Computational Thinking and Artificial Intelligence

Class 7

Student Handbook

CENTRAL BOARD OF SECONDARY EDUCATION

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PREFACE

The National Education Policy (NEP) aims to position India as a leader in emerging knowledge fields by integrating technologies like AI, Machine Learning, Big Data, and Computational Thinking into school education. It promotes technology-enabled, interactive, and gamified learning using tools such as Augmented Reality (AR), Virtual Reality (VR), and virtual labs to foster creativity, problem-solving, and interdisciplinary exploration. NCFSE 23 carries this recommendation further for implementation.

While Artificial Intelligence (AI) is an important requirement, Computational Thinking (CT) should be a broader skill, developing a foundation for learning AI. It can cover various aspects like Cybersecurity, basic networking, etc. Hence, CBSE approaches this by integrating Computational Thinking with AI and other technological advancements, without dependence on any platform.

The book engages learners with problems involving multi-layered constraints, conditional dependencies, optimisation strategies, data interpretation and structured decision-making across numerical, spatial and real-life contexts. It deepens Artificial Intelligence understanding through concepts such as rule-based classification, data representation, bias and fairness and decision-making systems, enabling students to analyse how data, rules and assumptions influence intelligent behaviour. The document also provides pedagogical guidance, learning resources, assessment support and classroom implementation guidelines to facilitate competency-based learning in alignment with NEP 2020.

TEAM CBSE

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Introduction

Computational Thinking (CT) is a problem-solving approach that comprises Decomposition, Pattern Recognition, Abstraction, Algorithm Design, Data Analysis and Troubleshooting. Computational Thinking Skills involve solving complex problems that promote thinking skills such as critical & creative thinking, abstraction and pattern recognition, as well as algorithmic thinking. Problem identification and problem solving necessitate the application of multidisciplinary understanding for creating effective solutions.

Artificial intelligence (AI) is a cutting-edge technology that empowers machines and computers to perform tasks that usually require mimicking human intelligence. These machines can perform complex thinking processes such as data analysis, pattern recognition, prediction of trends, solving problems and decision making. Thus, AI involves simulating cognitive processes associated with human intelligence and is widely applicable in various sectors such as banking, healthcare, defence, education, entertainment, agriculture and others for processing information, solving intricate problems and for planning.

The National Education Policy (NEP) aims for India to emerge as a global leader in new emerging knowledge domains such as artificial intelligence, machine learning, data analytics, 3-D machining etc. To realise this goal, the policy suggests teaching students Mathematics and Computational Thinking, along with new subjects like Artificial Intelligence, Machine Learning, and Data Science during their school education. The policy also focuses on technology-enabled learning and classrooms by using tools like artificial intelligence, machine learning, and adaptive testing to create knowledge.

The National Curriculum for School Education draws from this policy aspiration and emphasises the need to introduce these emerging domains of study and technologies in the school curriculum. It recommends inclusion of subjects such as design thinking, augmented reality, virtual reality, artificial intelligence, and computational thinking. Additionally, it promotes the use of gamified content, interactive content, and immersive experiences (such as AR, VR, or virtual labs) to enhance student learning. In a variety of subjects, including design, music, art, and sciences, these resources support students in knowledge creation and exploration, and development of capacities such as problem-solving, critical and creative thinking.

CBSE, under the aegis of the Department of School Education and Literacy, Ministry of Education, Govt. of India, is implementing a Curriculum on Computational Thinking and Artificial Intelligence (CT & AI) to inculcate AI-readiness in school students. This curriculum will be implemented from classes 3rd to 8th, in the session 2026-27, and aims to develop AI-Ready learners, by focussing on Computational Thinking Skills. The AI-readiness, so inculcated through CT Skills, will help develop the capacities of learners to use computational thinking, such as logical thinking, problem solving, pattern recognition, and so on, and understand the role and use of Artificial Intelligence in daily life. The Curriculum aims to build strong foundations in computational thinking, digital literacy, and responsible use of technology, along with nurturing innovation, critical thinking, and ethical decision-making capacities.

1. **Relevance: Importance of introducing Computational Thinking (CT) and Artificial Intelligence (AI)**

- **Preparing for the future:** To contribute to the world of work in modern societies, individuals need capabilities such as problem solving, using data effectively, identifying patterns, and applying AI ethically for various purposes in life.
- **Holistic Development:** Study of CT and AI contributes to development of reasoning, logical thinking, creative problem-solving skills, critical thinking, ethical decision-making abilities, leading to individual flourishing. It leads to creation of responsible digital citizens in society.
- **Interdisciplinary Relevance:** Embedding CT and AI concepts in the school curriculum helps students to develop an integrated view of the world by connecting various disciplines such as Mathematics, Science, Humanities etc.
- **Innovation and Entrepreneurship:** At the core CT and AI is about solving problems, devising innovative solutions and recreating human thinking. This leads to an entrepreneurial and innovative mindset in the learners.
- **Ethical Awareness:** Study of CT & AI will sensitise learners about the misuse and bias, fairness and inclusivity in AI systems.

2. **Objectives (Curricular Goals)**

- **CG-1:** Develops skills and capacities of computational thinking, namely, decomposition, pattern recognition, data representation, generalisation, abstraction, and algorithms to solve problems where such techniques of computational thinking are effective.
- **CG-2:** Develops spatial and visual reasoning.
- **CG-3:** Gain foundational knowledge of AI, its types, and domains.
- **CG-4:** Understand key ethical terms such as bias and fairness in relation to AI.
- **CG-5:** Demonstrates proficiency to use Computer & other devices, computer applications for learning and practical purposes such as data analysis, preparation of visual representations and communication of ideas.

3. **Learning Outcomes**

Computational Thinking (CT) Learning Outcomes

ABSTRACT THINKING

Students will be able to interpret and solve complex, multi-layered problems by:

- Visualising and analysing 3D objects and their transformations, including rotations, reflections, cross-sections, and nets.
- Understanding compound transformations involving multiple flips, turns, folds, and rearrangements.
- Identifying hidden relationships and constraints within incomplete figures, patterns, or logical setups.
- Analysing symmetry, congruence, and proportional reasoning across different representations.
- Interpreting relative positions, orientations, and viewpoints of objects in advanced visual scenarios.

PATTERN RECOGNITION

Students will be able to recognise, extend, and predict complex patterns involving:

- Multi-rule numerical sequences, including alternating, nested, and dependent patterns
- Algebraic patterns using variables, expressions, and functional relationships
- Visual and geometric patterns formed through transformations or growth rules
- Letter and symbol-based patterns involving positional and logical dependencies
- Integrated patterns combining numbers, shapes, symbols, and logical conditions

DECOMPOSITION

Students will be able to break down real-world and abstract problems by:

- Separating interconnected conditions and constraints into manageable components
- Analysing number properties (factors, multiples, ratios, percentages, powers) within layered clues
- Deconstructing problems involving spatial reasoning, measurements, and geometry
- Interpreting tables, grids, charts, and flow-based information with multiple dependencies
- Breaking multi-step logical situations (movement, exchanges, comparisons, scheduling) into ordered steps
- Translating visual or verbal information into structured data for systematic analysis

ALGORITHMIC THINKING

Students will be able to design and follow logical procedures to solve advanced problems involving:

- Rule-based sequences and algorithms with conditional branching
- Grid-based navigation and pathfinding with constraints and decision points
- Step-wise transformations involving calculations, swaps, transfers, or positional changes
- Ordering and arranging elements (people, objects, events) using multiple attributes and logical clues
- Solving problems using if–then reasoning, elimination strategies, and logical consistency checks
- Creating or analysing procedural steps to reach an optimal or valid solution

Artificial Intelligence (AI) Learning Outcomes

Learners will be able to:

- Distinguish key predictive techniques such as:
  - **Regression:** The method of predicting a number based on patterns in past data
  - **Classification:** The process by which a machine arranges things in a group based on what it has learned
  - **Clustering:** The process by which a system automatically puts similar items together
- Explain about the key domains of AI, namely:
  - **Data Science:** learn to manage and extract insights from data
  - **Computer Vision:** learn the basics of how machines understand and respond to visual information
  - **Natural Language Processing:** understand the basics and limitations of how computers process and handle natural language inputs
- Explain what **bias in AI** means, and identify situations where AI can give unfair results
- Demonstrate courteous, safe, and responsible use of technology as part of good digital citizenship

- Use safe practices for maintaining data privacy, including giving informed consent before personal data is collected, used, shared, archived, or deleted
    - Collect and organise simple structured data, interpreting patterns and trends, and create bar charts, line graphs and pie charts
    - Apply basic predictive approaches/techniques to a small dataset
    - Explain uses of AI in healthcare, education, transport, and communication

4. Mapped with NEP and NCF 2023

- The National Education Policy (NEP) aims to position India as a leader in emerging knowledge fields by integrating technologies like AI, Machine Learning, Big Data, and Computational Thinking into school education
- NCFSE 23 carries this recommendation further for implementation
- Learning standards are derived using the approach suggested in and are aligned to NCF SE-2023
- Curricular Goals are derived from the Aims of Education, along with other relevant considerations

5. Time Allocation

The Middle stage (Class 6–8) suggests 100 hours annually, including the time for specific topics on basics of AI and interdisciplinary projects. For Grade 7, the breakdown is:

- **Advanced CT skills:** 40 hrs. per academic year
- **Introductory concepts of AI:** 20 hrs. in an academic year
- **Interdisciplinary projects:** 40 hrs. total (20 hrs. allocated to each of the two required projects)

6. Approach / Pedagogy

- Use hands-on and real-world problems, collaborative and group work to solidify and apply multidisciplinary foundational knowledge on Coding, Data Analysis and Artificial Intelligence tools
- Use complex puzzles, riddles and games to build on the computational thinking abilities taught in the previous stage
- Deliver fundamental concepts of AI through explanations, demonstrations and hands-on experience
- Organise group discussions, design collaborative projects that integrate CT & AI, and offer guidance to students to carry out these projects
- Independent activities for students such as data collection, organisation and analysis created using digital tools or manually
- Discussions, debates and case studies on ethical use of AI

7. Assessment

Assessment approaches move away from traditional summative assessment to continuous, formative, and competency-based assessment. Methods for Class 7 include:

- Written Tests and Practical Examinations
- Project presentations, assignments, and reflective journals

- Interactive Group activities like treasure hunts
- Teacher Observation Journal
- Thematic Projects and Reflections/Group Discussions

CT and AI Transition

- Computational Thinking (CT) forms the basis of learning AI.
- Skills like breaking problems into parts, spotting patterns, filtering essential information, and designing step-wise procedures are the same reasoning processes that power AI and ML systems.
- The curriculum begins with the introduction of CT and deepens it as we move across the stages; AI is introduced later, once pre-requisite knowledge of CT is built for understanding AI.

How to Use This Book?

PART-1 Computational Thinking

The part 1 of this handbook is designed as a companion to the Mathematics textbook and is intended to be used alongside regular classroom teaching. Since it follows the same chapter sequence, the Mathematics teacher can seamlessly integrate it into daily instruction. As concepts are introduced in class, the corresponding questions from this book can be used to deepen understanding and encourage application.

Before beginning a chapter, the teacher is encouraged to read and identify the underlying concepts required for each question and plan how to align them with classroom teaching. As these concepts are taught, the teacher can introduce the related 'thinking questions' to students. It is important to note that the questions in this book are thinking-based and designed to promote analysis, reasoning, and problem-solving.

Teachers should adopt a facilitative approach, guiding students through prompts and discussions rather than directly providing solutions. Students should be given time to think and attempt independently, followed by classroom discussions where different approaches are shared and explored.

Some chapters also include activities that build intuition and engagement. These should be conducted before attempting the questions, as they help students approach the problems with better understanding.

PART-2 Artificial Intelligence

The part-2 of the handbook provides a structured introduction to Artificial Intelligence (AI) as a technology that enables machines to learn from data, recognise patterns, and make decisions. The concepts of AI are presented using simple explanations and real-life examples from areas such as healthcare, education, transport, and communication.

Each chapter includes:

- Foundational understanding of AI concepts
- Real-life examples and applications of AI
- Introduction to key AI domains such as Data Science, Computer Vision, and Natural Language Processing
- Activities and data-based tasks
- Reflection on ethical use of AI

The AI content progresses from introduction to application, including introductory predictive techniques such as regression, classification, and clustering. The book emphasises on ethical and responsible use of AI, including introduction to bias, fairness, privacy, and safe use of technology, enabling informed and thoughtful engagement with AI systems.

Teachers should approach the book with the mindset that the process of thinking is more important than arriving at the correct answer. Creating a safe and encouraging environment where students feel comfortable making mistakes, exploring multiple strategies, and expressing their reasoning is essential. The goal is to nurture confident, independent thinkers rather than focus solely on correctness.

PART-1

COMPUTATIONAL THINKING

Chapter 1: Large Numbers Around Us

1. **'X' is a 6-digit number formed using exactly three different digits. One of the digits appears once, another appears twice, and the third appears three times. When 2 lakhs are added to 'X', the resulting number 'Y' is still a 6-digit number. What is the highest possible value of 'Y'?**

   a) 977889 b) 999999 c) 999988 d) 999887

---

2. **What is the product of all the numbers on a telephone dial-pad?**

   a) 12345 b) 32451 c) 362880 d) None of these

---

3. **Sam forms two different 6-digit numbers, X and Y, using digits from 0 to 9 (without repetition within a number). Exactly two digits are common between X and Y.**
   - **The digit 9 appears in the same position in both numbers**
   - **Y ends with 0, has only one even digit, and its digits are arranged in descending order**
   - **6 is present in X, and the number of even digits on its left is equal to the number of even digits on its right**

   If X is the largest possible number, what is the difference between X and Y?

   a) 9310 b) 9210 c) 8420 d) 8310

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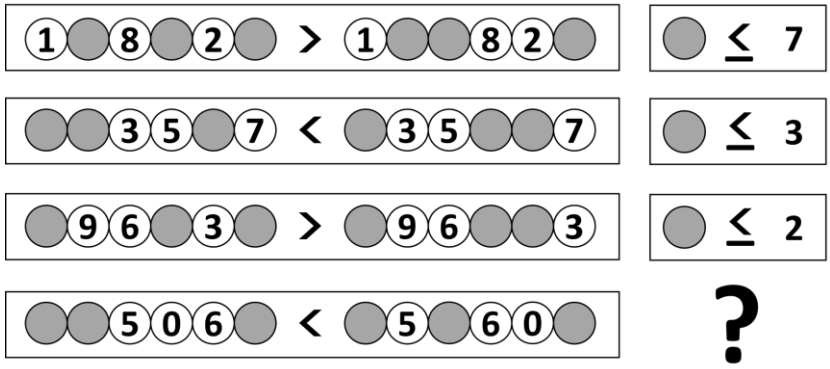
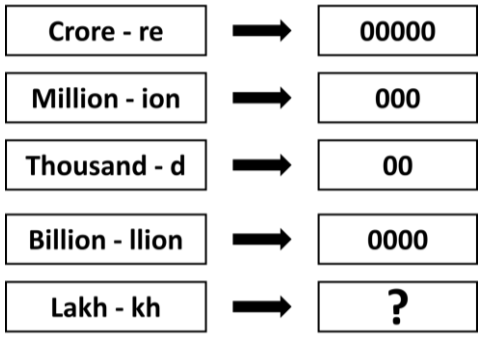
4. **If each of the rows follows the same theme, what will come in place of "?"**



a) ● ≤ 6 b) ● ≤ 4 c) ● ≤ 5 d) ● ≤ 9

---

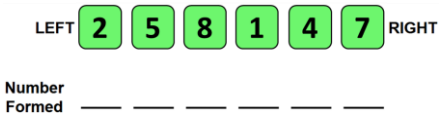
5. **What will come in place of "?"**



a) 0 b) 00 c) 000 d) 0000

6. **Six number tokens are given. Rearrange them to form a 6-digit number such that:**
   - **The difference between the first and last digits is as small as possible**
   - **The hundreds digit is double the thousands digit**
   - **No consecutive digits appear next to each other**
   - **All given tokens must be used exactly once**

   How many different 6-digit numbers between 2 lakhs and 8 lakhs can be formed under these conditions?



a) 1 b) 2 c) 3 d) More than 3

---

7. **Two five-digits numbers are formed using different digits from 0 to 9. Both numbers have some digits missing, as shown below:**
   Number 1: _ 1 _ 9 _
   Number 2: _ 4 _ 6 _
   No two consecutive digits of the number series are present in the same number.
   What is the maximum possible difference of the numbers formed?

   a) 47525 b) 52663 c) 52429 d) 46733

---

8. **A, B, C, D, and E each have a different number card among one hundred, one thousand, ten thousand, one lakh, and ten lakhs.**
   - **C has an even number of zeros in his number**
   - **A's number has 2 zeros less than C's number**
   - **D's number has 4 zeros more than A's number**
   - **The number of zeros in B is more than that of A but less than C**

   Which number card does E have?

   a) One thousand b) Ten thousand c) One lakh d) Ten lakh

---

9. **4 friends, Alex, Bob, Calvin and David have a different profession – Doctor, Lawyer, Cricketer, and Engineer and earn a different salary – ₹40,000, ₹50,000, ₹60,000 and ₹70,000 per year. (not necessarily in the same order)**
   - **The cricketer earns the highest**
   - **Alex earns more than Bob, while the doctor earns more than David, who is the engineer**
   - **Bob is the lawyer, and neither Bob nor David has an exact salary of ₹50,000**

   Which of these options shows the correct profession and salary of Calvin?

   a) Cricketer - ₹70,000 b) Doctor - ₹60,000 c) Doctor - ₹50,000 d) Doctor - ₹40,000

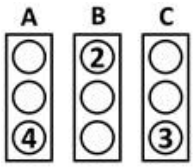
---

10. **The following are the clues to the 6-digit password of Nisha's laptop:**
    35 tens
    31 thousands
    25 ones
    423 hundreds
    14 ten thousands
    What is Nisha's password?

    a) 213625 b) 203675 c) 212375 d) 213675

The Thinking Spot

Columns A, B, and C contain 3 numbers each, such that:
- The number of times each number appears in all 3 columns combined, is equal to its value (e.g., 2 appears twice, 3 appears thrice, etc.)
- Each column contains AT LEAST TWO different numbers
If column A is the only column with THREE different numbers, then which column has the highest sum?



