STA 371G Help Session: Hypothesis Testing and P-Values

April 16, 2019

“A sports company is testing the effect of a new sports drink on 40-yard dash speed by giving 100 athletes a drink then immediately measuring their time. The company knows that the mean 40-yard dash time without the energy drink is 4.8 seconds. The mean of the 100 timed athletes is 4.71 seconds, with a sample standard deviation of 0.3 seconds. Does the new drink have an effect on 40-yard dash speed?”

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- Set up two hypotheses
  - Null Hypothesis (H_0) = The drink has no effect on speed
    - Think of the null hypothesis as the status quo – whatever is being tested has no effect
    - $\mu = \mu_x = 4.8$ seconds even with drink
  - Alternative Hypothesis (H_A) = The drink has an effect on speed
    - $\mu \neq \mu_x = 4.8$
- When should be accept the alternative hypothesis over the null hypothesis?
  - Let’s assume the null hypothesis is true. What is the probability we would have gotten these results with our random sample? If that probability is really small, we can probably reject the null hypothesis.

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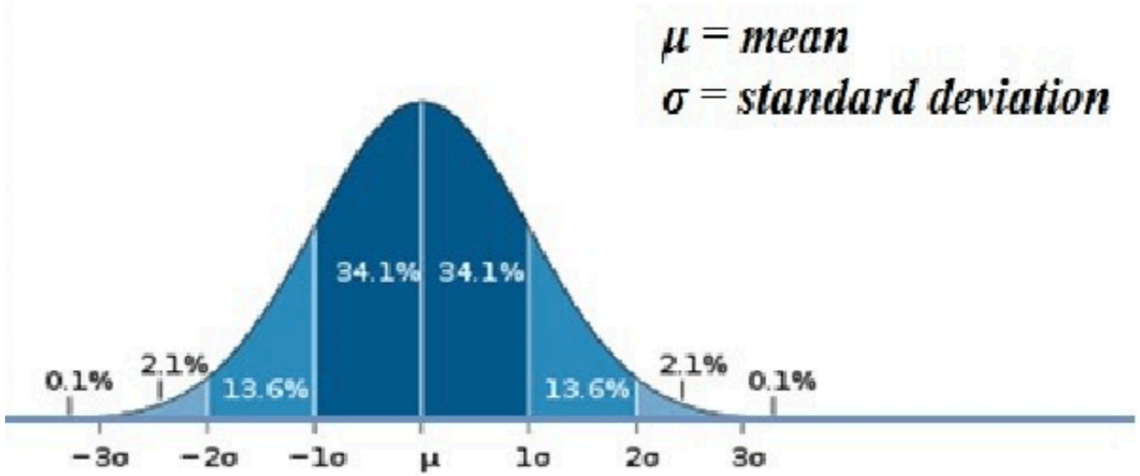
- Let's draw a sampling distribution of the results assuming the null hypothesis is true.
  - If the null hypothesis is true, the mean of the sampling distribution will be equivalent to the mean of the population, which is 4.8 seconds.



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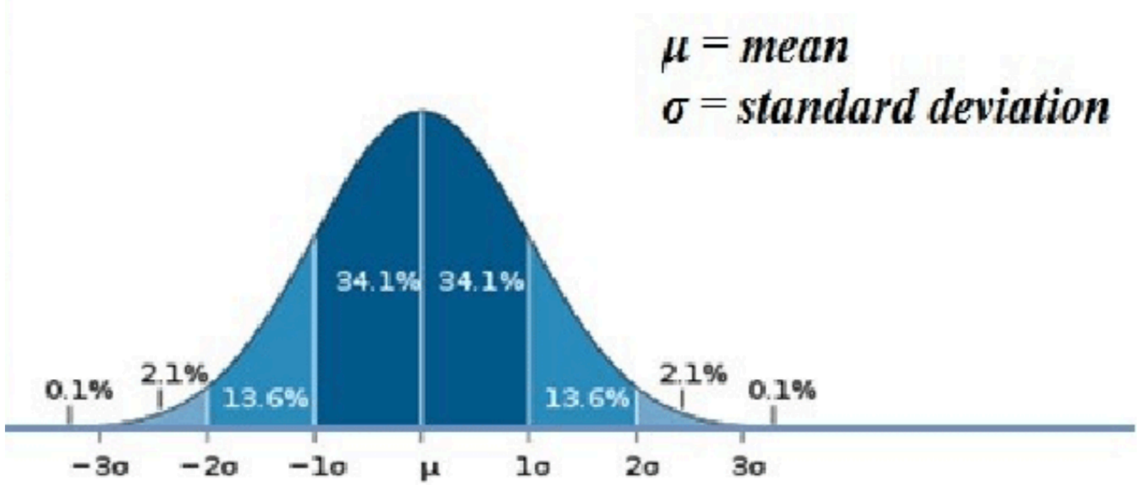
- Let's draw a sampling distribution of the results assuming the null hypothesis is true.
  - The population standard deviation can be estimated using the equation: $\sigma_x = \frac{\sigma}{\sqrt{n}}$
    - Estimated population standard deviation = 0.3/10 = 0.03 seconds



