(GAISE Guidelines and) The Statistics Investigative Process

AMATYC Conference

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Overview

- New GAISE Guidelines (review)
- Statistical Analysis Example (from real world)
- The Statistics Investigative Process
- Investigative Process Example
- Beyond the Analysis (focus on bias)
- Projects in the Classroom

GAISE Report - Simplifications

Original GAISE Report	Updated GAISE Report
Emphasize statistical literacy and develop statistical thinking.	Teach statistical thinking.
Stress conceptual understanding, rather than mere knowledge of procedures.	Focus on conceptual understanding.
Use real data.	Integrate real data with a context and a purpose.
Foster active learning in the classroom.	Foster active learning.
Use technology for developing conceptual understanding and analyzing data.	Use technology to explore concepts and analyze data.
Use assessments to improve and evaluate student learning.	Use assessments to improve and evaluate student learning.

GAISE Report – New Emphases

- **Teach statistics as an investigative process of problem-solving and decision-making. (Goal 2)**
  - Statistics is a problem-solving and decision-making process, not a collection of formulas and methods.
  - The investigative process begins with a question that can be translated into one or more statistical questions - questions that can be investigated using data.
- **Give students experience with multivariable thinking.**
  - The world is a tangle of complex problems with inter-related factors. Let's show students how to explore relationships among many variables.

