Statistical inference on two proportions and two means

Outline for today

Review of hypothesis tests for a single proportion

Hypothesis tests for two proportions

Hypothesis tests for two means

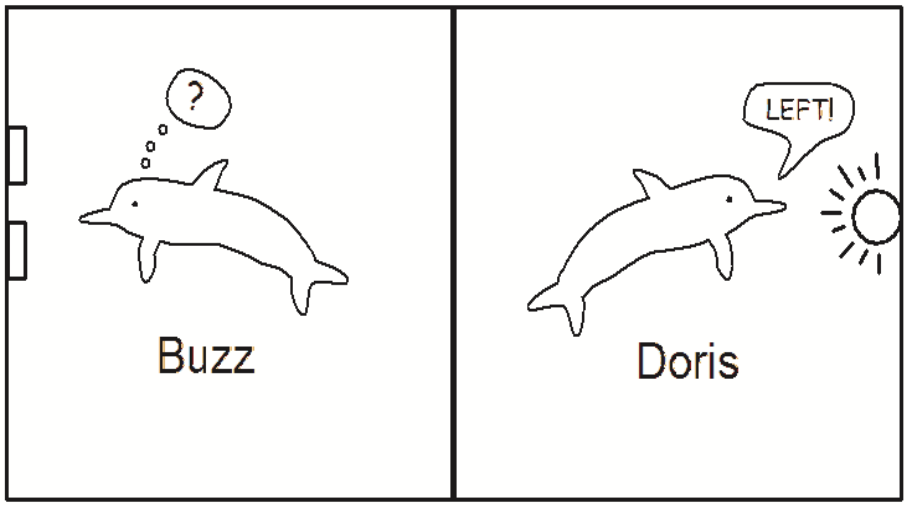
Review: hypothesis tests for a single proportion

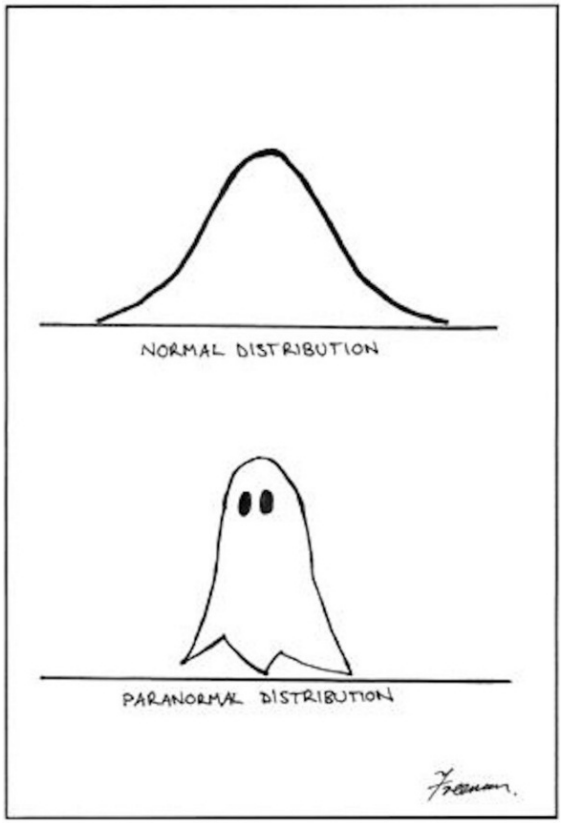
What was?

H_0: π =

H_A: π

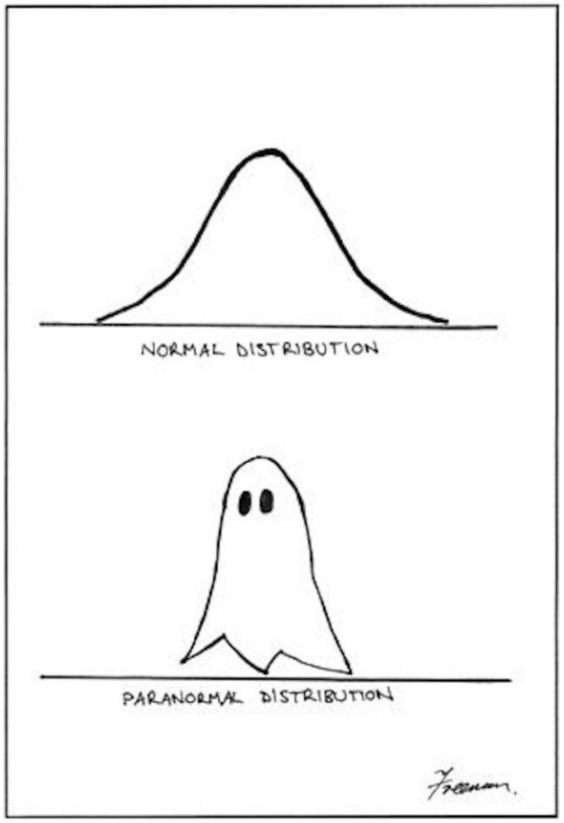
$\hat{p}$ =





The logic of hypothesis tests: card example

Review: ghost example



A telephone survey of 1,000 randomly selected US adults found that 31% of them say they believe in ghosts.

