Frequently Asked Questions

1. How do we test the statistical hypothesis?
Answer:
It can be said, that statistics enable scientists to test substantive hypotheses indirectly by enabling them to test statistical hypotheses directly. They test the "truth" of substantive hypotheses by subjecting null hypotheses to statistical tests on the basis of probabilistic reasoning. The hypothesis may be true or false. The process of taking decision about the acceptance and rejection of the null hypothesis is known as test of hypothesis. Hence in Statistical tests we come to a decision whether to accept or fail to accept the null hypothesis.

2. What do you mean by statistical errors?
Answer:
In statistical test theory the notion of statistical error is an integral part of hypothesis testing. The errors that we make in the process of taking decision about acceptance ad rejection of null hypothesis are known as statistical errors. The errors may occur because of bias (observer, instrument, recall, etc.) or due to wrong decisions. The result of the test may be negative, relative to null hypothesis or positive. If the result of the test corresponds with reality, then a correct decision has been made. However, if the result of the test does not correspond with reality, then an error has occurred. Due to the statistical nature of a test, the result is never, except in very rare cases, free of error. Generally we come across with two types of error which are distinguished as Type I error and Type II error.

3. What do you mean by a Type I error?
Answer:
In statistics, a **Type I error** is the incorrect rejection of a true null hypothesis. Usually a type I error leads one to conclude that a thing or relationship exists when really it doesn't:
For example, that a patient has a disease being tested for when really the patient does not have the disease, or that a medical treatment cures a disease when really it doesn't. A type II error is a false negative.
Type I error is also called error of the first kind. Hence a wrong decision that we take by rejecting a null hypothesis when it is actually true is known as a Type I error.

4. What is Type II error?
Answer:
A Type II error is the failure to reject a false null hypothesis. A type II error is a false negative.
Examples of type II errors would be a blood test failing to detect the disease it was designed to detect, in a patient who really has the disease; or a clinical trial of a medical treatment failing to show that the treatment works when really it does.
Type II errors are also called errors of the second kind. Hence a wrong decision that we take by accepting a null hypothesis when it is actually false is known as a Type II error

5. How do we make correct decisions in a test of hypothesis?
Answer:
We make correct decisions by
- Retaining the null hypothesis when the null hypothesis is true, or
- Rejecting the null hypothesis when the null hypothesis is false.

6. Explain Type I and Type II errors with an example.

Answer:
In the typical hypothesis testing situation, we come to the final decision where we either retain or reject the null hypothesis. Thus, a decision is made in the study. But, juxtaposed to this decision is the real truth. The null hypothesis is either true or false. What this yields is a two by two table that indicates the various combinations of decisions you make compared to the actual truth. Consider the following table.

	Null Hypothesis (H_0) is True	**Null Hypothesis (H_0) is False**
Retain Null Hypothesis	Correct Decision	Wrong Decision
Reject Null Hypothesis	Wrong Decision	Correct decision

At the side, notice that we have the two possible decisions we can make: either retain the H_0 hypothesis or reject the H_0 hypothesis.
At the top, we have the two possible states of truth: either the H_0 hypothesis is true or it is false. This sets up 4 possible different combinations of decision and truth. For example; assume for a moment that the null hypothesis is the population mean IQ score is 100. If the population mean is really 100 and we retain the null hypothesis, then we are in the upper left cell and have made a correct decision. To retain the null hypothesis when the null hypothesis is true is the right thing to do.
On the other hand, if the true mean is 100 and you reject the null hypothesis, then you have made the wrong decision and you are in the lower left cell. You have made a wrong decision what is called a Type i or Alpha error.

- If the null hypothesis is false and you retain the null hypothesis (upper right cell), then again you have made a wrong decision. You have retained the null hypothesis when the null hypothesis is not correct. Since this is the opposite of a Type I error, this is called a Type ii or Beta error.
- Finally, if you reject the null hypothesis when the null hypothesis is false, then you have made a correct decision. If the true population mean IQ score is not 100 and you reject the null hypothesis of 100, then you are saying that you do not think that the mean is 100 and you would be doing the right thing by rejecting the null hypothesis.

7. How do we make incorrect decisions in a test of hypothesis?

Answer:
We make Incorrect Decision by:

- Retaining the null hypothesis when the null hypothesis is false (TYPE II or beta error),
- Rejecting the null hypothesis when the null hypothesis is true (TYPE 1 or alpha error).

8. What do the researchers generally do in test of hypothesis?
Answer:
Generally speaking, researchers are not willing to reject the H_0 hypothesis if the chance of rejecting it (concluding that your treatment made a difference, that there is a non zero correlation, etc.) wrongly is greater than about 5%. One usually wants to reject the null hypothesis but they only want to do this if the chance that they do it incorrectly is rather low. Unfortunately, setting some criterion about how much Type I or alpha error rate we are willing to tolerate does little to regulate or establish what level of Type II error or beta we are

willing to tolerate. The literature seems to be fixated only on the rate of Type I errors without much attention to Type II error
H_0 is rejected with the awareness that an error might have been made, but the chances of that happening are less than 0.05. The conclusion of rejecting H0 on an average is correct more than 95% of the time.

