Crafting with Data

Reality, Illusions, Truth & the Future

Instructor: Rob Faludi

Plan for Today

- IRB
- Coin Tosses
- Central Tendency and Measures of Spread
- Probability
- Present Discovery project results
- Readings & Assignments

IRB Results

- Please hand in your IRB test passing grade

Coin tosses

- Please hand in your coin toss results, identified only with your code
- DON’T even hint as to whether they are real or imagined

Feeling Random

- recognize
- trust
- patternlessness as a pattern
- hard to do

Coincidences

- million events per day
- things become sure to occur together
- pattern-seeking

Central Tendency

Central Tendency

Central Tendency

- Mean $\overline{X} = \frac{\sum X_i}{n}$
- Median position (n + 1) / 2 and if no number then the mean of the nearest
- Mode most frequent number, but if none repeat there is no mode

Variation and Measures of Spread

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Variation and Measures of Spread

- range high - low

- variance $\sigma^2 = \frac{(1-2)^2 + (2-2)^2 + (3-2)^2}{3} = 0.667$ $S^2 = \frac{\Sigma(X - \bar{X})^2}{n-1}$

- standard deviation $\sigma = \sqrt{\frac{\Sigma\ (x - \bar{x})^2}{n - 1}}$

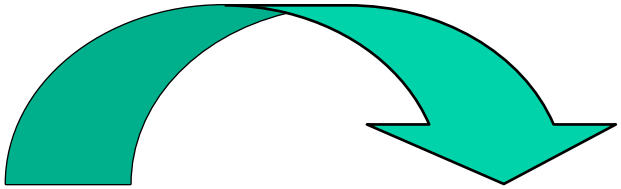
σ = lower case sigma
Σ = capital sigma
$\bar{x}$ = x bar