Does this provide evidence that more than 1 in 4 US adults believe in ghosts?

Steps for doing a hypothesis test

1. State the null and alternative hypothesis
   - H_0: $\pi = .25$
   - H_A: $\pi > .25$

2. Calculate the observed statistic
   - $\hat{p} = .31 = 310/1000$

3. Create a null distribution
   - Typical statistics you would expect to get if the null hypothesis was true

4. Create a p-value by calculating the probability of getting a statistics as great or greater than the observed from the null distribution

Creating a null distribution

We assume that the null hypothesis is true (H_0: $\pi = \pi_0$)

We create a distribution of statistics we would expect to observe if the null hypothesis was true

- If we are dealing with proportions what type of distribution should we use?
  - binomial distribution
- What are n, and π in our binomial distribution?

A Shiny App to create null distributions:

http://asterius.hampshire.edu:3838/baseball/sampling_distribution_proportion/

The amazing woman who can smell Parkinson's disease

Joy Milne claimed to have the ability to smell whether someone had Parkinson's disease

To test this claim researchers gave Joy 6 shirts that had been worn by people who had Parkinson's disease and 6 people who did not

Joy identified 11 out of the 12 shirts correctly

The amazing woman who can smell Parkinson's disease

1. State Null and Alternative in symbols and words

2. Calculate the observed statistic of interest

3. Use R to generate the null distribution that would occur if the null hypothesis was true (or the shiny app)

4. Calculate the p-value using results from steps 2 and 3

Hypothesis tests for comparing two proportions

Testing whether two proportions differ

Baseball questions that where we are interested in whether two proportions are different:

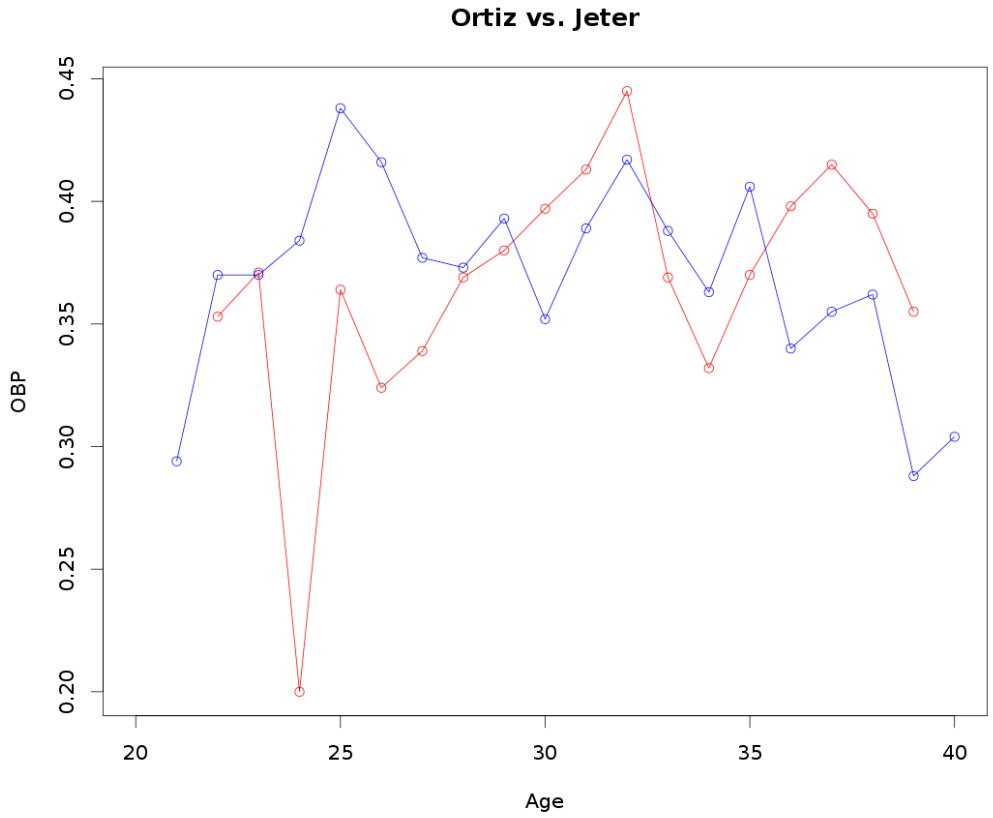
Is David Ortiz's OBP ability higher when:

- Away vs. Home?
- Day games vs. night games?
- Against left hand vs. right had pitchers?
- Than Derek Jeter's?

