Marketing Research and Analysis-II (Application Oriented)
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Lecture – 27
Non-Parametric Test - III

Welcome friends to the lecture series of the course of Marketing Research and Analysis. In the last few classes, we have been talking about conducting nonparametric tests basically.

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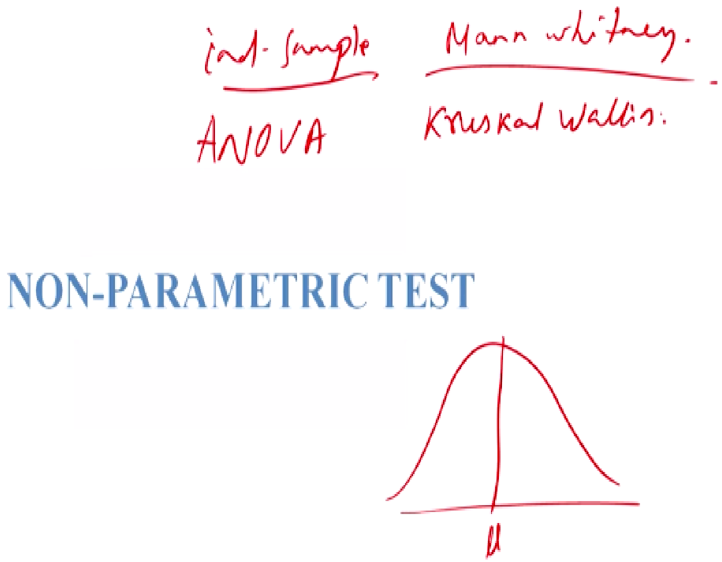

So what is this nonparametric test. As we had seen that nonparametric tests are basically the tests which are conducted when the data does not follow a normal distribution. So if the does not follow a normal distribution, the rule says that most of the statistical tests that you do they would be invalid if the data is not normal in nature. So I hope you understand. Normal means when the data follows a bell curve and the mean, median, mode they all lie on the middle portion.

So when the distribution is not normal of the data and it is more or less skewed or it is peaked or something, so in such a condition a nonparametric test is preferred over the parametric test. One more thing is that during the nonparametric test, the data is measured on a nominal or a ordinal scale instead of like parametric test you have the data on a continuous scale which we measure through basically like interval or ratio scale. The data is continuous in nature mostly, but in this case, the data follows a non-normal and it is mostly measured on a ordinal or a nominal scale.

The 2 popular tests that we had seen was one of them called the Mann-Whitney U test. So we said this test was similar to the independent sample t test in parametric condition. So you have independent sample t test for a normally distributed data and similarly when you have 2 sample different samples, but they are not normal in nature, you do a Mann Whitney U test, but when suppose you have more than 2 sample groups and then you cannot measure the 2 samples and you cannot you should not be doing multiple t tests, in such a condition for a normal data, you use the analysis of variance.

On the other hand if the same condition when the data is not normal or is a non-normal data, then we will used the Kruskal-Wallis test. So let us see. Today we will do some more of this nonparametric tests and try to utilize them in our research and academics as much as possible. Many times, I have seen people avoiding nonparametric test because they feel nonparametric tests are not powerful, but then so be it.

If it is not powerful, it does not mean it should not be used because the data demands or the data's condition is in such a manner that there you cannot use a parametric test, then you are left with very little option but to conduct the nonparametric ones.

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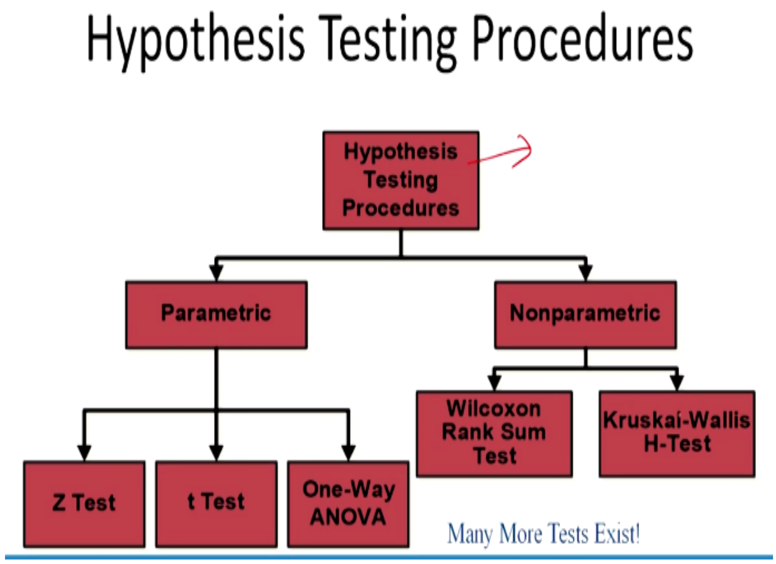

So we said hypothesis testing which is the most important part for any researcher to test the hypothesis whether it is the null hypothesis to be accepted or the alternate hypothesis is to accept, we always try to test that and the researcher s intention is always to measure the alternate, to see that the alternate is approved. So parametric nonparametric and we said Z test, t test, one-way ANOVA, and here we have Mann Whitney, Wilcoxon, Kruskal-Wallis and sign test, runs test, many of other tests.

