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Hypothesis Testing for the Population Mean: Finding the p-value

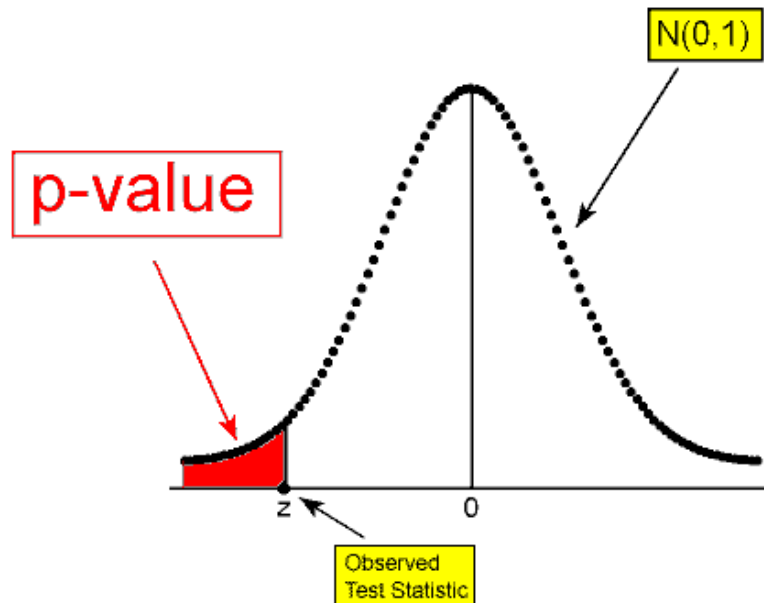
Learning Objective: Carry out hypothesis testing for the population proportion and mean (when appropriate), and draw conclusions in context.

3. Finding the p-value of the test

The p-value — the probability of getting data (summarized with the test statistic) as extreme as those observed or even more extreme (in the direction of the alternative hypothesis) when H_0 is true — for the z-test for the population mean is found exactly like the p-value in the z-test for the population proportion. We've already learned that the p-value is found under the null distribution of the test statistic, and since for both means (with σ known) and proportions the null distribution of the test statistic is $N(0,1)$, the p-value is calculated as follows:

