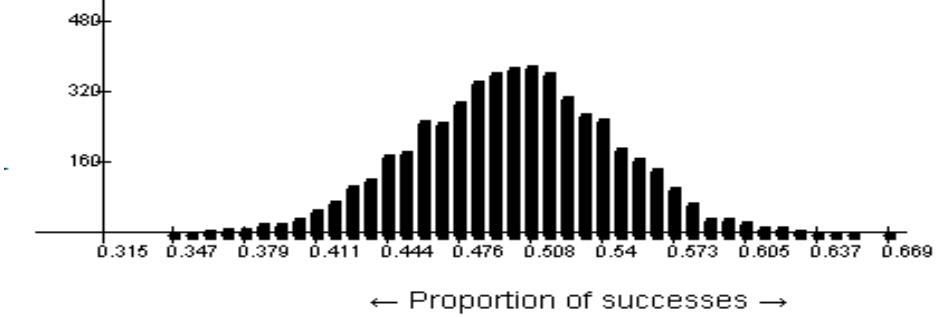
Stat 13, Intro. to Statistical Methods for the Life and Health Sciences.

1. Submit HW1 immediately (by Jan20, 2pm) to
   STATGRADER@STAT.UCLA.EDU or STATGRADER2 by email.
2. Normal distribution, CLT, and Halloween candy example.
3. Validity conditions for testing proportions.
4. Reject the null vs. accept the alternative, wealth and echinacea examples.
5. Sampling, bias, and students example.
6. Estimating the mean, and guessing elapsed time example.

Read chapters 2 and 3.
http://www.stat.ucla.edu/~frederic/13/W23 .
HW2 is due Fri Feb10 at 2pm and is problems 2.3.15, 3.3.18, and 4.1.23.
See day4 notes to make sure you are doing the correct problems.

1. Normal distribution, CLT, and halloween candy example.

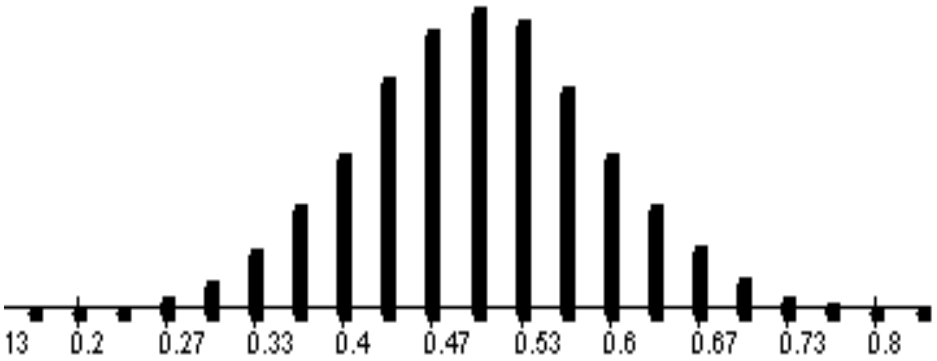
Section 1.5

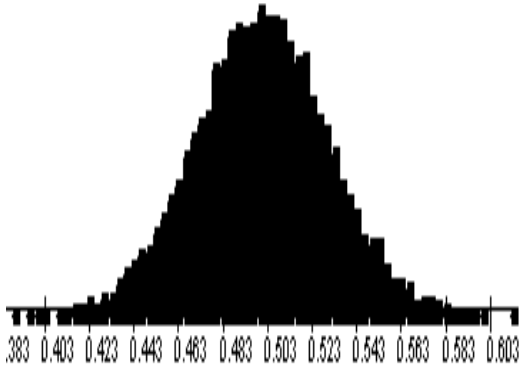


- The shape of most of our simulated null distributions always seems to be bell shaped. This shape is called the normal distribution.
- The Central Limit Theorem (CLT) dictates that, as *n* gets large, the sample mean or proportion becomes approximately normally distributed.
- When we do a test of significance using theory-based methods, only how our p-values are found will change. Everything else will stay the same.

