Computational Thinking and Artificial Intelligence

Class 8

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.

Learners engage with problems involving powers and number systems, proportional reasoning, geometric configurations and structured distributions, requiring decomposition of multi-variable scenarios, identification of complex patterns and design of stepwise algorithms under constraints. The Artificial Intelligence component deepens understanding of the AI project lifecycle, data-driven decision-making and ethical considerations such as bias and fairness, enabling students to critically analyse how data and models influence outcomes. The document also provides pedagogical guidance, resources, and assessment support aligned with NEP 2020 for effective classroom implementation.

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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, defense, 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 focusing 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, and ethical decision-making abilities, leading to individual flourishing and the creation of responsible digital citizens.
- **Interdisciplinary Relevance:** Embedding CT and AI concepts helps students develop an integrated view of the world by connecting various disciplines such as Mathematics, Science, and Humanities, showing that knowledge is not compartmentalized.
- **Innovation and Entrepreneurship:** At its core, CT and AI are about solving problems and devising innovative solutions, which leads to an entrepreneurial and innovative mindset.
- **Ethical Awareness:** Study of CT & AI will sensitize 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:** Develop 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 solve advanced, multi-layered problems involving abstract relationships and hidden structures, using:

- properties and relationships of numbers (powers, factors, remainders, divisibility)
- generalization across different number systems (decimal, binary, ternary, Roman, Chinese numerals)
- spatial visualization of 2D and 3D figures, including overlaps, intersections, and transformations
- logical interpretation of symbols, codes and operations representing numerical or algebraic ideas
- identification of essential information by ignoring irrelevant or misleading data

PATTERN RECOGNITION

Students will be able to identify, compare and extend complex patterns involving multiple simultaneous changes, formed using:

- Powers, exponents and numerical structures
- Relationships across different representations of the same number
- Geometric configurations and shape-based sequences
- Conditional patterns based on rules, constraints or dependencies
- Mixed patterns involving numbers, symbols, shapes, and movement

DECOMPOSITION

Students will be able to break down high-order logical problems into manageable components by:

- Separating given conditions, constraints, and goals
- Analyzing multi-step processes such as distribution, transfers and exchanges
- Breaking numerical expressions into simpler equivalent forms
- Interpreting tables, grids, networks and diagrams with multiple dependencies
- Structuring problems involving multiple variables, positions or cases

ALGORITHMIC THINKING

Students will be able to design, follow and evaluate multi-step logical procedures to solve problems involving:

- Rule-based transformations of numbers or symbols
- Stepwise movement on grids, tracks or paths with constraints
- Conditional instructions (if–then, either–or, must/must not)
- Sequential decision-making under given limitations
- Optimisation problems involving maximum or minimum outcomes

Artificial Intelligence (AI) Learning Outcomes

By the end of Grade 8, learners will be able to:

- Describe the stages of the AI project cycle as a stepwise structure (Define Problem, Collect Data, Test AI Tools, Reflect and Improve)
- Apply no-code tools to tackle real-world problems and reflect on their utility/effectiveness
- Explain how AI uses data, find and research sources of bias in datasets, and apply basic strategies to ensure fairness and inclusivity
- Recognize how bias in AI leads to unfair conclusions and realize the importance of accountability, privacy, and serving human interests
- Explain the uses of AI in daily life and understand AI as a specific type of algorithm that uses datasets, learning and prediction
- Analyse contributions of AI to fields like healthcare, automation, and education, understanding both benefits and risks
- Describe AI ethics as the values and guidelines that ensure AI is created and used responsibly

4. Mapped with NEP and NCF 2023:

- The National Education Policy (NEP) 2020 aims to position India as a leader in emerging fields by integrating AI, Machine Learning and CT into school education

- The National Curriculum Framework for School Education (NCF-SE), 2023 serves as the foundation for implementation, drawing Curricular Goals from the Aims of Education.
- Learning standards are designed as foundational capacities that are progressive, age-appropriate, and aligned to NCF-SE 2023.

5. Time Allocation:

The Middle Stage suggests 100 hours annually, allocated as follows for Grade 8:

- **Advanced CT Skills:** 40 hours per academic year
- **Introductory Concepts of AI:** 20 hours per academic year
- **Interdisciplinary Projects:** 40 hours total (20 hours for each of the two required projects)

6. Approach / Pedagogy:

- **Activity-Based:** Use of complex puzzles, riddles, and games to build on previous CT abilities
- **Experiential Learning:** Delivering fundamental AI concepts through explanations, demonstrations, and hands-on experience
- **Collaborative Work:** Organising group discussions, debates and collaborative projects that integrate CT & AI
- **Inquiry-Based:** Independent student activities such as data collection, organisation, analysis, and creation of diagrams/flow charts using digital tools or manually
- **Ethical Reflection:** Case studies and debates on the social impact and ethical use of AI.

7. Assessment:

Assessment is continuous, formative and competency-based, focusing on the ability to apply knowledge rather than rote memorization. Methods include:

- Written Tests and Practical Examinations
- Interactive Group Activities
- Thematic Projects and Reflective Journals
- Teacher Observation Journals and Group Discussions

8. CT and AI Transition:

Computational Thinking forms the intellectual backbone and foundation for learning AI. The curriculum follows a phased approach where CT skills—like breaking problems into parts and spotting patterns—build the cognitive structures necessary for students to eventually understand and create AI-driven solutions.

How to Use This Book?

PART-1 Computational Thinking

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

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 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.

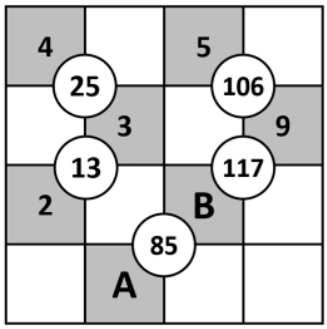
Teachers should approach the book with the mindset that the process of thinking is more important than arriving at the correct answer. Creating a safe and encouraging environment where students feel comfortable making mistakes, exploring multiple strategies, and expressing their reasoning is essential.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

PART-1

COMPUTATIONAL THINKING

Chapter 1: A Square and a Cube

1. In the following grid, all the circles follow the same theme. What will be the value of A + B?



a) 12 b) 14 c) 13 d) 15

---

2. Sam writes a list of natural numbers. The list has three perfect cubes and three perfect squares. If no number in the list has more than two digits, what is the MINIMUM number of distinct numbers he must have written?

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

---

3. If AB is a two-digit number whose cube is in the form of a 4-digit number "__ __ __ C" such that A < C < B, how many different values can C have?

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

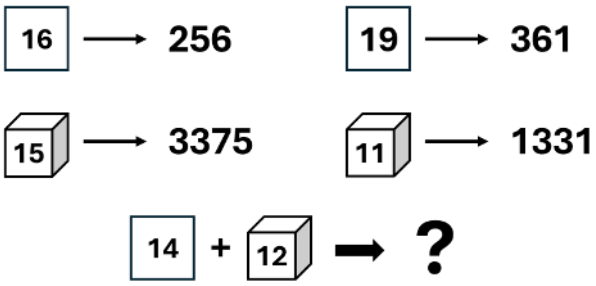
---

4. 56 × k is a perfect cube where k is a natural number. What could be the smallest possible value of k?

a) 36 b) 49 c) 56 d) 72

---

5. Each geometrical shape denotes a certain operation. What will come in place of "?"



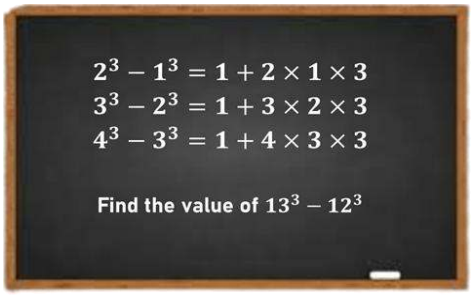
a) 2888 b) 1914 c) 1924 d) 340

---

6. XYZ is a 3-digit number such that it is the square of a multiple of 5. What will be the HIGHEST possible remainder of (XYZ)/100?

a) 10 b) 15 c) 20 d) 25

7. **A class teacher wrote the following pattern on the board, where an expression is written after the "=" sign in each row. She then asked the class to find the expression for 13^3 - 12^3. Which DIGIT appears the HIGHEST number of times in the expression that denotes 13^3 - 12^3?**



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

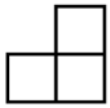
---

8. **Fill in the grid with the squares and cubes of digits 2 to 5 such that:**
   - **Each square/cube number appears twice**
   - **Both square and cube of the same number cannot appear in the same row/column**
   - **Same numbers do not appear diagonally**

   What is the maximum possible sum that can be obtained by the cells present in the configuration of Shape A (without rotation)?

64			4
27	125		
8		9	25
		16	

GRID

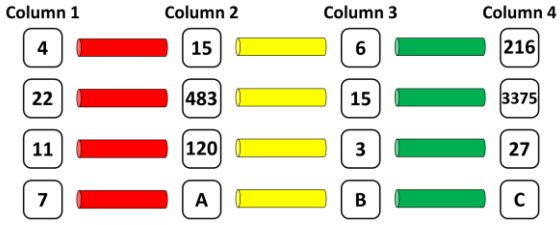


Shape A

a) 197 b) 161 c) 193 d) 216

---

9. **The image below shows a logic machine, where numbers move from Column to Column (starting from column 1 as input and reach column 4) through the tunnel, where they change in a different way, each time. What would be the sum of A, B, and C?**



a) 2259 b) 1795 c) 180 d) 1788

---

10. **Every column follows a certain rule. What number should come in place of "?"**

CL1	CL2	CL3	CL4
16	28	25	12
9	7	16	27
12	14	20	?

a) 17 b) 18 c) 19 d) 21

The Thinking Spot

Boxes are stacked in four columns A, B, C, and D, such that:

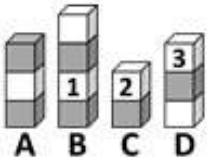
• Each box is labelled with a number from 1, 2, and 3, with labels on some of the boxes already shown in the image given below

• No two adjacent boxes in the same column are labelled with the same number

• No two adjacent columns have the same number on the topmost box

• For every column, the sum of the numbers labelled on the topmost and bottommost block is equal

In the shaded boxes, which of these numbers will occur the HIGHEST number of times?



a) 1 b) 2 c) 3 d) All of them occur equally

Chapter 2: Power Play

1. **Each term is written in exponential form. If the terms are rearranged in ascending order of their numerical values from left to right, how many terms remain in the same position as in the original arrangement?**

Left $4^3, 2^4, 3^3, 2^8, 5^2, 3^6$ **Right**

a) 0 b) 1 c) 2 d) 3

---

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

6, 26, 126, 626, ?

a) 3125 b) 3126 c) 926 d) 916

---

3. **A team is to be formed from a group of 7 students: A, B, C, D, E, F, and G where:**
   - **A and B cannot be in the same team, but at least one of them must be included in the team**
   - **C and D must either both be included or both be excluded from the team**
   - **E and F must either both be included or both be excluded from the team**

   If the team consists of 4 students, in how many different ways can it be formed?

a) 2 b) 4 c) 3 d) 6

---

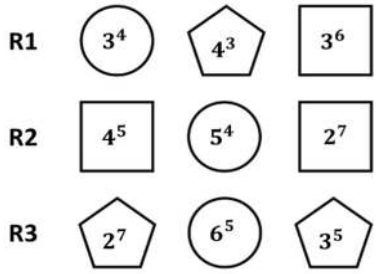
4. **Let X, Y, and Z be single-digit whole numbers. The number XY is a two-digit number formed using digits X and Y.**
   If $4000 < (XY)^Z < 5000$, what is the minimum possible value of XY?

a) 10 b) 16 c) 17 d) 15

---

5. **Raj must select three numbers from the grid from three DISTINCT shapes such that:**
   1. **Each number is chosen from a different row**
   2. **The number selected from Row R1 is the nth power of 3**
   3. **No digit is repeated among the bases and exponents of the chosen numbers**

   Based on these rules, what is the sum of the three selected numbers?



a) 1881 b) 7968 c) 1482 d) 1100

6. **A man has a bag with a maximum capacity of 2^4 units. He earns certain points for the books he carries in that bag and the load of each book is shown in the table below:**
   - **For every Management book added to the bag, 2 Fiction books must be added**
   - **For every Mathematics book added to the bag, 2 Physics books must be added**

   If he has to carry at least one book of each genre, what is the maximum number of points he can earn without exceeding the bag's capacity?

BOOK GENRE	LOAD	POINTS
Management	2^2	2^5
Mathematics	2^1	2^4
Physics	2^0	2^3
Fiction	2^0	2^2

a) 116 b) 120 c) 112 d) 104

---

7. **How many possible combinations of 1 owl and 1 tree can be made from 3 owls and 5 trees?**

a) 9 b) 10 c) 15 d) 16

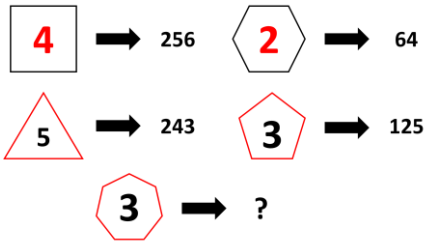
---

8. **Sam has Rs. 4000 in such a way that he has Re. 1 coins in power of 10, Rs. 2 coins in power of 5, Rs. 5 coins in power of 2, and the remaining coins of Rs. 10. The amount of money of each individual denomination of Re. 1, Rs. 2, and Rs. 5 is greater than or equal to thousand. At MAXIMUM, how many coins of Rs. 10 can he have?**

a) 53 b) 47 c) 38 d) 45

---

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



a) 243 b) 125 c) 343 d) 2187

---

10. **Sam and Tim are playing a number-maximizing game. Their numbers are shown in the table below (where A and B are undefined). They must modify their numbers using ONLY ONE of the following rules:**
    - **If the base is smaller than the exponent, the base n is replaced with 1/n**
    - **If the base is greater than the exponent, the exponent n is replaced with 1/n**

    Sam and Tim choose A and B and apply the rule exactly once in a way that maximizes their own numbers. What is the difference between the final numbers of Sam and Tim, where A and B are single-digit natural numbers?