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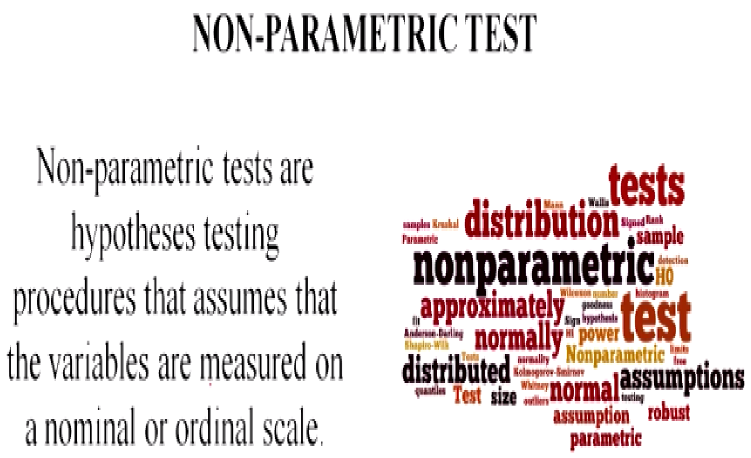

So nonparametric tests, I will repeat again, are hypothesis testing procedures that assumes that the variables are measured on a nominal or ordinal scale as I just told you.

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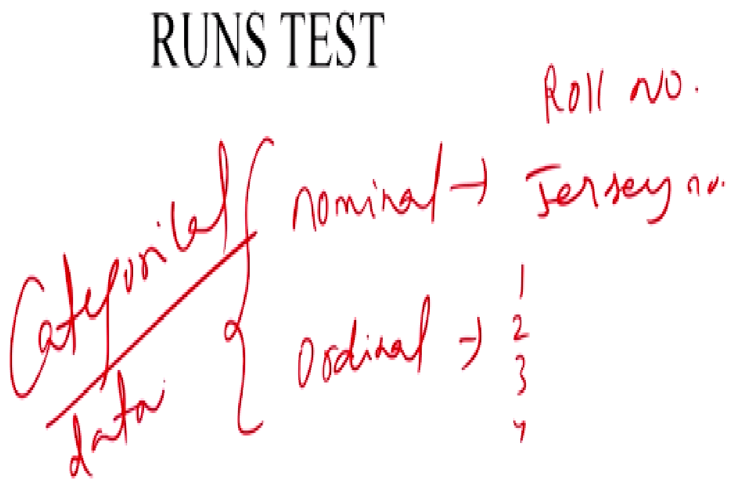

So you know what is a nominal scale. Basically a nominal scale is something which is just like a code for example the roll number, the jersey number of a player. So these are all nominal, so they are only for coding, the purpose is to identify, but however if suppose the data is also an ordinal that means it is in an order rank 1, rank 2, rank 4, rank 4 suppose, then also in such a condition we can use the nonparametric test. So basically if you see, these are categorical data mostly utilized.

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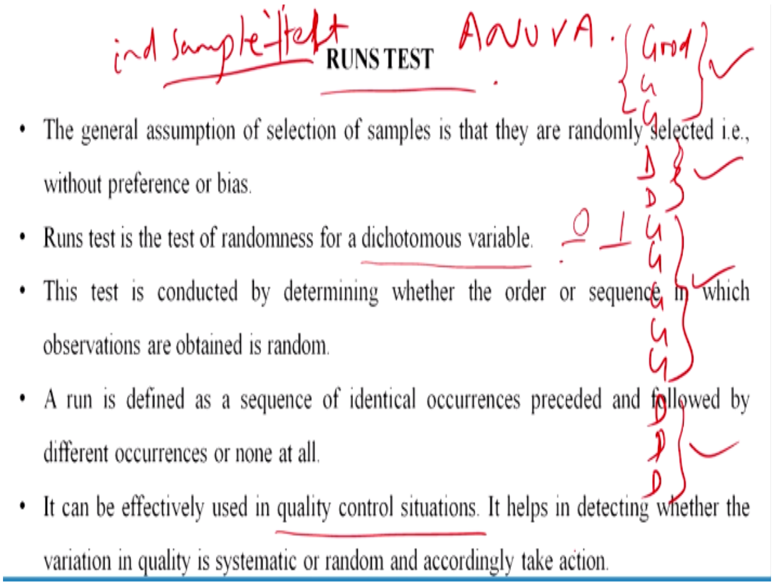

Now after the Mann Whitney U test and the Kruskal-Wallis test which we had done which I said represented the independent sample t test and the one-way analysis of variance, we are coming to a new test called the runs test. Now let us see what is this runs test. The general assumption of selection of samples here is that they are randomly selected, that is without any preference or bias. Now what does it mean. Suppose let us say a quality control manager is testing some of the products and while testing he assuming that the pattern of the data that he is checking is in a random basis.