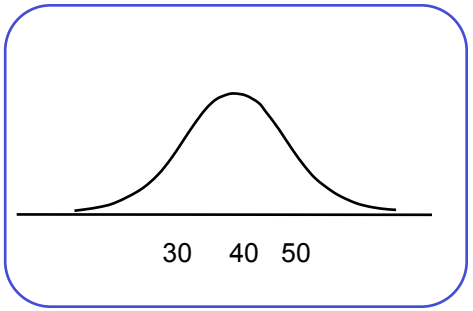
Probability

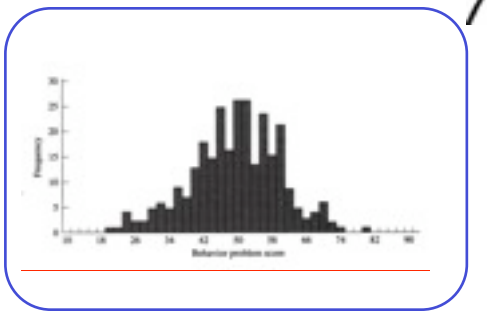
...with thanks to Larry Maloney

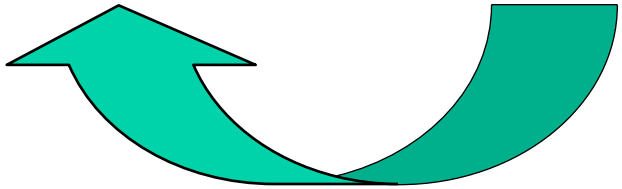
Nature

Experimentation









Data Analysis

Scientist

Mathematical Probability

Probability of an event

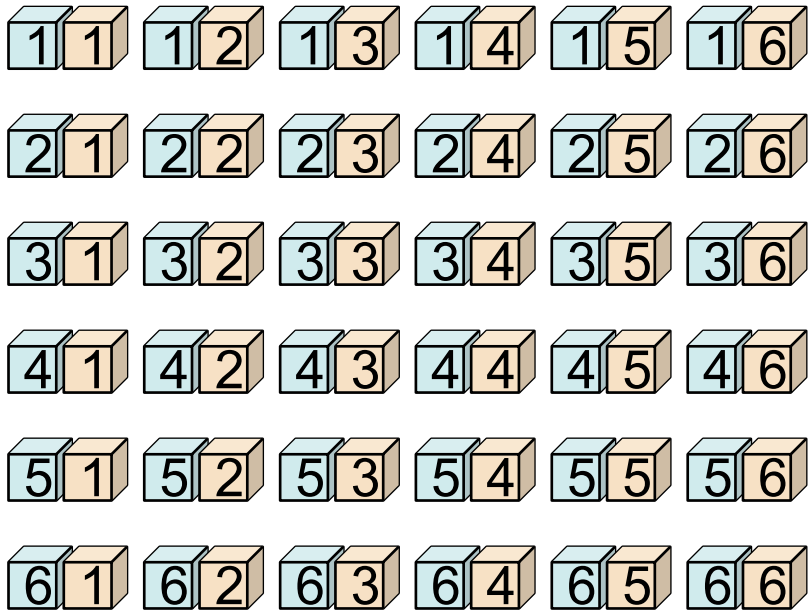
$$P[A] = \sum p_i$$

A. N. Kolmogorov

Mathematical Probability

Examples

$$p_i = 1/36$$

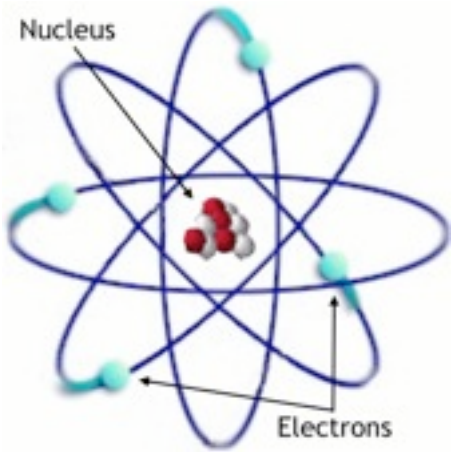


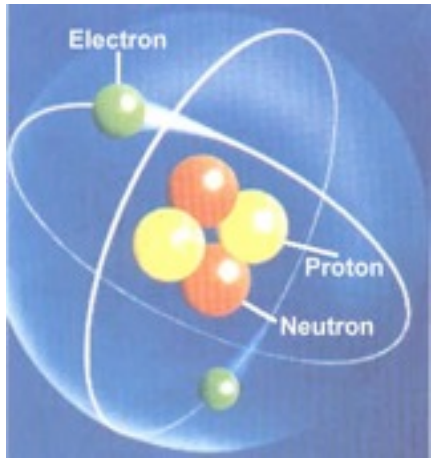
Two Dice

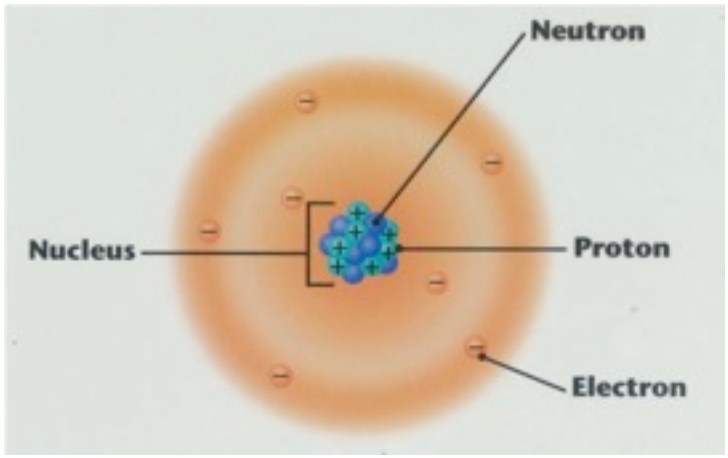
36 outcomes

What Causes Random?

- random is the meaningless part in confirmation and prediction
- not clear on what causes it
- quantum mechanics
- electron cloud
- parallel universes (Hugh Everett)
- structure?

