Example 1:  
71. Match the following concepts with their corresponding theoretical framework or methodology:  
Concept Theoretical Framework or Methodology  
I. Comparison Trees A. Empirical analysis of algorithms  
II. Lower Bounds through Reductions B. Algorithmic complexity theory  
III. Logic C. Knowledge representation in AI  
IV. Association Rules D. Data mining techniques  
Choose the correct answer from the options given below:  
(1) I-A, II-B, III-C, IV-D  
(2) I-B, II-C, III-D, IV-A  
(3) I-C, II-D, III-A, IV-B  
(4) I-D, II-A, III-B, IV-C  
Answer Key: 2   
Solution:   
• Comparison Trees: Utilized primarily in algorithm analysis, particularly in sorting and searching, where the tree structure helps to describe decisions taken by the algorithm.  
• Lower Bounds through Reductions: A fundamental concept in computational complexity, essential for proving the minimal computational effort needed to solve problems by reducing them to other known hard problems.  
• Logic: Central to artificial intelligence for formalizing rational thought and reasoning, especially in expert systems and other knowledge-based applications.  
• Association Rules: A common technique in data mining aimed at finding interesting correlations between variables in large databases.  
Hence, Option (2) is the right answer.  
  
Example 2:  
73. Match the following advanced topics with their primary field of application:  
Advanced Topic Field of Application  
I. Self Organizing Maps A. Neural network architectures  
II. Regression B. Statistical modeling in data analysis  
III. Conceptual Dependency C. Knowledge representation in artificial intelligence  
IV. Link Analysis D. Web data and social network analysis  
Choose the correct answer from the options given below:  
(1) I-A, II-B, III-C, IV-D  
(2) I-C, II-D, III-A, IV-B  
(3) I-B, II-C, III-D, IV-A  
(4) I-D, II-A, III-B, IV-C  
Answer Key: 1   
Solution:   
• Self Organizing Maps: A type of unsupervised learning neural network that uses a competitive learning technique to place inputs into a two-dimensional map.  
• Regression: A fundamental statistical technique used to understand the relationship between variables and often employed in predictive modeling.  
• Conceptual Dependency: A theory in artificial intelligence that focuses on representing the meanings of sentences in a manner that is independent of the language in which the sentences are written.  
• Link Analysis: Often used in the analysis of social networks and the web, focusing on relationships and flows between website nodes or social entities.  
Hence, Option (1) is the right answer.  
  
Example 3:  
75. Match the following techniques with their most aligned computational paradigm:  
Technique Computational Paradigm  
I. Hidden Markov Model A. Statistical learning  
II. Multi Layer Perceptron B. Deep learning  
III. Lower Bounds through Reductions C. Theoretical computer science  
IV. Summarization D. Natural language processing  
Choose the correct answer from the options given below:  
(1) I-A, II-B, III-C, IV-D  
(2) I-C, II-D, III-A, IV-B  
(3) I-B, II-C, III-D, IV-A  
(4) I-D, II-A, III-B, IV-C  
Answer Key: 4   
Solution:   
• Hidden Markov Model: Predominantly used in areas like speech recognition and bioinformatics, relying heavily on statistical probabilities.  
• Multi Layer Perceptron: A class of feedforward artificial neural network (ANN), a core component of deep learning.  
• Lower Bounds through Reductions: Central to theoretical computer science, especially in complexity theory to establish computational limits.  
• Summarization: A process in natural language processing aimed at reducing a large body of text into a condensed form, preserving key information.  
Hence, Option (4) is the right answer.  
  
Example 4:  
77. Match the following data-centric techniques to their corresponding usage scenarios:  
Technique Usage Scenario  
I. Clustering A. Identifying inherent groupings in data  
II. Support Vector Machine B. Classifying data into predefined categories  
III. Lower Bounds through Reductions C. Proving theoretical limits in computational complexities  
IV. Frames D. Structuring knowledge in artificial intelligence systems  
Choose the correct answer from the options given below:  
(1) I-A, II-B, III-C, IV-D  
(2) I-C, II-D, III-A, IV-B  
(3) I-B, II-C, III-D, IV-A  
(4) I-D, II-A, III-B, IV-C  
Answer Key: 1   
Solution:   
• Clustering: Used extensively in exploratory data analysis to find natural groupings in data, such as in market segmentation or social network analysis.  
• Support Vector Machine: A powerful classifier that works by finding the hyperplane that best divides a dataset into classes.  
• Lower Bounds through Reductions: Essential in establishing minimum computational requirements for solving problems, a key aspect of theoretical computer science.  
• Frames: Utilized in AI to represent stereotypical situations, aiding in understanding and reasoning about domain knowledge.  
Hence, Option (1) is the right answer.  
  
