Variorum Multi-Disciplinary e-Research Journal
Vol.,-05, Issue-II, May 2014

Hypothesis Testing through One Way of Analysis of Variance

Mr. Rajdhar Chaitaram Bedse: Research Scholar, JJT University Rajasthan

Dr. Balwant Singh: Research Guide, JJT University Rajasthan

Abstract

One way Analysis of Variance (ANOVA) is a hypothesis-testing technique used to test the equality of two or more population (or treatment) means by examining the variances of samples that are taken. The aims of hypothesis testing is to determine the likelihood that a population parameter, such as the mean, is likely to be true. ***Hypothesis testing*** *or* ***significance testing*** *is a method for testing a claim or hypothesis about a parameter in a population, using data measured in a sample. In this method, we test some hypothesis by determining the likelihood that a sample statistic could have been selected, if the hypothesis regarding the population parameter were true. The method of hypothesis testing can be summarized in four steps.* ***First*** *is, to begin, we identify a hypothesis or claim that we feel should be tested.* ***Second****, select a criterion upon which we decide that the claim being tested is true or not.* ***Third****, select a random sample from the population and measure the sample mean. Finally, Compare what we observe in the sample to what we expect to observe if the claim we are testing is true I, concluded that, hypothesis is one of the fundamental tools for research in any kind of investigation.*

Keywords: Hypothesis testing, ANOVA, test statistic, alternative hypothesis, Null hypothesis

Introduction:

The research process begins and ends with the hypothesis. It is core to the entire procedure and, therefore, is of the utmost importance. A hypothesis is an educated guess, based on the probability of an outcome. Scientists formulate hypotheses after they understand all the current research on their subject. Hypotheses specify the relationship between at least two variables, and are testable. For a hypothesis to function properly, other scientists must be able to reproduce the results that prove or disprove it. Two types of hypotheses exist: a null hypothesis, and a alternative hypothesis. In scientific research, there are a wide variety of different types of hypotheses that may need to be tested using the results of one or more experiments. In this paper, i shall formalize the procedure to be used in hypothesis testing. Although the procedure may seem a little rigid, it can be adopted for almost any situation.

Hypothesis testing is equivalent to the geometrical concept of hypothesis negation. That is, if one wishes to prove that the hypothesis is true, one first assumes that it isn't true. In the case of hypothesis testing the hypothesis may never be proven; rather, it is decided that the model of no effects is unlikely enough that the opposite hypothesis, that of real effects, must be true.

Four steps to hypothesis testing:

The goal of hypothesis testing is to determine the likelihood that a population parameter, such as the mean, is likely to be true. In this section, I describe the four steps of hypothesis testing are as follows.

Step 1: State the hypotheses.

Step 2: Set the criteria for a decision.

Variorum Multi-Disciplinary e-Research Journal
Vol.,-05, Issue-II, May 2014

Step 3: Compute the test statistic.

Step 4: Make a decision.

Step 1: State the hypotheses. Begin by stating the value of a population mean in a **null hypothesis or statistical hypothesis,** which we presume is true. This is stated in the null hypothesis. The basis of the decision is to determine whether this assumption is likely to be true. "*The **null hypothesis (H0)**, stated as the **null**, is a statement about a population parameter, such as the population mean, that is assumed to be true. The null hypothesis is a starting point. In other words null hypothesis state that there is no significant difference or relation between more than two or two means .We can test whether the value stated in the null hypothesis is likely to be true".*

It is worth mentioning here that, the only reason to testing the null hypothesis is because we think it is wrong. We state what we think is wrong about the null hypothesis in an **alternative hypothesis.** An **alternative hypothesis (H_1)** is a statement that directly contradicts a null hypothesis by stating that that the actual value of a population parameter is less than, greater than, or not equal to the value stated in the null hypothesis.
The alternative hypothesis states what we think is wrong about the null hypothesis, which is required for Step 2.

