

# Hypothesis Testing

Validating claims

# Hypothesis

- If I replace the battery in my car, then my car will get better gas mileage.
- If I eat more vegetables, then I will lose weight faster.
- If I add this particular fertilizer to my garden, then my plants will grow faster.
- If I take my vitamins every day, then I will not feel tired.

# Steps for Hypothesis Testing

1. Decide on the hypothesis you're going to test
2. Choose your test statistic
3. Determine the critical region for your decision
4. Find the p-value of the test statistic
5. See whether the sample result is within the critical region
6. Make your decision

# Testing the hypothesis

Q) A company has come out with a drug for snoring and it claims that cures 90% of people, how many people in the sample of 15 snorers would you expect to have been cured? What sort of distribution do you think this follows? Also, you have found out that it cured only 11 people. Is the company's claim false?

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Sol: 90% of 15 is 13.5, so you'd expect 14 people to be cured

There are a specific number of trials and the doctor is interested in the number of successes, so the number of successes follows a binomial distribution. If  $X$  is the number of successes then  $X \sim B(15, 0.9)$ .

# 1)Decide on the hypothesis

- According to the drug company, SnoreCull cures 90% of patients. We need to accept this position unless there is sufficiently strong evidence to the contrary
- The claim that we're testing is called the null hypothesis. It's represented by  $H_0$
- $H_0 : p = 0.9$

# 1) Decide on the hypothesis

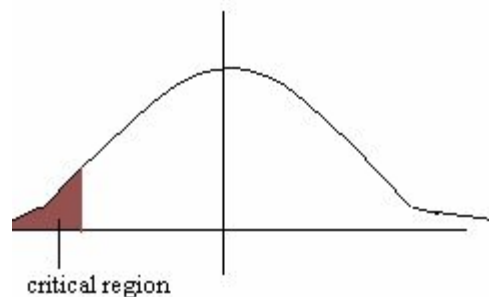
- According to the Company, SnoreCull, the drug cures 90% of patients. We need to accept this position unless there is sufficiently strong evidence to the contrary
- The claim that we're testing is called the null hypothesis. It's represented by  $H_0$
- $H_0 : p = 0.9$
- The counterclaim to the null hypothesis is called the alternate hypothesis. It's represented by  $H_1$
- $H_1 : p < 0.9$

## 2) Choose your test statistic

- The test statistic is the statistic that you use to test your hypothesis
- The number of people cured is the test statistic and let's use  $X$  to represent it
- Also, here  $X \sim B(15, 0.9)$



# 3) Determine Critical Region



If the number of snorers cured by SnoreCull falls in the critical region, then we'll reject the null hypothesis.

If  $H_0$  is true, we are 95% certain that the number of snorers cured will fall within this region



$$P(X < c) < \alpha, \text{ where } \alpha = 5\%$$

$\alpha$  -> Significance level

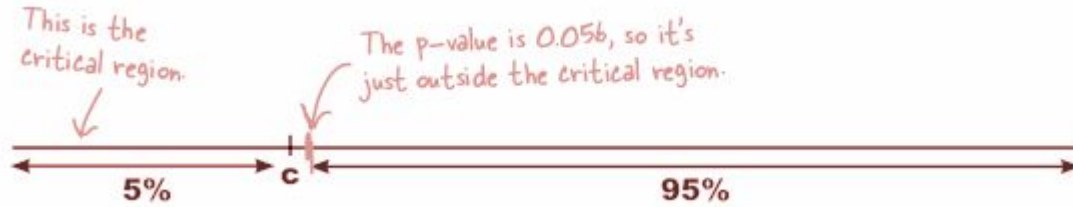
# 4) Find the p-value

If  $P(X \leq 11)$  is less than 0.05, then that means that 11 is inside the critical region, and we can reject  $H_0$ .



$$\begin{aligned} P(X \leq 11) &= 1 - P(X \geq 12) \\ &= 1 - ({}^{15}C_{12} \times 0.1^3 \times 0.9^{12} + {}^{15}C_{13} \times 0.1^2 \times 0.9^{13} + {}^{15}C_{14} \times 0.1 \times 0.9^{14} + 0.9^{15}) \\ &= 1 - (0.1285 + 0.2669 + 0.3432 + 0.2059) \\ &= 1 - 0.9445 \\ &= 0.0555 \end{aligned}$$

## 5) Is the sample result in the critical region?



## 6) Make your decision

- The p-value of the hypothesis test falls just outside the critical region of the test
- This means that there isn't sufficient evidence to reject the null hypothesis
- In other words, we accept the claims of the drug company

# Errors

- We may correctly accept or reject the null hypothesis, but even considering the evidence, it's also possible to make an error.
- We may reject a valid null hypothesis, or you might accept it when it's actually false.

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- We may correctly accept or reject the null hypothesis, but even considering the evidence, it's also possible to make an error.
- We may reject a valid null hypothesis, or you might accept it when it's actually false.
- A Type I error is when you wrongly reject a true null hypothesis
- Type II error is when you wrongly accept a false null hypothesis

		Reality	
		True	False
Measured or Perceived	True	Correct 😊	Type 1 error False Positive
	False	Type 2 error False Negative	Correct 😊