

How do you perform a t-test with unequal sample sizes?

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A t-test is a statistical method used to compare the means of two groups. When dealing with unequal sample sizes, there are a few steps to follow to perform a t-test accurately.

First, the samples must be independent and randomly selected from their respective populations. Next, the variances of the two groups must be compared using a test of equality of variances, such as Levene's test. If the variances are found to be significantly different, then a modified t-test called the Welch's t-test should be used instead of the traditional t-test.

Once the appropriate t-test has been determined, the test statistic and p-value should be calculated using the formula for the chosen test. The results can then be interpreted to determine if there is a significant difference between the means of the two groups.

In summary, performing a t-test with unequal sample sizes involves ensuring the independence and random selection of samples, testing for equality of variances, and using the appropriate t-test formula to calculate the test statistic and p-value. This method allows for accurate comparison of means between two groups with unequal sample sizes.

Perform a t-test with Unequal Sample Sizes

One question students often have in statistics is:

Is it possible to perform a t-test when the sample sizes of each group are not equal?

The short answer:

Yes, you can perform a t-test when the sample sizes are not equal. Equal sample sizes is not made in a t-test.

The real issues arise when the two samples do not have equal variances, which *is* one of the assumptions made in a t-test.

When this occurs, it's recommended that you use `var.equal = FALSE` instead, which does not make the assumption of equal variances.

The following examples demonstrate how to perform t-tests with unequal sample sizes when the variances are equal and when they're not equal.

Example 1: Unequal Sample Sizes and Equal Variances

Suppose we administer two programs designed to help students score higher on some exam.

The results are as follows:

Program 1:

n (sample size): 500x (sample mean): 80s (sample standard deviation): 5

Program 2:

n (sample size): 20x (sample mean): 85s (sample standard deviation): 5

The following code shows how to create a boxplot in R to visualize the distribution of exam scores for each

program:

#make this example reproducible

set.seed(1)

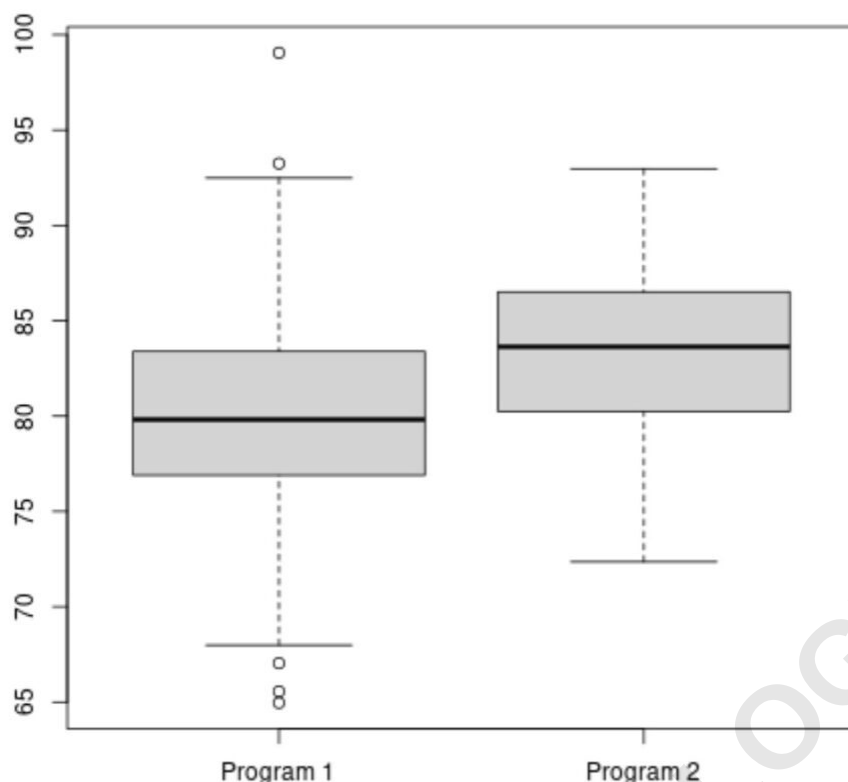
#create vectors to hold exam scores

program1 <- rnorm(500, mean=80, sd=5)

program2 <- rnorm(20, mean=85, sd=5)

#create boxplots to visualize distribution of exam scores

boxplot(program1, program2, names=c("Program 1","Program 2"))



The following code shows how to perform an independent samples t-test along with a Welch's t-test:

```
#perform independent samples t-test  
t.test(program1, program2, var.equal=TRUE)
```

Two Sample t-test

data: program1 and program2

$t = -3.3348$, $df = 518$, $p\text{-value} = 0.0009148$

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-6.111504 -1.580245

sample estimates:

mean of x mean of y

80.11322 83.95910

#perform Welch's two sample t-test

t.test(program1, program2, var.equal=FALSE)

Welch Two Sample t-test

data: program1 and program2

t = -3.3735, df = 20.589, p-value = 0.00293

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-6.219551 -1.472199

sample estimates:

mean of x mean of y

80.11322 83.95910

The independent samples t-test returns a p-value of .0009 and Welch's t-test returns a p-value of .0029.

