We looked at an introduction to hypothesis testing concepts. Let's look at our basic frame work for a hypothesis test.

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Every time we have done a hypothesis test, we have done it in exactly the same way. First we set up what is called a null hypothesis (H^0). The null hypothesis is the hypothesis that any observed variation in a sample is simply because of random chance. When I say observed variation, any difference in the sample outcome mean that's different from an expected population outcome. We say that it is only because of random chance.

If we use our quality control example, essentially the null hypothesis for the quality control example is that there is no problem with the production process even though it generated a sample with a mean weight of 2.68. The 2.68 we are saying is simply because of random chance variation. The null hypothesis, a null stands for zero, essentially says zero difference, a zero impact and every time the null hypothesis is set up the same way.

We also set up what is called an alternate hypothesis (H^A) and the alternate hypothesis is a negation of the null hypothesis. So in the quality control example, we will say the alternate hypothesis is that there is a problem with the production process. It is producing more than the specified weight.

Once we have a null hypothesis and an alternate hypothesis, we have to choose between the two. Remember these are like the two possible explanation that we had reviewed in an earlier example. If you remember the airline no-show we had said the sample showed us 3.7% and there were two possible explanations for 3.7%.

One possible explanation is that 3.7% is simply the outcome of random chance variation. That is equivalent to the null hypothesis. The second possible explanation was that the 3.7% tells us that there is a difference in the no-show rate. It has reduced and that is essentially the same as this alternate hypothesis. Remember our job is to decide which one we want to believe, the null hypothesis or the alternate hypothesis.

In order to do that we have to calculate a probability of observing this sample outcome simply because of random variation and in order to do that to calculate the probability we have to use the appropriate distribution. That is the test distribution in a hypothesis test.

What is the right distribution to use on the basis of the random variable in order to calculate probability? In the example that we had reviewed of quality control, the right distribution was to use normal because we were told that the data is normally distributed. Sometimes we may already have this information and sometimes we may have to derive this information based on the random variable and its outcome. But we must make sure that we are using the right test distribution

because otherwise the probability we can calculate may not be appropriate.

So far you know hypothesis test, we have understood that what is a null hypothesis and what is an alternate hypothesis, and what is the test distribution.

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We also need to think about the significance level. What is significance level? Essentially we are trying to choose between the null hypothesis and the alternate hypothesis on the basis of the probability of the observed outcome being driven by random chance.

Remember we also said in order to choose, we need an objective level of probability cut-off that is going to help us decide between null and an alternate and typically that is set to 5%. So the significance level are alpha (α) is the criteria used for reject the null hypothesis and usually it is set to 5%.

What is it mean to reject the null hypothesis? If the random chance probability of the observed outcome is less than 5% then we will conclude that they really is a difference between the sample and the population. In other words we are rejecting the null hypothesis that there is no difference between sample and population.

So the significance level is the criteria that is used for rejecting the null hypothesis and most often it

is set to 5%. However 5% is not a magic number or not the number that is used all the times. It is the most commonly used criteria, but sometimes people will change the level of (α) depending on business need and we will discuss this in a later set of examples.

Finally we calculate a p-value. A p-value is the probability of outcomes as extreme or more extreme than the sample outcome assuming that the null hypothesis is true. This is very important to understand. We are saying what is the probability that I will see sample average weights of 2.68 or greater, if I am really picking a samples from a population whose mean weight is 2.5 lbs.

So if I was speaking samples from an underlying population and the null hypothesis was true, there is no difference between sample and population. How likely is it that I will end up in seeing outcome as extreme or more extreme than the observed outcome? In the quality control example, that would be outcomes where weights are greater than 2.68.

In the airline example extreme outcome would be 3.7 or lower. How likely is it that simply because of random chance? I will see no-show percentages of 3.7 or lower. Remember extreme or more extreme than the observed outcome and the keyword here is extreme not greater than or less than but extreme as extreme or more extreme.

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Now what happens if your p-value is greater than the significance level? Remember if the p-value is less than the significance level, we reject the null hypothesis. If the p-value is not less than the significance level, we will accept the null hypothesis.

Let's recap this framework of hypothesis testing using the quality control example.

- Setup a null hypothesis. There is no problem with the process.
- Set up an alternate hypothesis. There is a problem with the process. Sample weights are higher than the population weights.
- What test distribution should be used? Data is distributed normally. We will use a normal distribution.
- What significance level should be set up? Let's use the most common significance level (α) of 5%.
- We need to calculate a p-value. Remember we want to calculate a p-value using a normal distribution function of the probability that I will see sample average weights of 2.68 or greater when my population mean is 2.5 and the standard deviation is 0.12 and the answer is 0.07. So now we compare the p-value to the significance level and remember we will reject the null hypothesis only if the p-value is less than the significance level.

  In this case the p-value of 0.07 is higher than the significance value of 0.05. Therefore we will not reject the null

hypothesis. In other words we will conclude that there is no problem with the process. That the variation that we are seeing is random chance variation and this is a hypothesis test.

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