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.

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.

--Question Starting--

88. Consider the following two statements related to Cloud Computing:

Statement I: In cloud computing, virtualization allows multiple operating systems to run concurrently on a single physical server, which enhances the hardware utilization and provides isolation between different systems.

Statement II: SaaS (Software as a Service) strictly offers software tools for developers to build applications, similar to PaaS (Platform as a Service), limiting users to application development environments only.

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Statement I is incorrect but Statement II is correct

Answer Key: 3

Solution:

• I(Correct): Virtualization is a technology used in cloud computing that enables multiple virtual machines to operate on a single physical server. It maximizes resource utilization and provides isolation, which is crucial for security and efficient management.

• II(Incorrect): SaaS provides users with access to applications hosted on cloud infrastructure, not tools for building applications. It differs from PaaS, which indeed provides development tools and environments. SaaS applications are typically end-user applications and do not restrict users to development environments.

Hence, Option (3) is the right answer.

--Question Starting--

89. Consider the following statements:

Statement I: In a multiplexed system, bandwidth is shared among multiple data channels by interleaving the signals in time, frequency, or code within the same transmission medium.

Statement II: Baseband transmission is a method of sending multiple signals over a single channel by shifting each signal to a different frequency.

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Statement I is incorrect but Statement II is correct

Answer Key: 3

Solution:

• I(Correct): Multiplexing is a technique used in data communication where multiple analog or digital signals are combined into one signal over a shared medium. The methods include time division (TDM), frequency division (FDM), and code division (CDM) multiplexing.

• II(Incorrect): Baseband transmission refers to sending a single digital signal over the transmission medium without altering the frequency of the signal. This is in contrast to broadband transmission, where multiple signals are sent over the same medium by shifting them to different frequencies.

Hence, Option (3) is the right answer.

--Question Starting--

90. Consider these two statements regarding CPU scheduling:

Statement I: Round-robin scheduling is a preemptive algorithm that utilizes time slicing to ensure that all processes receive an equal share of CPU time.

Statement II: Non-preemptive scheduling algorithms, such as Shortest Job First (SJF), can lead to shorter average waiting times compared to preemptive versions due to reduced context switching.

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Statement I is incorrect but Statement II is correct

Answer Key: 1

Solution:

• I(Correct): Round-robin is a preemptive CPU scheduling algorithm that uses fixed time slices or "quantum" to allocate CPU time to processes in a circular order, ensuring a balanced use of CPU.

• II(Correct): Non-preemptive scheduling algorithms like SJF can indeed result in reduced average waiting times, primarily because once a process starts executing, it runs to completion without interruption, minimizing the overhead caused by context switching.

Hence, Option (1) is the right answer.

--Question Starting--

91. Consider the following statements regarding error handling in data communication:

Statement I: Parity bits are added to data to allow the detection of single bit errors, enhancing the reliability of transmitted data.

Statement II: Automatic Repeat reQuest (ARQ) is an error-control method for data transmission that ensures error-free communication by using acknowledgments and timeouts.

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Statement I is incorrect but Statement II is correct

Answer Key: 1

Solution:

• I(Correct): Parity bits are utilized in data communication to detect errors in transmitted data. Adding a parity bit helps in identifying single-bit errors, which is a simple form of error detection.

• II(Correct): ARQ is a protocol for error control in data transmission that uses acknowledgments (ACK) and retransmissions (in case of timeouts or negative acknowledgments) to ensure that data is transmitted without errors.

Hence, Option (1) is the right answer.

--Question Starting--

92. Analyze the following statements related to Instruction Scheduling in code optimization:

Statement I: Instruction scheduling is a technique used in compilers to improve execution speed by rearranging the order of instructions to reduce stalls caused by data hazards.

Statement II: Local optimization techniques in compilers focus on optimizing smaller sections of code, often limited to single basic blocks, and do not take into account the effects of instruction scheduling across multiple blocks.

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Statement I is incorrect but Statement II is correct

Answer Key: 1

Solution:

• I(Correct): Instruction scheduling is an optimization technique used by compilers to reorder instructions to minimize waiting times for CPU resources and reduce pipeline stalls, thereby enhancing the program's execution speed.

• II(Correct): Local optimization focuses on optimizing code within a single block and does not consider interdependencies between blocks, which is different from more complex global optimization strategies that might involve reordering instructions across multiple blocks.

Hence, Option (1) is the right answer.

--Question Starting--

1. Which of the following statements about Windows OS internals and management features are correct?

I. Windows uses a hybrid kernel that combines features of monolithic and microkernel architectures.

II. Windows Task Scheduler uses a preemptive priority-based scheduling policy for managing processes.

III. NTFS (New Technology File System) in Windows does not support file-level security or journaling.

IV. Windows services can only be initiated by the user manually via the GUI and not during system boot.

Choose the correct answer from the options given below:

(1) I, and II only

(2) II and IV only

(3) II, III, and IV only

(4) All of the above

Answer Key: 2

Solution:

• I(Correct): Windows uses a hybrid kernel, which combines features of both monolithic kernels (like direct hardware interaction) and microkernels (like modularity). It’s not strictly microkernel or monolithic, but merges performance with modularity.

• II(Correct): Windows uses a preemptive, priority-based scheduling algorithm for threads. Threads with higher priority preempt lower-priority ones and the scheduler also considers quantum expiration for fair CPU distribution.

• III(Incorrect): NTFS supports file-level security via Access Control Lists (ACLs), journaling for fault tolerance and recoverability, compression, encryption, and disk quotas.

• IV(Incorrect): Windows services can be set to start automatically during system boot (e.g., DHCP Client, Windows Update), and can also be manually started via GUI (Services.msc) or command-line (sc, net start). Hence, not limited to manual start only.

Hence, Option (2) is the right answer.

--Question Starting--

2. Consider the following assertions about various cloud service models and technologies:

I. In IaaS, the cloud provider manages the virtualization infrastructure but leaves operating system management to the client.

II. SaaS applications cannot be customized or integrated with existing enterprise software.

III. Virtualization at the OS level allows multiple instances of different operating systems to run on the same physical hardware.

IV. A public cloud is generally considered more secure than a private cloud due to its larger scale and better resourced cybersecurity measures.

Choose the correct answer from the options given below:

(1) I and III only

(2) I and II only

(3) I, II, and IV only

(4) III and IV only

Answer Key: 2

Solution:

• I(Correct): In IaaS, the provider manages the hardware, storage, and virtualization, while the client is responsible for managing operating systems, applications, and possibly selected networking components (like firewalls).

• II(Correct): SaaS applications, while generally offering configuration options, are not typically customizable at the code level and may have limited integration capabilities compared to in-house developed applications.

