INFERENTIAL STATISTICS I - TESTING HYPOTHESIS ABOUT ONE SAMPLE MEAN: HINTS

BASIC CONCEPTS OF HYPOTHESIS TESTING

- *Null hypothesis (H_0)*: an assertion that a parameter in a statistical model takes a particular value; it is assumed true until experimental evidence suggests otherwise.
- *Alternative hypothesis (H_1/H_a)*: expresses the way in which the value of a parameter may derivate from that specified in the null hypothesis; it is assumed true when the experimental evidence suggests that the null hypothesis is false.
- *Type I error*: rejecting the null hypothesis when it is in fact true.
- *Type II error*: accepting the null hypothesis when it is in fact false.
- *Test statistics*: a function of a sample of observations that provides a basis for testing the validity of the null hypothesis.
- *Critical region*: the null hypothesis is rejected when calculated value of the test statistic lies within this region.
- *Critical value*: the value which determines the boundary of the critical region.
- *Significance level (α, alpha)*: the size of the critical value; region probability of a type I error.
- *One-tailed test*: the critical value is located wholly at one end of the end of the sampling distribution of the test statistic; H1 involves < or > but not both.
- *Two-tailed test*: the critical region comprises areas at both ends of the sampling distribution of the test statistic; H1 involves ≠.

THEORETICAL BACKGROUND ON TESTING HYPOTHESIS ABOUT ONE SAMPLE MEANS

If a researcher wants to compare the mean of one sample with a hypothesized population value, the one-sample Z-test or one sample t-test must be applied. The selection will be based on the assumptions underlying the test:

1. Assumptions underlying the **Z-test**:
   - Observations are independent of one another.
   - The observations are randomly sampled from the population.
   - Observations are normally distributed in the population.
   - The population variance is known.
2. Assumptions underlying the **t-test**:
   - Observations are independent of one another.
   - The observations are randomly sampled from the population.
   - Observations are normally distributed in the population.
   - The population variance is not known.

A. TESTING HYPOTHESIS ABOUT ONE SAMPLE MEANS: Z-TEST (THE POPULATION MEAN AND STANDARD DEVIATION KNOWN)

To copy the requested values in the Z-test sheet:

- Select the column Hemoglobin at 6 months and Treatment schema.
- Copy the data and paste them in Z-test sheet.
- Sort the data descending by Treatment schema.
- Delete the cells corresponding to patients who received bi-weekly schema.
- Delete the column Treatment schema.

What the values in the Z-test table means and how can be read?

- *Sample mean* (m): The mean of the haemoglobin at 6 months for patients who received daily treatment schema is equal with 10.82 mg/dl.
- *Hypothesis population mean* (μ): The value 13 indicates that the population mean of hemoglobin of newborn children is equal to 13 mg/dl.
- *Population standard deviation* (σ): The population standard deviation must be known in order to apply the Z-test. For this analysis, the population standard deviation is equal to 1.16.
- *Count* (n): the number of observations in the sample (also known as sample size). In our analysis n is equal with 49.

- *Standard error of the mean* (s): $s = \frac{\sigma}{\sqrt{n}}$. The standard error of the mean for our hypothesis is equal with 0.17.
- *Z:* $Z = \frac{m - \mu}{s}$. For our problem, the value is equal to -13.17.
- *Alpha:* The significance level for the statistical test (5% in our example).
- *Probability one-tailed (one-tailed P-value)*: not applied for out case (see the alternative hypothesis).
- *Z critical one-tailed*: not applied for out case (see the alternative hypothesis).
- *Probability two-tailed (two-tailed P-value)*: two-tailed probability associated with the obtained Z critical two-tailed. If the value is greater or equal with 0.05 then the null hypothesis is accepted; if is less than 0.05 the alternative hypothesis is accepted.
- *Z critical two-tailed*: is absolute value of the two-tailed critical value of Z for the selected value of alpha. For alpha equal with 0.05, the two-tailed critical value of Z is 1.96. If the Z value is greater than or equal with 1.96 then the alternative hypothesis is accepted; if is less than 1.96 the null hypothesis is accepted.

