Steps in Hypothesis Testing

1. Define the population characteristic (i.e. parameter) about which hypotheses are to be tested.

2. State the null hypothesis H_0.

3. State the alternative hypothesis H_a.

4. State the significance level for the test α. The Type I error probability that we can live with

5. Check all assumptions and state name of test.

6. State the name of the test.

7. State *df* if applicable (not applicable in proportion land).

8. Display the test statistic to be used without any computation at this point.

9. Compute the value of the test statistic, showing specific numbers used.

10. Calculate the P – value. …which is the probability of a Type I error so it it is less than α then we will reject H_0

11. Sketch a picture of the situation.

12. State the conclusion in two sentences -
    1. Summarize in theory discussing H_0.
    2. Summarize in context discussing H_a.

Errors - We make them, even though we're awesome

When we correctly reject a particular null hypothesis, we get to something called…

	Fail to reject H_0 i.e. Accept H_0	Reject H_0 i.e Accept H_a
H_0 true	Hooray!	Type I error α
H_a true	Type II error β	POWER!!

POWER is the probability that we correctly reject the null hypothesis

In other words, POWER is $1-\beta$

Type I error - reject H_0 when H_0 is true

Type II error - fail to reject H_0 when H_0 is false

And in case you're wondering, Power is a good thing:)

OR

Type I error - 1st equation correct and you pick the 2nd equation

Type II error - 2nd equation correct and you pick the 1st equation

Also called ‘level of significance’ or ‘significance level’.

α vs β

$P(\text{Type I error}) = \alpha$

$P(\text{Type II error}) = \beta$

If α goes up, then β goes down.

If α goes down, then β goes up.

$$\text{Power} = P(\text{rejecting a false } H_0) = 1 - \beta$$

Before we discuss how to calculate Power, a few important things to know about it:

3 ways for Power to increase

1. Increase α because β will go down
2. Increase Sample Size
3. The larger the discrepancy (distance) between the hypothesized parameter value and the true parameter value, the larger the power

Also called 'level of significance' or 'significance level'.

α vs β

$$P(\text{Type I error}) = \alpha$$

$$P(\text{Type II error}) = \beta$$

If α goes up, then β goes down.

If α goes down, then β goes up.

Find the *z*-value that corresponds to alpha

Use the z score formula to find the percentile

Use normalcdf with the standard normal curve to find POWER

Watch the coming example for the details.

$$\text{Power} = P(\text{rejecting a false } H_0) = 1 - \beta$$

Power is a good thing:)

3 ways for Power to increase

1. Increase α because β will go down
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It took Beau 3.2 minutes to order a Lamar Jackson jersey on fanatics.com and he claims that this is the true average time it takes to order a jersey from the site. Faith, Monzi, and Bella wonder if this is the true mean time it takes to order a jersey because his jersey is so popular. They are able to find 36 classmates to help them with a random sample to approximate the actual average time it takes to order a player jersey on the site. They test Beau's hypothesis with significance level $\alpha = 0.05$ knowing that $\sigma = 0.4$ minutes and their sample mean is 2.9 minutes. Assuming theirs is the true mean, what is the power of this test?

$H_0 : \mu = 3.2$

$H_a : \mu < 3.2$

$$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} = \frac{\bar{x} - 3.2}{0.4 / \sqrt{36}} = -1.645$$

Why –1.645, you ask?

This is a left tailed test (<) and = 0.05 means that we use invNorm(.05)

$$\frac{\bar{x} - 3.2}{0.4 / \sqrt{36}} \le -1.645 \qquad \bar{x} \le 3.2 - 1.645\left(0.4 / \sqrt{36}\right) \qquad \bar{x} \le 3.09$$

So if $\bar{x} \le 3.09$ then we will reject H_0

So we know that their sample mean of 2.9 is going to cause them to reject Beau's null hypothesis but what is the probability that they are correct in doing so?

