Abstract

In this problem 5 different kinds of tests are performed which are One Sample t-test, Two Sample t-test, Paired t-test, Prop test and F-test using the MASS package in R on Chem, Cats, Shoes and Bacteria dataset. These datasets are used to perform hypothesis testing to differentiate real and random parameters of data.

Keywords: [t-test, variance, hypothesis, inferential, statistics, f-test, one sample, two sample]

[Title Here, up to 12 Words, on One to Two Lines]

ANALYSIS:

# [PROBLEM A]

**Problem: First, load the MASS library in R. A. Package ‘MASS’ which provides a description of the datasets available in the MASS package.**

The package MASS contains the Chem, Shoes, Cats and Bacteria dataset. So if the package is not installed in R-studio first it should be downloaded and activated using the following code.

*Code:*

*install.packages(“MASS”)*

*library(MASS)*

## [PROBLEM B – One-sample t-test]

**One-sample t-test: Use the “chem” dataset to answer the question, “is the flour production company producing whole meal flour with greater than 1 part per million copper in it?”**

One sample t-test is mainly used to calculate the statistical difference of a sample mean and a hypothesis value of population mean.

First, I have used code to explore the data set and understand it and then I have added code to understand the t-test, its parameters and then perform the test.

*Code:*

*?chem*

*chem*

The Chem dataset is basically a vector of 24 determinations of copper in whole meal flour, in parts per million.

I have added the dataset in a variable called “chemdataset” and will perform the operations on it.

Other two lines of code displays the structure of the dataset and its first 5 rows.

*Code:*

*chemdataset <- chem*

*str(chemdataset)*

*head(chemdataset)*

Output;

> chemdataset <- chem

> str(chemdataset)

num [1:24] 2.9 3.1 3.4 3.4 3.7 3.7 2.8 2.5 2.4 2.4 ...

> head(chemdataset)

[1] 2.9 3.1 3.4 3.4 3.7 3.7

Now the next line of code shows the information about the t-test.

*Code: help(t.test)*

Null Hypothesis (H0: µ): Mean part per million of copper in the flour is equal to 1.

Alternate Hypothesis (H1: µ): Mean part per million of copper in the flour is greater than 1.

*Code: t.test(chemdataset, alternative = "greater", mu = 1*

Output:

One Sample t-test

data: chemdataset

t = 3.0337, df = 23, p-value = 0.002952

alternative hypothesis: true mean is greater than 1

95 percent confidence interval:

2.427162 Inf

sample estimates:

mean of x

4.280417

Conclusion: Here we can support the claim and alternate hypothesis is true

that flour production company producing whole mean flour with greater than 1 part per million.

There is sufficient evidence to reject the null hypothesis and the sample of

whole meal flour has great than 1 part per million copper in it.

### [PROBLEM C – Two-sample t-test]

**Two-sample t-test: Use the “cats” dataset to answer the question, “do male and female cat samples have the same body weight?”**

The cats dataset contains the heart and body weights of samples of male and female cats which are used for digital experiments. These are adult cats and their body weight is over 2kg.

Following code is used to explore the dataset and I have stored the dataset in “catsdataset” just to have a clear name.

*Code:*

*cats*

*?cats*

*catsdataset <- cats*

*str(catsdataset)*

*head(catsdataset)*

Output:

> str(catsdataset)

'data.frame': 144 obs. of 3 variables:

$ Sex: Factor w/ 2 levels "F","M": 1 1 1 1 1 1 1 1 1 1 ...

$ Bwt: num 2 2 2 2.1 2.1 2.1 2.1 2.1 2.1 2.1 ...

$ Hwt: num 7 7.4 9.5 7.2 7.3 7.6 8.1 8.2 8.3 8.5 ...

