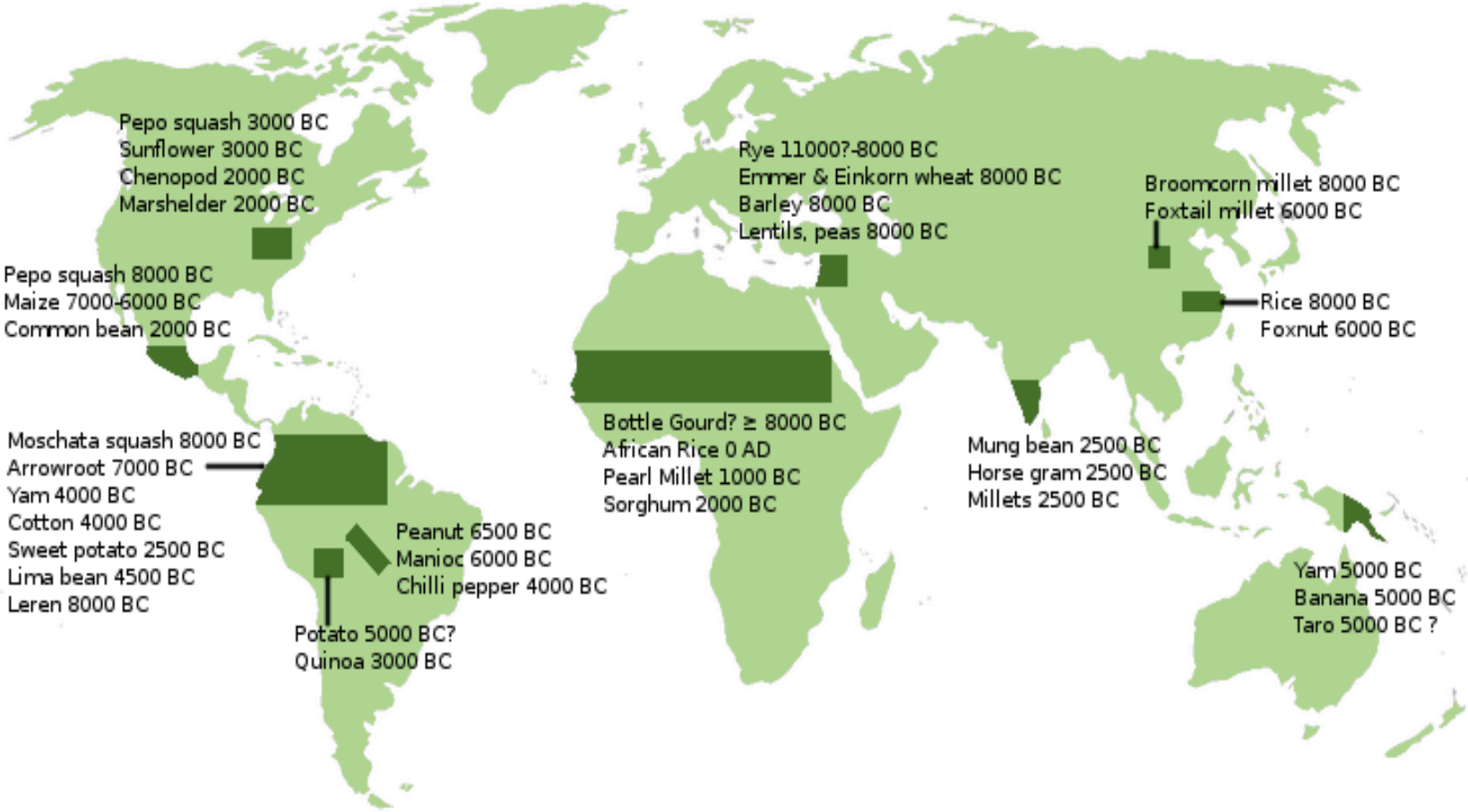
From the Agricultural Revolution to Today