Step 2: Set the criteria for a decision. To set the criteria for a decision, I state the **level of significance** for a test. The likelihood or level of significance is typically set at 5% in behavioral research studies. When the probability of obtaining a sample mean is less than 5% if the null hypothesis were true, then we conclude that the sample we selected is too unlikely and so we reject the null hypothesis. "***Level of significance**, or significance level, refers to a criterion of judgment upon which a decision is made regarding the value stated in a null hypothesis. The criterion is based on the probability of obtaining a statistic measured in a sample if the value stated in the null hypothesis were true*". In behavioral science, the criterion or level of significance is typically set at 5%. When the probability of obtaining a sample mean is less than 5% if the null hypothesis were true, then we reject the value stated in the null hypothesis. The alternative hypothesis establishes where to place the level of significance. Remember that we know that the sample mean will equal the population mean on average if the null hypothesis is true. All other possible values of the sample mean are normally distributed. The empirical rule tells us that at least 95% of all sample means fall within about 2 standard deviations (*SD*) of the population mean, meaning that there is less than a 5% probability of obtaining a sample mean that is beyond 2 *SD* from the population mean.

Step 3: Compute the test statistic. I use a **test statistic** to determine this likelihood**.** Specifically, a test statistic tells us how far, or how many standard deviations, a sample mean is from the population mean. The larger the value of the test statistic, the further the distance, or number of standard deviations, a sample mean is from the population mean stated in the null hypothesis. The **test statistic** is a mathematical formula that allows researchers to determine the likelihood of obtaining sample outcomes if the null hypothesis were true. The value of the test statistic is used to make a decision regarding the null hypothesis.

Step 4: Make a decision. I use the value of the test statistic to make a decision about the null hypothesis. The decision is based on the probability of obtaining a sample mean, given that the value stated in the null hypothesis is true. If the probability of obtaining a sample mean is

Variorum Multi-Disciplinary e-Research Journal
Vol.,-05, Issue-II, May 2014

less than 5% when the null hypothesis is true, then the decision is to reject the null hypothesis. If the probability of obtaining a sample mean is greater than 5% when the null hypothesis is true, then the decision is to retain the null hypothesis. In sum, there are two decisions a researcher can make:

1. Reject the null hypothesis. The sample mean is associated with a low probability of occurrence when the null hypothesis is true.
2. Retain the null hypothesis. The sample mean is associated with a high probability of occurrence when the null hypothesis is true.

The probability of obtaining a sample mean, given that the value stated in the null hypothesis is true, is stated by the ***p* value.** The *p* value is a probability: It varies between 0 and 1 and can never be negative. In Step 2, we stated the criterion or probability of obtaining a sample mean at which point we will decide to reject the value stated in the null hypothesis, which is typically set at 5% in behavioral research. To make a decision, we compare the *p* value to the criterion we set in Step 2."*A **p value** is the probability of obtaining a sample outcome, given that the value stated in the null hypothesis is true. The p value for obtaining a sample outcome is compared to the level of significance **Significance**, or **statistical significance**, describes a decision made concerning a value stated in the null hypothesis. When the null hypothesis is rejected, we reach significance. When the null hypothesis is retained, we fail to reach significance*."

When the *p* value is less than 5% ($p < .05$), I reject the null hypothesis. I will refer to $p < .05$ as the criterion for deciding to reject the null hypothesis, although note that when $p = .05$, the decision is also to reject the null hypothesis. When the *p* value is greater than 5% ($p > .05$), we retain the null hypothesis. The decision to reject or retain the null hypothesis is called **significance.** When the *p* value is less than .05, we reach significance; the decision is to reject the null hypothesis. When the *p* value is greater than .05, we fail to reach significance; the decision is to retain the null hypothesis.

Meanwhile, Analysis of Variance (ANOVA) is a hypothesis-testing technique used to test the equality of two or more population (or treatment) means by examining the variances of samples that are taken. ANOVA allows one to determine whether the differences between the samples are simply due to random error (sampling errors) or whether there are systematic treatment effects that cause the mean in one group to differ from the mean in another. Most of the time ANOVA is used to compare the equality of three or more means, however when the means from two samples are compared using ANOVA it is equivalent to using a t-test to compare the means of independent samples. ANOVA is based on comparing the variance (or variation) *between* the data samples to variation *within* each particular sample. If the between variation is much larger than the within variation, the means of different samples will not be equal. If the between and within variations are approximately the same size, then there will be no significant difference between sample means.

