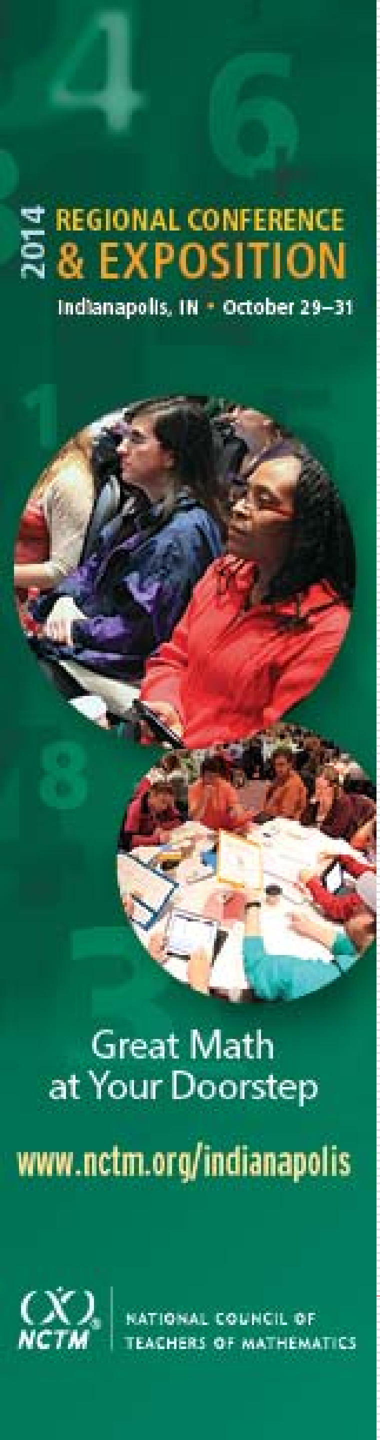

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Ruling Out Chance...

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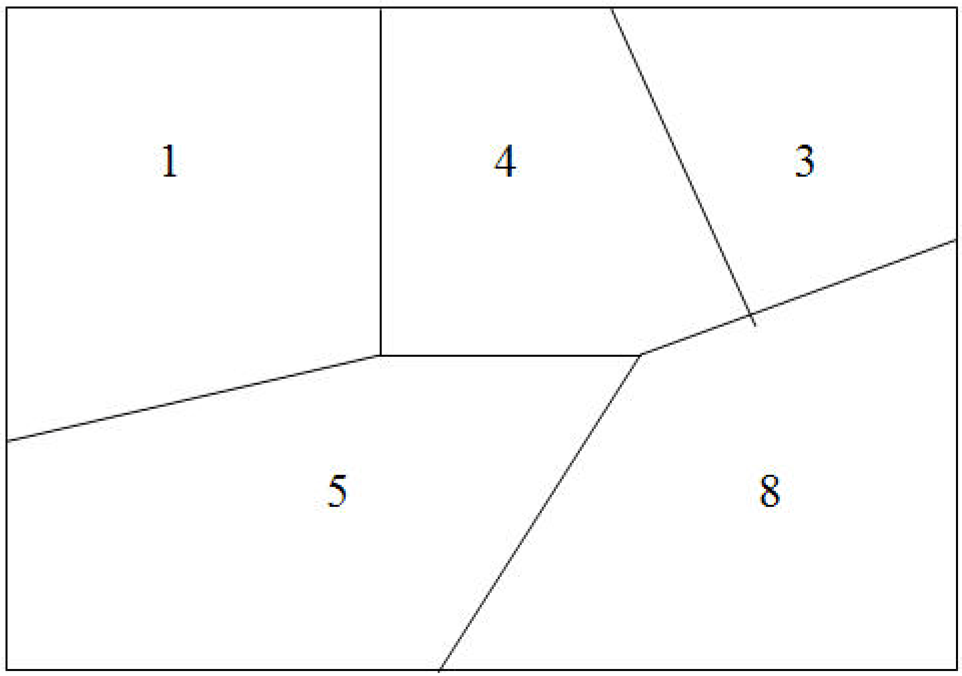
Consider the map of counties shown below. The number in each county is last month's incidence rate for a disease in cases per 100,000 population.
(Dick Schaeffer, 2005)



Statistical Versus Mathematical Thinking

- Mathematical Thinking
  - Explain patterns
  - Often a deterministic way of thinking
- Statistical Thinking
  - Search for patterns in the presence of variability
  - Acknowledge role of chance variation Often involves “Ruling Out Chance” as an explanation

Ruling Out Chance…

- The plan for today’s session: Three activities that illustrate the connections between probability and statistical inference.

