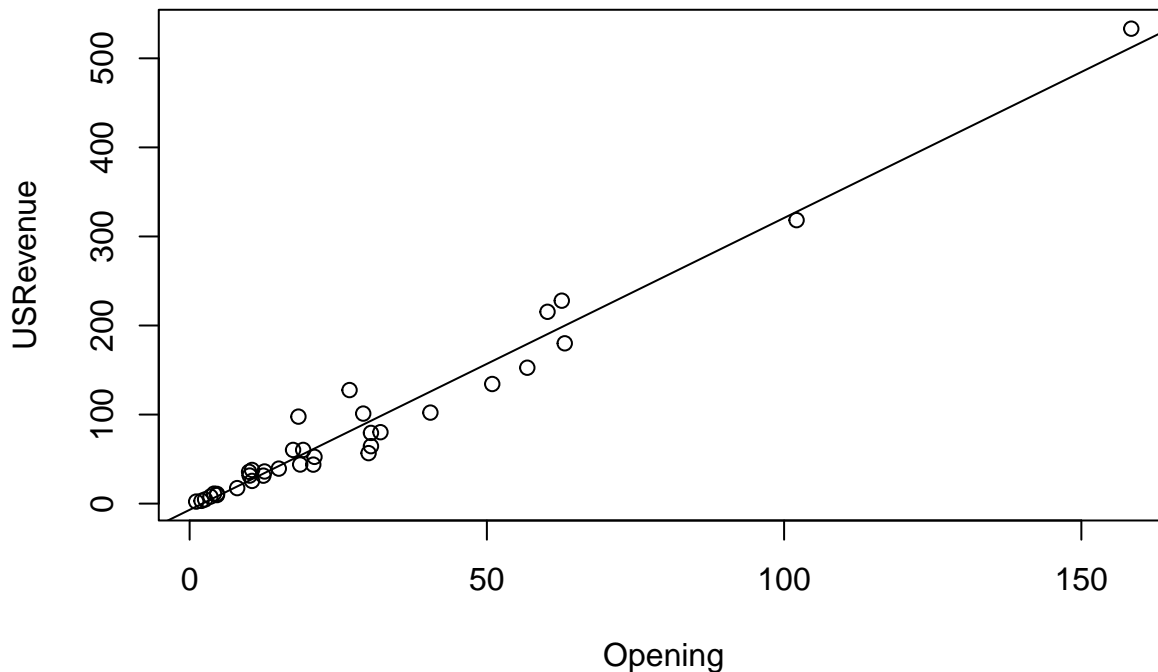
The trend is positive such that as variable theaters increases so does the variable USRevenue. The variables have a correlation coefficient of 0.7153432 which is classified as a moderate correlation. The relationship between these variables has a very obvious curvature which appears almost exponential.

d. Based on your findings in parts (a) through (c), which of the three explanatory variables would be most appropriate for predicting the response variable USRevenue? Justify your choice in a few sentences.

Opening is the best choice as predictor variable. The trend is positive such that as the variable opening increase so the variable USRevenue. The relationship between Opening and Us Revenue has a positive correlation coefficient that is almost perfect (.98) and the scatter plot indicates no pattern other than a positive linearity. The variable Budget is completely unsuitable as the residuals of the fitted values would increase as budget increased. Theaters is unsuitable as it's relationship is non-linear.

e. For the “most appropriate” variable identified in part (d), run a Simple Linear Regression analysis.

```
Opening_Model <- lm(USRevenue ~ Opening, data=Movies)
plot(USRevenue ~ Opening, data=Movies)
intercept_slope <- coefficients(Opening_Model)
abline(a=intercept_slope[1], b=intercept_slope[2])
```



```
summary(Opening_Model)
```

```
##
## Call:
## lm(formula = USRevenue ~ Opening, data = Movies)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -34.996 -11.855   1.763   7.771  46.293
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -6.9619     4.3875  -1.587   0.122
## Opening       3.2777     0.1033  31.744 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19.2 on 33 degrees of freedom
## Multiple R-squared:  0.9683, Adjusted R-squared:  0.9673
## F-statistic: 1008 on 1 and 33 DF, p-value: < 2.2e-16
```

f. State the regression equation.

Predicted US Revenue = $3.277 \times \text{Opening} - 6.9619$

g. Interpret the slope of the regression line (in context of this data set).

As Opening sales increases by 1 million, Predicted US Revenue will increase by 3.277 million.

h. Is it meaningful to interpret the y-intercept? Why or why not?

The y-intercept in this model is not meaningful as its p-value from testing the null hypothesis that the intercept is equal to zero is greater than 0.05 and thus the null hypothesis that the true y-intercept is zero

fails to be rejected.

Also,

The y-intercept: -6.9619 would imply negative revenue when Opening is 0, which is nonsensical in this context of producing a model for US Revenue.

i. State r-squared (i.e., the coefficient of determination) and explain what this value means (in context of the data set).

The R-squared of the model is .9683 which means that about 97% of the variance of the response variable US Revenue is explained by the value of the Predictor variable opening.

j. Use the regression equation from part (f) to predict the total US revenue for the movie named Get Smart. (Budget was 80 million dollars; it was shown in 3911 theaters; and its opening weekend revenue was 38.7 million dollars.) State your predicted value in a sentence that is in context of the data. Don't forget units!

```
predicted_USRevenue <- predict(Opening_Model, newdata = data.frame(Opening = 38.7))  
cat("The linear model predicts that the movie Get Smart which had an opening weekend revenue of 38.7 m
```

```
## The linear model predicts that the movie Get Smart which had an opening weekend revenue of 38.7 mil
```

The linear model predicts that the movie Get Smart which had an opening weekend revenue of 38.7 million dollars would have a total US Revenue of 119.884 million dollars.