Statistics for Business

2020 examinations with solutions

Author : Josemari Sarasola

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May 5 examination. Professor: Josemari Sarasola May 5, 2020

Welcome to the examination of Statistics for Business. As you know this examination is a 15% part of the global assessment in this subject. Before doing the exam please read attentively these rules. They are mandatory to ensure you solved the exam by your own in the required time. Data in the statement of the problem in the exam come from the number of your identity card. First of all, you must order the 8 digits in your identity card from the smallest to the largest. After that, you must transform zero digits: swing the 1st zero to 2, the 2nd one to 5, and the 3rd one to 8. If the are no zeros, go on. For example 30456700 swings, after ordering, to 23455678. From this ordered number, the first digit it's named #1, the second one #2, and so on. For example if the problem statement I say #3#1, you should take, according to the previous example, 42.

At the beginning of the problem you must start clearly your original identity card number, and the further transformation to get the number leading to data.

If you take another number from the beginning, you will get 0 in the exam. If you make any trick (or mistake) to change the number along the problem solving, your grade will be decreased by %50.

THE EXAM MUST BE HAND WRITTEN BY YOU. WHITE SHEETS ARE RECOMMENDED. YOU HAVE 110MIN TO SOLVE, SCAN AND UPLOAD YOUR EXAM IN EGELA PLATFORM. IF YOU HAVE INCONSISTENCY PROBLEMS RELATING TO DATA OR TECHNICAL PROBLEMS RELATED TO CONNECTIVITY ALONG THE EXAM THAT MAKE NO POSSIBLE TO UPLOAD YOUR EXAM IN THE EXECUTION TIME, TAKE A PICTURE OF THE SCREEN SHOWING THE PROBLEMS WITH YOUR SMARTPHONE AND SEND IT TO MY EMAIL ACCOUNT.

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TASK TO BE PERFORMED: Sugar quantity in a cookie must be smaller than #2#4gr on average. The quantity of sugar in the cookie follows allegedly a normal distribution. The standard deviation is allegedly 4gr. We have drawn a random sample of 9 cookies:

#1#2– #2#1 – #2#3 –#3#2– #3#4 – #6#7–#7#6– #8#7 – #8#7

1. **Test with a #4% significance level that the average of sugar quantity is being fulfilled.**
   (a) **By means of the p-value.**
   (b) **By means of the critical value.**
2. **Let's suppose the standard deviation is unknown. On the other side, let's suppose that the production team has set a new standard: now the average quantity of sugar must be exactly #5#6, no more and no less. With these new conditions (unknown standard deviation and new standard for sugar quantity), test if the new standard is fulfilled with a 5% (this value is fixed and hence the same for all for you) significance level, giving both**
   (a) **the t critical values, and comparing them to the t values you got;**
   (b) **and the critical values for the arithmetic mean of the sample of 9 cookies, and comparing them to the mean values you got.**

IMPORTANT: Set always the null hypothesis you are working with, and draw suitable graphics to explain your decision.

Switching my ID number: 30456700 → 23455678.

Taking data:

#1#2	#2#1	#2#3	#3#2	#3#4	#6#7	#7#6	#8#7	#8#7
23	32	34	43	45	67	76	87	87

(1)

The sugar quantity must be smaller than $\mu = 35$ on average. Data show that $\overline{x} = 54.88$. So it looks like the condition for sugar quantity is not fulfilled. Cautiously, we take as null hypothesis that the condition is fulfilled: $H_0 : \mu \leq 35$.

We reject the null hypothesis (small quantity of sugar) when mean sugar quantity is big enough. So we reject on the upper side.