Is David Ortiz OBP ability better than Jeter's

How can we approach this problem?

Let's start by plotting some data…



Is David Ortiz OBP ability better than Jeter's

Simplifying assumption for illustrative purposes – ability does not change over one's career

- Is this true?

Let's compare career statistics:

	Ortiz	**Jeter**
On-base	3357	4717
Plate appearances (minus SH)	8849	12505
OBP	0.379	0.377

Is David Ortiz OBP ability better than Jeter's

Let's do a hypothesis test that Ortiz had a higher OBP than Jeter

1. State the null and alternative hypotheses in symbols and words

- H_0: $\pi_o = \pi_J$ or $\pi_o - \pi_J = 0$
- H_A: $\pi_o > \pi_J$ or $\pi_o - \pi_J > 0$

What do we do next?

2. Observed statistic is: .379 - .377 = .002

Now what do we do?

Is David Ortiz OBP ability better than Jeter's

How can we create a distribution of this statistic that is consistent with the null hypothesis?

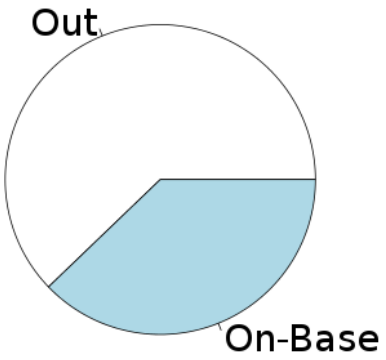
- i.e. how can we create a null distribution

Let's use simulation…

	Ortiz	Jeter
On-base	3357	4717
Plate appearances (minus SH)	8849	12505
OBP	0.379	0.377

Total On-base = 8074 Total PA = 21354 Total OBP = .378

Simulate Ortiz and Jeter's plate appearances by assuming they have equal OBP abilities:



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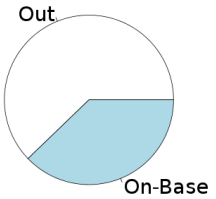
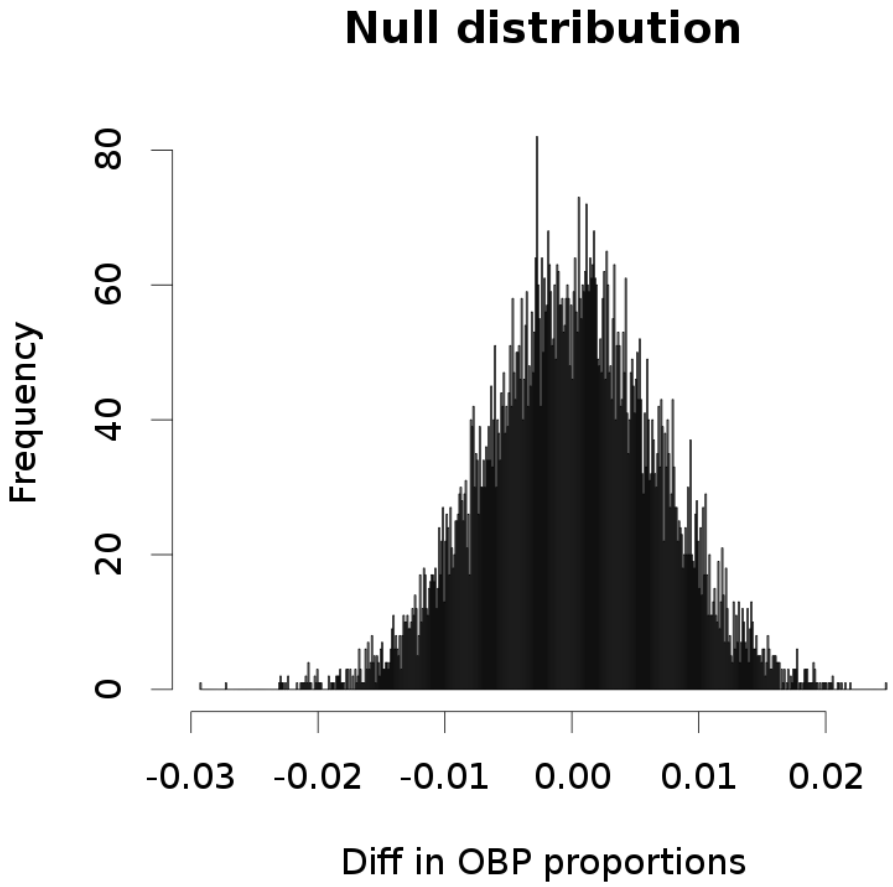


