Hypothesis Testing and Confidence Intervals - Quiz

Solutions

Question 1

Which of the following, generally, describes a difference between parametric and non-parametric hypothesis tests?

a. A parametric test is used on paired data and a non-parametric test is used on independet data.
b. A parametric test is used to compare two groups of data and a non-parametric test is used to compare more than two groups of data.
c. A parametric test is used on data that is normally distributed and a non-parametric test is used on data that is not normally distributed.
d. A parametric test is used on categorical data and a non-parametric test is used on numerical data.

SOLUTION: c.

Question 2

How can the normality assumption be tested in R?

a. *shapiro.test()*
b. *mean()* and *median()*
c. *hist()*
d. All of the above

SOLUTION: d.

Question 3

After running a Shapiro Wilk test, you get the following R output:

```
##
##  Shapiro-Wilk normality test
##
## data:  example1
## W = 0.98991, p-value = 0.944
```

Is the data normally distributed? If yes, why? If not, why not?

SOLUTION: The p-value is 0.944, which means that you cannot reject the null hypothesis of normality and thus can assume that the data is normally distributed.

Question 4

After running a Shapiro Wilk test, you get the following R output:

```
##
##  Shapiro-Wilk normality test
##
## data:  example2
## W = 0.92259, p-value = 0.002928
```

Is the data normally distributed? If yes, why? If not, why not?

SOLUTION: The p-value is 0.002928, which means that you can reject the null hypothesis of normality and thus can assume that the data is not normally distributed.

Question 5

What is the difference between *t.test(Group_1, Group_2)* and *t.test(Group_1, Group_2, paired=TRUE)*?

a. One is a test for independent data and the other one is a test for paired data
b. One is a two sample t-test and the other is a one sample t-test
c. One is a parametric test and the other one is a non-parametric test
d. One is a test for numerical information and the other one is a test for categorical information.

SOLUTION: a.

Question 6

If you want to compare two groups of independent, numerical data that is normally distributed, which R code do you need to use?

a. *t.test(Group_1, Group_2)*
b. *wilcox.test(Group_1, Group_2, paired=TRUE)*
c. *t.test(Group_1, Group_2, paired=TRUE)*
d. *wilcox.test(Group_1, Group_2)*

SOLUTION: a.

Question 7

If you want to compare two groups of paired, numerical data that is normally distributed, which R code do you need to use?

a. *t.test(Group_1, Group_2)*
b. *wilcox.test(Group_1, Group_2, paired=TRUE)*
c. *t.test(Group_1, Group_2, paired=TRUE)*
d. *wilcox.test(Group_1, Group_2)*

SOLUTION: c.

Question 8

If you want to compare two groups of paired, numerical data that is NOT normally distributed, which R code do you need to use?

a. *t.test(Group_1, Group_2)*
b. *wilcox.test(Group_1, Group_2, paired=TRUE)*
c. *t.test(Group_1, Group_2, paired=TRUE)*
d. *wilcox.test(Group_1, Group_2)*

SOLUTION: b.

Question 9

If you want to compare two groups of independent, numerical data that is NOT normally distributed, which R code do you need to use?

a. *t.test(Group_1, Group_2)*
b. *wilcox.test(Group_1, Group_2, paired=TRUE)*
c. *t.test(Group_1, Group_2, paired=TRUE)*
d. *wilcox.test(Group_1, Group_2)*

SOLUTION: d.

Question 10

A sports company wants to compare two materials, A and B, for use on the soles of running shoes. Each of ten participants in this study wore running shoes with the sole of one shoe made from Material A and the sole on the other shoe made from Material B. The sole types were randomly assigned to account for systematic differences in wear between the left and right foot. After three months, the shoes are measured for wear and the amount of wear was recorded, where a higher value indicates a better performance of the material. Is there a difference in the wear recorded for the two materials?

Give the null hypothesis and alternative hypothesis and interpret the p-value for the following R output:

```
##
##  Paired t-test
##
## data:  Material_A and Material_B
## t = -3.3489, df = 9, p-value = 0.008539
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.6869539 -0.1330461
## sample estimates:
## mean of the differences
##                   -0.41
```

SOLUTION:

Null Hypothesis: There is no differences between the wear for the two materials.
Alternative Hypothesis: There is a differences between the wear for the two materials.
Interpretation of p-value: The p-value is 0.008539. This is below the threshold of 0.05, which means that the null hypothesis can be rejected. Thus, there seems to be an actual difference in wear between the two materials.

Question 11

To test the normality assumption for paired data, you need to:

a. Check if the data in both groups is normally distributed
b. Draw only a histogram because the Shapio Wilk test will not work for paired data
c. Do nothing because the normality assumption does not need to be checked for paired data
d. Check if the difference between the two groups is normally distributed

SOLUTION: d.

Question 12

A study was conducted to compare the effect of two different analgesics on blood glucose levels. Fifteen subjects were given analgesic A and 12 were given analgesic B and the blood glucose levels recorded in mg/kg. The objective of the study is to determine if the blood glucose levels are higher with one or other analgesic.Is there a difference in the blood glucose levels for the two patient groups?