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So if $\bar{x} \leq 3.09$ then we will reject H_0

Let's get the z-score of 3.09 assuming that the mean is now 2.9 and check it against the standard normal curve

$$z = \frac{3.09 - 2.9}{0.4 / \sqrt{36}} \leq 2.855$$

So the area under the standard normal curve less than 2.855 is the region in which we reject the null hypothesis

normalcdf(–1E99,2.855) = 0.998

So the *power* of this test is 0.998

In other words, the probability of correctly rejecting Beau's stated mean is 0.998

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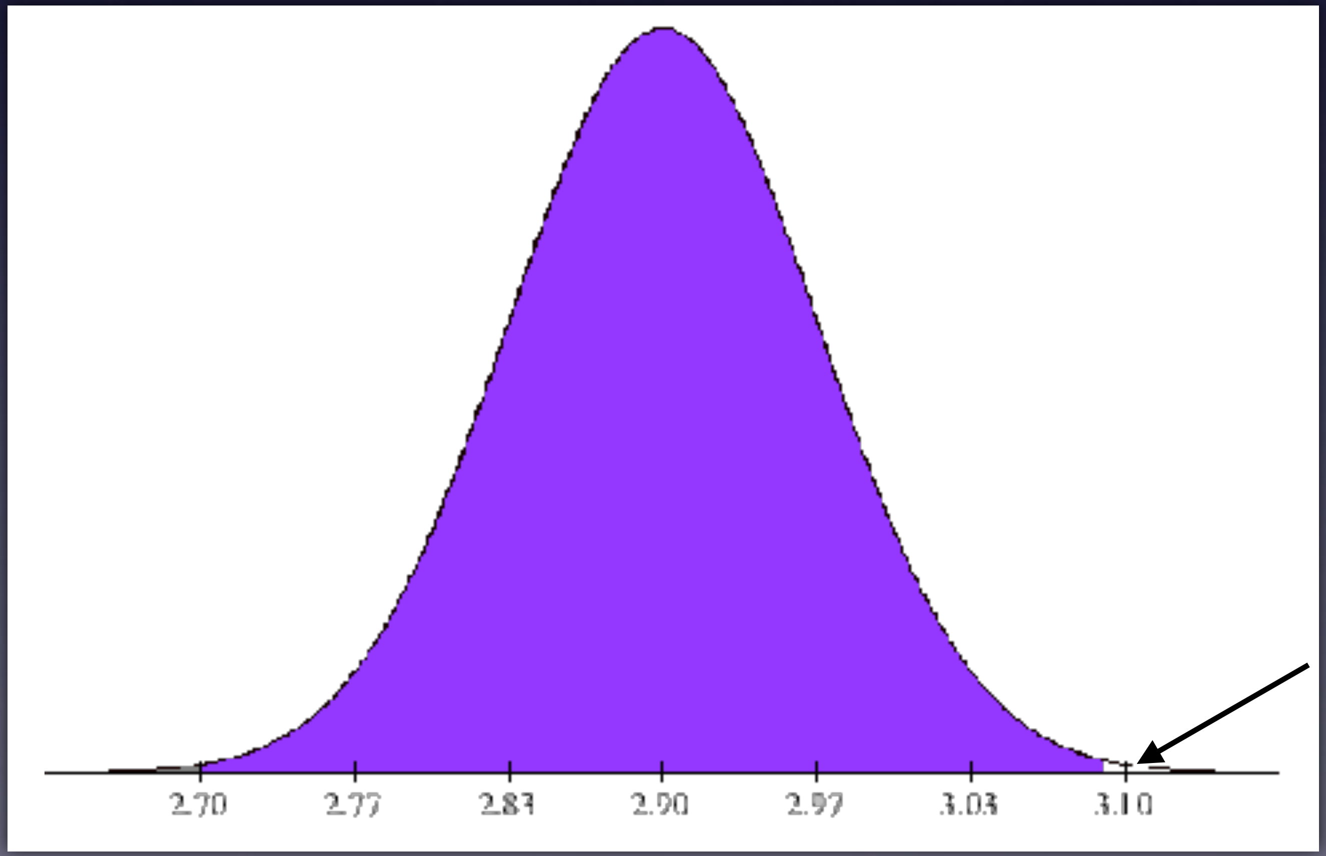
Graphically, it looks like this:



normalcdf(–1E99,2.855) = 0.998

So the *power* of this test is 0.998

Note the very small β which is the probability of a Type II error

In other words, the probability of correctly rejecting Beau's stated mean is 0.998

Also called 'level of significance' or 'significance level'.

α vs β

$$P(\text{Type I error}) = \alpha$$

$$P(\text{Type II error}) = \beta$$

If α goes up, then β goes down.

If α goes down, then β goes up.

Find the *z* or *t* value that corresponds to alpha

Use the z score formula to find the percentile

Area under the standard normal curve with the percentile as an endpoint will give you beta.

The complement of that is the POWER of the test

$$\text{Power} = P(\text{rejecting a false } H_0) = 1 - \beta$$

Power is a good thing:)

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