Sam's number	4^A
Tim's number	B^2

a) 2 b) 3 c) 1 d) 0

The Thinking Spot

Enter all the letters and the numbers of the Set in the empty squares of the grid given below, such that:
- Every vowel must have an even number in at least one of its adjacent squares
- The letter 'H' is not adjacent to 'A' or 6
- Two consecutive numbers cannot be in any adjacent squares
What will come in place of "?"
Note: *Squares are considered to be adjacent only if they share a common side. Squares sharing a common corner are not considered adjacent*

	5	
3	?	H

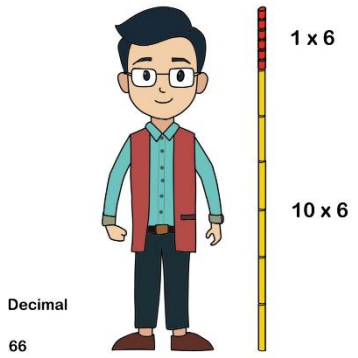
Set: A, E, Y, 2, 4, 6

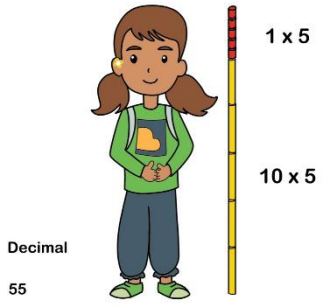
a) 6 b) Y c) E d) A

Chapter 3: A Story of Numbers

Activity Time

Measure your Height





Activity: Measuring your Height

1: Measuring your height with Decimal Pipes

We generally measure our height in the decimal number system, i.e., using base -10 numbers. We use powers of ten 10^0, 10^1, 10^2, 10^3, … (1, 10, 100, 1000, …) and digits from 0 to 9 (ten distinct symbols), to represent any number that exists.

Imagine now that you are measuring heights using PVC pipes of fixed lengths:
1 inch, 10 inches, 100 inches, and so on. Each pipe size is a power of 10. You also have 9 pipes of each length.

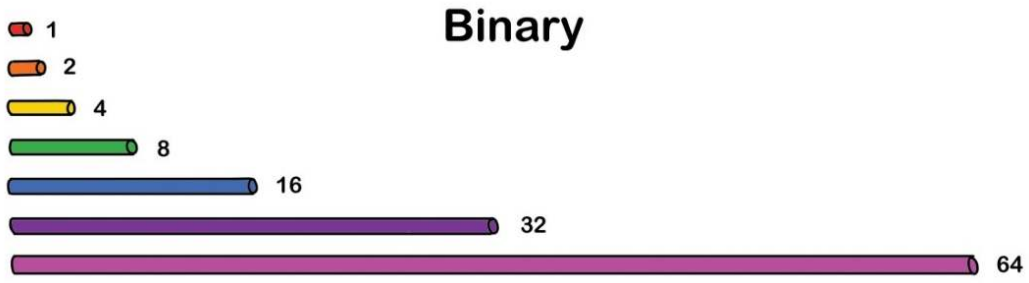
1. **How many of the decimal pipes will it take to measure the height of a 66-inch-tall person?**
   a) 21 pipes: 5 pipes of 10 inches height and 16 pipes of 1 inch height
   b) 7 pipes: 7 pipes of 10 inches height
   c) 9 pipes: 6 pipes of 10 inches and 3 pipes of 2 inches height
   d) 12 pipes: 6 pipes of 1 inch and 6 pipes of 10 inches

2: Measuring your height with binary pipes

We keep hearing that the language of computers is binary, the language of 0 and 1. But what are these binary numbers? How do we understand these in light of what we already know?

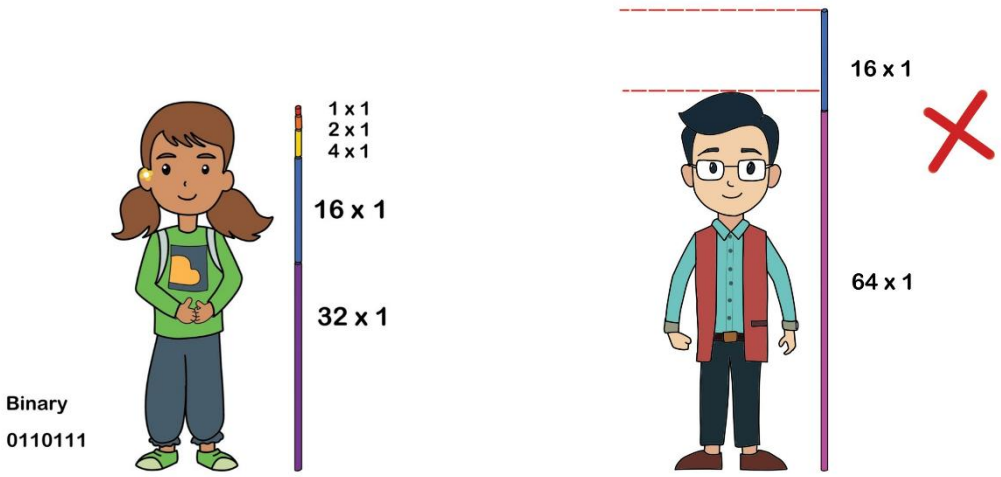
Instead of using decimal pipes, which are powers of 10, what happens if we use pipes of length 1, 2, 4, 8, 16, 32, 64, and so on? What is special about these numbers?

They are powers of 2. We have exactly one copy of each pipe length. We will call these pipes Binary pipes.



Let's measure a height in binary. For example, 55 = 32 + 16 + 4 + 2 + 1. We can tabulate the information below. Using this, we can say that the binary representation of 55 is $(110111)_2$.

55 in binary	$2^5=32$	$2^4=16$	$2^3=8$	$2^2=4$	$2^1=2$	$2^0=1$
$(110111)_2$	1	1	0	1	1	1



1. **Which all binary pipes will we use to measure the height of a 66-inch-tall person?**
   a) 63, 3
   b) 32, 16, 8, 4, 2, 1, 2, 1
   c) 64, 2
   d) 32, 32, 2

---

2. **Binary representation of 10 is:**
   a) 1010 b) 1111 c) 1000 d) 1100

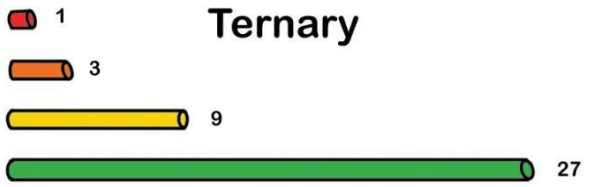
---

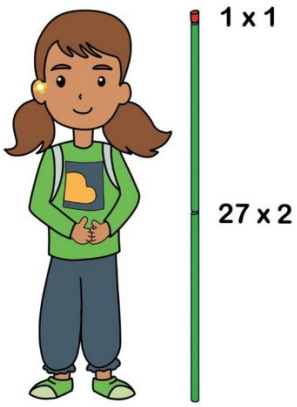
3. **Why can't we use the digit "2" in the representation of a number in binary?**
   a) It is illegal, as only 0 and 1 are given to us in the rules
   b) We can write any number using 0 and 1; there is no need for 2
   c) Computers dislike it
   d) It is too big

3: Measuring your height with ternary pipes

Instead of base 10 (decimal) and base 2 (binary), what if we set the base to something else, for example, 3?

Then we will have pipes of lengths 1, 3, 9, 27, 81…, all powers of 3, and 2 pipes of each length.





55 inches is 54 + 1 = 2 x 27 + 1 x 1.

55	3^3	3^2	3^1	3^0
$(2001)_3$	2	0	0	1

1. **When we measure 66 inches with ternary pipes, how will its representation be?**

   a) 2011 b) 2101 c) 2110 d) 2210

2. **What is the largest digit allowed in Base 3?**

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

3. **How will we write 100 in base 3 (ternary) notation?**

   a) $(3201)_3$ b) $(2333)_3$ c) $(11000)_3$ d) $(10201)_3$

Conclusion

We see that a number can be represented in many forms and symbols. Decimal notation is one of the many possible base number systems (Positional value system).

The fundamental idea is that we arrange the powers of the base number n in increasing order from right to left.

The face value at each place tells us how many times the corresponding power of the base is used to represent the number.

We also see that the base n system requires n distinct digits. These digits are 0 till n - 1.

Questions

1. **Some terms are missing in between the sequence. Find the missing terms in the order from left to right. VII, VI, VI, VII, V, VIII , _____ , _____ , III , X**

   a) VI, IX b) V, VIII c) IV, IX d) IV, V

---

2. **Find the odd one out from the following:**

   a)

   b)

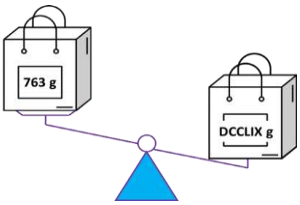
   c)

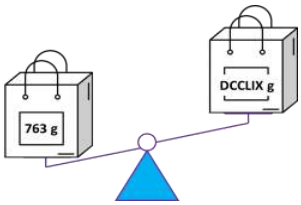
   d)

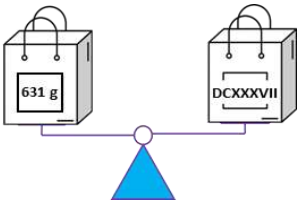
---

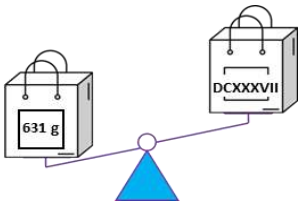
3. **In each of the given options, the weight of one bag is written in the Roman numeral form and that of the other bag is in Hindu - Arabic form. Identify the option that displays the tilt of the balance correctly.**

   Note: *The balance tilts towards the larger weight*

   a) 

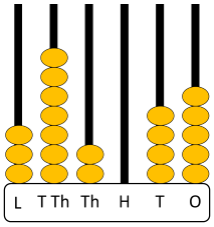
   b) 

   c) 

   d) 

---

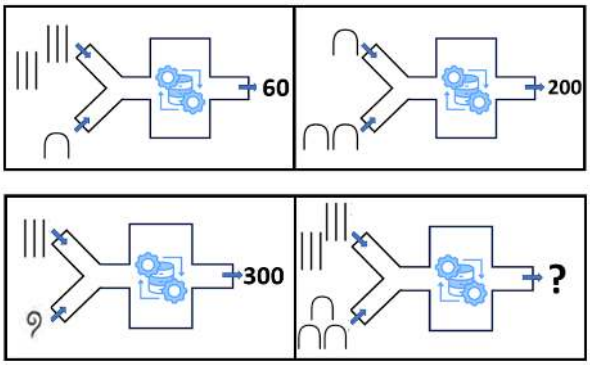
4. **On the abacus, select two poles, A and B, where pole B has fewer beads than pole A. Exactly one bead from pole A must be moved to pole B.**
   If more than one pole has fewer beads than A, move the bead to the pole that has the maximum number of beads among those poles.
   After making this single move, what is the highest possible 6-digit number that can be formed?

   a) 3,62,046 b) 4,72,035 c) 4,72,046 d) 4,62,045

5. What will come in place of "?"

Note: *All the numerals on the left of each term are from the same number system*



a) 18 b) 90 c) 36 d) 180

---

6. A 3 - digit code is formed using Chinese numerals (Zongs) and Roman numerals. Each row represents a guess, along with a statement describing how correct the guess is. Using these clues, determine the correct code.

IX	V	卌	One digit is correct but incorrectly placed and incorrect numeral
卌	丨	丅	One digit is well placed but wrong numeral
III	VIII	‖	No digit is correct
卌	VI	|||||	Two digits in the right numerals are correct but in the wrong positions.
‖	|||	IV	One correct digit at incorrect position and incorrect numeral

a) V |||| 丅 b) ||||| |||| VI c) |||| 卌 VI d) |||| ||||| 丅

---

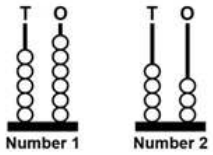
7. If certain numbers are coded as shown in the image, what would be the code for 208?

Number	Code
1	I
3	○
12	△○
34	□○○I
87	▽○○

a) ▽▽□△△I b) ▽▽□△△○

c) ▽▽□△○I d) ▽▽△△○I

8. **Two 2-digit numbers are represented below by stacking balls on poles. If you can shift/move EXACTLY ONE ball from a pole to any of the other three poles, what will be the MINIMUM possible difference between the numbers, finally?**

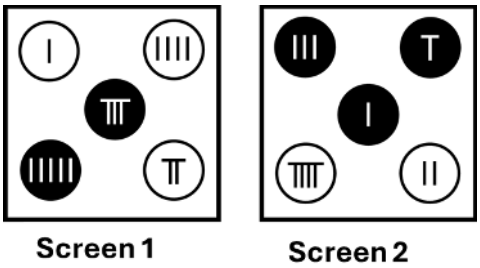


a) 1 b) 2 c) 11 d) 13

---

9. **Sam wants to create a 4-digit password using the buttons (Chinese numerals - Zongs) from the given screens. He must press the buttons in the same sequence as he wants the digits in the password to appear.**
   - **Every next button pressed must have a greater digit than the previous button**
   - **No two adjacent digits in the password can be selected from the same screen and from buttons of the same colour**

   How many different passwords can Sam form?