Food Production and Modification


Pepo squash 3000 BC
Sunflower 3000 BC
Chenopod 2000 BC
Marshelder 2000 BC
Pepo squash 8000 BC
Maize 7000-6000 BC
Common bean 2000 BC
Moschata squash 8000 BC
Arrowroot 7000 BC
Yam 4000 BC
Cotton 4000 BC
Sweet potato 2500 BC
Lima bean 4500 BC
Leren 8000 BC
Peanut 6500 BC
Manioc 6000 BC
Chilli pepper 4000 BC
Potato 5000 BC?
Quinoa 3000 BC
Rye 11000?-8000 BC
Emmer & Einkorn wheat 8000 BC
Barley 8000 BC
Lentils, peas 8000 BC
Bottle Gourd? ≥ 8000 BC
African Rice 0 AD
Pearl Millet 1000 BC
Sorghum 2000 BC
Broomcorn millet 8000 BC
Foxtail millet 6000 BC
Rice 8000 BC
Foxnut 6000 BC
Mung bean 2500 BC
Horse gram 2500 BC
Millets 2500 BC
Yam 5000 BC
Banana 5000 BC
Taro 5000 BC ?

Plants and water

Domestication took hundreds if not thousands of years

Different in different parts, trial and error, noticed that some grains had certain characteristics, replant them according to size, taste, etc.

Grains easier to store than other plants

Calories were important

Had to find ways to get water to plants

Irrigation developed

Surplus of food

Once surplus of food is created-

Stone tools to help procure the grain from the chaff

Population centers grew, needed to follow calendar, animals become more important to transportation and cultivation

Cooperation is essential, need laws and government

Need to protect farmers from loss

Code of Hammurabi

[48] If any one owe a debt for a loan, and a storm prostrates the grain, or the harvest fail, or the grain does not grow for lack of water; in that year he need not give his creditor any grain, he washes his debt-tablet in water and pays no rent for this year.

Surplus of food

Diversification of labor

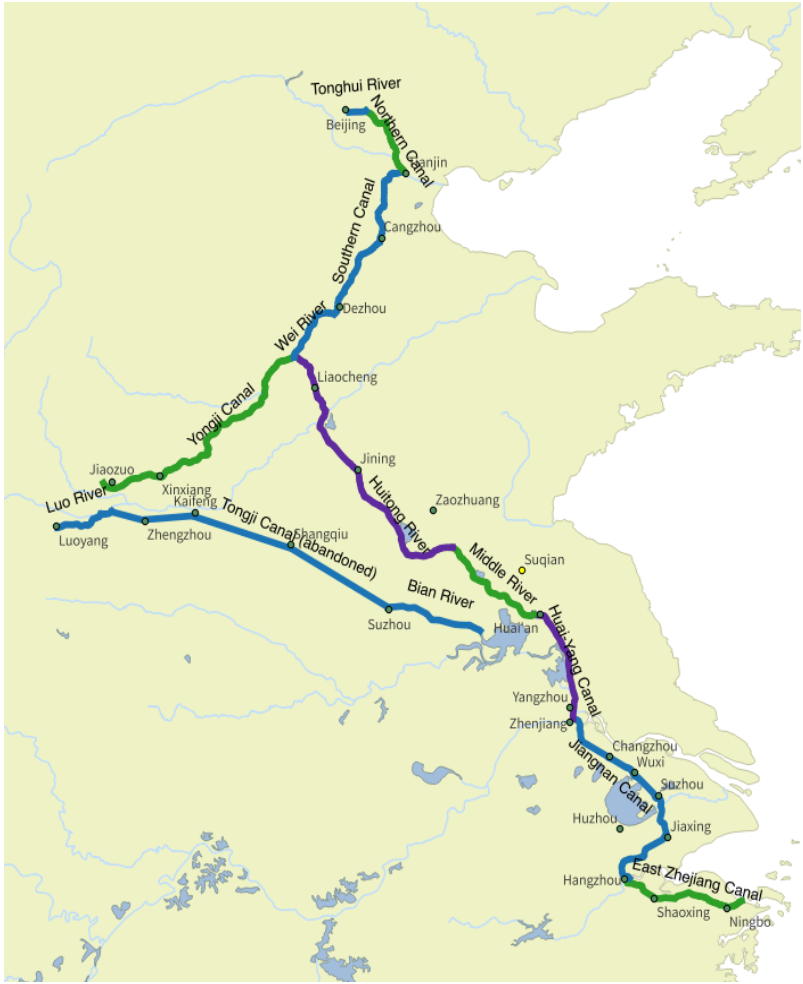
- Artisans
- Priestly class
- Rulers
- Laborers