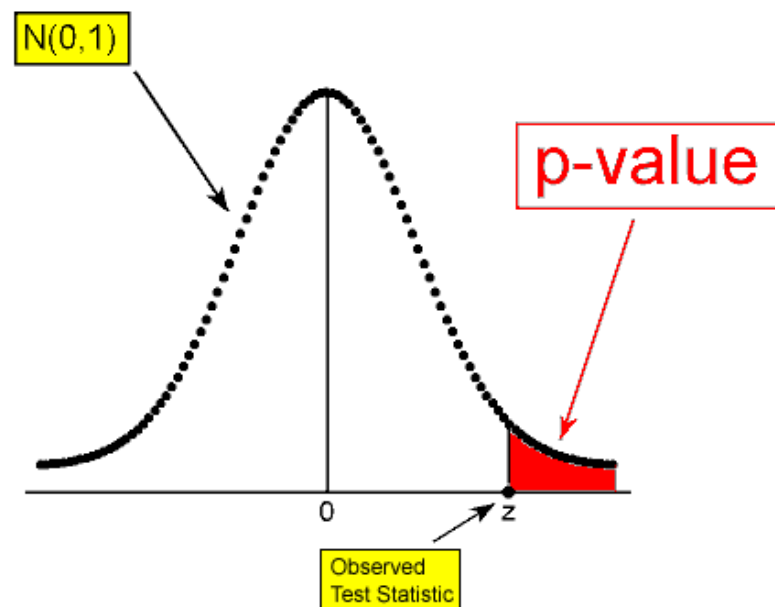
Less Than

- $H_a : \mu < \mu_0 \Rightarrow p\text{-value} = P(Z \leq z) :$



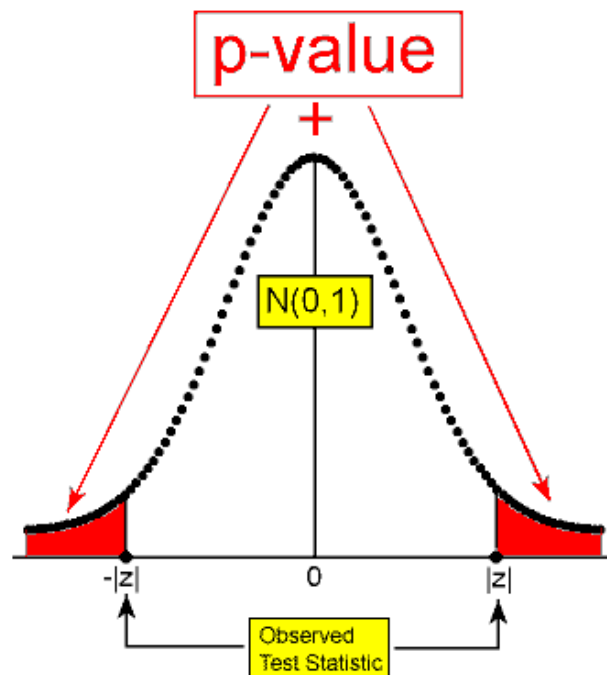
Greater Than

- $H_a : \mu > \mu_0 \Rightarrow p\text{-value} = P(Z \geq z) :$



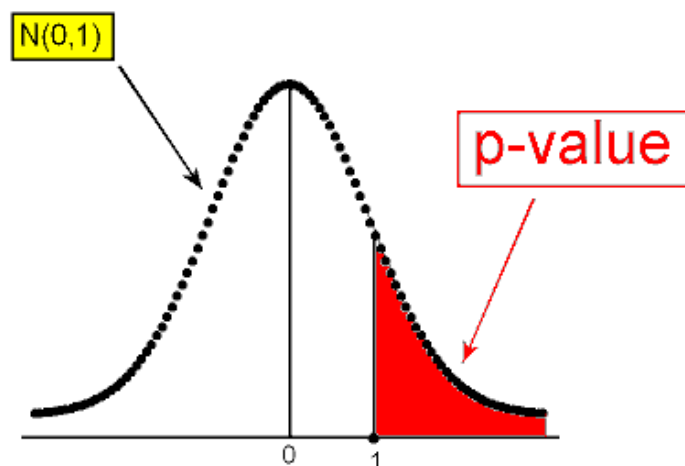
Not Equal To

- $H_a : \mu \neq \mu_0 \Rightarrow p\text{-value} = P(Z \leq -|z|) + P(Z \geq |z|) = 2P(Z \geq |z|) :$