(a) Column A
(b) Column B
(c) Column C
(d) Both columns B and C

Chapter 2: Arithmetic Expressions

1. **Identify the odd one out from the following expressions, after INTERCHANGING their operators.**

   a) 204 + 3 ÷ 29 b) 67 - 2 × 37 c) 48 ÷ 6 × 3 d) 195 × 49 - 2

---

2. **There is a seminar from 11:00 AM to 2:00 PM, where students must spend AT LEAST 1 hour in the seminar. The table displays the number of students entering and exiting the seminar at different times. What is the MAXIMUM possible number of students who spent at least 2 hours in the seminar?**

SR. NO	TIME	IN	OUT
1.	11:00 AM	120	
2.	12:00 PM	40	60
3.	1:00 PM	80	40
4.	2:00 PM		140

   a) 60 b) 80 c) 100 d) 120

---

3. **In the given expression, '8 @ 7 - 15 < 4 × 2 × 5' which operator cannot be used in place of '@', such that the condition remains valid?**

   a) - b) ÷ c) + d) ×

---

4. **A bus has 40 seats, and some seats are already occupied, with one passenger in each seat.**
   - **At the first stop, 5 passengers get off and 8 passengers get in**
   - **At the second stop, 2 passengers get off and 4 passengers get in**
   - **At the third stop, exactly half of the passengers get off**

   After this, half of the bus seats are occupied.
   Which of the following expressions represents the number of passengers on the bus at the beginning?

   a) 5 × 5 + 5 b) 6 × 6 - 4 c) 5 × 5 + 10 d) 6 × 6 - 5

---

5. **The following expression has a whole number 'n'. If a blank can either take '×4' or '–12', what is the least possible value of 'n'?**
   Expression: (n ____ ____) ____ = 96

   a) 9 b) 18 c) 4 d) 72

---

6. **Which operators should be interchanged to get the minimum value of the given expression?**
   8 × 4 + 2 - 1

   a) × and + b) + and - c) - and × d) No change

---

7. **In certain code, 1 is coded as 2, 3 is coded as 10, 5 is coded as 26.**
   In the same way, 4 is coded as A and 6 is coded as B.
   If C is the sum of A and B, which of the following is correct regarding C?

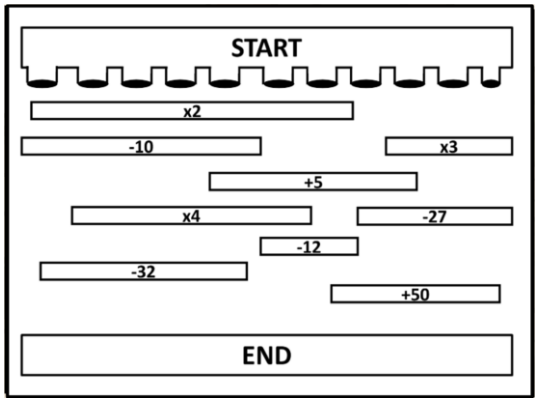
   a) C > 55 b) C < 50 c) C = 50 d) C < 55

8. In the following expression, each ball with a mathematical operator is swapped with the ball immediately to its left, to form a new arithmetic expression. What will be the value of NEW EXPRESSION - ORIGINAL EXPRESSION?

a) 63 b) 73 c) - 63 d) - 73

---

9. A stone with an initial value of 10 is dropped through one of the holes at the START and moves in a straight path to reach the END. As it passes each numbered bar along the way, its value changes according to the operation shown on that bar. What is the maximum value the stone can have when it reaches the END?



a) 60 b) 88 c) 53 d) 68

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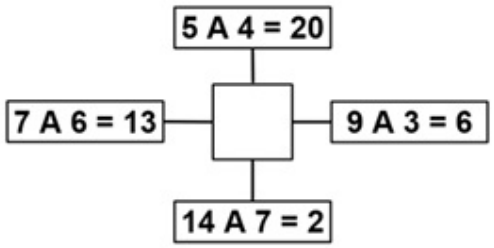
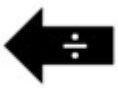
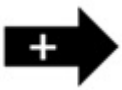
10. Each arrow has a mathematical operator. When placed in the centre box, its operator replaces the letter A in the equation it points to. Which arrow satisfies an equation based on this rule?



a)  b)  c)  d) 

The Thinking Spot

Tom, Sam, Mariya, John, and Bob each selected a shape. They placed their shapes in the grid below.

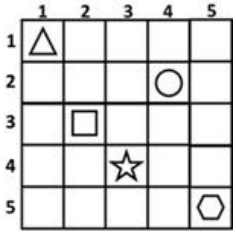
Tom's shape is neither a circle nor a triangle

Sam's shape is in column number 3

Mariya's shape is not in the first three rows

John's shape is neither square nor circle

Which of the following shapes is chosen by Bob?

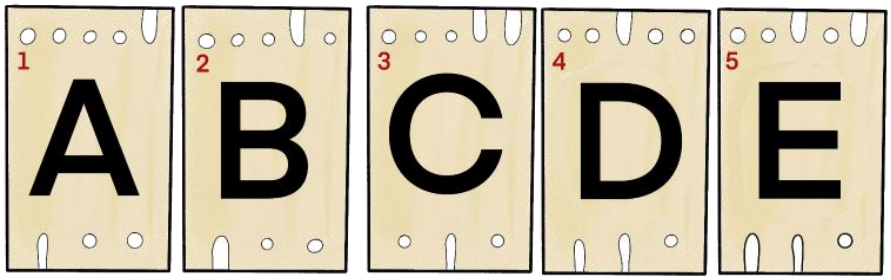


(a) Square (b) Circle (c) Hexagon (d) Triangle

Chapter 3: A Peek Beyond the Point

Activity Time

Activity: Punched Cards



Consider a set of cards with the alphabet written on them, and we shuffle them. The objective is to arrange them in alphabetical order.

One method is to find the card A first, then B and so on. This might take some time.

Now, notice that the cards have been punched on the top. There are an O-shaped and a U-shaped punch, and using these holes, we can sort the cards in an interesting way. Insert a stick in the set of cards starting from the rightmost hole. Once you lift the stick, some will come along with it. Now, bring them in front & repeat this for all sets of holes. Magically, the cards are sorted.

In our day-to-day life, we use the decimal number system, which uses the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The decimal number system is based on bundles of ten (Powers of 10 which is 1,10,100,1000,.....). Similarly, the binary number system is based on bundles of two (Power of 2 which is 1,2,4,8,.....). So, if we compare the two numbering systems for place values, this is what it looks like….

	Decimal (Bundles of Ten)	Binary (Bundles of Two)
Units Place	1	1
First Bundle	10 = 10	2 = 2
Second Bundle	10x10 = 100	2x2 = 4
Third Bundle	10x10x10 = 1000	2x2x2 = 8

The binary number system (popularly known as the language of computers) deals with only two numbers: 0 and 1. We can convert any decimal number to its binary equivalent and vice versa. You can convert any decimal number into a binary representation by writing it with the power of 2.

For example, 23 = 16 + 4 + 2 + 1.

23 in decimal	$10^1 = 10$	$10^0 = 1$
23	2	3

23 in binary	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
$(10111)_2$	1	0	1	1	1

1. What will be the binary representation for the decimal number 14?

a) 1010 b) 1100 c) 1110 d) 1111

The number of digits or bits (binary digits) in a binary number depends on the number. For example, numbers up to 7 can be represented in a 3-bit binary number, numbers from 8 to 15 in a 4-bit binary number, numbers from 16 to 31 similarly need an additional bit, hence a 5-bit binary number, and so on. There are 26 letters in English; hence, 5 sets of holes on each card for sorting.

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2. You want to perform a similar punched card activity with Hindi alphabets. How many holes are needed on each card?

a) 5 b) 6 c) 8 d) 10

Punching Pattern on the Card

Every alphabet can correspond to a number, and every number can be represented in the binary system. The following table contains the corresponding conversion from decimal to binary.

Letter	Corresponding Decimal Number	Corresponding Binary Number
A	1	00001
B	2	00010
C	3	00011
D	4	00100
E	5	00101
..	..	..
..	..	..
Y	25	11001
Z	26	11010

These binary numbers indicate to us a unique way to punch. Where there is 0, punch an O-shaped hole, and where there is 1, punch a U-shaped hole. For example: 01010 is the binary equivalent of J, so the holes on card J from left to right will be O U O U O.

---

3. Can you identify which card the binary pattern 10101 belongs to?

a) P b) S c) T d) U

---

4. The alphabet R comes 18th in the order starting from A as 1. What will be the punching pattern on Card R?

a) U0U0U b) UU0U0 c) U00U0 d) 0UU00

Punched cards, utilising binary choices is analogous to their role in powering early computing machines such as IBM sorters and Turing's Bombe. This binary concept has its roots in study of poetry in ancient India, which was well studied by Acharya Pingala's and documented in his work Chandaḥśāstra (~2 BCE).

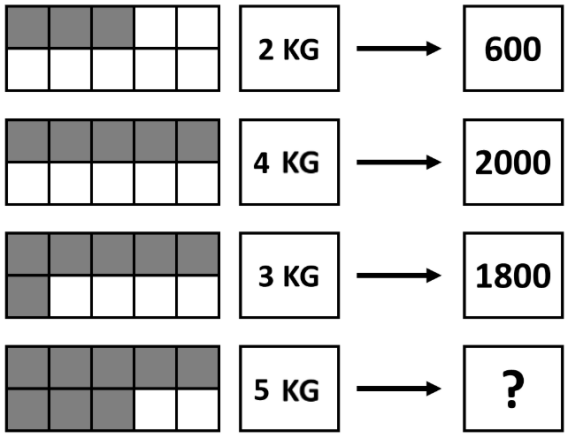
Questions

1. **Two decimal numbers differ by 3.6. In one of the numbers, the decimal point is moved one place to the right. After this change, both numbers become equal. Which was the smaller of the two original numbers before shifting the decimal point?**

   a) 0.4 b) 0.36 c) 3.6 d) 4

---

2. **What will come in place of "?"**



   a) 2000 b) 4000 c) 40000 d) 8000

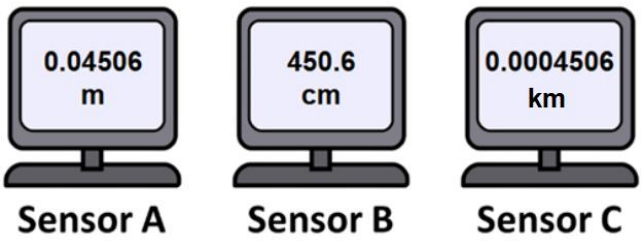
---

3. **Find the next term in the given series below:**
   85.41, 88.71, 89.01, 92.31, 92.61, 95.91, 96.21, __

   a) 96.51 b) 99.21 c) 99.51 d) None of these

---

4. **There are three sensors - A, B, and C. Each sensor displays the measurement of the length of the same item, but in different units: metres, centimetres, or kilometres. Only one sensor shows the correct length. The other two show values that are 10 times greater and 10 times smaller than the actual length (the units remain unchanged). Based on the readings shown, which sensor displays the correct length?**



   a) Sensor A b) Sensor B
   c) Sensor C d) Cannot be determined

5. What will come in place of "?" in the given series?

5	4
4.5	

,

4	4.5
4.25	

,

4.5	4.25
4.375	

,

4.25	4.375
4.3125	

,

4.375	4.3125
4.34375	

, ?

a)

4.3125	4.450
4.38125	

b)

4.3125	4.34375
8.65625	

c)

4.3125	4.34375
4.328125	

d)

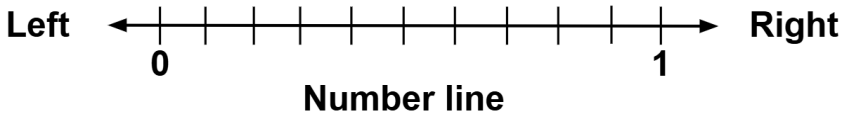
4.3125	4.375
4.32812	

---

6. Four friends A, B, C, and D each select a distinct point on the following number line (from 0 to 1) such that:

- **A's point is 4th to the right of D's point**
- **The value of C's point is at least 0.4 and B's point has the highest value among all friends**
- **No two friends choose adjacent points**

What is the LEAST possible sum of the points chosen by all of them?



Number line

a) 2.0 b) 1.9 c) 1.8 d) 1.4

---

7. Alex has to fill in the blank with a DECIMAL NUMBER formed using every digit among 0, 1, 2, 3, and 4, each exactly once, where:

- **The sum of the digits before the decimal point is equal to the sum of the digits after the decimal point**
- **The digits before the decimal point are in descending order and the digits after the decimal point are in ascending order**
- **The conditions of "<" are satisfied**

How many different numbers can be placed in the blank?

34.201 < _____ < 412.03

a) 2 b) 3 c) 4 d) More than 4

---

8. Raj measures the lengths of two objects, Object A and Object B, using a ruler marked in centimetres.

- **On Day 1, Object A measures 5.2 cm. Its length decreases by 1 line on Day 2, 2 lines on Day 3, 3 lines on Day 4, and so on, following the same pattern**
- **On Day 1, Object B measures 1.2 cm. Its length increases by 1 line on Day 2, 2 lines on Day 3, 3 lines on Day 4, and so on, following the same pattern**

On which day will the difference between the lengths of the two objects be the least?

Note: *The scale is in centimetres*

a) Day 3 b) Day 4 c) Day 5 d) Day 6

9. Some numbers are given in the boxes below. In each number, interchange the digits immediately to the left and right of the decimal point. After making this change, how many boxes will contain a number greater than 498.540?

491.893	497.860	491.855	490.993
A	B	C	D

a) 1 b) 2 c) 3 d) 4

---

10. Seven decimal numbers, A-G, are given.

1. **Arrange the numbers in ascending order to form Arrangement 1**
2. **Modify the numbers as follows:**
   - **For numbers in odd positions, move the decimal point one place to the right**
   - **For numbers in even positions, move the decimal point one place to the left**
3. **Arrange the modified numbers again in ascending order to form Arrangement 2**

In Arrangement 2, which pair(s) of numbers have exactly three numbers between them?

0.05, 0.505, 5.05, 5.55, 0.55, 5.005, 0.005

A B C D E F G

a) A and E b) G and D c) C and F d) E and D

The Thinking Spot

The numbers given below are to be placed in the grid in such a way that the sum of two adjacent numbers in the grid should be greater than 9 but less than 17. What will come in place of A and B?

Numbers: 2, 3, 5, 11, 15

14			A	8	B	12	1	

(a) A = 5 and B = 2
(b) A = 3 and B = 5
(c) A = 2 and B = 3
(d) A = 5 and B = 3

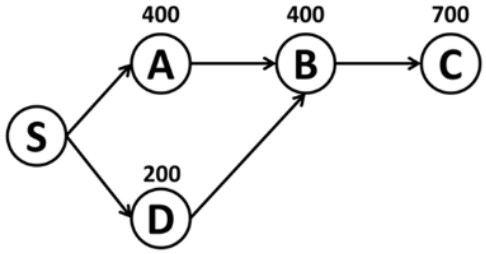
Chapter 4: Expressions using Letter-Numbers

1. **It is given that x means 'greater than', $ means 'equal to', < means 'not less than', A means 'less than' and + means 'not greater than'. Which of the following options has the same meaning as the given expression?**
   a x b A c

   a) a $ c A b b) b < a x c c) c x b A a d) c + b < a

---

2. **A factory 'S' sends goods to four cities: A, B, C, and D through pipelines (represented by arrows), as shown below. The demand of each city is mentioned above that city** *(for example, the demand at City A is 400 units)*. **The demands are satisfied exactly, and no extra units are left in the pipelines. If 300 units are sent through the pipeline from A to B, how many units are sent from D to B?**



   a) 200 b) 600 c) 800 d) 1000

---

3. **Each letter in Set 1 corresponds to exactly one different number from Set 2 (in any order).**
   Set 1: A, B, C, P, Q, R
   Set 2: 1, 2, 4, 5, 7, 9
   The following conditions are given:
   - **A and C are consecutive numbers, with A > C**
   - **P + Q = R, with P > Q**
   - **B is greater than both A and C**

   Using this information, find the value of: (4P+3B) − (2P+3C) + (2A−3B)

   a) 9 b) 13 c) 15 d) 11

---

4. **The sum of the ages of four people A, B, C, and D is 35. Each one of them is at least 8 years old. What is the MAXIMUM possible age of the oldest person?**

   a) 9 years b) 10 years c) 11 years d) 12 years

---

5. **3 whole numbers A, B, and C, satisfy the given conditions. At maximum, how many different possible values can C have?**

   A > B > C and A + B = 10

   a) 4 b) 5 c) 3 d) 2

---

6. **If the sum of the ages of Shubham and Shivam is 36. What would be the sum of their ages after 36 years?**

   a) 108 b) 136 c) 72 d) 96

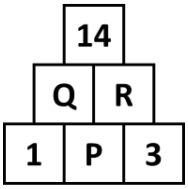
7. **A, B, and Z are natural numbers such that A + B = Z and:**
   - **The value of B is twice the value of A**
   - **The value of B is greater than 4**
   - **The value of Z is less than 10**

   What could be the value of A?

   a) 1 b) 2 c) 3 d) 4

---

8. **In the given image, each number equals the sum of the two numbers immediately below it. If P, Q, and R are unknown, what is the value of P × Q + R?**



   a) 42 b) 48 c) 38 d) 36

---

9. **5A, 5B, and C9 are 2-digit numbers, where A, B, and C represent one of the digits of the respective numbers, and A + B + C = 15. Find the MAXIMUM possible value of 3B + 4C + 8, if:**

$$5A > 5B > C9$$

   a) 43 b) 39 c) 31 d) 36

---

10. **All the cells having 'x' in the given calendar represent dates that are consecutive multiples of a particular number. The first 'x' represents the first Thursday of the month, as shown below. Which of the following is the last day of the month?**

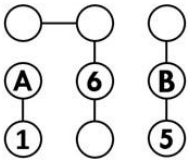
November

MON	TUE	WED	THU	FRI	SAT	SUN
			X			
		X				
	X					
X						

   a) Monday b) Sunday c) Saturday d) Friday

The Thinking Spot

Numbers from 1-9 are to be placed in the grid such that no two consecutive numbers are placed adjacent to each other.
For example, the bottom-left circle has 1, so the circle above it and the circle on the immediate right cannot have the number 2.
Each group of circles which are inter-connected by lines must contain either only odd or only even numbers.
Find the values of A and B.



