

## Unit 3: Math for AI (Statistics & Probability)

### 3.1 Importance of Math for AI

<b>Title: Math for AI</b>	<b>Approach: Interactive Session + Activity</b>
<b>Learning objectives:</b> <ul style="list-style-type: none"><li>Discuss the applications of Mathematics in AI.</li><li>To know the different mathematical concepts important for understanding AI?</li><li>How are statistics and probability used in different AI applications?</li></ul>	
<b>Summary:</b> In this chapter, Students are introduced to the mathematics required for designing an AI project. They will know about the essential mathematical concepts required to understand an AI project from the basics. They will be introduced to mathematical concepts of linear algebra, calculus, statistics, and probability through easy activities and examples. Learners will also be able to identify the use of statistics and probability in everyday life.	
<b>Learning Outcomes:</b> <ul style="list-style-type: none"><li>Students will be able to understand the importance of mathematics in the field of AI.</li><li>Students will be able to identify the essential mathematical concepts required for the understanding of A</li><li>Students will be able to define statistics and probability and describe their applications in AI</li></ul>	
<b>Pre-requisites:</b> <ul style="list-style-type: none"><li>Basic mathematical knowledge and analytical ability</li><li>Basic familiarity with AI</li></ul>	
<b>Key- Concepts:</b> <ul style="list-style-type: none"><li>Important mathematical concepts in AI</li><li>Introduction to statistics and probability</li></ul>	

#### Activity 1:

**Purpose:** observing and analyzing the numbers & Find the pattern.

- Find the missing number in the following series:  
2, 4, 6, 8, 10, 12, ?  
4, 10, 16, 22, 28, ?  
34, 31, 28, 25, 22, ?
- If Year 1 Profit was INR 1000; Year 2 Profit was INR 1500; Year 3 Profit was INR 2000; Year 4 Profit was INR 2500, can you predict the profit for Year 5?

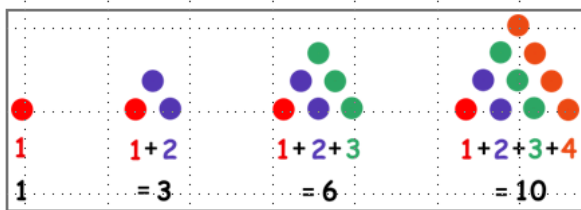
Ask the learners

- “How did you solve these puzzles?”
- “Was there any pattern that you recognized which could help you solve the puzzles?”

## How are Math and AI related?

Math is the study of patterns

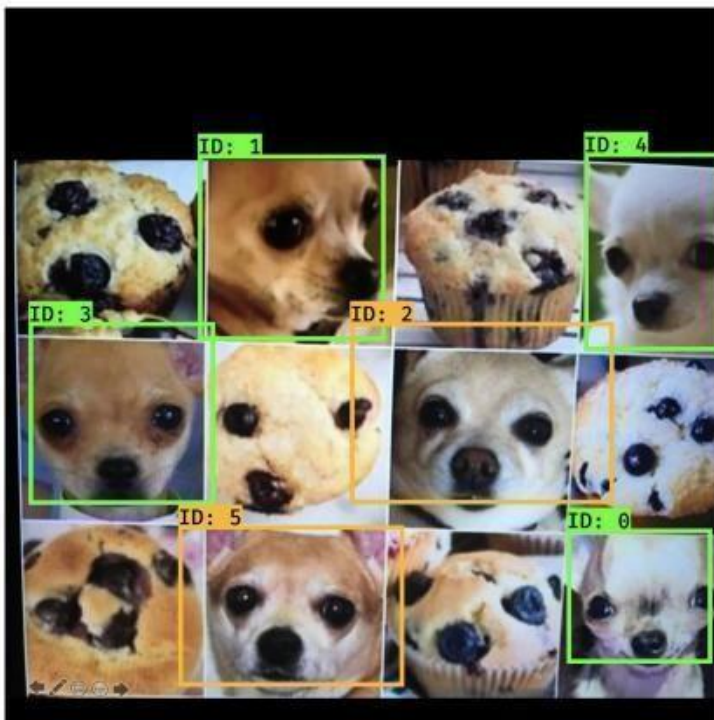
- To solve the puzzles, you identify an order/arrangement in the list of numbers or the images.
- This arrangement is called a pattern.
- These patterns exist all around us.
- We have patterns in numbers, images, and language.



