Recap

$\mu = 1800$
$\sigma = 100$

A retailer has 2000 stores in the country

Historical data tells us that weekly sales of shampoo bottles has an average of 1800, with a standard deviation of 100

Sales team wants to improve sales by hiring a marketing team

Hiring a marketing team can be expensive, so we need to be very sure that they will improve sales

Before deploying their strategy for all 2000 stores, they are tested in 50 stores

On the 50 stores, their average sales for that week was 1850

You are the data scientist who should tell your sales team whether this is statistically significant

Sales team has said that we will hire only if we are $99\,\%$ confident $\alpha = 0.01$

Another marketing team is also being considered

They are tested on 5 stores

On the 5 stores, their average sales for that week was 1900

Would you say this team is better than the first one?

Between the “blue team” and the “yellow team”, whom will you choose?

Recap

$\alpha = 0.01$

$\mu = 1800$

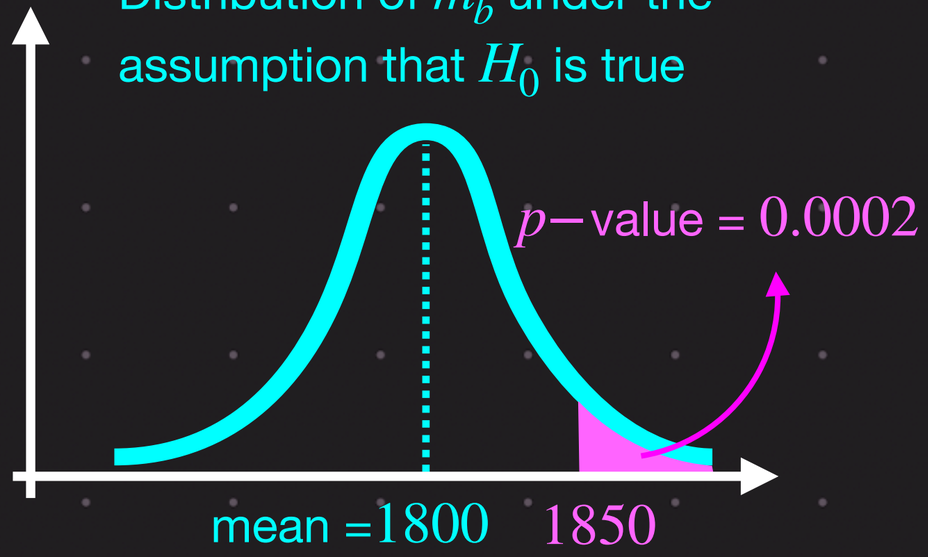
$\sigma = 100$

50 stores with average of 1850

$H_0 : \mu_b = 1800$

$H_a : \mu_b > 1800$

Distribution of m_b under the assumption that H_0 is true



$$\text{std dev} = \frac{100}{\sqrt{50}}$$

$$z = \frac{1850 - 1800}{100/\sqrt{50}} = 3.53$$

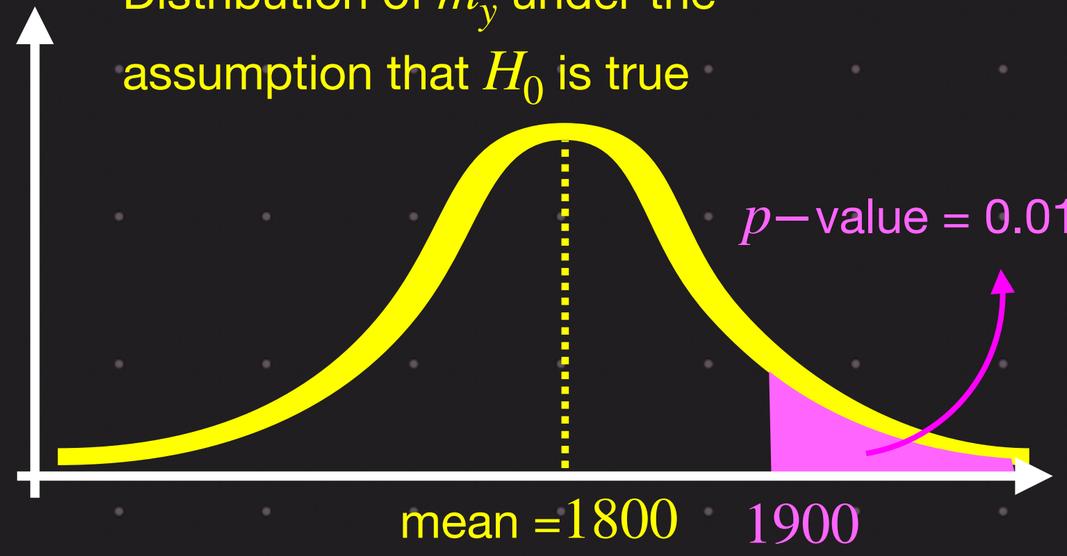
Reject H_0

5 stores with average of 1900

$H_0 : \mu_y = 1800$

$H_a : \mu_y > 1800$

Distribution of m_y under the assumption that H_0 is true



$$\text{std dev} = \frac{100}{\sqrt{5}}$$

$$z = \frac{1900 - 1800}{100/\sqrt{5}} = 2.23$$

Fail to reject H_0

Drug Recovery

Suppose two companies develop a drug for a disease.

Drug 1 was tested on 100 people, and the recovery days look like this

$[8, 5, 9, 10, \cdots, 16]$ The mean recovery time was 7.1 days

Drug 2 was tested on 120 people, and the recovery days look like this

$[12, 4, 7, 13, \cdots, 8]$ The mean recovery time was 8.07 days

Can we say one drug was better than the other?

Or was this small difference a coincidence?

For such cases we use the two-sample t-test

```
from scipy.stats import ttest_ind
```

IQ across two schools

Suppose there are two schools competing against each other

Each school says their students have higher IQ

So we conduct a test

Say the first school had numbers like this