GAISE Appendices

Went from 38 pages to 113 pages…

A. Evolution of Intro Stats & Emergence of Stat Ed Research

B. Multivariate Thinking

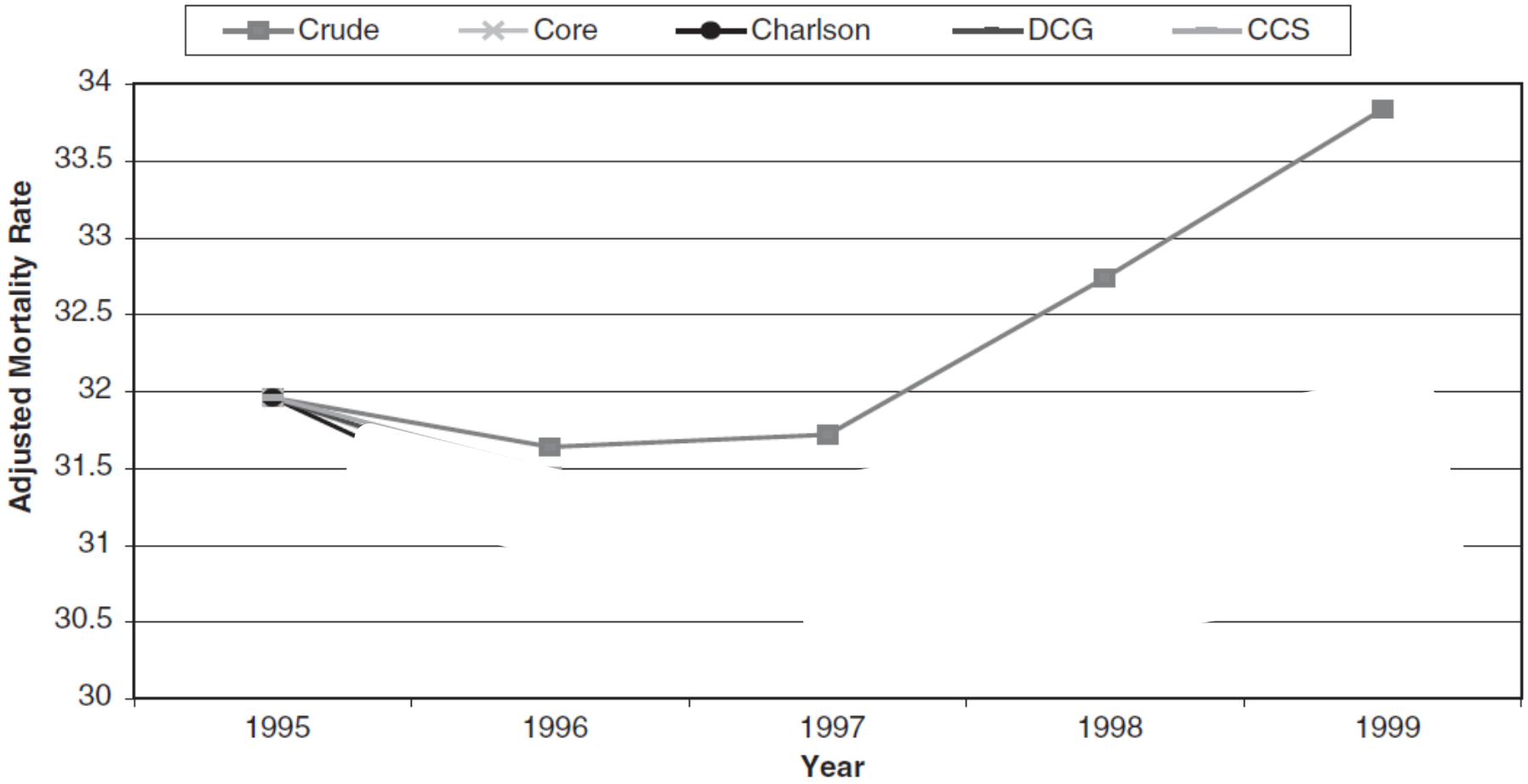
C. Activities, Projects, and Datasets

D. Examples of Using Technology

E. Examples of Assessment Items

F. Learning Environments

Figure 1: AMI Morality Trend for Risk-Adjusted Models (1995–1999)