• III(Incorrect): OS-level virtualization (containerization) allows multiple isolated user-space instances, but not instances of different OSs. Different OS instances require full virtualization or hardware-assisted virtualization.

• IV(Incorrect): Public clouds are not inherently more secure than private clouds; the security depends on many factors, including the implementation and management of security policies.

Hence, Option (2) is the right answer.

--Question Starting--

3. Evaluate the following statements concerning runtime systems and memory management in programming languages:

I. The activation tree and activation record are unrelated concepts in the context of runtime storage management.

II. Stack-based allocation of activation records can reliably support recursive function calls.

III. Parameter passing mechanisms like call-by-reference can potentially allow side-effects in the caller’s context.

IV. Symbol tables are only necessary at compile time and have no runtime utility.

Choose the correct answer from the options given below:

(1) I and II only

(2) II and III only

(3) I, III, and IV only

(4) All of the above

Answer Key: 2

Solution:

• I(Incorrect): The activation tree represents the calling relationships between functions at runtime, and the activation record is a stack frame in this context, used to store information about a function’s execution state.

• II(Correct): Stack-based allocation perfectly supports recursive calls as each call creates a new activation record on the stack, and each return deallocates the current stack frame.

• III(Correct): Call-by-reference allows the function to modify the argument’s actual memory, thus causing side-effects in the caller’s scope.

• IV(Incorrect): Symbol tables may be used at runtime in dynamic or late-binding scenarios to resolve identifiers, especially in dynamically typed languages or environments supporting reflection.

Hence, Option (2) is the right answer.

--Question Starting--

4. Which of the following statements about advanced algorithms are correct?

I. Parallel algorithms always result in linear speed-up relative to their sequential counterparts.

II. Approximation algorithms provide guaranteed optimal solutions within a bounded error margin.

III. Randomized algorithms use a deterministic approach to solve problems where the input is randomized.

IV. Merge sort can be effectively parallelized to improve performance on multi-core processors.

Choose the correct answer from the options given below:

(1) I and III only

(2) II and IV only

(3) I, II, and III only

(4) All of the above

Answer Key: 2

Solution:

• I(Incorrect): Parallel algorithms often face issues like overhead and limited parallelism, which may prevent linear speed-up.

• II(Correct): Approximation algorithms are designed to find solutions close to the optimal, with a known error bound.

• III(Incorrect): Randomized algorithms use random decisions within the algorithm to solve problems, not necessarily with randomized inputs.

• IV(Correct): Merge sort is a divide-and-conquer algorithm, which lends itself well to parallelization because different parts of the array can be sorted independently in parallel.

Hence, Option (2) is the right answer.

--Question Starting--

5. Analyze the following statements regarding programming languages and their translation:

I. All programming paradigms utilize the same model of computation such as Turing machines.

II. Binding times in programming languages can occur at compile time, load time, or runtime.

III. Syntax analysis is the final stage in the translation process from high-level code to machine code.

IV. Virtual computers provide a platform-independent execution environment for programs.

Choose the correct answer from the options given below:

(1) I and III only

(2) II and IV only

(3) I, II, and III only

(4) All of the above

Answer Key: 2

Solution:

• I(Incorrect): Different programming paradigms may utilize different models of computation, e.g., functional programming often relates to lambda calculus, while imperative programming relates more to Turing machines.

• II(Correct): Binding can occur at various stages depending on when values are assigned to variables, method calls are linked to their definitions, etc.

• III(Incorrect): Syntax analysis is an earlier stage in the compilation process, followed by semantic analysis and then code generation.

• IV(Correct): Virtual computers, such as Java's JVM or the .NET CLR, provide an abstraction layer that allows programs to run uniformly across different hardware platforms.

Hence, Option (2) is the right answer.

64. Consider these advanced statements about Artificial Neural Networks (ANN):  
I. Supervised learning in ANNs requires a dataset with predefined labels to train the model effectively.  
II. Multi-Layer Perceptrons (MLPs) are capable of learning non-linear decision boundaries due to their multiple hidden layers.  
III. Self Organizing Maps are used for unsupervised learning to preserve the topological properties of the input space.  
IV. Hopfield networks serve as a form of recurrent neural network, suitable for associative memory.  
V. In reinforcement learning, the absence of training datasets with labels makes it unsuitable for neural network applications.  
Choose the correct answer from the options given below:  
(1) I, II, and III only  
(2) I, II, IV and V only  
(3) I, II, III and IV only  
(4) II, III, IV and V only  
Answer Key: 3  
Solution:  
• I(Correct): Supervised learning in neural networks indeed requires labeled data, which helps the network learn to predict outputs based on inputs accurately.  
• II(Correct): MLPs, by design, have multiple layers including hidden layers that enable them to learn complex, non-linear decision boundaries, enhancing their predictive capabilities.  
• III(Correct): Self Organizing Maps (SOMs) are a type of unsupervised learning that aims to represent high-dimensional data in lower-dimensional spaces, preserving the topological features of the input space.  
• IV(Correct): Hopfield networks are recurrent neural networks designed for associative memory, storing and recalling patterns, which aligns with the statement’s claim.  
• V(Incorrect): Reinforcement learning is successfully applied in neural networks, where the system learns to make decisions by receiving rewards or penalties, despite not having a labeled dataset.  
Hence, Option (3) is the right answer.  
  
31. Consider the following detailed statements concerning data warehousing and data mining techniques:  
I. In a star schema, the fact table at the center connects to multiple dimension tables but does not support denormalization within those dimension tables.  
II. OLAP operations facilitate the summarization of information across multiple dimensions, but cannot be used to drill down to lower levels of granularity.  
III. Association rule mining should ensure a minimum support threshold to be effective but does not require a confidence measure.  
IV. K-Nearest Neighbour (KNN) classification can be utilized effectively without the need for a predefined number of clusters.  
V. Regression analysis is not suitable for predicting categorical target variables.  
Choose the correct answer from the options given below:  
(1) I, II, and III only  
(2) I, IV, and V only  
(3) IV, and V only  
(4) III, IV, and V only  
Answer Key: 3  
Solution:  
• I(Incorrect): In a star schema, the fact table connects to dimension tables, which are typically denormalized to enhance query performance. The statement’s claim that denormalization is not supported is false.  
• II(Incorrect): OLAP operations are specifically designed to not only summarize data across dimensions but also allow drilling down to detailed levels of granularity, enhancing analytical capabilities.  
• III(Incorrect): Association rule mining relies fundamentally on both support and confidence measures. The support threshold determines how frequently a rule appears, while confidence measures the accuracy of the inferred rule.  
• IV(Correct): K-Nearest Neighbor (KNN) is a classification technique that doesn’t require the number of clusters to be predefined, which is more characteristic of clustering algorithms like K-means.  
• V(Correct): Regression analysis is typically used for predicting continuous variables and is not ideally suited for categorical targets, which are better predicted using classification algorithms.  
Hence, Option (3) is the right answer.  
  