More modification

Chinese found a rice that grows twice a year

Need to supply the North with Southern rice

Build Grand Canal



More modification

Maize, corn to us, was one of the more “modified” foods in the ancient world

Darwin would use the term “artificially selected”

Production improvements

Use of oxen, cow, mules, horse- all came with technological innovation

- Horse shoes, ox collar, heavy plow
- More grains, quicker

Private land becomes a thing- more governance necessary

- Barbed wire to mark who owns what

Up to current GMO

The tension between government and science continues

Breakthrough to modern GM comes in the 1973

- Herbert Boyer and Stanley Cohen- targeted selected antibiotic resistance gene from one strain of bacteria to another
- Rudolf Jaenisch and Beatrice Mintz used same procedure and introduce a foreign DNA into a mouse embryo

The reaction was swift

“Although this new technology opened up countless avenues of research possibilities, immediately after its development, the media, government officials, and scientists began to worry about the potential ramifications on human health and Earth’s ecosystems.”

- From Corgis to Corn a Brief Look at the Long History of GMOs

Important Conference

1975- Asilomar Conference

Agreement on Guidelines to continue GE research:

Safety and containment procedures

Lead researcher responsible for safety of workers

Educate scientific community of important developments

Guidelines to stay flexible to account for future findings

Governments around the world agreed to continue GE research as a result

GE Food Consumed

GE Pharmaceuticals Manufactured

Genetic Engineering Technology Utilized

Artificial Selection/Selective Breeding Utilized

7,800 BCE

Oldest evidence of artificially selected crops

30,000 BCE

Artificial selection of wolves began

1974

Jaenisch & Mintz create first GE animal

1973

Boyer & Cohen develop Genetic Engineering (GE)

GE Experiment Moratorium

1975

Asilomar Conference sets guidelines for future GE experiments

U.S. Supreme Court allows patenting of GE organisms

1980

1982

FDA approves Humulin, the first pharmaceutical manufactured using GE technology

FLAVR SAVR Tomatoes become first GE food crop approved by U.S. Department of Agriculture

1992

1995

US EPA approves the first insecticide-producing crop

1996

Herbicide-resistant crops first introduced

2000

Golden Rice engineered to mitigate Vitamin A deficiency

Photo Credit: Erik De Castro / Reuters

The pharmaceutical ATryn becomes the first biological produced by a GE animal to be approved by the US FDA

2009

Post-Asilomar developments

1980- GE modifies bacteria to break down oil

Supreme Court finding also gives ownership rights to companies

1982- GM bacteria allows for synthesized human insulin

1987- Calgene’s Flavr Savr tomato

1995- First pesticide producing crop

More post-Asilomar developments

1996- Bt corn

1996- Roundup ready crops- soybean, corn, sugar beets

2000- Golden Rice to combat vitamin A deficiencies

No GE animals to date for human consumption

2009- Drug from GE animal, ATryn, to fight blood clotting disorder

Controversies

Religious and philosophical debate

Environmental and health

Bt and butterflies- no conclusive evidence found

Cotton and Indians- no conclusive evidence found

More and more regulatory initiatives to label- US currently has no mandatory law

Scientific community has largely concluded GM food poses no increased danger than regular crops

Source:

Gabriel Rangel is a Ph.D. candidate- Biological Sciences in Public Health Program, Harvard.

http://sitn.hms.harvard.edu/flash/2015/from-corgis-to-corn-a-brief-look-at-the-long-history-of-gmo-technology/

Some really interesting reading:

http://sitn.hms.harvard.edu/flash/2015/how-to-make-a-gmo/

http://sitn.hms.harvard.edu/signal-to-noise-special-edition-gmos-and-our-food/

Scientific Skepticism

What is Skepticism

- What does it mean to be skeptical? – *Small group discussion*
- There is an important distinction between skepticism in a general sense and scientific skepticism.
  - Climate deniers are sometimes called climate skeptics
  - This is very different from someone looking critically at claims, inferences, statistics , funding, etc for potential bias. This is scientific skepticism

More on Skepticism

- Why is scientific skepticism an important skill for people to have? – *Small group discussion*
- Early human history – Information rare and hard to find, and it had to be high quality, often life or death. (sources of food, water, etc)
- Information is so prevalent in our lives today, that it is known as the "Information Age"
- Today, you can find information everywhere, and a lot of it is of very poor quality or even completely misleading
- Being literate today means not just being able to read, but being able to understand the massive amount of information thrown at us every day. Understanding and determining the quality of information is critical today
- Manipulation by information – Google knows more about you then your parents or spouse.