(a) A = 9 and B = 3 (b) A = 3 and B = 9 (c) A = 7 and B = 3 (d) A = 9 and B = 8

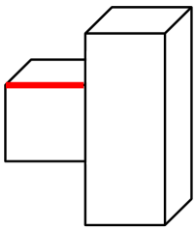
Chapter 5: Parallel and Intersecting Lines

1. **Each side of a square is divided into three equal parts by marking points on it. Using these points as endpoints, line segments are drawn inside the square, such that each line segment is parallel to at least one side of the square. What is the maximum number of squares that can be found in the resulting figure?**

   a) 6 b) 9 c) 14 d) 16

---

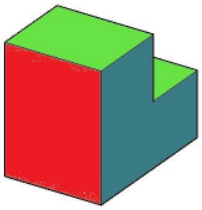
2. **The following arrangement is formed using a cube and a cuboid. How many edges are parallel to the edge highlighted by the red line?**



   a) 5 b) 6 c) 7 d) 8

---

3. **In the following solid, every edge has at least one other edge parallel to it. How many different pairs of PARALLEL FACES are present in the solid?**



   a) 8 b) 7 c) 6 d) 5

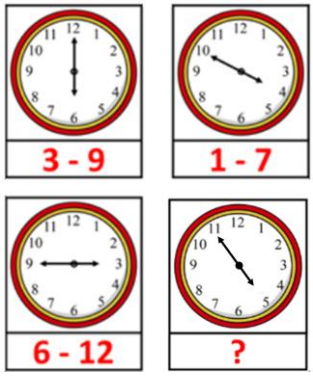
---

4. **In a clock, the hour hand and the minute hand are perpendicular to each other, where the minute hand is at 12. How many different possible positions the hands of the clock can have at this time?**

   a) 1 b) 2 c) 3 d) 4

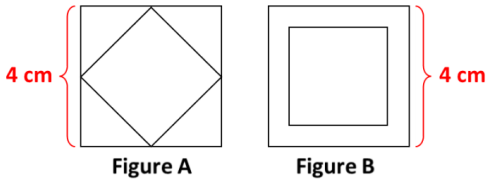
---

5. **If each of the given terms follows the same theme, what will come in place of "?"**



   a) 7 - 1 b) 2 - 8 c) 1 - 8 d) 5 - 11

6. **Figures A and B are formed using two transparent squares, each. If figure A is placed on top of figure B (without rotation), such that it completely overlaps figure B, how many right-angled triangles can be seen in the resultant image?**



a) 10 b) 12 c) 13 d) 14

---

7. **In triangle ABC, BC is the base.**
Point P lies on AB and point Q lies on BC such that PQ is parallel to AC.
Point R lies on AB and point S lies on AC such that RS is parallel to BC.
Lines PQ and RS intersect at a point O inside the triangle.
Which of the following quadrilaterals must be a parallelogram?

a) QPAC b) ORBQ c) QOSC d) SAPO

---

8. **Two lines intersect at point K.**
One angle is (ax − 10)° and its vertically opposite angle is (bx + 20)°.
Which of the following is DEFINITELY true?

a) a = b b) a ≠ b c) x = 10 d) a + b = 0

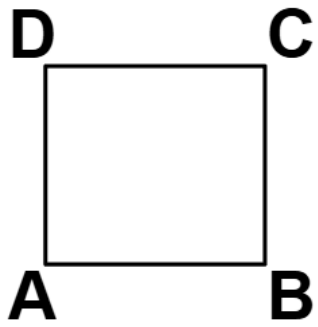
---

9. **A computer draws two intersecting lines. One angle formed at the intersection is 70°, but originally, it was intended to be 40°. Which of the following options shows the respective 'Expected and Resultant' measures of one of the other angles?**

a) 140 degrees and 110 degrees
b) 110 degrees and 140 degrees
c) 140 degrees and 170 degrees
d) 170 degrees and 140 degrees

---

10. **ABCD is a square of side length 4 m. Raj starts from point A and walks North to reach point D. From point D, he further walks 4 m without taking any turns and reaches point P. At P, he turns 135° clockwise and walks a certain distance and stops only when he reaches a point on the square. Which of the following statements is INCORRECT with respect to the boundary of the square and the path taken?**



a) PC ∥ DB b) ∠PCD = ∠DCA c) PC ≠ AC d) ∠DPC = ∠DCP

The Thinking Spot

A, B, and C are all different numbers having any value among 1, 2, and 5. What will come in place of C so that no two consecutive numbers are placed next to each other in any direction (vertically, horizontally, or diagonally)?

	C	3	
B	8	A	7
	6	4	

(a) 2 (b) 1 (c) 5 (d) None

Chapter 6: Number Play
Activity Time

Introduction

Solving puzzles always seems complex. But have you wondered how computers solve puzzles? We will see a simplified way to solve some puzzles by following simple instructions and using the binary computer language. This will give us insight into how we can break complex problems into smaller pieces that can be easily solved. By combining smaller problems, computers can solve a larger one.

Activity: Logical puzzle punch cards

In this activity, you will use punched cards to solve logical puzzles. By stacking, aligning, and filtering the cards, we will see how complex reasoning can be built from simple decisions - **True** or **False**, mirroring how binary logic works inside a computer.

The scenario is that you have the following lights in the room: **Yellow Y, Pink P, Red R, Green G,** and **Blue B**. By following the clues given in the **Case Cards**, you have to figure out which lights are **ON** in the given Puzzle. To solve these puzzles, we have a deck of cards representing all possible combinations of these lights being **ON** or **OFF**.

Understanding the cards

To solve these puzzles, we have a deck of cards representing all possible combinations of these lights being **ON** or **OFF**. Each card has five positions for holes on the top, and each position corresponds to a coloured light mentioned above in the given order.

Each position has two possible hole types: **U-shaped** or **O-shaped**. Each card represents one possible combination. If a light is **ON** in a card, then the hole corresponding to it is **U-shaped**. If a light is **OFF** in a card, then the hole corresponding to it is **O-shaped**.

Eg: **Yellow Y** is **OFF**, **Pink P** is **ON**, **Red R** is **ON**, **Green G** is **OFF**, **Blue B** is **OFF** is the card where the holes are **O U U O O**.

Each hole, thus, has 2 possible states. If we have two holes, then we have $2 \times 2 = 4$ possible states. Likewise, if we have 3 holes, we have $2 \times 2 \times 2 = 8$ states. Therefore, if we have 5 holes, we will have $2 \times 2 \times 2 \times 2 \times 2 = 32$ states. That is the number of distinct cards we have.

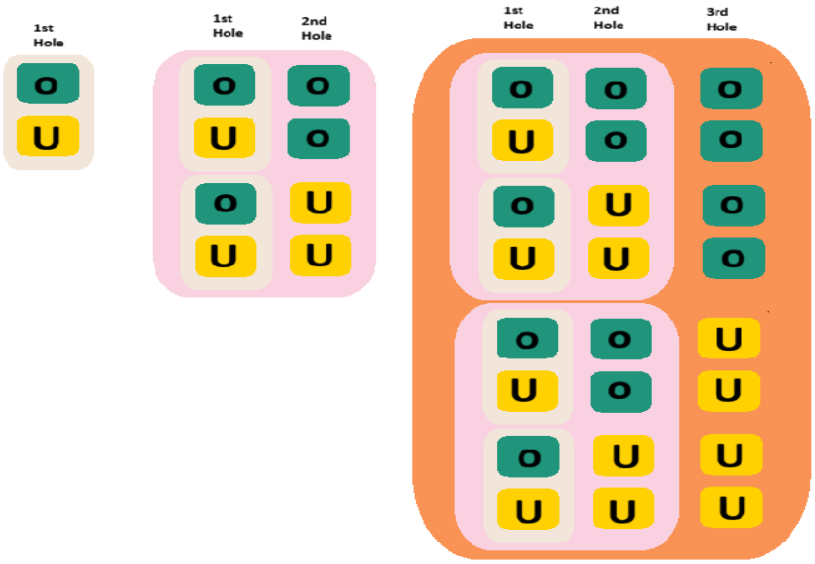


Figure: All the possible three-hole states and how they come from the two-hole states

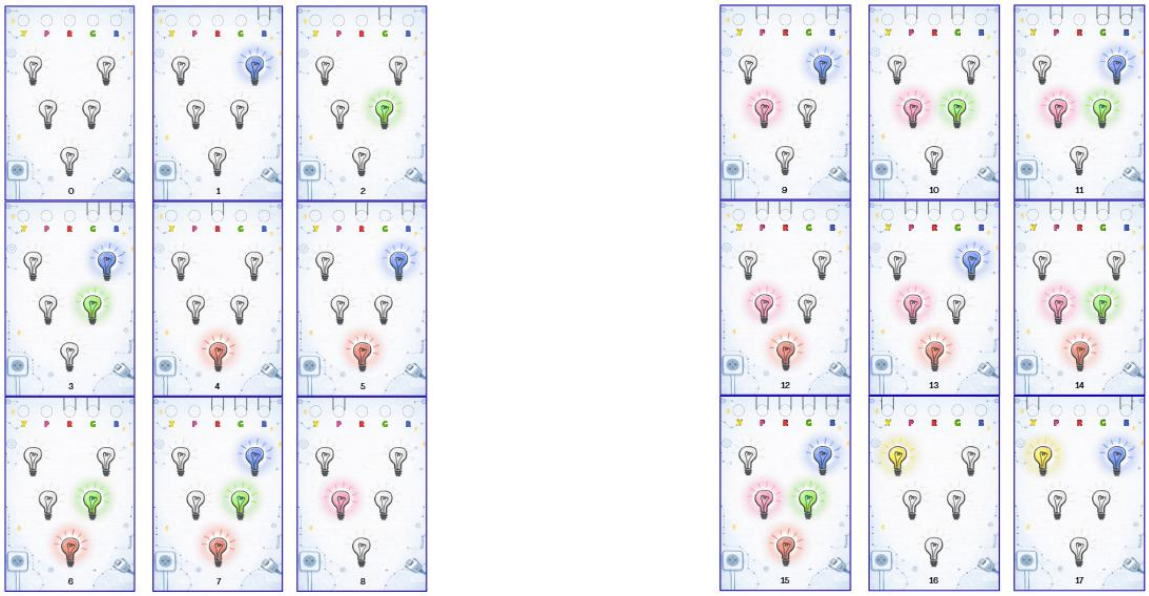


Figure: Some possible cards with 5 binary digits

Procedure

If the puzzle says a light is **ON**, we need to remove all cards where that light is **OFF**. For that, we put the stick into the deck of cards through the hole corresponding to that light and pull out all the cards that get stuck to it. We remove these cards because they got stuck due to **O-shaped** holes that indicate the light is **OFF**.

If we know some light is **OFF** in the puzzle, we remove all the cards that do not come out with the stick; these are the cards with **U-shaped** holes in positions corresponding to the given colour, which indicate that the light is **ON**.

Ensuring the above helps us solve the logical puzzles through punch cards.

Let's get familiar with the cards and the rules.

1. **Can you identify which bulbs are 'OFF' based on the card?**

a) **Blue B** and **Yellow Y** bulbs

b) **Green G** and **Red R** bulbs

c) **Red R** and **Yellow Y** bulbs

d) All bulbs are OFF

Understanding using a case

The operation of the cards is explained by showing how they can be used for solving a problem in two-valued logic.

We can start by taking **Case 1**, which contains the first 8 cards from 0 to 7, and focus only on the **Red R, Green G,** and **Blue B** lights. Three statements are given containing simple assertions and negation statements. The aim is to determine which bulbs are on or off among these.

To solve this problem, let's establish some notation. Only three terms are involved, so we shall be concerned with only the **Red R, Green G,** and **Blue B** holes.

Red bulb '**ON**', 1st position will be **U**	**Red** bulb '**OFF**', 1st position will be **O**
Green bulb '**ON**', 2nd position will be **U**	**Green** bulb '**OFF**', 2nd position will be **O**
Blue bulb '**ON**', 3rd position will be **U**	**Blue** bulb '**OFF**', 3rd position will be **O**

If all lights are **ON**, then **RGB = U U U**
If all lights are **OFF**, then **RGB = O O O**
If **Red** is **OFF, Green** is **ON, Blue** is **OFF**, then **RGB = O U O**
If **Red** and **Green** are **ON,** but **Blue** can be anything, then **RGB = U U X**

---

2. **Can you identify which bulb is OFF based on this pattern: RGB = U U O?**

a) **Red** bulb b) **Green** Bulb c) **Blue** Bulb d) All bulbs are OFF

Case 1: Focusing on RGB cards only (with 8 cards only)

Statements
I. The **Red** light is **ON**
II. The **Blue** light is **OFF**
III. **ON** light only has **OFF** Neighbour
The problem has three statements.

- *The statement **I**: "The **Red** light is **ON**"*

Insert the stick in the **R** position and lift.
The stick will raise all **RGB = O X X** cards: All cards where **Red** is **OFF**.
RGB = O X X cards are discarded.

All remaining cards are assembled into a pack once more (in any order), and we are ready for the second statement.

---

3. After performing an action using Statement I, how many cards are left in the pack?

a) 8 b) 4 c) 2 d) 1

- *The second statement, **II**, "The **Blue** light is **OFF**"*

---

4. After performing the action using Statement II, among these, which card will not be discarded?

a) **RGB = X X O** b) **RGB = U O U** c) **RGB = X X U** d) All will be eliminated

Correct answer: a. **RGB = X X O**
Explanation: We discard all the cards where **Blue** light is **ON**, **RGB = X X U,** and keep those cards where **RGB = X X O.**
Competencies: Algorithmic thinking, decomposition, pattern recognition

All remaining cards are assembled into a pack once more (in any order), and we are ready for the third statement.

- *The third statement, **III**, "**ON** light only has **OFF** Neighbour"*

After this action, only one card will be left, and that will be the solution to the logical puzzle.

5. **What is the pattern of the last card (solution)?**

a) **RGB = U U O** b) **RGB = U O U** c) **RGB = O U U** d) **RGB = U O O**

Case 2: Focusing on RGB cards only (with 8 cards only)

Statements

I. The **Red** light is **ON**

II. The Lights are either all **ON** or all **OFF**

---

6. **Among these, what would be the pattern of the solution?**

a) **RGB = U O O** b) **RGB = O O O** c) **RGB = U O U** d) **RGB = U U U**

More Puzzles

Below are three progressively harder cases. They introduce additional logic and multi-step filtering to mimic advanced truth-table-based reasoning. Each ends with one solution card.

Questions

1. **Form the largest four-digit odd number by selecting exactly one digit from each row and each column. What is the sum of the digits?**

7	4	5	3
6	9	2	6
5	1	3	2
8	9	7	4

a) 21 b) 22 c) 23 d) 24

---

2. **In the given image, S, T, and N represent distinct single-digit numbers, where T > S. What is the value of N + S?**

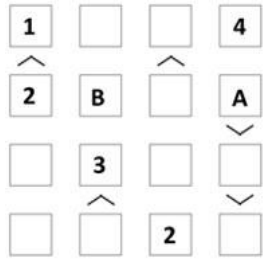
	S	T	6
+	T	S	N
1	7	6	8

a) 13 b) 12 c) 9 d) 11

---

3. **Each square of the given puzzle must be filled with a single-digit natural number such that:**
   - **The sum of all four different digits in each row and each column is 10**
   - **All the inequality signs (< and >) between the boxes must be followed**

   Find the correct values of A and B.



a) A = 3, B = 4 b) A = 2, B = 1 c) A = 1, B = 4 d) A = 3, B = 1

---

4. **How many cells contain a digit equal to the sum of all the other digits in its corresponding row and column combined?**

3			6
1	2	3	
	4		2
5			1

a) 2 b) 3 c) 4 d) 5

5. **Using the digits 1, 2, 3, and 4, form the highest and the smallest three-digit numbers such that each number contains exactly two different digits. What is the sum of the two numbers formed?**

a) 545 b) 555 c) 565 d) 575

---

6. **A 2-digit number is formed using two different digits, and the digits are reversed to create another 2-digit number. The difference between these 2 numbers CANNOT be:**

a) An even number b) An odd number c) A prime number d) An integer

---

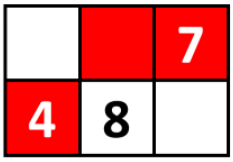
7. **A four-digit number has the same number of even and odd digits. Which of the following could possibly be the sum of the digits of this number?**

a) 11 b) 15 c) 20 d) All of these

---

8. **The given grid is to be filled with distinct single-digit natural numbers such that:**
   - **The sum of each row is the same and is an even number**
   - **The larger number in each column is placed in the red block**

   What is the sum of the numbers in the white blocks?



a) 16 b) 17 c) 15 d) 20

---

9. **A computer generates rectangles where the length and breadth (dimensions) follow a series. If the pattern continues, what will be the area of the next rectangle the computer should draw?**

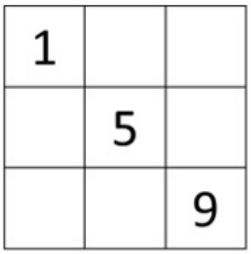
   $2 \times 3, 3 \times 5, 5 \times 8, 8 \times 13, 13 \times 21, ?$

a) 693 sq. units b) 2210 sq. units c) 442 sq. units d) 714 sq. units

---

10. **Given below is a 3 × 3 grid to be filled by numbers from 1 to 9 such that:**
    - **Every pair of adjacent digits in a row should have a difference of three**
    - **Some of the numbers have already been placed**

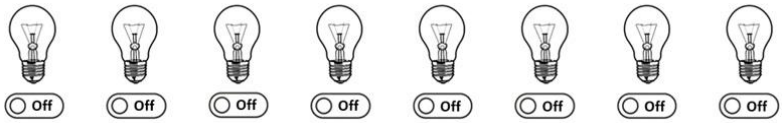
    Based on the given conditions, choose the correct option.



a) A row can have all numbers as even b) A row can have all numbers as odd
c) A row can have 2 even and 1 odd number d) All of these

The Thinking Spot

Given below are bulbs, each with a switch beneath it. When you press a switch, it lights up ONLY the adjacent bulbs and not the bulb above the switch. What is the minimum number of switches you need to press to light up all the bulbs?



