Sweetening Statistics with

Minitab® 18

Statistical Concepts:
What M&M's Can Teach Us.

M&M's can provide an ideal way to make statistics immediately understandable to students who are timid about the subject. By simply weighing a few bags of the peanut variety and counting their contents, students gather useful data. Through applying statistics to this data on the weight, color, quality, and other factors of the M&M's, students take an everyday item such as candy and transform it into a powerful learning tool.

⚖️ Are the M&M's weights accurate?

According to the package, each small bag of peanut M&M's should weigh 49.3 grams. To determine if the bag weights are on target, ask the students to measure the weight of say, 30 bags of M&M's and conduct a 1-sample t-test.

In our analysis, the t-test results include a very small p-value of 0.000. Since the p-value is much smaller than an α-level of 0.05 or even 0.01, we can reject the null hypothesis and conclude that the average bag weight is not equal to 49.3 grams.

In this case, however, it's good news for consumers—we can see from the average weight of 52.040 grams that, in fact, the average bag weight is significantly more than the 49.3 grams target.

👥 Can two people measure the same weights?

If one person measures 30 bags of M&M's and their friend measures the same 30 bags using the same scale, will they get similar measurements? Students can test this hypothesis using a paired t-test.

In our analysis, the p-value of 0.394 is larger than our chosen α-level of 0.05. Therefore, we fail to reject the null hypothesis and can conclude that there is not a significant difference between the average measurements taken by the two friends.

➖ Are there equal amounts of each color in a bag?

A pie chart lets us easily visualize the counts of each color. For example, there were 138 blue M&M's and only 63 red M&M's in our sample. But is the difference between these counts statistically significant? A chi-square test can tell us.

The p-value of 0.000 suggests that the observed counts are significantly different than what we would expect to see if there were an equal number of red, orange, yellow, green, blue, and brown M&M's.
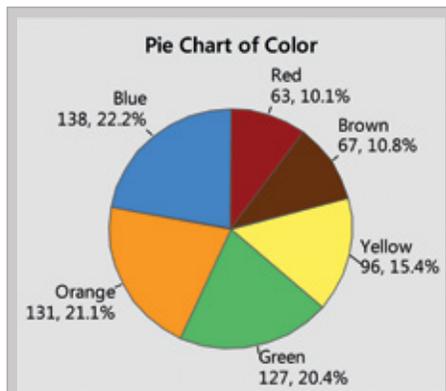
Graph created using Graph > Pie Chart.

One-Sample T: Weight(g)

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
30	52.040	2.807	0.512	(50.992, 53.088)

Test

Null hypothesis	$H_0: \mu = 49.3$
Alternative hypothesis	$H_1: \mu \neq 49.3$

T-Value	P-Value
5.35	0.000

Results generated using Stat > Basic Statistics > 1-Sample t.

Paired T-Test and CI: Person1, Person2

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Person1	30	52.040	2.807	0.512
Person2	30	52.047	2.802	0.512

Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for μ_difference
-0.00700	0.04435	0.00810	(-0.02356, 0.00956)

Test

Null hypothesis	$H_0: \mu\_difference = 0$
Alternative hypothesis	$H_1: \mu\_difference \neq 0$

T-Value	P-Value
-0.86	0.394

Results generated using Stat > Basic Statistics > Paired t.

Chi-Square Goodness-of-Fit Test

Observed and Expected Counts

Category	Observed	Test Proportion	Expected	Contribution to Chi-Square
Red	63	0.166667	103.667	15.9528
Yellow	96	0.166667	103.667	0.5670
Orange	131	0.166667	103.667	7.2069
Blue	138	0.166667	103.667	11.3708
Green	127	0.166667	103.667	5.2519
Brown	67	0.166667	103.667	12.9689

Chi-Square Test

N	DF	Chi-Sq	P-Value
622	5	53.3183	0.000

Results generated using Stat > Tables > Chi-Square Goodness-of-Fit Test (One Variable).

Test and CI for One Proportion

Descriptive Statistics

N	Event	Sample p	95% Lower Bound for p
622	87	0.139871	0.117497

Test

Null hypothesis	H_0: p = 0.15
Alternative hypothesis	H_1: p > 0.15

P-Value
0.776

Results generated using Stat > Basic Statistics > 1 Proportion.

Graph created using Graph > Scatterplot.

Correlation: Weight(g), Count

Correlations

Pearson correlation	0.458
P-value	0.011

Results generated using Stat > Basic Statistics > Correlation.

Results generated using Stat > Quality Tools > Gage Study > Gage R&R Study (Crossed).

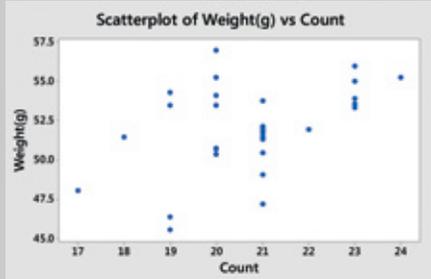# Do enough M&M's have the "m"?

M&M's are easily identified by the signature "m" printed on each piece of candy. It must pose a challenge to stamp the familiar symbol on a surface as uneven as a peanut M&M. It's not surprising, therefore, that sometimes this "m" is not perfectly printed.

Suppose there is a requirement that no more than 15% of M&M's have a misprinted "m." If we count the total number of M&M's and the number with misprints, we can conduct a 1 proportion test.

Of the 622 M&M's we evaluated, 87 had misprints. Using a 1 proportion test and an alternative hypothesis of greater than 15%, we get a p-value of 0.776. Because the p-value is greater than an α equal to 0.05, we can conclude that the proportion of misprinted M&M's is 15% or less.

Is there a correlation between the number of M&M's in each bag and the bag weights?

You may suspect that as the number of M&M's in each bag increases, so does the weight of the bags. We can use a scatterplot to examine this relationship and a correlation test to see if this theory is true.

The scatterplot of our data shows that, in general, as the number of M&M's in a bag increases, so does the weight. In addition, the correlation p-value of 0.011 indicates that we can reject the null hypothesis and conclude that there is a significant positive, linear relationship between the bag weights and the number of M&M's inside.

Additional Considerations

Although measuring Gage repeatability and reproducibility is well beyond the scope of a typical university statistics course, you can also use M&M's to teach more advanced statistical techniques. For instance, we used Minitab to create a Gage R&R measurement plan, followed the plan to measure 10 bags of M&M's twice each in a random order, and then analyzed the measurement results.

The resulting total Gage R&R percent study variation of 1.14% is well below the 10% ideal, indicating that very little variation was due to the measurement system. In addition, the R Chart is in control, while the XBar Chart is out-of-control. Therefore, our measurement system is acceptable.
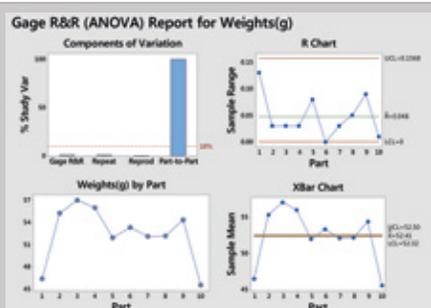
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Additional Teaching Resources

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