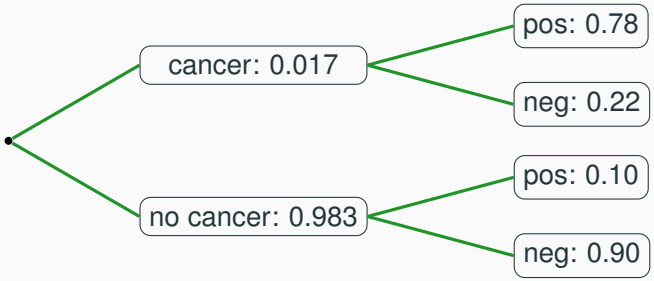
Announcements

- Written homework 4 due on Monday!
- Lab 5 due on Monday as well!
- Test 1 a week from today
  - All material from today onward is not on the test
  - Covers Ch 1, Ch 5.1–5.3, Ch 6.1 and 6.3, and A.1–A.2
  - I'm trying to get study materials up sometime tomorrow
  - If you haven't done them, you do have the practice problems from each chapter
- In-class lab on Sampling on Monday
- Physics Tea today at 3!
- Read Ch 2.3,2.4 for next Wednesday
- Polling: `rembold-class.ddns.net`

Last class. . .

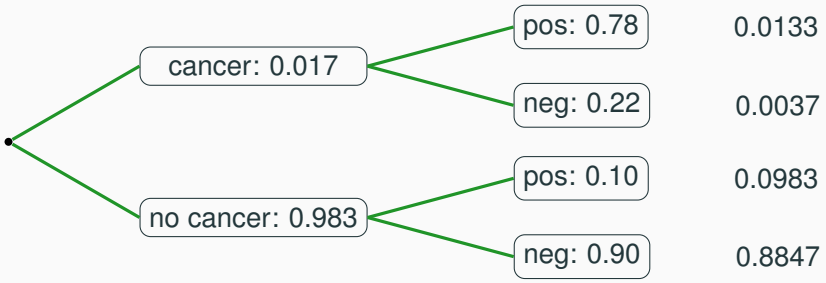
If a mammogram yields a positive result, what is the probability that a patient actually has cancer?



$$P(C|+) = \frac{P(C \text{ and } +)}{P(+)} = \frac{0.0133}{0.0133 + 0.0983} = 0.12$$

Last class. . .

If a mammogram yields a positive result, what is the probability that a patient actually has cancer?



$$P(C|+) = \frac{P(C \text{ and } +)}{P(+)} = \frac{0.0133}{0.0133 + 0.0983} = 0.12$$

Repeat Trials

Suppose a women who gets tested once gets a positive result. Now she'd like to get tested again.

- Previously, the odds of cancer/no cancer were 1.7% / 98.3%
- After one positive test, they change
- Now the odds of cancer/no cancer are 12% / 82%

Warm Up

What are the odds that the women has cancer given that the second mammogram comes back positive? The odds of correct diagnosis and false positive are the same as they were before (78% positive given they have cancer, and 10% positive given no cancer.)

A) 0.0936

B) 0.088

C) 0.48

D) 0.52

Warm Up

What are the odds that the women has cancer given that the second mammogram comes back positive? The odds of correct diagnosis and false positive are the same as they were before (78% positive given they have cancer, and 10% positive given no cancer.)

A) 0.0936

B) 0.088

C) 0.48

D) 0.52

Gender Discrimination

- In 1972, as part of a study on gender discrimination, 48 male bank supervisors were each given the same personnel file and asked to judge whether the person should be promoted to a branch manager job that was described as “routine”.
- Files were identical except that half of the supervisors had files showing the individual was male and half had files showing the person was female
- It was randomly determined which supervisors got “male” applications and which got “female”.
- 35 files were selected for promotion
- Study was testing whether females were unfairly discriminated against.

Is this an observational study or an experiment?