(a) 2 (b) 3 (c) 4 (d) 5

Chapter 7: A Tale of Three Intersecting Lines

1. **If the sides of an equilateral triangle and that of a square are of equal length, what can you say about the area of both the shapes?**

   a) The area of the square is the same as that of the triangle
   b) The area of the triangle is greater than that of the square
   c) The area of the square is greater than that of the triangle
   d) None of these

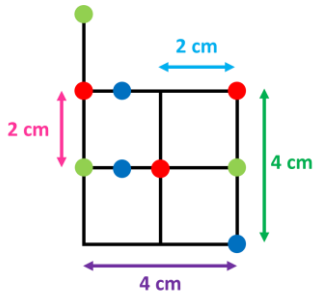
---

2. **Three identical pieces of paper, each in the shape of an equilateral triangle, are joined together edge to edge, with no gaps or overlaps. Which of the following figures can be formed by joining them?**

   a) Rhombus b) Trapezium c) Hexagon d) Triangle

---

3. **If dots of the same colour are connected to form triangles, which triangle is not formed by any coloured dots?**



   a) Right-angled triangle b) Obtuse angled triangle
   c) Equilateral triangle d) Isosceles triangle

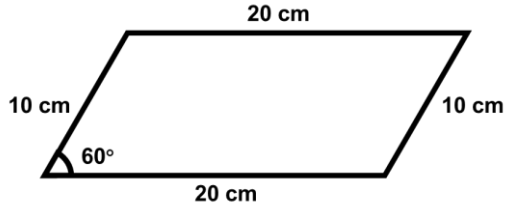
---

4. **Is the given triangle isosceles, scalene, or equilateral?**
   Information 1: The given triangle is similar to a right-angled triangle
   Information 2: The given triangle is not a scalene triangle
   To answer the given question, which of the given information is/are sufficient?

   a) Only 1
   b) Only 2
   c) Both 1 and 2 together
   d) Question cannot be answered even if both pieces of information are used

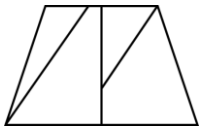
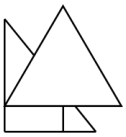
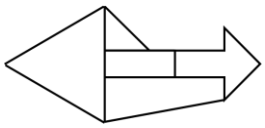
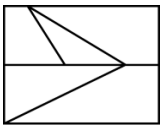
---

5. **At least how many folds are required to convert the given paper sheet into an equilateral triangle?**



   a) 1 b) 2 c) 3 d) 4

6. **Each option contains exactly two types of triangles from the following: a right-angled triangle, an equilateral triangle, and a scalene triangle. Which option contains both a right-angled triangle and an equilateral triangle?**
   Note: *Consider only those triangles whose all three sides are clearly visible*

a)  b)  c)  d) 

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7. **An isosceles triangle has a perimeter of 23 cm and all its side lengths are whole numbers. The two equal sides are multiples of 3. How many different possible lengths can the third side have?**

   a) 1 b) 2 c) 3 d) 4

---

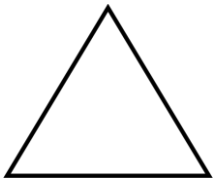
8. **Two triangles, triangle X and triangle Y, are given. Only partial information about their corresponding sides and angles is provided below.**
   Question: Are triangles X and Y similar?
   Information 1: Two pairs of corresponding sides of triangle X and triangle Y are proportional, but no information is given about the third pair of corresponding sides.
   Information 2: Two pairs of corresponding angles of triangle X and triangle Y are equal, but no information is given about the third pair of corresponding angles.
   To answer the given question, which of the given information is/are sufficient?

   a) Only 1
   b) Only 2
   c) Both 1 and 2 together
   d) Question cannot be answered even if both pieces of information are used

---

9. **An equilateral triangle is given. Inside it, two straight lines are drawn in any direction. If the triangle is cut along these two lines, what is the maximum number of right-angled triangles that can be formed?**

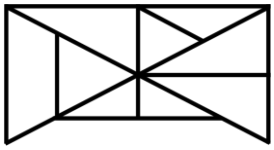
   Note: *You cannot form a triangle by joining two or more pieces.*



   a) 2 b) 3 c) 4 d) 5

---

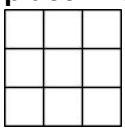
10. **How many right-angled triangles are there in the given figure?**



   a) 7 b) 8 c) 9 d) 10

The Thinking Spot

A 3 x 3 grid is shown below. You need to place some circles in the cells without making three in a row, column, and diagonal. How many circles at maximum can you place in the grid?



(a) 5 (b) 4 (c) 6 (d) 7

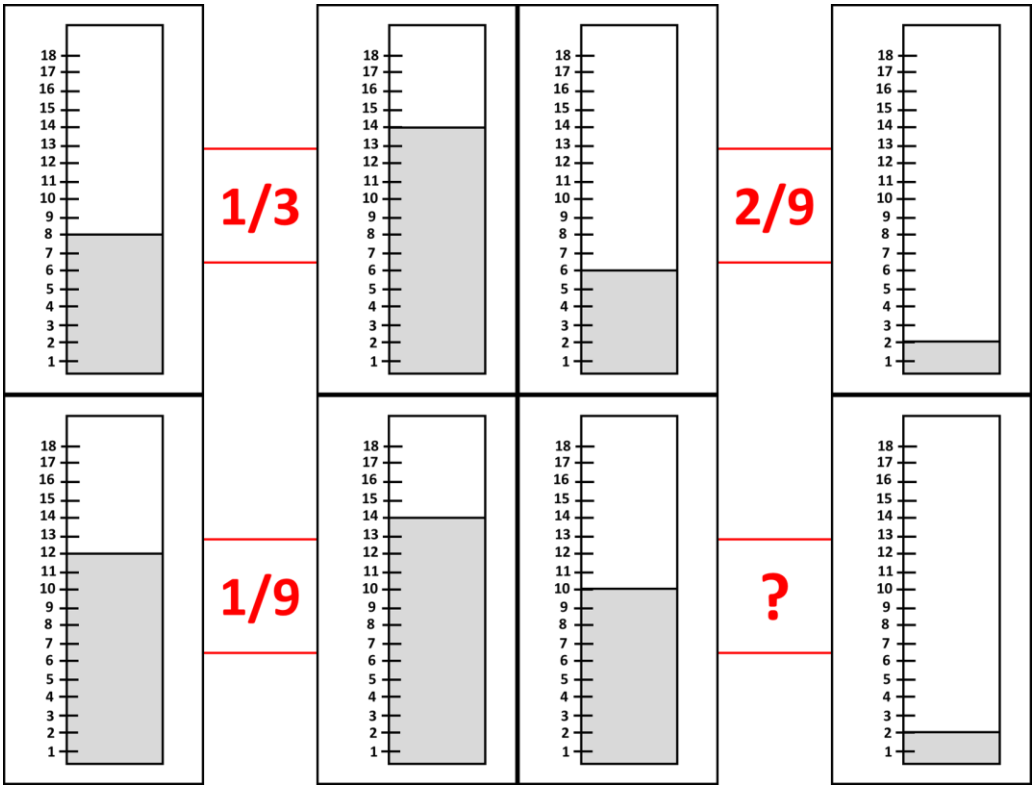
Chapter 8: Working with Fractions

1. **Samuel received chocolates for his birthday. He decided to share it with his family.**
   - He keeps 1/3rd of the chocolates for himself
   - He gives 1/4th of what is left to his sister Sarah
   - He gives the remaining 12 chocolates (except the ones which he kept for himself) to his brother
   How many chocolates had Samuel received in total before he shared it?

   a) 20 b) 22 c) 24 d) None of these

---

2. **If each of the given terms follows the same theme, what will come in place of "?"**



a) 2/9 b) 2/3 c) 4/9 d) 1/9

---

3. **A bus started its journey from Mumbai.**
   - 1/4th of the passengers got off the bus in Pune and 35 new passengers got on the bus
   - Half of the passengers got off the bus in Goa with no new passengers getting on the bus
   When the bus left from Goa, the total number of passengers was 85. How many passengers boarded the bus from Mumbai?

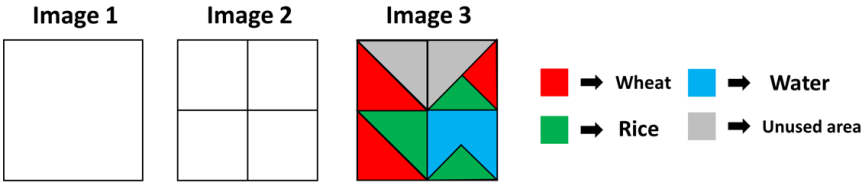
   a) 135 b) 170
   c) 180 d) Cannot be Determined

4. **Which of the following statements is/are sufficient to answer the given question?**
Question: What fraction of the initial liquid remains in the vessel after Day 2?
Statement 1: The vessel originally contained 100 litres of liquid
Statement 2: On Day 1, the amount of liquid that evaporates is equal to half of the quantity that would remain if one-third of the initial liquid were removed
Statement 3: On Day 2, the liquid left in the vessel becomes one-fourth of the quantity that was present at the beginning of Day 2

a) Statement 3 alone is sufficient
b) Both Statement 1 and Statement 2 are necessarily required
c) Both Statement 2 and Statement 3 are necessarily required
d) Question cannot be answered even if all the Statements are used

---

5. **A farmer has a square farm as shown in Image 1. He divides it into 4 equal parts as shown in Image 2. Now, he allotted certain portions of land for specific purposes (Rice crop, Wheat crop, Water) and some part of the farm is unused, as shown in Image 3. What fraction of the new farm is occupied by wheat?**



a) 3/16 b) 1/4 c) 5/16 d) 6/16

---

6. **A wire is bent to form a rectangle with length L and breadth B. After some time, the length is increased by one-fifth of its original value, and the breadth is decreased by one-fifth of its original value. After this change:**
   - **The perimeter of the rectangle remains the same**
   - **The area of the rectangle decreases by 100 sq. cm**

What was the original length of the rectangle?

a) 25 cm b) 40 cm c) 45 cm d) 50 cm

---

7. **A number sequence is mentioned below:**
19/2,38/6,76/18,152/54,…
Which will be the first term of the series that will be less than 1?

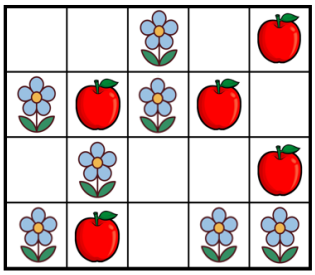
a) 7th term of the series
b) 8th term of the series
c) 10th term of the series
d) None of these

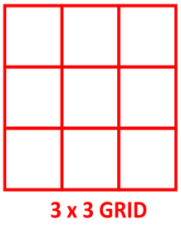
---

8. **A box has 98 chalks. Each day, a teacher picks up a chalk to write.**
When a chalk becomes 1/7 of its original size, she sets it aside.
Whenever she collects enough such small pieces to make one full chalk, she joins them and uses it. For how many days will the 98 chalks last?

a) 84 b) 98 c) 112 d) 114

9. **A grid contains apples and flowers in some of its cells. A 3 × 3 square frame can be placed on the grid without rotating and without extending outside the grid, covering exactly 9 cells. In how many different positions can the frame be placed so that at least one-third of the covered cells contain flowers?**





a) 3 b) 5 c) 4 d) 6

---

10. **Each circle is divided into equal parts, with some parts shaded. A fraction is written to the right of each circle. How many of these fractions correctly represent the shaded part of their corresponding circles?**

a) 4 b) 3 c) 2 d) 5

The Thinking Spot

You have a collection of 10 different squares arranged as shown below. What is the minimum number of pairs of squares you need to interchange to ensure that white and black squares are arranged alternately?

Note: *If you swap 1 black square with 1 white square, it is counted as 1 PAIR OF SQUARES being swapped*

(a) 1 (b) 2 (c) 3 (d) 5

PART-2
ARTIFICIAL INTELLIGENCE

Chapter 1. AI Domains and Applications

Before moving ahead, let us briefly revisit some important ideas about Artificial Intelligence and data.
Intelligence is the ability to learn, think, understand, and solve problems. Artificial Intelligence (AI) refers to machines designed to perform tasks that normally need human intelligence, such as recognising patterns, making decisions, or solving problems. However, not all smart machines use AI. Some devices simply follow fixed instructions, a process called **automation**.

AI systems learn from data that can be numbers, words, images, videos or sounds. Data helps to understand patterns and draw conclusions. Recognising patterns helps in making better decisions in daily life.

Technology should be used responsibly. This means keeping your passwords safe, protecting your personal information, and getting your parents' permission before sharing anything online. To build a good digital footprint, always follow ethical guidelines, stay safe, and share positive content.

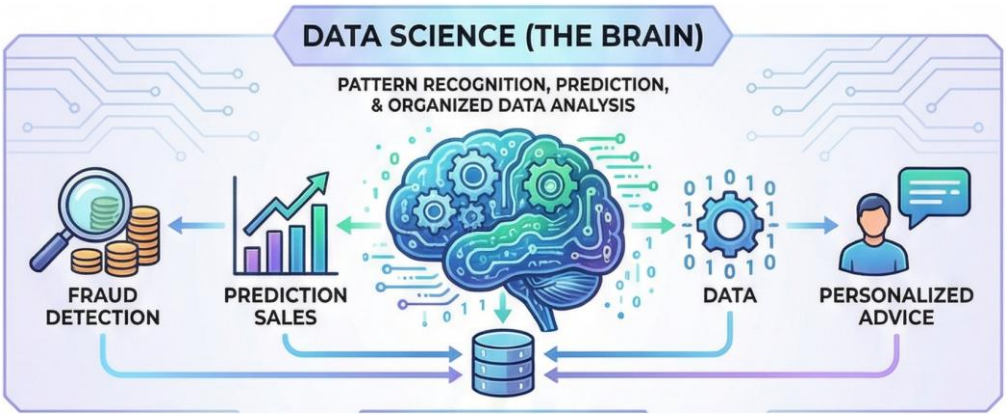
Meaning of AI Domains

The term **AI domains** defines the study and use of various fields within AI, which are meant to replicate human thinking capabilities, such as learning, seeing, understanding language and problem-solving. AI is not just a single technology, but it is a branch of different domains. These domains are further classified based on the type of data they work with and the task they complete, allowing machines to perform tasks that usually require human intelligence.

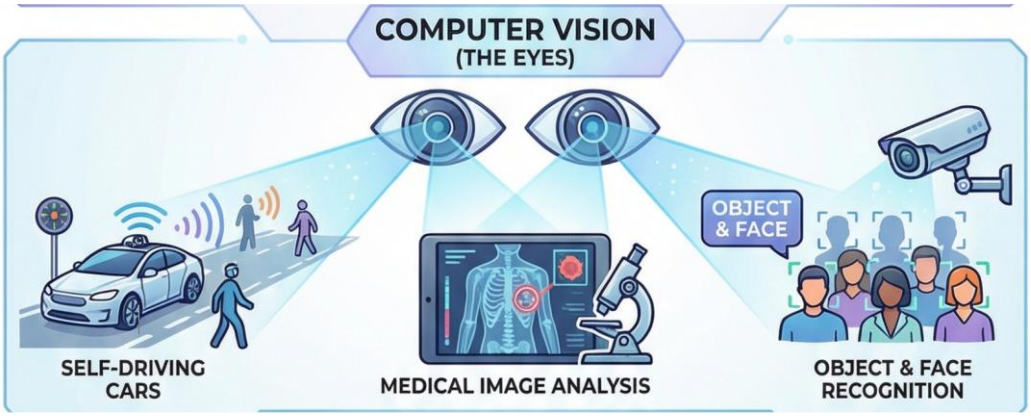
Some important domains of AI are classified as:

1. Data Science
2. Computer Vision
3. Natural Language Processing

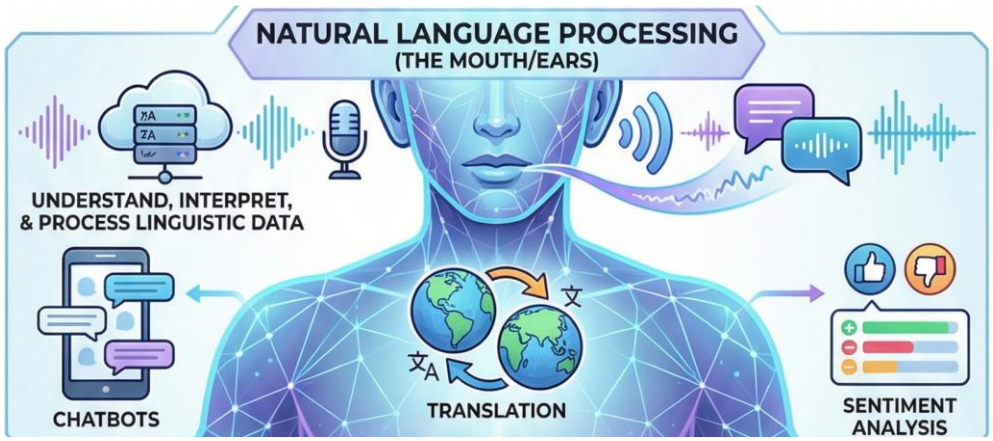
↳ **Data Science (The Brain):** This technology looks for patterns and predicts outcomes by using organised data like numbers or text. It is useful for spotting fraud, predicting sales, and giving personalized advice.



↳ **Computer Vision (The Eyes):** This technology uses images and videos to find faces, recognize objects, or read text. It is particularly important for self-driving cars and medical image analysis.



↳ **Natural Language Processing (The Mouth/Ears):** This technology can understand, interpret, and create human language by processing linguistic data like speech or text. It is used in chatbots, translation, and sentiment analysis.



Predictive techniques in AI

Prediction in AI is not magic, but there is the logic and mathematics behind every prediction. How?

- Using data collected in the past to predict what can happen in the future.
- Training a model to identify patterns and apply those patterns and trends to new and unseen data.