1. Examine these statements about Process Management:  
I. The critical-section problem addresses the need to avoid race conditions in concurrent processes.  
II. Semaphores are primarily used to signal between processes, not for mutual exclusion.  
III. Peterson's solution is a software-based solution for achieving process synchronization in a multi-processing environment.  
Which of the following is correct?  
(1) I and II only  
(2) I and III only  
(3) II and III only  
(4) All of the above  
Answer Key: 2  
Solution:  
• I(Correct): The critical-section problem indeed focuses on preventing race conditions by ensuring that multiple processes do not execute critical sections of code simultaneously.  
• II(Incorrect): Semaphores are used for both signaling and mutual exclusion, providing a means to control access by multiple processes to a common resource.  
• III(Correct): Peterson's solution is a classic software approach to prevent concurrent processes from entering their critical sections at the same time, thus ensuring proper synchronization.  
Hence, Option (2) is the right answer.  
  
53. Analyze the following intricate statements about graph theory:  
I. In a simple graph, each edge connects two distinct vertices with no parallel edges or self-loops.  
II. A weighted graph can be represented using an adjacency matrix where the elements reflect the weight of the edges, not just their existence.  
III. Eulerian paths require each vertex to have an even degree, except for exactly two vertices that can have an odd degree.  
IV. Hamiltonian circuits involve visiting each vertex exactly once, but do not require returning to the starting vertex.  
V. Graph coloring problems involve assigning colors to vertices so no two adjacent vertices share the same color, and is NP-complete.  
Choose the correct answer from the options given below:  
(1) I, II, and III only  
(2) I, II, IV and V only  
(3) I, III and IV only  
(4) I, II, III and V only  
Answer Key: 4  
Solution:  
• I(Correct): A simple graph is defined exactly by edges that connect distinct vertices without parallel edges or self-loops.  
• II(Correct): In a weighted graph, an adjacency matrix is a suitable representation where each cell (i, j) can hold the weight of the edge between vertices i and j, indicating the cost or length of the connection.  
• III(Correct): Eulerian paths require that all vertices have an even degree except for exactly two, which must have an odd degree. This condition allows the path to start and end at different vertices.  
• IV(Incorrect): A Hamiltonian circuit by definition requires not only visiting each vertex exactly once but also returning to the starting vertex, forming a closed loop.  
• V(Correct): The graph coloring problem, where no two adjacent vertices can be the same color, is indeed NP-complete, indicating its computational complexity and difficulty in finding an optimal solution.  
Hence, Option (4) is the right answer.  
  
2. Consider the following statements regarding Memory Hierarchy and its components:  
I. Virtual memory allows an operating system to use hard disk space to simulate extra memory.  
II. Associative memory is a type of memory that is accessed based on its content rather than a specific address.  
III. Cache memory speeds up operations by keeping recent or frequently used data items closer to the processor.  
Which of the following is correct?  
(1) I and II only  
(2) I and III only  
(3) II and III only  
(4) All of the above  
Answer Key: 4  
Solution:  
• I (Correct): Virtual memory allows the operating system to use hard disk space as an extension of RAM, simulating additional memory to run larger programs or multiple processes.  
• II(Correct): Associative memory, also known as content-addressable memory (CAM), is accessed by content rather than by specific memory addresses. This feature is crucial for high-speed searching applications.  
• III(Correct): Cache memory, being closer to the CPU, stores copies of data from frequently used main memory locations. As a result, it reduces the time to access data from the main memory, effectively speeding up the operation.  
Hence, Option (4) is the right answer.  
  
3. Assess the following statements pertaining to the Run Time System:  
I. Activation records are used to keep track of function calls and local variables during execution.  
II. Stack allocation of activation records can lead to fragmentation in the runtime memory.  
III. Symbol tables are used to store information about the scope and binding of identifiers.  
Which of the following is correct?  
(1) I and III only  
(2) I and II only  
(3) II and III only  
(4) All of the above  
Answer Key: 1  
Solution:  
• I(Correct): Activation records indeed store information about the active functions, including return addresses, parameters, and local variables, essential for managing function calls and returns.  
• II(Incorrect): Stack allocation of activation records does not lead to fragmentation; instead, it uses a contiguous block of memory, growing and shrinking in a disciplined manner. Fragmentation is more associated with heap memory allocation.  
• III(Correct): Symbol tables play a critical role in storing details about identifiers, including their scope (visibility) and binding information, which relates to the association of various program elements with memory.  
Hence, Option (1) is the right answer.  
  
4. Review the following statements related to Database System Concepts and Architecture:  
I. The three-schema architecture includes the internal, external, and conceptual schemas, promoting data abstraction and independence.  
II. Data independence means that the schema can be altered without affecting the front-end application.  
III. Client-server architecture in DBMS does not support transaction processing.  
Which of the following is correct?  
(1) I and II only  
(2) I and III only  
(3) II and III only  
(4) All of the above  
Answer Key: 1  
Solution:  
• I(Correct): The three-schema architecture indeed separates data access into three levels, helping to manage data abstraction and offering independence between these layers.  
• II(Correct): Data independence allows the modification of the schema at one level of a database system without having to alter the schema at the next higher level, thus preserving the application's usability.  
• III(Incorrect): Client-server architecture in DBMS does support transaction processing. It is designed to handle transactions between clients and servers, including those that involve data manipulation and queries.  
Hence, Option (1) is the right answer.  
  
42. Evaluate the following complex statements about Big Data systems:  
I. Hadoop's architecture inherently supports real-time processing by minimizing data movement and utilizing in-memory computing.  
II. The MapReduce programming model is inherently unsuited for iterative algorithms as it requires data to be loaded and processed in distinct phases.  
III. HDFS does not support the storage of small files efficiently, as each file consumes a metadata block in the namespace.  
IV. Big Data systems typically require data cleansing at the initial stages to ensure high-quality data integration.  
V. Types of Big Data include structured, unstructured, and semi-structured, but not metadata as it does not represent a form of data content.  
Choose the correct answer from the options given below:  
(1) I, II, and III only  
(2) II, III, and IV only  
(3) I, IV, and V only  
(4) II, IV, and V only  
Answer Key: 2  
Solution:  
• I(Incorrect): Hadoop primarily supports batch processing rather than real-time processing, which is better handled by other technologies such as Apache Storm or Spark Streaming.  
• II(Correct): The MapReduce model is less effective for iterative algorithms because each iteration must be processed as a separate MapReduce job, leading to inefficiencies and high latency.  
• III(Correct): HDFS is not optimized for handling small files. Each small file still requires a full block of metadata, which can quickly consume valuable namespace and lead to inefficiencies.  
• IV(Correct): Initial data cleansing is crucial in Big Data systems to ensure that the data integrated from various sources maintains quality and consistency, which is critical for subsequent analysis.  
• V(Incorrect): Metadata is considered a type of Big Data since it describes other data and provides context, which is essential for data management and analysis.  
Hence, Option (2) is the right answer.  
  
