# Chapter 7 Hypothesis Testing

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## Contents

# 1 Hypothesis Testing 假设检验

## 1.1 Definition and Concepts

1. null hypothesis, $H_0$: "no change"
2. We believe the null hypothesis to be true unless overwhelming evidence exists to the contrary ("innocent until proven guilty")
3. The alternative hypothesis, $H_1$, or $H_A$ (in this class, we all use $H_1$), is a second statement that contradicts $H_0$.
4. Either $H_0$ or $H_1$ must be true (mutually exclusive, exhaustive).

5. We need overwhelming evidence to conclude that $H_1$ is true. - That is why the alpha value, or the "threshold", should be very low, so the chance that $H_0$ is true is very low.

## 1.2   Calculation

1. We calculate the probability of $H_0$ is true, which is the probability that you get a mean value from samples that is as extreme or more extreme than $\bar{X}$ if you assume that $H_0$ is true.
2. For now, we assume the population show normal distribution.
3. z-test:

$$Z = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$$

4. calculating the p-values for z-tests:

# p-values for z-tests

- We calculate our p-value as follows, for each of the three types of tests (*z-tests*):

- One-sided, lower-tailed hypothesis ($H_1 : \mu < \mu_0$):

  - `pnorm(z)`

- One-sided, upper-tailed hypothesis ($H_1 : \mu > \mu_0$):

  - `1-pnorm(z)`

- Two-sided hypothesis ($H_1 : \mu \neq \mu_0$):