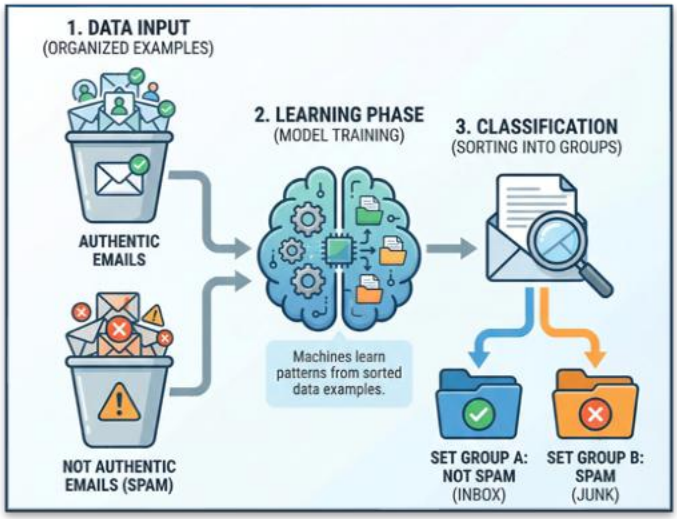
For example, AI can be used to predict crop yield. By analysing data like weather conditions, soil quality, and past harvests, AI can estimate how much crop will be produced in a season.

Introduction to Classification

Classification is a method used in AI systems where the machines sort data into particular categories. In this method, the system is trained using examples in which the correct answers are already known. This training process is called **learning**. By studying these examples, the model learns patterns and then uses them to classify new data correctly.

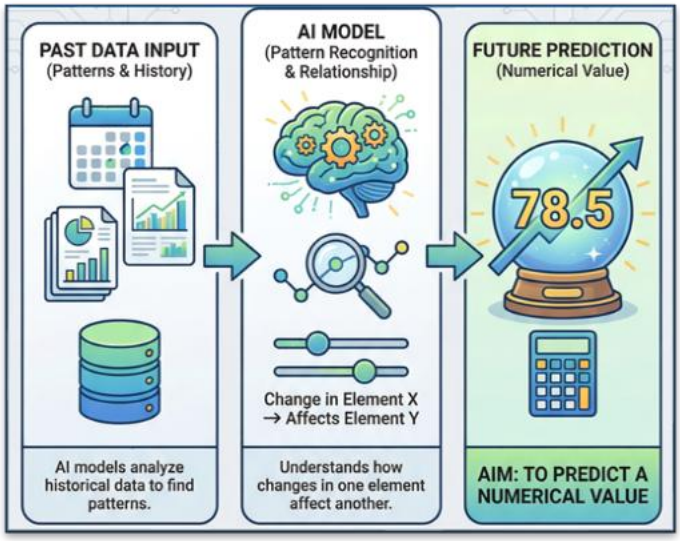
In classification, data is placed into set groups instead of being given a general value.

For example, an email service scans messages and determines if a message is spam or not spam based on previous examples.



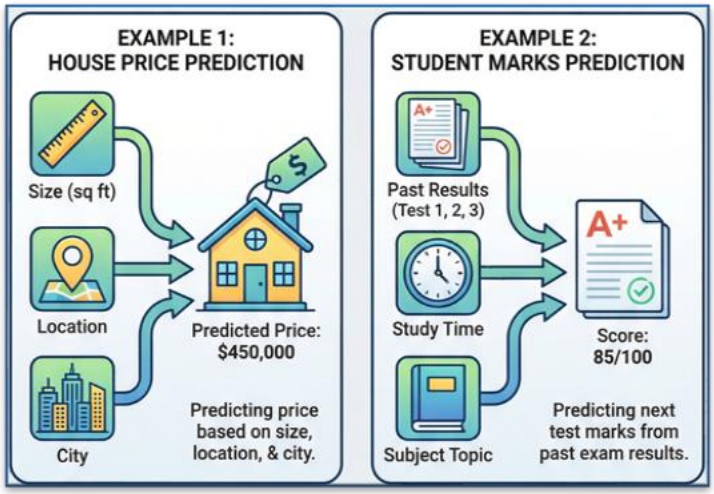
Introduction to Regression

Regression is an approach in artificial intelligence where AI models predict **numerical** values based on past data. In regression, AI models look at patterns in the data and learn how changing one piece of information can change the number they predict.



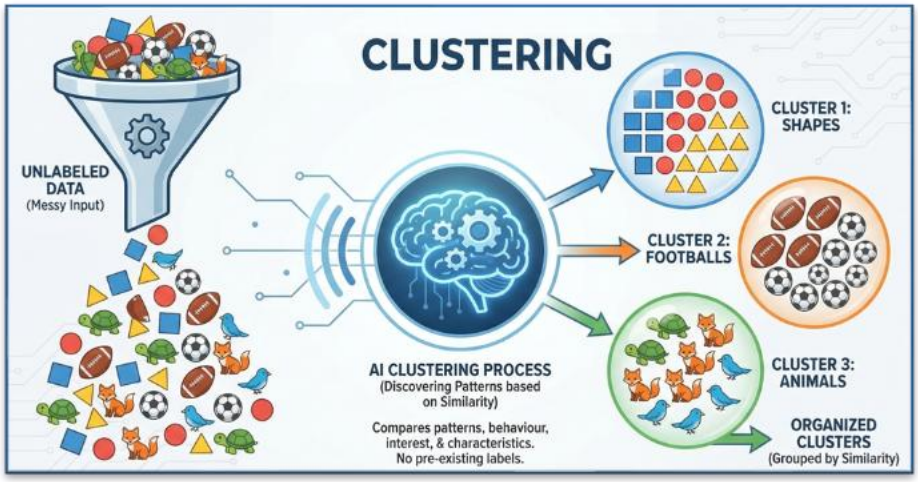
In regression, the aim is to predict a numerical value.

For example, predicting the price of a house based on its size, location, and city you are looking for. Similarly, by analysing a student's past exam results, a computer program can predict how many marks the student might achieve on the next test.



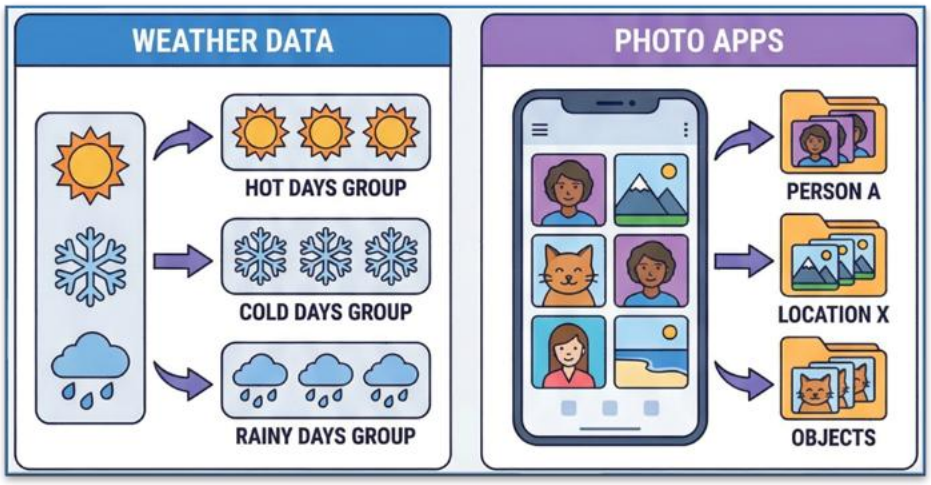
Introduction to Clustering

Clustering is a method in AI that **groups similar** data together. Unlike classification, clustering does not use labelled data, as no labels are given in advance. Clustering compares patterns, behaviour, interests, and characteristics of data sets and discovers its own pattern. It forms separate groups based on the similarities in the data.



<u>In clustering, similar elements of data are grouped together without assigning predefined labels.</u>

For example, weather data might be grouped by similar days such as hot, cold, or rainy, and photo apps can automatically organise pictures of the same person or location.



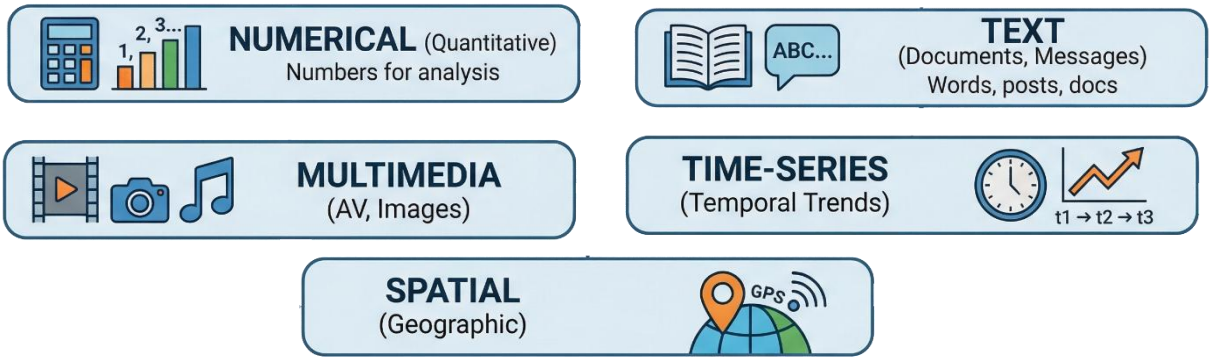
What are Datasets?

When talking about AI and Machine Learning, datasets are **groups** of **data** that are used to **teach** and **evaluate** machine learning models. The goal of these datasets is to give the models the information they need to learn patterns and make predictions; hence, **datasets** are important to the progress of AI and machine learning. They help researchers and experts solve many real-world problems such as speech and picture recognition, as well as predictive analytics and natural language processing.

Each piece of information in a **dataset** is called a data point or record with several **attributes** or **features**. Typically, datasets are arranged in formats such as tables, charts and spreadsheets, which make the information easy to access and help in making the correct data-driven decisions.

Types of Datasets

Datasets can be categorised in several ways. Here are some of the most important types of datasets.



- **Numerical Datasets:** Hold numbers used for quantitative analysis.
- **Text Datasets:** Hold text, posts, messages, documents.
- **Multimedia Datasets:** Hold images, videos and audio files.
- **Time-Series Datasets:** Hold data collected over a period of time to analyse trends and patterns.
- **Spatial Datasets:** Hold geographic information such as GPS data.

Based on Data Structure

- **Structured datasets:** Datasets that are organised for easy search and evaluation of data.
- **Unstructured datasets:** Datasets that are not organised or have no clear structure. They may include several types of data.
- **Hybrid datasets:** Datasets that include both structured and unstructured data.

Dividing a data set

A dataset is usually divided into **three parts**:

1. **Training dataset:** This part of the data is used to teach the AI models, where these models learn from the patterns and trends.
2. **Validation dataset:** This part of the data is used to evaluate and improve the learning while the AI models are still training.
3. **Test dataset:** In this part the final check is done to see if the AI models have learnt correctly.

For Example:

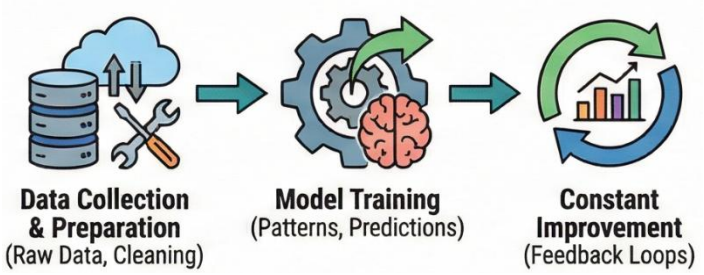
- You have learnt a new chapter from your math notes (**training**)
- You try and practise some of the sums (**validation**)
- You take the final test. (**test dataset**)

For Example:

- Assume you have **100 images of animals**. Let us divide 100 images as 60% for training, 20% for validation, 20% for testing.
- You train the AI model with **60 images** (*training images*).
- After training, validate the model with **20 images** (*validation images*).
- At the end, you test the model with the **20 test images**.
- The computer never sees the test photos before; it's like a **final exam**.

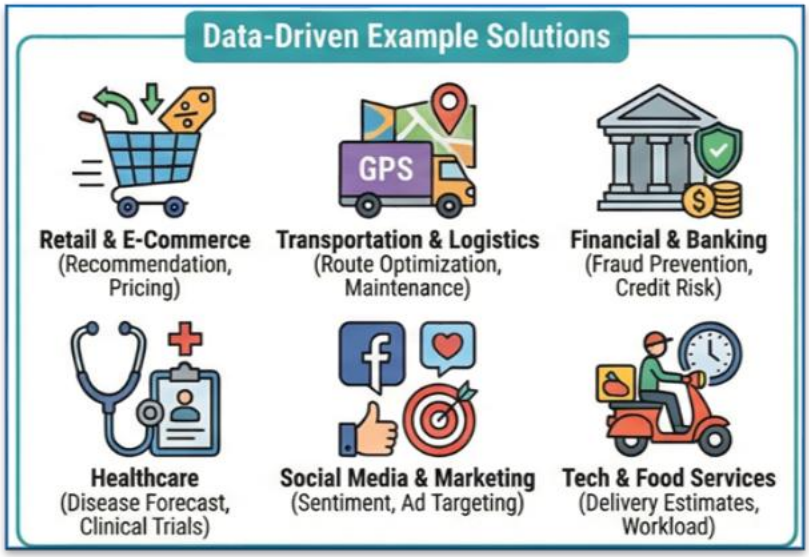
Data Science

Data science involves studying data, including the development of methods for recording, storing, and interpreting data to extract meaningful information. Data can be numbers, text, images, videos, or other forms of information that can be stored and analysed. Primary areas of mathematics, statistics, computer science, and domain knowledge are all used in data science to identify patterns in the data. These patterns enable humans and machines to make good decisions and solve real-world problems.

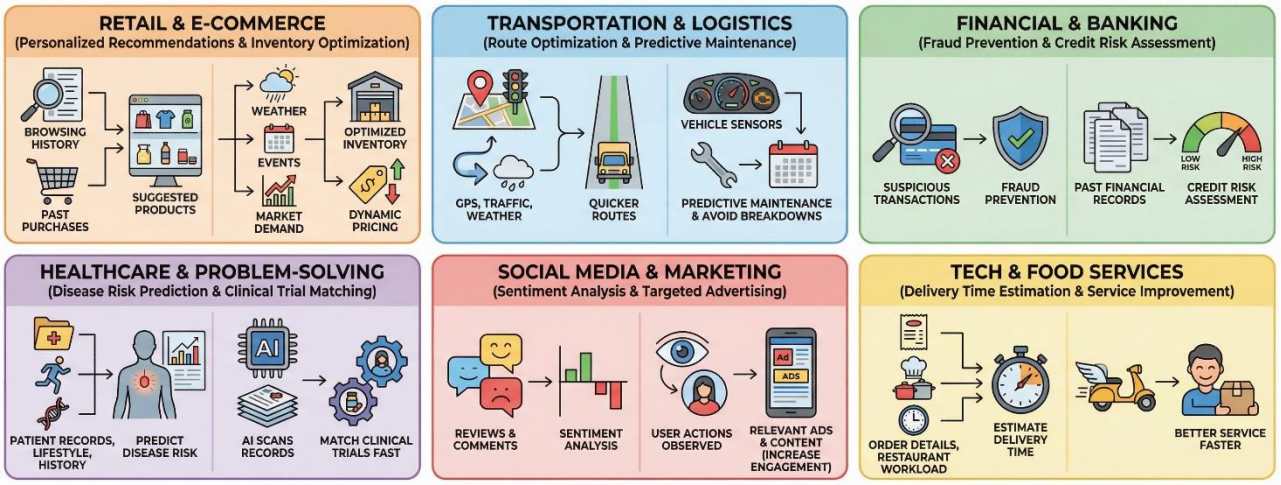


Data Science Function of AI is Enabled by:

- **Data Collection and Preparation:** Raw data is collected from various sources and cleaned so that it is accurate and provides useful input for generating models.
- **Model Training:** AI programs are given processed data in order to identify patterns and generate predictions.
- **Constant Improvement:** Data scientists repetitively analyse and tweak models with fresh data to improve the accuracy of their findings, a process known as feedback loops.



Data-Driven Example Solution Sets



- **Retail Experience and E-Commerce Solutions:**
  Retailers analyse customer behaviour, such as browsing history and past purchases and then **predict** which products or content customers are most likely to pick. Even sales data can be linked with local factors like weather and events to improve stock management. Prices can also be adjusted based on market demand and competitor pricing.

- **Transportation Experience and Logistics Solutions:**
  Artificial intelligence uses GPS **tracking**, **traffic** conditions, and **weather** forecasts to decide how to use quicker delivery routes. Sensors in cars can also give information on how well the car is running, which can help you find out when it needs maintenance and avoid breakdowns.

- **Financial Experience and Banking Solutions:**
  Data is used by banks and other financial institutions to **investigate suspicious** transactions and stop them from happening. Data analytics also help banks determine how much credit risk a borrower carries by examining past records of financial transactions.

- **Healthcare Experience and Problem-Solving Solutions:**
  Hospitals use data to analyse **patient records**, lifestyles, and medical histories in order to **predict** the risk of disease. Similarly, AI technology scans medical records in seconds to match patients with appropriate clinical trials, rather than weeks or months of repetitive searching. This promotes the advancement of research and treatment.

- **Social media and marketing Solutions:**
  Brands look at reviews and comments on the internet to use sentiment analysis to learn more about how people feel. Users' actions are carefully observed so that ads and content are shown that are more relevant to each user's interests, which increases engagement.

- **Tech and Services for Food Solutions:**
  Machine learning is used by food delivery companies to estimate how long it will take to prepare and deliver food by looking at things like the details of the order, the restaurant workload, and the time of day. This helps ensure that customers get better service faster.

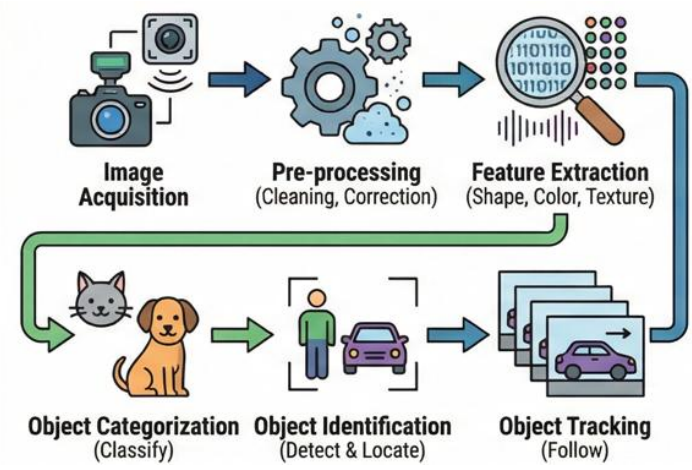
Computer Vision

Computer vision is the field of study and technology in AI that lets machines **see**, **understand**, and make **sense** of visual information in the same way as we humans do. It gives these machines the ability to process, comprehend and get useful information from images, videos and even real-time video streaming.