There can be 2 things, either it is a random or it can be systemic in nature. Suppose it is systemic in nature, then there is some scope for correction, you can do some correction over that is some systematic problem is there, but if it is random, then it is very difficult. So the general assumption of selection of sample is that they are randomly selected, that is there is no preference or bias. Runs test is a test of randomness for a dichotomous variable.

So it basically takes 0 and 1, you can say 0 and 1 as the 2 yes or no condition, so it is a binominal condition. This test is conducted by determining whether the order or sequence in which the observations are obtained is random. Now what do I mean it? I will show an example, but I am just giving you a brief. Let us say the manager is checking suppose what is the condition of the computers.

Suppose is the first computer that came he checked was good one, the second was a good one, the third was a good one, the fourth was a defective item had some defect, the fifth one also had some defect, sixth was good, seventh good, eighth good, ninth good, tenth good, eleventh again defective, twelve defective suppose, thirteenth defective suppose. So what is the order or sequence in which the observations are obtained that is to be checked. A run is defined as a sequence of identical occurrences preceded and followed by difference occurrences or none at all.

Now what does it mean. When I say let us say this is good, good, good, then defective, defective. So this says what is the sequence of occurrences. Now how many goods have come in one time, then what is the defective, where did this break basically, where did the pattern break. So let us say there are 2 here. Then again you have 5 good, then may be 3 defective. So ultimately you can say this is 1, 2, 3, 4; so there are 4 groups you can say. It can be effectively used, where it can be used the question comes.

It can be used effectively in quality control situations as I had been explained to you. It helps in detecting whether the variation in quality is systemic or random and accordingly action can be taken. I hope you are understanding. So in a quality control situation, suppose the quality control manager is finding that the arrangement of the occurrence of this machines or the product or the whatever the goods are in a particular order and whether that order of occurrence is random or nonrandom in nature.

If it is random, then it is a different thing, but if it is nonrandom, then we would have to look into it why there is a nonrandom basis, because randomness means there is no preference, there is no bias, but if there is systematic or a nonrandom occurrence, then there might be some problem which can be corrected.

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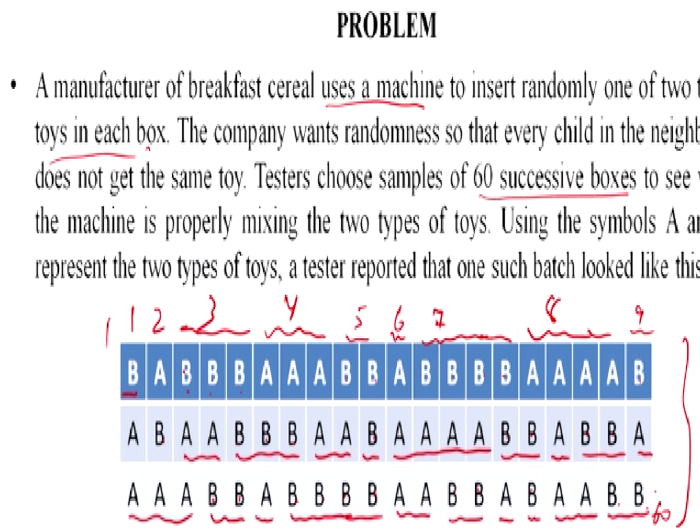

So let us take a problem. So a manufacturer of breakfast cereals is using a machine to insert randomly one of 2 types of toys, you must have seen now a days company is like even McDonald's, there are chocolates in which within the chocolate, there will be small small toys to attract the children. So these toys are being put into the breakfast cereal boxes. So the company wants randomness. Why does the company want randomness, so that every child in the neighborhood does not get the same toy.

See if every child gets the same toy, then the children would feel there is no fun and you know how human psychology is, the children also have their own competition among themselves whether my toy is better than yours or your toy is better than mine or this competition goes on. So if the company inserts the same toy, then there is no fun for the children, in fact they would feel whether there is no difference, so it is all the same.

So in order to create an excitement among the children, the company wants to ensure that different toys are put it in the boxes so that the children can have some form of excitement. Now testers choose samples of 60 successive boxes, so 60 successive cereal boxes were taken to see whether the machine is properly mixing the 2 types of toys. So using the symbols A and B to represents the 2 types of toys, a tester reported that one such batch looked like this. Now what is this let us see.

So first if you see B type of toy in the first cereal box, second one A, B, B, B, A, A, A, B, B, A, B, B so it goes on till you reach to the sixtieth. This is the first, this is the sixtieth correct.

So the sixtieth box also they have put in. So now the company wants to know whether the occurrence of these toys is in a random order or is this not in a random order.