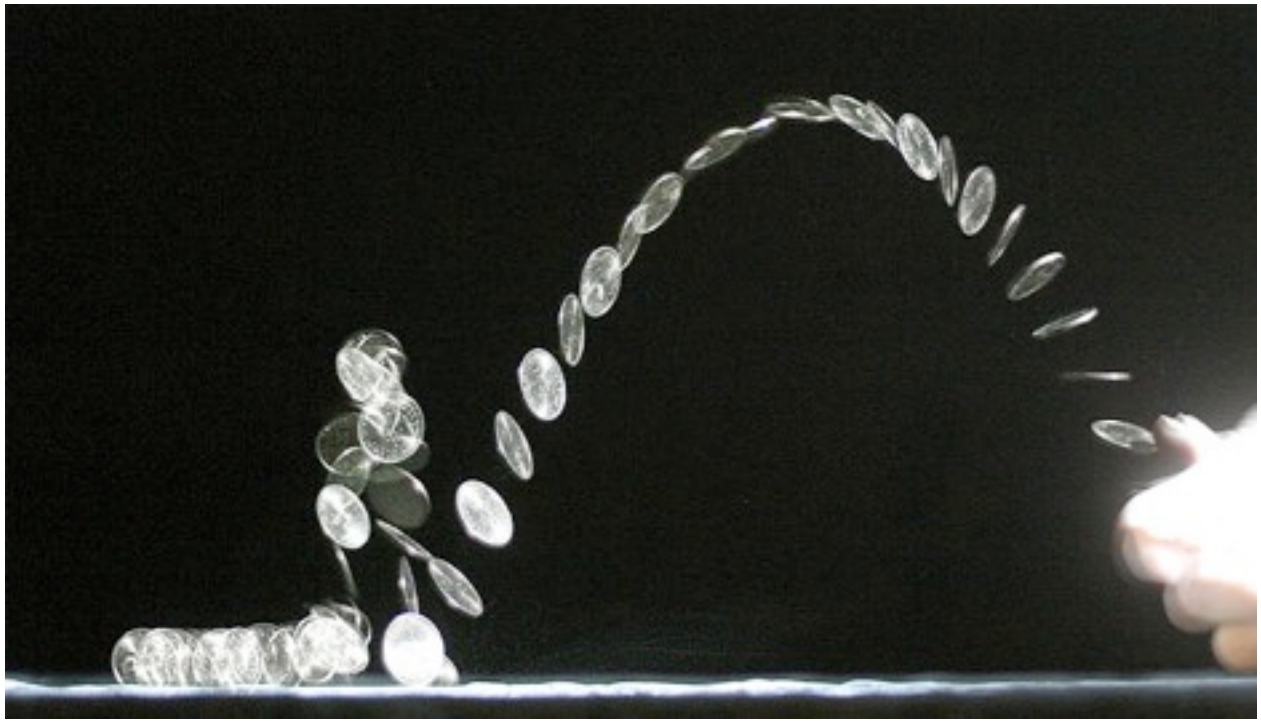






Cumulative Probability

$$P[AB] = P[A] * P[B]$$



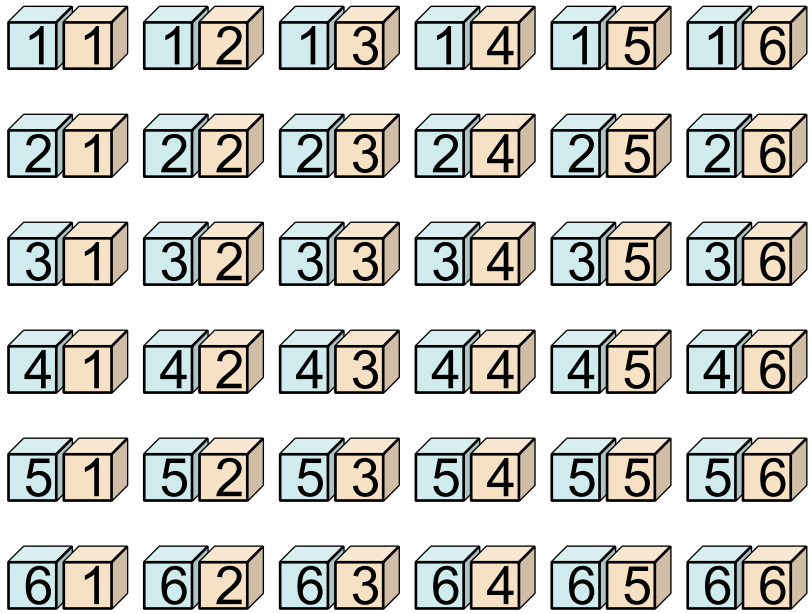
Conditional Probability

$$P[A \mid B] = P[AB] / P[B] \qquad if \; P\Big[B\Big] \neq 0$$

Mathematical Probability

Examples

$$p_i = 1/36$$



Two Dice

36 outcomes

One-in-a-million

- happens
- always happens
- three-in-a-row
- what's random will become predictable

