

Probability Review

- probability: likeliness/chance: 0 to 1 (or 0 to 100%)
- algebra of probability
 - event will occur = 1 – probability it won't
 - if independent then probabilities multiply

example: 3 people—NO shared birthday (ignoring leap years and assuming independence)—have probability:

$$\frac{364}{365} \frac{363}{365}$$

So probability of at least 2 of them sharing a birthday:

$$1 - \frac{364}{365} \frac{363}{365}$$

- expected value can give us an idea of likely outcomes, e.g.
 - $\frac{1}{16}$ # coin tossers for HHHH
 - $.5 \cdot 85 + .05 \cdot 100 + .3 \cdot 75 + .15 \cdot 95$ for grade
 - data might be in a decision matrix like in *Friend or Foe*
- law of large numbers
- Benford's law: first digit in many real-life data sets > 500 approximates a logarithmic trend where 1 occurs about 30% of the time while 9 less than 5%

Data Analysis

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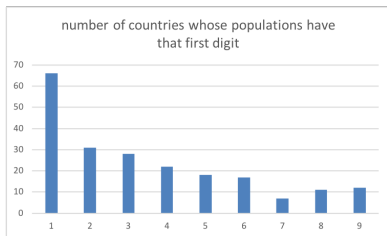
- collecting data
- presenting data
- analyzing data

Data can be subject to bias and distortion, and are definitely subject to probability and random variations.

Benford's Law?

Below is country population data from 2018. Does it satisfy Benford's Law?

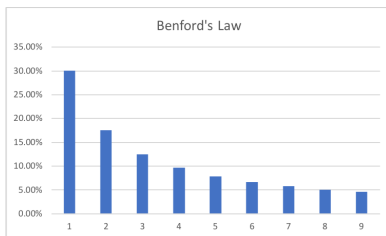
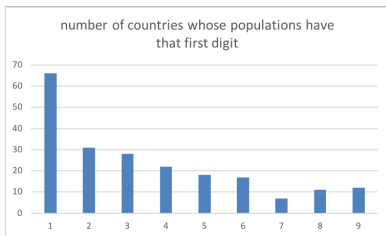
- a) it fits perfectly
- b) this proves it is fraudulent data and should lead to arrests
- c) we should use a larger data set to have a better fit
- d) what's a Benford's Law?
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Forensic evidence obtained during illegal search and seizure?

Institutional Review Board and Ideal Collection

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- **Beneficence** (maximize benefits as you minimize risks)
- **Justice** (benefits and burdens of research are equitably distributed)

Reproducibility, consensus, and random sampling if possible



Picture credit: <http://med.stanford.edu/content/dam/sm-news/images/2016/06/Replication.jpg>

Kat is making measurements in lab and is confident that they have set it up properly. When Kat tries to do the required calculations to verify the formulas in the book, the data seems wrong. So Kat does the mathematical calculations to determine what a correct set of data would be and simply changes the data to match the calculations.

- a) I feel strongly that Kat's actions are ok
- b) I somewhat feel that Kat's actions are ok
- c) I somewhat feel that Kat's actions are problematic
- d) I feel strongly that Kat's actions are problematic
- e) other

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falsification?

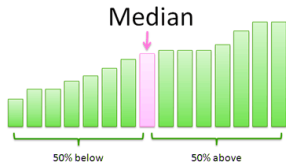
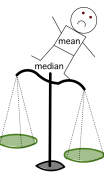
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A research group wants to study the effectiveness of a quercetin supplement, and has contacts at the Watauga County Detention Center, Rikers Island in New York, and Silivri Penitentiaries Campus in Turkey. Quercetin is a flavonoid found in fruits and vegetables that is a strong antioxidant. Do you think Appalachian State University's Institutional Research Board (IRB) will approve such research?

- a) yes and I have a good reason why
- b) yes but I'm unsure of why
- c) no but I'm unsure of why not
- d) no and I have a good reason why not
- e) other

Presenting Central Tendency Measures

- **average**: mean is the middle of the data via “weight” or distance. Sum all the numbers and divide by how many
- **median**: middle of the ordered data, i.e. the midpoint of the distribution. A number and place, if there is no middle number, it is the average of the two nearest



1. data set: 1 2 3 4 5
2. data set: 1 2 4 9
3. A realtor wants to advertise how inexpensive it is to live in an area. Should they use the mean or median. Why?


Picture credit: 1. self-created

2. <http://www.testingtreatments.org/2015/02/04/>

[more-than-average-confusion-about-averages/mean-mediocre-median-small/](http://www.testingtreatments.org/2015/02/04/more-than-average-confusion-about-averages/mean-mediocre-median-small/)


3. <https://byjus.com/maths/median/>

Florence Nightingale—Visualization of Stats to Save Lives



To understand God's thoughts one must study statistics ... the measure of his purpose.

— Florence Nightingale

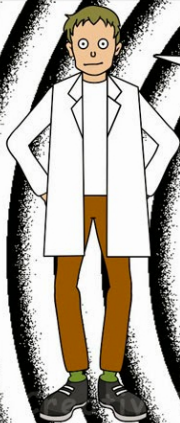


colorization © todayinsci

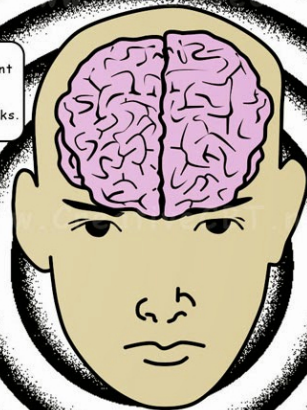
More science quotes at Today in Science History todayinsci.com

Picture credit:

The Experiment

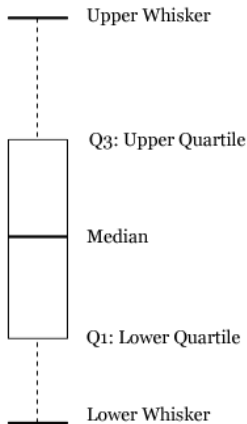


In this experiment we tested the hypothesis that mind reading works.