Ask learners if they can identify any patterns around themselves.

AI is a way to recognize patterns

- AI can learn to recognize patterns, like human beings.
- AI can see patterns in different types of data - numbers, images, and speech and text.
- These patterns help AI to solve puzzles – like identifying dogs and muffins, or predicting hurricanes!



**ID: 0**

**Type:** Dog

**Breed:** Chihuahua (41.0%)

**Emotion:** Scared (98.0%)

Scared (98.0%), Angry (2.0%), Happy (0.0%), Neutral (0.0%), Sad (0.0%)

Say "Just like we can recognize patterns in numbers, words, pictures, etc., AI can also recognize similar patterns."

Hence,

- Math is the study of patterns
- AI is a way to recognize patterns in order to take decisions
- AI needs Math to study and recognize patterns in order to take decisions

Can you identify any pattern in the image given below?

$$\begin{aligned}
 1 \times 9 + 2 &= 11 \\
 12 \times 9 + 3 &= 111 \\
 123 \times 9 + 4 &= 1111 \\
 1234 \times 9 + 5 &= 11111 \\
 12345 \times 9 + 6 &= 111111 \\
 123456 \times 9 + 7 &= 1111111 \\
 1234567 \times 9 + 8 &= 11111111 \\
 12345678 \times 9 + 9 &= 111111111 \\
 123456789 \times 9 + 10 &= 1111111111
 \end{aligned}$$

### Activity 3:

**Purpose:** To find connections between sets of images and using that to solve problems, think smartly, and grasp tricky ideas.

1.		
2.		
3.		
4.		
5.		
6.		

Complete the sequence in the left column by identifying the correct missing piece in the right column out of A or B.

Understanding math will help us to better understand AI and its way of working, but what kind of math is needed for AI?

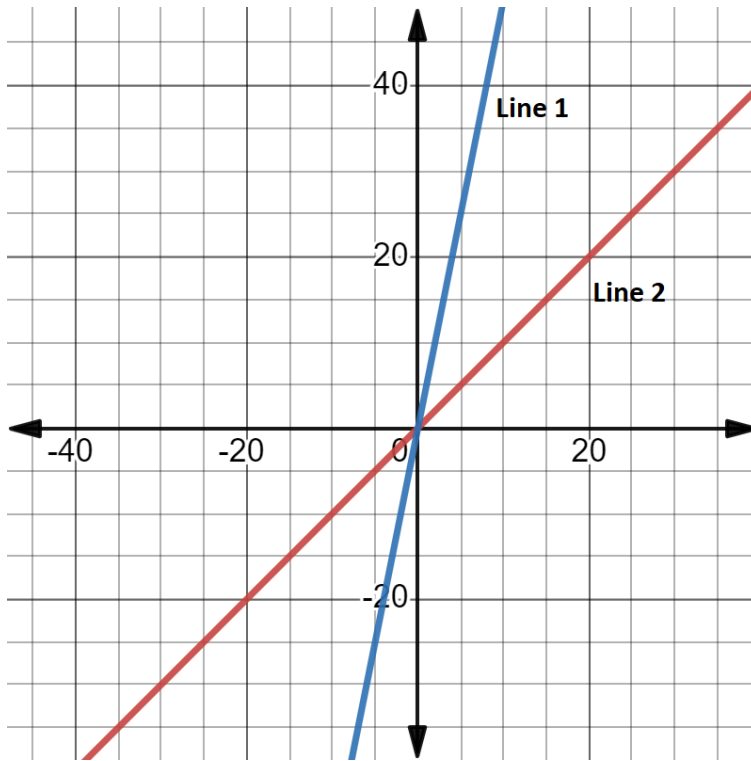
**Let us take a look!**

## Essential Mathematics for AI

Let's think and answer the following questions:

- 11, 22, 33, 44, 55 – Can you find out the middle value from the given numbers?
- 

- In the given figure, which of the two lines is more slanted? Line 1 or Line 2?



