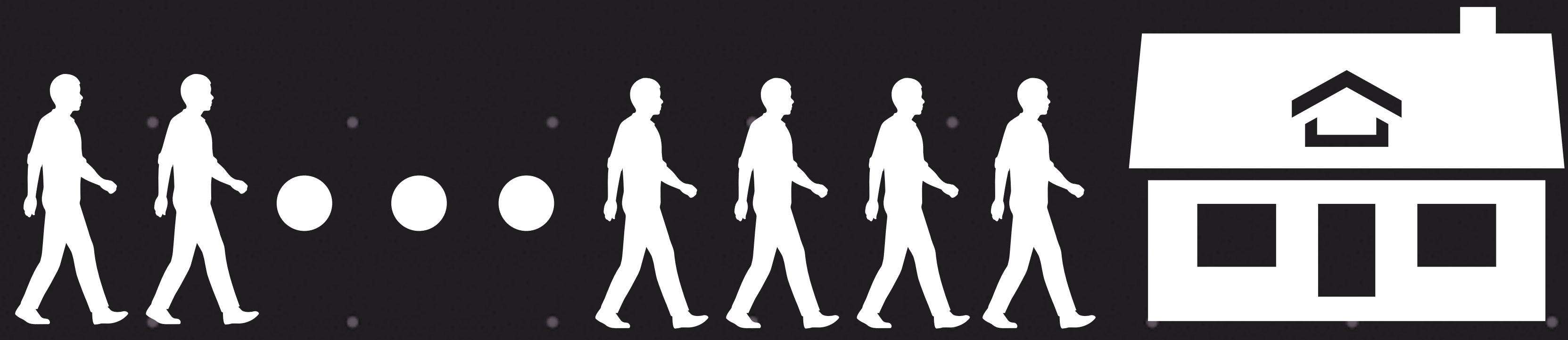
The average number of customers entering a store is 2000 per month

A marketing company is hired to improve this number

The next month, number of customers was seen to be 2128

With 95% confidence, is this improvement statistically significant?

2000 per month on average



What should the null and alternate hypothesis be?

$H_0 : \mu = 2000 \quad H_a : \mu > 2000$

What is the test statistic?

$N$: Number of people entering the store in a month

Distribution of the test statistic $N$? Poisson with rate 2000 per month

Right, left tailed, or two-tailed? Right tailed

What is the p-value?

$P[N \geq 2128 \,|\, H_0$ is true$] = 1 - P[N \leq 2127 \,|\, H_0$ is true$]$ = `1 - poisson.cdf(2127, mu=2000)` $= 0.002$

What is $\alpha$? $\alpha = 0.05$

Is p-value $< \alpha$? Yes

We reject the null hypothesis We say that the marketing worked

## Recommender System

When a customer buys a T-shirt, a recommender algorithm also suggests a few related items

The recommender system in production (legacy) that has a success rate of 10%

You and your team have developed a new deep learning algorithm for recommendation

It is tested before deploying. Of the next 500 customers, 72 bought items recommended by the new model.