Two Focal Areas for Scientific Skepticism

1. **Generation of Science Knowledge** – How does science work? Consider the reliability of each step of the process – Observational, Conceptual, Sociocultural. How might bias enter or be expressed at each step?
2. **Communication of Science Knowledge** – How is science information shared with the public. Consider authors & audiences, meanings & messages, representations & reality. How might bias enter or be expressed at each step?

Skepticism and GMO Studies

- https://geneticliteracyproject.org/mission-financials-governorship/

Skepticism and GMO Studies

"No effects on human health have been shown as a result of the consumption of GM foods by the general population in the countries where they have been approved.

—World Health Organization

"Decisions on the future of our food and agriculture should not be based on misleading and misrepresentative claims that a "scientific consensus" exists on GMO safety.

— European Network of Scientists for Social and Environmental Responsibility (ENSEER)

GMO FEEDING STUDIES

Researchers can test the safety of transgenic crops (GMOs) by feeding them to animals. Here are a few simple guidelines to determine if a study is designed correctly and is of good quality.

Feed Analysis

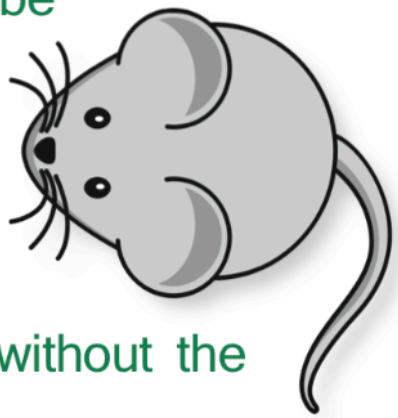
Control and transgenic feeds should be as similar as possible and nutritionally equivalent. The feed should be examined for anti-nutrients and contaminants such as toxin-producing fungus.

Feed Source

Transgenic crops and controls should be genetically similar, and should be grown in the same place in the same year. The genetic background and environment can cause differences in nutrition and other qualities of the feed.

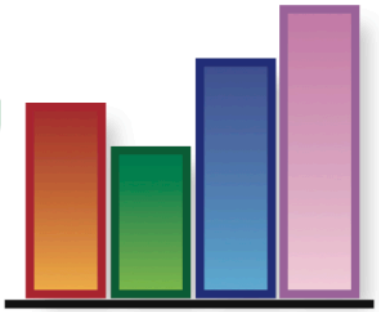
Controls

There must be a control group of animals raised the same way as treatment groups, but without the treatment.



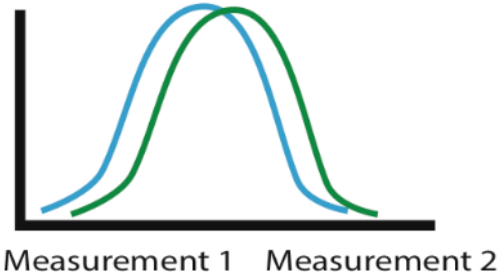
Statistics

Appropriate statistical tests should be used, not just searching for statistical significance. The study must have enough animals for the statistical tests.



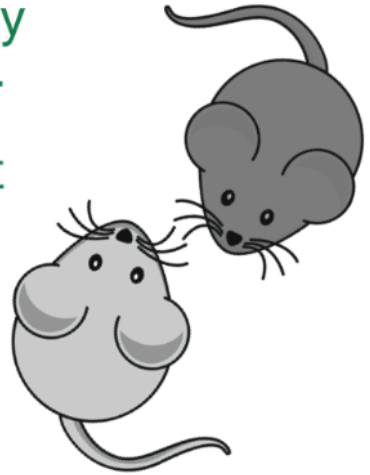
Reproducibility

Findings should be reproducible. If results do not agree with similar studies, authors should provide a plausible explanation.



Relevance

A measured difference does not necessarily indicate harm. Differences should be put in context with the natural variation for the species.