75. Evaluate these complex statements about Web Programming technologies:  
I. HTML and DHTML are both markup languages; DHTML is simply a more dynamic version of HTML that incorporates CSS and JavaScript.  
II. XML is exclusively used for displaying data and cannot be employed for data storage or transport.  
III. Java applets run independently of the client browser, providing functionalities without interacting with the browser’s own runtime environment.  
IV. Servlets are server-side components that generate dynamic content in response to client requests, typically deployed on J2EE servers.  
V. Scripting languages like JavaScript can manipulate both client-side and server-side components but are primarily used for enhancing the user interface.  
Choose the correct answer from the options given below:  
(1) I, II, and III only  
(2) I, III, and IV only  
(3) I, IV and V only  
(4) II, III, IV and V only  
Answer Key: 3  
Solution:  
• I(Correct): HTML and DHTML are indeed both markup languages, with DHTML being an "enhanced" version of HTML that incorporates CSS for styling and JavaScript for dynamic behaviors.  
• II(Incorrect): XML is a flexible markup language used not just for displaying data but also widely used for data storage and transport, such as in web services and configuration files.  
• III(Incorrect): Java applets are designed to run within a client browser and interact with its runtime environment, contrary to the statement. They are dependent on the browser’s capabilities and settings.  
• IV(Correct): Servlets are indeed server-side Java programs that dynamically process requests and construct responses, typically running on J2EE servers like Apache Tomcat.  
• V(Correct): Scripting languages, particularly JavaScript, are used for client-side scripting to enhance user interfaces, but they also possess capabilities to manage server-side scripting through environments like Node.js.  
Hence, Option (3) is the right answer.  
  
5. Analyze the following statements about Semantic Analysis in compiler design:  
I. Inherited attributes are used to pass contextual information down the parse tree.  
II. A dependency graph is essential for determining the order of evaluation in attribute grammars.  
III. S-attributed definitions can only utilize synthesized attributes, which are derived from child nodes alone.  
Which of the following is correct?  
(1) I and III only  
(2) I and II only  
(3) II and III only  
(4) All of the above  
Answer Key: 2  
Solution:  
• I(Correct): Inherited attributes indeed pass information downwards in the parse tree, allowing context to be maintained across different levels of the tree.  
• II(Correct): Dependency graphs are crucial as they help to identify the dependencies among attributes within nodes, thereby setting the correct order of evaluation to ensure all attributes are calculated accurately.  
• III(Incorrect): S-attributed definitions use only synthesized attributes, which are computed solely from child nodes’ attributes in a bottom-up manner, not involving parent node context.  
Hence, Option (2) is the right answer.

--Question Starting--

63. Consider a scenario where a NoSQL database is utilized for storing voluminous sets of unstructured data. The database is configured to support both high read and write loads. A developer is tasked with designing a query that involves a collection with millions of documents. The query must efficiently retrieve documents based on a field that is currently not indexed. Which of the following approaches will most likely optimize the query's performance?

(1) Increasing the replication factor of the data nodes

(2) Creating a compound index that includes the queried field

(3) Using a map-reduce function to process data in parallel

(4) Partitioning the data based on the value of a frequently accessed field

Answer Key: 2

Solution:

• **Option 1 (Incorrect):** Increasing the replication factor enhances fault tolerance and data availability by maintaining multiple copies of data across nodes. However, it does not improve query performance, as it does not reduce the time required to scan a non-indexed field in a large collection.

• **Option 2 (Correct):** Creating a compound index on the queried field allows the database to use the index to locate matching documents efficiently, avoiding a full collection scan. For a collection with millions of documents, indexing significantly reduces query execution time, making it the most effective optimization approach.

• **Option 3 (Incorrect):** Using a map-reduce function enables parallel processing across multiple nodes, which can handle large datasets. However, map-reduce is designed for batch processing and incurs significant overhead (e.g., disk I/O for intermediate results), making it less efficient than indexing for real-time query optimization.

• **Option 4 (Incorrect):** Partitioning (sharding) distributes data across nodes based on a shard key. If the queried field is not the shard key, the query may still require scanning all shards, providing little performance benefit for non-indexed fields. Partitioning is more effective when queries align with the shard key.

Hence, Option (2) is the right answer.

--Question Starting--

64. An AI model is being developed to classify text into categories. The model uses a multi-layer perceptron (MLP) neural network. During the training phase, the model suffers from high variance, indicating overfitting. Which of the following techniques is most appropriate to reduce overfitting in an MLP?

(1) Increasing the number of layers in the network

(2) Introducing dropout layers in the network

(3) Reducing the learning rate of the backpropagation algorithm

(4) Using a larger dataset for training

Answer Key: 2

Solution:

• (Incorrect): Increasing the number of layers can potentially lead to more overfitting due to the increased complexity of the model.

• (Correct): Introducing dropout layers randomly disables a fraction of the neurons during training, which helps in preventing the network from being overly dependent on any specific neuron, thus reducing overfitting.

• (Incorrect): Reducing the learning rate might help in achieving a more stable convergence but does not directly address overfitting.

• (Incorrect): A larger dataset can reduce overfitting by providing more representative data, but it’s less direct than dropout and depends on data availability and quality.

Hence, Option (2) is the right answer.

--Question Starting--

65. In an object-oriented programming context, a software developer is designing a system where several types of vehicles, such as cars, bicycles, and buses, need to be managed. The system must allow for adding new types of vehicles without altering existing code. Applying which principle would most effectively achieve this requirement?

(1) Inheritance

(2) Polymorphism

(3) Encapsulation

(4) Instantiation

Answer Key: 2

Solution:

• (Incorrect): While inheritance allows for a hierarchy and reusability of code, it doesn’t fully support the addition of new types without altering existing classes.

• (Correct): Polymorphism, by defining a common interface or abstract class for all vehicles, allows new vehicle types to implement the interface without modifying existing code, adhering to the Open-Closed Principle.

• (Incorrect): Encapsulation hides implementation details within classes but doesn’t directly enable adding new types without altering existing code.