How does Computer Vision Work?

Computer vision is a set of algorithms, techniques, and concepts that enable machines to **recognise** and **interpret visual** information. It is a way of extracting information from images and videos that typically uses machine learning, pattern recognition, image processing and in particular, deep learning and neural networks.

The process of computer vision typically involves the following steps:



- **The Image Acquisition:**
  The computer vision process first **collects** visual **information** from images and videos. This crucial information is collected from several sources such as cameras, sensors and stored image.

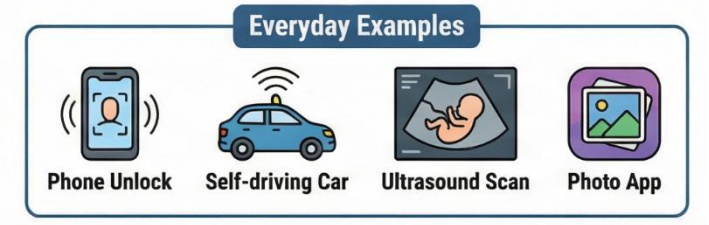
- **Pre-processing:**
  The pre-processing stage ensures that the data is not only **accurate** but also **reliable**. Image pre-processing typically involves noise reduction, distortion correction, and brightness/contrast adjustment to improve image quality.

- **Feature Extraction:**
  Feature extraction involves detecting important **pattern** or feature of an image. These features could include shape and texture, colour distribution, or edge profile. This enables the model to obtain the valuable data and information from sorting and analysing it.

- **Object Categorization:**
  Once the model is trained, it can identify the category of a new image by **comparing** its extracted features with those learned during training. Based on this comparison, the system classifies the object into a specific category. So, for example, the trained model can tell whether a given image is a cat or a dog.

- **Object Identification:**
  It detects and **identifies** specific objects in an image and also finds their location. For example, in a street image, the system can find a car, a person, and a traffic signal, and draw boxes around each object to show where they are placed.

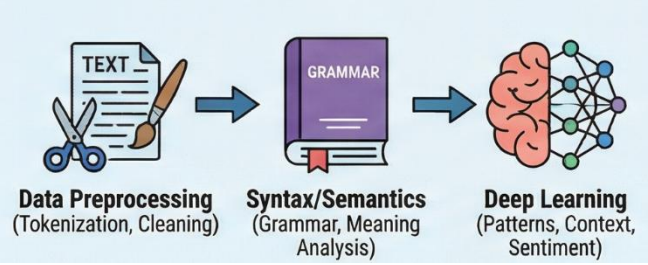
- **Object Tracking:**
  There are different applications for object tracking techniques, such as tracking an object across a sequence of video frames or images. The system tracks objects in each frame, which **preserves** their identity over the entire sequence under challenging conditions such as varying lights and motion.
  For example, in CCTV footage, the system can keep track of a specific car as it moves across different frames, continuously following the same car from the start to the finish of the video.



- **Face Unlock:** Phones create a facial map to unlock the screen.
- **Autonomous Vehicles:** Systems that recognise pedestrians, lane markings and traffic signals.
- **Medical Imaging:** Ultrasound images to check the health of unborn babies.
- **Photo Organization:** Applications that automatically label people and objects in photos for easy searching.

Natural Language Processing

Natural Language Processing (NLP) is a branch of AI that helps machines read, write, listen, and speak in human language. NLP systems teach machines to read and respond to language like humans do. It enables machines to comprehend not just what the words mean, but also the sentiment behind those words. You can use NLP to tell whether a message is happy or sad or angry and react accordingly. Thanks to NLP, these systems can interact with users in a smarter and more intuitive way.

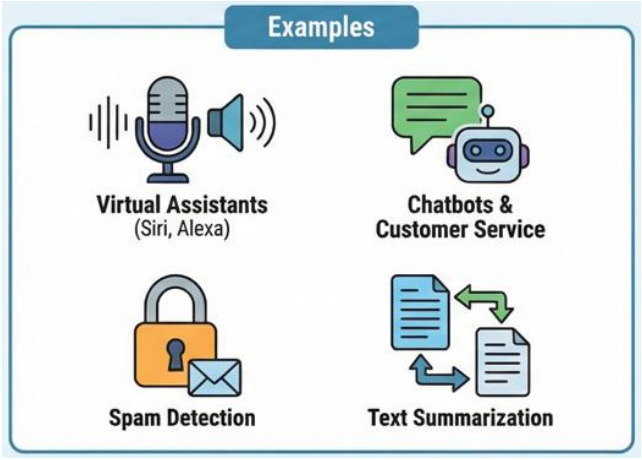


How Machines Understand Human Language

- **Data Pre-processing (Cleaning):**
  Prior to the actual analysis, raw data is processed by tokenisation, where sentences are broken into words as well as removes punctuation; converts text to lowercase and stemming, which reduces each word to its root form.
- **Syntax/Syntactic Analysis:**
  This is simply how NLP systems study the grammatical structure of sentences to understand how words are arranged.
- **Semantics (Meaning Analysis):**
  Natural language processing systems can understand the meaning of words and phrases, including word-sense disambiguation, which means identifying the correct meaning of words with multiple meanings, such as bat which can mean both sports equipment and an animal.
- **Deep Learning:**
  Huge datasets are used to train models and find patterns that help the system to understand context, sentiment, and purpose.

Examples of Natural Language Processing

- **Virtual assistants:** Virtual assistants use NLP to understand what you say when you talk to them.
- **Chatbots and Customer Service:** Questions are answered by automated systems, and customer feedback is analysed
- **Spam detection:** Email filters find content that is not appropriate or needed
- **Text Summarization:** Making short summaries of long papers automatically



Points to remember:

- ✓ Artificial Intelligence (AI) is divided into different domains based on the type of data and tasks performed.
- ✓ Data Science focuses on analysing structured data to find patterns and make predictions.
- ✓ Computer Vision enables machines to process, understand and interpret images and videos.
- ✓ Natural Language Processing (NLP) allows machines to read, understand and generate human language.
- ✓ Classification is a technique that assigns data into predefined categories.
- ✓ Regression is used to predict continuous numerical values.
- ✓ Clustering groups similar data together without using predefined labels.

Exercise

A. Multiple Choice Questions.

1. Which AI technique predicts numerical values?
   a) Classification b) Clustering
   c) Regression d) Detection
2. Which AI domain works with images and videos?
   a) NLP b) Data Science
   c) Computer Vision d) Science
3. Clustering is mainly used to:
   a) Predict marks b) Group similar data
   c) Translate language d) Detect spam
4. In classification, the output is:
   a) A continuous value b) A predefined category
   c) A random number d) A chart
5. In dataset division, which data is used for final evaluation?
   a) Training b) Validation
   c) Test d) Raw data

B. Fill in the Blanks.

1. Regression predicts _____ values.
2. Clustering does not require _____data.
3. Computer Vision works mainly with _____ and videos.
4. NLP helps machines understand _____.
5. A dataset is divided into training, validation, and _____sets.

C. Short Answer Questions.

1. Differentiate between classification and regression.
2. What is clustering? Give one example.
3. Explain the importance of datasets in AI.
4. List the steps involved in Computer Vision.
5. How does NLP help in communication systems?

D. True or False.

1. Regression predicts categories.
2. Clustering is a supervised learning method.
3. Test data is used to evaluate model performance.
4. Computer Vision can detect object locations.
5. NLP can analyse sentiment in text.

E. Identify the AI Domain.

AI APPLICATION	IDENTIFY THE TERM
Analysing MRI scans	
Text summarization of long articles	
Recommending products based on past purchases	
Grouping customers by buying behaviour	
Chatbot answering customer queries	

Chapter 2: AI in Industries

Imagine waking up in the morning and asking your phone to check the weather. It answers right away. A navigation app tells you which route to take to go to school to avoid traffic. A learning app can assist you in solving a difficult math problem. A doctor uses a smart machine to monitor a patient's health. Artificial Intelligence (AI) makes all of these things possible.
AI is not just a technology idea; it is a powerful tool that changes how things work in the world. AI is helping people make better decisions and live better lives in many places, such as at home, in schools, on the road, and on their phones.

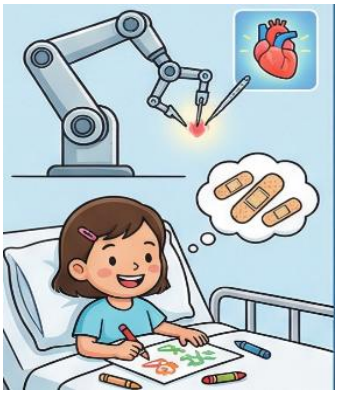
AI and Healthcare

When someone is sick, we depend on hospitals and doctors to help them get better. Today, AI is working with medical professionals to improve healthcare by making it faster, safer, and more accurate.

Use of AI in Hospitals and Medicine

AI-powered machines and devices in modern hospitals help doctors examine patients more closely. AI models can look at X-ray or MRI images and quickly point out areas that show problems. Doctors may be able to find infections and tumours much earlier than they have been able to in the past, which could save thousands of lives.
Some patients have smart devices like fitness bands and health apps that record heart rate, steps, and sleep. These devices monitor health information and alert the user if something appears abnormal. If a user's heart rate becomes irregular, the device could recommend visiting the doctor right away. Robotic surgeries make complex surgeries safer and shorten the time it takes for patients to heal.

Case Study: Precision in Heart Surgery



A young girl had to undergo heart surgery. Usually, this kind of surgery would need large incisions and a long time to heal. Instead, doctors used an AI-assisted robotic system. The AI helped steady the surgeon's hands by removing even the smallest natural shaking. Three small cuts were used to perform the surgery. A few days later, the girl was sitting up and drawing with crayons. **AI did not do the surgery by itself; it helped the doctor do it in a safer and gentler way.**

Improving Accuracy and Decision-Making

AI can read thousands of medical reports in just a few seconds. A medical professional could spend hours or days examining so much data. AI can quickly compare the symptoms of a patient with global medical data and recommend treatment options.

If a patient somewhere has an unusual illness, AI systems will be able to go through the medical records of patients in the world to find others with similar illnesses and see what worked best. This leads to better decision-making and fewer errors. Support from AI enables doctors to spend more of their time on patient care and less time searching out potentially unknown research findings.

AI in Education

AI is making education smarter and more engaging. Today students no longer limit themselves to textbooks and traditional classroom settings. They can have access to innovative ideas through a digital medium, which is interactive in nature and conducive to learning.

AI in Teaching and Learning

AI is powering many educational apps and websites that are now available to students in new and engaging ways. These sites teach through videos, quizzes, and games. When a student responds to a question, the system immediately checks it and provides feedback.

Teachers also use the tools to keep track of how students are doing and grade their work. Teachers do not have to spend as much time grading papers, which means they can spend more time helping students learn concepts better.

For example, web-based applications such as digital learning platforms make it easy for teachers to share notes, assign homework, and interact with students.

Learning Support

AI-powered learning apps help students who find subjects like mathematics difficult by providing simpler explanations and additional practice problems. Students who learn the concepts quickly are given more challenging and customised tasks to keep them engaged and motivated. This approach helps students develop a greater self-confidence and love of learning.

Case Study: AI-based online class reminders.

Meet Aisha, a 10-year-old girl who often forgot to attend her online classes on time and missed important lessons. To solve this problem, her school introduced an AI-based reminder system.

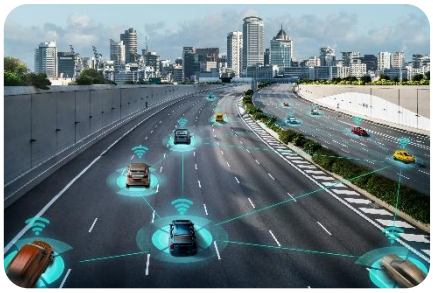
The system learned her class schedule and sent timely reminders before each session. It also adjusted the notifications based on her daily routine. As a result, Aisha began attending classes regularly and showed improvement in her learning and overall performance.

AI did not just send reminders, but it built a regular learning habit for Aisha.

AI in Transport

Have you ever wondered how navigation programs determine the fastest route to a destination? The answer is artificial intelligence.

The Role of AI in Transport Sector



AI is used by traffic control systems to keep busy roads safe. Sensors and cameras keep track of how many cars are on the road. AI looks at this data and then controls the traffic lights to make traffic flow better, reduce congestion and prevent sudden braking.

AI helps navigation apps find the quickest way to get to your destination. If there is traffic or an accident, the app instantly recommends a new way. This feature saves time and fuel. For example, self-driving car companies have developed vehicles that can see obstacles, read traffic signs, and help drivers.

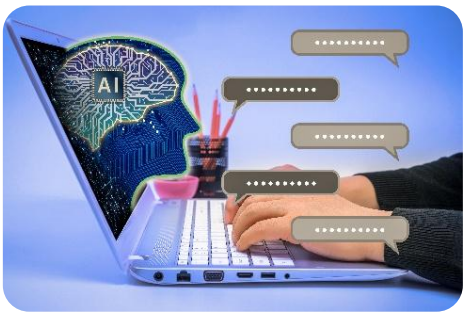
Improving Safety and Efficiency

The AI technology also helps to prevent accidents by minimizing the chances of human error. The cars can alert and slow down if the driver is distracted. Public transport systems also use AI to maintain schedules. Buses and trains run on time because AI helps plot routes and track delays. This kind of technology takes people off crowded roads with grinding traffic and lets them travel in peace to their destinations.

Case Study: Smarter Traffic During Monsoon

During the monsoon season, heavy rains in Mumbai frequently cause traffic congestion. An AI traffic system analysed weather information and traffic patterns. Drivers use navigation devices to find other routes before heavy rain begins. AI began adjusting traffic patterns in anticipation of heavy rain. As a result, traffic during heavy rains improved significantly. **AI used historical and real-time data to anticipate congestion and optimise the system.**

AI in Communication



Communication is an important part of our daily life. With the help of Artificial Intelligence, it has become faster, easier, and more efficient.

Email services and messaging apps are leveraging AI to sort through messages, including blocking spam mails. This prevents the loss of important messages. Voice assistants respond to voice commands by answering questions and sending messages. Translation tools help people understand different languages quickly. This makes it easy for people from different countries to communicate.

Video platforms use AI to recommend videos that viewers are likely to watch, based on the kinds of videos they already prefer. This helps users find useful and interesting content.

Faster and Better Information Exchange

AI enables the rapid flow of information around the world. It enhances sound and video quality during online classes or meetings. Background noise is reduced, and the voice becomes much clearer. For example, if students are taking an online class at home, then Artificial Intelligence can help reduce background noise so they can hear the teacher clearly. AI enhances communication tools to keep people constantly connected and informed.

Case Study: AI in a Rescue Mission

A rescue ship in the sea got distress calls in various languages all within minutes during an emergency. The rescue team did not know how to speak all of these languages. The messages were quickly translated by an AI system. It even detected the speakers' fear and urgency. The system warned that one person sounded extremely distressed. The rescue team saved the boat by reaching in time.

AI did more than translate words; it helped save lives.

Advantages of Using AI in Different Industries

Several Industries have been benefitted by Artificial Intelligence as it helps them improve their efficiency.AI is not taking away the jobs, it is helping in increasing productivity. Hospitals, banks, factories etc., are improving their quality of work by using AI

Saves Time and Increases Work Speed

AI is remarkably good at carrying out repetitive tasks. AI systems can also work nonstop without getting exhausted or bored to complete any task in time.

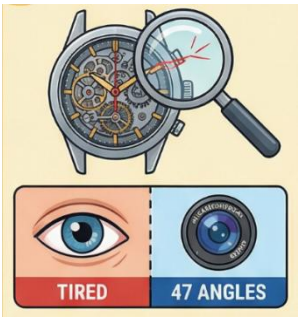
Reduces Costs

Efficient planning of work for any business saves money and AI assists in that. It can help in avoiding costly machine breakdowns by identifying issues in time. It also helps control stock and energy use, which diminishes waste.

Improves Quality

Artificial Intelligence is supportive in improving the quality of product and services. It helps in checking items carefully and in detecting even small imperfections, leading to more reliable results.

Case Study: Ensuring Perfect Quality



Human eyes may get tired using magnifying glasses to look at small gears in a watch factory. Human inspectors missed about 3% of defects. An AI high-resolution vision system now checks each gear from 47 different angles and compares it to millions of perfect samples. It once found a scratch so small that it was only one-hundredth the width of a human hair! For an athlete who needs to be on time, even seconds matter.

AI makes sure that things are right when they need to be perfect.

Helps in Better Decision Making

Artificial intelligence can quickly process large amounts of data. It will find patterns and make relevant suggestions. AI helps businesses and other organisations make informed decisions and plan for the future.

Better customer service

Many organizations are developing AI chatbots and virtual assistants. Customers receive quick responses from AI, allowing them to get help without waiting in long lines. In addition, AI recommends products that customers may need, providing a more convenient shopping experience.

Improves safety

AI monitors workplace environments and alerts personnel to potential hazards. It also helps secure information online by detecting fraud and identifying hacking attempts. This helps protect businesses.

Case Study: AI Inspires New Designs

An AI system, while studying thousands of patents noticed something unusual. The shape of bird wings and certain ship designs had similar patterns. A new ship design with tender wing-like curves is suggested by AI. This reduced water resistance by 18%. It has helped in supplying medical equipment and medicines to remote islands faster and with less fuel in these ships.

AI connects ideas from different fields and helps humans develop better solutions.

Points to remember:

- ✓ Artificial Intelligence (AI) is a powerful tool that helps industries work quicker, smarter, and more proficiently.
- ✓ AI is used in many areas such as healthcare, education, transport, communication, and business.
- ✓ In education, AI provides personalised learning by adjusting lessons according to a student's learning pace and ability.
- ✓ AI improves transport systems by managing traffic lights, predicting congestion and suggesting faster routes.
- ✓ AI improves communication by filtering spam emails, translating languages and enhancing audio and video quality.