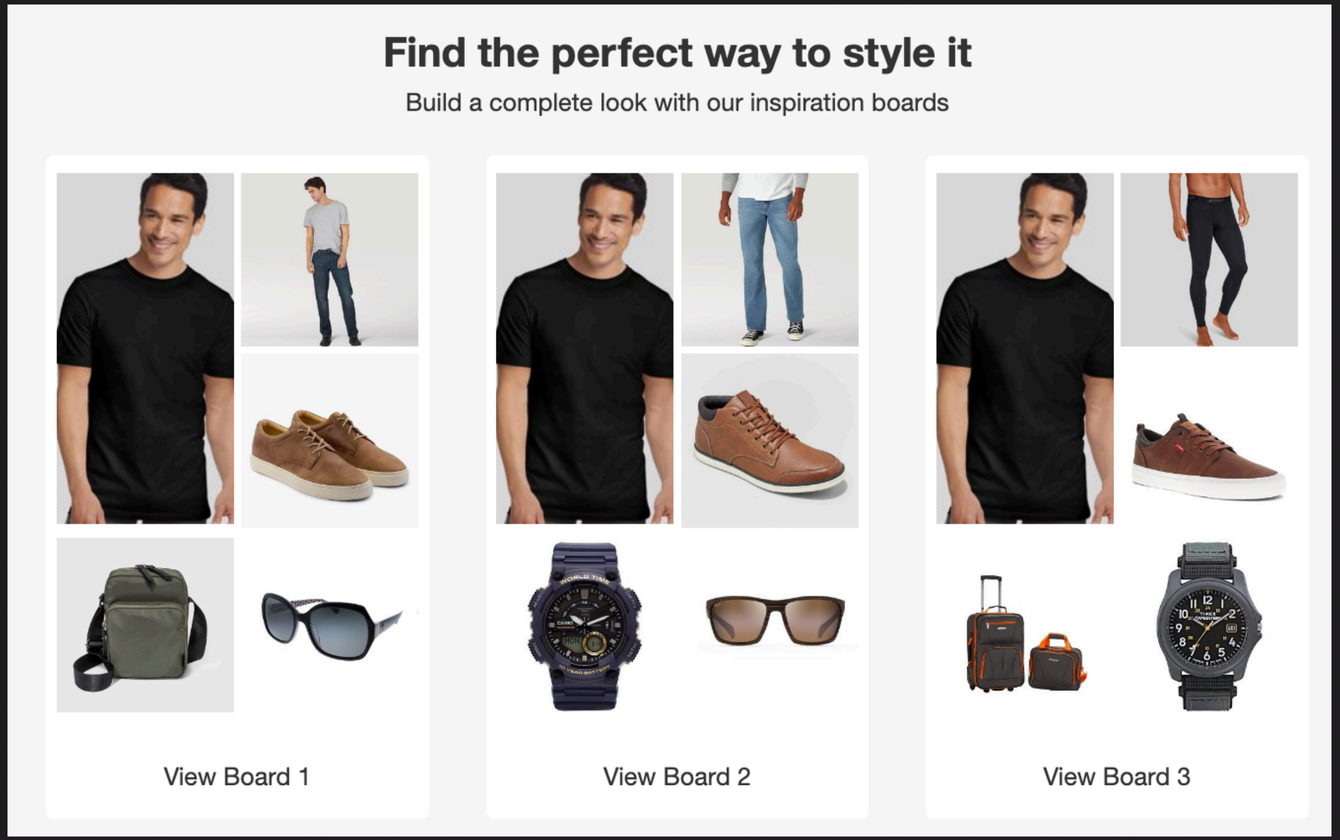
Is the improvement brought by the new model is statistically significant at 95% confidence?

Null and alternate hypothesis?

$H_0 : p = 0.1 \qquad H_a : p > 0.1$

$H_0$ assumes new model has same performance

This means that the $72/500 = 0.14$ of the new model is just fluke




What is the test statistic?

$X$ : Number of people who bought the recommended items

Distribution of the test statistic $X$? Binom(n=500, p=0.1)

Right, left tailed, or two-tailed? Right tailed

What is the p-value?

$P[X \geq 72 \,|\, H_0 \text{ is true}] = 1 - P[X \leq 71 \,|\, H_0 \text{ is true}] =$ `1 - binom.cdf(71, n=500, p=0.1)` $= 0.001$

What is $\alpha$? $\alpha = 0.05$

Is p-value $< \alpha$? Yes We reject the null hypothesis We say that the new model is better

## SQL Queries

SQL Queries are equally likely to:

a) Execute successfully in 1 minute,

b) Fail at 3 minutes

Upon failure, we run the query again till it is successful. Find the expected time to run this query

Let $S$ denote success in first attempt and $F$ denote failure in first attempt

$$E[X] = E[X \mid S]P[S] + E[X \mid F]P[F]$$

$$= (1)P[S] + (3 + E[X])P[F]$$

$$E[X] = 4$$

## Simulate a fair coin from a biased coin

There is a coin that lands heads 70% of the times

How can we use this coin so that it lands heads 50% of the times?

Verify the output of your algorithm using 10000 simulations at 95% confidence

Let us toss the biased coin twice

Sample space S = {HH, HT, TH, TT}

$$P[HH] = 0.7 * 0.7$$

$$P[HT] = 0.7 * 0.3$$

$$P[TH] = 0.3 * 0.7$$

$$P[TT] = 0.3 * 0.3$$

These two have same probability

| Biased | Fair |
|---|---|
| $HH \rightarrow$ | Ignore |
| $TT \rightarrow$ | Ignore |
| $HT \rightarrow$ | $H$ |
| $TH \rightarrow$ | $T$ |