> head(catsdataset)

Sex Bwt Hwt

1 F 2.0 7.0

2 F 2.0 7.4

3 F 2.0 9.5

4 F 2.1 7.2

5 F 2.1 7.3

6 F 2.1 7.6

The cats dataset has male and female cats. So, to perform two sample t-test I have divided the dataset into 2 subsets which are “male cats” and “female cats”. Thus two sample t-test is used two to check the statistical difference between two population means.

*Code:*

*male <- subset(catsdataset,Sex == "M")*

*male*

*female <- subset(catsdataset,Sex == "F")*

*female*

Null Hypothesis (H0: µ): Body Weight of Male and Female is equal.

Alternate Hypothesis (H1: µ): Body weight of male and female is not equal.

*Code:*

*t.test(male$Bwt,female$Bwt,alternative = "two.sided")*

Output:

Welch Two Sample t-test

data: male$Bwt and female$Bwt

t = 8.7095, df = 136.84, p-value = 8.831e-15

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

0.4177242 0.6631268

sample estimates:

mean of x mean of y

2.900000 2.359574

Here the mean of body weight of male cats is 2.9 and mean of body weight of female cats is 2.359 which is less than average male body weight. Moreover, the p-value = 8.831e -15 which is way less than significance level (0.05). So, here we reject the null hypothesis and conclude that body weight of male is not equal to female.

#### [PROBLEM D – Paired t-test]

**Use the “shoes” dataset to answer the question, “did material A wear better than material B?”**

This is used to compare mean differences between two population means when the observations have been obtained in pairs. The difference between the paired values is assumed to be normally distributed.

The shoes dataset is a list of two vectors which provides the wear of shoes of materials A and B for one foot of ten boys.

Mean of shoes A and shoes B is 10.63 and 11.04 respectively. The following code shows that along with the structure of the dataset.

*Code:*

*help(shoes)*

*shoes*

*mean(shoes$A)*

*mean(shoes$B)*

*shoesdataset <- shoes*

*str(shoesdataset)*

Output:

> help(shoes)

> shoes

$A

[1] 13.2 8.2 10.9 14.3 10.7 6.6 9.5 10.8 8.8 13.3

$B

[1] 14.0 8.8 11.2 14.2 11.8 6.4 9.8 11.3 9.3 13.6

> mean(shoes$A)

[1] 10.63

> mean(shoes$B)

[1] 11.04

> shoesdataset <- shoes

> str(shoesdataset)

List of 2

$ A: num [1:10] 13.2 8.2 10.9 14.3 10.7 6.6 9.5 10.8 8.8 13.3

$ B: num [1:10] 14 8.8 11.2 14.2 11.8 6.4 9.8 11.3 9.3 13.6

Null Hypothesis (H0: µ): The mean wear of material A is equal to material B

Alternative Hypothesis (H1: µ): The mean wear of material A is greater than material B

*Code:*

*t.test(shoesdataset$A, shoesdataset$B, alternative = "greater", paired = TRUE)*

Output:

Paired t-test

data: shoesdataset$A and shoesdataset$B

t = -3.3489, df = 9, p-value = 0.9957

alternative hypothesis: true difference in means is greater than 0

95 percent confidence interval:

-0.6344264 Inf

sample estimates:

mean of the differences

-0.41

Conclusion:

Here the p-value is 0.9957 which is greater than the significance level (0.05). Thus, we do not reject the null hypothesis and conclude that material A wear is better than B.

**[PROBLEM E – Test of equal or given proportions]**

**Use the “bacteria” data set to answer the question, “did the drug treatment have a significant effect of the presence of the bacteria compared with the placebo?”**

Bacteria dataset tests the presence of bacteria in children’s with Otis media in Australia.

Using the following code to explore the dataset.

*Code:*

*?bacteria*

*str(bacteria)*

*head(bacteria)*

*ncol(bacteria)*

*nrow(bacteria)*

Output:

> str(bacteria)

'data.frame': 220 obs. of 6 variables:

$ y : Factor w/ 2 levels "n","y": 2 2 2 2 2 2 1 2 2 2 ...