• (Incorrect): Instantiation is merely the creation of objects and does not pertain to the design principle needed for scalability and maintenance.

Hence, Option (2) is the right answer.

--Question Starting--

60. A symmetric key algorithm requires the same key to be used for both encryption and decryption processes. Given the complexity of securely managing shared keys over large networks, which of the following is the most critical vulnerability associated with symmetric key cryptography in a scenario where multiple endpoints communicate sensitive data?

(1) Key distribution complexity

(2) Cipher text-only attack

(3) Man-in-the-middle attack

(4) Digital signature forgery

Answer Key: 1

Solution:

• (Correct): Key distribution complexity is the most critical vulnerability, as securely sharing symmetric keys across large networks is prone to interception (e.g., via man-in-the-middle attacks), compromising the entire system.

• (Incorrect): Cipher text-only attacks attempt to deduce keys from cipher text but are impractical against modern ciphers like AES, making them less critical than key distribution issues.

• (Incorrect): Man-in-the-middle attacks exploit insecure key distribution in symmetric systems but are a secondary consequence compared to the root issue of key distribution complexity.

• (Incorrect): Digital signature forgery relates to public-key infrastructures, not symmetric key encryption.

Hence, Option (1) is the right answer.

--Question Starting--

63. Consider the implementation of a multithreading environment in a modern operating system, where the system needs to handle multiple user requests simultaneously without compromising on performance. Given the complexities of thread management, which of the following would best describe a scenario where the operating system successfully minimizes the overhead of context switching between threads while maximizing resource utilization?

(1) Cooperative multithreading

(2) Kernel-level threading

(3) Hardware multithreading

(4) User-level threading

Answer Key: 1

Solution:

• (Incorrect): Kernel-level threading involves the OS kernel in managing threads, which can introduce significant overhead due to system calls and kernel transitions.

• (Correct): Hardware multithreading (e.g., Hyper-Threading) minimizes context switch overhead by allowing multiple threads to execute simultaneously on a single core, maximizing CPU resource utilization through pipeline sharing.

• (Incorrect): Cooperative multithreading reduces context switches by voluntary yielding but risks poor resource utilization due to potential thread monopolization, unsuitable for modern OSes.

• (Incorrect): User-level threading can offer benefits in terms of switching times but lacks integration with the OS for optimal resource management.

Hence, Option (1) is the right answer.

--Question Starting--

40. In a complex software project, a team employed various graph algorithms to optimize network data flow. They utilized Breadth-First Search (BFS) for tiered access control visualization, Depth-First Search (DFS) for dependency analysis, Dijkstra's algorithm for shortest paths in service connectivity, Ford-Fulkerson for maximizing data throughput, and Kruskal's algorithm for minimizing infrastructure cost through an optimal spanning tree. Given these applications, which algorithm is least effective in directly addressing the redundancy and efficiency of data paths in a dynamically changing network?

(1) Depth-First Search provides thorough coverage but does not guarantee the shortest or most efficient path.

(2) Dijkstra’s algorithm, while optimal for static shortest paths, struggles with real-time updates in a dynamic network.

(3) Ford-Fulkerson algorithm focuses on maximum flow, not necessarily on path efficiency or redundancy.

(4) Kruskal’s algorithm ensures a minimum spanning tree that might not adapt quickly to network changes.

Answer Key: 4

Solution:

• (Incorrect): DFS is comprehensive but isn’t focused on path efficiency—more on exploration.

• (Incorrect): Dijkstra’s is indeed designed for shortest paths but adapting it for dynamic changes can be challenging; it's still effective in many scenarios.

• (Incorrect): Ford-Fulkerson is optimal for determining maximum flow which is crucial for data throughput but doesn't directly tackle path redundancy or efficiency.

• (Correct): While Kruskal’s provides a minimum cost spanning tree, it is static and less adaptable to network changes that affect redundancy and path efficiency directly.

Hence, Option (4) is the right answer.

--Question Starting--

35. A software development team is analyzing different programming languages and their compilers to enhance application performance. They considered various attributes such as type-checking, memory management, and the ease of use of debuggers and macros. Among the languages evaluated were C, which uses a compiler; Python, interpreted; and JavaScript, typically executed in a JIT-compiled environment. Which element is least likely to influence the runtime performance optimization in a heterogeneous computing environment?

(1) The static type system of a compiler which facilitates optimization at compile-time.

(2) The dynamic type system of an interpreter that incurs runtime overhead.

(3) The effectiveness of JIT compilation in optimizing execution speed dynamically.

(4) The use of macros for code simplification and not direct performance enhancement.

Answer Key: 4

Solution:

• (Incorrect): Static types allow compilers to optimize code more aggressively, improving performance.

• (Incorrect): Dynamic typing indeed adds overhead by requiring type checks at runtime, affecting performance.

• (Incorrect): JIT compilers optimize code during execution, adapting efficiently to various runtime conditions.

• (Correct): While macros simplify code and can improve maintainability, they do not inherently optimize runtime performance.

Hence, Option (4) is the right answer.

--Question Starting--

40. In a database design session for a large-scale enterprise application, a team of architects debates the optimal use of SQL features to enhance data integrity and security. They discuss the application of constraints to enforce business rules, the strategic use of views to limit data exposure, and the implementation of stored procedures for better control over database logic. Considering SQL injection vulnerabilities, which feature, if not properly implemented, poses the greatest risk to data security?

(1) Stringent type constraints that prevent incorrect data types from being stored.

(2) Views that restrict access to sensitive data but do not sanitize inputs.

(3) Stored procedures that encapsulate business logic yet can be exploited if not parameterized properly.

(4) Database triggers that automatically enforce business rules without direct user input.

Answer Key: 3

Solution:

• (Incorrect): Type constraints ensure data integrity by enforcing correct data storage but don’t directly prevent SQL injection.

• (Incorrect): Views limit data exposure but if they incorporate user inputs without proper sanitization, they can be exploited.

• (Correct): Properly implemented stored procedures can safeguard against SQL injection, particularly through parameterization.

• (Incorrect): Triggers execute automatically based on data changes and typically do not interact directly with user inputs, reducing the risk of injection.

Hence, Option (3) is the right answer.