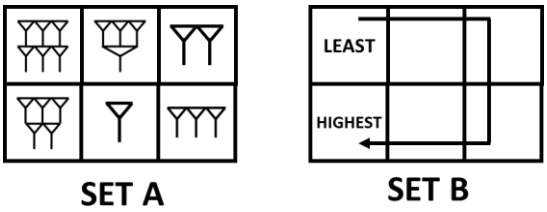


a) 1 b) 2 c) 3 d) 4

---

10. **Rearrange the numbers in Set A into ascending order, as shown in Set B. The blocks can be rearranged only by swapping adjacent blocks. What is the MINIMUM number of swaps required to do this?**

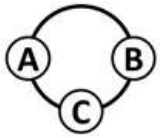
    Note: *Blocks that have common sides are considered to be adjacent. Blocks that have a common corner alone are not adjacent*

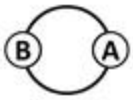


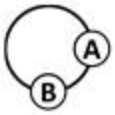
a) 3 b) 4 c) 5 d) 6

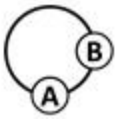
The Thinking Spot

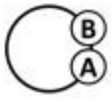
As shown below, A, B, and C are positioned at different starting points on a circular track. B runs at half the speed of A, while C runs at twice the speed of A.
If all three start running at the same time and in the same direction, what could be the positions of A and B by the time C completes one full round of the track?



(a) 

(b) 

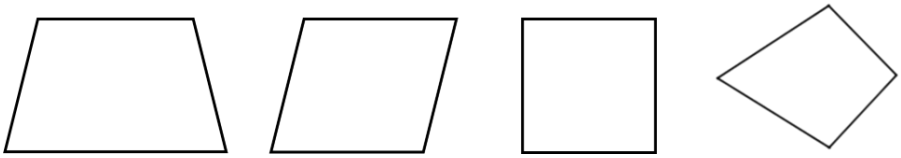
(c) 

(d) 

Chapter 4: Quadrilaterals

1. **Raj colored the following shapes (Trapezium, Parallelogram, Square, Kite) in Red, Yellow, Green, and Blue, not necessarily in the same order.**
   - **The shape colored in Red has no parallel sides**
   - **The shape with each of its angles equal to 90°, is not Yellow**
   - **The shape with two pairs of parallel sides is not Green**

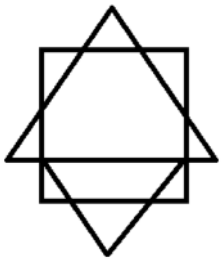
   Which shape did he color in yellow?



a) Trapezium b) Parallelogram c) Square d) Kite

---

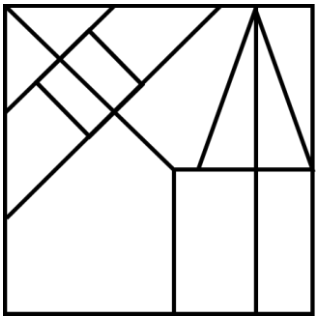
2. **How many quadrilaterals are there in the given figure?**



a) 8 b) 9 c) 10 d) 11

---

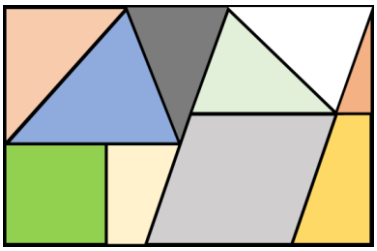
3. **How many rectangles are there in the given figure?**
   Note: *For the purpose of this question, please count all squares also as rectangles*



a) 8 b) 9 c) 10 d) 11

---

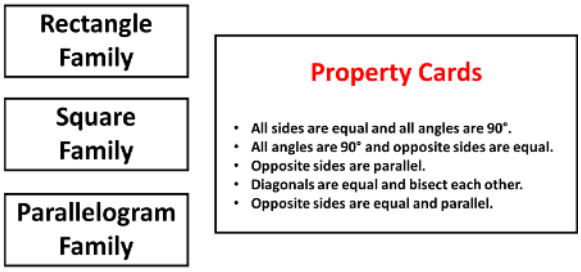
4. **In the given tangram, how many quadrilaterals are made with exactly 3 colored tiles?**



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

5. **Below are three families of shapes and a set of Property Cards.**
   - **A property card should be placed into a family if the property applies to that family**
   - **A single property may belong to more than one family**

   After placing all the property cards, which family will have the maximum number of properties?



a) Square Family b) Rectangle Family c) Parallelogram Family d) Both a and c

---

6. **In the grid, each letter stands for the initial of a shape: Square, Rhombus, Kite, Trapezium, and Parallelogram. How many pairs of adjacent letters represent two shapes in which the diagonals bisect each other?**

R	K	S	P	T	R	P	S	T	P	R	S	K

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

---

7. **Find the option that does NOT belong to the elements in the given set.**
   Set = (Angle between diagonals of a Rhombus, Each angle of a rectangle, Each angle of a square)

   a) Angle inscribed in a semicircle
   b) Half of sum of opposite angles of a Cyclic Quadrilateral
   c) Each angle of an Equilateral Triangle
   d) Angle opposite to Hypotenuse in a Right - Angled Triangle

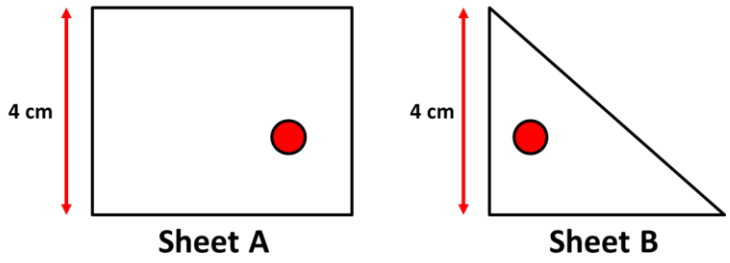
---

8. **Which shapes from the given options will NOT form a quadrilateral when any two identical shapes are joined along any one of their sides?**
   Note: *You can rotate the shapes but they cannot overlap each other*

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

---

9. **Two transparent sheets are shown below. Sheet A is a rectangle and Sheet B is a right-angled triangle. Rearrange the sheets so that the red points overlap exactly (without rotating or flipping the sheets). How many quadrilaterals are formed in the final figure?**



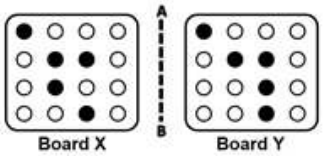
a) 3 b) 4 c) 5 d) 6

10. Paul and Sam are at different positions and start walking in opposite directions but along parallel paths. After covering the same distance, each of them turns toward the starting point of the other person and walks straight (without taking any other turns) until they reach each other's starting points. What can we say for certain about the shape formed by BOTH their paths together?

a) The shape of the paths is a rectangle
b) It has no lines of symmetry
c) Opposite sides are of same length
d) Both options a and c

The Thinking Spot

Given below are two boards, X and Y. Clicking any circle on Board Y changes its colour from black to white, or white to black.
What is the MINIMUM number of clicks required to transform Board Y into the MIRROR IMAGE of Board X?



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

Chapter 5: Number Play

1. **A, B, C, D, and E are five distinct whole numbers, with 16 as the smallest number. When arranged in ascending order, the difference between any two consecutive numbers is 8.**
   - **It is given that D is the greatest number and A is the least**
   - **Also, B is greater than E but less than C**

   Which of the following numbers is definitely divisible by 32?

   a) A b) B c) C d) E

---

2. **A control panel has three bulbs - A, B, and C. Each bulb is associated with one fixed divisor (greater than 3). A bulb glows whenever the entered number is divisible by its own divisor. A technician tested the panel with several numbers and noted which bulbs glowed, as shown in the table below.**

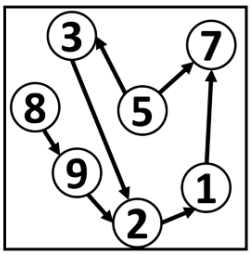
   Using this information, if 56 is entered, which bulb(s) will glow?

Number entered	Bulbs that glow
12	A,B
16	B
35	C
42	A,C
18	A

   a) A and C b) Only B c) B and C d) A and B

---

3. **Using the digits shown in the Box, form the largest possible 6-digit number that is divisible by 9 (without repeating the digits). In the number formed, which place values contain digits that point to a greater digit than themselves in the box?**



BOX

   a) Hundreds and Ones b) Ones and Tens c) Thousands and Tens d) Ones and Thousands

---

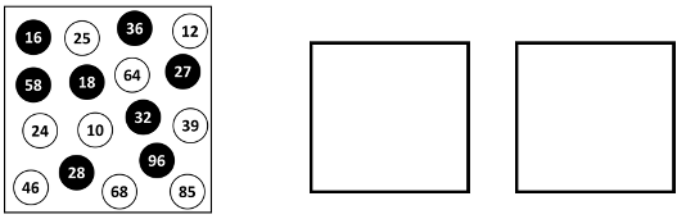
4. **Sam has two different two-digit numbers such that:**
   - Both numbers are divisible by 9
   - None of the numbers is a multiple of 18

   What is the LEAST possible sum of the two numbers?

   a) 45 b) 72 c) 63 d) 54

5. **The numbers of the SET will be distributed to the Box 1 and Box 2, based on the conditions given below:**
   - **If the number is a multiple of 4 it goes to Box 1**
   - **If the number is a multiple of 6 it goes to Box 2**
   - **If the number is a multiple of both 6 and 4 it goes in both the boxes**

   Find the ratio of the number of BLACK CIRCLES in Box 1 to the number of WHITE CIRCLES in Box 2, finally.



SET **Box 1** **Box 2**

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

---

6. **Ashish and Devika together choose two different numbers from 2 to 24 (both inclusive). The chosen numbers are multiplied, and the product is divided by 25. The remainder decides the result:**
   - **If the remainder is less than 10, Devika wins**
   - **If the remainder is more than 14, Ashish wins**
   - **In all other cases, the game is a draw**

   What is the minimum possible sum of the numbers chosen by Ashish and Devika such that Ashish wins the game?

   a) 7 b) 8 c) 9 d) 6

---

7. **On the six faces of a die, even numbers from 2 to 12 are written.**
   - **All multiples of 4 are written on adjacent faces such that no two of these faces are opposite to each other**
   - **The sum of the numbers on any two opposite faces is always greater than 10**

   Which of these pairs are written on opposite faces?

   a) 8 and 10 b) 12 and 6
   c) 2 and 12 d) Cannot be determined

---

8. **In the year 2020, Simran's age was a multiple of 6. In the year 2024, her age was a multiple of 11. Which of the following could possibly be the age of Simran in the year 2024?**

   a) 11 years b) 22 years c) 33 years d) 44 years

---

9. **The middle number of 5 consecutive even numbers is 5p. Exactly two numbers in the sequence are divisible by 4, and only one is divisible by 5. Among the following values, which could be the possible value of p.**

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

10. A cryptarithmetic multiplication is shown below. Here, P, Q, M, and N are distinct single-digit natural numbers. MN represents a two-digit number, and PQN represents a three-digit number. What is the smallest possible value of P + M?

$$\begin{array}{r} MN \\ \underline{\times\ \ 6} \\ PQN \end{array}$$

a) 3 b) 1 c) 4 d) 5

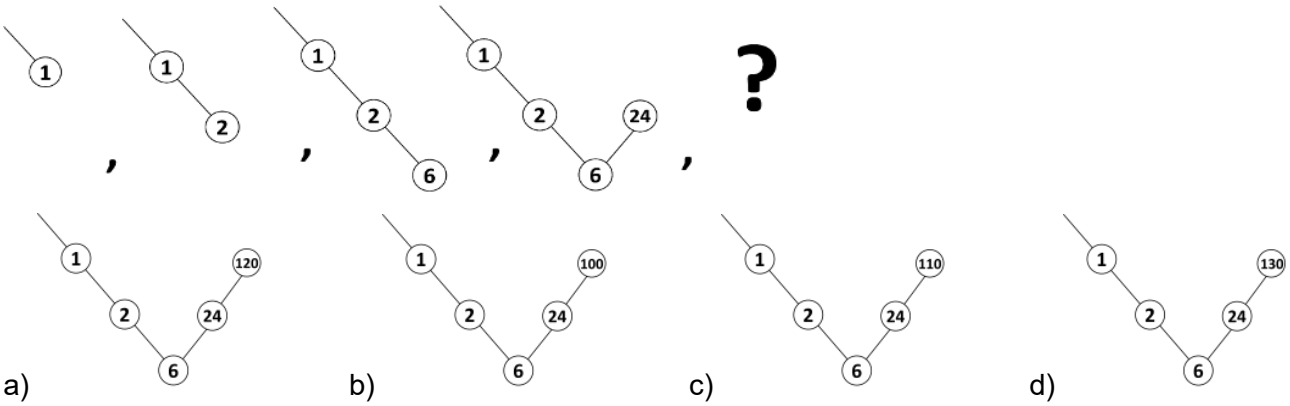
The Thinking Spot

There are 9 switches in a row on a switchboard. 3 of them belong to lights and the remaining are of fans.
Every two consecutive light switches have exactly two fan switches between them. The switch at the extreme right is NOT a light switch and the switch at the extreme left is NOT a fan switch.
Which of them is definitely a light switch?