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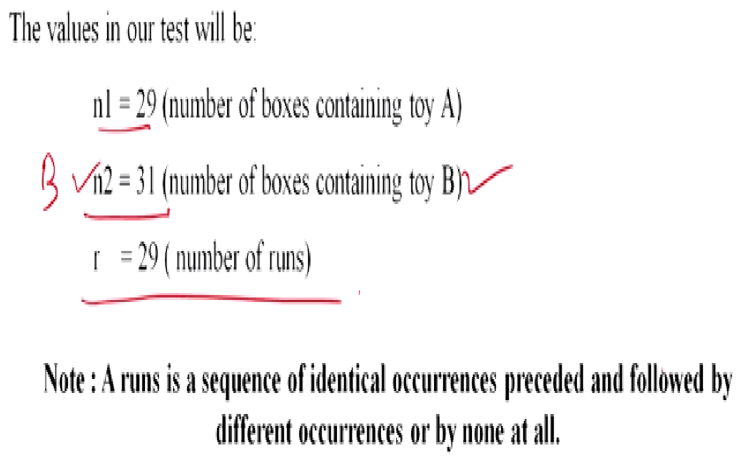

So the values in our test will be now what n1 and n2. So let us see what is n1, let us say n1, let us take how any Bs are there? So 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31. So you can see n2 so B, toy B is 31 and n1 is obviously 60-31 is 29. So what is the r? Now let us look at the r. Now r is we are saying the continuity of the occurrence of a particular type of goods or service or product let us say. So let us say what is the occurrence of B and A in this case. So you see for example here.

So there is only one B, then there is an A. So this is 1, this is 2. Then B, B, B, so this is one group 3. Then A, A, A, A; 4 right. Can you understand why it is one? Because all 3 are continuously coming. Then 5, 6, 7, 8, 9, so 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, so there are 29 runs that is what it is trying to say if you see. So r = 29, the number of runs is 29. So what it says, a run is a sequence of identical occurrence preceded and followed by different occurrences or by none at all.

So you can simple be you can understand whether the continuity is there or it is breaking. If there is a breaking, then it is a new run.

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- The number of runs or r is a statistic with its own special sampling distribution and its own test.
- Obviously, runs may be of different lengths, and various numbers of runs can occur in one sample.
- Statisticians can prove that too many or too few runs in a sample indicate that something other than chance was at work when the items were selected.
- A one sample runs test is based on the idea that too few or too many runs show that the items were not chosen randomly.
- To derive the mean of the sampling distribution of the r statistic, use the following formula:

$$\mu_r = \{(2n_1n_2) / n_1+n_2\} + 1$$
$$= [\{(2)(29)(31)\} / (29+31)] + 1$$
$$= 30.97 \text{ (mean of r statistic)}$$

$$\frac{2n_1n_2}{n_1+n_2} + 1$$

The number of runs or r is a statistic with its own special sampling distribution and its own test. Obviously runs may be of different lengths, obviously we have seen it is somewhere it was 1, somewhere 2, somewhere 3, 4 and various numbers of runs can occur in one sample. Statisticians can prove that too many or too few runs in a sample indicate that something other than chance was at work. Now what does this mean? Suppose you see the number of runs is too few, what does that mean.

That means the number of similar products occurring constantly was on a very high level. Suppose on the other hand, the number of runs is too small, is too lengthy let us say, is too may is too may or too few, so the first case was too few, so too few runs means most of the occurrence was at continuously therefore a longer time, but when it is too many that means what only for may be one time it is occurring and then it is not occurring, may be then again it is occurring after sometime, so the number of runs have increased.

So what does it mean? If it is too many or too few, then you see in a sample the something other than chance was at work, so it is not random, there is some problem in it. A one sample runs test is based on the idea that too few or too many runs show that items were not chosen randomly and there is a systematic problem. To derive the mean of the sampling distribution, let us use the formula. So what is the formula. The formula is as it is written 2n1n2/n1+n2+1. Now taking this you have that means how much, 2 x 29 n1, n2 is 31/31+29, 60+1.

So my mean of the r statistic is how much, 30.97. So what do I require to have my calculation. So to calculate, I need my standard error also, correct.

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The standard error of the r statistic can be calculated with this formula:

$$\sigma_r = \sqrt{\frac{\{2n_1n_2(2n_1n_2-n_1-n_2)\}}{(n_1+n_2)2*(n_1+n_2-1)}}$$

$$= \frac{\sqrt{\{(2)(29)(31)(2*29*31-29-31)\}}}{\sqrt{(29+31)^2(29+31-1)}}$$

$$= \sqrt{14.71}$$

$= 3.84$ (standard error of the r statistic)

So let us see the standard error is how much, can be calculated as 2n1n2 x w hole over 2n1n2 – n1-n2/n1+n2 whole square x n1+n2-1. Now let us do this here. It is done, you can just check. So 2 x 29 x 31 whole over, then 2 x 29 x 31 n1n2 – 29-31/root over of 29+31 square which is 60, 29+31-1, so this gives to 14.71 or is equal to 3.84. So we have the value, we have our mu, we have our standard error. So can we calculate the z, oh yeah let us see, let us go by it.