Exercise

A. Multiple Choice Questions.

1. Artificial Intelligence mainly helps industries to become:
   a) Traditional b) Efficient
   c) Slow d) Manual
2. In healthcare, AI mainly helps in:
   a) Diagnosis b) Advertising
   c) Packaging d) Decoration
3. In education, AI provides:
   a) Cancelling classes b) Personalised learning
   c) Reducing learning d) Extra homework
4. In transport systems, AI is used to:
   a) Manage traffic b) Increase traffic congestion
   c) Stop route planning d) Remove public transport
5. AI supports better decision-making by:
   a) Ignoring available data b) Analysing large amounts of data
   c) Making random guesses d) Avoiding pattern recognition

B. Fill in the blanks.

1. AI-powered machines help doctors detect diseases at an _____stage.
2. Robotic surgery can make complex operations _____and reduce recovery time.
3. AI learning programs can understand how each student_____ best.
4. Traffic control systems use _____and cameras to monitor vehicles on roads.
5. AI translation tools help people understand different_____.

C. Short answer questions.

1. How does AI help in healthcare?
2. Explain how AI supports personalised learning in education.
3. How does AI improve transport systems?
4. Mention two advantages of using AI in industries.
5. How does AI improve customer service?

D. True or False:

1. AI can help doctors detect diseases at an early stage.
2. AI completely replaces teachers in classrooms.
3. AI helps traffic systems manage congestion.
4. AI cannot analyse large amounts of data quickly.
5. AI improves communication by reducing background noise in online meetings.

E. Identify the AI Applications.

AI APPLICATION	FIELD
Analysing MRI scans	
Giving instant quiz feedback	
Controlling traffic lights	
Blocking spam emails	
Managing inventory and energy use	

Chapter 3: Data Visualisation and Analysis

In today's digital era, we see data all around us. Each time that we use a mobile phone, search on the internet, shop online, or even check the weather, data is created. Schools manage marks and attendance; hospitals keep track of the patients coming in, while scientists gather measurements during experiments. Data is useful only when it is organised, understood, and presented in a clear and meaningful way.

Consider the following scenario:

You are the captain of your school's cricket team. After the last match, you have a list of every ball bowled, every run scored, and every catch dropped. That extensive list is just **data**. But if you arrange it to see which bowler took the most wickets, that is **organising**. And if you draw a simple chart showing which overs had the most runs that is **visualising**. Now you can create a better bowling plan for the next match. The **information and insight** you get from data can help you make better decisions.

In this chapter, we will learn what is data, how it is collected and organised, and how to transform data into useful information through visualisation and analysis. By learning these skills, you will begin to think like a young data scientist.!

What is Data?

Data can take many forms. It can be a single number, a list of numbers or even something more complex such as a book, a collection of newspapers, a picture, a sound clips, or a video. Data can also be derived from scientific instruments, mobile apps, websites, and sensors.

For example:

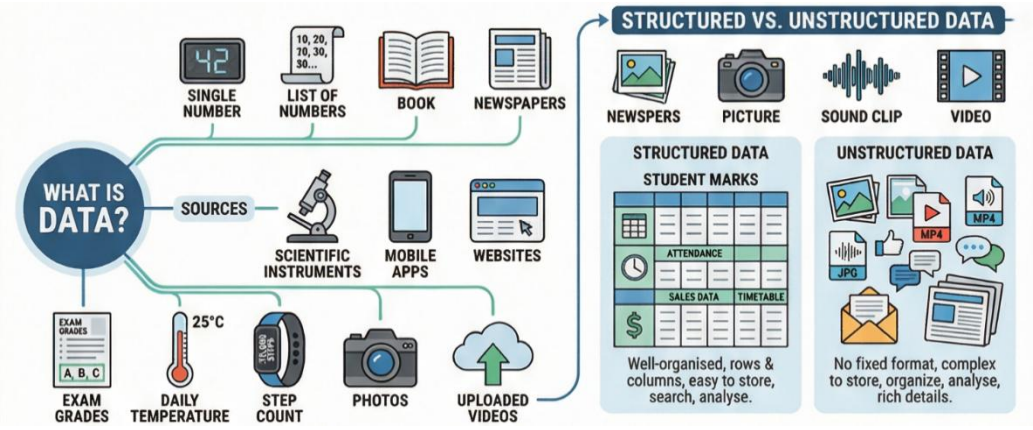
- Grades that students achieve in an exam
- Daily temperature readings
- Number of steps recorded by a fitness band
- Photos taken by a camera
- Videos uploaded online

All these are different forms of data. Once data is collected and well-structured, it becomes easier to study and understand patterns in it.

Structured and Unstructured Data

Data is often divided into two main types: **structured** and **unstructured.**

Structured data is well-organised and follows a clear format. It typically comes in rows and columns, as it does in tables or spreadsheets. This is the kind of data that you can easily store, search, and analyse.



Examples of structured data:

- A table of student marks
- Attendance records
- Sales data in a spreadsheet
- A timetable

Unstructured data does not follow a fixed format; it requires more effort to store, organise and analyse due to its complexity.

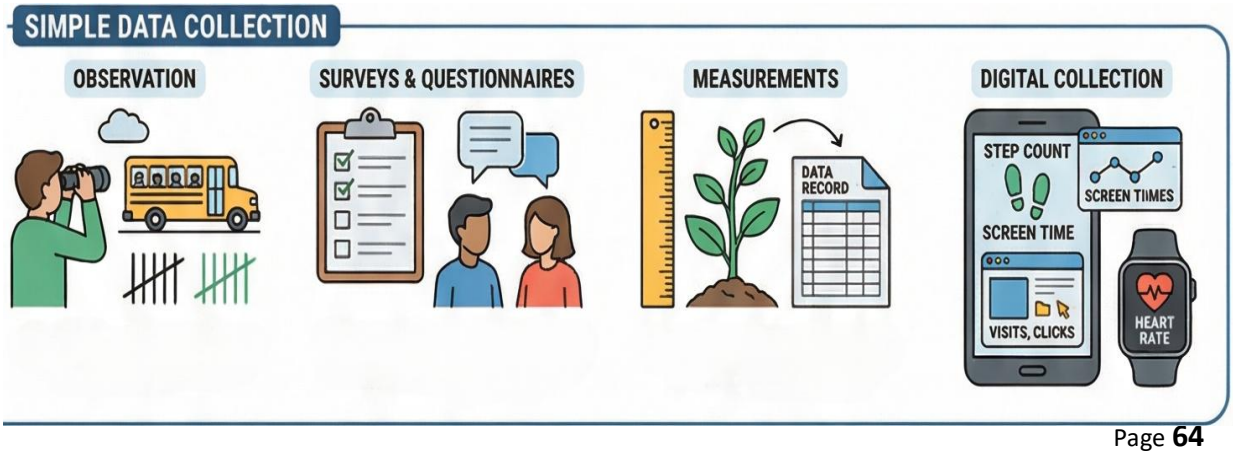
Examples of unstructured data:

- Images and videos
- Audio recordings
- Social media posts
- Emails and articles

Both kinds of data are extremely important. Structured data is easier to analyse, but unstructured, unorganised data often contains rich and detailed information.

Simple Methods of Data Collection

The data could be collected in many simple ways. Even students can collect meaningful data in their everyday life.



Observation

Data can be collected by observing things carefully.

For example: Counting the number of students who take the school bus to get to school.

Surveys and Questionnaires

One common way is to ask questions and record the answers.

For example: conducting a survey among classmates about their favourite sports.

Measurements

Data can also be collected by using instruments to measure and record values.

For example: Measuring plant growth every week.

Digital Collection

Many devices automatically collect data.

For example:

- Step count and screen time on mobile phones
- Websites recording the number of visits and clicks
- Smartwatches monitoring heart rate

Understanding Digital Data

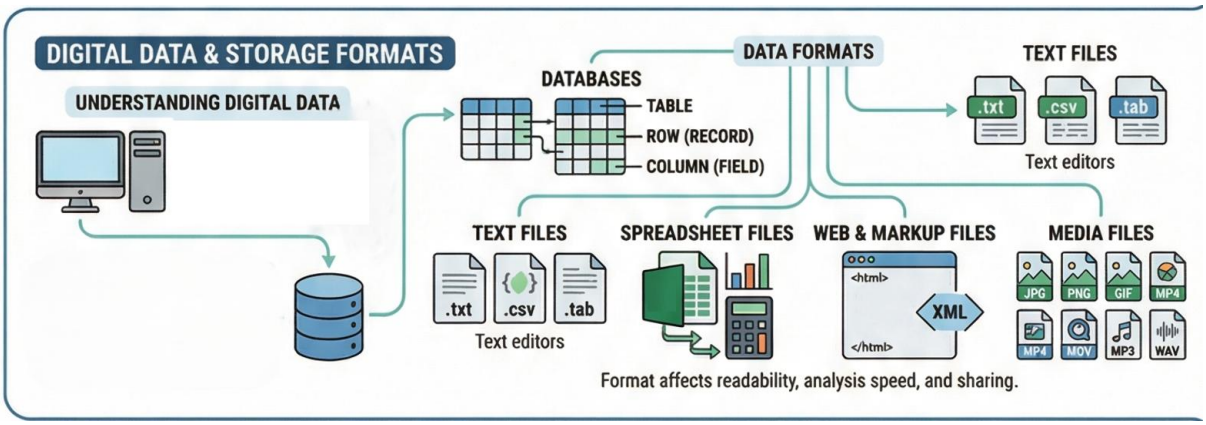
When data exists in digital form, it must be saved in a format that computers can read and process. The way data is stored determines how easily it can be analysed.

For example:

- It is easier to see how frequently words appear on websites than in scanned images of old books.
- You can instantly search through data stored in a well-organised database.
- Data that is not well-organised is difficult to understand.
- This is why storing data in proper formats is particularly important.

Data Formats and Storage

Digital data can be stored in many different formats. Each format is designed for a specific purpose.



Databases

A database is a structured collection of data. It stores data in tables made up of rows and columns.

Key terms:

- **Table**: A group of similar data items
- **Row** (Record): One complete entry in a table
- **Column** (Field): A specific piece of data about each record

Large organisations use databases because they allow fast searching and easy updating of data.

Text Files

Data can be stored in a simple readable text format. These files can be opened using any text editor.

For example:

- Plain text files
- CSV (comma-separated values) files
- Tab-separated files

These files are easy to read, edit and share between different applications.

Spreadsheet Files

Data is stored in tables in spreadsheet files like Excel. They are commonly used in schools, offices and companies.

Spreadsheets allow:

- Sorting data
- Creating charts
- Performing calculations

Web and Mark-up Files

Some information is kept in specialized formats that are used on the Internet.

For example:

- HTML files: These files are used to display web pages
- XML files: These files store data with labels that describe the information.

These formats help computer understand and display content properly.

Media Files

Data is not always text or numbers. Media files are also data.

- Images: JPG, PNG, GIF
- Videos: MP4, MOV
- Audio: MP3, WAV

These files store visual and sound information and are widely used in digital communication.

Why Data Format Matters

The format of data affects:

- How easily it can be read
- How quickly it can be analysed
- Whether it can be shared across different systems

A well-structured dataset will save you time and ensure accuracy in your analysis.

Organising Data for Analysis

Once data is collected, it must be organised properly. Unorganised data can be confusing and difficult to understand.

Arranging Data in Tables

Tables are one of the easiest forms of data to organize.

For example:

Student Name	Marks
Sunshine	85
Happy	78
Flower	92

Tables make it easy to:

- Compare values
- Identify the highest and lowest values
- Prepare data for charts

Preparing Data for Visualisation

Before creating charts, data must be cleaned and organised.

Steps include:

1. Removing errors or duplicates
2. Filling missing values
3. Arranging data in order
4. Grouping related items

Clean, well-organised data results in clear and effective visualisations.

What is Data Visualisation?

Data visualisation is the process of transforming data into a visual representation, such as a chart, graph, or map. Visuals help us understand information more easily than long tables of numbers.

Data visualisation allows us to interpret and understand **data**. When we look at information visually, our brains are particularly good at detecting patterns and trends. The meaning of the data becomes clearer when we view it as a graph or chart. Visualisation mostly involves our eyes, but sometimes other senses can also help us understand data.

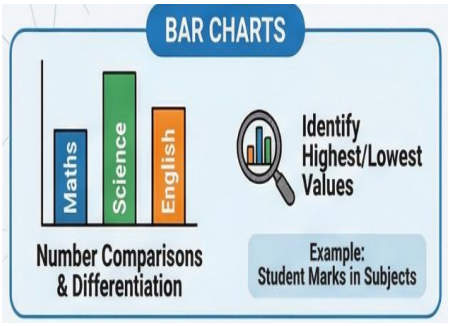
For example:

- Sound patterns inside music data
- Some devices use touch-based signals.

The primary goal of data visualisation is to make it easier to identify patterns, trends, and important information.

Common Types of Data Visualisation

Bar Charts



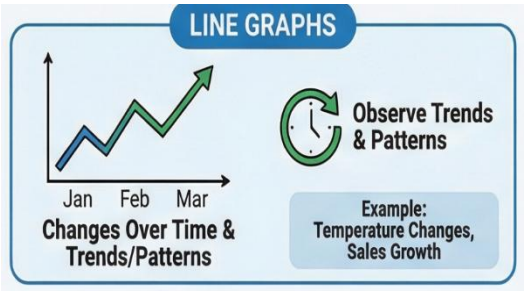
Bar charts use rectangular bars to **represent** data.

For example: the marks of certain students in different subjects.

Bar charts help to:

- Compare numbers easily
- Identify the highest and lowest values
- Differentiate between categories quickly

Line Graphs



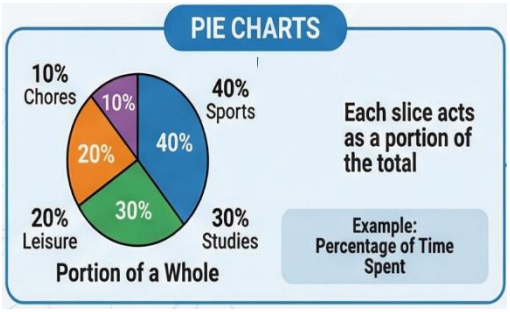
Line graphs are used to show how data **changes** over time.

For example:

- Changes in temperature every day
- The growth of a plant over time
- Monthly sales

Line graphs are extremely helpful for observing trends and patterns over time.

Pie Charts



Pie charts help us **compare** the sizes of different parts of a whole.

For example:

- The percentage of students choosing different sports
- The amount of time spent on various activities

Each slice acts as a portion of the total.

Interpreting Data

Creating charts is only the first step. The real value comes from **understanding** what they display.

Reading Charts and Graphs

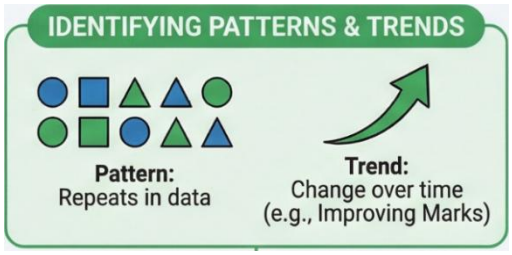
Read a chart correctly:

- Check the title
- Look at labels on axes
- Observe values and units
- Study colours or legends

Understanding these parts helps us read charts accurately.

Identifying Patterns and Trends

A **pattern** is any sequences, similarities, or behaviours that follow a rule or show a particular trend. The **trend** shows how data changes over time.



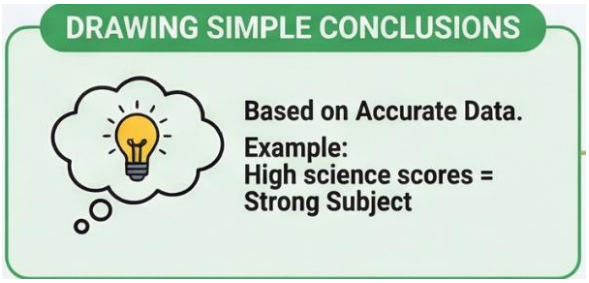
For example:

- Improving marks over several months
- Rising temperature during the summer season
- Increased online shopping sales during festivals

Recognising patterns helps in making predictions and better decisions.

Drawing Simple Conclusions

After studying data, we can draw **conclusions**.



For example:

- If a chart shows that most students score highest in science, we can conclude that science is a strong subject for the class.

However, conclusions should always be based on accurate data.

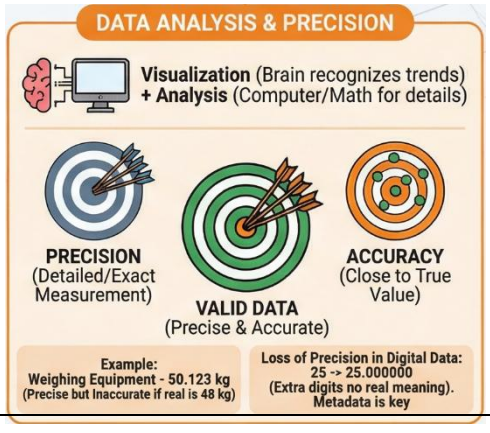
Introduction to Data Analysis

Data analysis is the process of examining data to extract meaningful information. It helps us understand what the data means and how it can be used. Both visualisation and analysis help us learn from data.

- When we visualise data, our brains are better able to recognise trends.
- Computers and mathematics are used in analysis to obtain more detailed insights.

Often, we look at charts first and then analyse the data further to understand it better.

Precision, Accuracy, and Valid Data



When dealing with data, precision and accuracy are **two** key factors.

→ **Precision** refers to how detailed or exact a measurement is.

→ **Accuracy** refers to how close a measurement is to the true value.

A measurement can be precise but not accurate, or accurate but not precise.

For example:

Weighing equipment that consistently displays 50.123 kg is considered exact. However, if the actual weight is 48 kg, the measurement is not accurate

- Valid data refers to a dataset that is accurate and precise.
- Valid data is crucial for accurate analysis and conclusions.

Loss of Precision in Digital Data

Sometimes, original precision could possibly be missing while data is processed by computers.

For example:

- A number may originally be recorded as 25.
- After processing, it may appear as 25.000000.
- The extra digits do not add real meaning.

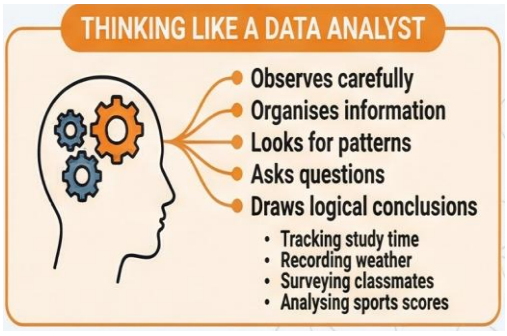
This shows why it is important to understand the original data and its precision. Metadata, which means information about data often stores details about precision and accuracy.