(a) 2nd switch from the left (b) 3rd switch from the left
(c) 6th switch from the right (d) 5th switch from the left

Chapter 6: We Distribute Yet Things Multiply

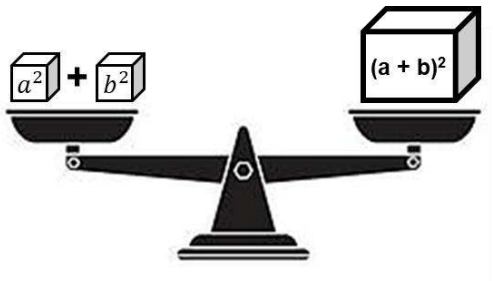
1. What will come in place of "?"



a) b) c) d)

---

2. On a weighing scale, both a and b are whole numbers. Which conclusion is logically correct?



a) The scale can balance only when one of the numbers is 0
b) The scale can balance for any values of a and b
c) The scale can balance only when a = b = 1
d) The scale can balance only when a and b are single - digit natural numbers

---

3. There are 49 sets of marbles, numbered from 1 to 49. The set numbered k contains k marbles. The marbles in set 49 are sold at ₹1 per marble, those in set 48 at ₹2 per marble, those in set 47 at ₹3 per marble, and so on, with the price per marble increasing accordingly. What is the difference between the maximum and minimum total amount for which a set of marbles can be sold?

a) $49^2 - 25^2$ b) $25^2 - 7^2$ c) $49^2 - 7^2$ d) $50^2 - 25^2$

---

4. A merchant has ($19^2 - 1$) coins. He must distribute the coins to some children.
The number of children is equal to the number of distinct prime factors of 30.

- **First, each child receives 4 packs of 6 coins each**
- **Then, after this distribution, the merchant must give each child 3 more packs of 6 coins each, ONLY IF the remaining coins are more than half of the original count**

Which of the following expressions represents the number of coins finally left with the merchant, after the distribution(s)?

a) $(19^2 - 1) - 3(6 \times 4)$
b) $(19^2 - 1) - 3(6 \times 4 + 3 \times 6)$
c) $(19^2 - 1) - 3(6 \times 4 - 3(3 \times 6))$
d) $(19^2 - 1) - 5(6 \times 4 + 3 \times 6)$

5. **A two-digit number XY is formed using two different digits. When the sum of its digits is added to the number, a new number is formed, which is divisible by 3. Which of the following will be DEFINITELY true about the new number?**

a) X is a multiple of 3
b) Y is a multiple of 3
c) X + Y is a multiple of 3
d) None of these

---

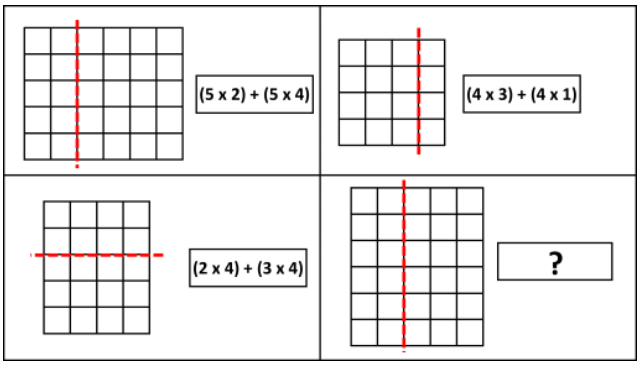
6. **A, B, and C are three different digits among 1 - 9. How many digits CANNOT be assigned to "A" if the following condition is true?**

$$A + B \times C = 25$$

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

---

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



a) (2 x 4) + (2 x 6)
b) (6 x 3) + (6 x 4)
c) (1 x 6) + (1 x 4)
d) (6 x 2) + (6 x 3)

---

8. **A team of three painters - A, B, and C - must paint rooms and each painter paints 3 rooms per working day. They are scheduled to work for 50 days starting Monday.**
   - **Painter A does not work on weekends (no Saturdays or Sundays)**
   - **Painter B does not work on every 5th day (Day 5, Day 10, Day 15, and so on)**
   - **Painter C works on all 50 days**

   Based on the above rules, determine an expression that represents the total number of rooms painted by all three painters combined.

a) 3 × 50
b) 3 × (3 × 50)
c) 3 × (36 + 40 + 50)
d) 3 × 3 × (36 + 40 + 50)

---

9. **A train runs from A to D via B and C. The number of passengers entering and leaving at each station is given in the table. Each passenger buys a separate ticket for each segment travelled (A→B, B→C, C→D).**

   Ticket prices are:

   A→B = Rs. 1, B→C = Rs. 2, C→D = Rs. 1

   Which of the following is the total cost of all tickets purchased?

Stations	In	Out
A	150	-
B	60	80
C	70	50
D	-	150

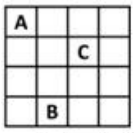
a) Rs. [(150 x 1) + (70 x 3) + (60 x 2) + (80 x 1)]
b) Rs. [(150 x 1) + (70 x 2) + (60 x 1) + (80 x 1)]
c) Rs. [(150 x 1) + (70 x 1) + (60 x 2) + (80 x 1)]
d) Rs. [(150 x 1) + (70 x 3) + (60 x 1) + (80 x 1)]

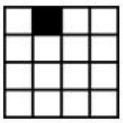
10. If 2(pq + rs) is coded as PQ_2_RS, 3(kl + mn) is coded as KL_3_MN and 4(gh + ij) is coded as GH_4_IJ, what will be the possible code of the SIMPLIFIED FORM of the following expression?
(a + b)(c + d) – (a – b)(c – d)

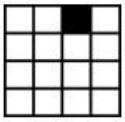
a) AC_2_BD b) AD_3_BC c) AB_2_CD d) AD_2_BC

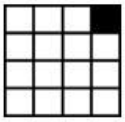
The Thinking Spot

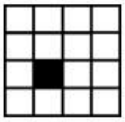
Two coins are hidden in the grid below in two different rows and columns.
• None of the coins is in A's column, but one is in its row
• None of the coins is in B's row, but one is in its column
• None of the coins is in C's row, but one is in its column
Which of the following blocks CANNOT have a coin?



a) 

b) 

c) 

d) 

Chapter 7: Proportional Reasoning

1. **A fruit basket has different fruits, Bananas, Apples, Cherries, and Strawberries.**
   - The bananas are 1/3 the number of cherries and twice that of apples
   - The strawberries are 4 more than the number of apples
   - The number of fruits of each variety are all even numbers less than 15
   Based on the above statement, fill in the blank with the appropriate fruit name. For every 3 strawberries, there are proportionately 6 _____.

   a) Bananas b) Apples c) Cherries d) All of the above

---

2. **There are two unknown proportional ratios, A : B and C : D, where A, B, C, and D are DIFFERENT single-digit numbers.**
   - A is 2 less than C
   - D is 3 times B
   What is the HIGHEST difference between any two values among A, B, C, and D?

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

---

3. **A mixture contains milk and water. When 15 litres of water is added to it, the total quantity of the mixture becomes 120 litres, where the quantity of milk and water have the LEAST POSSIBLE DIFFERENCE between them. Now, an additional 35 litres of mixture having the same milk-to-water ratio as the original mixture is added to this new mixture. What will be the ratio of milk to water in the final mixture?**

   a) 1:1 b) 5:6 c) 15:16 d) 16:15

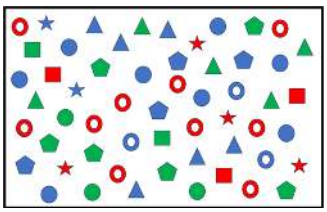
---

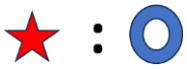
4. **Six friends A, B, C, D, E, and F are standing in a straight line positioning from 1 to 6 (from left to right).**
   - The positions of A and C are in 1 : 2 ratio
   - E is at an extreme end and F is at an odd numbered position
   - B is next to D
   - The positional ratios of D to E are in proportion to C to B
   What is the position of F?

   a) 1 b) 3
   c) 5 d) Cannot be determined

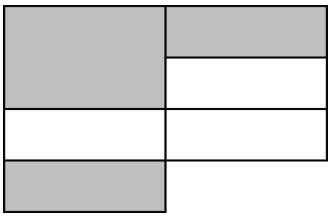
---

5. **In the image given below, the ratio of blue stars to red stars is 1 : 2. Similarly, answer the following question based on the image.**
   What should replace the question mark so that the ratios are in proportion?



a)
b)
c)
d) 

6. **Find the ratio of unshaded (white) rectangles to ONLY PARTIALLY shaded (grey + white) rectangles in the figure given below.**
Note: *Please count all squares as rectangles for the purpose of this question*



a) 1 : 2 b) 5 : 6 c) 5 : 7 d) 4 : 7

---

7. **Three children have ages in the ratio 2 : 3 : 4. Each receives pocket money equal to Rs. 5 less than their age, and together they have Rs. 30.**
How much minimum extra money should be added so that their final amounts are in the same ratio as their ages?

a) Rs. 4 b) Rs. 6 c) Rs. 8 d) Rs. 12

---

8. **In a digital clock of HH : MM format, how many times the time will be as such the HH : MM ratio will be in proportion to 1 : y where y is a single digit number?**
(Here, the clock is in 12 hour format, where HH : MM will be 00-12 : 00-59)

a) 49 b) 89 c) 81 d) 101

---

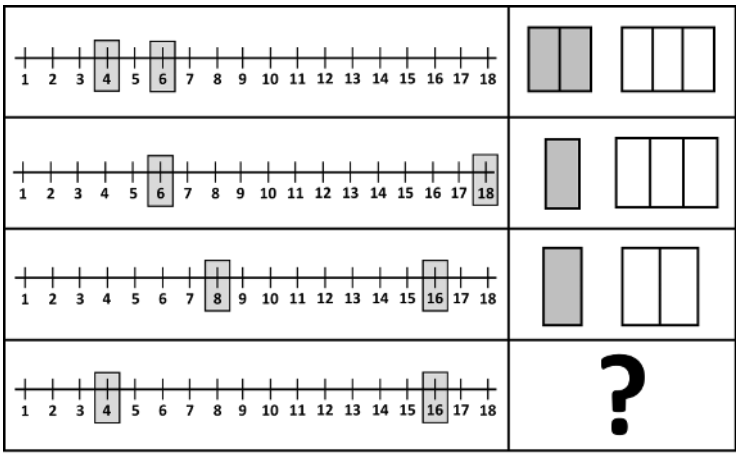
9. **A fruit seller sells apples and mangoes to 10 customers:**
   - **The price per dozen of apples and mangoes is in the ratio 3 : 5**
   - **Each customer buys a pack in which the number of apples and mangoes is in the ratio 1 : 3, and both quantities are multiples of 4**
   - **The price of each fruit is a whole number greater than 10**

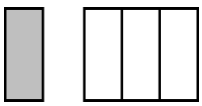
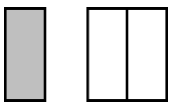
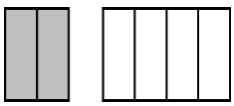
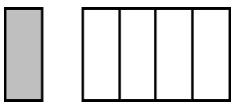
If the total amount collected from all the customers is ₹8064, what is the MAXIMUM possible number of packs sold to a customer?

a) 24 b) 18 c) 21 d) 19

---

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



a)  b)  c)  d) 

The Thinking Spot

Sam arranged the following 4 blocks vertically, one on top of another, such that

• There are at least 2 blocks below the block having a circle

• The block with a triangle has at least 1 block above it

• The block having a rectangle is immediately above the block having a star

How many different arrangements satisfy all the above conditions?

(a) 0 (b) 1 (c) 2 (d) 3

PART-2
ARTIFICIAL INTELLIGENCE

Chapter 1: AI Project Lifecycle

Imagine a world where machines can hear, see, talk, and even take decisions. This may sound like a scene from a science fiction movie. It is not; it is Artificial Intelligence (AI).

AI is a type of technology that gives machines and computers the ability to perform work that normally requires human intelligence. These machines can perform complex tasks done by humans, like analysing data, finding patterns, predicting trends, solving problems, and making decisions by using data and learning from past experiences.

AI systems are designed to learn, adapt, and improve their performance over time. In simple words, AI is human-made intelligence that allows machines to behave intelligently. How is this possible?

Artificial Intelligence systems have been created to mimic human cognitive processes.

They can:

- **Analyse data:** Humans read and understand information to get knowledge. Similarly, AI studies large amounts of data to find meaning and make decisions. It can manage huge data quickly and efficiently.
- **Recognize patterns:** AI recognises patterns and relationships in data, such as trends, similarities, or repeated behaviours, by learning from various examples.
- **Learn from experience:** AI keeps improving over time by learning from new data. The more it learns, the better its performance becomes, much like humans improving with practice.
- **Make predictions or decisions:** Using what it has learned, AI can predict outcomes or make decisions, often based on probabilities and past data.

AI at Work: It's All Around Us!

AI is an important part of our everyday lives.

Here are a few examples:

In Healthcare: AI helps doctors diagnose diseases faster and more accurately by looking at medical scans and reports.
At Home: AI powers smart home devices like speakers that play your favourite music when you tell them to and thermostats that learn what temperature you like.
Getting Around: AI is the main technology behind self-driving cars and helps navigation apps find the quickest routes.
On Your Smartphone: AI is used when you use a voice assistant on your phone to set a reminder or when your photo app automatically puts pictures of the same person together.
Personalised Apps: It suggests new videos, items, and products you might like based on what you have done in the past.

How does AI learn?

The real magic behind Artificial Intelligence lies in **data**. Artificial intelligence and Machine Learning systems learn from data. These models learn by analysing huge datasets and recognising patterns. For example, Voice assistants, language translators and recommendation systems are so intelligent that they seem to know everything—that is only because they have access to massive data and keep training themselves. Every AI-driven program works correctly when supported by accurate and reliable data.

What is an AI Project?

Creating an AI application isn't magic, but it is a defined process. An AI project is the journey of developing a smart system to solve a real-world problem by learning from data.