Under H_0, the arithmetic mean distributes like this:

$$\overline{x} \sim N\left(\mu = 35, \sigma = \frac{4}{\sqrt{9}} = 0.66\right)$$

(1a)

$\alpha = 5\%$. Let's calculate the p-value:

$$P[\overline{x} > 54.88] = P\left[Z > \frac{54.88 - 35}{0.66}\right] = P[Z > 30.12] \approx 0 < \alpha \rightarrow \ \textit{reject } H_0$$

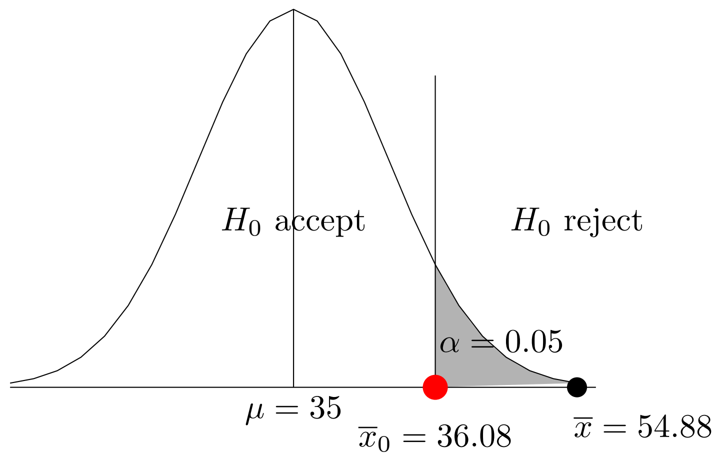
There is strong enough evidence that the mean sugar quantity is bigger that 35 on average.

(1b)

Let's calculate the critical value for the arithmetic mean:

$$P[\overline{x} > \overline{x}_0] = P\left[Z > \frac{\overline{x}_0 - 35}{0.66}\right] = 0.05 \rightarrow \frac{\overline{x}_0 - 35}{0.66} = 1.64 \rightarrow \overline{x}_0 = 36.08$$

The rejection region is the sample mean being bigger than 36.08. In fact, it is 54.88. So we reject the nulla hypothesis and state that the sugar quantity is larger than 35 on average.



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(2)

If the standard deviation is unknown we have to estimate it:

$$\hat{s} = \sqrt{\frac{(23-54.88)r + \ldots + (87-54.88)^2}{9-1}} = 24.67$$

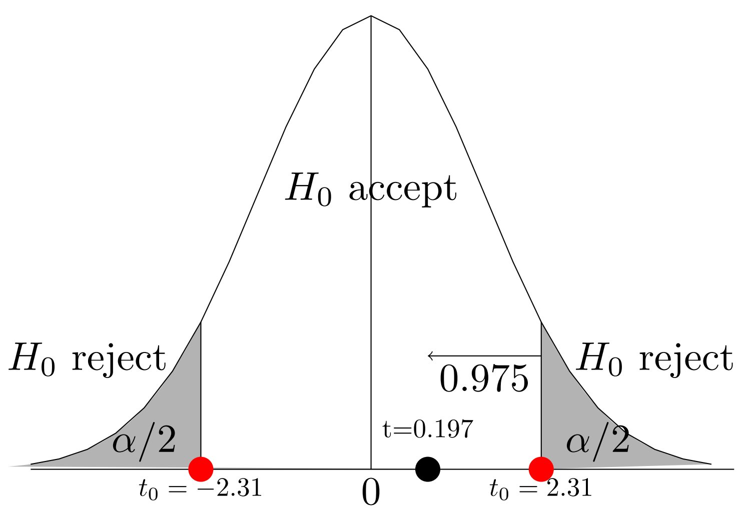
Now the population average must be exactly 56. Taken the sample means, it seems it doesn't hold. So we take as the null hypothesis that it holds: $H_0 : \mu = 56$.

We reject the null hypothesis both when the sample mean is very big and small. So it's a two-sided test. Let's calculate the t statistics:

$$t = \frac{54.88 - 56}{\frac{24.67}{\sqrt{9}}} = 0.197$$

(2a)

Now let's calculate the critical values on both sides for t. We take the t distribution with 9-1=8 degress of freedom: $t_{8,0.975} = 2.31$. So, the critical values for t are ± 2.31. The real t statistics is not beyond those values so we accept the null hypothesis: the average quantity is fulfilled.



$\boxed{\text{(2b)}}$

Now let's calculate the critical values for the sample mean:

$$t = \frac{\overline{x}_0 - 56}{\frac{24.67}{\sqrt{9}}} = \pm 2.31 \rightarrow \overline{x}_0 = 75;\ \overline{x} = 37$$

As the sample mean we got is not beyond those values we accept the null hypothesis.