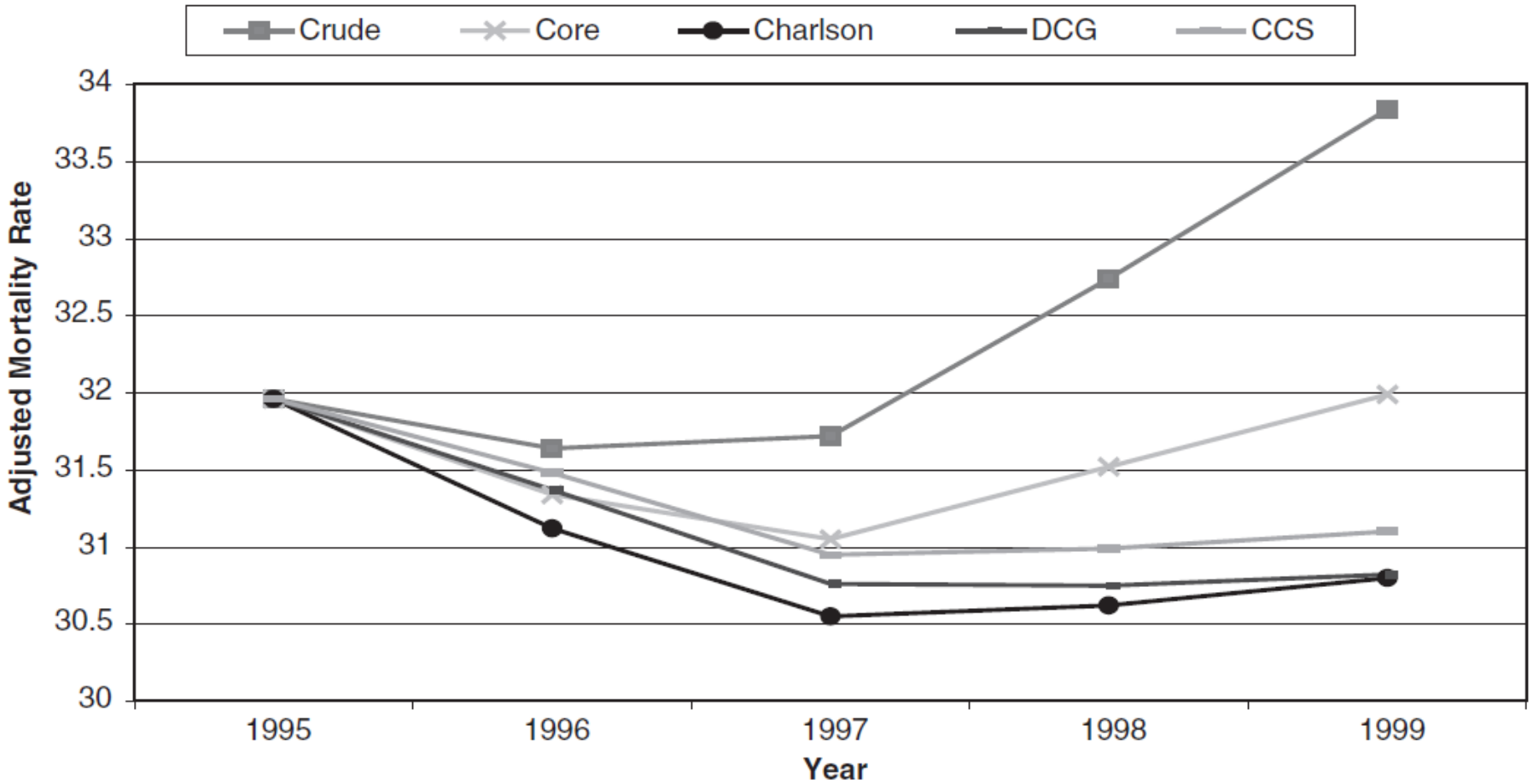


Example 1
Mortality Trends after Heart Attacks

- Problem – AMI mortality rates began rising after 1997. Why? Could this be due to poorer healthcare? differential access to healthcare? patients being sicker? (US Congress mandated a report from HCFA (now CMS))
- Plan – Investigate sicker patients hypothesis using Medicare data
- Data
  - Approval from HCFA, data tapes, extraction to SAS
  - Data checking and manipulation
  - Comorbidity constructs created (based on three models)
- Analysis
  - Core model – age, sex, original reason for Medicare entitlement
  - Risk-adjusted models
- Conclusion
  - Risk-adjusted models showed leveling off or AMI mortality
  - Hypothesis generation – preMI predictive of postMI mortality

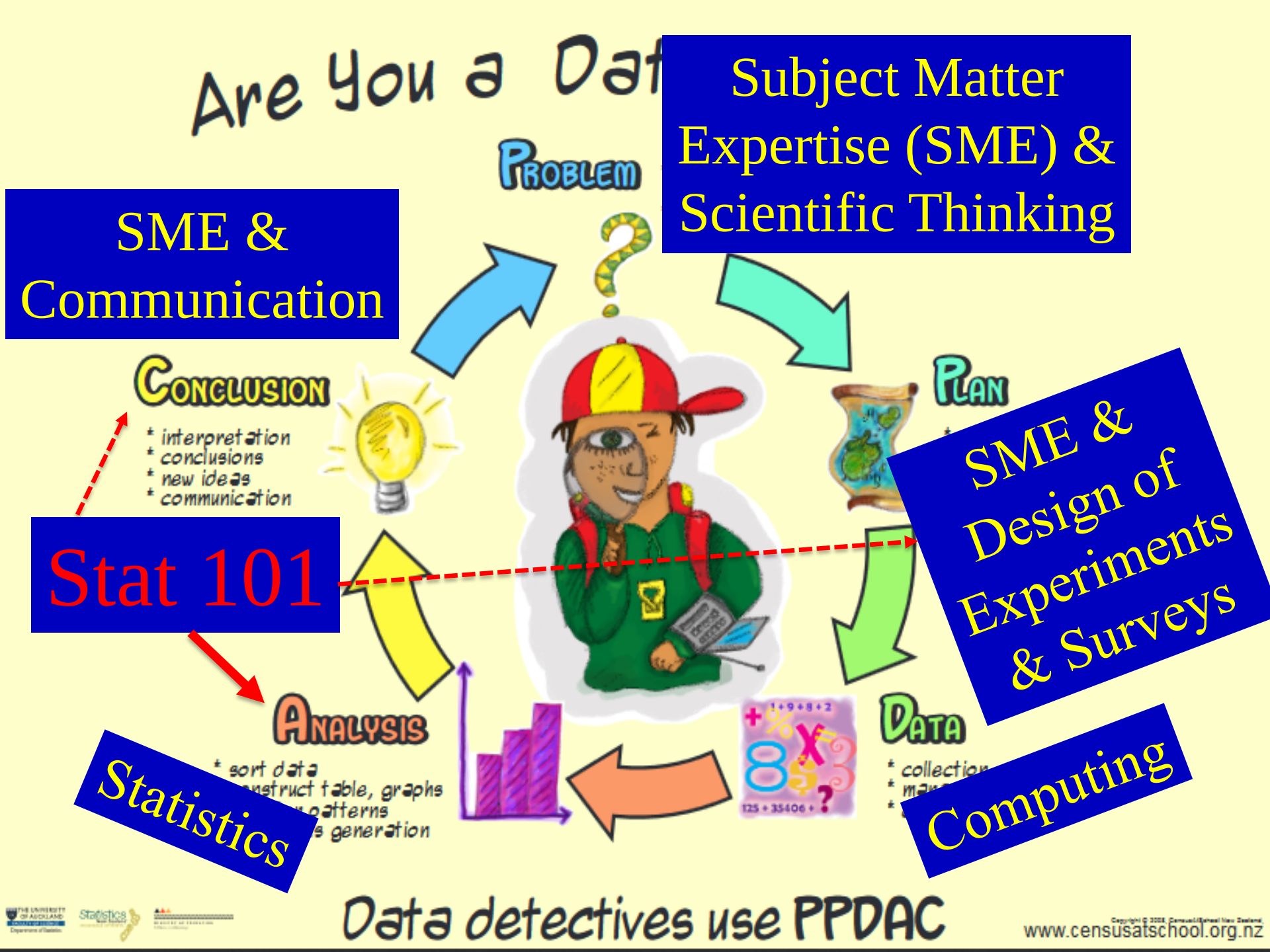
Using Claims Data to Examine Mortality Trends Following Hospitalization for Heart Attack in Medicare (Ash, Posner, et. al., 2003)