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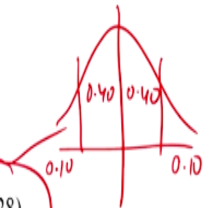
- In the one sample runs test , the sampling distribution of r can be closely approximated by the normal distribution **if either n1 or n2 is larger than 20.** 29, 31
- Our cereal has a sample of 60 boxes , so we can use the normal approximation.
- Management is interested in testing at the 0.20 level the hypothesis that the toys are randomly mixed, so the test becomes:

  Ho: The toys are randomly mixed

  H1 : The toys are not randomly mixed

  α = 0.20 (level of significance) (+/- 1.28)



(Note: In a one-sample runs test, a symbolic statement of the hypothesis is not appropriate)

In the one sample run test, the sampling distribution of r can be closely, this is very important please check, the sampling distribution of r can be closely approximated by the normal distribution, if either n1 or n2 is larger than 20. If it is larger than 20, then it automatically follows a normal distribution. Our cereal in this case has a sample of 60 boxes. So we have

60 and both n1 and n2 are 29 and 31, so which is bigger than the magic number of 20 okay. So the management is interested now in testing at what level, at 20%, so what is my 20%, 20% is my significance level.

The hypothesis that the toys are randomly mixed. Now taking our significance level depends up on the choice of the researcher, at what level the researcher wants to test his hypothesis, mostly we take 1%, 5%, 10%, even 20% you can take. So in this case, he is taking 20%. What happens when you increase the significance level? It means that when you increase your alpha, that means what, the tendency to make your type one error is increasing.

So that means what, the manufacturer is taking a risk to rather lose the few of the good products rather than testing it again and again that is the literal meaning of it. So what is my null hypothesis. The toys are randomly mixed, it is random, so this is always my null hypothesis in the r test. What is my alternate, the toys are not randomly mixed. See, generally some people might be getting confused that we use the word not in case of a null, no, it is not like that.

We always have said whatever we want to disprove, that is my null hypothesis, most of the time right. So in this case what is the null hypothesis, toys are randomly mixed and we want to we want to see it is it is actually not random, so that is what we want to know. So what we want to know is my not randomly mixed is my alternate. Alpha is 20% and the value of 20%, that means what. If you go to the area under the curve, so how does it look, so this is let us say, remember one more thing, it is mostly the runs test is a two-tailed test.

Now why it is a two-tailed test, because it can be lesser than or it can be more than. So 0.10 here, 0.10 here, 20% I have divided, so this portion is my 0.40, 0.40 correct, so total mix of 100 or 1. So the value at 0.20, at 20% level of significance the alpha, the z value, the table value is 1.28, plus or minus 1.28.

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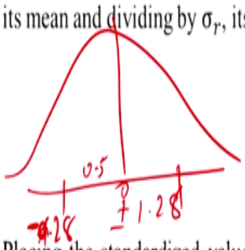
- Because too many or too few runs would indicate that the process by which the toys are inserted into the boxes is not random, a two tailed test is appropriate.
- We use following equations to standardize the sample r statistic, 29 , by subtracting μ_r , its mean and dividing by σ_r, its standard deviation.



$$z = (r - \mu_r)/\sigma_r$$
$$= 29-30.97$$
$$= -0.513$$

$$z = \frac{x-\mu}{\sigma_x}$$

- Placing the standardized value on the z scale shows that it falls well in the acceptance region (+/- 1.28)
- **Therefore, management should accept the null hypothesis and conclude from this test that toys are being inserted in boxes in random order.**

So because too many or too few runs would indicate that the process by which the toys are inserted into the boxes is not random, a two-tailed test is appropriate, that is what I was saying, is not random. So if it is not random, it could be either side correct, so that is why it is a two-tailed test and most of the time the runs test follows a two-tailed test. So we use the following equations to standardize the sample r statistics, twenty nine, by subtracting mu, its mean and dividing by so that is the formula..

If you remember z = z x, earlier we used to use this general formula upon the standard x standard error. So here instead of x we have the r, which we have the number of runs minus the mu and other things remain the same. So our value is -0.513, so it is towards the negative side, left tailed. Placing the standardized value on the z scale shows that it falls well in the acceptance region. Now what is my acceptance region, so z plus or minus 1.28, this is 0, so this -1.28, +1.28.

So where is our value lying, now minus, this is minus, this is minus, zero point let us say five, 0.5. So that means what therefore what should the management do? Since it is lying well within the range, the management cannot reject the null hypothesis, so he should accept the null hypothesis, actually the word should accept is not to be used, that is not the correct word, it should be said the management cannot reject the null hypothesis and conclude from this test the toys are being inserted into the boxes in a random order.

So what is it saying, the management accepts the null hypothesis that the toys were being put into the boxes or placed into the boxes in a random manner. So this is the first test that we talked about. So if you see the use of a runs test can be in many ways. So as you suppose in a shop or in a mall or in a quality control check, so wherever this kind of things are happening, whether the satisfaction or dissatisfaction level of customer in a store, so we want to just see whether the customer are happy or not and what is the occurrence of their happiness or unhappiness these things, so we use the runs test. I hope the runs test is clear to you.