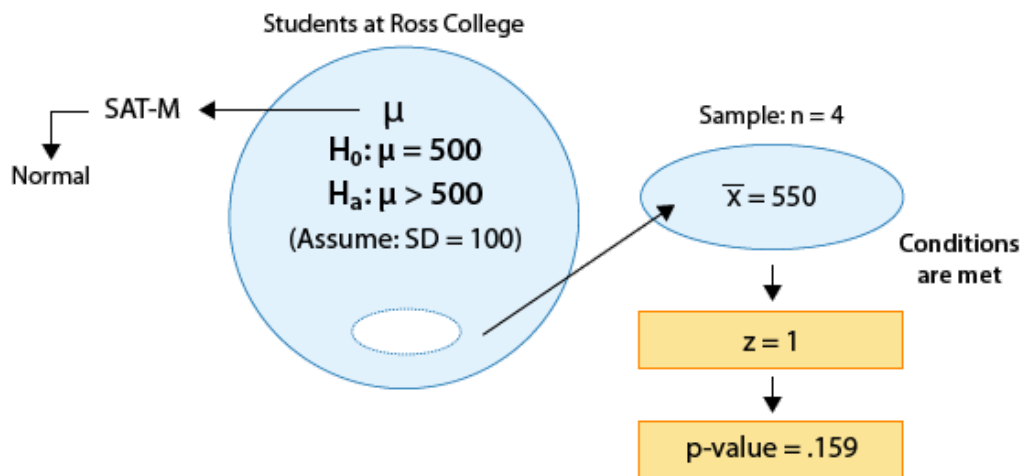
Example: 1

In the example about the SAT-M scores of students at Ross College, the test statistic was found to be $z = 1$. The p-value is therefore $P(Z > 1)$:



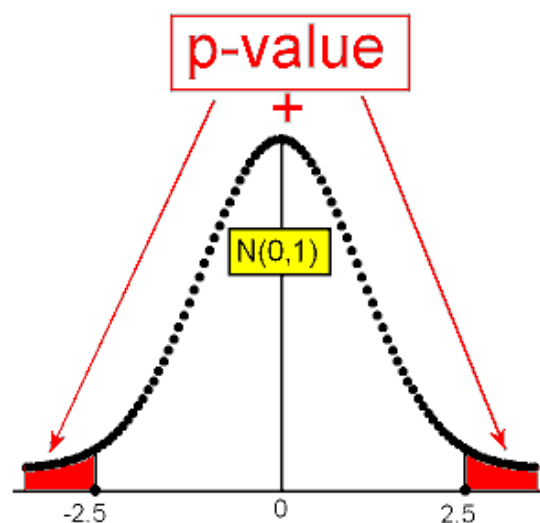
To find the p-value, we can either:

- use the (68% part of the) Standard Deviation Rule for the normal distribution, which tells us that the p-value is approximately 0.16 (since $P(-1 < Z < 1) = 0.68$), or
- use the normal table, or
- carry out the test using statistical software. In this case, we get a p-value of 0.159.

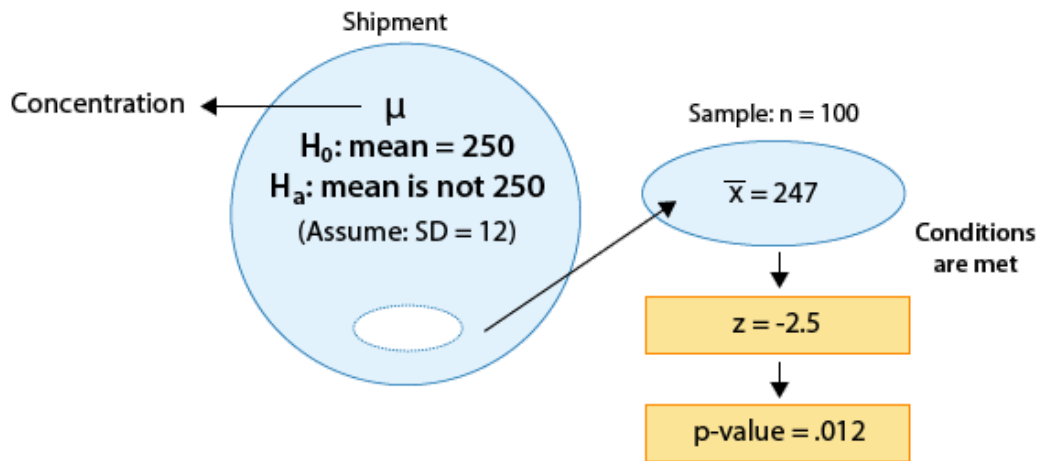


Example: 2

In the concentration level example, the test statistic was found to be -2.5. Since this is the two-sided test, the p-value is the combination of the two shaded areas in the following figure.



The p-value is therefore twice $P(Z > 2.5)$. We can either use the table, or carry out the test using statistical software. In this case, we get a p-value of 0.012.



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