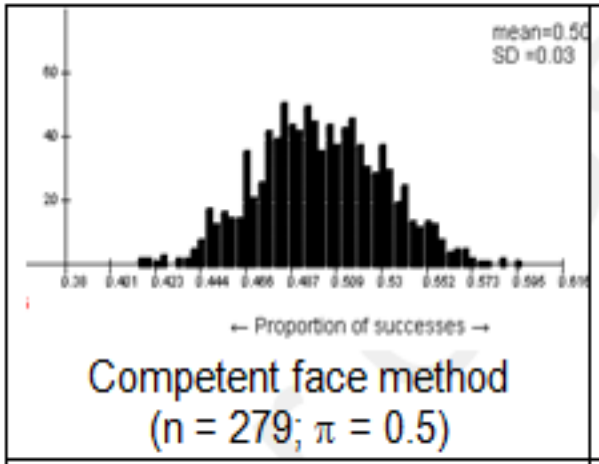
The Normal Distribution

- Both of these are centered at 0.5.
  - The one on the left represents samples of size 30.
  - The one on the right represents samples of size 300.
  - Both could be described as normal distributions.

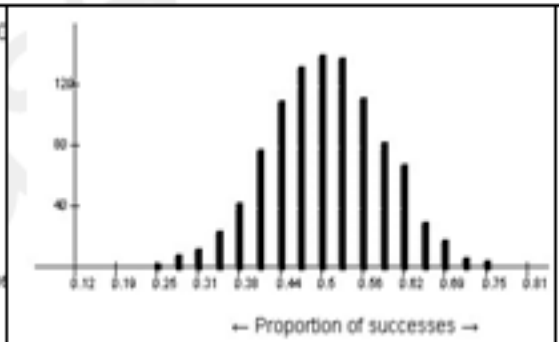




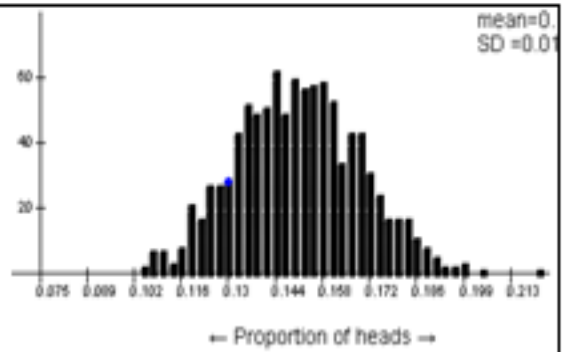
- Which ones will normal distributions fit?



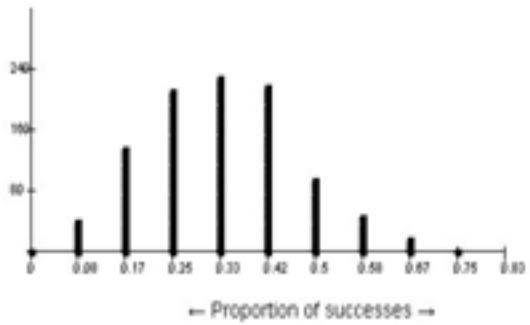
Competent face method
(n = 279; π = 0.5)



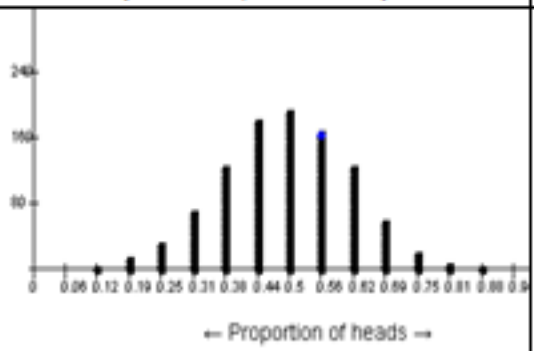
Competent face method
(n = 32; π = 0.5)