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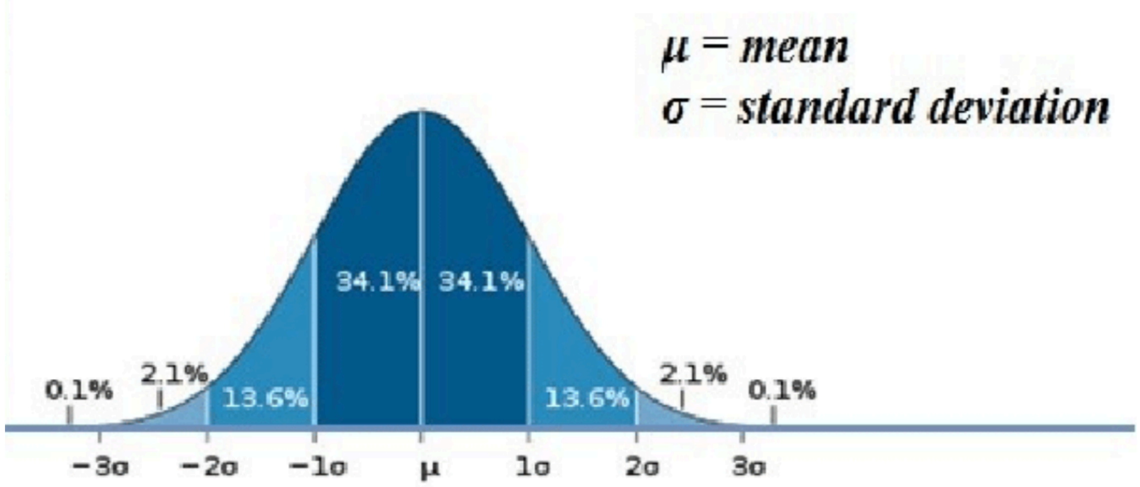
- Let's draw a sampling distribution of the results assuming the null hypothesis is true.
  - How many standard deviations is our sample mean away from the population mean, and what is the probability of getting this sample mean randomly?
    - Z-Score = $\frac{4.71-4.80}{0.03} = -3$



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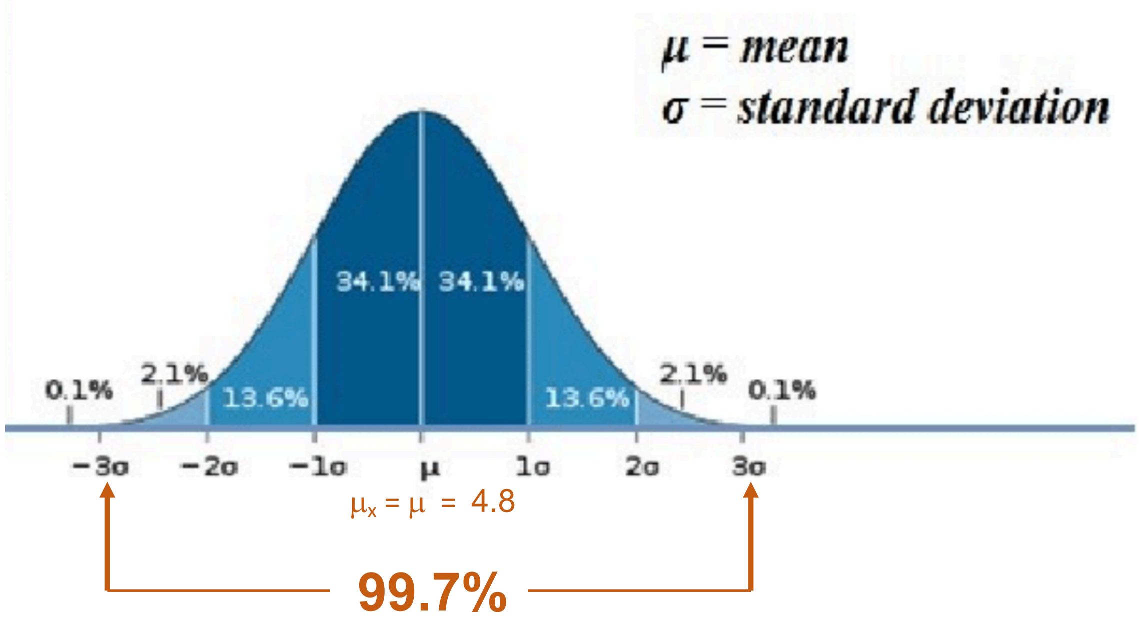
- Let's draw a sampling distribution of the results assuming the null hypothesis is true.
  - What is the probability of getting a result as or more extreme than this?
    - Z = 3 = 0.3%; Therefore, if we assume the null hypothesis is correct, there is a 0.3% chance of obtaining these results by chance. Therefore, our **p-value would be 0.003**