Ruling Out Chance...

Activity 1: The Cookie Game

(My favorite activity of all time, with apologies to those who have seen it before)

Discussion Points

- Cookie Game illustrates the thought process that underlies almost all of statistical inference
  - Could this have happened by chance when…
  - Competing claims about a population, one of which is initially assumed to be true (the null hypothesis)
  - Sample from the population
  - A decision based on whether the observed outcome would have been likely or unlikely to occur BY CHANCE when the null hypothesis is true

Discussion Points

- Convincing evidence vs. proof
- Relationship between probability assessment and choice of significance level

Ruling Out Chance...

- Activity 2: Inappropriate Dress

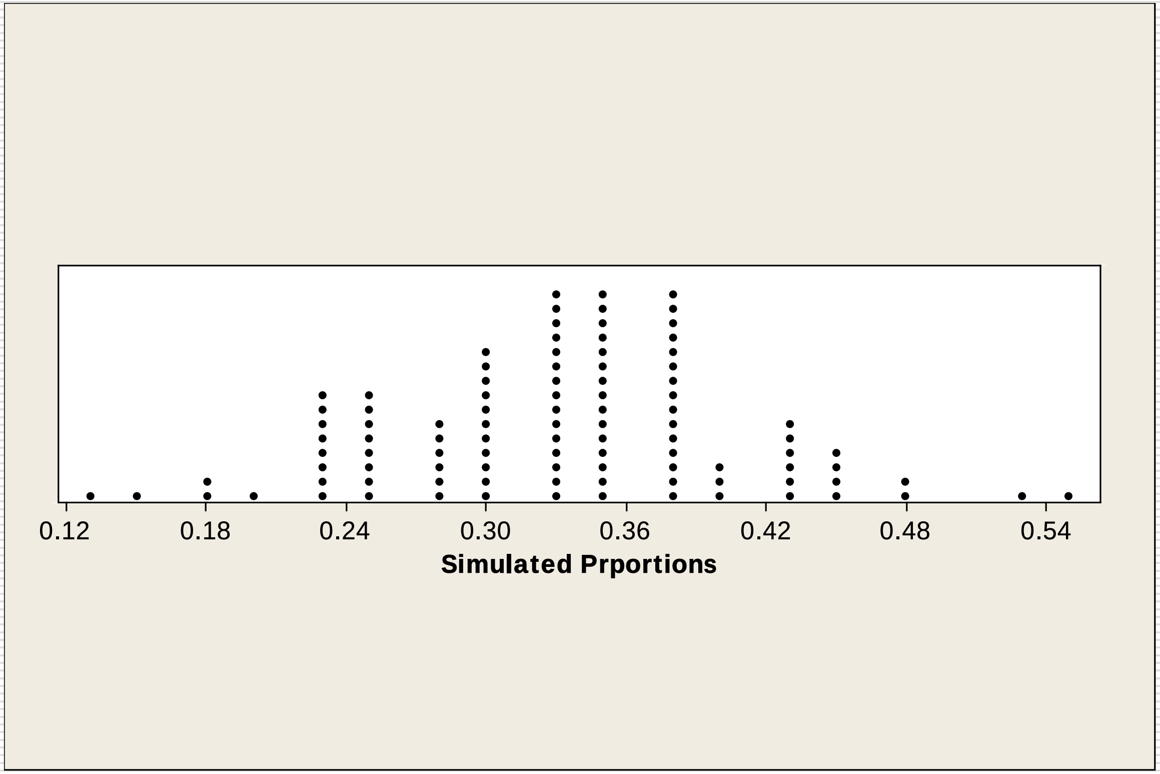
- A CareerBuilders (www.careerbuilders.com) press release dated June 17, 2008 claims more than one third of employers have sent an employee home for inappropriate attire. Suppose that in a random sample of 40 employers, 15 report that they have sent an employee home to change clothes. Do the data provide convincing evidence that the CareerBuilders claim is correct?

