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***Questions***

*1. What do you understand by hypothesis testing*

*2. Differentiate between the classical and the p-value approach for hypothesis testing.*

*3. What is the importance of hypothesis testing in Research*

*Answers*

*1* ***Hypothesis testing****:*

 *Hypothesis testing is an act in statistics whereby an analyst*[*tests*](https://www.investopedia.com/terms/w/wilcoxon-test.asp)*an assumption regarding a population parameter. In other words, testing a hypothesis is trying to determine if your observation of some phenomenon is likely to have really occurred based on statistics. The methodology employed by the analyst depends on the nature of the data used and the reason for the analysis.*

 *It is used to assess the plausibility of a hypothesis by using sample data. Such data may come from a larger population, or from a data-generating process.*

*2*

***P-value***

*The P-value is a number that tells us how unusual our sample results are, given that the null hypothesis is true.*

*It is the probability that the computed value of a test statistic is at least as extreme as a specified value of the test statistic when the null hypothesis is true.*

*Thus the P-value is the smallest value of* $α$ *for which we can reject a null hypothesis.*

***Critical Value***

*These are the values of the test statistic that separate the rejection and non-rejection regions. If a Two-tailed, left-tailed or right-tailed test is performed at a specified significance level (*$α$*), the critical values are;*

$\pm Z\_{\frac{α}{2}} $ *- Two-tailed*

*-*$Z\_{α}$ *- Left-tailed*

$Z\_{α}$ *- Right-tailed*

***Classical Approach***

*The Classical Approach to hypothesis testing is to compare a test statistic and a critical value. It is best used for distributions which give areas and require you to look up the critical value (like the Student's t distribution) rather than distributions which have you look up a test statistic to find an area (like the normal distribution).*

*The Classical Approach also has three different*[*decision rules*](https://people.richland.edu/james/lecture/m170/ch09-typ.html)*, depending on whether it is a left tail, right tail, or two tail test.*

***One problem with the Classical Approach is that if a different level of significance is desired, a different critical value must be read from the table.***

***P-Value Approach***

*The P-Value Approach, short for Probability Value, approaches hypothesis testing from a different manner. Instead of comparing z-scores or t-scores as in the classical approach, you're comparing probabilities, or areas.*

*The level of significance (alpha) is the area in the critical region. That is, the area in the tails to the right or left of the critical values.*

*The p-value is the area to the right or left of the test statistic. If it is a two tail test, then look up the probability in one tail and double it.*

*If the test statistic is in the critical region, then the p-value will be less than the level of significance. It does not matter whether it is a left tail, right tail, or two tail test. This rule always holds.*

*Reject the null hypothesis if the p-value is less than the level of significance.*

*You will fail to reject the null hypothesis if the p-value is greater than or equal to the level of significance.*

*The p-value approach is best suited for the normal distribution when doing calculations by hand. However, many statistical packages will give the p-value but not the critical value. This is because* ***it is easier for a computer or calculator to find the probability than it is to find the critical value.***

***Another benefit of the p-value is that the statistician immediately knows at what level the testing becomes significant.*** *That is, a p-value of 0.06 would be rejected at an 0.10 level of significance, but it would fail to reject at an 0.05 level of significance. Warning: Do not decide on the level of significance after calculating the test statistic and finding the p-value.*

***Classical vs. P- Value: a Hypothesis Test***

*To demonstrate the difference between the classical test of significance and a test using the P- value, we'll examine a scenario involving an experimental drug which claims to lower the heart rate to 35 beats per minute.   A test involving 45 randomly sampled patients yields a mean of 33.6 beats per minute.*

### *https://web.stanford.edu/dept/radiology/cgi-bin/classes/stats_data_analysis/lesson_10/hyp_test.gif*

### *We have found very strong evidence that the drug actually lowers the heart rate below 35 beats per minute.  What would a test using*[*P- value*](https://web.stanford.edu/dept/radiology/cgi-bin/classes/stats_data_analysis/lesson_10/classical-P2.html)*yield?*