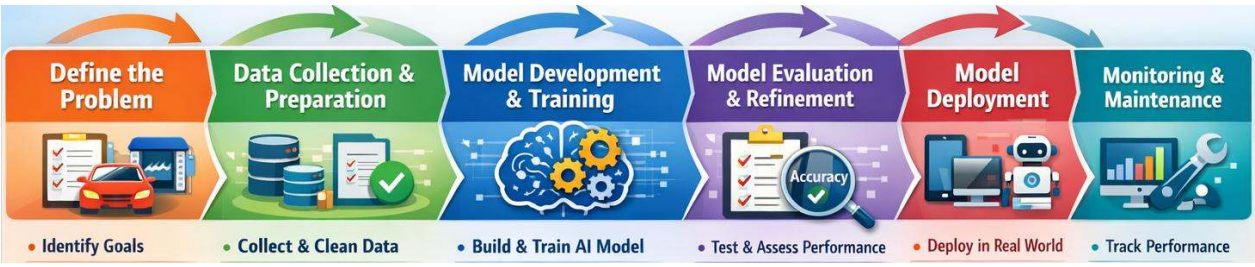
Think of it like a science fair project. You have a clear goal: *Will a plant grow better with sunlight?* For an AI project, the goal is just as specific, for example, to build a system that can recommend a new product to a user or create a filter that automatically detects spam emails.

An **AI project** is a step-by-step process of developing a system or model using artificial intelligence technology to solve a real-world problem by learning from past data. Similar to science projects, AI projects also have specific goals, such as recommending songs or detecting spam emails. The developed AI-based system is first trained on previous data, then identifies patterns, and makes predictions or decisions. The entire process of building, testing, and improving the system step by step is called the **AI project lifecycle.**

AI Project lifecycle:

The AI project lifecycle is an iterative, six-stage framework, for developing, deploying, and maintaining AI tools. It starts with defining the problem, data collection and preparation for modelling, development and training of AI models, model evaluation and its refinement, deployment of the model and continuous monitoring and maintenance.

Key Phases of AI Project lifecycle:



1. Define the problem:

The first and most crucial step in an AI project lifecycle is to define or identify the problem or goal clearly. At this stage, we must determine how the system should work and whether the AI system is really required for this project. It may be possible to complete the project without AI using simple automation.

Let us take an example of an Automatic car wash system

In this problem, the steps are:

- The car enters the bay
- Sensor detects Vehicle Position
- The car moves forward on the conveyor
- For a fixed duration, water is sprayed
- Soap is applied for a fixed time
- Brushes rotate at programmed speed
- Rinse cycle run
- Dryer activates
- The system stops when the car exits

In this example, there is no learning, adaptation, or decision-making beyond the programmed logic. No matter how big or small the car is, the machine always does the same things in the same way. It doesn't think, *this car is really dirty; maybe I should scrub it longer.* It simply does what it is told to do. So, you don't need AI to solve this problem. The system only needs rules that could be set up ahead of time and automated. These kinds of systems have fixed set rules and do not learn from data. This is an example of **automation**, not **AI**.

To develop an **AI-based car wash system**, learning, adaptation, and decision-making using AI replace fixed rules, where cameras with AI system scan the car to detect its size, dirt level, and type of dirt, and the system then decides water spray time, soap usage, and brush speed based on the dirt instead of fixed timing.

AI-based car wash uses **AI** to **detect** car size and dirt level and adapt washing actions. In contrast, in **automation** there is no learning, adaptation, or decision-making and the system follows fixed rules without thinking or improving.

Some other examples:

- **Traffic signal control:**
  - **Time**-based (automation): Traffic lights change every 30 seconds, no matter how many cars are waiting
  - **AI**-based: Traffic lights can also be controlled using AI. Where AI models are designed to adjust green light timing based on traffic density
- **Irrigation system:**
  - **Time**-based (automation): This irrigation system has a timer that waters the plants every day at 7 AM, no matter what the weather is like
  - **AI**-based: The irrigation system can also be developed using AI. Where AI models are designed to water plants based on soil moisture and weather using predictive analytics.

Identifying the problem or goal that an AI system really needs, is an essential task during the development of an AI project.

2. Data Collection and Preparation:

After defining the problem that requires AI, **Data collection** and preparation are the next important phase of an AI project lifecycle. AI systems/models mainly learn from past data, so the quality of that data is a **crucial factor** affecting their **performance**.

Let me give you a fun analogy:

Think about how you would teach a friend to bake a cake. The cake will be a disaster if you do not give the right ingredients or if the recipe is full of mistakes. AI is the same. The AI will be bad if the data is bad. In the world of AI, there is a well-known saying: **Garbage In, Garbage Out.**

Data collection:

Relevant data can be collected from the various sources based on the problem. Some of the sources of data collection are:

- **Sensors**: It is a device that measures physical changes in the environment and convert them into a measurable electrical signal. For example, temperature sensor measures the heat, or light sensor can detect the light intensity and convert it into an electrical signal.
- **Surveys:** Data is collected by asking questions and collecting responses from people
- **Websites:** Data can be collected from online sources such as articles, social media platforms, and websites.
- **Historical records:** These include past data stored in files, reports, or records.

Let us take an example:

To predict whether a student will score more than 75% marks in the exam or not. This is something every student secretly worries about, right?

For this problem, we can collect the following data from the previous students:

- **Attendance percentage** shows whether regular attendees usually score better
- **Hours studied per day** show if studying more helps improve performance
- **Previous test marks** show how they performed in earlier tests
- **Participation in class** Yes or No shows whether active students are more likely to succeed
- Final exams result Above 75% or Below 75% is the result we want to predict

Students	Attendance	Study Hours	Test Marks	Participation	Final Result
Student 1	90%	3 hours	78	Yes	Above 75%
Student 2	60%	1 hours	55	No	Below 75%
Student 3	80%	2 hours	70	Yes	Above 75%

This step is called data collection.

Data Preparation:

For developing an AI system, we need a large amount of data. However, during the data collection, the data we usually collect is raw or unorganised.

It may contain:

- **Missing values** are the data points that are not recorded, empty or unavailable in a dataset
- **Duplicate entries** are the data points that are repeated more than once in a dataset
- **Incorrect information** are data points that are incorrect and inaccurate
- **Irrelevant data** are data points that are not related or useful to the given problem

The data we collect is often raw and unorganised. It may contain errors, missing values, or unnecessary information. Therefore, we clean and organise the data before using it to train an AI model.

The following steps are commonly used during the data preparation:

Data Cleaning:

- Remove errors or irrelevant data
- Fill missing values
- Remove duplicate data

Data Formatting:

- Convert text into number (if required)
- Arrange data in a spreadsheet neatly

Data Labelling:

- Assign correct categories (e.g., Spam/Not Spam, Pass/Fail)

3. Model Development and Training:

After the data collection and preparation, the next step is AI model development and its training. Model development means creating an AI model that solves the problem defined in stage 1. An AI model works like the brain of the system. It learns from data and uses that learning to make predictions.

Think of it like this:

You are a teacher, and the AI model is your student. The data is your textbook. You teach the student (the model) by showing it examples from the textbook (the data). Over time, the student learns the patterns and can answer questions on its own.

Let us look at the previous example whether a student will score more than 75% or not. Create an AI model to address this issue by using the following data to learn from past students:

- Study hours
- Attendance
- Test marks
- Participation in class

This learning process of a model is known as **model training**.

The model will learn from the information of student 1, student 2, and student 3 and find the relationship between these students. It might notice that students with attendance above 75% usually score well. Or that students who study less than 2 hours rarely cross 75%. It's like the model is connecting the dots!

4. Model Evaluation and Refinement

After training, the model is tested using new data to check how well it works. Its performance is usually measured by accuracy, which shows how many predictions are correct.

Testing means checking the model using a test dataset. A test dataset is a set of data that was not used during training. It helps us understand how well the model performs on new, unseen data.

Think of it like this:

You taught your friend how to identify birds using a book with 10 pictures. Now you show them 5 new bird pictures they have never seen before. If they correctly identify 4 out of 5, their accuracy is 80%.

In the same previous example of predicting whether a student will score more than 75% marks in the exam or not, the accuracy of these predictions largely depends on the quality of the data used to train the model.

Let us consider from our training, the model learned that a student would get more than 75% if they have:

- More than 80% attendance
- Study more than two hours
- Get more than 75 on tests
- Participate in class

If not, the student will likely score below 75%. Now, this trained model will work for two new students, student 4 and student 5. Based on what it learned, the model predicts that student 4 will get more than 75%, but student 5 will get less than 75%.

Students	Attendance	Study Hours	Test Marks	Participation	Final Result
Student 4	82%	2.5 hours	77	Yes	**Above 75%**
Student 5	70%	1.5 hours	62	No	**Below 75%**

The model correctly predicts for 2 out of 2 students, so the accuracy of the developed model is 100%. Great job, model!

Suppose there are 10 students during the model evaluation, and the developed model correctly predicts for 7 of them. Then the model's accuracy is 70%.

There may be a condition: if our model correctly predicts only 2 out of 10 students, then its accuracy is only 20%. In this case, **model refinement** is required.

Model Refinement: Model refinement means improving the model when it does not give satisfactory results.

We can improve the model by making changes as given below:

- Adding more data
- Removing incorrect data
    - Changing model settings

- Training the model again

This process continues until the model performs well.

5. Model Deployment:

After the model has been trained, tested, and refined, the next stage is to deploy it in real-world use. It means the model is now ready for use :

- Take the input data (e.g., images, signals, or voice)
- Make prediction
- Help users in the real situation

It is like graduation day for your AI. It has learned, it has passed its tests, and now it's time for it to get a job!

In the previous example, a model is developed to predict whether a student will score more than 75%. This model can be **added or deployed** to a school software system after evaluation. The teacher enters the student information (like study hours, attendance, etc.) and then the system predicts the result of which students will score more than 75% and who will not.

Real-life examples of deployment:

- Spam detection in email apps
- Recommendation system in shopping apps
- Voice assistant
- Face unlock in smartphones

6. Monitoring and Maintenance

After the model is deployed and in use in the real world, the next key step is **Monitoring** and **Maintenance**. Monitoring is the continuous checking of the performance of the deployed AI model whereas Maintenance is to update the model to keep it accurate and efficient over time.

It regularly checks the following essential tasks:

- Is the system working correctly?
- Is the model giving the correct prediction?
- Has the accuracy remained the same or decreased?

In the previous example of score prediction, after some months or years, the model accuracy may have reduced because:

- Study pattern may change
- The exam pattern may change
- New types of questions may be introduced

If the deployed model is monitored regularly, it can help identify when it is not working properly or when its accuracy reduces. In such cases, the model needs to be updated or improved.

The model can be updated by:

- Adding new data
- Retraining the model
- Fixing the errors
- Improving performance

Points to remember:

- ✓ AI systems learn from data.
- ✓ A clear problem must be defined before building an AI system.
- ✓ AI models identify patterns in data.
- ✓ AI projects follow a step-by-step lifecycle.
- ✓ AI systems improve over time with more data.

Exercise

A. Multiple Choice Questions.

1. AI learns from:
   a) Magic b) Luck c) Data d) Guessing

   _____

2. In spam detection, the AI problem is to:
   a) Send emails b) Write emails c) Delete all emails d) Identify spam emails

   _____

3. The first stage of a project cycle is:
   a) Defining the problem b) Data collection c) Model development d) Model deployment

   _____

4. If an AI model predicts 8 out of 10 spam emails, the accuracy of the model is:
   a) 50% b) 20% c) 80% d) 100%

   _____

5. AI model improves because:
   a) It thinks like a human b) It has feelings c) New data is added d) It gets angry

   _____

B. Fill in the blanks.

1. AI learns by finding _____ in data.
2. An AI project follows a _____cycle.
3. Spam emails often contain suspicious _____.
4. After testing, we _____the system.
5. AI cannot work without _____.

C. Short answer questions.

1. How does AI learn?
2. Why is defining the problem important in an AI project?
3. What happens in the testing stage of an AI project?
4. What is meant by accuracy in AI?

5. Give one real-life example of an AI project.

D. Think and apply.

1. Imagine you are building an AI system to detect fake news.

Fill the table:

Stage	Your Answer
Define the problem	_____
Collect data	_____
Test AI tools	_____
Reflect and improve	_____

2. An online shopping company wants to build an AI system to predict whether a product will be delivered **on time or late**.

   To build this system, the company collects the following data from previous orders:

Order No.	Distance	Weather	Traffic	Delivery Partner	Final Status
01	5 km	Clear	Low	Experienced	On Time
02	20 km	Rainy	High	New	Late
03	10 km	Clear	Low	Experienced	On Time
04	15 km	Rainy	High	New	Late

After training, the model learned from the following pattern and delivery will be on time, if:

- Distance is less than 10 km.
- Weather is Clear
- Traffic is Low
- Delivery partner is experienced

Based on the learned pattern, complete the following table.

Order No.	Distance	Weather	Traffic	Delivery Partner	Final Status
05	8 km	Clear	Low	Experienced	_____
06	18 km	Rainy	High	New	_____

Chapter 2: Artificial Intelligence and Its Applications

Artificial Intelligence is making our lives better, faster, and more efficient. Most of the time you don't realize it. AI helps us make better decisions and improves processes, which is quietly transforming our lives.

Have you ever thought about how your phone knows what you say, how online games change their difficulty based on your skill level, or how your emails are automatically sorted into spam and important? It is AI that actually works behind the scenes to make systems smarter and more responsive.