Figure 1: AMI Morality Trend for Risk-Adjusted Models (1995–1999)



Take Home Messages – AMI Study

- Statistical thinking is more than running a test
  - % time spent on planning, scientific meetings, data approval and processing? 90%
  - % time spent on statistical analysis (multiple regression) 10%
  - Statistics as stories
    - Helps with student motivation!
    - Jessica Utts talk at Joint Statistical Meetings
    - Hans Rosling – Gapminder


Are You a Dat
Subject Matter Expertise (SME) & Scientific Thinking
SME & Communication
Problem
Plan
SME & Design of Experiments & Surveys
Data
Computing
Analysis
Statistics
Conclusion
* interpretation
* conclusions
* new ideas
* communication
Stat 101
Data detectives use PPDAC
www.censusatschool.org.nz

Bonus/Rebate Example

- Are people more likely to spend money if it is called a bonus or if it is called a rebate?
- How might you design a study to examine this?
- See example…

Beyond the Analysis…

- Ask good questions…
  - What motivates students about this study?
  - What discovery do they make that is interesting and/or relevant to their lives?
- Pay attention to…
  - Study design
  - Bias
  - Multivariate thinking (Peck)
  - Communication

Population Estimation

- Separate into two groups…

- What is your best guess for the population of the Philippines?
- Record and review these
- This is an example of bias!

Bias

- Bias is any systematic difference between the sample and the population (or the estimate and the true value). Could be due to…
  - Types of units that are excluded from the sample
  - Process of collecting or manipulating data
  - etc.
- For Intro Stat students…
  - I care less about them naming than describing bias
  - Are they under- or over- estimating?