Give the null hypothesis and alternative hypothesis and interpret the p-value for the following R output:

```
##
##  Welch Two Sample t-test
##
## data:  Analgesic_A and Analgesic_B
## t = -2.3382, df = 22.591, p-value = 0.02861
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -29.72983  -1.80350
## sample estimates:
## mean of x mean of y
##  68.40000  84.16667
```

SOLUTION:

Null Hypothesis: There is no difference between the glucose levels of the two patient groups.
Alternative Hypothesis: There is a difference between the glucose levels of the two patient groups.
Interpretation of p-value: The p-value is 0.02861. This is below the threshold of 0.05, which means that the null hypothesis can be rejected. There thus seems to be an actual difference between the glucose levels of the two patient groups.

Question 13

Which of the following tests can be used to compare three or more groups of numerical data (Note: Choose as many answers as you need)?

a. *oneway.test(DataframeVariable DataframeGroup, var.equal=TRUE)*
b. *ANOVA(Variable ~ Group, data = Dataframe)*
c. *t.test(DataframeVariable DataframeGroup)*
d. *kruskal.test(Variable ~ Group, data = Dataframe)*

SOLUTION: a. and d.

Question 14

In an effort to reduce the calorie content of their donuts, a company tried four different fats to see which one was least absorbed during the deep frying process. Each fat was used for six batches of two dozen donuts each, and the grams of fat absorbed by each batch of donuts were recorded. Is there a difference in the absorption of the four types of fat?

Indicate the type of test performed, give the null hypothesis and alternative hypothesis, and interpret the p-value for the following output:

```
##
##  One-way analysis of means
##
## data:  values and ind
## F = 5.4063, num df = 3, denom df = 20, p-value = 0.006876
```

SOLUTION:

Type of test: ANOVA
Null Hypothesis: There is no difference in absorption between the four fat types.
Alternative Hypothesis: There is a difference in absorption between the four fat types.
Interpretation of p-value: The p-value is 0.006876. This is below the threshold of 0.05, which means that the null hypothesis can be rejected. There thus seems to be an actual difference in absorption between the four fat types.

Question 15

What is the difference between the Chi-square Goodness-of-Fit test and the Chi-square test of independence? And how is this difference indicated in R even though both test use the command *chisq.test()*?

SOLUTION:
The Chi-square Goodness-of-Fit test is performed on one categorical variable to compare it to an expected distribution. The Chi-square test of independence is used to compare to categorical variables to the expected counts for those variables if the null hypothesis that there is no relationship between them is true.

Although the same command is used in R, the type of data you put into the command changed the type of test performed.

Question 16

Using the data given in the table below, complete the code for the following hypothesis test in R for a study where you are interested in finding out if the proportions of skyscrapers among high bulidings in Canada and the USA differ:

```
prop.test(x = c(  ,  ), n = c(  ,  ),correct=FALSE)
```

Height of Buildings	Canada	USA
Skyscrapers (over 100 stories)	10	45
Other high buildings (between 80 and 100 stories)	53	86
Total of high buildings (over 80 stories)	63	131

SOLUTION: *prop.test(x = c(10, 45), n = c(63, 131),correct=FALSE)*

Question 17

How do you calculate the expected values used in the Chi-square test of independence calculation in R?

a. *table(DataframeVariable)expected*
b. *exp(Dataframe$Variable)*
c. *chisq.test(DataframeVariable)expected*
d. *expected(Dataframe$Variable)*

SOLUTION: c.

Question 18

Which requirements need to be meet for a Chi-square test of independence to be valid (Note: Choose as many answers as you need)?

a. Normality
b. No more than 20% of expected values should be less than 5
c. All expected values should be greater than 1
d. No more than 50% of expected values should be less than 5

SOLUTION: b. and c.

Question 19

What can you do if you do not meet the requirements for a Chi-square test of independence (Note: Choose as many answers as you need)?

a. If it is a 2x2 table, perform a Fisher's exact test instead
b. Nothing
c. Perform a Chi-square Goodness-of-Fit test instead
d. Regroup the data

SOLUTION: a. and d.

Question 20

Interpret the confidence interval reported on the following hypothesis test between the wear of two different materials for the soles of running shoes. Also explain why reporting a confidence interval is useful.

```
##
##  Paired t-test
##
## data:  Material_A and Material_B
## t = -3.3489, df = 9, p-value = 0.008539
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.6869539 -0.1330461
## sample estimates:
## mean of the differences
##                   -0.41
```

SOLUTION: The mean difference between the two materials is -0.41. However, since this test is performed on a sample, the mean is likely to change somewhat if another sample drawn from the same population. The reported 95% confidence interval on this test is [-0.6869539, -0.1330461] takes this into account and provides a range of possible mean values. More precisely, this confidence intervals means that you can be 95% confident that the true difference in wear is somewhere between -0.69 and -0.13.So one material can have as much as 0.69 less wear than the other or as little as 0.13 less than the other.