- A has 2 plants, B has 3 plants, C has 1 plant, D has 7 plants. How many plants are there in total?
- 

- If the coin shown in the figure below is used for a toss, what can be the possible result?



**Head**



**Tail**

Just like us, AI can also solve 4 type of problems using Math.

## AI uses Math for:

- **Statistics (Exploring data):** Example – What is the middle value of the data? Which is the most common value in the data?
- **Calculus (training and improving AI model):** Example – which line is more slanted? Which figure covers more area?
- **Linear Algebra (finding out unknown or missing values):** Example – How many plants are there in total? How many cars are there in a city?
- **Probability (predicting different events):** Example – what will be the possible results of a coin toss? Will it rain tomorrow?

## 3.2 Statistics

Ask learners to answer some or all of these questions as an assignment. Meanwhile, take dummy numbers and walk the learners through the questions.

- Can you find out the total weight of your family members?
- Can you find out the total number of students in your school?
- Can you find out the maximum temperature in your city during the last month?

**Definition of Statistics:** “*Statistics is used for collecting, exploring, and analyzing the data. It also helps in drawing conclusions from data.*”

- Data is collected from various sources.
- Data is explored and cleaned to be used.
- Analysis of data is done to understand it better.
- Conclusions and decisions can be made from the data.

### Applications of Statistics:

- Predict the performance of sports teams
- It can be used to find out specific things such as:
  - the reading level of students
  - the opinions of voters
  - the average weight of a city’s resident

#### Activity 4:

Purpose: Uses of Statistics in real life.

Write any two applications of Statistics in real life.

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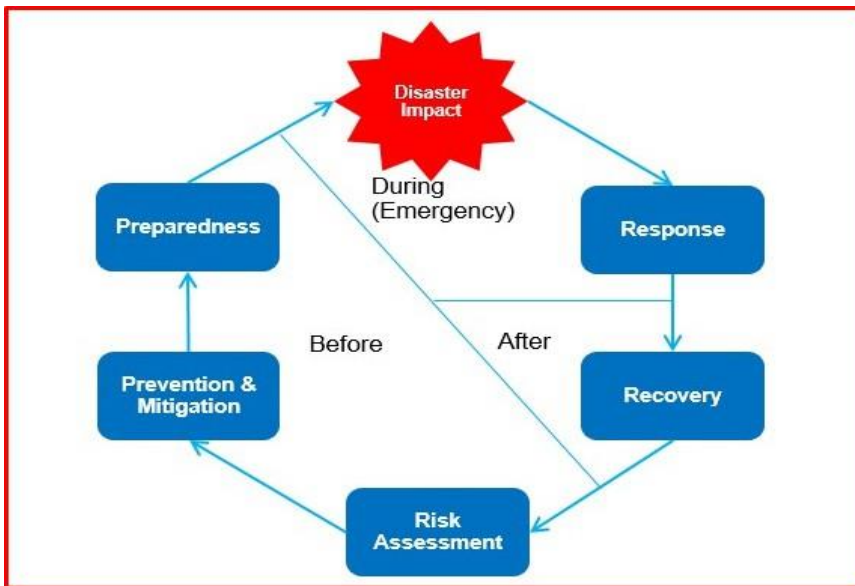
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## Some more applications of Statistics

### Disaster Management

- Authorities use statistics to alert the citizens residing in places that might be affected by a natural disaster in near future.

