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**Assignment 4**

**Exercise 4.1**

We are testing to see if an r = 0.876 based on n = 40 pairs are significantly different from 0, so, if the r value indicates that the Weight Watcher program is effective in reducing weight.

**Hypothesis:**

*Null hypothesis:*H0: ρ = 0

*Alternative hypothesis:*

Ha: ρ ≠ 0

**Significance level:**

α = 0.01

**Data:**

Data yields r = 0.876, n = 40.

**Test statistic:**

Tρ has a t-distribution with n – 2 = 40 – 2 = 38 degrees of freedom.

Observed value tρ = r = 11.1961483659

**Critical values:**

We have a two-tailed test with α = 0.01 and n = 40, so we get the critical values

-t38,0.01 and t38,0.01, which gives: -2.712 and 2.712.

Since tρ = 11.196 > 2.712, we reject H0.

**Conclusion:**

There is enough evidence to reject the claim that there is no linear correlation between the before weight and the after weight. So, one could argue that the value of r indicates that the Weight Watcher program is effective in reducing weight.

**Exercise 4.2**

**Hypothesis:**

*Claimed Distribution:*

For each category month, the expected value of baseball players is the same.

Therefore, the Pi of every category is also equal to all other Pi

*Null hypothesis:*H0: The above claimed distribution is agreed by the frequency counts.

*Alternative hypothesis:*

Ha: The above claimed distribution is not agreed by the frequency counts.

**Significance level:**

α = 0.05

**Data:**

Data yields n = 387+329+366+344+336+313+313+503+421+434+398+371 = 4515.

Pi= 4515/12 = 376.25

**Test statistic:**

X2 has a chi-squared distribution with n – 1 = 4515 – 1 = 4514 degrees of freedom.

X2 93.0717607973422

**Critical values:**

We have a right-tailed test with α = 0.05 and n = 4515, so we get the critical values

X24514,0.05, The closest amount of degree of freedom found in table 4 is 100, which gives: 140.169

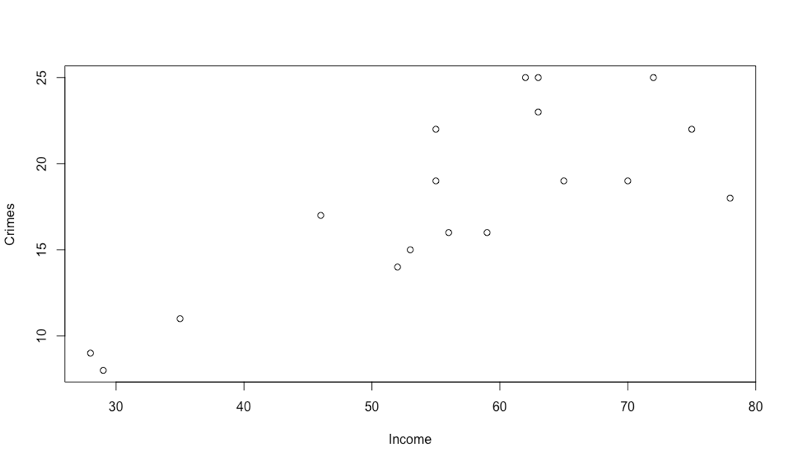
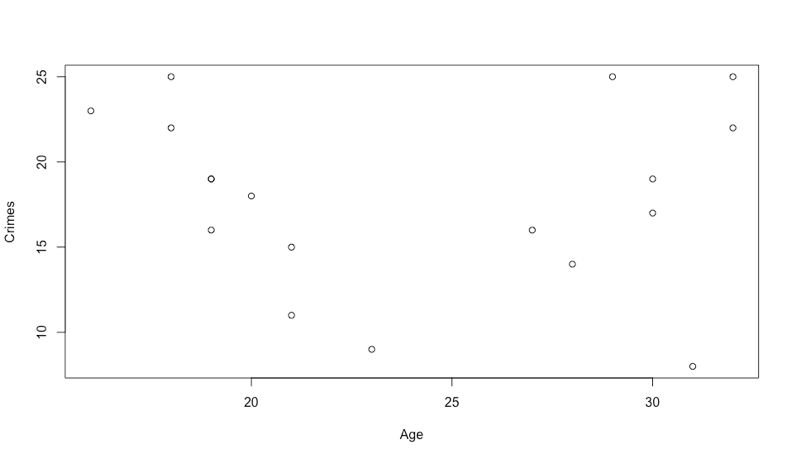
Since X2= 93.072 < 140.169, we fail to reject H0.

**Conclusion:**

There is not enough evidence to reject the claim that the frequency counts agree the claimed distribution (American-born major league baseball players are born in different months with the same frequency). Therefore we can reject the claim that “there is sufficient evidence to warrant the rejection of the claim that American-born major league baseball players are born in different months with the same frequency”.

**Exercise 4.3**

a)

Scatterplot of variables *age* and *crimes.*  
The sample linear coefficient is -0.071 (rounded).   
  