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SIGN TEST

The next test that we talk about is called the sign test. Now what is the sign test? Now if you see the sign test is not a very powerful test although, but it has its own application. Now let us see what is the sign test.

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Sign Test

- Sign test is a test for examining differences in the location of two populations, based on paired observations , that compares only the signs of the differences between pairs of variables without taking into account the ranks.
- Its name comes from the fact that it is based on the direction (or signs for plus or minus) of a pair of observations, not on their numerical magnitude.

Assumptions

The data should be from two samples.

The two dependent samples should be paired or matched.

For example, depression scores from before a medical procedure and after.

The sign test is a test for examining differences in the location of 2 populations based on the paired observations that compares only the signs. So suppose somebody has got let us say in exam 29, another fellow has got 30, so let us if we compare, this is got more, so to say this so we will say suppose we are taking this as the choice, so plus. In another paper, this fellow has got let us say 28 and he has got 27, so minus. So when we are comparing this way, so we have a one reference group, so let us say 31, 20, and this is 29, so again minus.

So we are doing this. It compares the sign of the differences between the pair of variables without taking into account the ranks. So the ranks are not to be taken here, it is only the sign. Its name comes from the fact that it is based on the direction of a prior of observations not on the numerical magnitude, so that is right since there is no numerical magnitude, this test is not a very strong test although, I will show you there is another test called Wilcoxon signed-rank test that is more powerful than this one, but still let me explain both of these tests, and you can use this one also for your academic researches.

Assumptions; data should be from 2 samples. So there are 2 sample groups, let us say group 1, group 2. The 2 dependent samples should be paired or matched, so you are pairing or you are comparing, so that is what we are doing, so we are comparing one against the other. For example, depression scores from before a medical procedure and after. If you remember when we were talking about the parametric tests, so when we were saying suppose a medicine is being given to a person to reduce his blood pressure, what we were doing?

We were checking the blood pressure before of a set of patients, may be a 40 patients, 50 patients, and then we were giving them the drug and after a month or 2 month or something a time period, we were again checking the blood pressure of the patients and seeing whether there is a significant difference. If there is difference, you would to say that it is because of the impact of the medicine right. So it is a similar test, only thing is here we are taking only the sign, but otherwise the procedure or the thinking process remains the same.

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PROBLEM

- Consider the result of a test panel of 40 college juniors evaluating the effectiveness of two types of classes: large lectures by full professors and small sections by graduate assistants.
- The responses to this request : "Indicate how you rate the effectiveness in transmitting knowledge of these two types of classes by giving them a number from 4 to 1. A rating of 4 is excellent and 1 is poor".
- In this case , the sign test can help us determine whether students feel there is a difference between the effectiveness of the two types of classes.
- The evaluation of two teaching methods is converted into signs.
- Here, a plus sign means the student prefers large lectures , a minus sign indicates a preference for small sections, and a zero represents a tie (no preference).

+ – 0

Let us take a problem. Consider the result of a test panel of 40 college juniors evaluating the effectiveness of 2 types of classes, large lectures by full professors and small sections by graduate assistants. So in a college, you must have also faced this situation many a times, the lectures have been taken by full professors almost all the time, but sometimes the graduate assistants also do help the professors and they help in taking some tutorials and some classes okay.

So they wanted to check whether the effectiveness of these 2 types of classes are same or there is some difference because we always cannot say that a professor only teaches well and the assistants are not that good because may be the assistant is also going to be a professor, he might be a very intelligent boy or a person so or a girl. So in such a condition, let us check whether the effectiveness of these 2 types of classes remains the same or is it different.

The responses to this request indicate how you rate the effectiveness in transmitting knowledge of these 2 types of classes by giving them a number from 4 to 1 right, a rating of 4 is excellent and 1 is poor. Suppose I have taken a class and you give me a rate of 4 then it is an excellent class, suppose you give a rate of 1, it is not a good class, a poor class. In this case the sign test can help us determine whether students feel there is a difference between the effectiveness of the 2 types of classes, one taken by the lecture, the professors, and other by the graduate assistants.

The evaluation of these 2 teaching methods is converted into signs okay. So you have given a score and from these scores we will develop the signs. Here a plus sign means the student prefers large lectures taken by the lectures, a minus sign indicates a preference for small sections and a 0 represents a tie no preference. So what is it saying? Large lectures if it is preference plus, if it is preference for small sections or taken by the graduate assistants minus, and no preference then it is a tie, 0.