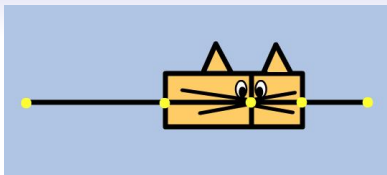


Visualizing the 5-Number Summary: Box plots

1. Excel can give us lo, q1, median, q3, hi. choose an axis and scale for your data: [6, 9, 11, 14, 18]
2. create a visual of these 5 numbers—plot with lines across
3. draw the box and whiskers



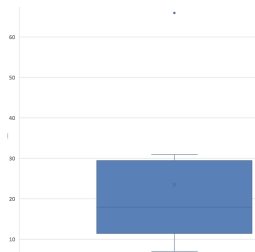
Box and Whisker Plots



Picture credit:

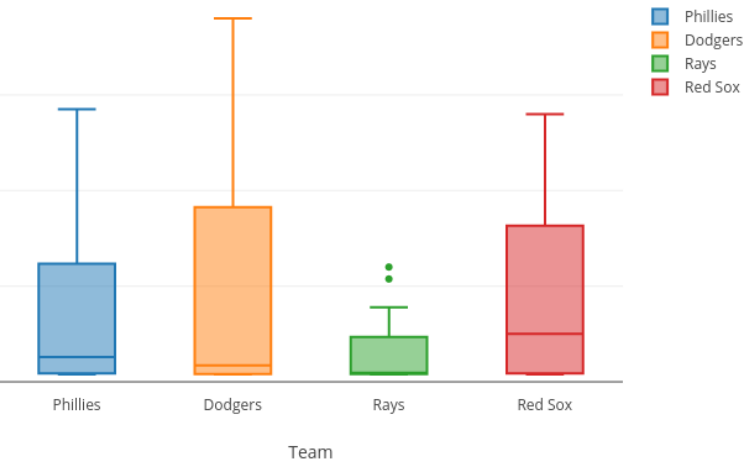
<https://oursland.edublogs.org/2015/02/26/hss-id-a-12-and3-box-and-whiskers-plot/>

- useful for making comparisons between subgroups using side-by-side box plots
- easy to see the middle 50% of the data in the box...
- central value (median), spread, distribution, and variability



- 2018 country populations—who is the outlier at the top?

Baseball Team Salaries



<https://plot.ly/~nebeirne/13/baseball-team-salaries.png>

Comparing and Ranking Countries—Your Data

The **WORST GRAPH** I've ever seen

Submitted by

Dave Bock

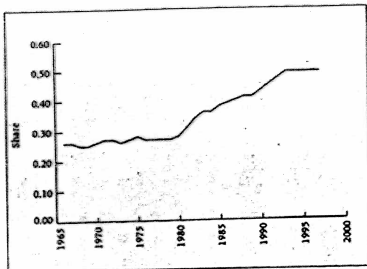
bock@htva.net

Ithaca High School, Cornell University

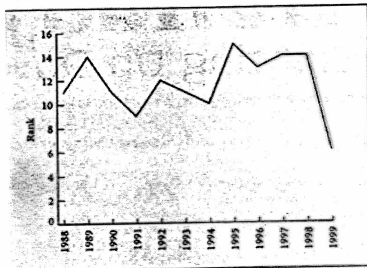
Ithaca, NY

First, note the two individual graphs:

- Tuition spans 1965 - 1999, 35 years
- Ranking spans 1989 - 1999, 11 years
- Ranking has an inverted "down-is-better" orientation



BY THE NUMBERS: OVER 35 YEARS, CORNELL'S TUITION HAS TAKEN AN INCREASINGLY LARGER SHARE OF ITS MEDIAN STUDENT FAMILY INCOME.



RICKING ORDER: OVER 12 YEARS, CORNELL'S RANKING IN US NEWS & WORLD REPORT HAS RISEN AND FALLEN ERRATICALLY.

ITHACA TIMES

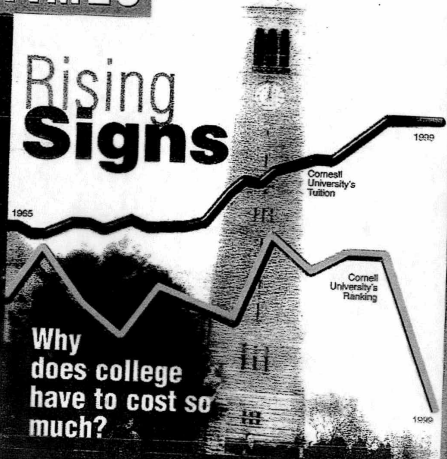
Visit us online at <http://www.ithacatimes.com>

Planning Board approves
Widewaters development

IC students occupy Job Hall

Cayuga Vocal Ensemble
ushers in the holidays with
"Judas Maccabaeus"

Rising Signs



Why
does college
have to cost so
much?