If we take a look at the scatterplot, it does not seem like there is any relationship between the two variables. The sample linear coefficient is -0.071 - very close to 0, which also suggest that there is no linear relationship between the two.  
  
b)   
Scatterplot of variables *income* and *crimes.* The sample linear coefficient is 0.792 (rounded).

If we take a look at the scatterplot, we do see signs of a positive linear relationship. Since the sample coefficient is 0.792, which is very close to 1. This suggests that there is indeed a positive linear relationship.

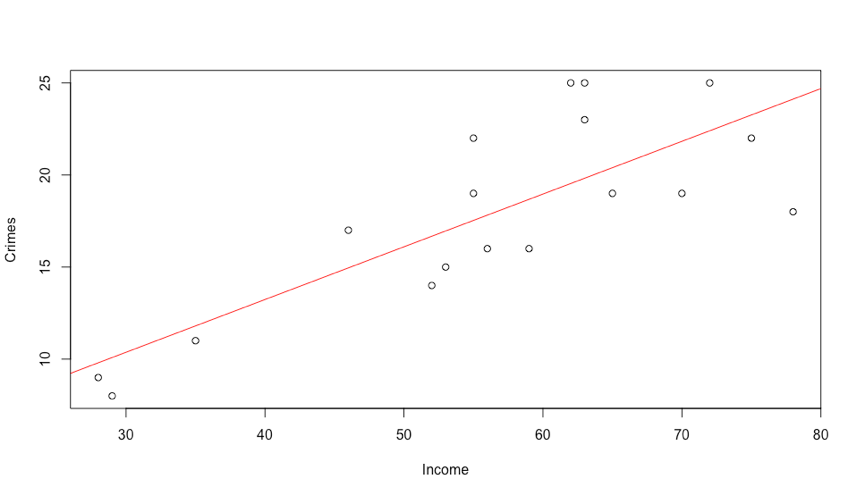
c) The fitted regression equation is given by

The R function *lm(crime$crimes ~ crime$income, data = crime)*yields

Intercept: b0 = 1.781

Slope: b1 = 0.286

So, the fitted regression equation becomes =



Scatterplot of variables *income* and *crimes*, with also plotted.

d) Claim: There is no linear relationship between the variables *income* and *crimes*.

**Hypothesis:**

*Null hypothesis:*

*Alternative hypothesis:*

**Significance level:**

α = 0.05

**Data:**

Data yields b1 = 0.286 and = 0.055

**Test statistic:**

The test statistic = b1 / has a t-distribution with n-2 = 18 – 2 = 16 degrees of freedom under H0. The observed value: = 0.286 / 0.055 = 5.2

**Critical values:**

We have a two-tailed test with α = 0.05 and n = 18, so we get the critical values –t16,0.05 and t16,0.05 which gives: -2.120 and 2.120.

Since = 5.2 > 2.120, we reject H0.

**Conclusion:**

The is sufficient evidence to warrant the rejection of the claim that there is no linear relationship between the variables *income* and *crimes*.

e) The requirements that have to be met are:

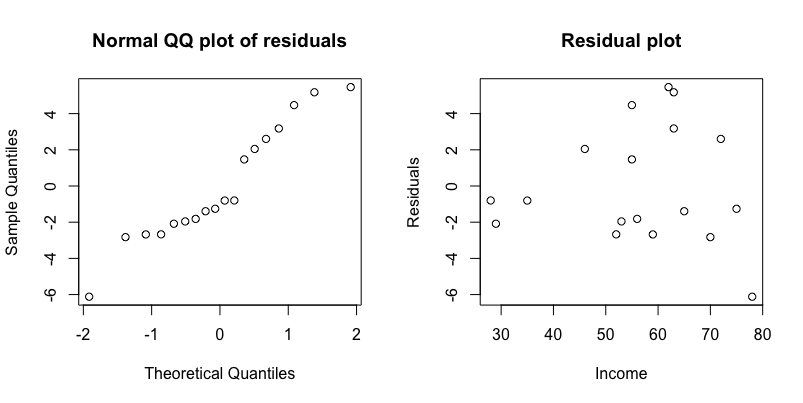
Errors are should be:

- Independent, something we can assume to be true

- Normally distributed

- Have a fixed standard deviation

With R, using qqnorm and plot for the residuals, we get the following plots:



From the QQ plot, we see that the plot follows approximately a straight line, so this probably comes from a normal distribution.

For the residual plot, there is no obvious pattern in the residuals. This has to be the case, otherwise there is something wrong: because our residuals look randomly placed, we can say that we have a fixed standard deviation. So we can positively say that the requirements for testing linearity are met.