$ ap : Factor w/ 2 levels "a","p": 2 2 2 2 1 1 1 1 1 1 ...

$ hilo: Factor w/ 2 levels "hi","lo": 1 1 1 1 1 1 1 1 2 2 ...

$ week: int 0 2 4 11 0 2 6 11 0 2 ...

$ ID : Factor w/ 50 levels "X01","X02","X03",..: 1 1 1 1 2 2 2 2 3 3 ...

$ trt : Factor w/ 3 levels "placebo","drug",..: 1 1 1 1 3 3 3 3 2 2 ...

> head(bacteria)

y ap hilo week ID trt

1 y p hi 0 X01 placebo

2 y p hi 2 X01 placebo

3 y p hi 4 X01 placebo

4 y p hi 11 X01 placebo

5 y a hi 0 X02 drug+

6 y a hi 2 X02 drug+

> ncol(bacteria)

[1] 6

> nrow(bacteria)

[1] 220

*Code:*

*bacteria\_dataset <- bacteria*

*bacteria\_dataset*

*table (bacteria\_dataset$y, bacteria\_dataset$trt)*

Output: > table(bacteria\_dataset$y,bacteria\_dataset$trt)

placebo drug drug+

n 12 18 13

y 84 44 49

Placebo = y + n = 84 + 12 = 96

Drug = (y + y) + (n + n) = 93 + 31 = 124

Null Hypothesis (H0: µ): The effect of drug on bacteria is equal to placebo

Alternate Hypothesis (H1: µ): The effect of drug on bacteria is greater than placebo

*Code:*

prop.test(x=c(93,84),n=c(124,96),alternative = "greater")

Output:

2-sample test for equality of proportions with continuity

correction

data: c(93, 84) out of c(124, 96)

X-squared = 4.6109, df = 1, p-value = 0.9841

alternative hypothesis: greater

95 percent confidence interval:

-0.2189373 1.0000000

sample estimates:

prop 1 prop 2

0.750 0.875

Conclusion:

Here the p-value is 0.9841 which is greater than significance level (0.05). Thus, we do not reject the null hypothesis. To conclude there is not enough evidence that drug has more impact on bacteria than placebo.

**[PROBLEM F – F-test]**

Use the “cats” data set to test for the variance of the body weight in male and female cats.

F-Test is used to identify the statistical models in the dataset and find one which is best for population of the data sample.

Null Hypothesis (H0: µ): The variance of male and female cats body weight is same.

Alternate Hypothesis (H1: µ): The variance of male and female cats body weight is not same.

*Code:*

?*var.test*

*var.test(male$Bwt,female$Bwt)*

Output:

F test to compare two variances

data: male$Bwt and female$Bwt

F = 2.9112, num df = 96, denom df = 46, p-value = 0.0001157

alternative hypothesis: true ratio of variances is not equal to 1

95 percent confidence interval:

1.723106 4.703057

sample estimates:

ratio of variances

2.911196

Here the ratio of variances is 2.911196 and p-value is 0.0001157 which is less than the significance level and thus we reject the null hypothesis. The variances of male and female cats body weight is not same.

##### [Conclusions]

B – We reject the null hypothesis and the sample of whole meal flour has great than 1 part per million copper in it.

C - We reject the null hypothesis and conclude that body weight of male is not equal to female.

D - We do not reject the null hypothesis and conclude that material A wear is better than B.

E - We do not reject the null hypothesis and conclude there is not enough evidence that drug has more impact on bacteria than placebo.

F - We reject the null hypothesis and conclude that the variances of male and female cats body weight is not same.

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References

stats. (n.d.). Retrieved from https://www.rdocumentation.org/packages/stats/versions/3.4.1/topics/prop.test

. F-Test: Compare Two Variances in R. (n.d.). Retrieved from http://www.sthda.com/english/wiki/f-test-compare-two-variances-in-r#compute-f-test-in-r