Since the p-value of each test is less than .05, we would reject the null hypothesis in each test and conclude that

there is a statistically significant difference in mean exam scores between the two programs.

Even though the sample sizes are unequal, the independent samples t-test and Welch's t-test both return similar results since the two samples had equal variances.

Example 2: Unequal Sample Sizes and Unequal Variances

Suppose we administer two programs designed to help students score higher on some exam.

The results are as follows:

Program 1:

n (sample size): 500x (sample mean): 80s (sample standard deviation): 25

Program 2:

n (sample size): 20x (sample mean): 85s (sample standard deviation): 5

The following code shows how to create a boxplot in R to visualize the distribution of exam scores for each

program:

#make this example reproducible

set.seed(1)

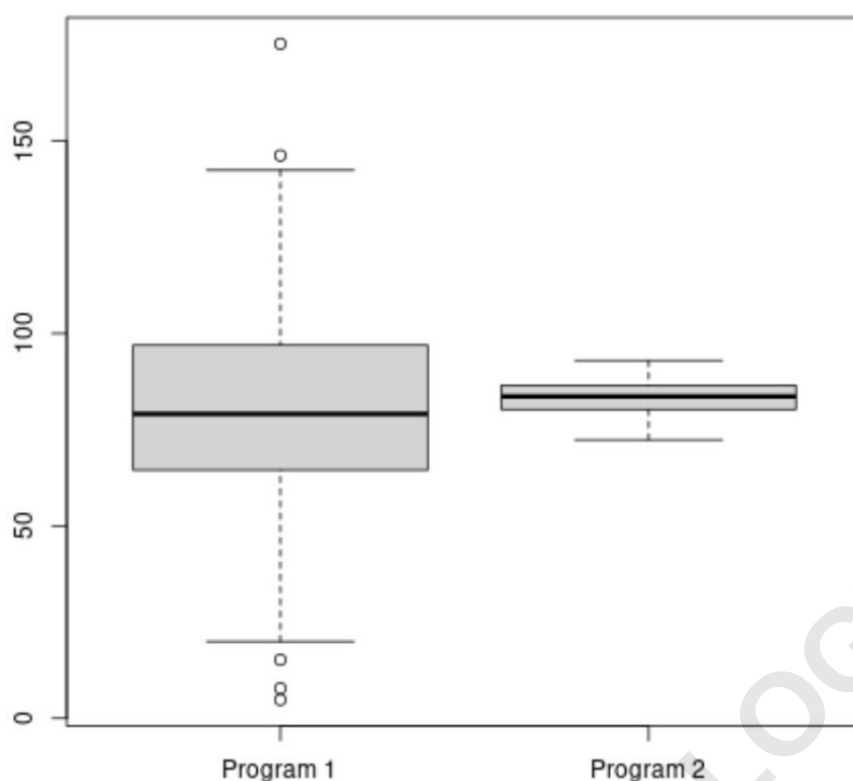
#create vectors to hold exam scores

program1 <- rnorm(500, mean=80, sd=25)

program2 <- rnorm(20, mean=85, sd=5)

#create boxplots to visualize distribution of exam scores

boxplot(program1, program2, names=c("Program 1","Program 2"))



The mean exam score for Program 2 appears to be higher, but the variance of exam scores for Program 1 is much higher than Program 2.

The following code shows how to perform an independent samples t-test along with a Welch's t-test:

```
#perform independent samples t-test  
t.test(program1, program2, var.equal=TRUE)
```

Two Sample t-test

data: program1 and program2

t = -0.5988, df = 518, p-value = 0.5496

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-14.52474 7.73875

sample estimates:

mean of x mean of y

80.5661 83.9591

#perform Welch's two sample t-test

t.test(program1, program2, var.equal=FALSE)

Welch Two Sample t-test

data: program1 and program2

t = -2.1338, df = 74.934, p-value = 0.03613

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-6.560690 -0.225296

sample estimates:

mean of x mean of y

80.5661 83.9591

The independent samples t-test returns a p-value of

.5496 and Welch's t-test returns a p-value of .0361.

The independent samples t-test is not able to detect a difference in mean exam scores, but the Welch's t-test is able to detect a statistically significant difference.

Since the two samples had unequal variances, only Welch's t-test was able to detect the statistically significant difference in mean exam scores since this test does not make the assumption of equal variances between samples.

The following tutorials provide additional information about t-tests: