**Overview of Hypothesis Testing**

1. State the null and alternative hypotheses

Example (coin toss – is the coin biased)

H0: p = 0.50

HA: p != 0.50

where p is the probability of getting heads.

1. Carry out an experiment to get a sample statistic (e.g., sample proportion), whose distribution is known under H0.
2. Convert the sample statistic to a test statistic (e.g., convert to a z score), whose distribution is also known under H0.
3. Calculate a p-value, which is the probability that the test statistic differs from its expected value by as much as it does (or more).

If we flip a coin 100 times, and get 62 heads, the P-value is the probability that we observe at least 12 heads more or less than what is expected by chance (assuming the null hypothesis – that the coin is fair – is true)

The corresponding Z-statistic is 2.4 (or 2.3 with the continuity correction).

The p-value is the probability that a random sample from the standard normal distribution is at least 2.4 away from 0.

Note that the Z score is the number of standard deviations from the mean.

So the p-value in this case is the probability that under the null hypothesis, the observed proportion of heads would be more than 2.4 standard deviations away from the mean (or expected proportion of heads).

1. Make a decision regarding H0.

If p -value < 0.05, we would reject H0 and conclude that the coin was biased

If p-value > 0.05., we would fail to reject H0 and conclude that there is not sufficient evidence that the coin is biased.

In the color-blind example, the proportion of color-blind males is about 0.098 and the proportion of color blind females is about 0.0068.

This is a difference of 0.098 – 0.0068 = 0.0912.

The p-value is the probability that the difference (in absolute value) between the sample proportions is at least 0.0912 (assuming that the null hypothesis – that there is no difference in colorblind rates between males and females – is true)

The corresponding Z-statistic is 10.9. The p-value is the probability that a normally distributed observations is 10.9 standard deviations or more from the mean.

*Let’s do the same thing but for a 1-sample t-test*

1. State the null and alternative hypotheses

Example (does GPA of a specific class significantly differ from 3.3, which is a B+)

H0: mu = 3.3

H1: mu != 3.3,

where mu is the mean GPA

1. Carry out an experiment to get a sample statistic (e.g., sample mean), whose distribution is known under H0 (this would be true if the standard deviation was known).
2. Convert the sample statistic to a test statistic (e.g., convert to a t statistic), whose distribution is also known under H0.
3. Calculate a p-value, which is the probability that the test statistic differs from its expected value by as much as it does (or more).

In a sample of 19 students, the mean GPA is about 3.37, which differs from the expected mean by 3.37 – 3.30 = 0.07. The P-value is the probability that our observed GPA is 0.07 more or less than what is expected by chance (assuming the null hypothesis – that the mean GPA is 3.3 – is true)

The corresponding t-statistic is 0.934. The p-value is the probability that a random sample from the t distribution (with 19 – 1 degrees of freedom) is at least 0.07 away from 0.

So the p-value in this case is the probability that under the null hypothesis, the observed sample mean is more than 0.934 sample standard deviations away from the expected mean.

1. Make a decision regarding H0.