Example 5:  
79. Match the following concepts with their appropriate analytic focus:  
Concept Analytic Focus  
I. Comparison Trees A. Optimization of search and sort algorithms  
II. Regression B. Prediction and correlation analysis in statistics  
III. Expert Systems C. Decision making in artificial intelligence  
IV. Data Modeling for Data Warehouses D. Organizing large-scale historical data for analysis  
Choose the correct answer from the options given below:  
(1) I-A, II-B, III-C, IV-D  
(2) I-C, II-D, III-A, IV-B  
(3) I-B, II-C, III-D, IV-A  
(4) I-D, II-A, III-B, IV-C  
Answer Key: 1   
Solution:   
• Comparison Trees: A structured representation used to optimize and evaluate the performance of sorting and searching algorithms.  
• Regression: A statistical tool used to model and analyze relationships between variables, crucial for predictive analytics.  
• Expert Systems: AI systems designed to make decisions based on complex rules and databases, mimicking human expert decision-making capabilities.  
• Data Modeling for Data Warehouses: Involves structuring data specifically for query and analysis, supporting business intelligence activities.  
Hence, Option (1) is the right answer.  
  
59. In a Linux system, a process scheduler must decide the next process to run on a CPU core. Consider the following processes with their associated burst times in milliseconds and priorities (lower number indicates higher priority):  
- Process A: Burst time = 10ms, Priority = 2  
- Process B: Burst time = 15ms, Priority = 1  
- Process C: Burst time = 8ms, Priority = 4  
- Process D: Burst time = 12ms, Priority = 3  
Assuming the scheduler uses both priority and burst time to make scheduling decisions in a preemptive scheduling scheme, which process would most likely be scheduled next?  
(1) Process A  
(2) Process B  
(3) Process C  
(4) Process D  
Answer Key: 4   
Solution:   
• (Incorrect): Process A, despite having a high priority, has a longer burst time compared to D.   
• (Incorrect): Process B has the highest priority but the longest burst time, which makes it less ideal for a preemptive approach focusing on quick task switching.   
• (Incorrect): Process C has the shortest burst time but the lowest priority.   
• (Correct): Process D strikes the optimal balance with a moderate burst time and higher priority (compared to C), making it the ideal candidate for minimizing context switch delays and maintaining system responsiveness.   
Hence, Option (4) is the right answer.

--Question Starting--  
63. A Turing Machine (TM) is designed to compute a function which doubles the input encoded in unary on the tape (e.g., input '111' should output '111111'). Given this requirement, which of the following is a necessary component of the machine's construction?  
(1) A state that marks the middle of the tape  
(2) A state that detects the end of the original input  
(3) A state for error detection  
(4) A state that moves the head back to the tape's beginning after writing  
Answer Key: 4   
Solution:   
• (Incorrect): Marking the middle of the tape is not required for doubling the input.   
• (Incorrect): While detecting the end of the input is crucial, it is not as critical as ensuring the head returns to start for correct output generation.   
• (Incorrect): Error detection, while generally useful, is not specifically necessary for the described functionality of this TM.   
• (Correct): After writing the doubled input, moving the head back to the beginning of the tape ensures that the TM halts correctly and displays the entire output as intended.   
Hence, Option (4) is the right answer.  
  
Assuming the scheduler uses both priority (lower number means higher priority) and burst time to make scheduling decisions, which process would most likely be scheduled after considering both factors optimally for a preemptive scheduling scheme?  
(1) Process A  
(2) Process B  
(3) Process C  
(4) Process D  
Answer Key: 4   
Solution:   
• (Incorrect): Process A, despite having a high priority, has a longer burst time compared to D.   
• (Incorrect): Process B has the highest priority but the longest burst time, which makes it less ideal for a preemptive approach focusing on quick task switching.   
• (Incorrect): Process C has the shortest burst time but the lowest priority.   
• (Correct): Process D strikes the optimal balance with a moderate burst time and higher priority (compared to C), making it the ideal candidate for minimizing context switch delays and maintaining system responsiveness.   
Hence, Option (4) is the right answer.

