

# Information Retrieval

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So much of life, it seems to me, is determined by pure randomness.

– **Sidney Poitier.**

God does not play dice with the universe.

- **Einstein.**



# The Law – Robert M. Coates

From the book, “The World of Mathematics – Volume IV”.

**Triborough Bridge, NY, USA.**  
(aka Robert F. Kennedy Bridge)



Late 1940s, NY: *No other bridge or main highway was affected, and though the two preceding nights had been equally balmy and moonlit, on both of these the bridge traffic had run close to **normal**.*

*It just looked as if everybody in Manhattan who owned a car had decided to drive out to Long Island that evening.*

# No Reason!



**Sergeant:** “I kept askin’ them” he said, “Is there night football somewhere that we don’t know about? Is it the races you’re goin’ to?”

But the funny thing was half the time they’d be askin’ me. “What’s the crowd for, Mac?” they would say. And I’d just look at them.

# Time for Action

- At this juncture, it was inevitable that Congress should be called on for action.



- Senator said, “*You can control it*”. Re-education and reforms were decided upon. He said, (we need to lead people back to) “*the basic regularities, the homely **averageness** of the American way of life*”.

If normal things stop happening, if we lose regularities in life, our planet could become unlivable!

# The Law of Large Numbers

Known as the Fundamental theorem of Probability

**The average of the results obtained from a large number of trials should be close to the expected value, and will tend to become closer as more trials are performed.**

# Expectation

- Roll a dice. Assume you may see 1 to 6 with equal probability.
- Expected Value = ?

$$\frac{1 + 2 + 3 + 4 + 5 + 6}{6} = 3.5$$

**According to the law of large numbers, if a large number of six-sided dice are rolled, the average of their values (sometimes called the sample mean) is likely to be close to 3.5, with the precision increasing as more dice are rolled. – Wikipedia.**

# Quiz: A Minor Digression

- What is the fundamental theorem of algebra?

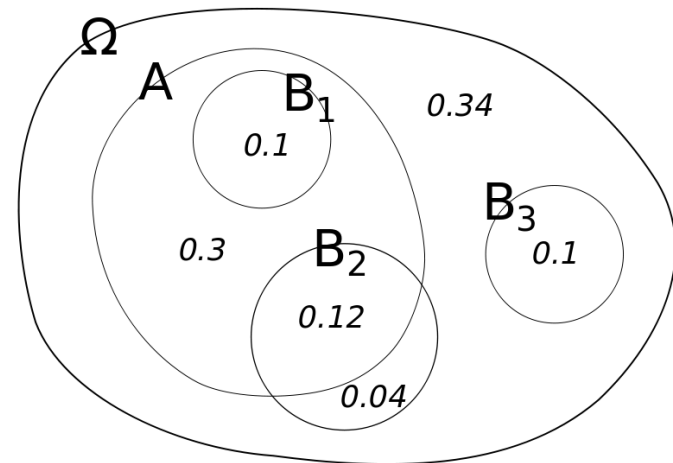


# Quiz

- What is the fundamental theorem of algebra?
  - Loosely, “Every polynomial has root(s)”
  - More Precisely, “*every non-constant single-variable polynomial with complex coefficients has at least one complex root.*” [Source: Wikipedia].

# Quiz: Conditional Probability

- $P(A) = 0.52$ ,
- $P(B_1) = 0.1$ , and so on as shown below
- What is  $P(A|B_1)$ ?
  - $P(A|B_1) = 1$ .

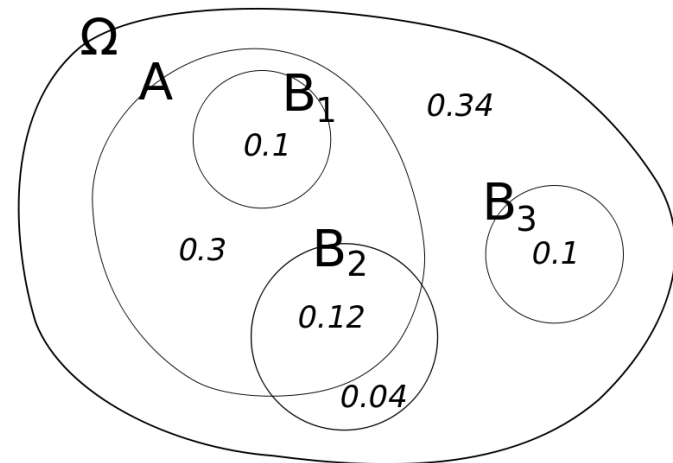


Euler Diagram

# Quiz: Conditional Probability

- What is  $P(A|B_2)$ ?

$$P(A|B_2) = 0.12 / (0.12 + 0.04) = 0.75.$$



Euler Diagram

# Revisiting Probability

- Developers in two companies are distributed as follows. Compute Joint Probabilities.