## *Classical vs. P- Value: a Hypothesis Test*

### *Here are the results using the P- value.   The P- value was found using Excel.*

### *https://web.stanford.edu/dept/radiology/cgi-bin/classes/stats_data_analysis/lesson_10/hyp_test2.gif*

*As you can see, the hypothesis is rejected as in the classical approach.   The advantage of using this method is that a* ***conclusion can be reached***[***using P- value alone***](https://web.stanford.edu/dept/radiology/cgi-bin/classes/stats_data_analysis/lesson_10/Palone.html)***, without establishing a significance level.***

*3 Hypothesis testing is used in confirmatory data analysis. Confirmatory Data Analysis is the part where you evaluate your evidence using traditional statistical tools such as significance, inference, and confidence.*

*At this point, you’re really challenging your assumptions. A big part of confirmatory data analysis is quantifying things like the extent any deviation from the model you’ve built could have happened by chance, and at what point you need to start questioning your model.*

*Confirmatory Data Analysis involves things like: testing hypotheses, producing estimates with a specified level of precision, regression analysis, and variance analysis(evaluating the difference between the planned and actual outcome).
In this way, your confirmatory data analysis is where you put your findings and arguments to trial.*

*ANALYTICAL FRAME WORK*

*Like other application fields in medical sciences as well , the*

*analytical frame work in respect of testing of hypothesis*

*comprises of 1. formulating research hypothesis 2. framing*

*corresponding null hypothesis 3. selecting appropriate test of*

*significance and finally 4. approving/disapproving research*

*hypothesis on the basis of acceptance/rejection of null*

*hypothesis.*

*1. The starting point, is framing a hypothesis as per*

*objectives of the main theme of the research body, which*

*is commonly known as a research hypothesis; like-*

*medicine a cures the disease 'd' in a better way than*

*medicine b; vaccinated persons are less prone to smallpox*

*as compared to unvaccinated persons; high potency dose*

*cures the disease more quickly as compared to a low*

*potency dose; adoption of healthy life-style checks the*

*diabetes mellitus and its ill effects more effectively;*

*smoking is a cause of Lungs infection ; students who take*

*pre course orientation classes perform better in creativity*

*to their research problem than those who do not take pre*

*course orientation classes; persons living in urban areas*

*have better access to high-tech medical facilities than*

*those living in rural areas: high status persons are more*

*susceptible to hive than low status persons.*

*2. After formulating the research hypothesis, the next step*

*consists of making corresponding null hypothesis*

*(a statistical hypothesis which (i) can be tested for its*

*validity i.e. Acceptance/rejection and (ii) is more*

*popularly known as a hypothesis of zero difference or no*

*difference.*

*3. Thereafter, the next point of concern is selecting and*

*using the most appropriate statistical test like the t-test ,*

*the z-test, the F-test, the chi-square test, for testing the*

*statistical significance or in significace, of the*

*observed result on the basis of acceptance/rejection of the*

*null hypothesis; to find out as to whether the observed*

*result is a real one “or” it is only due to some*

*chance/error factor. This is decided by adopting any of the*

*following methods, i.e. Method (i) or method (ii): Method*

*(i) test statistic based method*

*If at a specified probability level (most commonly used*

*0.05 and 0.01 i.e. 5% and 1% levels of significance).*

*(a) Calculated test statistic (t/z/F/ chi-square) is less than the*

*corresponding table value, then it is not significant and we*

*can accept the null hypothesis.*

*(b) Calculated test statistic is equal to or greater than the*

*corresponding table value, then it is significant and we*

*shall reject the null hypothesis.*

*Method (ii) - p-value based method:*

*As per prevalent notions*

*(a) If the test statistic's corresponding p-value is greater than*

*0.05; then the observed result is statistically not*

*significant.*

*(b) If the, p-value is less than 0.05 but greater than 0.01, then*

*the observed result is statistically significant.*

*(c) If the p-value is less than 0.01, then the observed result is*

*statistically highly significant. It is also most pertinent at*

*this point to very clearly know that (i) t-test and z-test are*

*mainly used to test the significance of difference between*

*two means, two proportions, two correlation*