<u>Simulation:</u>

1. Flip a coin 8849 times for Ortiz and 12505 for Jeter
2. Compute difference in proportion of on-base events
3. Repeat 10,000 times

Is David Ortiz OBP ability better than Jeter's

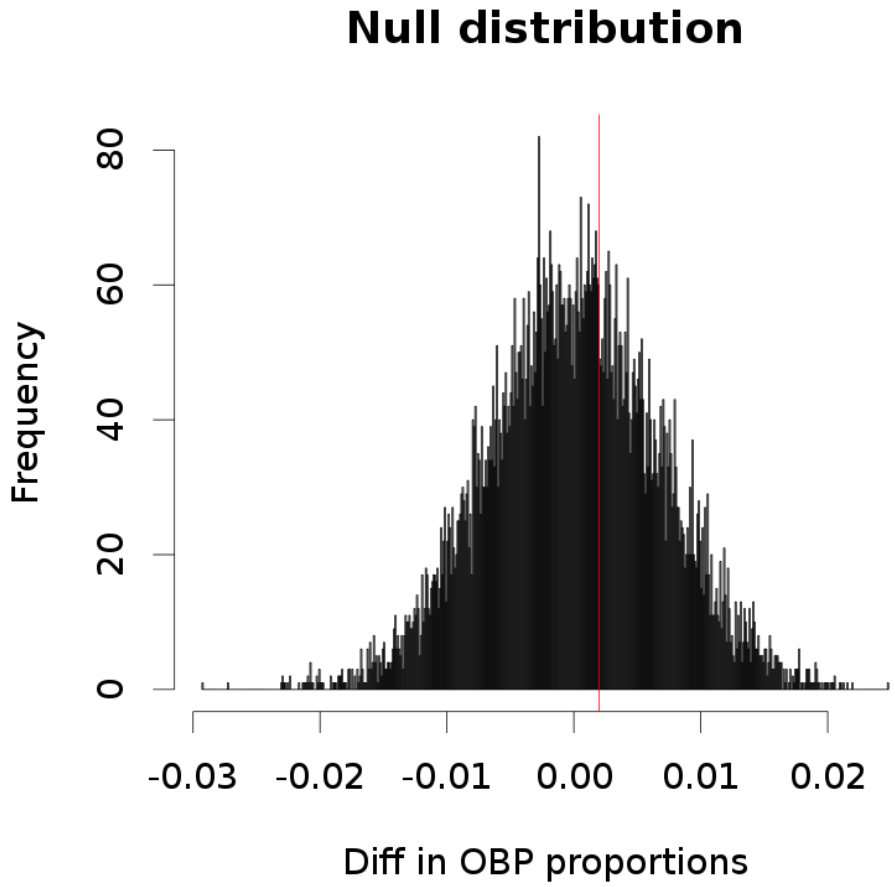
Results of the simulation…



What do we do next?

Is David Ortiz OBP ability better than Jeter's

Results of the simulation…



And what do we do now?

Is David Ortiz OBP ability better than Jeter's

3,784 of the 10,000 different in simulated proportions were greater than the observed different in OBP proprotions

so the p-value is…

p-value = .3784

Conclusion?

Creating the null (randomized) distribution in R

	Ortiz	Jeter
On-base	3357	4717
Plate appearances (minus SH)	8849	12505
OBP	0.379	0.377

```
Ortiz.num.PA <-  8849
Jeter.num.PA  <- 12505

Total.num.PA <-   8849  +  12505          # total PA for both players
Total.OB <- 3357 + 4717                   # total times on-base for both players

total.OBP <- Total.OB/Total.num.PA        # OBP if both players had the same ability

obs.diff.OBP <- .379 - .377               # observed statistic of interest
```

Creating the null distribution in R

```
sim.Ortiz.OBP <- rbinom(10000, Ortiz.PA, total.OBP)/Ortiz.PA
sim.Jeter.OBP <- rbinom(10000, Jeter.PA, total.OBP)/Jeter.PA

null.dist.vec  <-  sim.Ortiz.OBP - sim.Jeter.OBP
p.value   <-   sum(null.dist.vec >=   obs.diff.OBP)/10000
```