To complete calculus on Z-test table:

One sample Z-test	
H_0 hypothesis	The mean of hemoglobin at 6 month is not different by the population mean
H_a hypothesis	The mean of hemoglobin at 6 month is different by the population mean (two-tailed test)
Population mean	13
Population standard deviation	1.16
Sample size (n)	=COUNT(A2:A50)
Sample mean	=AVERAGE(A2:A50)
Standard error of the sample mean	=population standard deviation/(SQRT(n))
Z	=(sample mean - population mean)/(standard error of the mean))
alpha	0.05
Probability one-tailed	=1-NORMSDIST(ABS(Z))
Z critical one-tailed	=ABS(NORMSINV(Alpha)
Probability two-tailed	=2*(1-NORMSDIST(ABS(Z)))
Z critical two-tailed	=ABS(NORMSINV(Alpha/2)

Z-test conclusions (by examples):

- Statistical: H_1 is accepted.
- Clinical: The mean of hemoglobin at 6 months at patients who received daily treatment schema proved to be statistically significant smaller compared to population mean.

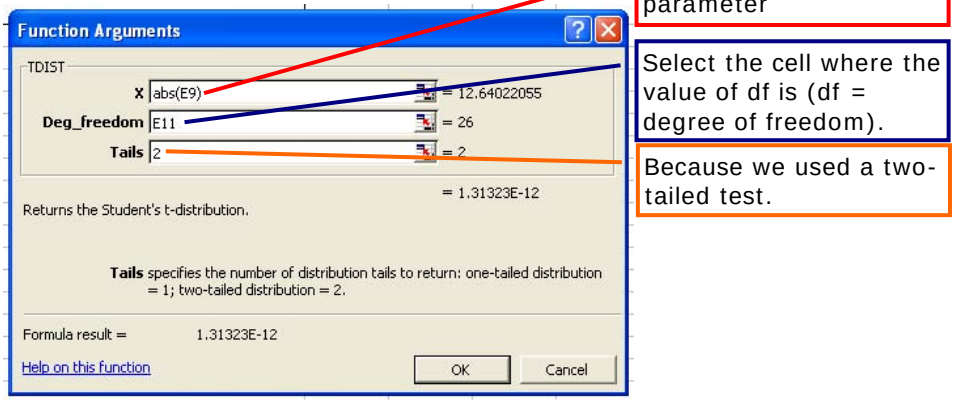
B. TESTING HYPOTHESIS ABOUT ONE SAMPLE MEAN: T-TEST

To calculates the values of t-test parameters:

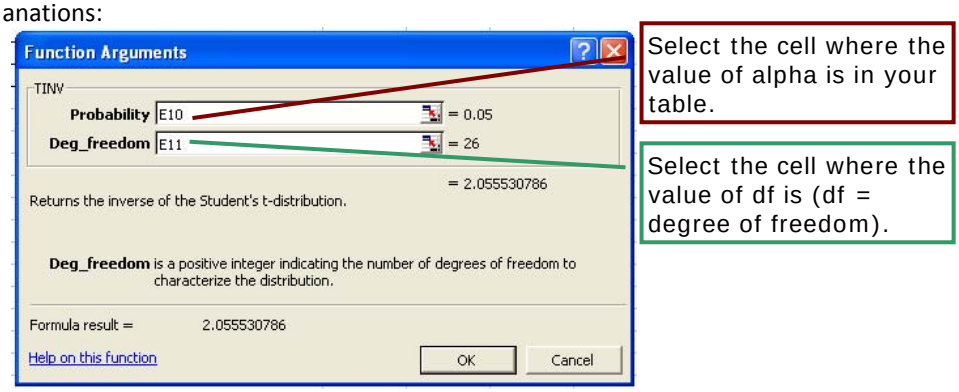
One sample T-test	
State null hypothesis	
State alternative hypothesis	
Population mean	13
Sample mean	=AVERAGE(A2:A28)
Sample standard deviation	=STDEV(A2:A28)
Sample size	=COUNT(A2:A28)
Standard error of the mean	=E6/SQRT(E7)
t	=(E5-E4)/E8
alpha	0.05
df	=E7-1
Probability two-tailed	=TDIST(ABS(E9),E11,2)
t critical two-tailed	=TINV(E10,E11)

Statistical conclusion	Since probability for two-tailed is less than 0.05 the alternative hypothesis is accepted.
Clinical conclusion	The mean of haemoglobin at 6 months of sample included into the study is statistically significant smaller compared to population mean.

TDIST dialog window with explanations:



TINV dialog window with explanations:



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