WELCOME TO

TECH I.S.

# Introduction to Probability

# Classical Probability

Classical Probability assumes all outcomes in a sample space are equally likely, then calculates likelihood of something happening.

| | |
|---|---|
| ***Event*** | A result of an experiment , usually expressed as a letter (A,B,...) |
| ***Outcome*** | A result of the experiment that cannot be broken down into smaller events. |
| ***Sample Space*** | The set of all possible outcomes. |

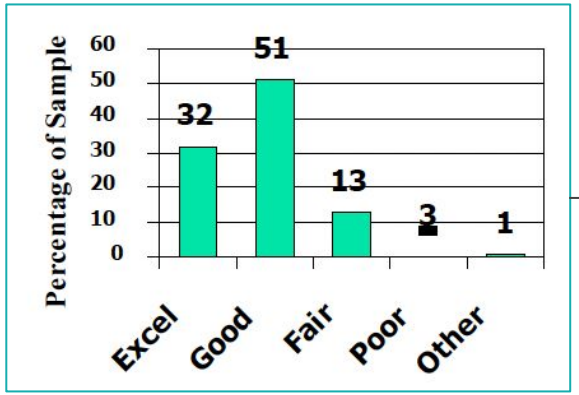
$$P(A) = \frac{Number\ of\ Outcomes\ that\ satisfy\ A}{Total\ number\ of\ Outcomes\ in\ the\ sample\ space}$$

# Empirical Probability

**Empirical Probability is based on experience, we <u>actually</u> perform the experiment and record data.**

$$P(A) = \frac{n(A)}{n(S)} \quad \begin{matrix} \leftarrow number\ of\ times\ the\ event\ actually\ occurs \\ \leftarrow number\ of\ times\ the\ experiment\ is\ performed \end{matrix}$$