  - If $z \leq 0$: `2*pnorm(z)`

  - If $z > 0$: `2*(1-pnorm(z))`

Notes for two sided hypothesis:
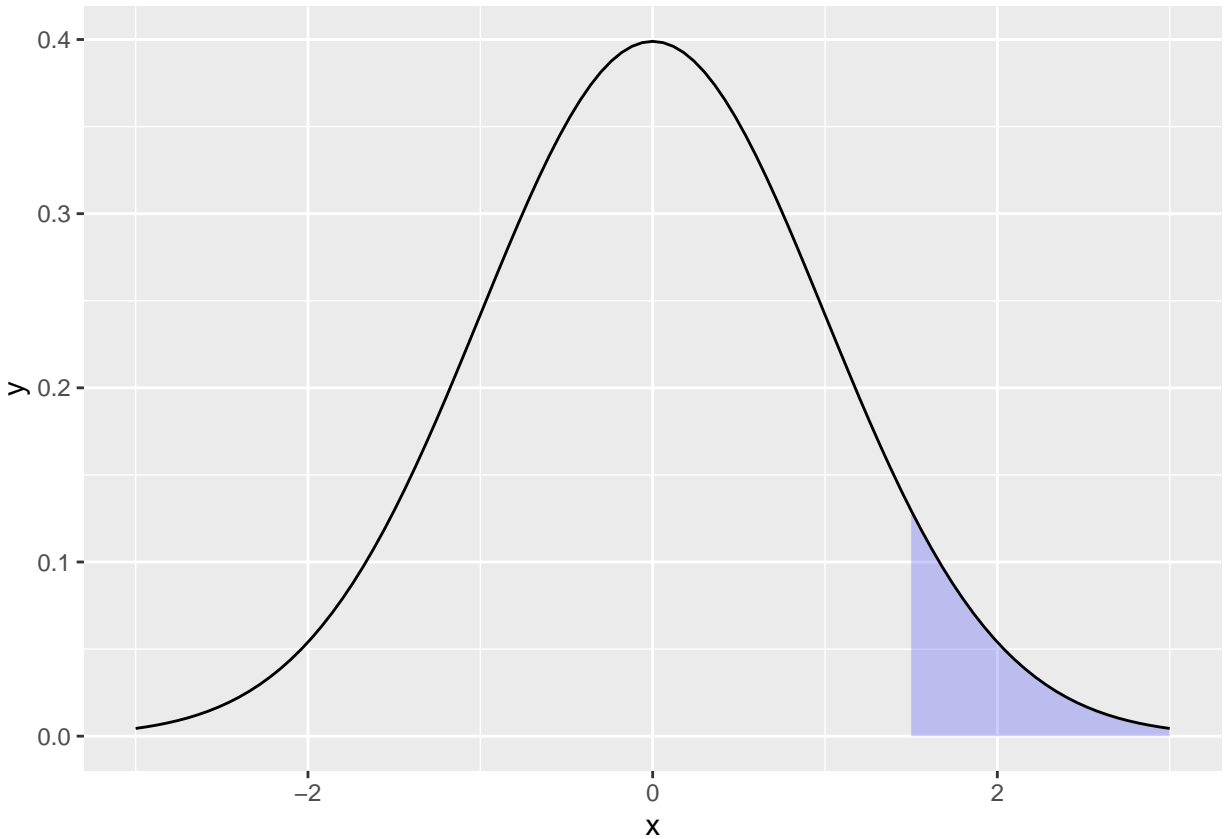
when z < 0, you get probability (pnorm(z)) like this:

```
## -- Attaching packages ----------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.3.6      v purrr   0.3.4
## v tibble  3.1.8      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.3      v forcats 0.5.2
## -- Conflicts ------------------------------------------- tidyverse_conflicts() --
```

```
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```
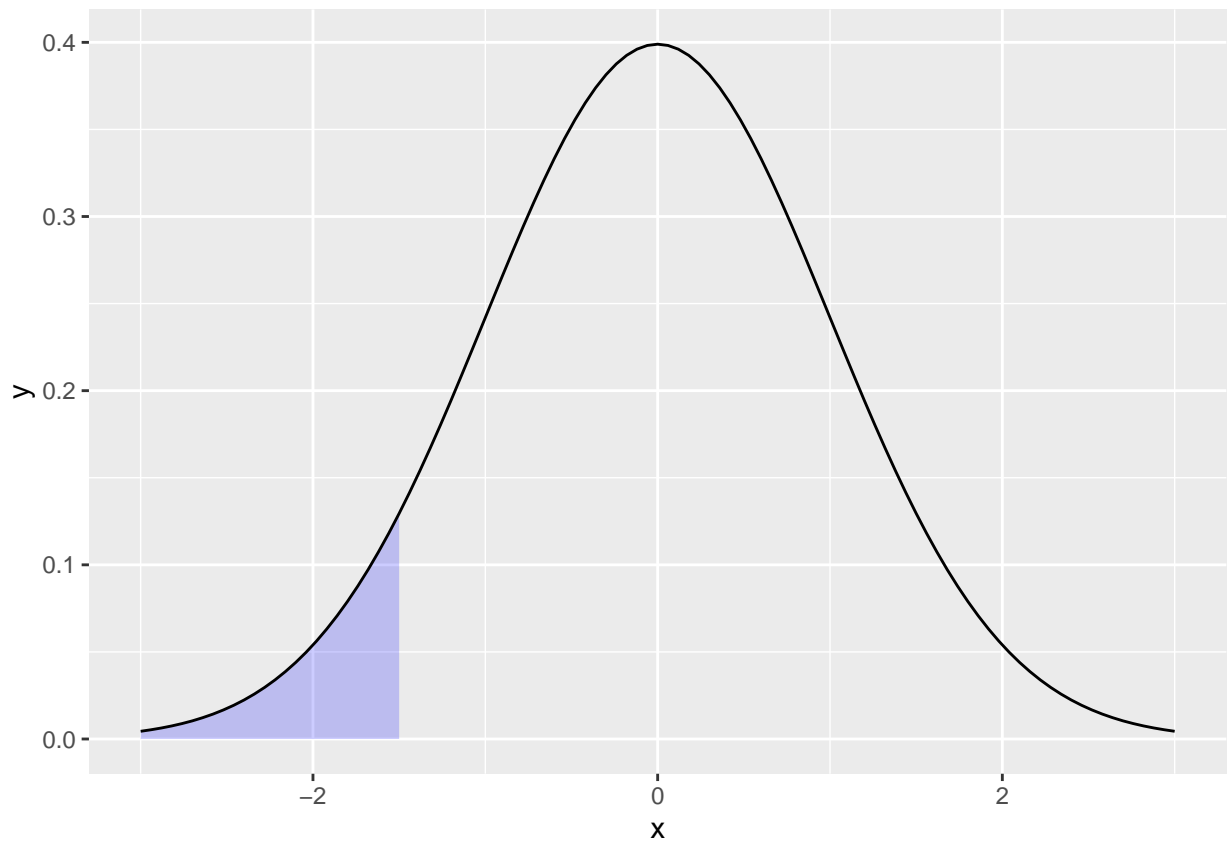


when z > 0, you get probability (1 - pnorm(z))like this:

# 2 Hypothesis Testing and Confidence Interval

## 2.1 Mathematically equivalent.

# 3 Type I and Type II errors

## 3.1 Definition

## 3.2 Calculation

# 4 Power

## 4.1 Definition

## 4.2 Calculation