In today's digital world, AI plays a crucial role in solving many of society's major concerns. In this chapter, four key applications will be explored, where AI is making a significant impact:

- Environment
- Automation
- Healthcare
- Education

AI for Environmental Problem Solving

Several serious environmental issues that require immediate attention and action are plaguing the globe. Problems such as plastic pollution, air pollution, soil degradation, deforestation, poor waste management, and loss of wildlife are not limited to one country but affect the entire globe. These issues impact human and animal health, the environment, and the future of life on Earth.

AI provides powerful tools for protecting the environment such as tracking ocean plastic trash, monitoring deforestation, tracking biodiversity, and so on by analysing the vast amount of data.

Some of the most common environmental issues are:

- Plastic Pollution
- Air Quality Problems
- Waste Management Challenges
- Wildlife loss
- Soil Degradation

Let us discuss these in detail

Plastic Pollution

Most of us may think visiting the beach will look like a scenic walk along the sandy shoreline filled with seashells. Instead, you have plastic bottles and bags and wrappers everywhere. As heartbreaking as it is, this has become a frequent sight in many coastal areas today.

Plastic pollution is among the direct environmental threats facing the world. India generates nearly 3.5 million tonnes of plastic waste every year, half of which enters rivers and oceans. Plastic breaks down over centuries. Many animals such as fish and other sea creatures often think these tiny pieces of plastic are food. It could hurt or kill them. Plastics basically do not biodegrade but break down into the micro plastics, which enter the food chain and are found in foods that we eat.

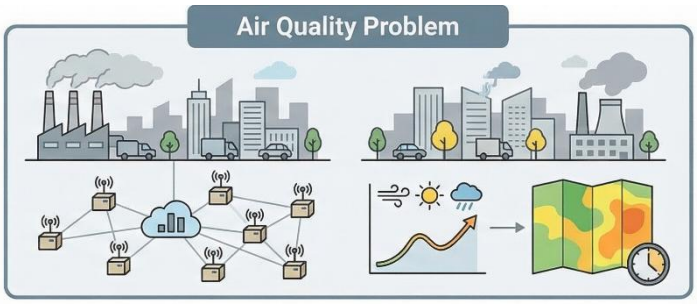
How AI Helps

AI can play a significant role in reducing remove the plastic pollution. AI systems can analyse satellite images to detect the areas where plastic waste is dumped. In 2023, 70 plastic dumps were identified in Himachal Pradesh using satellite imagery by the Department of Environment Science and Technology (DEST). This helps authorities and environmental organisations take faster action to remove the waste.

Air Quality Problem

Take a deep breath. What is actually in the air you just inhaled? In many cities, the air contains harmful pollutants from vehicles, factories, and the burning of crop stubble in nearby agricultural areas. During winter months, some cities often experience severe air pollution, with the air quality index reaching hazardous levels. Every year, millions of people worldwide die as a result of air pollution.

Poor air quality affects everyone, but children and the elderly are particularly at risk. It can cause breathing difficulties, trigger asthma attacks, neurological and immune system disorders. It may also reduce cognitive ability and cause mental fatigue in a child. Students living in highly polluted areas may find it harder to focus on their studies and impair students' academic performance.



How AI Helps

AI systems can analyse data from air quality monitoring stations spread across a city. By studying patterns in pollution levels and combining this with weather data, AI can predict when and where air pollution will increase. This allows authorities to take preventive measures, such as:

- Advising schools to cancel outdoor activities
- Alerting hospitals to prepare for more patients with breathing problems
- Temporarily restricting vehicles in highly polluted areas

- Informing farmers about weather conditions suitable for stubble burning

The first air quality monitoring and early warning system was launched in Ahmedabad, Gujarat, in May 2017 by the Ministry of Earth Science. Initially, this system was not based on AI. It relied on traditional methods of collecting and analysing environmental data, such as pollutant levels and weather conditions.

In recent years, several Indian cities have begun implementing AI-based air quality forecasting systems. These systems help municipal corporations issue health advisories to citizens, especially when pollution levels are at their peak. Commuters can check air quality apps to decide whether to wear masks or take alternative routes with cleaner air.

Waste Management Challenges

Have you ever noticed where your household waste goes after the garbage truck collects it? In many Indian cities, waste ends up in landfills, massive dumping grounds where trash accumulates for years. These landfills release harmful gases, produce unpleasant odours, and sometimes catch fire. They also contaminate groundwater, affecting the health of nearby communities.

India faces a significant challenge in waste management because much of our waste is mixed, and wet organic waste is thrown together with dry recyclable materials. This mixing makes recycling difficult and reduces the value of recyclable materials.

How AI Helps

AI can improve waste management in several ways:

- Smart sensors in bins can monitor waste levels and optimize collection routes. The Pune Municipal Corporation has integrated AI-driven technologies to modernize waste management. They have developed an AI-powered mobile application that helps citizens report waste dumping in their neighbourhoods. Citizens can take photos of garbage piles and upload them through the app. The AI system identifies the location and type of waste, then automatically generates a work order for the nearest cleaning squad. This has significantly reduced response times and helped keep neighbourhoods cleaner.
- AI-powered sorting systems at waste processing facilities can identify and separate different types of waste automatically. In Indore, waste processing plants are using AI-based automated sorting machines which help to segregate the plastic, metal, and organic waste efficiently.
- Image recognition technology can help citizens identify whether an item is recyclable or not. Nowadays, mobile applications are available where users can scan the object and check whether an item is recyclable or not.

Wildlife Loss

Did you know why dinosaurs vanished from the Earth? This occurred many years ago due to a natural disaster and environmental changes. Similarly, some previous studies show that an increasing number of cell phone towers in cities is reducing bird populations. This means that when living conditions change significantly, species may not survive. Even today, many animals are becoming rare or disappearing completely.

Loss of wildlife is a growing problem, with many animal and plant species declining due to habitat loss, poaching, and human-wildlife conflict. As forests shrink and human settlements expand, animals lose their homes and sources of food. Poaching remains a serious concern. Despite strict laws, poachers continue to hunt endangered species for their skin, bones, and other body parts, which are sold illegally.

How AI Helps

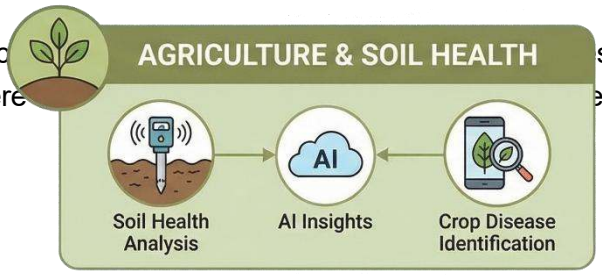
AI is becoming an invaluable tool for wildlife conservation:

- Camera traps with AI capabilities can automatically identify animal species and send real-time alerts when endangered animals are spotted. **Trail Guard AI cameras** have been deployed in many tiger reserves in India. This system detects animals like tigers and other species, identifies them, and shares the information with officials in real time.
- AI systems can analyse satellite images to detect changes in forest cover and identify areas where habitat loss is occurring. In India, the **Forest Survey of India (FSI)** collects the Indian forest satellite images annually and automatically detects deforestation, degradation and forest cover changes based on image processing with AI.

Soil Degradation

Ever thought about why some soil can't grow crops like it once did? This happens due to the degradation of soil over time. Nowadays, soil degradation is a major environmental issue worldwide. The factors affecting soil degradation are mainly unsustainable farming practices, excessive use of chemical fertilisers, deforestation, and industrial pollution. Degraded soils are less productive, making it harder to grow crops and threatening food security.

Soil degradation also affec s after harvest, which adds to air pollution. If the soil were ecompose and enrich the soil naturally.



How AI Helps

AI can assist farmers in understanding and improving soil health:

- AI systems analyse soil data from sensors to provide recommendations on fertiliser use, irrigation, and crop rotation. In the 2026 Union Budget, the Indian government announced an **AI-powered platform called Bharat Vistaar** to help farmers with localised information including soil conditions, weather, pest detection, and expert advice in their own languages. This aims to give crop and soil recommendations that could include fertiliser and irrigation guidance.
- AI-powered mobile applications allow farmers to take photos of crop problems and receive instant advice. The **Indian Ministry of Agriculture and Farmers** launched the **CROPIC**, which stands for 'Collection of Real Time Observations and Photo of Crops.' It is a mobile app that farmers can use to share shots of their crops at different stages of growth. This system checks the health of crops, finds signs of stress or damage, and allows real-time tracking.

AI-Assisted Healthcare

AI is revolutionizing healthcare globally by allowing for faster, more accurate, and cost-effective diagnosis and treatment. India's healthcare system serves over 1.3 billion people, but there is still a significant gap between healthcare needs and available resources. AI is helping to overcome this gap by assisting with early disease identification, medical image analysis, and decision support for healthcare personnel. It also supports virtual healthcare and remote patient monitoring, allowing patients to consult with doctors via telemedicine platforms and wearable devices that track vital signs in real time.

Some of the important applications in healthcare where AI is now used in real life are:

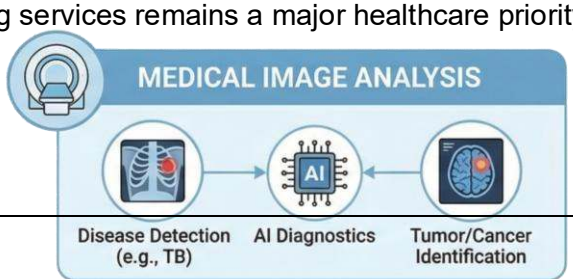
- Medical Image Analysis
- Predictive Healthcare
- Remote Patient Monitoring

<u>Let us discuss in detail</u>

Medical Image Analysis

Did you ever think about how a doctor determines whether a bone is fractured when someone falls and gets injured? It can be determined using the X-rays images which are the medical images. Similarly, other health issues can be diagnosed using the medical imaging technique like X-rays, CT scans MRIs and ultrasound.

In India, there is a shortage of radiologists, especially in rural areas. This means patients often have to travel long distances or wait for weeks for their reports, delaying timely diagnosis and treatment. Limited access to medical imaging facilities affects the detection of serious conditions such as tuberculosis (TB), cancers and heart diseases at early stage. Thus, improving the availability and accessibility of medical imaging services remains a major healthcare priority in our country.



How AI Helps

Nowadays, AI can analyse medical images with remarkable accuracy, often spotting details that human eyes might miss. For example:

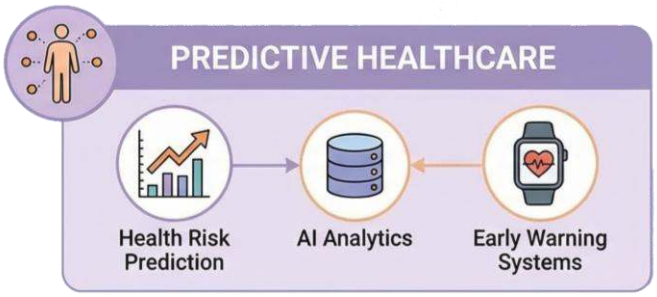
- AI can detect early signs of tuberculosis in chest X-rays. India has adopted AI-driven tools to automatically analyse chest X-rays for TB screening. This tool is validated by the Indian Council of Medical Research (ICMR). These tools are being used across multiple states and Union Territories to screen vulnerable populations and presumptive TB cases, helping accelerate early detection and reduce diagnostic delays.
- AI can also help identify tumours or cancers with the scan images. The Telangana government has initiated a pilot programme to integrate AI into public healthcare facilities for the early detection of cancers using high-resolution imaging and reliable diagnostic analysis. This project focuses on oral, breast, and cervical cancers and aims to improve diagnosis speed and accuracy in regions with a shortage of radiologists.

Predictive Healthcare

Have you ever imagined if it's possible to foresee health problems before they actually occur? Currently, it is possible due to predictive healthcare.

Predictive healthcare uses data from our medical records, lab reports, wearable devices, lifestyle patterns and even family history to anticipate the potential illness and health risks. By analysing trends and patterns, healthcare providers can identify patients who are at higher risk, enabling timely interventions and preventive care.

In India, where healthcare resources are limited and patient loads are high, predictive healthcare can help prioritise care, reduce hospital visits, and improve overall health outcomes.



How AI Helps

AI is transforming predictive healthcare by analysing the vast dataset including medical history, lifestyle habits, real-time wearable data and family history. Manually, analysing this large amount of data is extremely difficult and time-consuming, making AI a powerful tool for identifying health risks at early stage.

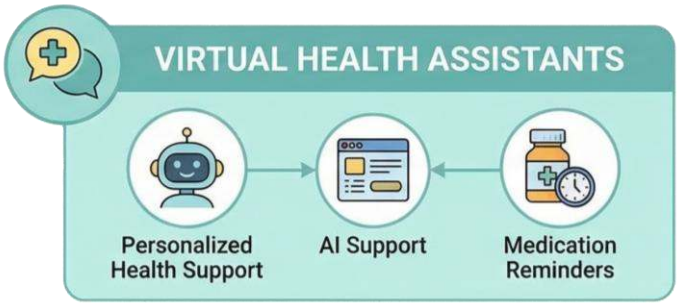
Here's how AI helps in predictive healthcare:

- AI analyses the patient data such as medical history, lifestyle habits, real-time wearable data and family history to identify individuals at higher risk of diseases such as diabetes, heart disease or certain cancers. In India, under the **Ayushman Bharat Digital Mission (ABDM),** health records of millions of citizens are being digitised, allowing AI-driven predictive tools to analyse patient data and flag high-risk individuals for timely interventions and preventive care.

Virtual Health Assistants

Have you ever thought how patients can receive medical guidance without visiting a clinic or hospital? This is now possible with the help of Virtual Health Assistants.

In India, mainly in rural areas, not everyone has easy access to a doctor. People may travel for hours to reach the nearest clinic. Even in cities, getting a doctor's appointment can take days. Virtual health assistants help bridge this gap.