	Java	C	Total
Company-X	1	17	18
Company-Y	37	20	57
Total	38	37	75

	Java	C	Total
Company-X	0.013	0.227	0.24
Company-Y	??	??	??
Total	0.506	??	??

$$P(\text{Company-X,Java}) = 1/75 = 0.013$$

# Revisiting Probability

- Developers in two companies

	Java	C	Total
Company-X	1	17	18
Company-Y	37	20	57
Total	38	37	75

	Java	C	Total
Company-X	0.013	0.227	0.24
Company-Y	0.493	0.267	0.76
Total	0.506	0.494	1

- Joint Probability  $P(\text{Company-X, Java}) = 0.013$ .
- $P(\text{Company-Y, Java}) = 0.493$
- Sometimes written as  $P(AB)$  or  $P(A \cap B)$

# Revisiting Probability

- Developers in two companies

	Java	C	Total
Company-X	1	17	18
Company-Y	37	20	57
Total	38	37	75

	Java	C	Total
Company-X	0.013	0.227	0.24
Company-Y	0.493	0.267	0.76
Total	0.506	0.494	1

- $P(\text{Company-Y} | \text{Java}) = ??$
- Is  $P(\text{Company-Y} | \text{Java}) == P(\text{Java} | \text{Company-Y})$  ?

# Revisiting Probability

- Developers in two companies

	Java	C	Total
Company-X	1	17	18
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	Java	C	Total
Company-X	0.013	0.227	0.24
Company-Y	0.493	0.267	0.76
Total	0.506	0.494	1

- $P(\text{Company-Y} | \text{Java}) = 37/38 = 0.974$
- $P(\text{Java} | \text{Company-Y}) = 37/57 = 0.649$

# Odds

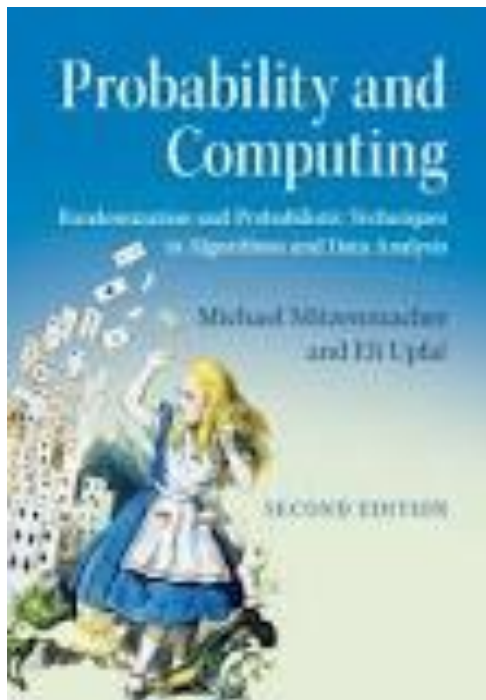
- Odds,  $O(A) = P(A)/P(A') = PA/(1-P(A))$



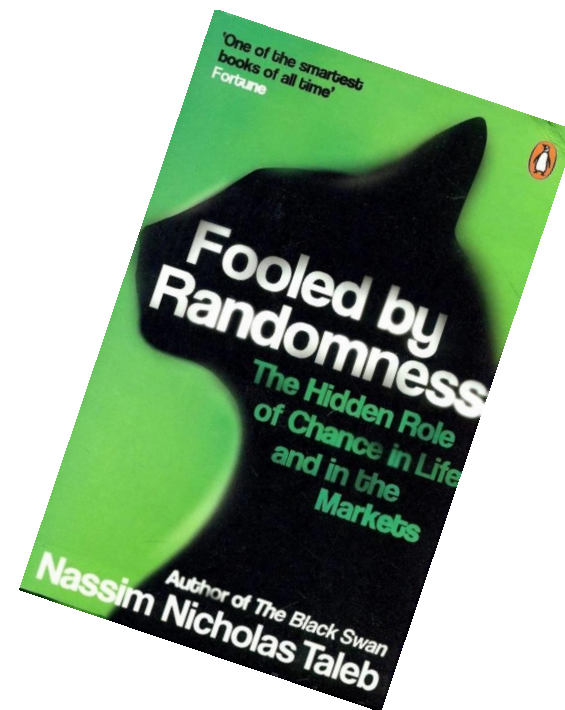
# Quiz

- What is the probability of getting a 5 when rolling a six sided dice? Assume a fair dice.
- What is the odds of the same event?

# Reading



Probability and Computing - Eli Upfal and Michael Mitzenmacher



Fooled by Randomness - Nassim Nicholas Taleb