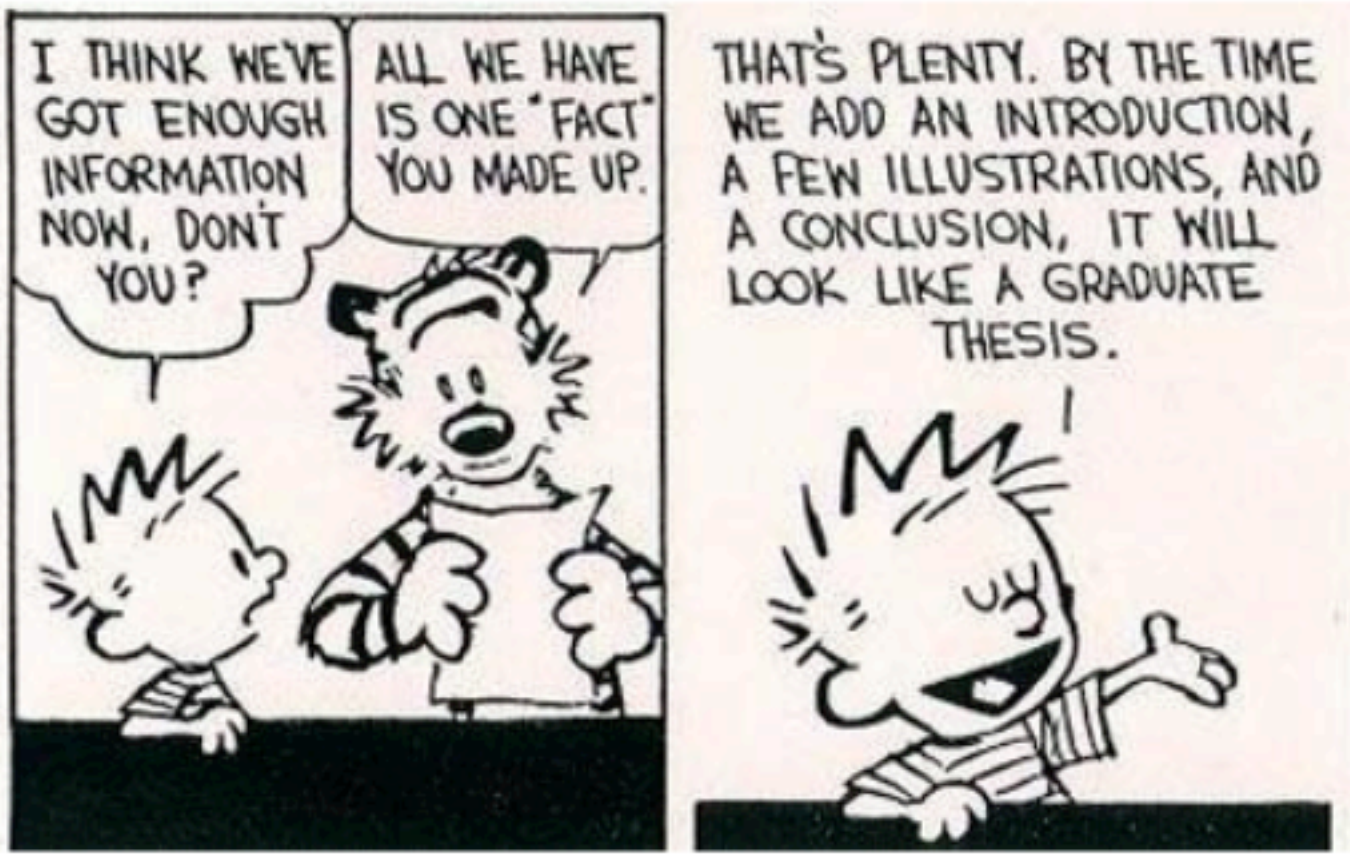


biofortified.org

BIOLOGY FORTIFIED

By Layla Katiraee (@biochicaGMO) in collaboration with Anastasia Bodnar (@geneticmaize) for Biology Fortified, Inc (@franknfoode)

Statistics can be manipulated



How Statistics can be manipulated

- **Sample bias**
- **Analysis bias**
- **Reporting statistical functions without context**
- **Graphic Representations**

Sample Bias

- It is impossible to count every single plant in a field, every bacteria in a culture
- Scientists strive to take a representative sample from the entire population
- Small group discussion – What can help pick a representative sample?