72. Match the following computational models and their respective language classes:  
Model Language Class  
I. Turing Machine A. Context-Free Languages  
II. Finite Automaton B. Recursive Languages  
III. Pushdown Automaton C. Recursively Enumerable Languages  
IV. Linear Bounded Automaton D. Regular Languages  
Choose the correct answer from the options given below:  
(1) I-C, II-D, III-A, IV-B  
(2) I-B, II-C, III-D, IV-A  
(3) I-B, II-A, III-C, IV-D  
(4) I-A, II-B, III-D, IV-C  
Answer Key: 1  
Solution:  
• Turing Machine: Recognizes recursively enumerable languages, which include all decidable and undecidable problems.  
• Finite Automaton: Recognizes regular languages, defined by regular expressions.  
• Pushdown Automaton: Recognizes context-free languages, useful for parsing nested structures like programming language grammars.  
• Linear Bounded Automaton: Recognizes recursive languages, which are decidable within a bounded space.  
Hence, Option (1) is the right answer.

73. Match the following complexities in computational models with their corresponding characteristics:  
Complexity Characteristic  
I. Time Complexity A. Number of states in the automaton  
II. Space Complexity B. Size of the model description  
III. State Complexity C. Amount of memory used  
IV. Descriptional Complexity D. Time taken to complete computation  
Choose the correct answer from the options given below:  
(1) I-D, II-C, III-A, IV-B  
(2) I-B, II-D, III-C, IV-A  
(3) I-C, II-B, III-D, IV-A  
(4) I-A, II-B, III-C, IV-D  
Answer Key: 1  
Solution:  
• Time Complexity: It refers to the time taken to complete the computation, often measured in terms of the number of steps.  
• Space Complexity: The amount of memory used during computation, measured in units like bits or bytes.  
• State Complexity: Refers to the number of states in an automaton, impacting how it processes inputs.  
• Descriptional Complexity: Measures the size of a model’s description, such as the number of states or rules.

Hence, Option (1) is the right answer.

74. Match the following graphics transformations with their matrix representations:  
Transformation Matrix Representation  
I. Translation A. [1 0 dx; 0 1 dy; 0 0 1]  
II. Scaling B. [cos(θ) -sin(θ) 0; sin(θ) cos(θ) 0; 0 0 1]  
III. Rotation C. [sx 0 0; 0 sy 0; 0 0 1]  
IV. Reflection D. [1 0 0; 0 -1 0; 0 0 1]  
Choose the correct answer from the options given below:  
(1) I-A, II-C, III-B, IV-D  
(2) I-B, II-D, III-A, IV-C  
(3) I-C, II-A, III-D, IV-B  
(4) I-D, II-B, III-C, IV-A  
Answer Key: 1  
Solution:  
• Translation: The matrix [1 0 dx; 0 1 dy; 0 0 1] represents a shift by dx units in the x-direction and dy units in the y-direction.  
• Scaling: The matrix [sx 0 0; 0 sy 0; 0 0 1] scales an object by sx times in the x-direction and sy times in the y-direction.  
• Rotation: The matrix [cos(θ) -sin(θ) 0; sin(θ) cos(θ) 0; 0 0 1] rotates an object by θ degrees.  
• Reflection: Reflects an object across the y-axis, represented by [1 0 0; 0 -1 0; 0 0 1].  
Hence, Option (1) is the right answer.

50. An algorithmic research team is analyzing the performance of a new sorting algorithm. The initial tests show a recurrence relation T(n) = 2T(n/2) + n with a base case of T(1) = 1. They need to determine the asymptotic complexity of this algorithm to compare it with established sorting algorithms. What is the asymptotic complexity of this algorithm?  
(1) O(n log n)  
(2) O(n^2)  
(3) O(log n)  
(4) O(n)  
Answer Key: 1  
Solution:  
• (Correct): The recurrence relation T(n) = 2T(n/2) + n falls into the case 2 of the Master Theorem, where the work done at each level of the recursion forms a geometric series. Solving this recurrence gives a complexity of O(n log n), which is typical for divide-and-conquer sorting algorithms like merge sort.  
• (Incorrect): O(n^2) would be typical of algorithms with quadratic complexity, such as bubble sort, which does not match the given recurrence.  
• (Incorrect): O(log n) is typical of algorithms that decrease the problem size exponentially without significant work at each step, unlike the given relation.  
• (Incorrect): O(n) would indicate a linear complexity, which underestimates the work done in the recurrence, as it involves recursive division of the problem.  
Hence, Option (1) is the right answer.  
  
62. An advanced language translator is designed to optimize the execution of a high-level language into machine code. The translator uses a sophisticated method to handle the binding times of various constructs within the language. Considering the translator's capability to optimize static and dynamic bindings, which scenario best demonstrates a dynamic binding advantage in the context of polymorphic behavior?  
(1) Linking a function call to its definition at compile time  
(2) Resolving variable types based on their runtime values  
(3) Assigning memory addresses to variables during program execution  
(4) Compiling a loop structure with a fixed number of iterations  
Answer Key: 2  
Solution:  
• (Incorrect): Linking function calls at compile time is static binding, not dynamic, and doesn’t support runtime polymorphism.  
• (Correct): Resolving variable types at runtime enables dynamic binding in polymorphism, allowing method calls to be dispatched based on an object’s runtime type, enhancing flexibility.  
• (Incorrect): Assigning memory addresses during runtime is more about dynamic memory management rather than binding.  
• (Incorrect): Compiling a loop with a fixed iteration count is a compile-time decision and does not leverage the benefits of dynamic binding.  
Hence, Option (2) is the right answer.  
  
64. A computer system uses a stored program organization where the program instructions and data are stored in the same memory module. During the execution of a program, the system encounters an interrupt which necessitates a context switch. Considering the role of different registers and the nature of the instruction cycle, which of the following best describes the process that ensures the current program state is preserved for later resumption?  
(1) The instruction register is updated with the address of the next instruction.  
(2) The program counter is incremented to the next instruction's address.  
(3) The stack pointer is adjusted to allocate space for the interrupt service routine.  
(4) The status and program counter are saved onto the stack.  
Answer Key: 4  
Solution:  
• (Incorrect): Updating the instruction register does not preserve the current state of the program; it merely prepares the CPU to execute the next instruction.  
• (Incorrect): Incrementing the program counter does not preserve the state; it simply moves the execution point forward.  
• (Incorrect): Adjusting the stack pointer is part of handling the stack for new data or function calls but alone does not preserve the complete program state.  
• (Correct): Saving the status register and program counter onto the stack during an interrupt ensures that the current state of the program can be restored accurately after the interrupt service routine completes, preserving the continuity of the program execution.  
Hence, Option (4) is the right answer.  
  
