

## Who I am...

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"There are three kinds of lies: lies, damned lies and statistics"


Benjamin Disraeli
1804-1880
Prime Minister of England 1874-1880


## "He uses statistics as a drunken man uses lamp posts

## - for support rather than for

 illumination"$$
\text { Andrew Lang Poet } 1844-1912
$$


"Statistics ... the most important science in the whole world: for upon it depends the practical application of every other science and of every art; the one science essential to all political and social administration, all education, all organization based on experience, for it only gives results of our experience."

## WE BEGIN WITH THE FAIR COIN TOSSING GAME

1) Flip a coin 4 times
2) do this a billion times
3) what proportion of the billion games has 2 heads and 2 tails?

Correct answer is equal to or closest to:

$$
\underline{0.1} \quad \underline{0.2} \quad \underline{0.3} \quad \underline{0.4} \quad \underline{0.5}
$$

# DISTRIBUTION OF GUESSES 

(Personal sample of Prof Corey)

| Proportion | N | $\%$ |
| :---: | :---: | :---: |
| 0.1 | 93 | 8.58 |
| 0.2 | 203 | 18.73 |
| 0.3 | 138 | 12.73 |
| 0.4 | 126 | 11.62 |
| 0.5 | $\underline{524}$ | $\underline{48.34}$ |
| Totals | 1084 | 100.00 |

## 16 POSSIBLE RESULTS OF FLIPPING A COIN 4 TIMES

| $\frac{\text { TTTT }}{0}$ | $\frac{\text { HTTT }}{1}$ | $\frac{\text { HHTT }}{2}$ | $\frac{\text { HHHT }}{3}$ | $\frac{\text { HHHH }}{4}$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| $1 / 16$ | $4 / 16$ | $6 / 16$ | $4 / 16$ | $1 / 16$ |
| 0.0625 | 0.250 | 0.375 | 0.250 | 0.0625 |

## KNOM YOUR SUMAS


$\square$ The little girl did not know that there was more than one way of getting a sum of two numbers that is equal to 9
$\square$ Many students did not know the number of ways of getting two heads and two tails in four tosses of a fair coin

Before introducing an important application of this coin flipping result we introduce the General Statistical Model.

Suppose we want to compare patients on two different drugs, diets or exercise programs. Call these exposures.

We have n patients in each group. How did they get assigned into groups?

- One way is to select the data from a database in what is called an observational study.
- In the other way subjects did not choose the exposure but were randomly allocated to the two groups by the scientist in what is called a randomized trial.


## THE BINOMIAL PROBABILITY MODEL FOR COIN FLIPPING

$$
\begin{aligned}
& P\left[B_{n}=h\right]={ }_{n} C_{h} \times P^{h} \times Q^{n-h}=\frac{n!}{h!\times(n-h)!} \times P^{h} \times(1-P)^{n-h} \\
& P\left[B_{4}=2\right]=\frac{4!}{2!\times(4-2)!} \times 0.5^{2} \times 0.5^{2}=6 \times(0.5)^{4}=\frac{6}{16}=0.375 \\
& 4!=4 \times 3 \times 2 \times 1 \\
& 2!=2 \times 1
\end{aligned}
$$

Describing the Binomial probability distribution is a simple way to introduce the concept of a random variable ( $B_{n}$ ). If the trial was not a flip of a coin but a homozygous offspring (aa) of heterozygous parents (Aa) then $p=0.25$

BINOMIAL PROBABILITY DISTRIBUTION N=4 $\mathrm{P}=0.5$


BINOMIAL PROBABILITY HISTOGRAM


Important Result:: Probabilities are AREAS under a histogram.

GAUSSIAN CURVE ON BINOMIAL HISTOGRAM


Important Result: Total area under the histogram and under a Gaussian or Normal probability curve is 1.0

