Hypothesis Testing

Tests of Significance

The test of significance is a method of making due allowance for the sampling fluctuation affecting the results of experiments or observations. The fact that the results of biological experiments are affected by a considerable amount of uncontrolled variation makes such test necessary. These tests enable us to decide on the basis of the sample results, if :

i. The deviation between the observed sample statistic and the hypothetical parameter value, or
ii. The deviation between two sample statistics, is significant or might be attributed to chance or the fluctuation.

For applying the tests of significance, we first set up a hypothesis – a definite statement about the population parameters. In all such situation we set up an exact hypothesis such as, the treatments do not respect of the mean value, and follow an objective procedure of analysis of data which leads to a conclusion of either of two kinds :.

1) Reject the hypothesis, or
2) Not reject the hypothesis.

Testing Hypotheses

A hypothesis test is an assessment of the evidence provided by the data in favor of (or against) some claim about the population.

General Procedure for Hypotheses Testing

Formulate the ***null hypothesis*** and the ***alternative hypothesis*****.**

- **The null hypothesis** H_0 is the statement being tested. Usually it states that the difference between the observed value and the hypothesized value is only due to chance variation.

  For example, $\mu = 16$.

- **The alternative hypothesis *Ha*** is the statement we will favor if we find evidence that the null hypothesis is false. It usually states that there is a real difference between the observed and hypothesized values.

  For example, $\mu \neq 16$, $\mu > 16$, or $\mu < 16$.

  A test is called:.

  - **two-sided** if *Ha* is of the form $\mu \neq 16$.
  - **one-sided** if *Ha* is of the form $\mu > 16$, or $\mu < 16$.

The types of error

1- The *size of a test*, often called ***significance level***, is the probability of committing **a Type I error**. A Type I error occurs **when a null hypothesis is rejected when it is true**. This test size is denoted by **α (*alpha*)**. The **1- α** is called the ***confidence level***, which is used in the form of the (1- α)*100 percent confidence interval of a parameter.

2- **Type II error** is a false negative, ***or the acceptance of the null hypothesis when it is false***. The probability of a type II error is indicated by **β**. The probability of avoiding a type II error is called ***the power P*** of an experiment, and depends on the number of replicates.

	Do not reject H_0	Reject H_0
H_0 is true	Correct Decision 1-α Confidence level	Type I Error α Size of a test (Significance level)
H_0 is false	Type II Error β	Correct Decision 1-β Power of a test

that α represents the probability that the null hypothesis is rejected when in fact it is true and should not be rejected, and β represents the probability that the null hypothesis is not rejected when in fact it is false and should be rejected. ***The power of the test, which is 1-β*** (that is, the complement of β), indicates the sensitivity of the statistical test in detecting changes that have occurred by measuring the probability of rejecting the null hypothesis when in fact it is false and should be rejected. The power of the statistical test depends on how different the actual population mean really is from the value being hypothesized (under H_0), the value of α used, and the sample size. If there is a *large difference* between the actual population mean and the hypothesized mean, the power of the test will be much **greater** than if the difference between the actual population mean and the hypothesized mean is *small*. Selecting a larger value of α makes it easier to reject H_0 and therefore increases the power of a test. Increasing the sample size increases the precision in the estimates and therefore increases the ability to detect differences in the parameters and increases the power of a test.

Examples

Ex. From the following data(3 , 4 , 5 , 3 , 7 , 8 . 6 , 4) find the :

A. $\overline{Y}$

B. Standard deviation (S.D.)

C. Sum of squares (SS).

D. Variance (S^2).

Solution:.

	Y_i	$Y_i - \bar{Y}$	$(Y_i - \bar{Y})^2$
	3	-2	4
	5	-0	0
	4	-1	1
	3	-2	4
	7	+2	4
	8	+3	9
	6	+1	1
	4	-1	1
Total	40	0	24

$$\bar{Y} = \frac{\sum Yi}{n} = \frac{40}{8} = 5$$

$$SS = \Sigma(Y_i - \bar{Y})^2 = 24$$

$$S^2 = \frac{SS}{d.f} = \frac{24}{8-1} = 3.43$$

$$S = \sqrt{S^2} = \sqrt{3.43} = 1.8$$

Note:. d.f. (degree of freedom) = n-1 .

Note:. there are two methods to obtain S^2

1- The normal method:.

$$S^2 = \frac{SS}{d.f}$$

$$S^2 = \frac{\Sigma(Yi - \bar{Y})2}{n-1}$$

2- The fast method :.

$$S^2 = \frac{\sum Yi^2 - \frac{(\sum Yi)^2}{n}}{n-1}$$

Now calculate Standard error(Se) to a above example?

$$Se_{\bar{y}} = \sqrt{\frac{S^2}{n}} = \frac{S}{\sqrt{n}}$$

$$= \frac{1.8}{\sqrt{8}} = 0.64$$

Question:. Here are measurements of the level of phosphate in the blood of a patient, in milligrams of phosphate per deciliter of blood, made on 6 consecutive visits to a clinic:.

5.6 , 5.2 , 4.6 , 4.9 , 5.7 , 6.4

Compute the mean, standard deviation, variance, and standard error?

Example :. (test one mean)

The birth hospital in Karbala explained the weight mean of child is 5.5 kg at 2012 . The random sample is chosen consist of 30 child and the weights mean is 5.1 kg, with standard deviation is 0.9 kg. Are there significance effects between the weights mean of children in this year and last years? The significance level (α) is 0.01 .

Solution :.

The first step is hypotheses putting.

H_0 :. $\mu = 5.5$

H_a :. $\mu \neq 5.5$, H_{a1} :. $\mu > 5.5$, H_{a2} :. $\mu < 5.5$

The second step is hypothesis test.

$$t = \frac{\bar{y} - \mu}{S\bar{y}}$$

$$t = \frac{5.1 - 5.5}{\frac{0.9}{\sqrt{30}}} = -2.434$$

The third step is find ***t table*** value at (α=0.005 and d.f 29 **. why???**)

t table = 2.756

The fourth step is the conclusion

t cal.(2.434) < t tab.(2.756)

We must accept H_0 (i.e. do not found significance differences between the weights mean of children in this year and last years).

Question :.

The ABC company to cigarettes production indicated to nicotine ratio in its production is equal or less than 17.5mg . The random sample is chosen consist of 9 cigarettes and calculated nicotine ratio in its as bellow:.

18 , 16 , 20 , 19 , 18 , 19 , 18 , 18 , 17

Is the claim of this company true or false , tested that at α = 0.05 ?