How AI Helps

Virtual Health Assistants use AI to provide personalized and timely health support, helping patients access care without visiting a clinic or hospital. For example:

- AI can remind patients to take medicines on time and schedule follow-up visits. Some mobile applications now use AI-powered assistants to track prescriptions, set reminders, and manage health records efficiently.
- AI-powered chatbots and virtual assistants provide instant answers to common health questions and guidance on managing minor conditions. The government of Madhya Pradesh launched an **AI-powered SUMAN SAKHI chatbot** to provide 24X7 health information for women, especially on *maternal care, high-risk pregnancy conditions.*

AI and Intelligent Automation

Have you ever noticed how many everyday routine tasks around us are accomplished fast and effectively with little human effort? This is only achievable with the inclusion of AI in automation. Earlier, washing machines required manual adjustments for wash duration, water level, and cycle type depending on the clothes. Nowadays, AI-powered washing machines can automatically determine the load, fabric type and dirt level. They adjust the quantity of water used, the amount of detergent used, and the time it takes to wash. This improves washing efficiency, saves water and energy and reduces the need for human effort.

In India, AI-driven automation is used across a variety of sectors, including transportation, agriculture, banking, healthcare, and home appliances. Some of the important applications of AI in automation are:

- Smart Transportation

- Agriculture
- Smart Homes

Let us discuss in detail

Smart Transportation

Anyone who has travelled in an Indian city knows about traffic congestion. The hours wasted in traffic jams could have been spent studying, playing, or spending time with family. Moreover, traffic congestion contributes significantly to air pollution.

Did you ever think how traffic can be managed more efficiently in busy cities? Smart transportation uses advanced technologies to improve traffic flow, reduce congestion, and enhance road safety. By analysing real-time data from sensors, cameras, and GPS systems, transportation systems can make better decisions and respond quickly to changing conditions.

How AI Helps

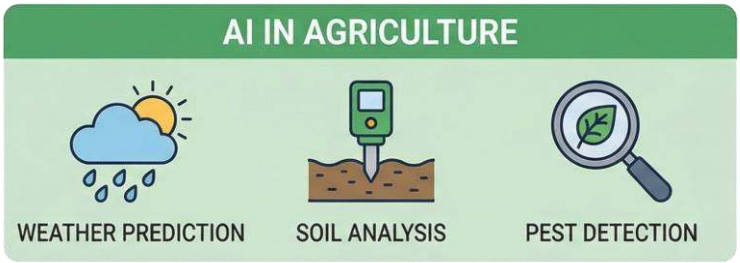
AI plays a significant role in making transportation systems smarter and more efficient. It can analyse traffic patterns using data from cameras, sensors, and GPS devices. This information helps in several ways:

- An AI-based traffic signal system can be developed instead of a time-based traffic signal system. In cities like Delhi and Bengaluru, AI has already been introduced in traffic signal systems, where signal timing adjusts based on real-time traffic conditions.
- AI-powered cameras are already installed in many cities that automatically detect traffic violations such as speeding and not wearing a helmet and issue fines accordingly.
- Nowadays, navigation apps analyse the traffic data and suggest routes that avoid traffic jams.

AI in Agriculture

In India, agriculture is labour-intensive and dependent on weather conditions. The farmers depended on manual observation and expertise to determine when to irrigate crops, apply fertilizer and manage pests. Irrigation was frequently done at predetermined intervals without regard for soil moisture levels, overwatering, or shortage of watering. It affects and sometimes destroys crops. In many cases, farmers could not identify the problems in crops early and delayed taking the necessary action.

Have you ever wondered how farming can be done more efficiently with less effort? AI in agriculture is enabling automation of many farming activities, reducing manual work and improving productivity. Tasks such as irrigation, sowing, spraying fertilizers, and harvesting can now be automated using smart machines and data-driven systems.



How AI Helps

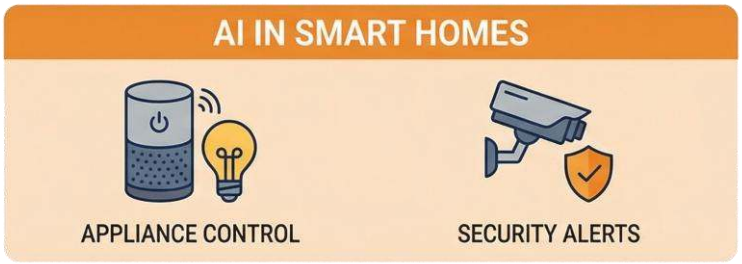
AI empowers farmers with information and insights:

- Weather predictions help farmers decide when to plant and harvest. In India, the **India Meteorological Department (IMD)** provides weather forecasts and agrometeorological advisories to farmers. Using these predictions, farmers can decide the best time for sowing, irrigation, and harvesting.
- Soil analysis helps optimize fertiliser and water use. In India, under the **Soil Health Card Scheme**, the government tests soil samples and provides farmers with detailed reports on soil nutrients.
- Pest detection systems identify problems before they destroy crops. In India, platforms like **National Agriculture Market (e-NAM)** and apps such as **Kisan Suvidha** help farmers identify pest and disease issues by analysing crop images. Farmers can upload photos of affected crops, and the system suggests possible problems and solutions, enabling early action to prevent crop loss.

AI in Smart Homes

Have you ever wondered how homes can become smarter and more convenient to live in? AI in smart homes is making this possible by automating everyday tasks and improving comfort, security and energy efficiency. Devices such as smart lights, thermostats, security cameras and voice assistants can learn user preferences and adjust settings automatically.

Earlier, domestic equipment needed human operation, such as turning off or on a light using switches. Today, you can switch on and off a light with your voice.



How AI Helps

AI plays a significant role in making home smarter. For example:

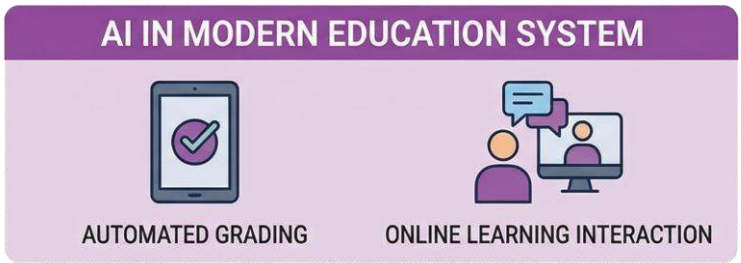
- AI can automatically control the electrical appliances such as fan, light, washing machine and air conditioning (AC) based on your voice or usages pattern.

- AI-powered cameras and sensors can detect the unusual activities at your home and share real-time alerts to the owner or nearest police station.

AI in the Modern Education System

In India, the traditional education system often relies on classroom teaching, manual assessments, and fixed schedules. Teachers have to manage large class sizes, making it difficult to give individual attention to every student. Assessments are usually checked manually, which can be time-consuming and may delay feedback. In many cases, students have to wait for days or even weeks to understand their mistakes and improve their performance.

Have you ever thought about how learning and evaluation can be made more efficient and accessible for teachers and students? AI in modern education is transforming the way students learn and teachers teach. Tools such as automated assessment systems and virtual classrooms are making education more flexible and effective.



How AI Helps

- **Automated assessment systems:** AI can evaluate assignments, quizzes, and exams quickly and provide instant feedback. In India, platforms like **DIKSHA** and government digital education initiatives use automated systems to assess student performance and help teachers track progress efficiently.
- **Virtual classrooms:** AI enables online learning where students and teachers can interact in real time from different locations. In India, platforms like **SWAYAM** and government-supported virtual learning programs allow students to attend classes, access study materials, and learn without the need to be physically present in a classroom.

Hands-On Learning with No-Code AI Tools

You don't need to be a computer programmer to build AI models. No-code AI tools allow anyone to create AI applications by simply providing examples. These tools use simple graphical interfaces where you upload data and train models with a few clicks.

Popular No-Code AI Platforms

- **Teachable Machine** (teachablemachine.withgoogle.com)
- **Machine Learning for Kids** (machinelearningforkids.co.uk)

Both platforms provide step-by-step tutorials and video guides to help you get started.

Hands-On Activity 1: Waste Classification Model

Problem: Create an AI model that can identify three types of waste:

- Plastic
- Paper
- Organic waste (food scraps, leaves, etc.)

Steps to Follow:

1. **Collect Images**
   - Take 20-30 photos of plastic items (bottles, bags, containers)
   - Take 20-30 photos of paper items (newspapers, notebooks, cardboard)
   - Take 20-30 photos of organic waste (fruit peels, vegetable scraps, dry leaves)
   - Try to vary the background and lighting in your photos
2. **Upload and Label**
   - Open Teachable Machine and start a new image project
   - Create three classes: "Plastic," "Paper," and "Organic"
   - Upload your images to the appropriate classes
3. **Train the Model**
   - Click the "Train Model" button and wait 30-60 seconds
   - Your model is now learning to recognise different waste types
4. **Test Your Model**
   - Find new waste items that your model hasn't seen before
   - Use your webcam or upload photos to see what your model predicts
   - Note whether it correctly identifies each type

What to Observe:

- Which waste type does your model identify most accurately?
- Does it confuse any categories? For example, does it mistake shiny plastic for paper?
- What happens when you show it something that doesn't fit any category?

Hands-On Activity 2: Voice Command Recognition

Problem: Create an AI model that recognises three voice commands:

- Start
- Stop
- Help

Steps to Follow:

1. **Set Up Your Project**
   - In Teachable Machine, start an "Audio Project"
   - Create three classes: "Start," "Stop," and "Help"
   - Add a fourth class called "Background Noise"
2. **Record Training Samples**

- For each command, record yourself saying it 15-20 times
- Vary your voice—say it loudly, softly, quickly, and slowly
- For "Background Noise," record 20 seconds of silence and room sounds

3. **Train the Model**
   - Click "Train Model" (this takes a bit longer for audio)
   - Wait for training to complete

4. **Test Your Model**
   - Speak each command clearly into your microphone
   - See if your model correctly identifies each command
   - Ask family members to test it with their voices

<u>What to Observe:</u>

- Does your model work for voices other than yours?
- Does background noise affect accuracy?
- Are similar-sounding words ever confused?

Points to remember:

- ✓ AI helps solve real-world problems in healthcare, education, environment, and daily life
- ✓ In environmental protection, AI helps monitor pollution, manage waste, track wildlife, and improve soil health
- ✓ In healthcare, AI assists with medical imaging, predicts health risks, powers virtual assistants, and enables remote patient monitoring
- ✓ In automation, AI improves transportation, agriculture, and home management
- ✓ In education, AI enables personalised learning, smart tutoring, and accessible virtual classrooms
- ✓ No-code AI tools allow anyone to build and train AI models without programming knowledge

Exercise

A. Multiple Choice Questions.

1. AI helps in environmental protection by:
   a) Tracking wildlife population
   b) Predicting pollution levels
   c) Detecting plastic waste
   d) All of the above

2. No-code AI tools allow users to:
   a) Program AI models using coding
   b) Train AI models without coding
   c) Only analyse text data
   d) Replace teachers completely

3. AI can predict future health risks by analysing a patient's:
   a) Favourite movies
   b) Medical history and lifestyle habits
   c) Social media posts
   d) Travel destinations

4. Which environmental problem can AI help solve by analysing satellite images of rivers and oceans?
   a) Soil degradation
   b) Plastic pollution
   c) Air pollution
   d) Water shortage

5. An example of AI in smart homes is:
   a) Self-driving cars
   b) Voice-controlled appliances
   c) Tracking wildlife populations
   d) Predicting diseases

B. Fill in the Blanks

1. AI-powered _____ can answer health questions and remind patients to take medicines.
2. Satellites and sensors help AI detect _____ pollution in oceans and rivers.
3. AI in education can provide _____learning tailored to each student's needs.
4. Wearable devices allow AI to perform _____ patient monitoring.
5. Platforms like_____ allow students to train AI models without coding.

C. Short Answer Questions

1. Name two ways AI helps in reducing environmental problems.

2. How does AI assist doctors in medical diagnosis?
3. Give one example of AI application in smart homes.
4. What is the benefit of personalised learning in education?
5. Explain the role of AI in agriculture.

D. Think and Apply

1. Design a simple AI project using a no-code platform to help sort waste in your school. What steps would you follow?
2. How can AI predict and prevent water shortage in your area?
3. Suggest a way AI could help students struggling with mathematics.
4. If you were a farmer, how would you use AI to improve crop production and protect soil health?

Chapter 3: Data and Fairness in AI

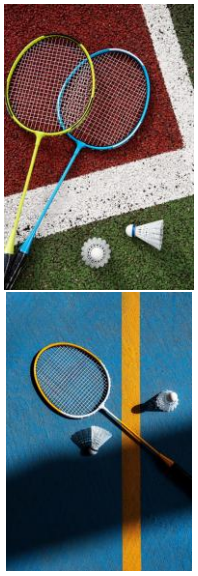
One of the artists' groups in Seoul, Korea, collected photographs of clouds that looked slightly similar to human faces. They gave it to an AI face-detection program and very surprisingly, the program reported all the images as face detected!! We as humans also sometimes imagine faces in the clouds, but the project revealed an error in the training data of the AI program. The data for the face recognition system has a greater portion of images with lighter skin-color male data, which may lead to misprediction.

The example let us realize that:

- AI looks for patterns they have learned from the training dataset.
- The training data influences what AI detects.
- Considering the role of AI in all fields in our society, it becomes crucial to analyse the balance in the training data.

Role of Data

Consider training an AI program to identify a cricket bat and badminton racket from the input images. The AI model will be provided with many images to train it for identifying a bat and a racket. AI carefully studies these images and looks for patterns such as the long, flat shape of a cricket bat, the oval frame and strings of a badminton racket. Over time, AI learns to distinguish between these two objects based on these patterns. After learning from these examples, AI tries to identify new images correctly.