**<u>Example</u>: What is the chance that someone rates their football team as good or better?**

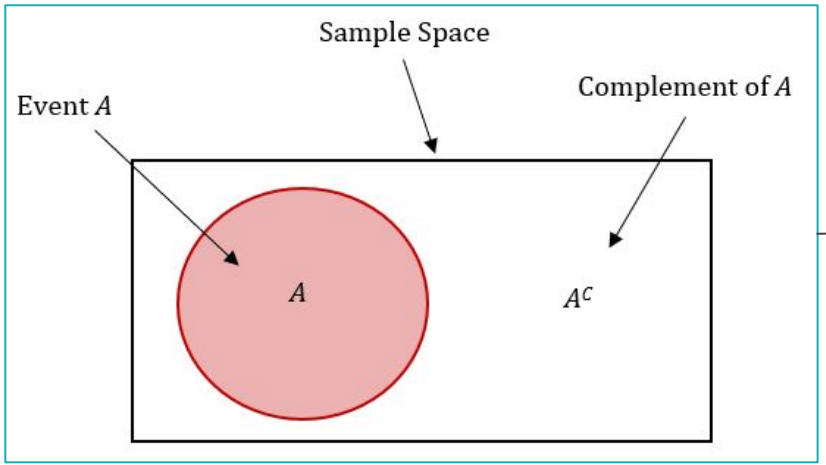



**0.51 + 0.32 = 0.83**

# Rule of Complement

**Complement of an Event, is the event that does not occur.**

**Probability of A' is (1 - Probability of A)**




$$P(A)+P(A')=1$$

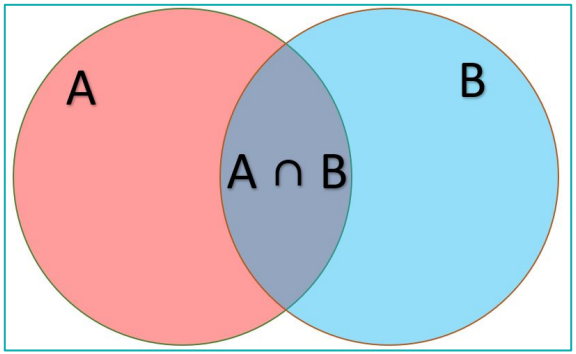
$$P(A)=1-P(A')$$

# Joint Probability

**Joint Probability is the likelihood that two or more events will coincide.**

**The UNION of two events A and B is that either A occurs or B occur or both occurs (All colored parts)**

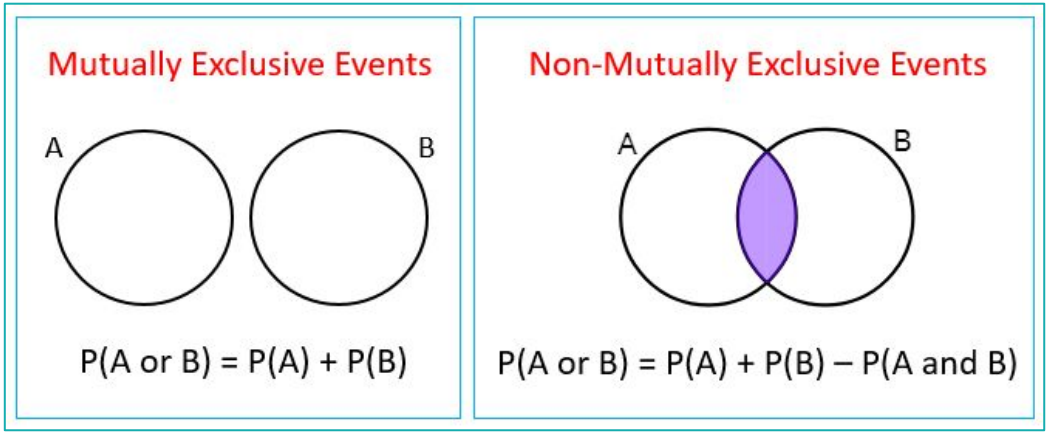
**The INTERSECTION of two events A and B is that both A and B will occur (Dark middle part only)**



# Mutually Exclusive Events

**Mutually Exclusive Events (or Disjoint Events): Two or more events that cannot occur at the same time.**

**Suppose you are rolling a six-sided die.**
**What is the probability that you roll an odd number or you roll a 2?**



# Example - Joint Probability

**In a group of students, 40% are taking Math, 20% are taking History and 10% of students are taking both Math and History.**

**Q: Find the Probability of a Student taking either Math or History or both.**

P(M or H) = 40% + 20% - 10% = 50%

**Q: Find the Probability of rolling A: (2 or less) AND B: (5 or More) ?**

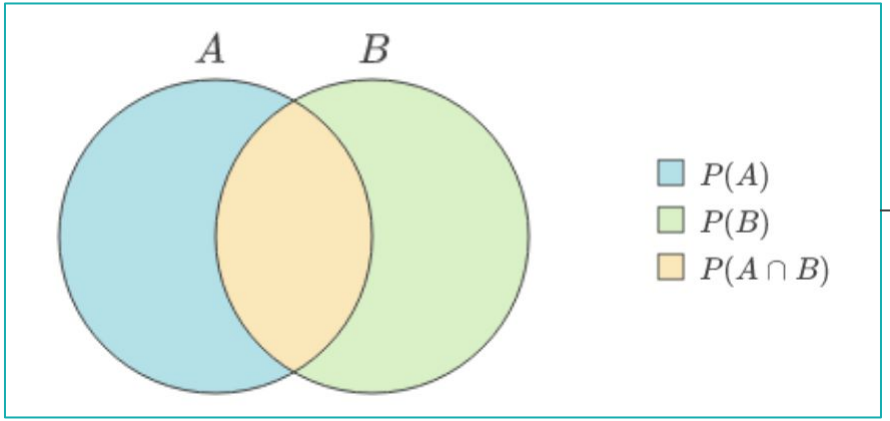
A: Roll 2 or less  B: Roll 5 or more

A: Roll 2 or less  B: Roll 5 or more
P(A)=2/6  P(B)=2/6
P(A or B) = P(A) + P(B) = 4/6

# Conditional Probability

**The probability of an event occurring GIVEN that another event has already occurred.**

**P (A|B) denotes the conditional probability of event A occurring given that event B has occurred.**




$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$$

# Conditional Probability - Example

**If someone asks you, what is the likelihood that you're carrying an umbrella?**

**Your first question would be: Is it raining?**

**Thus, knowing whether it is raining affects the chances that you're carrying an umbrella.**

P(Umbrella ∩ Rain): 0.20
P(Umbrella ∩ No Rain): 0.40
P(Rain): 0.25
P(No Rain): 0.75

$$P(\text{Umbrella}|\text{Rain}) = \frac{P(\text{Umbrella} \cap \text{Rain})}{P(\text{Rain})} = \frac{0.20}{0.25} = 0.80$$

$$P(\text{Umbrella}|\text{No Rain}) = \frac{P(\text{Umbrella} \cap \text{No Rain})}{P(\text{No Rain})} = \frac{0.40}{0.75} = 0.53$$

# Marginal Probability

When we have a larger set of related variables that you collected for a study, we might want to focus on one of them to answer a specific question.

Marginal probability focuses on one variable ignoring a other set of related variables.

**Example**:

Given Accident data for DUI and non-DUI of driver,

Find Probability a Driver had Accident when DUI & non-DUI.

| | Accident | No Accident | Total |
|---|---|---|---|
| **DUI** | 70 | 130 | 200 |
| **Non- DUI** | 30 | 770 | 800 |
| **Total** | 100 | 900 | 1000 |

A = Accident → P(A) = 100/1000 = 0.10

D = DUI → P(D') = 1 – 200/1000 = 0.80

# Independence

**If Event A does not affect Event B and vice-versa , then they are INDEPENDENT events.**

P(A|B)=P(A) → P(B|A)=P(B) → $P(A \cap B) = P(A)P(B)$

**Example: If we roll a die twice, the outcome of the first roll and second roll have no effect on each other - thus they are independent.**

For example,
When we roll a dice twice the probability of getting a 6 is $\frac{1}{6}$.

So the probability of getting a 6 and a 6 is $\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$.

# Much obliged.

TECH I.S.