

# Monte Carlo Simulation

---

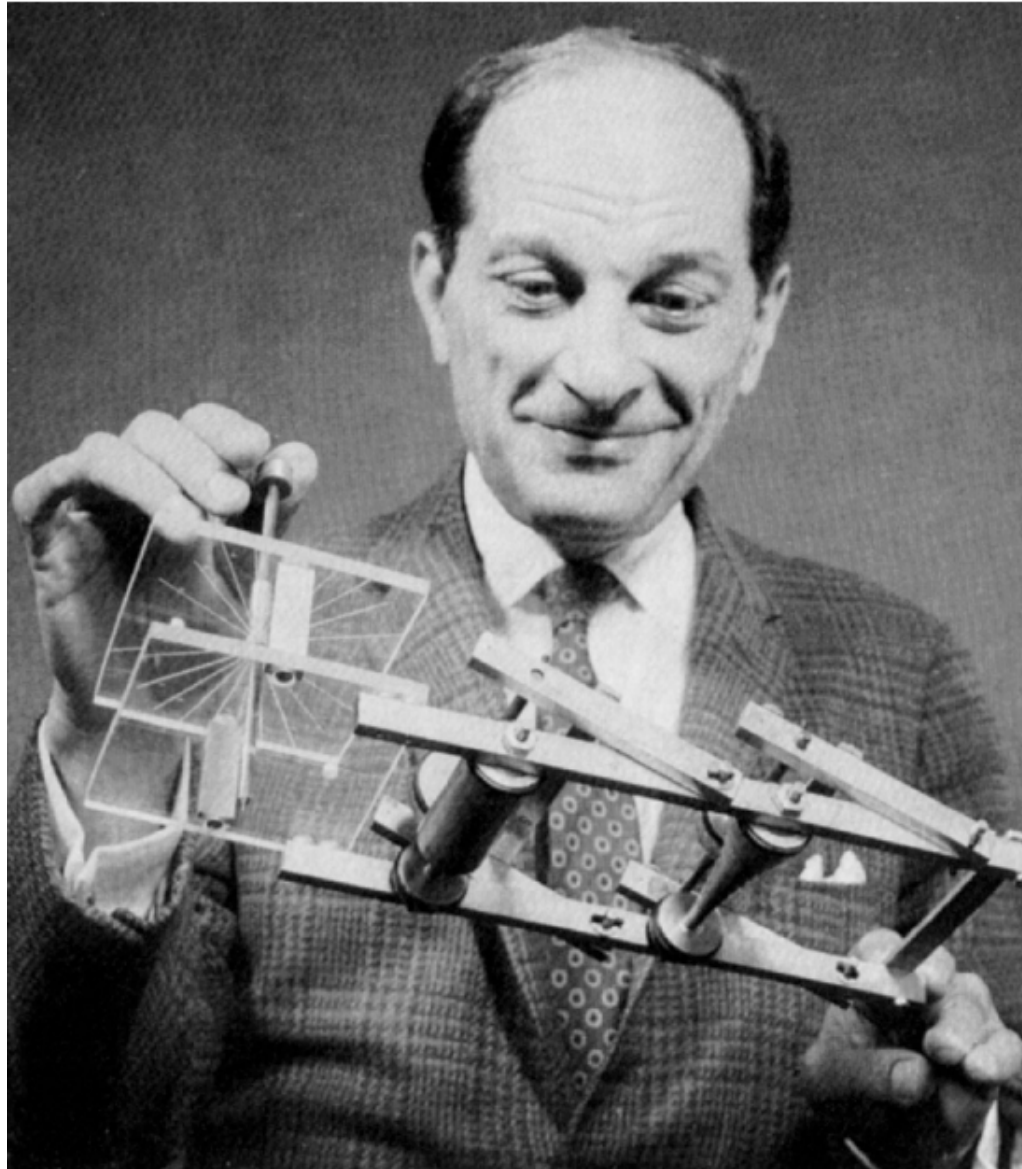


Photo by Sam Garza



# Stanislaw Ulam

---



# We've Been Doing this Already

---

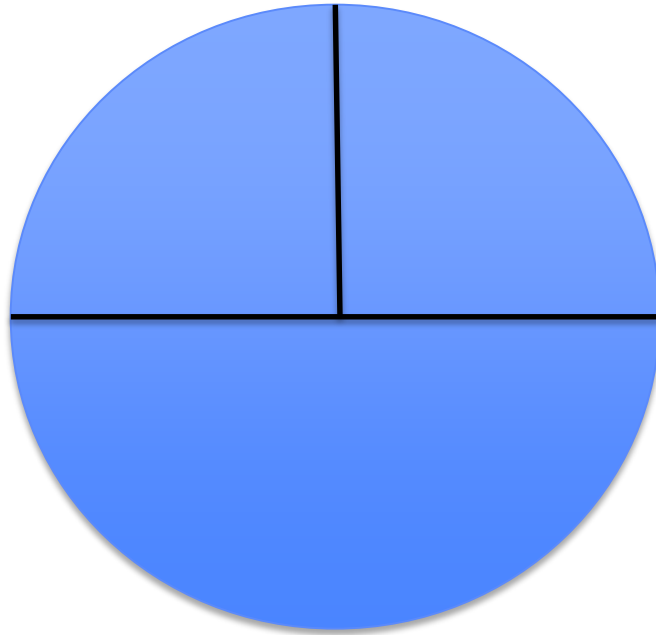
- A method of estimating the value of an unknown quantity using principles of inferential statistics.
- **Inferential statistics**
  - **Population**: a set of examples
  - Sample: a proper subset of a population
  - Key fact: a random sample tends to exhibit the same properties as the population from which it is drawn.

# Finding Pi

---

3.1415926535897932384626433832795028841971693  
99375105820974944592307816406286208998628034  
82534211706798214808651328230664709384460955  
05822317253594081284811174502841027019385211  
05559644622948954930381964428810975665933446  
12847564823378678316527120190914564856692346  
03486104543266482133936072602491412737245870  
06606315588174881520920962829254091715364367  
89259036001133053054882046652138414695194151  
16094330572703657595919530921861173819326117  
93105118548074462379962749567351885752724891  
22793818301194912983367336244065664308602139  
49463952247371907021798609437027705392171762  
93176752384674818467669405132000568127145263  
56082778577134275778960917363717872146844090  
12249534301465495853710507922796892589235420  
19956112129021960864034418159813629774771309  
96051870721134999999837297804995105973173281  
60963185950244594553469083026425223082533446  
85035261931188171010003137838752886587533208  
38142061717766914730359825349042875546873115  
95628638823537875937519577818577805321712268  
06613001927876611195909216420198

Image from Tom Murphy



$$\frac{\textit{circumference}}{\textit{diameter}} = \Pi \quad \textit{area} = \Pi * \textit{radius}^2$$