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Evaluation of 40 students of two types of classes

Panel member number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Score for large lectures (1)	2	2	4	4	3	3	4	2	4	1	3	3	4	4	4	1	1	2	2	4
Scores for small lectures (2)	3	2	2	3	4	2	2	1	3	1	2	3	4	4	3	2	3	2	3	3
Sign of score 1 minus score 2	-	0	+	+	-	+	+	+	+	0	+	0	0	0	+	-	-	0	-	+

Panel member number	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Score for large lectures (1)	4	4	4	3	3	2	3	4	3	4	3	1	4	3	2	2	2	1	3	3
Scores for small lectures (2)	1	4	3	3	2	2	1	1	1	3	2	2	4	4	3	3	1	1	4	2
Sign of score 1 minus score 2	+	0	+	0	+	0	+	+	+	+	+	-	0	-	-	-	+	0	-	+

So let us take this 40 students. So 1, 2, 3, 4, up to 20 you can see here. Then 21, 22, goes up to 40 here. So the first case, the student gives for the large lecture a score of 2 and for here for the small lecture he gives a score of 3, so the large lectures are being taken by the professor now the graduate assistants are taking only few students, may be 5, 10 small sections, so may be the are able to focus on them on a one to one basis individually, so may be the students like them. So what is this sign of the score, now 2-1 is minus, so this is a minus.

Second case, here also gets a 2, here also gets 2. So in this this should have been 0 actually right, it should have been 0 right. So it is 4, 2 in this case, so it is a plus okay; 4, 3 plus; 3, 4 minus. So you can understand 3, 2 plus, so the preference is here, the preference is again here, preference is here, preference is here, there is no preference the tie as it was a tie here, so here again preference, no preference, no preference, no preference, preference, this one is a preference here, this one is a preference, no preference, it goes on right, so you can see you can carry on so till the fortieth you have done.

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Analysis of table provides that:

- Number of + signs = 19
- Number of – signs = 11
- Numbers of 0s = 10
- **Total sample size = 40**

So analysis of the table provides, if I do not whether I have to correct this one or not, anyway let us not, it is just a number. So let us say the number of positive signs if you add, now these are the positive signs, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 right. So let us say the 19 is the number of signs positive and 11 signs were negative. So it could be now it can be different also, I do not whether we can change it, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, so it is now 10 right and this automatically 19+10 = 29, then it becomes 11 right, that can be changed.

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- We are using the sign test to determine whether our panel can discern a real difference between the two types of classes.
- Because we are testing perceived differences , we shall exclude tie evaluation (0s).
- We can se that we have 19 plus sign and 11 minus signs, for a total of 30 useable responses.
- If there is no difference between the two types of classes , p (the probability that the first score exceeds the second score) would be 0.5 and we would expect to get about 15 plus signs and 15 minus signs.
- We would set up our hypotheses like this :
  Ho: $p = 0.5$ (No difference between two type of classes)
  H1: $p \neq 0.5$ (There is difference between two type of classes)

So let us say because I have already solved it, so let us keep it as it is. We are using the sign test to determine whether our panel can design a real difference between the 2 types of classes. So what is the objective, to find out whether there is a real difference existing between the 2 types of classes, the professor's large one and the graduate assistant's small one. Because we are testing perceived differences, we shall exclude the tie evaluation, that is the 0. So we can have 19 plus signs and 11, it is now 10 actually, assume it is 11 right for a total of 30 useable responses.

If there is no difference between the 2 types of classes, the probability that the first score exceeds the second score would be 0.5 and would expect to get about 15 plus and 15 minus. So what is my null hypothesis. My null hypothesis says no difference between the 2 type of classes, this is generally how we frame the null hypothesis. So what is the probability, 50%, 50%, so 0.5, 0.5. Second case is my alternative where it is saying there is difference between the 2 types of classes, so my p is not equal to 0.5, so it may be more for someone, less for the other.

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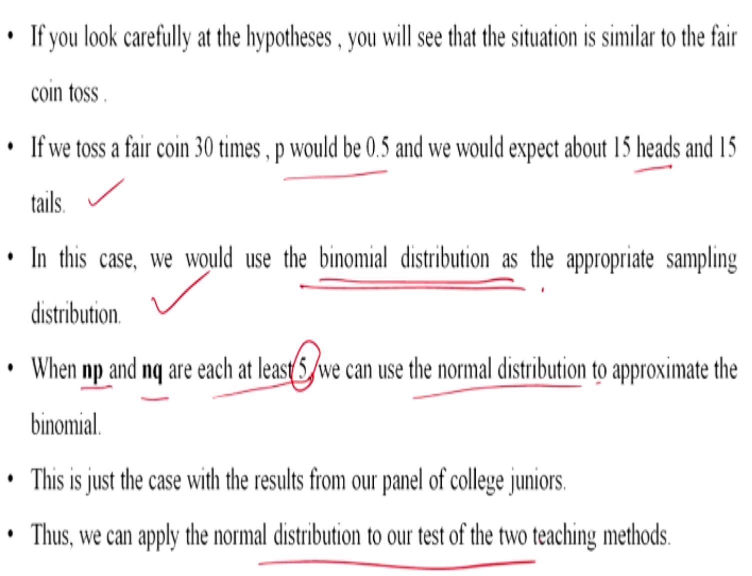

If you look carefully at the hypothesis, you will see that the situation is similar to the fair coin toss, which generally in a binomial distribution we talk about tossing a coin and what is the result coming up. So if we toss a fair coin 30 times, p would be 0.5, the null hypothesis and would expect about 15 heads and 15 tails, that is what is my probability of the null hypothesis. In this case, we would use the binomial distribution that is what I am talking about as a appropriate sampling distribution, because it is only a yes or no right.