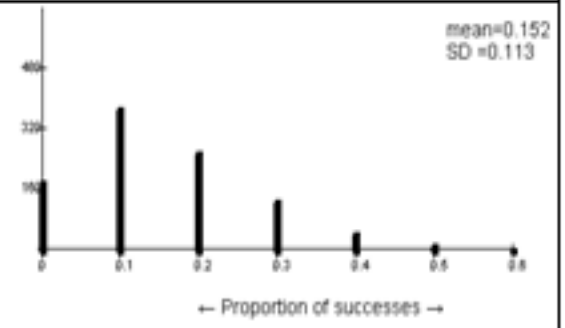
St. George's
(n = 361; π = 0.15)



Rock Paper Scissors
(n = 12; π = 0.3333)



Doris/Buzz
(n = 16; π = 0.5)



St. George's
(n = 10, π = 0.15)

When can I use a theory-based test that uses the normal distribution?

- The shape of the randomized null distribution is affected by the sample size and the proportion under the null hypothesis.
- The larger the sample size the better.
- The closer the null proportion is to 0.5 the better.
- For testing proportions, you should have at least 10 successes and 10 failures in your sample to be confident that a normal distribution will fit the simulated null distribution nicely.

Advantages and Disadvantages of Theory-Based Tests

- **Advantages of theory-based tests**
  - No need to set up some randomization method
  - Fast and Easy
  - Can be done with a wide variety of software
  - We all get the same p-value.
  - Determining confidence intervals (we will do this in chapter 3) is much easier.
- **Disadvantages of theory-based tests**
  - They all come with some validity conditions (like the number of success and failures we have for a single proportion test).

Example 1.5: Halloween Treats

- Researchers investigated whether children show a preference to toys or candy
- Test households in five Connecticut neighborhoods offered children two plates:
  - One with candy
  - One with small, inexpensive toys
- The researchers observed the selections of 283 trick-or-treaters between ages 3 and 14.

Halloween Treats

- Null: The proportion of trick-or-treaters who choose candy is 0.5.
- Alternative: The proportion of trick-or-treaters who choose candy is not 0.5.

- H_0: $\pi = 0.5$
- H_a: $\pi \neq 0.5$

- 283 children were observed
  - 148 (52.3%) chose candy
  - 135 (47.7%) chose toys

Standard Deviation of $\hat{p}$

- Under the null distribution, the standard deviation of $\hat{p}$ is $\sqrt{\pi(1-\pi)/n}$ where π is the proportion under the null and n is the sample size.
- $\sqrt{\frac{0.5(1-0.5)}{283}} = 0.0297.$

Theory-Based Inference

- The theory-based standard error works if we have a large enough sample size.
- We have 148 successes and 135 failures. Is the sample size large enough to use the theory-based method?

Standardized Statistic

- $\frac{0.523-0.5}{.0297}$ = 0.774.
- This is our Z-statistic, meaning the sample proportion is 0.774 SEs above the mean.
- Remember that a standardized statistic of more than 2 indicates that the sample result is far enough from the hypothesized value to be unlikely if the null were true.
- We had a standardized statistic that was not more than 2 (or even 1) so we don't really have strong evidence against the null.

Halloween Treats

- To compute the p-value in *R*,
  2*(1-pnorm(.774)) ~ 0.439.
- The theory-based p-value is 0.439 so if half of the population of trick-or-treaters preferred candy, then there's a **43.9%** chance that a random sample of 283 trick-or-treaters would have 148 or more, or 135 or fewer, candy choosers.
- Since 43.9% is not a small p-value, we don't have strong (or even moderate) evidence that trick-or-treaters prefer one type of treat over the other. We cannot reject the null hypothesis.