Sample proportion $= \frac{15}{40} = .38$

Is chance variation from sample to sample (sampling variability) a plausible explanation for why the sample proportion is greater than 1/3?

- To be convinced, we must see a sample proportion not just greater than 1/3, but one that is enough greater than 1/3 that it is not likely to have occurred just by chance due to sampling variability.
- **Ruling Out Chance:** What kind of sample proportions would not be convincing? What kind of sample proportions would we expect to see just due to chance when the population proportion is 1/3 ?

The dotplot



Discussion Points

- Can't rule out chance...

- What does this conclusion mean? Have we proven that the proportion is NOT greater than 1/3?

Ruling Out Chance...

- Activity 3: Duct Tape to Remove Warts
- Some people seem to believe that you can fix anything with duct tape. Even so, many were skeptical when researchers announced that duct tape may be a more effective and less painful alternative to liquid nitrogen, which doctors routinely use to freeze warts. The article “What a Fix-It: Duct Tape Can Remove Warts” (*San Luis Obispo Tribune*, October 15, 2002) described a study conducted at Madigan Army Medical Center. Patients with warts were randomly assigned to either the duct tape treatment or the more traditional freezing treatment. Those in the duct tape group wore duct tape over the wart for 6 days, then removed the tape, soaked the area in water, and used an emery board to scrape the area. This process was repeated for a maximum of 2 months or until the wart was gone.
- Data on handout

- Duct tape was more successful (84% successes) than liquid nitrogen (60% successes), but is this convincing evidence that the duct tape treatment is superior? Could this have happened by chance just due to the random assignment?
- **Ruling Out Chance**: Suppose that there is no difference between the treatments and that these 36 people would have had successful removal no matter which treatment was applied. If this is the case, the difference between the 15 successes for the liquid nitrogen group and the 21 successes for the duct tape group is just due to the “luck of the draw” when the random assignment to groups was done.

The Frequency Distribution

Based on 100 trials

Number Of Successes	Count	Percent
15	3	3.00
16	8	8.00
17	26	26.00
18	24	24.00
19	26	26.00
20	10	10.00
21	2	2.00
22	1	1.00

Discussion Points

- Observed result “unlikely” to have occurred by chance just due to the random assignment of subjects to experimental groups
(reference to Cookie Game activity for what constitutes “unlikely”)
- “Ruled out” chance. What does this conclusion mean? Can we be certain?

Linking to Common Core

- Activities Illustrate Common Core Standards under Making Inferences and Justifying Conclusions.

  - S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (Cookie Game, Inappropriate Dress)

Linking to Common Core Continued

- S-IC.2 Decide if a specified model is consistent with results from a given data-generating process. (Cookie Game, Inappropriate Dress)
- S-IC.4 Use data from a randomized experiment to compare two treatments: use simulations to decide if differences between parameters are significant. (Duct Tape to Remove Warts)
- S-IC.5 Evaluate reports based on data. (Inappropriate Dress, Duct Tape to Remove Warts)

Linking to Traditional Methods in AP Statistics

- Can move from activities like these to the more formal approaches, linking to the activities
  - Sampling distributions become our way of deciding whether we can rule out chance in situations where our intuition isn't adequate (as it was in the cookie game) or when we get tired of simulating (in the case of proportions).
  - Can then move from situations involving proportions where simulation is more straight forward to situations involving means that don't lend themselves to simulation. Theoretical results rather than simulation provide the information needed to decide if we can "rule out chance".

Linking to Traditional Methods

- Hypothesis testing logic and types of conclusions that can be drawn—students remember the cookie game activity and the logic involved
- Convincing evidence and significance levels (the cookie game activity makes the customary choices for significance levels seem intuitively reasonable—What does it take to rule out chance?)
- P-Values as a basis for drawing a conclusion (the activities motivate why it is reasonable to base conclusions about a population based on the P-Value as a measure of whether it is likely or unlikely that we would observe a sample result as extreme as what was observed just by chance if the null hypothesis is true)

Thanks for coming!

Feel free to contact me with any questions.

Email for a copy of the Powerpoint slides.

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