Benford's Law

Real World "Digit" Patterns

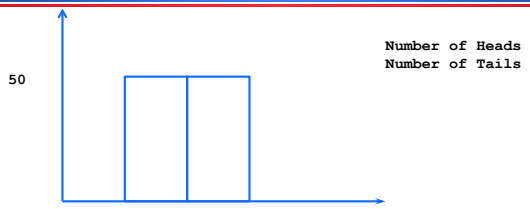
Today

- **Today: Benford's Law**
  - » **HW: Applications of Benford's Law**
- **Wednesday**
  - » **Benford's Law Conclusion**
- **Friday**
  - » **Chapter 2 Discussion (Quiz?),**
  - » **Class Photo**
- **HW: Summary Due Before class Friday**
  - » **Chapter 2**
  - » **Hardcopy due: Friday before class**
  - » **Softcopy due midnight before the class Friday.**

Benford' Law is about Number Distributions

- **Specifically about the Distribution of the First Digit in real world data.**
- **Before getting into the trenches of Benford's Law lets simply talk about (review) different Distributions.**
  - » **What do they look like?**
- **So lets explore:**
  - » **What is a numeric Distribution?**

Oh No! Coin-toss Again



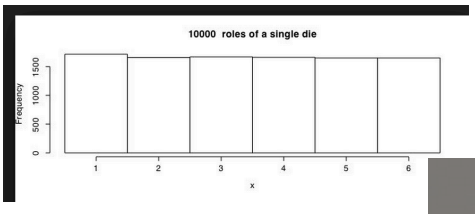
- **Uniform Distribution**
  - » **Excel's Random : 0 to .99**

    =IF(INT(RAND()+0.5)=1,"H","T")

    INT: Rounds down to the nearest INT

    Add .5 so half the numbers rounds down to 1 and half to zero.

1000 Roles of a Single Die



- **Uniform Distribution**

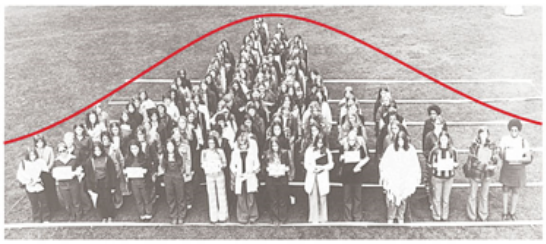
  =IF(INT(RAND()+0.5)=1,"H","T"

  INT: Rounds down to the neare

  Add .5 so half the numbers rou down to 1 and half to zero.

Example: Human Height

- **IF we take the population of earth and then sort them according to height**



- **Normal Distribution : Gaussian Distribution**

Bell Curve

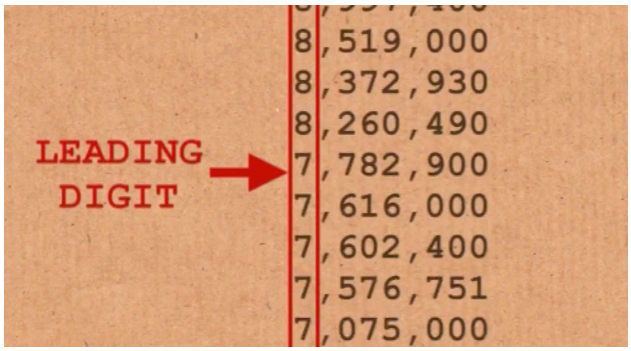
- Heights of people
- Size of things produced by machines
- Blood pressure
- Test Grades in a LARGE class.

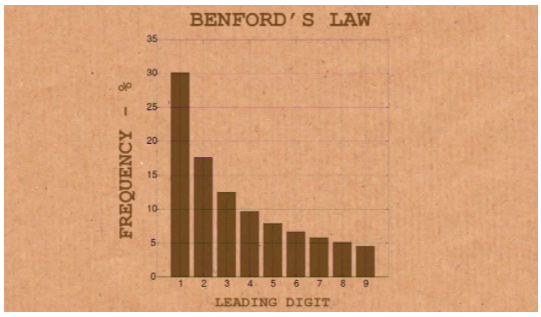
- http://www.mathsisfun.com/data/standard-normal-distribution.html

What about Benford's Law? What is its Distribution?

Numeric Data	Leading DIgit
235	2
975	9
124	1
536	5
611	6
385	3
196	1
745	7
385	3

Example: Population of all the countries in the world





The Ideal: Benford's Law

d	*P*(*d*)	Relative size of *P*(*d*)
1	30.1%	
2	17.6%	
3	12.5%	
4	9.7%	
5	7.9%	
6	6.7%	
7	5.8%	
8	5.1%	
9	4.6%	

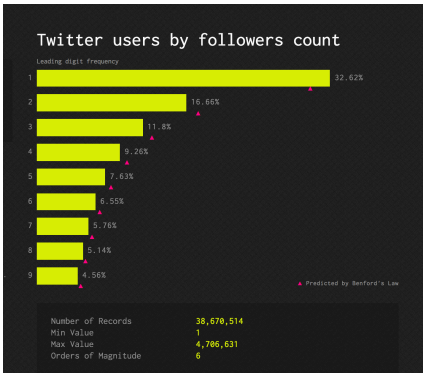
When does it not work well?

- **When number's are assigned! Or there are thresholds (max/min).**
  - » **Check numbers**
  - » **Invoice numbers**
  - » **Number's with built in max and minimum**

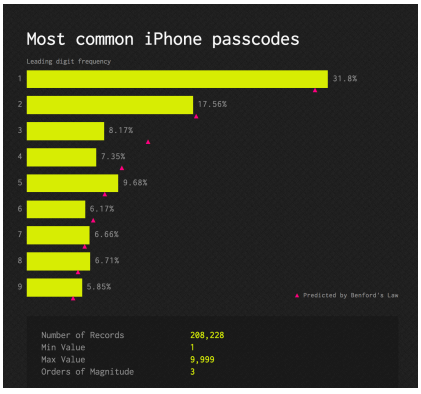
Benford's Law

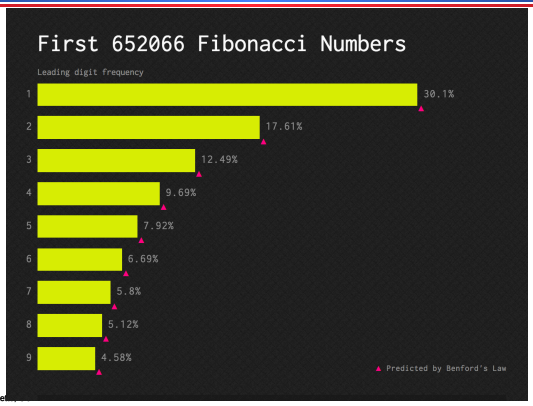
- **Read Resource: Wikipedia!**
- **http://en.wikipedia.org/wiki/Benford's_law**

More Examples



http://testingbenfordslaw.com/twitter-users-by-followers-count





- Heights of buildings
- Amount of money in your wallet
- Rolling of a die
  - 1 Die, value of 'dots' have a uniform distribution
  - 2 Dice: Question: Are Values of the dots:
    - Uniform
    - Non-Uniform
    - Benfordian

More Examples

- http://www.youtube.com/watch?v=O8N26edbqLM
- 10 minute Videos:
  - http://www.youtube.com/watch?v=vlsDjbhbADYs
  - http://www.youtube.com/watch?v=XXjlR2OK1kM
    - (country from last video)