1. Assuming the scheduler uses both priority (lower number means higher priority) and burst time to make scheduling decisions, which process would most likely be scheduled after considering both factors optimally for a preemptive scheduling scheme?  
(1) Process A  
(2) Process B  
(3) Process C  
(4) Process D  
Answer Key: 4   
Solution:   
• (Incorrect): Process A, despite having a high priority, has a longer burst time compared to D.   
• (Incorrect): Process B has the highest priority but the longest burst time, which makes it less ideal for a preemptive approach focusing on quick task switching.   
• (Incorrect): Process C has the shortest burst time but the lowest priority.   
• (Correct): Process D strikes the optimal balance with a moderate burst time and higher priority (compared to C), making it the ideal candidate for minimizing context switch delays and maintaining system responsiveness.   
Hence, Option (4) is the right answer.

73. Match the following data models with their specific application areas:  
Data Model Application Area  
I. Temporal Database B. Tracking historical changes in weather conditions  
II. Geographic Information Systems C. Managing spatial data for urban planning  
III. Multimedia Databases D. Storing and retrieving multimedia content in digital libraries  
IV. Deductive Databases A. Inferring new facts in medical diagnosis systems  
Choose the correct answer from the options given below:  
(1) I-B, II-C, III-D, IV-A  
(2) I-C, II-B, III-A, IV-D  
(3) I-A, II-D, III-B, IV-C  
(4) I-D, II-A, III-C, IV-B  
Answer Key: 1   
Solution:  
• Temporal Database: Ideal for applications requiring tracking of changes over time, such as historical weather data.  
• Geographic Information Systems: Essential for handling and analyzing geographical data, crucial in urban planning.  
• Multimedia Databases: Supports the efficient storage and retrieval of multimedia items, useful in digital libraries.  
• Deductive Databases: Used in complex querying environments like medical diagnosis, where inference is key.  
Hence, Option (1) is the right answer.  
  
--Question Starting--  
75. Match the following types of virtual machines with their primary utility:  
Type of Virtual Machine Utility  
I. System Virtual Machine A. Running multiple operating systems on a single physical machine  
II. Process Virtual Machine B. Supporting application development in a platform-independent environment  
III. Hardware Virtual Machine C. Enabling deeper hardware-level simulation and testing  
IV. Software Virtual Machine D. Facilitating specific software applications  
Choose the correct answer from the options given below:  
(1) I-B, II-C, III-A, IV-D  
(2) I-C, II-D, III-A, IV-B  
(3) I-A, II-B, III-C, IV-D  
(4) I-D, II-A, III-B, IV-C  
Answer Key: 3   
Solution:  
• System Virtual Machine: Provides the capability to host multiple operating systems on a single physical hardware.  
• Process Virtual Machine: Designed to offer a platform-independent programming environment, e.g., the Java VM.  
• Hardware Virtual Machine: Focuses on simulating the entire hardware system for purposes like development and testing.  
• Software Virtual Machine: Often used to run specific software applications within a controlled environment.  
Hence, Option (3) is the right answer.

36. Consider a finite group \( G \) of order 56, where \( G \) is a non-abelian group with a normal subgroup \( H \) of order 7. Suppose \( G \) also possesses an automorphism that maps any element to its inverse, and there exists a subgroup \( K \) isomorphic to \( \mathbb{Z}/8\mathbb{Z} \). Given these conditions, how many distinct Sylow 2-subgroups can \( G \) have?  
(1) 1  
(2) 2  
(3) 7  
(4) 14  
Answer Key: 1  
Solution:  
• (Correct): The number of Sylow 2-subgroups in \( G \), denoted as \( n\_2 \), must satisfy \( n\_2 \equiv 1 \pmod{8} \) and \( n\_2 \) divides 7. The only number fitting both conditions is 1.  
• (Incorrect): While 2 is a possible divisor of 7, it does not satisfy \( n\_2 \equiv 1 \pmod{8} \).  
• (Incorrect): Although 7 divides 56, it does not satisfy \( n\_2 \equiv 1 \pmod{8} \).  
• (Incorrect): 14 is not a divisor of 7, and hence it cannot be the number of Sylow 2-subgroups.  
Hence, Option (1) is the right answer.