59. In a Hadoop-based system designed to process and store petabytes of data across thousands of servers, a data engineer is optimizing a MapReduce job that processes time-stamped web log data. The job's performance is suboptimal due to excessive data shuffling between the map and reduce phases. To address this, the engineer proposes modifications to the job configuration. Which of the following modifications is likely to minimize the data shuffling without compromising the integrity of the data processing?  
(1) Increasing the number of reducers  
(2) Decreasing the number of mappers  
(3) Implementing a combiner function in the map phase  
(4) Expanding the HDFS block size  
Answer Key: 3  
Solution:  
• (Incorrect): Increasing the number of reducers might actually increase data shuffling as more data needs to be moved across nodes.  
• (Incorrect): Decreasing the number of mappers could limit parallel processing capabilities, potentially increasing processing time rather than optimizing shuffling.  
• (Correct): Implementing a combiner function can reduce the volume of data transferred between the map and reduce phases by aggregating intermediate data locally on each mapper, thus minimizing network congestion and improving overall job performance.  
• (Incorrect): Expanding the HDFS block size affects data storage and retrieval but does not directly influence the shuffling process between map and reduce phases.  
Hence, Option (3) is the right answer.  
  
65. In the process of optimizing an intermediate code generation for a high-level programming language, a compiler designer is tasked with improving the handling of Boolean expressions in control flow structures. Specifically, the goal is to reduce the overhead associated with evaluating complex Boolean expressions. Which strategy would most effectively optimize the evaluation of these expressions during runtime?  
(1) Implementing short-circuit evaluation in the code generation phase  
(2) Introducing additional temporary variables to store intermediate results  
(3) Using a more efficient data type for Boolean values  
(4) Optimizing the logical operator precedence and associativity  
Answer Key: 1  
Solution:  
• (Correct): Short-circuit evaluation in code generation skips unnecessary evaluations (e.g., in A && B), reducing runtime overhead for complex Boolean expressions.  
• (Incorrect): Introducing additional temporary variables might help in readability or maintainability but could increase memory usage and processing time rather than reduce it.  
• (Incorrect): Using a more efficient data type for Boolean values might save space but does not directly address the overhead of evaluating complex expressions.  
• (Incorrect): Optimizing precedence/associativity is resolved at parse time, with limited runtime impact compared to short-circuit evaluation.  
Hence, Option (1) is the right answer.  
  
64. An expert system for medical diagnosis uses a combination of logic, rules, and ontologies to infer diseases based on symptoms. Considering the complexity of human diseases and the variability of symptoms, which of the following is the most critical aspect to enhance the system's ability to handle uncertainty and improve diagnostic accuracy?  
(1) Increasing the number of rules  
(2) Enhancing the logical inference algorithms  
(3) Integrating machine learning models  
(4) Expanding and refining the ontologies  
Answer Key: 3  
Solution:  
• (Incorrect): Increasing the number of rules allows the system to cover more specific cases and variations in symptom presentations, but it may not efficiently address the inherent uncertainty in symptom presentations.  
• (Incorrect): While enhancing logical inference algorithms is important, it does not specifically address the variability and uncertainty of symptoms.  
• (Correct): Integrating machine learning models can help in analyzing complex patterns and variability, significantly enhancing the system's ability to handle uncertainty in symptom presentations and improve diagnostic accuracy.  
• (Incorrect): Expanding and refining ontologies helps in understanding the relationships between concepts but does not directly address the symptom variability.  
Hence, Option (3) is the right answer.  
  
45. A software company is developing a new file management system to be integrated into the latest version of a popular operating system. The system needs to efficiently handle a large volume of small to large files and support both local and networked user access. Which component of the Windows operating system architecture should be most intensively focused on to optimize for these requirements?  
(1) File System  
(2) Terminal Services  
(3) Memory Management  
(4) Device Management  
Answer Key: 1  
Solution:  
• (Correct): The File System is directly related to how data is stored, accessed, and managed. Optimizing the file system will directly impact the performance and efficiency of the file management system, especially in handling various file sizes and types, both locally and over a network.  
• (Incorrect): Terminal Services deal with remote desktop access and session management, which, while important, are less directly impactful on file management system performance.  
• (Incorrect): Memory Management is crucial for overall system performance but is less specific to the nuances of file system operations.  
• (Incorrect): Device Management primarily handles the interaction of hardware devices with the OS, which is tangential to file handling efficiency.  
Hence, Option (1) is the right answer.  
  
30. In a large social network, an algorithm is required to find the shortest path between two users to suggest the quickest route for information flow or friend recommendation. The network changes frequently with users joining and leaving, and paths can become obsolete quickly. Which graph algorithm is best suited for finding shortest paths in such a dynamic graph?  
(1) Dijkstra’s algorithm  
(2) Bellman-Ford algorithm  
(3) Floyd-Warshall algorithm  
(4) A\* search algorithm  
Answer Key: 1  
Solution:  
• (Correct): Dijkstra’s algorithm, with dynamic adaptations (e.g., caching or incremental updates), efficiently finds single-pair shortest paths in sparse, dynamic graphs like social networks

• (Incorrect): Bellman-Ford handles negative weights but like Dijkstra’s, isn’t the best for frequent updates.  
• (Incorrect): Floyd-Warshall computes all-pairs shortest paths but is impractical for large, sparse graphs due to O(V^3) complexity and costly updates.  
• (Incorrect): A\* is great for single-source shortest paths with heuristics to guide the search but less effective for dynamic, all-pairs requirements.  
Hence, Option (1) is the right answer.  
  
59. Consider a segmented memory management scenario where a process is allocated multiple segments. Each segment has a different size and usage pattern, leading to variability in access frequency. Given the potential of page fault rates varying across segments due to these factors, what is the best strategy for allocating frames to minimize overall page faults?  
(1) Allocate frames based on the size of the segment.  
(2) Allocate frames equally among all segments.  
(3) Allocate frames based on the segment’s access frequency.  
(4) Allocate frames randomly across segments.  
Answer Key: 3  
Solution:   
• (Incorrect): Allocating frames based on the size of the segment ignores the frequency with which segments are accessed, which is crucial in reducing page faults.  
• (Incorrect): Equal allocation does not account for variation in segment usage and could lead to inefficient memory use.  
• (Correct): Allocating frames based on access frequency optimally manages memory by adapting to the actual usage patterns of different segments, thereby minimizing page faults.  
• (Incorrect): Random allocation does not strategically target the variability in access frequency and size, potentially leading to higher page faults.  
Hence, Option (3) is the right answer.  
  