Bias Examples - Collection

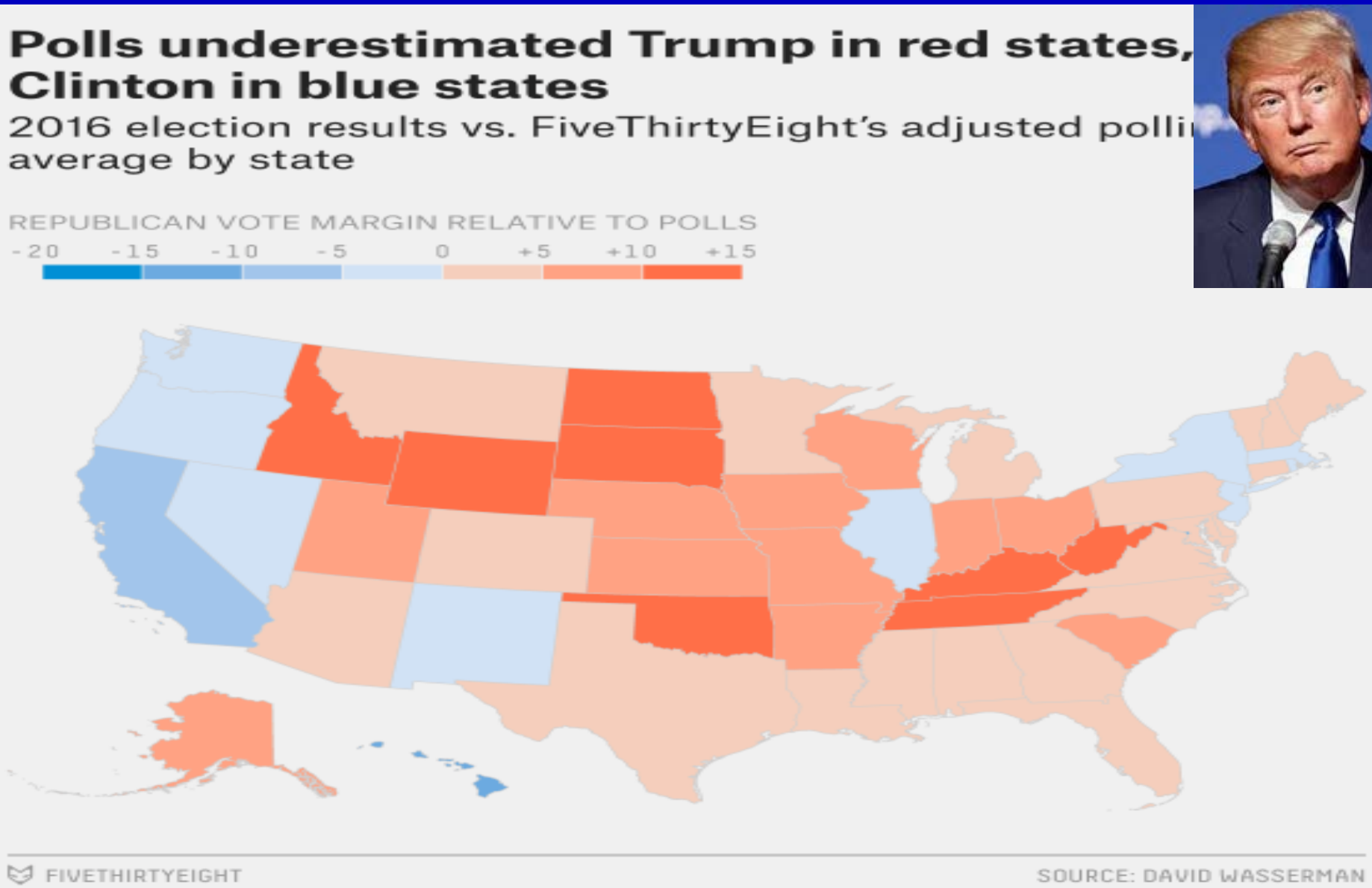
- Sampling only the basketball team when you want the average height of students
- Sampling only the basketball team when you want the average GPA of students
- Ignoring the fact that some people won’t tell you their GPA when you ask them
- The wording or order of questions
- Data processing (Gould)

Bias Activity…

Consider designing a survey to inquire with your peers about their views on the presidential election.

1) Create a question that is biased.
2) Create a question that is unbiased.
3) What other issues might arise and how might you reduce these?

Why Should We Care About Bias?



Reinforcing the Investigative Process

- Teach the data investigation process early
- Repeat the process always (often)
- Do projects

I hear and I forget.
I see and I remember.
I do and I understand.
--- Confucius

Why Projects?

- Teach students the investigative process
- They are more memorable for students (me)
- Understand the *messiness* and *subjectivity* of data…
  - Variable definition / population of interest
  - Collection – nonresponse, question choice, measurement
  - Cleaning – data errors, outliers, merging data files
  - Processing – creating variables, missing data

Why Projects? (cont'd)

- Allows learning of new statistical techniques
- Teach the 80/20 concept of prep & report vs. analysis
- Teach the idea of "building up" your analysis
- Get away from the "one analysis and done" fallacy
- Offer intrinsic motivation due to
  - Application
  - Ownership of work
  - Novel discovery

Projects in Your Class

- Five main aspects
  - Goal, design, collect, analysis, report
- Joint project decisions for the class?
  - None, goal, goal + design, goal + design + data
- Project groups vs. individuals
  - Self-selected vs. assigned groups

Project Timeframe – Fall Semester

- Proposal (Oct)
  - Group members and name
  - Goal of study
  - Variables (3+, 1+ quant, 1+ categ, explan/response)
  - Data collection process
  - Need topic? Meet to talk about hobbies, etc.
- Group meeting with professor (Oct/Nov)
- Submission of Data (before Thanksgiving)
- Project presentation (last week of semester)
- Project report (after feedback from students/me)

Project Presentations/Reports

- Goal and hypotheses
- Data collection process
- Graphical and numerical analyses
- Build up – univariate, bivariate, multivariate
- Summary
- Limitations – bias (uncontroll-ed/-able)
- How could I have improved the project?