*coefficients, two regression coefficients with the t-test*

*being suitable for samples of small size ( less than 30 )and*

*the z-test for samples of large size (at least 50 ) (ii) chi-*

*square test is mainly used for testing the significance of*

*difference between observed (experimental) and the*

*expected(theoretical/hypothetical) frequencies and testing*

*association between two attributes like vaccination and*

*control of disease and that it is suitable for samples of large*

*size ( at least 50 ) (iii) f-test is used for testing significance*

*of difference between a number of means ( more than two)*

*through analysis of variance ( ANOVA) tables.*

*4. The last and the final step consist of deriving the final*

*result in terms of validity/invalidity of research*

*hypothesis leading towards accepance/rejection of*

*postulated research theory.*

*As mentioned elsewhere- (a) the rejection of null*

*hypothesis results to statistical significance of the observed*

*result and therefore validating and declaring the research*

*hypothesis as true. (b) The non rejection (acceptance) of null*

*hypothesis indicates statistical insignificance of the observed*

*result and therefore devalidating and declaring the research*

*hypothesis as false.*

*PROBLEM BASED ILLUSTRATIONS (PBI) s:*

*To have still more clarity in respect of above, a few problem*

*based illustrations (pbi) s are being presented in nut and shell,*

*as under:*

*1) Problem: to find out whether medicine a is better than*

*medicine b Research hypothesis: medicine a is better than*

*medicine a. Null hypothesis: there is no difference in*

*medicine a and medicine b.*

*Result: the rejection of null hypothesis indicates a*

*significant difference i.e. a real difference between the two*

*medicines and therefore results to acceptance of research*

*hypothesis, while the acceptance of null hypothesis*

*indicates an insignificant Difference i.e. a difference only*

*due to chance or error factor; and therefore it results to*

*rejection of research hypothesis. (In this we can use the t-*

*test or the z-test as per size of sample).*

*2) Problem: to find out whether vaccination against hepatitis*

*b is effective in controlling hepatitis b. Research*

*hypothesis: vaccination against hepatitis b is effective in*

*controlling hepatitis b. Null hypothesis: vaccination and*

*hepatitis b are independent of each other. Result: the*

*rejection of null hypothesis results to effectiveness of*

*vaccination in controlling hepatitis b and therefore*

*validates the research hypothesis; while its acceptance*

*indicates ineffectiveness of vaccination in controlling*

*hepatitis b and therefore invalidates the research*

*hypothesis. (This can be tested by chi-square test).*

*3) Problem: to find out, whether the proportion of disease*

*affected persons in the experimental group is lower than*

*that in the control group.*

*Research hypothesis: the proportion of disease affected*

*persons in the experimental group is lower than that in the*

*control group. Null hypothesis: there is no difference in the*

*proportions of disease affected persons in the*

*experimental and the control groups. Result: the rejection*

*of null hypothesis shows a significant difference between*

*the two proportions and therefore validates the research*

*hypothesis to declare that proportion of disease affected*

*persons in experimental group is lower than that in the*

*control group; while its acceptance shows the difference of*

*proportions as insignificant and hence results to rejection*

*of the research hypothesis (t test or z test)*

*4) Problem: to find out whether, being on diet is associated*

*with sex.*

*Research hypothesis: females are more adhesive to being*

*on diet, as compared to males.*

*Null hypothesis: sex and being on diet, are independent of*

*each other.*

*Result: the rejection of null hypothesis results to association*

*between sex and being on diet and therefore validates the*

*research hypothesis that females are more.*

*Adhesive to being on diet as compared to males, while its*

*acceptance shows no association between sex and being on*

*diet and results to rejection of research hypothesis. (this can be*

*checked by chi-square test).*

*CONCLUSION*

*As a concluding remark of this key note , it may be pointed*

*out that (i) a null hypothesis or in turn , a research hypothesis*

*instead of being proved is always subject to be tested for its*

*validity i.e. Acceptance or rejection towards its final approval*

*or disapproval. (ii) It must be clear in respect of its approach,*

*scope and the perspectives to which it corresponds and (iii) it*

*maintains its unambiguity.*