Eye Color example

- Use handout to determine statistics on eye color
- Compare your table, entire class to following data:

32%
BLUE

25%
DARK
BROWN

16%
BROWN

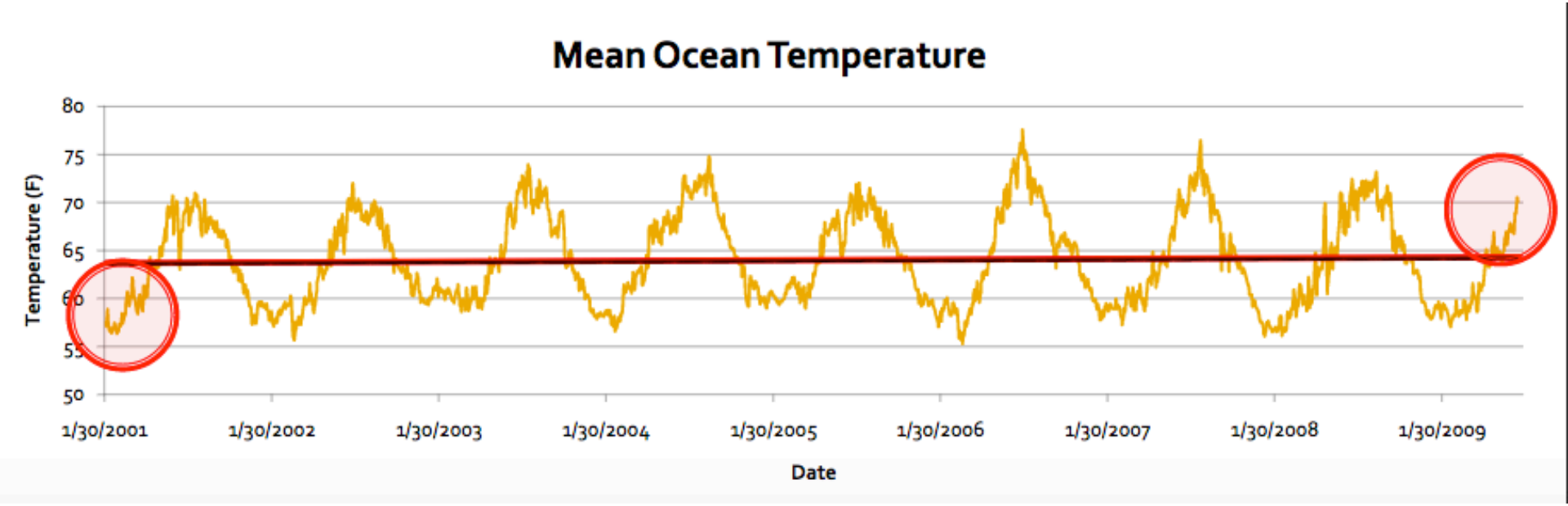
15%
HAZEL

12%
GREEN

EYE COLOR DEMOGRAPHICS*