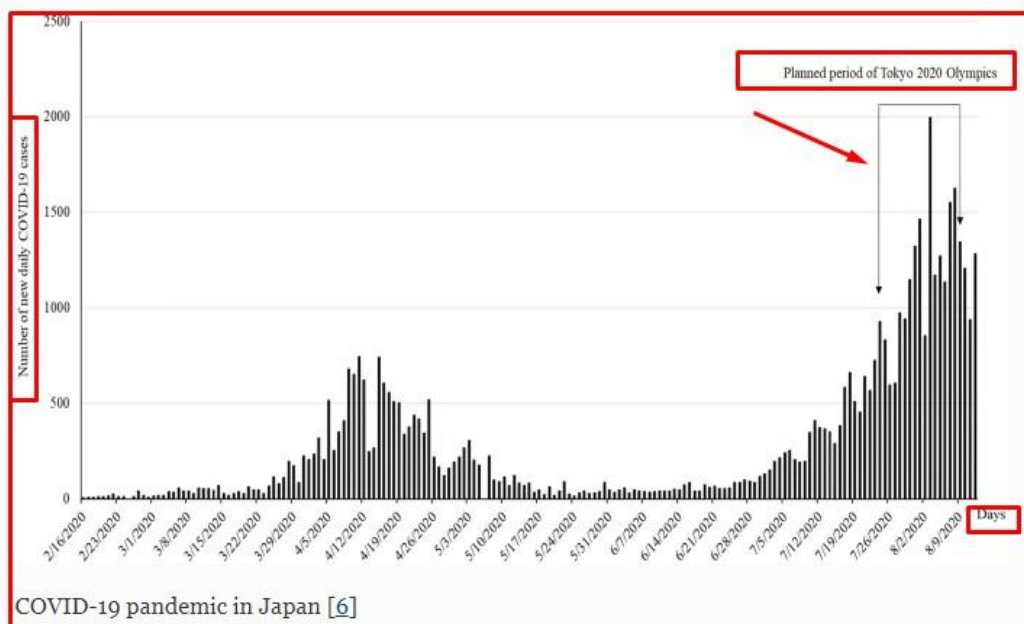
- The disaster management teams use statistics to know about the population, and about the services and infrastructure present in the affected area.



Ask students to think about more ways in which statistics can be used for disaster management.

## Sports

- The Tokyo 2020 Olympics were postponed due to the developing global situation in light of the Covid-19 pandemic.
- Statistics revealed that COVID cases sharply increased in Japan during the planned period of Olympics.