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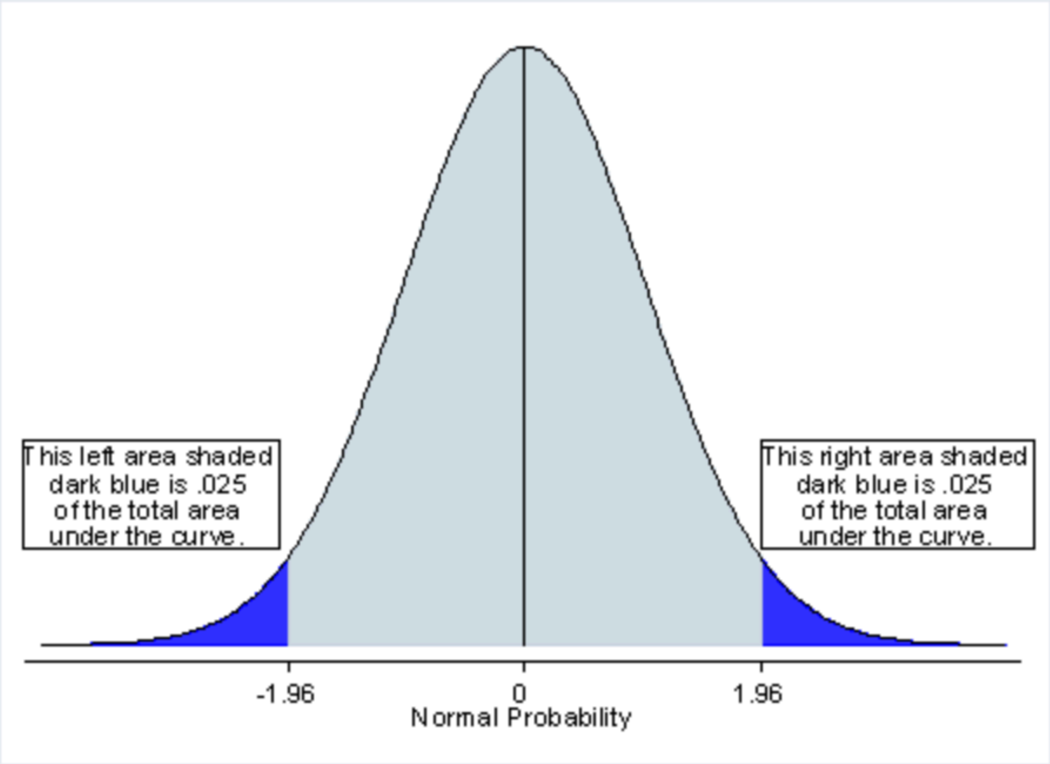
- In order to validate our alternate hypothesis, we must compare our p-value to a threshold, or an alpha value
  - We **can reject the null hypothesis** at alpha values of 0.1, 0.05, and 0.01 because our p-value is **less** than the alpha value
  - We **cannot reject the null hypothesis** at an alpha value of 0.001, because our p-value is **greater** than the alpha value
- Remember – we are testing for **statistical significance**

Two-Tailed Hypothesis Test

- $\mu \neq \mu_x$
  - Half of alpha is allotted to each tail
  - Tests for relationship in 2 directions
  - Mean is considered significantly different if test statistic is in the top $\alpha/2$ or bottom $\alpha/2$ of distribution
  - Ex: Alpha of 0.05



One-Tailed Hypothesis Test

- **μ >/< μ_x**
- Alpha is allotted to one tail
- Tests for relationship in 1 direction
- Mean is considered significantly different if test statistic is in the top α or bottom α of distribution
- More power to detect an effect
- Ex: Alpha of 0.05