Assumptions of ANOVA:

(i) All populations involved follow a normal distribution.

(ii) All populations have the same variance (or standard deviation).

(iii) The samples are randomly selected and independent of one another.

Finally, ANOVA assumes the populations involved follow a normal distribution, ANOVA falls into a category of hypothesis tests known as parametric tests. If the populations involved did not follow a normal distribution, an ANOVA test could not be used to examine the

Variorum Multi-Disciplinary e-Research Journal
Vol.,-05, Issue-II, May 2014

equality of the sample means. Instead, one would have to use a non-parametric test (or distribution-free test), which is a more general form of hypothesis testing that does not rely on distributional assumptions.

References:

Armitage P, Berry G, Matthews JNS. Statistical Methods in Medical Research. 4. Oxford, UK: Blackwell Science; 2002

Armstrong, J. Scott (2007). "Significance tests harm progress in forecasting". *International Journal of Forecasting* **23** (2): 321–327

Bewick V, Cheek L, Ball J. Statistics review 7: Correlation and Regression. Crit Care. 2003;7:451–459. doi: 10.1186/cc2401. [PMC free article] [PubMed] [Cross Ref]

Bland M. An Introduction to Medical Statistics. 3. Oxford, UK: Oxford University Press; 2001.

Chow, Siu L. (1997). *Statistical Significance: Rationale, Validity and Utility*. ISBN 0-7619-5205-5.

E. L. Lehmann (1997). "Testing Statistical Hypotheses: The Story of a Book". *Statistical Science* **12** (1): 48–52

Hazewinkel, Michiel, ed. (2001), "Statistical hypotheses, verification of", *Encyclopedia of Mathematics*, Springer, ISBN 978-1-55608-010-4

Howell, David (2002). *Statistical Methods for Psychology* (5 ed.). Duxbury. p. 94. ISBN 0-534-37770-X

Le Gall JR, Lemeshow S, Saulnier F. A new simplified acute physiology score (SAPS II) based on a European/North American multicenter study. JAMA. 1993;270:2957–2963. doi: 10.1001/jama.270.24.2957. [PubMed] [Cross Ref]

Lehmann E.L. (1992) "Introduction to Neyman and Pearson (1933) On the Problem of the Most Efficient Tests of Statistical Hypotheses". In: *Breakthroughs in Statistics, Volume 1*.

Lehmann, E.L.; Romano, Joseph P. (2005). *Testing Statistical Hypotheses* (3E ed.). New York: Springer. ISBN 0-387-98864-5.

Montgomery DC. Design and Analysis of Experiments. 4. New York, USA: Wiley; 1997.

Moore, David (2003). *Introduction to the Practice of Statistics*. New York: W.H. Freeman and Co. p. 426.ISBN 9780716796572

Neyman, J.;Pearson, E.S. (1933)."On the Problem of the Most Efficient Tests of Statistical Hypotheses". *Philosophical Transactions of the Royal Society A* **231** (694–706): 289–337.doi:10.1098/rsta.1933.0009

Variorum Multi-Disciplinary e-Research Journal
Vol.,-05, Issue-II, May 2014

Nickerson, Raymond S. (2000). "Null Hypothesis Significance Tests: A Review of an Old and Continuing Controversy". *Psychological Methods* **5** (2): 241–301.

Oakes, Michael (1986). *Statistical Inference: A Commentary for the Social and Behavioural Sciences*. Chichester New York: Wiley. ISBN 0471104434.

Triola, Mario (2001). *Elementary statistics* (8 ed.). Boston: Addison-Wesley. p. 388. ISBN 0-201-61477-4

Whitely E, Ball J. Statistics review 5: Comparison of means. Crit Care. 2002;6:424–428. doi: 10.1186/cc1548. [PMC free article] [PubMed] [Cross Ref]

Wilson González, Georgina;Kay Sankaran (1997). "Hypothesis Testing". *Environmental Sampling & Monitoring Primer*. Virginia Tech.