IN THE USA

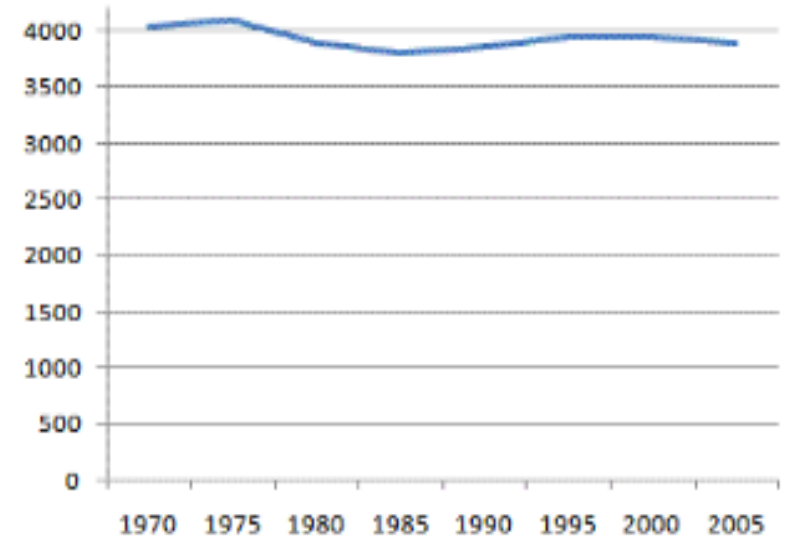
How the analysis of data can be biased

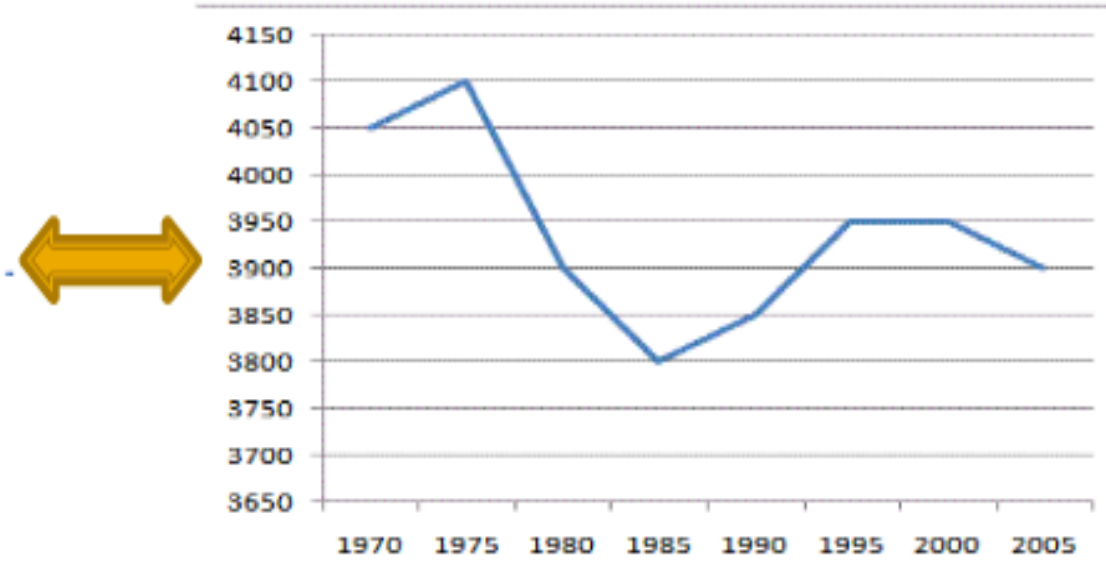


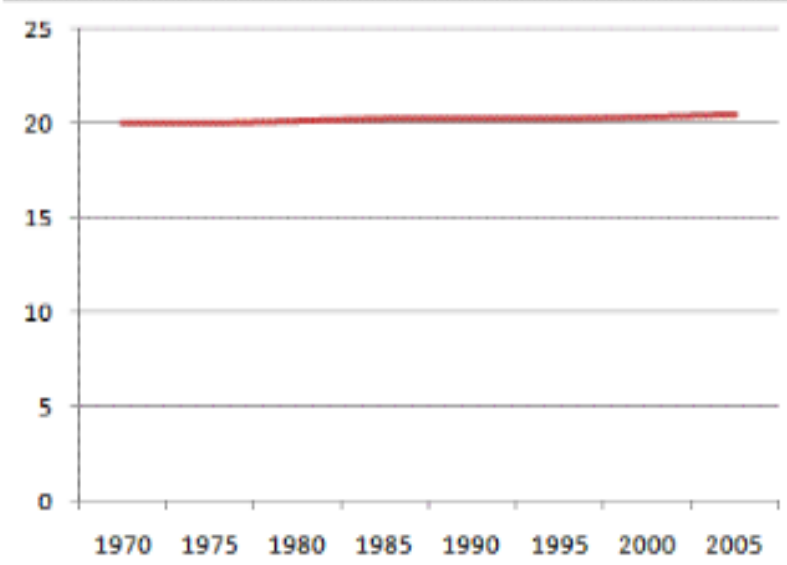
Reporting Statistical Functions without Context