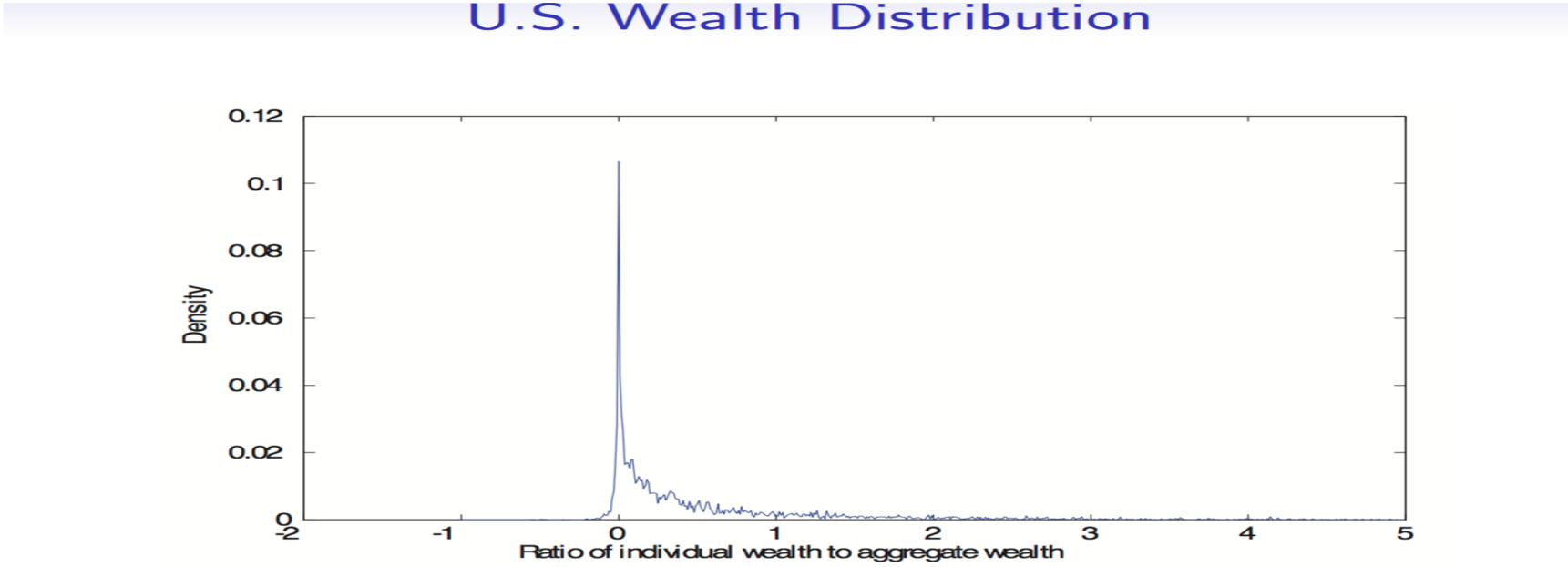
2. Validity conditions for testing proportions.

- You should have at least 10 successes and 10 failures in your sample to be confident a normal distribution will fit the simulated null distribution nicely.
- Your observations should be (at least approximately) independent. We will discuss what this means later in this lecture when we talk about sampling.

3. Rejecting the null vs. accepting the alternative.

– Benoit Mandelbrot.
  We've tested it on many datasets and found the Pareto distribution "fits perfectly".

– from B. Moll (2012).