Gender Discrimination

- In 1972, as part of a study on gender discrimination, 48 male bank supervisors were each given the same personnel file and asked to judge whether the person should be promoted to a branch manager job that was described as “routine”.
- Files were identical except that half of the supervisors had files showing the individual was male and half had files showing the person was female
- It was randomly determined which supervisors got “male” applications and which got “female”.
- 35 files were selected for promotion
- Study was testing whether females were unfairly discriminated against.

Is this an observational study or an experiment? Experiment

Results

Does there appear to be a relationship between promotion and gender?

	Promoted	Not Promoted	Total
Male	21	3	24
Female	14	10	24
Total	35	13	48

Results

Does there appear to be a relationship between promotion and gender?

	Promoted	Not Promoted	Total
Male	21	3	24
Female	14	10	24
Total	35	13	48

% of males promoted: 21/24 = 87.5%

Results

Does there appear to be a relationship between promotion and gender?

	Promoted	Not Promoted	Total
Male	21	3	24
Female	14	10	24
Total	35	13	48

% of males promoted: 21/24 = 87.5%

% of females promoted: 14/24 = 58.3%

Results

Does there appear to be a relationship between promotion and gender?

	Promoted	Not Promoted	Total
Male	21	3	24
Female	14	10	24
Total	35	13	48

% of males promoted: 21/24 = 87.5%

% of females promoted: 14/24 = 58.3%

Should we be outraged?

Options

There is a difference of almost 30% between the proportions of male and female files promoted. There are a few things that might explain this:

- The difference in the proportions of promoted male and female files is due to chance, and is not evidence of gender discrimination.
- Promotion is dependent on gender, as males are more likely to get promoted. Hence there is evidence for gender discrimination.

Constructing a Test

We end up with the two competing claims:

Null Hypothesis: H_0

- "There is nothing going on."
- Promotion and gender and independent.
- No gender discrimination happening.
- Observed difference in proportions is simply due to chance.

Alternative Hypothesis: H_A

- "There is something going on."
- Promotion and gender are dependent.
- There is gender discrimination happening.
- Observed difference in proportions is not due to chance.

Stand trial, ye data

Hypothesis testing is very much like a court trial:

- Different hypothesis for the defendant

  H_0: Defendant is innocent

  H_A: Defendant is guilty

- The evidence is the collected data
- The evidence is judged: “Could these data plausibly have happened by chance is the defendant is innocent?”
  - If they are very unlikely to have occured, then the evidence raises more than reasonable doubt in our minds about the innocent of the defendant
- Have to make a decision at some point. How unlikely is unlikely?

Never Innocent

- If the evidence is not strong enough to reject the assumption of innocence, the jury returns wit ha verdict of “not guilty”.
  - The jury never states that the defendant is innocent, just that there is not enough evidence to convict.
  - The defendant may be totally innocent, but the jury has no way of being sure.
- In statistical terms, we “fail to reject the null hypothesis”
  - We never declare the null hypothesis to be true, because we don’t have a way of telling that
  - We never “accept the null hypothesis”

The burden of proof

- In a trial, the burden of proof is on the prosecution
- In statistics, the burden of proof is on the unusual claim
- The null hypothesis is the ordinary state of affairs, so it is the alternative hypothesis that we consider unusual and for which we must gather evidence.

Recap:

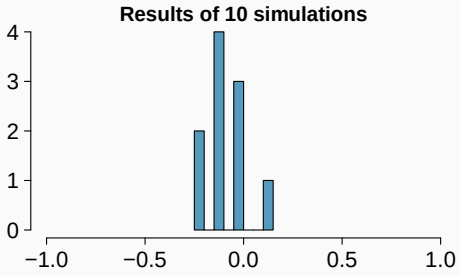
- We start with a ***null hypothesis (H_0)*** that represents the status quo.
- We also have an ***alternative hypothesis (H_A)*** that represents our research question. What are we testing for?
- We conduct a hypothesis test under the assumption that the null hypothesis is true, either by simulation or theoretical methods
- If the test results suggest that the data do not provide convincing evidence for the alternative hypothesis, we stick with the null hypothesis. If they do, then we reject the null hypothesis in favor of the alternative.