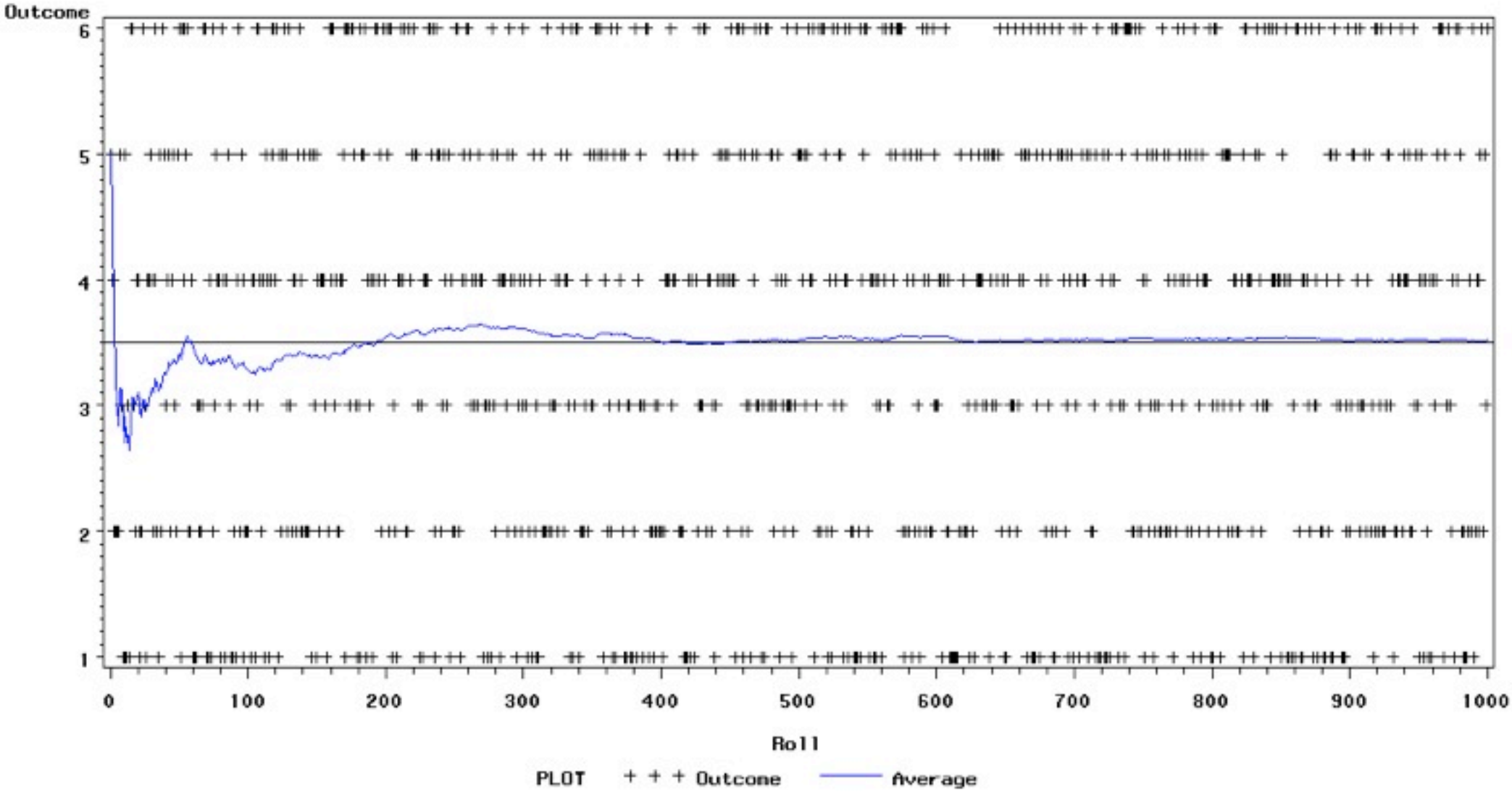
Law of Large Numbers

- All about the mean of a distribution

- sample average converges to the expected mean as *n* increases

LAW OF LARGE NUMBERS IN AVERAGE OF DIE ROLLS

AVERAGE CONVERGES TO EXPECTED VALUE OF 3.5



Central Limit Theorem

- All about the shape of the distribution

- As the sample size n increases, the distribution of the sample average of these random variables approaches the normal distribution with a mean μ and variance σ2 / n irrespective of the shape of the original distribution.

Hands-on Statistics

http://www.mathsisfun.com/probability/quincunx.html

Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin.

-- John von Neumann

Random in Processing, Arduino

- random()
- http://processing.org/reference/random_.html
- http://www.arduino.cc/en/Reference/Random
- randomSeed()
- http://processing.org/reference/randomSeed_.html
- http://arduino.cc/en/Reference/RandomSeed

Statistics in Java

- http://commons.apache.org/math/
- http://commons.apache.org/math/userguide/stat.html

Discovery Seeker: Results

- question you had
- how you collected data
- analysis attempted
- answers you may now have

Readings and Assignments

- Readings
  - none this week, *you have plenty to do*
- Assignments
  - Build either a real quincunx OR make a program to simulate a quincunx (or if you're feeling inspired, build any device or program that incorporates the probability density distribution (normal curve) in its fundamental operation)
  - Discovery assignment: **if needed**, revise and re-present a final view of your data.