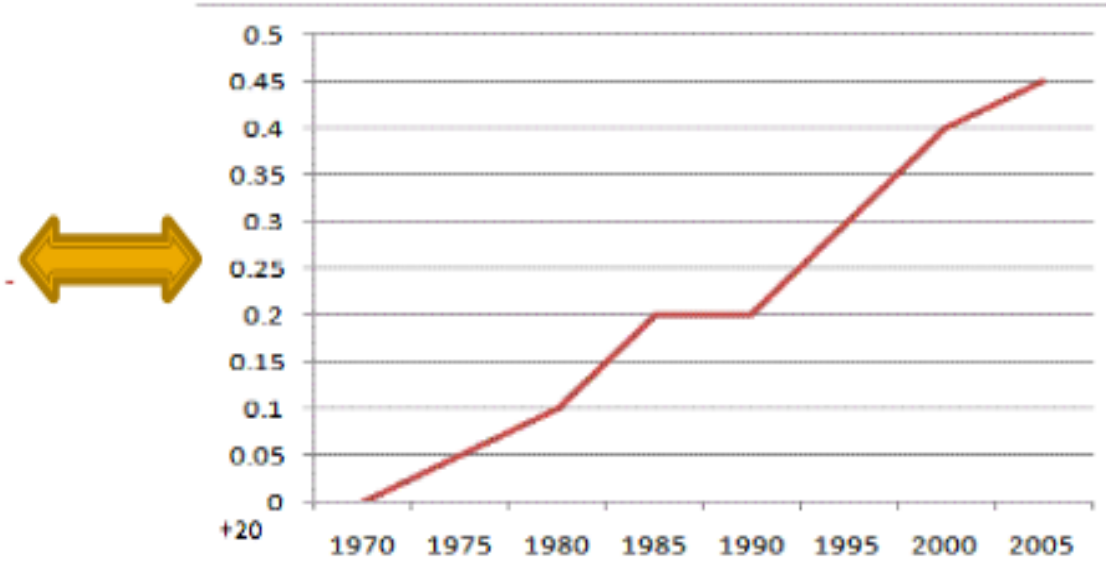
- Reporting an average or percentage with a very small sample size
- Using statistical terminology without the full context of the situation. Average, Median, Mode, etc
- Example $1000 distributed within this class:
  - 40 students @ $25 each = $1000 = $25 avg
  - 39 students @ $0, 1student @ $1000 = $25avg

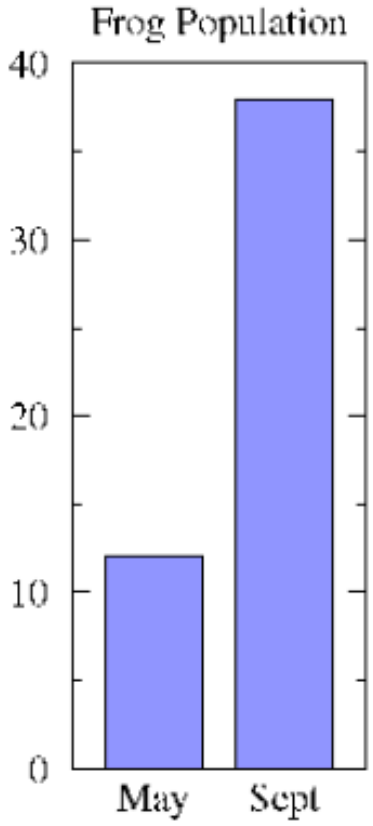
Graphics are commonly used to mislead

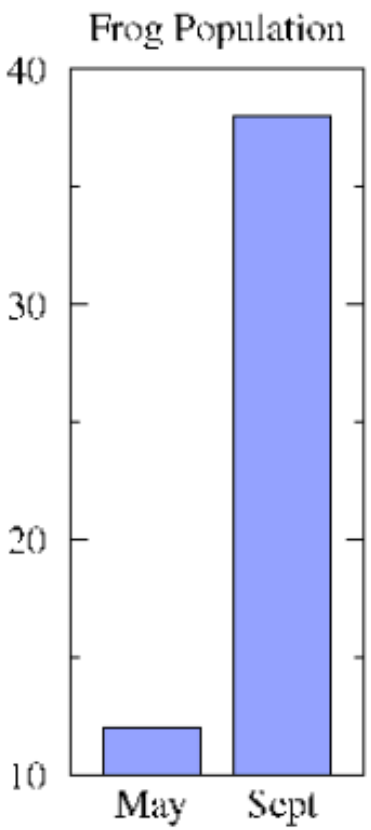












- Here, the data is the same but by changing the axis labels, someone was able to really suggest that the difference in population was much greater than it was.

How to look at information skeptically

- Know Your Sources Document!
- Look at the sources – If none given, do NOT trust
- Look for Bias with sample, analysis, lack of context, and graphics
- Do NOT believe everything you are shown just because it has “science” or “data” in the name. Does the source have other motives to manipulate your opinion.

References

https://cseweb.ucsd.edu/~ricko/CSE3/Lie_with_Statistics.pdf

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