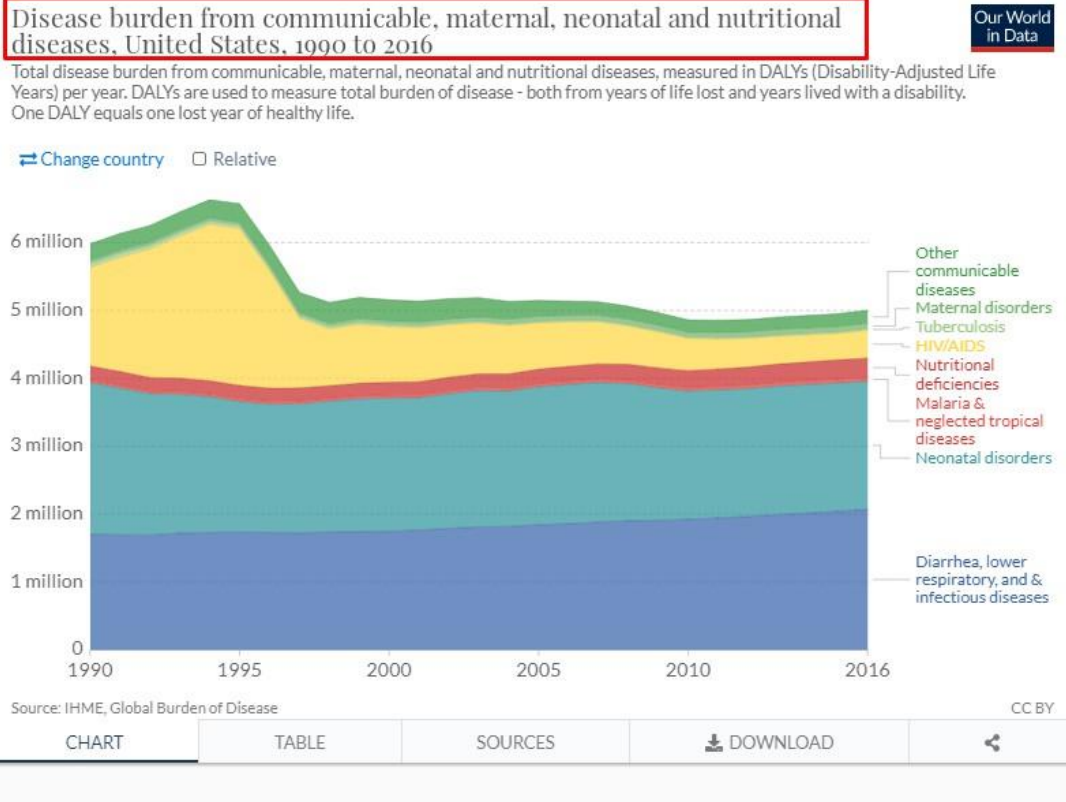


Ask learners to think of more ways in which statistics can be used in sports.

## Disease prediction

- US government uses statistics to understand which disease is affecting the population the most.

- This helps them in curing these diseases more effectively.
- Example - government can analyze the areas where COVID cases are increasing, or where the vaccination drive needs to be improved.



### Weather forecast

- Computers use statistics to forecast weather.
- They compare the weather conditions with the information about past seasons and conditions.

<i>Day</i>	<i>Max.</i>	<i>Min.</i>	<i>Forecast</i>
Sun	36°C	24°C	Sunny and hot
Mon	34°C	22°C	Sunny
Tue	30°C	20°C	Dry and cloudy
Wed	32°C	21°C	Cloudy
Thu	27°C	16°C	Rain
Fri	30°C	20°C	Light showers
Sat	32°C	21°C	Cloudy

## Few more facts

- Kids watch around 1.5-3 hours of TV per day while being in childcare.
- 72% of teens often (or sometimes) check for messages or notifications as soon as they wake up, while roughly four-in-ten feel anxious when they do not have their cellphone with them.
- 77% of children don't get enough physical exercise.
- Almost a quarter (23%) of children aged five to 16 believe that playing a computer game with friends is a form of exercise.
- 69% of all children experience one or more sleep-related problems at least a few nights a week.
- Only 54% of US children aged 3 to 5 years attend full-day preschool programs.
- At least 264 million children worldwide (about 12%) don't go to school.

### Activity 5: Car Spotting and Tabulating

Purpose: To implement the concept of data collection, analysis and interpretation.

#### Activity Introduction:

- In this activity, youth will engage in data collection and tabulation.
- Data collection plays a key role in Artificial Intelligence as it forms the basis of statistics and interpretation by AI.
- This activity will also require youth to answer a set of questions based on the recorded data.

## Activity Guidelines

### Data Collection

- Visit the following link:  
[https://www.youtube.com/watch?v=4A5L3x3TVuc&ab\\_channel=CarvingCanyons](https://www.youtube.com/watch?v=4A5L3x3TVuc&ab_channel=CarvingCanyons)
- Fill the table while watching the video using tally.

Car colour	Number of cars spotted
Red	
Black	
White	

### Reference Tally

1		6	
2		7	
3		8	
4		9	
5		10	



### Data Analysis

- How many cars are spotted in total?
- 

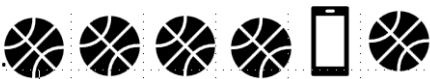
- Which colour has been spotted the maximum amount of time?


### Data Interpretation



- What is the most common colour choice for the residents of this area?
- 
- Answer hint: The colour observed the maximum number of times.
- 




## 3.3 Probability

**Purpose: To understand the possibility of occurrence of an event.**

1.  If you select an object without looking, which object are you more likely to pick?  
A. Ball                      B. Phone

2.  If you pick a fruit from above, how likely are you to pick an apple?  
A. Certainly                      B. Impossible

3.  If you select an object without looking, how likely are you to pick ?  
A. Certainly                      B. Impossible

4.  If you select a star without looking, which star are you more likely to pick?  
A.                       B. 

### Introduction to probability

Probability is a way to tell us how likely something is to happen. For example – When a coin is tossed, there are two possible results or outcomes: heads (H) or tails (T)