When np and nq are each at least 5, we can use the normal distribution to approximate the binomial. So if you remember, we had also done this earlier when we were talking about testing a hypothesis based on proportions, if you remember, just you can go back to your earlier slides also or earlier notes. This is just the case with results from our panel of college juniors, thus we can apply the normal distribution to our test because we have more than 5.

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Therefore,

p_{Ho} = 0.5 (hypothesized proportion of the population that prefers large lectures)

q_{Ho} = 0.5 (hypothesized proportion of the population that prefers small lectures)

n = 30 (sample size)

$\bar{p}$ = 0.633 (proportion of success in the sample {19/30}

$\bar{q}$ = 0.367(proportion of failure in the sample {11/30}

So my null hypothesis is 0.5, my alternate let us say the ones the hypothesized proportion of population that prefers large lectures is 0.5, for small lectures is again 0.5, my n is 30, 19+11, my p the rate of success is 19/30, so you remember the number of success of the lectures is 19 positive, so 19/30. What is the failure, now failure is 11, obviously if the total is 30, 19 is my success, then obviously 11 is left, so 11/30.

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- Suppose the chancellor's office wants to test the hypothesis that there is no difference between student perception of the two types of classes at the 0.05 level of significance.
- The first step is to calculate the standard error of the proportion:

$$\sigma_p = \sqrt{pq/n}$$
$$= \sqrt{0.5 * 0.5/30}$$
$$= \sqrt{0.00833}$$
$$= 0.091$$

Suppose the chancellor's office wants to test the hypothesis that there is no difference between student perception of the 2 types of classes at the 5% level of significance, let us calculate. So what is the formula. Standard error of proportion is root over of p x q/n, so 0.5 x 0.5/30 so this gives me a 0.091. What else do we require?

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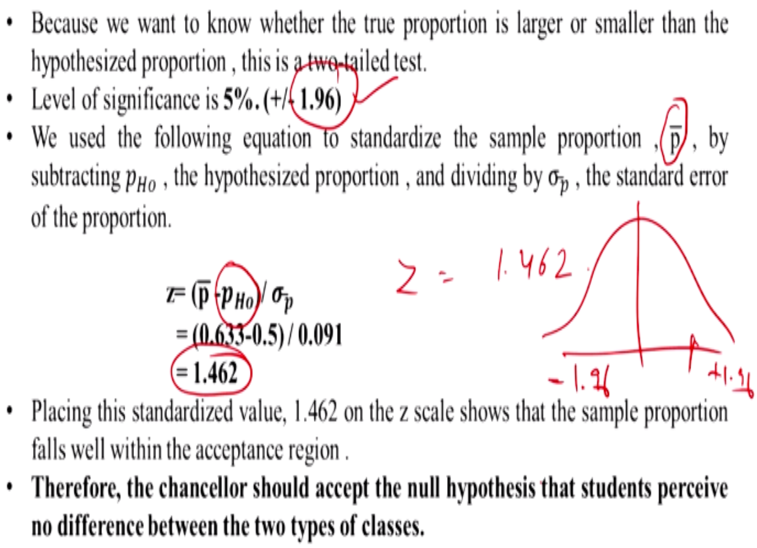

So because you want to know whether the true proportion is larger or smaller than the hypothesized proportion, this is a two-tailed test because it can fall on either side, to the left side or right side. Level of significance is 5% so the table value of 1.96 plus or minus. So the equation is now z is equal to what is the equation. We use the following equation to standardized the sample proportion p bar by subtracting pH0, so that means this is the observed you can say, this is the mean as you compare with that.

So the p bar – pH0 hypothesized/ standard of proportion gives me a value of 1.462, so the z value that we calculate is now 1.462. So if you put this value on the standardized on the compare on the z scale, it shows that this is within the boundary, that is it is less within the 1.96 range. So +1.96, -1.96, so it is within this range, so somewhere here it is falling. So therefore, the chancellor should accept the null hypothesis that students perceived no difference between the 2 types of classes.

So through the signs test, you can also find out whether the preference for a product or a service is there or not, in this case which lecture is better, the lecturer one or let us say the graduate student one. So you can do this through a sign rank test. So what I will do is, I think we have done 2 tests today. So we have first done with the runs test right which has own application and utility.

Then we started with the sign test and we said the sign test may not be a very powerful test, but it has its own application and it is very interacting that today by just comparing 2 values or 2 different parameters and through the developing signs, you can check the hypothesis, whether the null hypothesis is to be accepted or is to be rejected or the alternate has to be accepted. Anyway, so I think I have tried to make it clear and we have understood the following 2 tests.

In the next lecture, we will discuss about we will continue with some more nonparametric test and then we will move to something else. Thank you very much, have a wonderful time.