**AC52012 – Research Methods**

**Quantitative Methods Assessment**

Loukas Tsouroplis

[2437780@dundee.ac.uk](mailto:2437780@dundee.ac.uk)

**Exercise 1**

1. The sample is not representative because although 1000 random users participated in the study, they were not randomly chosen. It was their choice to participate so the sample could be biased, with an example of that being that the group which is against providing real data being more vocal and thus more eager to participate in the study whilst the group that was eager to provide their data could be more probable to ignore the survey.
2. The specific can contains 0.8133lb of Pepsi which is 0.82410 - 0.8133 = 0.0108lb less than the mean. To see if this is unusual or not, we have to compare it with the standard deviation which is 0.00570lb. From what we can see the difference from the mean is less than 2 standard deviations. However, according to Chebyshev’s theorem, at least 75% of all values lie within 2 standard variations of the mean. In casual terms this means that it is usual for a Pepsi can weigh 0.8133lb.
3. **I.** Each week has 5 business days, so the probability of an employee being selected on Monday is 1/5. Since the order of how they are selected does not matter, the probability of 2 employees being selected on Monday is 1/5 x 1/5 = 1/25.

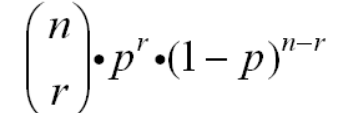
**ii.** An employee is selected at a random day of the week with probability 1. Since the week has 5 business days the probability that the second employee will get hired at the same day as the first is 1/5.

**iii.** The procedure is the same as in C ii. The first employee is selected at a random day of the week with probability 1. The probability of the second employee getting selected at the same day is 1/5. The probability of the third employee getting selected at the same as the previous 2 is (1/5) ^2. By repeating this process, we conclude that the probability that 10 people in the same department were all hired on the same day of the week is thus 1x (1/5) ^9.

\*All calculations in exercise 1.C were done under the assumption that there is equal likelihood of getting hired in each day of the week.

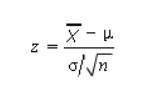
**Exercise 2**

1. Since we are asked to find the probability of x successes in n repeated trials, this can be calculated using the binomial probability. Since there are only 2 outcomes for each trial which are “overturned” and “not overturned” the conditions to meet the formula underneath are met:



In our case, numbers of trials n is 20, successful trials r is 8 and p=q=1-p=0.5 By using a calculator to compute the formula above with the given numbers the result is 0.12013435364 which means that the probability that among 20 challenges, exactly 8 are successfully overruled is approximately 12%.

1. We know that the IQ scores follow a normal distribution and in order to get accepted in Mensa one needs to be in the top 2% percent of IQ scores. We will start by looking at a z-table. The minimum z-score that passes the 98% threshold is 2.06. This means that the minimum IQ score required to cross the 98% threshold is 2.06 times the standard deviation higher than the mean. We know that the mean is 100 and standard deviation is 15. The desired value will be the mean plus 2.06 times the standard variation which is 100 + 2.06 x 15 = 130.9. We conclude that the minimum IQ required to be admitted to Mensa is 130.9.
2. The Central Limit Theorem states that the **sampling distribution of the sample means** approaches a normal distribution as the sample size gets larger — no matter what the shape of the population distribution. This fact holds especially true for sample sizes over 30. Since in the selected trial the sample size n is 49, we can apply the CLT. We will begin by calculating the z-score using the following formula:



We are given that mean μ is 205.5cm and standard deviation σ is 6.6cm. Sample size n is 49 and x stands for the less than value which is 207.0cm. By using a calculator, the z-score is approximately 1.5909. By looking up that value in a z-table the probability that overhead reach distance is smaller than 207.0cm is 0.4441.

1. The following table describes the sampling distribution of the sample proportion of girls from three births.

|  |  |
| --- | --- |
| Proportion of girls | Probability |
| 0 | 1/8 |
| 1/3 | 3/8 |
| 2/3 | 3/8 |
| 1 | 1/8 |

The mean of the sample proportions is 0.5 since it is equally possible to have a boy or girl from each birth in this trial.

**Exercise 3**

1. In order to test the hypothesis regarding a population’s mean with the critical values method, first we need to check the requirements that 1. The sample is a random simple sample (which is given) 2. The population is normally distributed or n>30(normal distribution given). Since all the requirements are met, we can proceed with testing the claim with the following steps:

*Step 1:* “has a mean equal to 1100.0cm^3” translates to μ=1100.0 cm^3 in symbolic form.

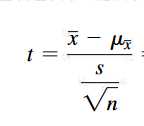
*Step 2:* The alternative to the original claim is μ =/ 1100.0cm^3 in symbolic form.

*Step 3:* Because the statement from step 2 does not contain the condition of equality, it becomes the alternative hypothesis H1. The null hypothesis H0 is the statement μ=1100.0 cm^3.

*Step 4:* The significance level is given and is a=0.01.

*Step 5:* Because the claim is made about the population mean, the sample statistic most relevant to this test is the sample mean. We use the t distribution because the relevant sample statistic is x and the requirements for using the t distribution are satisfied.

*Step 6:* In order to calculate t, we use the following formula:



And t=0.8125 after calculations with computer. According to the t-table and with α freedom degree of 9 the critical values is 2.821.

*Step 7:* Since 0.0815<2.821 we fail to reject the original hypothesis H0.

*Step 8:* There is not sufficient evidence to warrant rejection of the claim that brain volume means equals 1100cm^3.

1. We are given that n=12, s=9.50 and σ=15. We assume that we have a simple random sample, and we know that the population has a normal distribution. Thus, the requirements are met to test claims about s using the P-values method.

*Step 1:* The statement “have a standard deviation less than 15” is σ<15 in symbolic form.

*Step 2:* If the original claim is false then σ>=15.

*Step 3:* The expression σ<15 does not contain equality, so it becomes the alternative hypothesis H1. The null hypothesis H0 is σ=15.

*Step 4:* Significance level is given and is a=0.05.

*Step 5:* Because the claim is made about σ, we will use the Chi-square(x^2) distribution.

*Step 6:* In order to calculate the Chi-square value, we will use the formula:



By using a calculator, we compute that X^2=4.412(rounded). We can now calculate the P-value using R as shown in the image:

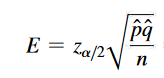


*Step 7:* Since the P-value is greater than the significance level of 0.05 that we are given, we fail to reject the H0 hypothesis.

*Step 8:* Since the original claim does not include equality and we fail to reject the H0, there is not sufficient evidence to support the claim that pilots have an IQ score with a standard deviation smaller than that of the normal population.

1. Before we begin, we need to do a requirement check. Since it was an online survey, we can assume that it is a simple random sample. The conditions for a binomial experiment are also satisfied since our statement can be expressed as a yes or no. Finally, with 144 respondents and 20.8 percentage both the number of successes and failures are greater than 5. Thus, we may begin constructing the confidence interval estimate.

Firstly, we need to calculate the margin of error E. We will do so by using the formula:



n is the number of respondents which is 144, p is 0.208 and q is 1-p. The critical value Za is equal to 1.96 which is given in the book of elementary statistics as it is a common one. After using the calculator, the margin of error E=0.066.

Now that we know the margin of error it is easy to construct the confidence interval estimate by using:

P^ - E < p < p^ + E

0.208-0.066< p < 0.208+0.066

0.142<p < 0.274.