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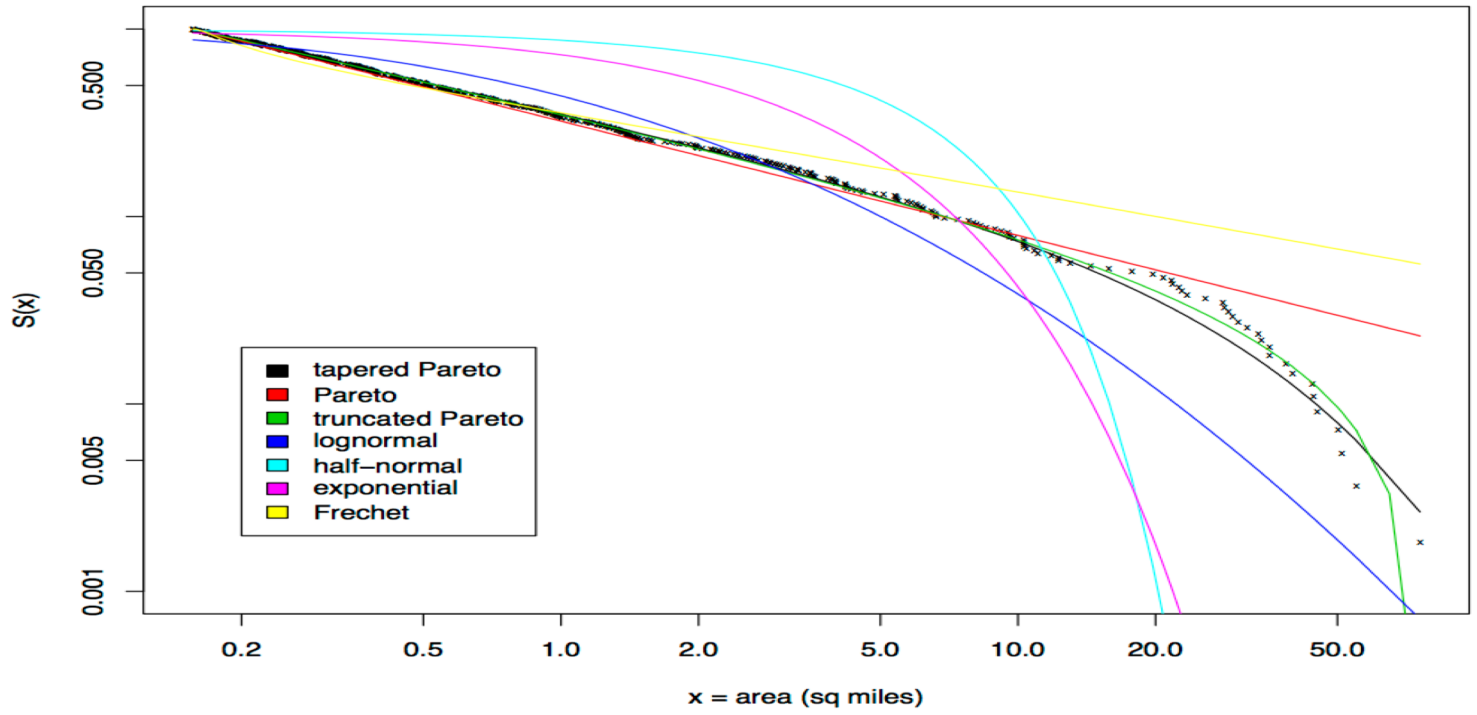

Rejecting the null vs. accepting the alternative.

- Benoit Mandelbrot.
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- Think about it. What is the null hypothesis of the test. Is it possible to show that the model fits perfectly?
- You might not reject the null with a certain n, and then as n grows, you reject it.
- Nowadays people are using the tapered Pareto distribution instead of the Pareto.
- Echinacea vs. placebo. n = 58. Oneil et al. 2008.

Rejecting the null vs. accepting the alternative.

- 28 in echinacea group and 30 in placebo group.
- "[V]olunteers recruited from hospital personnel were randomly assigned to receive 3 capsules twice daily of either placebo (parsley) or E. purpurea [echinacea] for 8 weeks during the winter months. Upper respiratory tract symptoms were reported weekly during this period.
- "Individuals in the echinacea group reported 9 sick days per person during the 8-week period, whereas the placebo group reported 14 sick days ($z = -0.42$; $P = .67$)."

Rejecting Ho vs. accepting Ha.

- conclusion in Oneil et al. (2008), "commercially available E. purpurea capsules did not significantly alter the frequency of upper respiratory tract symptoms compared with placebo use."
- From sciencebasedmedicine.org, "[The study] added to the evidence that *Echinacea* is not useful for prevention of colds or flus. They found no difference in incidence of cold symptoms."
- ABC News headline "Study: Echinacea no help for colds".

Rejecting Ho vs. accepting Ha.

Rejecting Ho vs. accepting Ha.

Today, most of the evidence seems to indicate that echinacea does boost the immune system a little bit and help to fight colds. From WebMD: "Extracts of echinacea do seem to have an effect on the immune system, your body's defense against germs. Research shows it increases the number of white blood cells, which fight infections. A review of more than a dozen studies, published in 2014, found the herbal remedy had a very slight benefit in preventing colds."