The probability equation defines the likelihood of the happening of an event. It is the ratio of favorable outcomes to the total favorable outcomes. The probability formula can be expressed as,

$$P(A) = \frac{\text{Number of favorable outcomes to A}}{\text{Total number of possible outcomes}}$$

Probability of an Event =

**Number of Favorable Outcomes / Total Number of Possible Outcomes**

We say that the probability of the coin landing H is  $\frac{1}{2}$  and the probability of the coin landing T is  $\frac{1}{2}$

When we talk about probability, we use a few terms that help us understand the chances for something to happen.

Probability can be expressed in the following ways:

- Certain events: An event will happen without a doubt
- Likely events: The probability of one event is higher than the probability of another event
- Unlikely events: One event is less likely to happen than another event
- Impossible events: There's no chance of an event happening
- Equal Probability events: Chances of each event happening is same

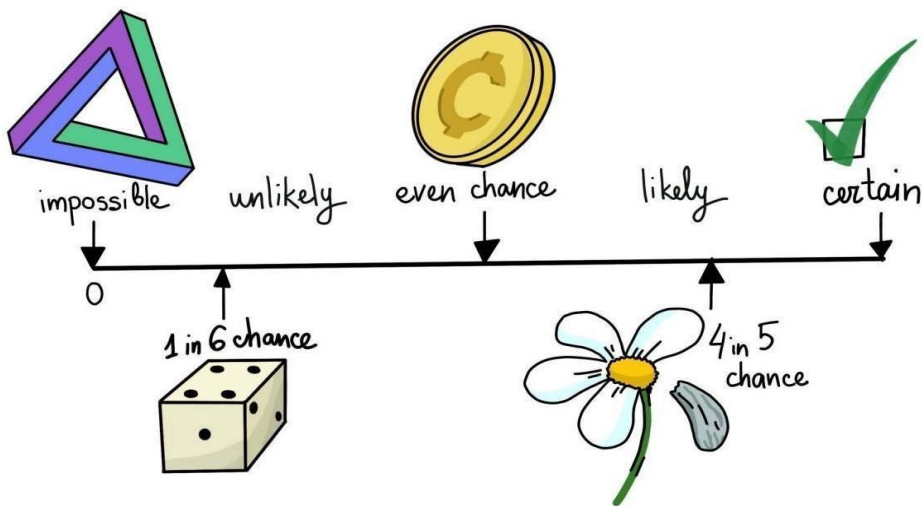
The probability of an event occurring is somewhere between impossible and certain.

- If an event is certain or sure to happen, it will have a probability of 1.

For example, the probability that it will rain in the state of Florida at least once in a specific year is 1.







- If an event will never happen or is impossible, it will have a probability of 0.

For example, the probability that you can pick a red ball from a bag containing only blue balls is 0.



Imagine you have a bag full of stars where 7 stars are  and 3 stars are .

Try to fill in the blanks with – likely, unlikely, certainly, impossible, equal probability

1. If you pick a star from the bag without looking, it is \_\_\_\_\_ that you will pick .
2. If you pick a star from the bag without looking, it is \_\_\_\_\_ that you will pick a .
3. If you pick a star from the bag without looking, it is \_\_\_\_\_ that you will pick a .
4. If you remove 4  from the bag, and pick a star without looking, there is an \_\_\_\_\_ that you will pick either  or .

5. If you pick an object from the bag without looking, you will \_\_\_\_\_ pick a star.

Let's try to understand the concept of Probability using a relatable example.

Consider a relatable scenario!

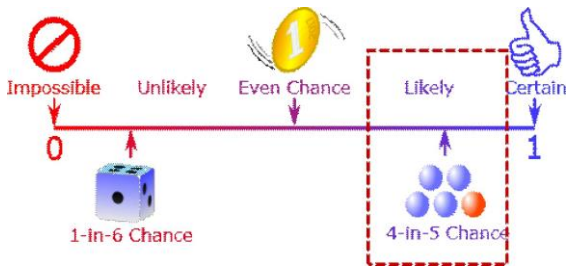
You want to go to your best friend's birthday party next Saturday. Your parents decide to make a deal with you.