Question 37: In an optimized production schedule, a plant manager must decide how to allocate resources among four different products. Each product has a different profit contribution and resource requirement. The total available resources limit the production of each product. The manager uses a linear programming model to maximize profit. Given changes in market demand, how should the manager adjust the resource allocation to maintain optimal profit if the profit contribution of two products increases?  
(1) Adjust the objective function coefficients in the linear programming model.  
(2) Re-analyze the constraints to accommodate increased demand.  
(3) Implement the dual simplex method to re-optimize the solution.  
(4) Use sensitivity analysis to understand the impact of changes on the optimal solution.  
Answer Key: 1  
Solution:  
• (Correct): Adjusting objective function coefficients is necessary to address changes in profit contributions, directly influencing the maximization goal in the linear programming model.  
• (Incorrect): Re-analyzing constraints primarily addresses changes in the availability or nature of resources, not changes in profit contributions.  
• (Incorrect): The dual simplex method is used when the current solution becomes infeasible, which is not directly related to changes in profit contributions.  
• (Incorrect): Sensitivity analysis is useful for understanding the impact of changes, but it is a diagnostic tool rather than a method to directly adjust the model for profit changes.  
Hence, Option (1) is the right answer.

38. A computer system employs a microarchitecture where multiple registers interact via a common bus system to perform various arithmetic and logical operations. If the system must execute a sequence of instructions involving conditional logic and arithmetic functions, what type of microoperation is primarily used to ensure correct execution sequence and outcomes?  
(1) Memory transfer operations  
(2) Logic microoperations  
(3) Conditional set/reset operations  
(4) Arithmetic microoperations  
Answer Key: 3  
Solution:  
• (Incorrect): While memory transfers are essential for moving data among registers, they do not control the execution sequence of operations.  
• (Incorrect): Logic microoperations perform logical functions but do not directly influence the execution sequence.  
• (Correct): Conditional set/reset operations are crucial as they determine the flow of execution based on conditions, thus ensuring the correct sequence and outcomes of the instructions.  
• (Incorrect): Arithmetic operations are involved in calculations but do not control the overall sequence of instruction execution.  
Hence, Option (3) is the right answer.

Question 39: When implementing a new software module, a team of developers uses a white-box testing strategy to validate the logic of the code. Which testing approach should they use to ensure that all possible logical paths are tested, considering the complexity and potential hidden bugs in the code?  
(1) Basis Path Testing  
(2) Control Structure Testing  
(3) Unit Testing  
(4) Regression Testing  
Answer Key: 1  
Solution:  
• (Correct): Basis Path Testing is a white-box testing method focused on executing all logical paths through the code, making it suitable for uncovering hidden logical errors.  
• (Incorrect): While Control Structure Testing is another form of white-box testing, it does not focus as explicitly on covering all logical paths as Basis Path Testing.  
• (Incorrect): Unit Testing is a broader category that can include various testing methods but does not specifically ensure all logical paths are covered unless specifically designed to do so.  
• (Incorrect): Regression Testing ensures that new changes do not adversely affect existing functionalities, but it is not specifically designed to cover all logical paths in new code.  
Hence, Option (1) is the right answer.

40. In a computer science curriculum, a professor decides to illustrate the efficiency of data structures in handling large datasets. Students are tasked with implementing a search algorithm that efficiently manages searching operations in a large database. Which data structure would most likely provide the fastest average search times, assuming the data is organized and indexed appropriately?  
(1) Linked List  
(2) Binary Search Tree  
(3) Hash Table  
(4) Stack  
Answer Key: 3  
Solution:  
• (Incorrect): Linked Lists offer sequential access, which is inefficient for large data sets as it requires \( O(n) \) time complexity for search operations.  
• (Incorrect): Binary Search Trees can offer efficient search times; however, their performance degrades to \( O(n) \) in the worst case (e.g., when the tree becomes skewed).  
• (Correct): Hash Tables provide \( O(1) \) average time complexity for search operations, making them ideal for handling large, indexed datasets.  
• (Incorrect): Stacks are designed for LIFO access and are not suitable for efficient search operations across large datasets.  
Hence, Option (3) is the right answer.

1. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
   Assertion (A): Classification algorithms in data mining can predict categorical class labels and can adapt based on new data input.  
   Reason (R): Classification is primarily concerned with the distribution and correlation of data rather than prediction of class labels.  
   In light of the above statements, choose the most appropriate answer from the options below:  
   (1) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
   (2) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.  
   (3) Assertion is correct, but Reason is incorrect.  
   (4) Assertion is incorrect, but Reason is correct.  
   Answer Key: 3  
   Solution:  
   • (Assertion is Correct): Classification algorithms are designed to predict categorical class labels by learning from a labeled dataset and can adapt when new data is introduced.  
   • (Reason is Incorrect): Classification is primarily focused on predicting class labels based on the features of instances in the data. It indeed uses data distribution and correlation to make these predictions, but the main goal is label prediction, not just analysis of data distribution.  
   Hence, Option (3) is the right answer.
2. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
   Assertion (A): In stored program organization, the instructions to be executed are stored in the main memory.  
   Reason (R): This storage allows the computer to perform operations without reprogramming the physical hardware for each new task.  
   In light of the above statements, choose the most appropriate answer from the options below:  
   (1) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
   (2) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.  
   (3) Assertion is correct, but Reason is incorrect.  
   (4) Assertion is incorrect, but Reason is correct.  
   Answer Key: 3  
   Solution:  
   • (Assertion is Correct): Stored program organization implies that programs are stored in computer memory while being executed, enabling the CPU to fetch and execute instructions sequentially from memory.  
   • (Reason is Incorrect): While it is true that storing programs in memory allows for more versatile use of the computer, the primary reason for this storage is not to avoid reprogramming hardware but to facilitate the sequential execution of instructions and easier switching between tasks.  
   Hence, Option (3) is the right answer.
3. Assertion (A): Alpha-beta pruning is an optimization technique used in the minimax algorithm to reduce the number of nodes evaluated in the search tree.  
   Reason (R): This reduction is achieved by logically determining that certain parts of the tree need not be explored, as they cannot influence the final decision.  
   Options:  
   (1) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
   (2) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.  
   (3) Assertion is correct, but Reason is incorrect.  
   (4) Assertion is incorrect, but Reason is correct.  
   \*\*Correct Answer Key: 1\*\*  
   \*\*Corrected Solution:\*\*  
   • (Assertion is Correct): Alpha-beta pruning enhances the minimax algorithm by skipping the evaluation of certain branches in the game tree, which cannot possibly affect the final outcome of the minimax decision.  
   • (Reason is Correct and a Correct Explanation): The reason accurately describes that the reduction in the number of nodes evaluated is achieved by not exploring parts of the tree that will not influence the final decision.  
   Hence, Option (1) is the right answer.
4. Assertion (A): LR parsers are capable of handling a wider range of grammars than LL parsers.  
   Reason (R): LR parsers use a state-based approach to parsing which allows them to look ahead and make more informed decisions about which production rules to apply.  
   Options:  
   (1) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
   (2) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.  
   (3) Assertion is correct, but Reason is incorrect.  
   (4) Assertion is incorrect, but Reason is correct.  
   \*\*Correct Answer Key: 1\*\*  
   \*\*Corrected Solution:\*\*  
   • (Assertion is Correct): LR parsers are indeed more powerful than LL parsers and can parse a broader class of grammars due to their ability to handle more complex constructs with fewer restrictions on grammar form.  
   • (Reason is Correct and a Correct Explanation): The state-based approach and lookahead capability of LR parsers are indeed integral to their ability to handle a wider range of grammars, as it allows them to resolve ambiguities and reduce conflicts effectively.  
   Hence, Option (1) is the right answer
5. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
   Assertion (A): Intermediate code generation involves transforming high-level language statements into a lower-level, machine-independent code.  
   Reason (R): This transformation allows for optimization across different target platforms, enhancing the efficiency of the generated code.  
   In light of the above statements, choose the most appropriate answer from the options below:  
   (1) Both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.  
   (2) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.  
   (3) Assertion is correct, but Reason is incorrect.  
   (4) Assertion is incorrect, but Reason is correct.  
   Answer Key: 3  
   Solution:  
   • (Assertion is Correct): Intermediate code serves as a bridge between high-level languages and machine code, providing a platform-independent format that can be further optimized for specific hardware during later stages of compilation.  
   • (Reason is Incorrect): While the transformation to intermediate code does facilitate cross-platform optimization, the main purpose of intermediate code generation is not efficiency enhancement but rather to provide a standard, machine-independent format that simplifies further compilation steps.  
   Hence, Option (3) is the right answer.