9. What is the effect of sample size on errors?
Answer:
The size of the sample is related to both types of errors. With a fixed value of type one error and a fixed sample size n, the value of type two error is predetermined. If type two error is too large, it can be reduced by either raising the level of type one error for fixed n, or by increasing n for a fixed level of type one error. Although type two error is seldom determined in an experiment, researchers can be assured that it is reasonably small by collecting a large sample.

10. Explain the consequences of type I and Type II errors in a Jury trial.
Answer:
The H_0 hypothesis in a trial, when we give the benefit of doubt to the person on trial, is that the person is not guilty and did not commit the crime. Look at the following diagram.

	H_0 is true Innocent	H_0 is false Guilty
Retain H_0 (Acquit)	Correct Decision (Let an innocent person go free)	Incorrect decision (Let a guilty person go free)
Retain H_0 (Convict)	Incorrect decision (Convict an innocent person)	Correct Decision (convict a guilty person)

If the person is really not guilty and the jury votes "not guilty" and acquits the person, then they have made the correct decision. The jury has set free an innocent person. If the person is actually not guilty but the jury convicts the person anyway, then the jury has made a wrong decision.

- TYPE I or alpha error. Convicting an innocent person is an error of the "first kind". On the other hand, if the person is really guilty and the jury votes to acquit the person, then they again have made a mistake and this type of mistake in decision is called a TYPE II or beta error. This is an error of the "second kind". Finally, if the jury votes to convict the person and the person really did commit the crime, then the jury has made the correct decision

- The main purpose of a trial is to convict guilty persons. Certainly, we want the jury to arrive at the correct decision and if the person is not guilty, then we hope the jury will acquit the person. However, the defence side of the case (to defend the person on trial) is not the side to bring the case to trial

- It is the prosecution side; they are the ones to instigate the entire trial process. In this context therefore, the hopes of the trial system (in addition to finding the truth) is to convict persons of the crime they were charged with especially if they really committed the crime.

11. Briefly explain the theory behind errors in testing.

Answer:

From the Bayesian point of view, a type I error is one that looks at information that should not substantially change one's prior estimate of probability, but does. A type II error is one that looks at information which should change one's estimate, but does not. (Though the null hypothesis is not quite the same thing as one's prior estimate, it is, rather, one's pro forma prior estimate.)

Hypothesis testing is the art of testing whether a variation between two sample distributions can be explained by chance or not. In many practical applications type I errors are more delicate than type II errors. In these cases, care is usually focused on minimizing the occurrence of this statistical error.

Suppose, the probability for a type I error is 1%, then there is a 1% chance that the observed variation is not true. This is called the *level of significance*, denoted with the Greek letter ∩ (alpha). While 1% might be an acceptable level of significance for one application, a different application can require a very different level.

For example, the standard goal of six sigma is to achieve precision to 4.5 standard deviations above or below the mean. This means that only 3.4 parts per million are allowed to be deficient in a normally distributed process

12. What are the consequences of errrors in testing?

Answer:

Both types of errors are problems for individuals, corporations, and data analysis. A false positive (with null hypothesis of health) in medicine causes unnecessary worry or treatment, while a false negative gives the patient the dangerous illusion of good health and the patient might not get an available treatment.

A false positive in manufacturing quality control (with a null hypothesis of a product being well made) discards a product that is actually well made, while a false negative stamps a broken product as operational. A false positive (with null hypothesis of no effect) in scientific research suggest an effect that is not actually there, while a false negative fails to detect an effect that is there.

Minimizing errors of decision is not a simple issue; for any given sample size the effort to reduce one type of error generally results in increasing the other type of error. The only way to minimize both types of error, without just improving the test, is to increase the sample size, and this may not be feasible.

13. Write a note on causes for errors in testing.

Answer:

Just because the sample mean (following treatment) is different from the original population mean does not necessarily indicate that the treatment has caused a change.

You should recall that there usually is some discrepancy between a sample mean and the population mean simply as a result of sampling error.

Because the hypothesis test relies on sample data, and because sample data are not completely reliable, there is always the risk that misleading data will cause the hypothesis test to reach a wrong conclusion. Two types of error are possible.

14. What are the causes for Type I errors?

Answer:

Causes for Type I errors

- A Type I error occurs when the sample data appear to show a treatment effect when, in fact, there is none.
- In this case the researcher will reject the null hypothesis and falsely conclude that the treatment has an effect.
- Type I errors are caused by unusual, unrepresentative samples. Just by chance the researcher selects an extreme sample with the result that the sample falls in the critical region even though the treatment has no effect.
- The hypothesis test is structured so that Type I errors are very unlikely; specifically, the probability of a Type I error is equal to the alpha level.

15. What are the Causes for Type II errors?

Answer:

Causes for Type II errors

- A Type II error occurs when the sample does not appear to have been affected by the treatment when, in fact, the treatment does have an effect
- In this case, the researcher will fail to reject the null hypothesis and falsely conclude that the treatment does not have an effect
- Type II errors are commonly the result of a very small treatment effect. Although the treatment does have an effect, it is not large enough to show up in the research study