### Scenario 1

If you pass your test on Friday, it is likely you will go to the birthday party.



In other words, your chances of going are greater than staying at home if you pass.

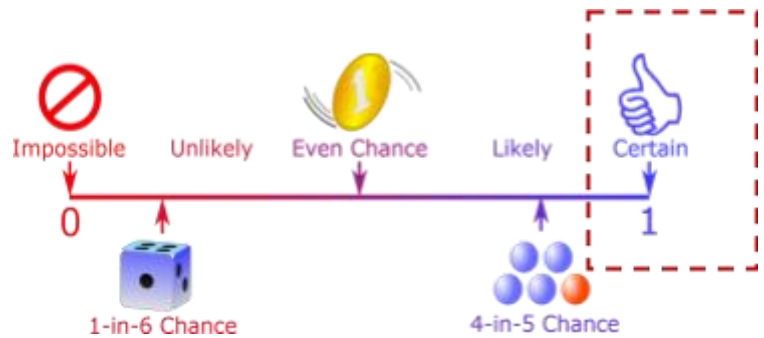


### Scenario 2

It is certain you will go to the party if you pass your test on Friday.



In other words, if you pass that test, you will go. No doubt about it!

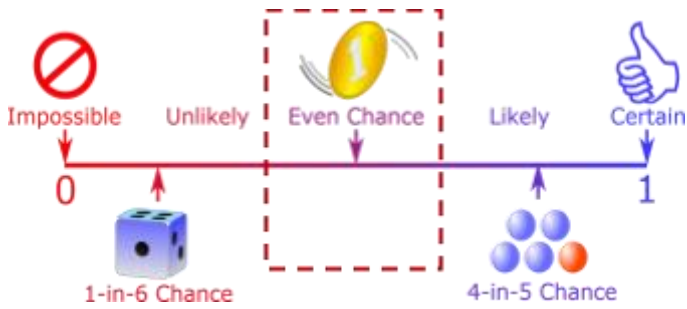


### Scenario 3

We already have plans for Saturday, there is an equal probability for you to go to the party or to stay with us, we will see on Friday.



In other words, both events can happen, and both are equally probable.

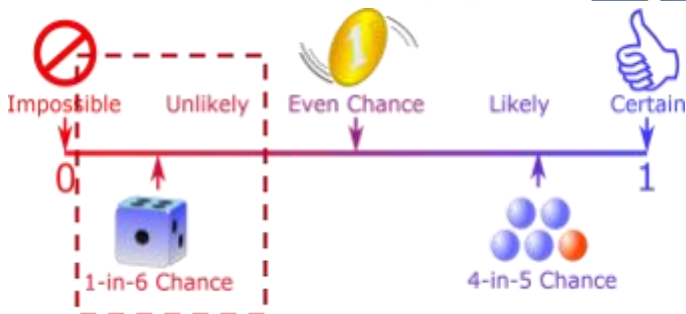


### Scenario 4

If you don't pass that test on Friday, it is unlikely you will go to the birthday party.



In other words, your chances of staying at home are higher than going to the party if you don't pass the test



Hope the terms impossible, unlikely, even, likely and certain are clearer now!  
 Moving on, take a look at some applications of Probability in Real Life!

## Probability - Applications

### Sports

- Probability can be used in estimating batting average in Cricket.
- Batting average in Cricket represents how many runs a batsman would score before getting out.
- For instance, if a batsman had scored 45 runs out of 100 from only boundaries in the last match. Then, there is a chance that he will score 45% of his runs in the next match from boundaries.