Training Data		
Label	Cricket Bat	Badminton

Most training images are of cricket bats compared to a badminton racket. Now, if we show the new image, what will the AI guess?

Think

- How many images are included?
- How are the images similar? How are images different?
- Do you expect the algorithm's accuracy to be?
  - Better for Cricket Bats
  - Same for both
  - Better for Badminton rackets

It will guess a cricket bat for most of the time. This happens because the AI learns only from the data it is given. It does not understand objects in the way humans do. Instead, it finds patterns based on the examples it has seen. When one type of object appears more often in the training data, the AI becomes better at recognizing that object. It becomes less accurate for objects with fewer examples. The correct image recognition will depend heavily on the balance in the training data.

Importance of Data

- AI does not think like humans. It only learns from the data we give for training.

- If the data is good and balanced, the AI works well. However, problems arise when certain groups of data are overrepresented or underrepresented in the training.

Automatic translation in AI sometimes produces gender stereotypes. Look at the example below for the Hindi text and its English translation.

Hindi Sentence	English Translation from AI
वह डॉक्टर है	He is a doctor.

But the Hindi sentence does not specify gender. Training data often contained more examples of male doctors. AI will learn stereotypes present in the training data.

Understanding Bias

Computer scientist Joy Buolamwini tested AI-technology to recognise face by major technology companies. She discovered that some systems worked very well for light-skinned men but made more mistakes for women and people with darker skin tones. The reason was simple: the systems were trained using datasets that contained far more photos of certain groups than others. In one demonstration, the computer failed to detect her face until she wore a white mask. This showed that AI systems can behave unfairly when the training data does not represent everyone.

Bias in Dataset

- Some data does not represent everyone equally. This is called bias.
- Bias means the data is unbalanced or unfair.

AI systems are used (or will be used) in many places

Recommending videos, approving loans, helping doctors, selecting job applicants. But if the data contains bias, the AI may make unfair decisions. For example, an AI system helps companies choose candidates. If past hiring data mostly includes men, the AI may learn that men are better candidates. Even if that is not true.

Consider a scenario,

A school is building an AI program that recommends sports to students. The system looks at past data about which students enjoyed different sports. Here is the training data:

Sports	Training Data

	(Students who enjoyed it)	
	Boys	**Girls**
Cricket	55	15
Badminton	10	20

The AI program studies the data and tries to learn patterns. It may notice that most boys played cricket, and most girls played badminton. Now imagine a new girl student joins the school.

Think

- What sport do you think the AI will recommend to new users based on the data above?
  - Is the AI making the recommendation based on ability or data pattern?
  - Do you think the recommendation is fair to every student?
  - How could we improve the data so that the AI makes fairer recommendations?

Ensuring Fairness

A company once built an AI program for the recruitment of employees. The system learned from past hiring data. But in previous years, most of the hired engineers were men. Because of this pattern, the AI began to favour resumes that looked similar to those of male applicants. The example shows how AI can learn human biases from historical data if developers are not careful. AI should be built to help everyone, not just a few people.

How can we make AI Fair?

- **Bias check:** Test the AI-programs to see if they recognise/treat various categories differently.
- **Human supervision:** Human review the AI decisions instead of trusting them blindly.
- **Transparency:** Understanding how an AI system works and how it makes decisions.

Many online platforms use AI to recommend videos, songs, or articles that users might enjoy. The AI program learns from data such as videos people watch, they like/share. The AI then recommends videos that are similar to popular ones. When the system recommends videos to new users, it may mostly suggest English/Hindi language videos. As both have very high total view counts. Videos in smaller regional languages may appear less often in recommendations.

- Could this affect creators who make videos in regional languages? Why?
- What could the platform do to ensure that different languages are represented fairly?

Activity: Supervised Learning & Bias?

1. Go to *https://teachablemachine.withgoogle.com* and click on 'Train models on images'
2. Click 'Add samples', then 'file' & 'Choose files'
3. Locate the Teachable Machines Cat-Dog Dataset in the Drive.
4. Click 'Dogs', then 'training dataset'. Click 'open' to add an image to the training set. Be sure to add all images at once.
5. After all of the images have been added, click Add samples. Repeat with cat training images.

Exercise

1. For the dog training dataset, record the following:
   - How many images are included?
   - How are the images similar?
   - How are the images different?

2. For the cat training dataset, record the following:
   - How many images are included?
   - How are the images similar?
   - How are the images different?

Once your classifier is finished, test your dataset with the images below. Fill in the table on the next page about your testing dataset:

Image	Classification	Confidence Score	Correct?

1. Which class did your classifier work better on? Why do you think that is?
   a. Cats
   b. Dogs
2. With your group, use the photos on the tables to re-curate your training dataset. Record the following:
   a. For the dog training dataset, record the following:
      - How many images are included?
      - How are the images similar?
      - How are the images different?
   b. For the cat training dataset, record the following:
      - How many images are included?
      - How are the images similar?
      - How are the images different?
3. Train your new classifier on your two new training datasets.
   Once your classifier is finished, test your dataset with the cards given to you containing the following image. Fill in the table on the next page about your testing dataset:

Image	Classification	Confidence Score	Correct?

4. Did your new algorithm work?
   - ○ Better for dogs
   - ○ The same for both cats and dogs
   - ○ Better for cats

Chapter 4: Ethics and Responsible AI

In earlier chapters, you explored how **Artificial Intelligence systems collect data**, recognise **patterns**, and make **predictions**. You also saw that AI can be a powerful tool. It helps in education, healthcare, business, and even in many activities of our daily life. As AI systems become more powerful, an important question arises.

How should AI be created and used responsibly?

Responsible AI refers to designing and using artificial intelligence in ways that are fair, safe, transparent and beneficial to society.

Technology does not exist in isolation. It affects people, communities and society. The choices made by AI systems can influence opportunities, decisions and even people's lives. That is why technology must be guided by ethical principles.

Before we begin, let us consider a few important questions:

- What do we mean by AI ethics?
- Why is privacy important in the digital world?
- How can bias affect AI decisions?
- What is misinformation, and why does it spread so easily?
- Who is responsible when AI systems make mistakes?

What is AI Ethics?

When new technology is created, people often ask a simple question:

What can this technology do?

But there is another question that is equally important.

What should this technology do?

This second question takes us into the world of **ethics**.

AI Ethics refers to the values and principles that guide how artificial intelligence systems should be designed, developed, and used. Ethics remind us that technology must serve people and society.

AI ethics ensure that systems:

- Are fair
- Respect privacy
- Help society
- Remain accountable

Consider an AI system used in healthcare. It should help doctors treat all patients equally and carefully. So ethical AI is not only about making systems **smart** and **efficient**. It is about making systems **responsible** and **trustworthy**.

Reflect

Can a system be considered successful if it is fast and accurate but harms certain groups of people? Why or why not? Discuss your ideas with your classmates.

Privacy in the Digital World

Think about the apps and websites you use every day. Some apps ask for your name. Some ask for your location. Others ask for permission to access your photos or contacts. Have you ever wondered **why they need this information?**

The idea of protecting such information is called **privacy**. **Privacy** means keeping your personal information safe and under your control.

In today's digital world, many platforms collect data such as:

- Your name
- Your location
- Your photographs
- Health information
- Browsing history
- Contact details

If this information is misused, it can cause serious problems. For example Identity theft, financial fraud, and damage to someone's reputation. That is why we should always think carefully before sharing personal information.

Before sharing data online, ask yourself a few questions:

- Why is this information needed?
- Who will be able to see it?
- How long will it be stored?
- Can I delete it later?

Developing **good digital habits** helps protect privacy. Never share sensitive information such as OTPs, bank details, passwords, or personal identification numbers (PINs).

Remember something important. Privacy is not about hiding from the world. It is about **having control over your personal information**.

Consider the following scenario:

A student is installing an app on a mobile phone. On the phone screen, a message appears asking for permissions such as Location, Contacts, Photos, and Camera. The student pauses and thinks before clicking **Allow**. A small thought bubble appears with questions like, **why** does the app need this? and **Who** can see my data?

Before sharing personal information online, always think about why the app needs it and how your data might be used.

Bias and Fairness in AI

Artificial Intelligence systems learn from **data**. But what happens if the data itself is incomplete or unfair? The system may learn patterns that are also unfair. This is known as **bias**. Bias in AI can lead to outcomes that treat people unequally.

An unfair AI system may:

- Reject deserving candidates
- Spread stereotypes
- Ignore minority groups
- Make incorrect predictions

Let us consider an example.

Suppose a system is trained mostly with data from one city or one social group. When it is used in other places, it may not perform well.

Why? Because it has not learned from **diverse experiences.** For instance, if a facial recognition system is trained mostly using images of people from one region, it may not correctly recognise people from other regions.

How Can Bias Be Reduced?

Developers and organisations take several steps to reduce bias.

- Use diverse and representative data
- Test systems carefully before deployment
- Allow human review of important decisions
- Monitor performance regularly

Fair AI systems aim to treat people **equally** and **respectfully**. But fairness does not happen automatically. It requires careful **design**, **continuous testing**, and **responsible use**.

Misinformation and Social Impact

Today, information travels faster than ever. A message shared on social media can reach thousands of people in just a few minutes. But here is a question to think about.

Is every piece of information online **true**? **Not always.**

Sometimes false or misleading information spreads quickly. This is called **misinformation**. Misinformation means **incorrect** or **misleading** information shared with others. Modern AI tools can sometimes make this problem even more serious.

AI tools can:

- Create realistic fake images
- Generate fake news articles
- Imitate voices
- Produce misleading videos

Such content can influence people in many ways.

It may affect:

- Public opinion
- Elections
- Careers and reputations
- Public trust
- Social harmony

For example, a fake message about a health emergency or an exam cancellation can spread quickly on social media and create confusion before the truth is verified. That is why it is important to think carefully before sharing information online.

Before believing or forwarding a message, try to:

- Check the source of the information

- Verify facts from trusted websites
- Read beyond headlines
- Think critically

Technology can shape society. Every user has a role in ensuring that truthful and responsible information spreads.

Accountability and Human Control

Let us imagine an AI system is used in a hospital. The system analyses patient data and suggests which patient needs urgent care. This may be helpful. But suppose the system makes a mistake.

Who should be responsible?

The machine?

Or the people who created and used it?

These questions bring us to the idea of accountability.

Accountability means that humans remain responsible for the decisions and actions of AI systems.

Whenever AI is used, we must ask some important questions:

- Who created the system?
- Who checks whether it works correctly?
- Who fixes mistakes if they occur?
- Who is responsible if harm happens?

<u>AI systems are used in many important fields:</u>

AI systems are used in many important fields such as healthcare, education, banking, law, and public services. In such areas, human supervision is essential. AI should assist human decision-making, not replace human judgment completely. Machines can analyse data quickly. But final responsibility must always remain with people.

Consider the following scenario:

A team of doctors is sitting in a hospital meeting room reviewing a patient's medical report. On a large screen, an AI system displays the message:

Patient Risk Level: High.

The doctors carefully examine the data and discuss the result. One doctor points to the screen and suggests that the AI's recommendation should be checked again before making a final decision.

AI can assist decisions, but humans must review outcomes and remain accountable.

Points to remember:

- ✓ AI ethics help guide how technology should be designed and used.
- ✓ Privacy means protecting and controlling personal data.
- ✓ Bias can lead to unfair outcomes in AI systems.
- ✓ Misinformation can spread quickly with the help of digital tools.

- ✓ Humans must remain accountable for decisions made using AI.

Exercise

A. Multiple Choice Questions.

1. AI ethics focus on:
   a) Making machines faster b) Making machines cheaper
   c) Ensuring responsible use d) Deleting apps

   _____

2. Privacy means:
   a) Sharing everything online b) Protecting personal information
   c) Hiding from society d) Deleting apps

   _____

3. AI bias can occur when:
   a) AI systems are turned off b) Data used for training is incomplete or unfair
   c) Computers are slow d) The internet is not working

   _____

4. Before sharing information online, what should you do?
   a) Share it quickly b) Think about why the information is needed
   c) Forward it to everyone d) Ignore the message

   _____

5. AI systems learn patterns from:
   a) Books b) Data c) Games d) Images

   _____

B. Fill in the Blanks.

1. Misinformation means _____ information.
2. Fair AI systems treat people _____.
3. Humans must remain _____ for AI decisions.
4. AI systems learn patterns from _____.
5. Incorrect or misleading information shared online is called _____.
6. Humans must remain _____for decisions made using AI systems.

C. Short Answer Questions.

1. Why is privacy important in the digital world?
2. Give one example of misinformation.
3. What does accountability mean in AI systems?
4. What are AI ethics?
5. What is misinformation?
6. Why is human supervision important when AI systems are used?

D. Case-Based Questions.

1. A student installs an app that asks for permission to access location, contacts, and photos. The student pauses and thinks about why the app needs this information.
   - What important digital habit is the student practising?
2. An AI system used in healthcare suggests that a patient has a high-risk level. Doctors carefully review the AI's recommendation before making a final decision.
   - Why is human review important in this situation?
3. An AI system is trained mostly with data from one city and later used in other places. The system does not work well for people from different regions.
   - What problem in AI does this example show?
4. A message spreads quickly on social media, but the information in it is incorrect.
   - What is this situation called, and what should users do before sharing such messages?

E. One-Word Challenge.

Write one word that matches the description:

Description	One word
Protection of personal information	
Incorrect or misleading information shared online	
Unfair patterns learned by AI from data	
Moral principles guiding technology use	
Responsibility for AI decisions	

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