**Null hypothesis, p-value, confidence Interval and level of significance**

The terms null hypothesis (H0), p-value otherwise known as probability value, confidence interval (C.I) and level of significance (α) are inter-related.

For any statistical testing we define two hypotheses, null hypothesis (H0) and the alternative hypothesis (H1). The null hypothesis, in general is a normal situation stating that the changes (whatever we are testing for) has no effect. However, the alternative hypothesis is the other way around. It signifies that the changes have effect on the outcomes.

Then there comes level of significance (α) and the p-value. We can say the term level of significance (α) is a threshold to judge the null hypothesis (H0). The choice of level of significance (α) is arbitrary. Typically, a small number i.e. percentage like 1% (.01), 5% (.05), 10% (.1) etc.

How do we do it? how do we judge the null hypothesis (H0)? Well, we judge the null hypothesis based on the p-value that we calculate form the before changes and after changes dataset. The p-value is the probability of a test statistic assuming the null hypothesis (H0) is true.

Now how confident are you about your statement. This is when confidence interval comes in. Generally, confidence intervals (C.I) are 99%, 97%, 95%, 90% etc. calculated as 1 – α. Basically, whatever is left after subtracting the level of significance (α).

Decision making:

If the p-value < level of significance (α): We reject the null hypothesis i.e. we have enough evidence to assume the alternative hypothesis(H1) is true.

And If the p-value ≥ level of significance (α): We do not reject the null hypothesis i.e. we have enough evidence to support the null hypothesis(H0).

So basically, the smaller the p-value the greater the evidence against the null hypothesis.

Example:

Let’s say a company has done some machine upgrades. Now we are to test if the upgrade has effectively increased the production or not. Let’s say, mean production per hour was 300 items before upgrade

So, our hypotheses would be,

Null hypothesis (H0): 300, There is no change in production due to the upgrade. (Remember H0 is the normal situation)

Alternative hypothesis (H1): 300, The upgrade in machines has increased production.

So, we have mean production per hour was 300 items before upgrade. Let’s take few more samples after upgrade and find the mean production per hour. Let’s denote it by and = 325 and calculate p-value. Let’s assume we have chosen the level of significance (α) as 5% (.05).

P-value = p ( ≥ 325 | 300(the null hypothesis is true))

Now if this

p-value < .05(α): We reject the null hypothesis i.e. we have enough evidence to assume the alternative hypothesis (H1: 300) is true.

Or if

P-value ≥ .05 (α): We do not reject the null hypothesis i.e. we have enough evidence to support the null hypothesis (H0 : 300) is true.

One very important fact to know that:

p (observed | H0 is true) ≠ p (H0 is true | observed).

The confidence interval (1- α) is the range that states that percentage of the times the new observations will fall in that range. Since ours is .05 we can say that if we take 100 samples 95 of them would fall in our interval.