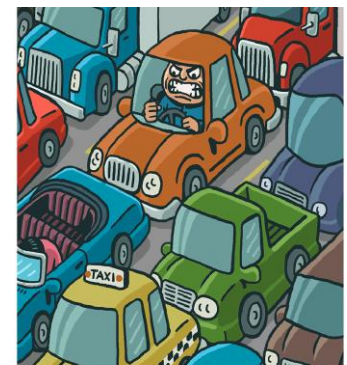
### Weather Forecasting

- One of the most common real-life examples of using probability is weather forecasting.
- It is used by weather forecasters to assess how likely it is that there will be rain, snow, clouds, etc., on a given day in a certain area.
- Forecasters may say things like “there is a 70% chance of rain today between 4 PM and 6 PM” to indicate a medium to high likelihood of rain during certain hours.



### Traffic Estimation

- Regular people often use probability when they decide to drive to someplace.
- Based on the time of day, location in the city, weather conditions, etc. people tend to make probability predictions about how bad traffic will be during a certain time.
- For example, if you think there's a 90% probability that traffic will be heavy from 6 PM to 7:30 PM in your vicinity then you may decide to wait during that time.



### Let's discuss

- Does math play a crucial role in AI life cycle?  
\_\_\_\_\_
- What is statistics?  
\_\_\_\_\_

### 3. What is probability?

#### Key Takeaway:

1. Math is essential for understanding AI models in depth.
2. Different math concepts used for AI are Statistics, Probability, Linear Algebra and Calculus.
3. Applications of math can be found in everyday life.

### Reflection

- Why is math necessary for designing an AI project?

### Revision Time

#### Part A

1. Match the following:

A

- i) Probability
- ii) Calculus
- iii) Statistics
- iv) Linear Algebra

B

- a) exploring data
- b) finding out unknown or missing values
- c) predicting different events
- d) training and improving AI model.

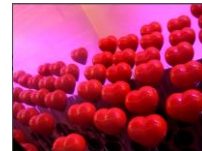
2. If you are to throw an arrow to this pie chart, in which color is the arrow more likely to fall?

- a) Red
- b) Blue
- c) Yellow
- d) Green



3. If you select a balloon without looking, how likely is it that you will pick a blue one?

- a) Probable
- b) Certain
- c) Unlikely
- d) Impossible



4. With one throw of a 6-sided die, what's the probability of getting an even number?

- a)  $\frac{1}{5}$
- b)  $\frac{2}{5}$
- c)  $\frac{5}{6}$
- d)  $\frac{1}{2}$

5. Which of the following is an equation?

- a)  $2x + 5$
- b)  $x + 2 = 4x$
- c)  $x^2 + 2x$
- d)  $5 + 5x + 5x^2$

6. What is the value of x?  $10x - 8 = 6x$

- a) 8
- b) 4
- c) 2
- d) 6

7. Which two are examples of descriptive statistics?

- a) Median and correlation.
- b) Mean and standard deviation.

- c) Mode and regression analysis.
  - d) Variance and Hypothesis testing.
8. What is the probability of getting head when you toss a coin once?
- a) 0.75
  - b) 1
  - c) 0
  - d) 0.5
9. Getting seven in die throwing is a possible event. (True/False).
10. The median of the data: 155, 160, 145, 149, 150, 147, 152, 144, 148 is
- a) 149
  - b)150
  - c)147
  - d)144

**Answer the following question:**

1. Explain the relationship between Mathematics and Artificial Intelligence, providing justification for their interconnection.
2. Aman is confused, how probability theory is utilized in artificial intelligence, help Aman by providing two examples to illustrate its importance.
3. Define Certain events and likely events with examples.
4. Write any two examples of Impossible and equal probability events.
5. Radhika collected the data of the age distribution of cases admitted during a day in a hospital.

<b>Age (in years)</b>	<b>10</b>	<b>12</b>	<b>14</b>	<b>15</b>	<b>16</b>
<b>Cases admitted (in a day)</b>	<b>5</b>	<b>7</b>	<b>9</b>	<b>22</b>	<b>11</b>

Find the average number of cases admitted in hospital. Also, draw a line graph to represent the data graphically.

6. Identify the likely, unlikely, impossible and equal probability events from the following
  - a. Tossing a coin
  - b. Rolling an 8 on a standard die
  - c. Throwing ten 5's in a row
  - d. Drawing a card of any suite