Project Assessment

- Individual assessment of group project
  - All students get the same grade?
  - All students must present?
  - Participation grade (4 students = 400 points)
- Peer Evaluation
- Rubric

Peer Evaluation Questions

- In one or two brief sentences, summarize the main findings of the presentation
- What did the presenter do well?
- What could be improved in the presentation or what was unclear?
- What other suggestions do you have for the presenter?

Evaluation Rubric

- **Organization (20%) - How well can you understand the sequence of information?**
- 1 – The presentation was disorganized and hard to follow. Transitions were difficult to understand and I wasn't sure what was going on for much of the presentation.
- 3 – At times, I wasn't sure of the logical progression, but the presentation had an order and flow that was I could follow.
- 5 – The presentation was very clear and easy to follow.
- **Statistics (50%) - How well does the presenter demonstrate proficiency in use of the correct statistical tools and measures?**
- 1 – The presenter has minimal, if any, grasp on when to use certain statistical tests or frequently used an incorrect test. They didn't justify their choice of which test was appropriate.
- 3 – The presenter used tests appropriately, but didn't verify assumptions or demonstrate why each one was appropriate. Some interpretations were incorrect or confusing.
- 5 – The presenter has a clear grasp of when each test should be used, how to implement it, and how to interpret the results.
- **Graphics (10%) - Were the graphics helpful or distracting?**
- 1 – The graphs were misleading, mislabeled, or incomplete.
- 3 – The graphs were helpful in understanding the data and results, but distractions persist, including mislabeling or cluttered presentations.
- 5 – The graphs were very helpful in understanding the data and results.
- **Mechanics (10%)**
- 1 – The presentation had numerous grammatical and spelling mistakes that were distracting.
- 3 – The presentation was mostly clear and accurate, with minor errors.
- 5 – The presentation contained no grammatical or spelling errors.
- **Overall Presentation (10%) - Did the presenter mumble or did they speak clearly?**
- 1 – I couldn't understand most of what was being presented. I was bored by the presentation.
- 3 – I followed most of the talk, but sections were unclear.
- 5 – The presentation was clear and concise. I was excited by the presentation.

Projects Resources

- Robin Lock
- Simply Statistics blog
- Duke University
- UC Berkeley Undergrad Research Group
- Austin CC – Mary Parker
- Sources of data (for secondary analysis)
  - See Stat Ed Resources at Center for Stat Ed
  - www.tinyurl.com/StatEdResources

Journal of Stat Ed Articles on Projects

- Implementation of Discovery Projects in Statistics (2013)
- The Effect of a Student-Designed Data Collection Project on Attitudes Toward Statistics (2008)
- Teaching Students to Use Summary Statistics and Graphics to Clean and Analyze Data (2005)
- Learning Statistics at the Farmers Market? A Comparison of Academic Service Learning and Case Studies in an Introductory Statistics Course (2010)
- Studying student benefits of assigning a Service-Learning project compared to a traditional final project in a Business Statistics Class (2008)
- Project-driven courses – Love, Dierker (Passion-driven, project-based), Hydorn (Service-learning), etc.

Example Projects

- Is there response bias? Students found no difference in responses to questions whether they were asked via interview or anonymous survey. Comment – Need more sensitive question
- Students who spend more time on non-academic computer use had a lower GPA.
- Student with no sexual partners last semester had a higher GPA than those who seldom (<1/wk), often (1-2/wk), or frequent (>2/wk) had sexual relations. The latter three categories showed no difference. The sample size was too small, though, to make any real inferences.
- Students drink more coffee during finals.
- Students usually get more than the recommended amount of cardiovascular exercise.
- Students with jobs had a higher mean stress level than students wthout jobs.
- The more marijuana students smoke, the lower their GPA.
- GPA was not associated with class time nor study time. Students who took more credits (class hours) did study more, though.
- There was an association found between political affiliation and major.
- Males and females both come late to class (at roughly equal rates).
- Boston University has 6% non-heterosexual females, 8% non-heterosexual males.
- Students with higher GPA are more satisfied with their college education.
- Women and men do not differ in their opposition to the war in Iraq.
- Villanova students who sleep less than 4 hours per day, have a lower GPA, on average. Those that sleep 6-8 hours per day have the highest GPA. (BU study showed no association)
- How religious you are is not associated with whether you go to therapy.