# Rhind Papyrus



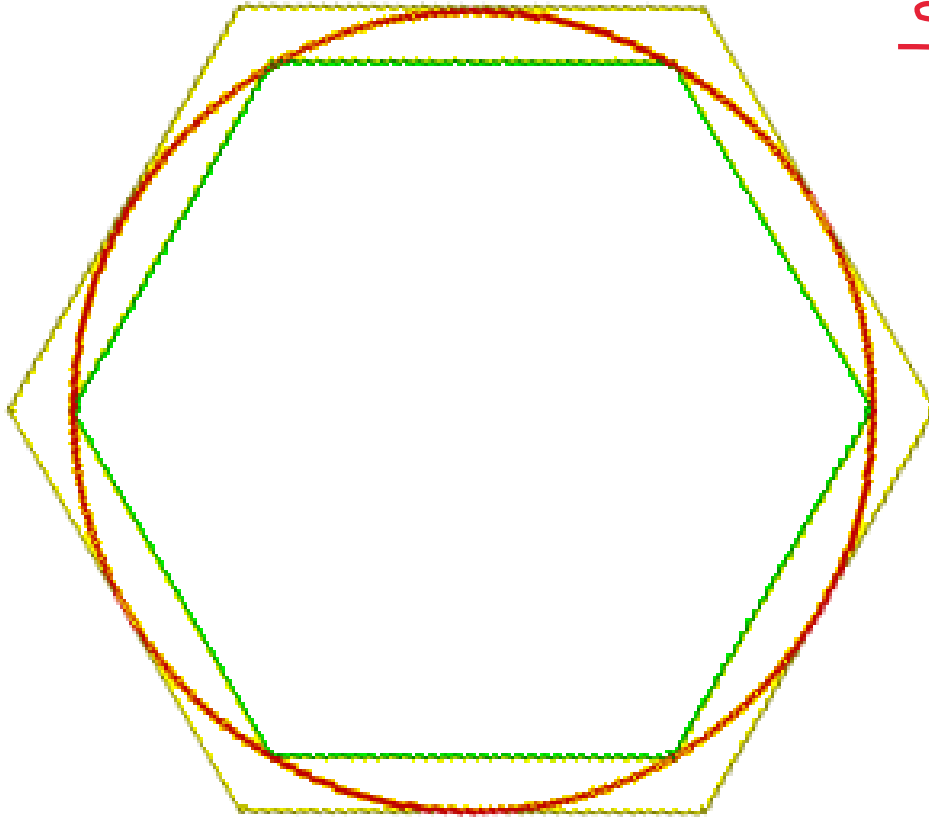
*“And he made a molten sea, ten cubits from the one brim to the other: it was round all about, and his height was five cubits: and a line of thirty cubits did compass it round about.”*

**—1 Kings 7.23**



# Archimedes

upper and lower polygen

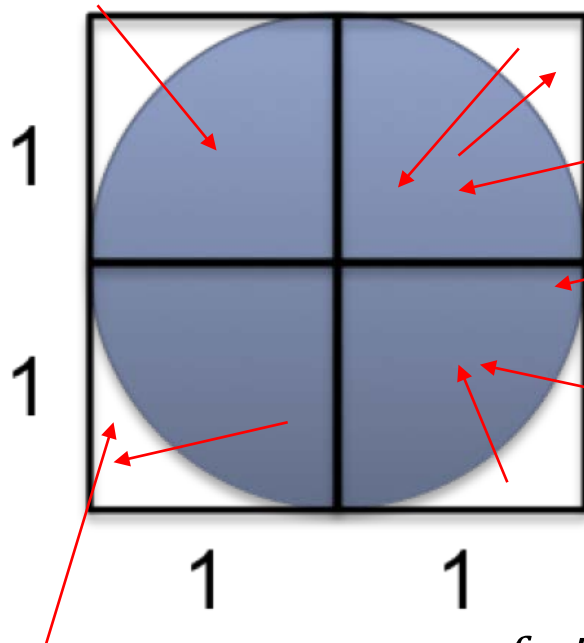


$$\frac{223}{71} < \pi < \frac{22}{7}$$

$$3.1418$$

# Buffon-Laplace

French  
monte carlo simulation



$$A_s = 2 * 2 = 4$$

$$A_c = \pi r^2 = \pi$$

dropping enough

$$\frac{\text{needles in circle}}{\text{needles in square}} = \frac{\text{area of circle}}{\text{area of square}}$$

$$\text{area of circle} = \frac{\text{area of square} * \text{needles in circle}}{\text{needles in square}}$$

$$\pi \text{ area of circle} = \frac{4 * \text{needles in circle}}{\text{needles in square}}$$

# Arrows Are More Fun than Needles

---



Photo Dharma

# Not a Practical Method

---

- In the next segment, we take Ana's advice and build a simulation