Thinking Like a Data Analyst

Learning data visualization and analysis helps develop important thinking skills.

A data analyst:

- Observes carefully
- Organises information
- Looks for patterns
- Asks questions
- Draws logical conclusions



Students can also practice these skills in their daily lives.

Example activities:

- Tracking daily study time
- Recording weather changes
- Surveying classmates
- Analysing sports scores

These activities are simple ways to develop analytical thinking.

Points to remember:

- ✓ Data can be structured (like tables) or unstructured (like videos).
- ✓ We can collect data through observation, surveys, measurements, and digital devices.

- ✓ Data is stored in different formats such as databases, spreadsheets, text files, media files.
- ✓ Visualisation (charts and graphs) helps us see patterns easily.
- ✓ Bar charts compare quantities, line graphs show changes over time, pie charts show parts of a whole.
- ✓ Interpreting data means reading charts correctly and drawing conclusions.

Exercise

A. Multiple Choice Questions.

1. Which of the following is an example of structured data?
   a) Social media posts b) Audio recordings
   c) Student marks in a table d) Videos
2. Which method of data collection involves carefully watching and recording information?
   a) Survey b) Measurement
   c) Observation d) Digital collection
3. Which type of graph is best used to show changes over time?
   a) Pie chart b) Line graph
   c) Bar chart d) Table
4. Before creating charts, data should first be:
   a) Deleted b) Randomly arranged
   c) Cleaned and organised d) Converted into videos
5. Which of the following is an example of unstructured data?
   a) Student marks in a table b) Attendance record
   c) Audio recording d) Sales data in a spreadsheet

B. Fill in the Blanks.

1. Data visualization transforms data into a _____ form such as charts or graphs.
2. A database stores data in _____ and columns.
3. Unstructured data includes _____ and videos.
4. Accuracy refers to how close a measurement is to the_____ value.
5. A pattern is something that appears _____ in the data.

C. Short Answer Questions.

1. What is data? Give two examples.
2. Differentiate between structured and unstructured data.
3. Why is data format important?
4. What steps are involved in preparing data for visualization?

5. Explain the difference between precision and accuracy with an example.

D. True or False.

1. Pie charts show how data changes over time.
2. Structured data is easy to search and analyse.
3. Valid data must be both accurate and precise.
4. Observation is a method of data collection.
5. Extra digits added during processing may reduce meaningful precision.

E. Identify the Skill Used.

SITUATION	**SKILLS USED** *(Data Collection / Data Organisation / Data Visualisation / Data Analysis)*
A student counts how many classmates come to school by bus.	
The cricket team captain arranges match scores in rows and columns.	
A student studies a line graph and concludes that marks improved over time.	
A pie chart is created to show favourite sports in the class.	
Duplicate entries are removed before preparing a chart.	

Chapters 4: Ethics and AI Bias Awareness

In the previous chapters, we explored how data is collected, organised, analysed, and visualised. We understood that Artificial Intelligence systems depend heavily on data. But an equally important question now arises:

Just because AI can make decisions, should it make every decision?

Technology is powerful. When that power influences hiring people for jobs, healthcare, banking, education, or security, it must be guided by ethical principles. AI is not only a technical system but also a social system that affects human lives.

What is Ethics in AI?

Ethics are the moral principles guiding us to be right, fair, and responsible. In our day-to-day life, ethics helps us to make choices about how to treat one another.

AI ethics is the study of how Artificial Intelligence is designed and used while considering important moral questions. It emphasises on how we generate, develop, and use AI systems responsibly. It also makes sure that AI systems promote objectivity, responsibility, transparency, integrity, and welfare of life on earth without any harm to anyone.

Ethical AI is about creating safe and efficient systems for society.

For example:

- ✓ Prediction about a disease risk must not be discriminatory based on race or income.
- ✓ The screening of job applications by AI, it must not disadvantage certain groups of people.
- ✓ The content recommended by algorithm must not give any harmful misinformation to the user.

Importance of Ethical Use of AI

→ **Prevent Discrimination**
AI systems keep learning from past data and patterns. The AI system may replicate the patterns of discrimination shown by the data in the past. Ethics provide a safety net which help to check unfair treatment based on gender, caste, creed, race, ethnic background, disability, or any other socio-economic bias.

→ **Build Trust**
To build trust for AI systems in the society, it has to be transparent about how it works and does not hide its decisions. Only then people will feel more confident using it. When technology is open and truthful, it becomes easier for users to rely on it.

→ **Ensure Responsibility**
Imagine a bank saying, 'The computer has not accepted your loan.' Can the computer be responsible for it solely? No. Humans must be accountable and responsible for the decisions and choices made by the machines using AI systems. If an AI system makes a wrong calculation or judgement, the organisation that created or used it must be held responsible.

Protect Privacy
AI systems manage huge amounts of personal data. Ethical use ensures strong data protection. Laws such as the General Data Protection Regulation and the California Consumer Privacy Act protect privacy rights and set rules for data safety.

→ **Legal Compliance**
Ethics are no longer just a choice. **The Digital Personal Data Protection Act**, 2023 sets rules for how personal data can be legally used in India. It gives people rights including being able to see their data, correct inaccurate information, and ask for it to be deleted. Before collecting personal data, organisations must obtain permission, and they can be punished for misusing it.

The Information Technology Act, 2000 offers a legal framework on cyber law, electronic transactions and responsibilities in cyberspace.
The Reserve Bank of India also sets rules for digital lending platforms that use automated tools in financial services. These guidelines ensure transparency and fairness in the lending operations.

Bias in AI

Bias is a term used in Artificial Intelligence to describe unfair outcomes that favour some groups over others. Always remember, machines do not have built-in biases. They usually come through biased training data.

- Inaccurate descriptions
- Inaccurate assumptions made while building the model
- Using the wrong or indirect data to represent something

AI systems use data to detect trends and patterns. If the data contains unfair patterns, the AI system may repeat or even increase those unfair patterns in its results.

What is Bias?

Have you ever seen someone make a decision without checking all the facts? Maybe someone says, '*Only tall students should be in the basketball team*.' But what if a shorter student is very skilled? That would be unfair. This kind of unfair preference is called **bias**.

Bias means an unfair preference for or against someone or something. Bias can happen in everyday situations.

Daily Life Examples

- Choosing only tall students for a team without checking their skills
- Thinking only boys can play cricket
- Assuming students from cities perform better than rural students

Bias can occur in people, but it can also appear in AI systems. Machines do not create bias on their own.

Bias usually comes from:

- The data used to train the system
- The way the system is designed
- Human decisions made during development

So, when people build AI systems, they must be careful.

Reflect on the following situation:

A sports teacher is selecting players for a basketball team. He is facing the students and pointing only to tall students. He asks them to stand in a line.

Two shorter students are standing nearby, holding basketballs and sports shoes in their hands, looking keen to play. They appear capable and prepared, but they are not being paid any attention.

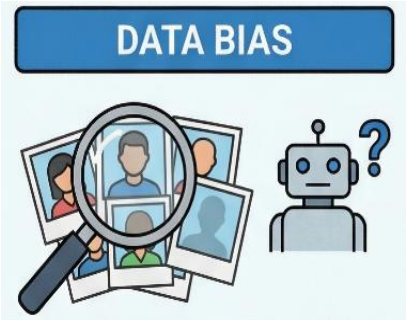
Bias happens when decisions are made without considering everyone fairly.

What are the various kinds of Bias?

Learning to identify various kinds of bias in society helps to understand how discriminating results can be generated by AI systems. Generally, bias is not intended. It usually happens because of the type of data used to train the AI system, the way the system is designed, or how certain factors are measured.

Some more common forms of bias

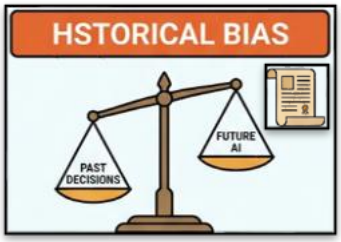
❍ Data Bias



When the data used to train an AI, system does not include some people or situations, it leads to Data bias. If some groups are absent or presented less, the system may not work well for them.

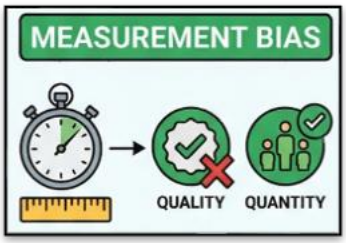
For example, if a facial recognition system is trained mainly on images of a particular group of people, it may be less accurate in recognizing others.

❍ Historical Bias



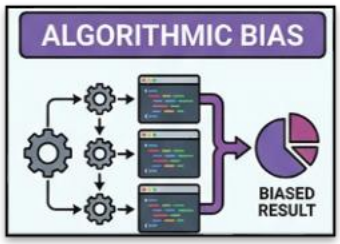
Historical bias happens when past discriminating decisions are included in the data. Since AI systems learn from historical data, they may replicate the previous mistakes. For example, if a past hiring decision has favoured a particular group, an AI system trained on that data may continue the same unfair trend.

❍ Measurement Bias



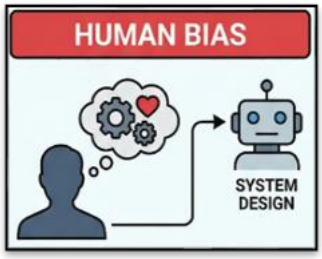
Measurement bias occurs when the wrong parameters are used to judge or measure something. Because of this, the result may not reflect the reality. For example, if an employee's performance is judged only by the number of hours put in to complete a task, it may ignore how well the work was done. In such cases, the record does not accurately reflect a person's performance.

❍ Algorithmic Bias



Algorithmic bias comes from the way the AI model is designed. Certain guidelines, assumptions, or giving too much importance to one factor may unintentionally favour one group over another. Even when the data is balanced, the design of the system may still lead to unfair results.

❍ Human Bias



AI systems are made and trained by humans. Human bias, traditions, or likings can influence the choice of data or the design of the system. This shows that AI is not completely unbiased and can imitate human choices.

Bias in AI can result in:

- Biased decisions when giving loans
- Unfair appointment or recruitment decisions
- Wrong predictions about crime risks

- Incorrect medical or health advice
- Mistakes in identifying people

AI systems work on a large scale, which is why biased choices may negatively affect many people. Even useful technology can face problems when people lose trust in automated systems.

Case Examples of AI Bias

Why ethical safeguards are necessary?

1. **Hiring Algorithm (2014–2018)**
   A company created an AI technology that helped review job applications by learning from resumes submitted over the last ten years. Since most of the resumes it reviewed were from men, the system began to favour male-related patterns. It assigned lower ratings to women's resumes.
   As a result, the AI system learned from this biased data and made unfair recommendations. When the company discovered this bias, it stopped using the technology and changed how the system worked.

2. **Facial Recognition Disparities**
   Researchers have found that some commercial facial recognition algorithms are much better at recognising the faces of light-skinned people more accurately than darker-skinned people. One well-known study found that systems made mistakes less than 1% of the time for light-skinned men but 30–35% of the time for darker-skinned women. This happened because the system was trained with limited and unbalanced data. Since it did not have enough examples from all the groups, it gave less accurate results.

3. **Healthcare Risk Prediction Algorithm**
   A healthcare system tried to predict how sick a patient might become by looking at how much money they had spent on medical treatment in the past. However, spending less money does not always mean a person is healthier. Some people spend less because they cannot afford treatment or do not have easy access to hospitals. Because of this, the system sometimes judged their health risk as lower than it actually was, even when their illness was just as serious.

Lessons learned from these mistakes

- Data can replicate the society and situations it comes from. It is never neutral.
- AI systems should be checked regularly to ensure the fairness.
- Using balanced and varied data helps diminish bias.
- Data should be reviewed before and after it is used in an AI system.
- AI systems need consistent monitoring to keep unfair results under check.

Responsible and Fair Use of AI

AI systems should help humans. But they should not completely replace human judgment.

Let us see how responsible AI can be used

Use AI Responsibly

The application of AI includes the accountability of both developers and users.

Human-in-the-Loop (HITL)

In high-risk industries including healthcare, law, and finance, the decision of humans must be final. AI should support human finding rather than take authority away from humans.

Transparency and Ability to Explain

AI systems should explain how they make decisions, very clearly. People should be able to aware of the reasons behind the achieved result. When the process is clear, it is easier to find errors and correct discriminating or biased decisions.

Data Privacy

AI systems should protect personal information. Any data collected must be kept safe, should be used only for right reasons, and not shared or misused without permission.

Ensuring Fairness in AI Applications

→ **Fairness takes effort.**
AI systems are not always unbiased and fair; they require hard work to be fair. To ensure impartiality, the system must be carefully designed from the beginning to make sure the system treats all people in a balanced and neutral way.

→ **Use diverse and balanced data.**
AI systems should be trained using balanced and diversified data. The people, ages, and social groups included in the AI training data should be different. If the data is missing or incomplete, the results may be wrong.

→ **Check for bias regularly.**
AI should be checked regularly to make sure that every person is treated equally without any discrimination and, if unfair trends are found, they should be corrected.

Avoid using sensitive characteristics unfairly.
Decision related to human beings must not be taken based on the factors like gender, religion, social or economic background and other sensitive areas. Everyone should be treated equally.

→ **Continuous monitoring**
Even after introducing an AI based system regular checks are important to make sure it is fair. AI systems need to be tested and upgraded over time because there is no assurance of bias free functioning of a system.

Digital Citizenship

In today's world, it is almost unimaginable living without technology. Attending classes online, posting on social media, streaming movies, playing online games, and searching for answers on the internet have become an integral part of human lives. Therefore, it is inevitable for us to depend on it. It makes it important to follow rules in the online world just as we do in the real world.

A good **digital citizen** always uses technology and the internet responsibly. Digital citizenship means using computers, smartphones, and tablets in a safe, responsible and respectful way. A responsible digital citizen knows how to use technology intelligently, recognize harmful content, safeguard personal information, and treat others online with respect.

A good digital citizen:

- Thinks carefully each time before posting anything online
- Respects others while communicating online
- Protects personal information.
- Uses technology for learning and positive purposes

Rights of Digital Users

Every user has some rights in the digital space.

- ✓ **Right to Access Information**
  Everyone has the right to explore information, learn on the Internet, and use digital devices for education and communication.
- ✓ **Right to Privacy**
  People have the right to keep their personal information safe. They must not use someone else's pictures, passwords, and confidential data inappropriately.
- ✓ **Right to Freedom of Expression**
  We can distribute our ideas and opinions. However, this freedom should not be used to spread harm, insults or hatred.
- ✓ **Right to Safety**
  Online users should feel safe and protected from cyberbullying, fraud and harassment.

Responsibilities of Digital Users

Let us see one example of Cyberbullying

There was a quiet student named **Ishaan** in a school. A few students thought it would be fun to make a fake social media account pretending to be him. They posted silly, embarrassing things like they were him. Soon enough, other students all over school were laughing at Ishaan, thinking he was the one posting those messages. He got so terrified, embarrassed and felt helpless to the extent that he just stopped coming to school.

This kind of **cyberbullying** is extremely **dangerous**. What we learn from this example is that every online action has consequences. We must take responsibility and always respect others' identity and dignity. We must not humiliate anyone whether it is online or offline.

Remember rights do come with duties. In order to keep the Internet a safe place to operate, users must act responsibly.

- **Respect Others**
  Do not write mean or false things about others online. Do not spread rumours about friends or classmates. Do not attack or bully anyone.
- **Protect Personal Information**
  Never share passwords, OTPs, addresses or your personal photographs. Always think carefully before uploading or sharing anything online.
- **Think Before You Click or Share**
  All information on the internet is not always true. Always check or verify information before forwarding messages or posting news.
- **Follow rules and laws**
  Downloading suspicious files, hacking accounts, or spreading false information is wrong and may be punishable by law.
- **Maintain a Positive Digital Footprint**
  Information shared online can stay there for a long time. Always maintain a positive online profile.

Why Digital Citizenship Is Important

The internet is used by millions of people around the world. A single thoughtless or inconsiderate post can cause harm to a large extent. When each of us acts as an accountable digital citizen, the internet becomes a courteous, friendly, and harmless community.

Digital citizenship shows that when technology is used responsibly, it can be a great resource for learning, creating, and connecting.

Points to remember:

- ✓ Ethics in AI- It means making sure AI systems are rational, transparent, responsible and harmless for everyone.
- ✓ Bias in AI- It occurs when systems produce biased results that favour some groups over the others.
- ✓ Responsible AI – It requires human intelligence, transparency, privacy protection and continuous monitoring.
- ✓ Digital citizenship- It means using technology responsibly, respectfully and safely.

Exercise

A. Multiple Choice Questions.

1. Which of the following is an example of structured data?
   a) Video footage b) A table of student marks in a spreadsheet
   c) A written paragraph d) A collection of photos in a gallery
2. AI bias mainly comes from:
   a) Equal results for all b) Wrong math answer
   c) Fast internet d) Facial recognition errors for darker skin
3. Human-in-the-Loop (HITL) means:
   a) AI decides alone b) Humans check final decisions
   c) No monitoring d) AI ignores humans
4. Which principle protects personal data?
   a) Fairness b) Transparency
   c) Privacy d) Speed
5. Which is a responsibility of a digital citizen?
   a) Spread rumours b) Share passwords
   c) Verify information d) Hack accounts

B. Fill in the Blanks.

1. Ethics guide us to be fair and _____.
2. AI systems learn patterns from _____.
3. Using _____ and balanced data helps reduce bias.
4. Digital users have the right to _____.
5. Human-in-the-Loop keeps _____in final control.

C. Short Answer (2–3 lines)

1. What is AI ethics?
2. Give one example of historical bias.
3. Why is transparency important in AI?
4. Name two rights of digital users.
5. What is data bias?

D. Case-Based Questions

1. A hiring system prefers male candidates based on the past data which included mostly men.
    - What type of bias is this?
2. A health AI diagnosis illness based only on money spent on treatment.
    - What type of bias is this?
3. A loan application is rejected by AI.
    - Why should a human review the decision?
4. A student shares false news online.
    - Which responsibility is not followed?

E. One-Word Challenge

Write one word that matches the description:

DESCRIPTION	ONE WORD
Repeating past unfair patterns	
Missing groups in training data	
Final decision taken by humans	
Moral rules that guide decisions	
Responsible use of technology	

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