Simulation

- If things are independent, the differences are due to chance
- If results from a ***chance model*** look like the data, we can determine that the differences are simply due to chance (and that promotion and gender are independent)
- If results from the chance model do not look like the data, then we can determine that the differences are not due to chance, but due to an actual effect (and that promotion and gender are dependent).

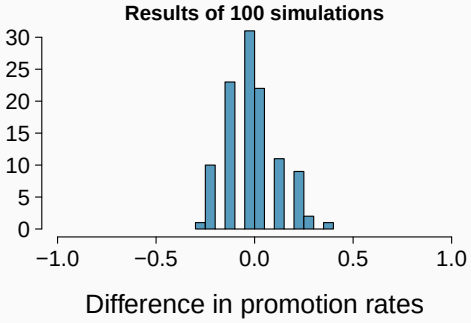
Computing the simulation

- Already have the machinery to simulate a sample
  - Used it in “Hot Hands” lab
  - `sample(choices, size=35, replace=TRUE)`
- Want to do that many times and keep track of the results
- Can give us an idea of the odds of a certain event randomly happening



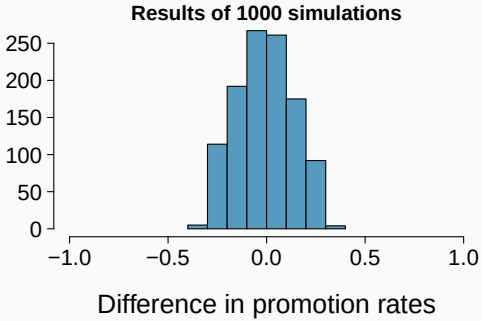
Computing the simulation

- Already have the machinery to simulate a sample
  - Used it in “Hot Hands” lab
  - `sample(choices, size=35, replace=TRUE)`
- Want to do that many times and keep track of the results
- Can give us an idea of the odds of a certain event randomly happening



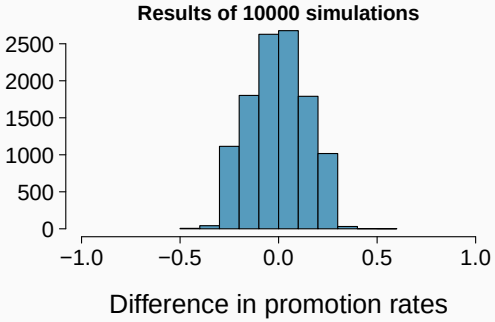
Computing the simulation

- Already have the machinery to simulate a sample
  - Used it in “Hot Hands” lab
  - `sample(choices, size=35, replace=TRUE)`
- Want to do that many times and keep track of the results
- Can give us an idea of the odds of a certain event randomly happening



Computing the simulation

- Already have the machinery to simulate a sample
  - Used it in “Hot Hands” lab
  - `sample(choices, size=35, replace=TRUE)`
- Want to do that many times and keep track of the results
- Can give us an idea of the odds of a certain event randomly happening



Results of simulation

How many trials in each batch were equal or larger than the 29.2% difference we saw in the experiment?

- 10 sims: 0/10 = 0%
- 100 sims: 1/100 = 1%
- 1000 sims: 4/1000 = 0.4%
- 10000 sims: 34/10000 = 0.34%

Results of simulation

How many trials in each batch were equal or larger than the 29.2% difference we saw in the experiment?

- 10 sims: 0/10 = 0%
- 100 sims: 1/100 = 1%
- 1000 sims: 4/1000 = 0.4%
- 10000 sims: 34/10000 = 0.34%

So it seems pretty unlikely that this difference is purely due to chance!