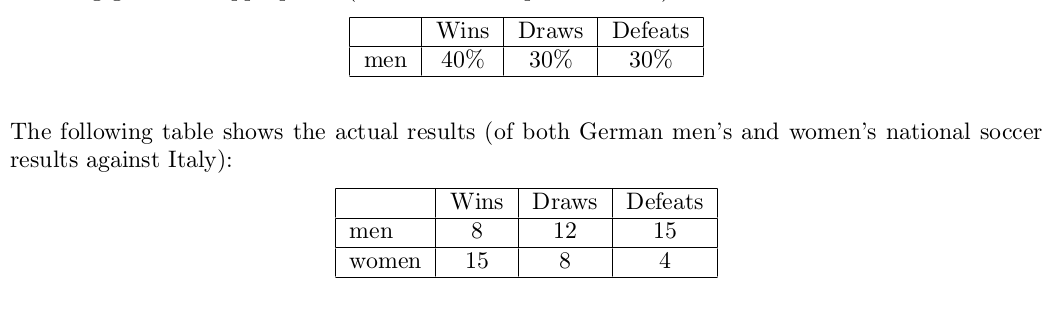
**Exercise 4.4**

During the previous Christmas party, Dennis was asked to give an estimate of the

general chances that Germany would win (or lose) against Italy in matches of the national men’s

soccer teams. He always thought that he knew a lot about soccer, so he was confident that the

following guess was appropriate (from a German point of view):



a) n = 8+12+15=35

Pwin  = 0.4

Ewin = 0.4\*35 = 14

b) Use the significance level α = 10% to test Dennis’ guess with a goodness-of-fit test.

(See the first page of the assignment for detailed instructions about testing).

Furthermore, Dennis claimed that the German men’s and women’s national soccer teams have the

same chances of winning (and of losing) against the respective Italian teams.

*Claimed Distribution:*

*Pwin = 0.4*

*Pdraw = 0.3*

*Pdefeat= 0.3*

*Null hypothesis:*H0: The above claimed distribution is agreed by the frequency counts.

*Alternative hypothesis:*

Ha: The above claimed distribution is not agreed by the frequency counts.

**Significance level:**

α = 0.1

**Data:**

Data yields n = 35

Ewin = 14

Edraw = 10.5

Edefeat =10.5

**Test statistic:**

X2 has a chi-squared distribution with n – 1 = 35 – 1 = 34 degrees of freedom.

X2 4.714

**Critical values:**

We have a right-tailed test with α = 0.1 and n = 35, so we get the critical values

X234,0.1, The closest amount of degree of freedom found in table 4 is 30, which gives 43.773 of area to the right.

Since X2= 4.714 < 43.773, we fail to reject H0.

**Conclusion:**

There is not enough evidence to reject the claim that the frequency counts agree the claimed distribution of Dennis.

c) Should you use a test of independence or a test of homogeneity to test Dennis’ second claim?

Motivate your answer and formulate the null and alternative hypothesis.

d) Create a matrix results containing the data and use it to perform the test of part c). Take

significance level α = 5%.

(See the first page of the assignment for detailed instructions about testing).

e) How many games would the German men have won against Italy if the second claim was true?

f) Now combine Draws and Defeats among each, men and women. This results in a 2 × 2

contingency table. Use Fisher’s exact test and significance level α = 1% to test the directed

claim

G) a : “Men have worse chances to win a soccer match against Italy than women.”

(See the first page of the assignment for detailed instructions about testing).

**Appendix**

4.3 a)

> crime = read.table("/Users/lucasfaijdherbe/Library/Mobile Documents/com~apple~CloudDocs/Computer Science/Statistical Methods/Assignments/Assignment 4/Excersises/crimemale.txt", header = T)

> plot(crime$age, crime$crimes, xlab = 'Age', ylab = 'Crimes')

> cor(crime)

age income crimes

age 1.00000000 -0.4145025 -0.07095301

income -0.41450249 1.0000000 0.79155727

crimes -0.07095301 0.7915573 1.00000000

b)

> plot(crime$income, crime$crimes, xlab = 'Income', ylab = 'Crimes')

> cor(crime)

age income crimes

age 1.00000000 -0.4145025 -0.07095301

income -0.41450249 1.0000000 0.79155727

crimes -0.07095301 0.7915573 1.00000000

c and d)

> lmsim = lm(crime$crimes ~ crime$income, data = crime)

> summary(lmsim)

Call:

lm(formula = crime$crimes ~ crime$income, data = crime)

Residuals:

Min 1Q Median 3Q Max

-6.117 -2.054 -1.031 2.462 5.465

Coefficients:

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

(Intercept) 1.78111 3.21597 0.554 0.587

crime$income 0.28636 0.05527 5.181 9.1e-05 \*\*\*

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

Residual standard error: 3.315 on 16 degrees of freedom

Multiple R-squared: 0.6266, Adjusted R-squared: 0.6032

F-statistic: 26.85 on 1 and 16 DF, p-value: 9.097e-05

e)

> lmsim = lm(crime$crimes ~ crime$income, data = crime)

> par(mfrow=c(1,2))

> qqnorm(lmsim$residuals, main="Normal QQ plot of residuals")

> plot(crime$income, lmsim$residuals, main = "Residual plot", ylab = "Residuals", xlab = "Income")