$[101, 115, 90, \cdots, 112, 97]$ Let us say average was 103.7

And yellow team has these numbers

$[108, 105, 99, \cdots, 111, 98]$ Let us say average was 102.9

Is there a statistical significance in this difference?

Or was it just chance?

For such cases we use the two-sample t-test

```
from scipy.stats import ttest_ind
```

One sample Test

Supply chain: We compared average sales in 50 stores against a fixed number: 1800

$H_0 : \mu_b = 1800$ $H_a : \mu_b > 1800$

Premature children IQ We compared average IQ of 50 prematurely born children fixed number: 1800

$H_0 : \mu = 100$ $H_a : \mu \neq 100$

Drug Vs No drug Patients recover on average 15 days without drug. Will it reduce after taking the drug?

$H_0 : \mu = 15$ $H_a : \mu < 15$

We are comparing one set of samples against a fixed number (population mean)

Two sample test

Supply chain: We directly compare two marketing teams

$H_0 : \mu_b = \mu_y$ $H_a : \mu_b \neq \mu_y$

Two states IQ Two competing states, where each state says their students have higher IQ

Let μ_1 be the average IQ of first state, and μ_2 be the average IQ of another state

$H_0 : \mu_1 = \mu_2$ $H_a : \mu_1 \neq \mu_2$

Two Drugs Let μ_1 be the average recovery for drug 1, and μ_2 be the average for drug 2

$H_0 : \mu_1 = \mu_2$ $H_a : \mu_1 \neq \mu_2$

We are comparing two sets of samples against each other

Youtube ads

Youtube wants to increase its ads revenue. They decide to put up 2 ads instead of one

Is this a good move? This could lead to a decrease in the average watch time

Can we test this effect? We need two groups: control and treatment

Control group sees one ad

Watch times of control group are like this

$[3.4,\ 2.4,\ 1.7,\ 0.4,\ \cdots,\ 4.2]$ Mean: $m_1 = 3.6$

Treatment group sees two ads

Watch times of the treatment group are like this

$[3.5,\ 3.2,\ 2.5,\ 0.1,\ \cdots,\ 3.1]$ Mean: $m_2 = 3.05$

1) Setup the hypothesis $H_0 : \mu_1 = \mu_2$

$H_a : \mu_1 \neq \mu_2$

2) Choose the right test statistic

$m_1 - m_2$? ✘

$$\frac{m_1 - m_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$ ✔

3) Right/Left/Two-tailed? Two-tailed

4) Compute p-value

5) Compare p-value with α

If we are sure that the effect will only reduce the time, we can go for “greater” alternative

$H_0 : \mu_1 = \mu_2$

$H_a : \mu_1 > \mu_2$

Right-tailed