Responsible Statistics

Using mathematics to shape public opinion

Andrew Nelson <andnels123@gmail.com>
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Statistics

- A powerful tool that can
  - Describe trends and make predictions
  - Support hypotheses
  - Validate scientific theories
  - Describe surveys and public opinions
- Bertrand Russell so eloquently stated,

"Mathematics, rightly viewed, possesses not only truth, but supreme beauty."

- Math is the truest descriptor of the universe.
  - We trust math to give us the truth of things
- Statistics is an applied math that is sometimes misinterpreted or not "rightly viewed"
  - **Manipulation of public opinion**

Vaccines Cause Autism!

- A study by Dr. Wakefield in 1998 claimed to link autism to vaccines in children[1]
- Media spread this correlation like wildfire
- Result
  - Millions of parents have refused to vaccinate their children
  - Measles and Rubella cases increased dramatically
- The Lancet later retracted Wakefield's Study due to poor use of statistics (and fabricating data)[2]
- Many parents still refuse to vaccinate their children because they are afraid it will cause autism

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Errors in Autism study

- Correlation versus causation
  - A correlation between children vaccinated and those who develop autism does not imply that vaccines cause the autism
- Ignoring base rates of autism cases
  - How many unvaccinated children develop autism? Is this number significantly different than vaccinated autistic children?
- Small sample size
  - Wakefield's study compared 12 subjects. As a rule of thumb, statisticians find 30 to be a significant sample size.
- Wakefield was also accused of altering the results (but we'll ignore that for the moment)[2]

- How do we know which studies to believe?

Correlation Vs Causation

- Correlation describes how strongly two variables are related
  - A study published by the Journal of Applied Psychology found mean income to be directly correlated to height[3]
  - Does this mean that tallness causes a person to have a higher income? Absolutely not.

- Establishing causal relationships is tricky and conservative
  - Hill's Criteria for establishing Causation
  - Causal relationship between smoking and lung cancer


Common Errors

- Ignoring biases and sampling errors
  - Often disregarded to achieve the desired result
- Ignoring base rates
  - As in the case of vaccines and Autism
- Confusing Causation and Correlation
- Misunderstanding or ignoring conditional probabilities
- Presentation of statistics
  - Mislabeled graphs
  - Purposefully misleading presentation of data or trends
  - Sometimes used to sway public opinion…

Dishonest Graph
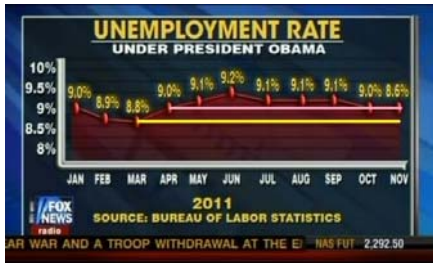
Fox News graphical representation of unemployment rate[4]

Actual Unemployment Graph
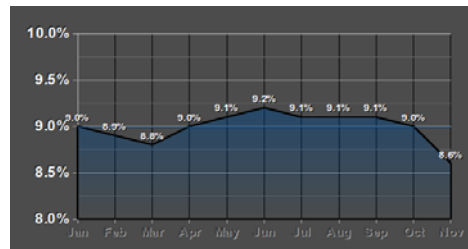
- True unemployment graph using the same data from The Bureau of Labor Statistics, on the same scale.
- Shows November to have the lowest unemployment rate, rather than one of the highest

Statistical Literacy

- The ability to make sense of statistics
  - Just as literacy is the ability to make sense of written language
  - Involves critical evaluation of data, graphs, percentages and sampling techniques
- Importance
  - As important as literacy of written language
  - Interpretation of descriptive statistics, scientific correlations, quality of an argument
  - Ability to form one's own opinion by knowing how to correctly interpret data
  - Evaluate arguments and validity of claims

Becoming Statistically Literate

- Be critical of graphs in media
  - Check source of data
  - Evaluate the graph axes, trend lines, correlation coefficients
- Be critical of Percentages
  - Often formed from small sample sizes
  - Do not reflect true population (to keep in mind for political polls)
- Question the context in which data are being applied
  - Do the conclusions that are made follow?
- Look at numbers objectively, without bias
- Invest in "Statistics for Dummies" and learn a little of the math behind commonly used statistical analyses

Conclusion

- A population can be statistically literate
  - Informed public → democratic system works efficiently
  - Form individual opinions rather than accepting conclusions
  - Critically read and evaluate an argument or article that uses statistics to make conclusions
- Students must be taught statistical literacy as routinely as they are taught how to read!
  - All students should be able to think about and critically evaluate an argument rooted in statistics

- When we view statistics rightly, we can see the truth and beauty in what is being described

Works Cited

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3. Judge, Timothy. "The Effect of Physical Height on Workplace Success and Income." *Journal of Applied Psychology* 89.3 (2004): 428-41. *American Psychological Association (APA)*. Web.
4. Wemple, Erik. "Fox News's Unemployment Chart: Better Graphics?" *Washington Post*. The Washington Post. Web. <http://www.washingtonpost.com/blogs/erik-wemple/post/fox-newss-unemployment-chart-better-graphics/2011/12/12/gIQAUVgNqO_blog.html>.