  
40. Consider an encryption scheme where a large prime number is essential for generating public and private keys. Suppose a developer needs to implement an algorithm that checks whether a given number, n, is prime. The chosen algorithm should efficiently handle very large numbers typical in modern cryptographic applications. Which algorithm is most appropriate for this scenario given its efficiency and practicality in cryptographic contexts?  
(1) Miller-Rabin primality test  
(2) Sieve of Eratosthenes  
(3) Euclid's algorithm for computing greatest common divisors  
(4) Trial division method  
Answer Key: 1  
Solution:  
• (Correct): The Miller-Rabin primality test is a probabilistic test that provides a high level of accuracy for large numbers and is commonly used in cryptographic applications due to its balance of efficiency and reliability.  
• (Incorrect): While effective for smaller ranges, the Sieve of Eratosthenes is not practical for very large numbers due to its memory and processing requirements.  
• (Incorrect): Euclid's algorithm is used for finding greatest common divisors, not for testing primality.  
• (Incorrect): Trial division is simple but extremely slow for large numbers, making it impractical for use in cryptography.  
Hence, Option (1) is the right answer.  
  
65. In a microprogrammed control unit, the sequence of microinstructions is determined by the control memory. Given the need for flexibility and efficiency in handling various instruction sets, which design aspect of the control memory is most crucial for optimizing the execution of complex instruction sets?  
(1) The size of the control memory  
(2) The speed of the control memory  
(3) The reconfigurability of the control memory  
(4) The address sequencing mechanism in the control memory  
Answer Key: 4  
Solution:  
• (Incorrect): While size is important, it does not primarily affect the execution efficiency of complex instruction sets.  
• (Incorrect): Speed enhances overall performance but is not specific to handling complex instruction sets more effectively.  
• (Incorrect): Reconfigurability provides flexibility but does not address the sequencing needs of complex instruction sets.  
• (Correct): The address sequencing mechanism determines the order of microinstruction execution, which is crucial for efficiently managing complex instruction sets.  
Hence, Option (4) is the right answer.  
  
62. In an OSI model, a packet from a network layer is encapsulated into a frame in the data link layer and then converted into bits at the physical layer. Considering the encapsulation and de-encapsulation process combined with error control and flow control mechanisms, which layer primarily handles the detection and retransmission of damaged frames?  
(1) Network layer  
(2) Physical layer  
(3) Transport layer  
(4) Data link layer  
Answer Key: 4  
Solution:  
• (Incorrect): The network layer handles logical addressing and routing, not frame error handling.  
• (Incorrect): The physical layer deals with the transmission of raw bits over a communication channel and does not manage frame integrity.  
• (Incorrect): Although the transport layer manages overall transmission reliability, it does not directly handle frame retransmission.  
• (Correct): The data link layer is responsible for frame error detection and retransmission, ensuring reliable frame delivery.  
Hence, Option (4) is the right answer.  
  
35. An algorithm designer is tasked with optimizing a resource allocation system where multiple tasks with varying priorities must be assigned to a limited number of processors to achieve the best throughput. The tasks can arrive dynamically, and their processing can be paused and resumed. Which design technique will most effectively solve this complex, real-time scheduling problem?  
(1) Greedy algorithm  
(2) Dynamic programming  
(3) Backtracking  
(4) Branch and bound  
Answer Key: 2  
Solution:  
• (Incorrect): Greedy algorithms make locally optimal choices and might not adapt well to dynamic changes in task prioritization or processor availability.  
• (Correct): Dynamic programming can effectively handle the complexities of dynamic task arrival and the need for optimal state reassessment after every new task arrival or task completion, making it ideal for achieving the best overall throughput in a real-time system.  
• (Incorrect): Backtracking is typically used for decision problems where all possible solutions need to be explored; it is inefficient for real-time systems.  
• (Incorrect): Branch and bound is used to find the optimal solution for combinatorial problems and would be less efficient in a dynamic and real-time context.  
Hence, Option (2) is the right answer.  
  
63. In an enterprise network, a security administrator configures a series of cryptographic measures to secure data transmissions between internal systems. This setup includes the application of both symmetric and asymmetric cryptographic algorithms. Which of the following scenarios best illustrates the use of a digital signature to ensure the integrity and authenticity of a communication?  
(1) Encrypting data using the recipient’s public key  
(2) Encrypting data using the sender’s private key  
(3) Digitally signing a message with the sender’s private key  
(4) Using symmetric key encryption to speed up the data transfer  
Answer Key: 3  
Solution:  
• (Incorrect): Encrypting data with the recipient's public key is typical for ensuring confidentiality using asymmetric encryption.  
• (Incorrect): Encrypting data with the sender's private key does not typically ensure integrity or authenticity in a standard cryptographic model.  
• (Correct): Digitally signing a message with the sender’s private key is the correct method to ensure both the integrity and the authenticity of the communication.  
• (Incorrect): Using symmetric key encryption primarily speeds up data transfer but does not ensure the integrity and authenticity of a communication.  
Hence, Option (3) is the right answer.  
  
  
63. A duplex communication system is designed to operate under both noisy and noiseless channel conditions. The system uses both digital and analog signals. Considering the attributes of signal transmission and the effects of channel noise, which method of signal transmission would generally provide better performance in terms of error rates under noisy channel conditions?  
(1) Analog transmission  
(2) Digital transmission with baseband modulation  
(3) Digital transmission with passband modulation  
(4) Analog transmission with frequency modulation  
Answer Key: 3  
Solution:  
• (Incorrect): Analog transmission is more susceptible to noise, making it less reliable under noisy conditions.  
• (Incorrect): Digital transmission with baseband modulation is typically used for short distances and is more prone to noise.  
• (Correct): Digital transmission with passband modulation, such as phase shift keying (PSK) or frequency shift keying (FSK), tends to be more robust against noise, making it suitable for noisy channels.  
• (Incorrect): Although frequency modulation improves analog signal resistance to noise, it does not match the performance of digital techniques.  
Hence, Option (3) is the right answer.

27. An AI research team is developing a robot that can adapt its strategies based on environmental changes and previous outcomes using a genetic algorithm. The researchers are debating over the best way to represent the robot's strategy choices in the genetic algorithm. Which of the following encoding strategies is most likely to hinder the genetic algorithm's ability to effectively explore a diverse range of solutions?  
(1) Binary encoding, which simplifies crossover and mutation operations.  
(2) Permutation encoding, suitable for ordering and sequencing problems.  
(3) Direct encoding of strategy parameters as floating-point numbers.  
(4) Hierarchical encoding that rigidly defines parent-child relationships in strategy components.  
Answer Key: 4  
Solution:  
• (Correct): Binary encoding is versatile and makes genetic operations straightforward, often enhancing the GA's exploration capabilities.  
• (Correct): Permutation encoding is particularly effective in problems where the order matters, such as routing or scheduling, allowing the GA to explore permutations efficiently.  
• (Correct): Direct encoding allows for a direct manipulation of parameters, providing a fine-grained control over the solution space, beneficial for continuous optimization.  
• (Incorrect): Hierarchical encoding can impose constraints on how components interact and evolve, potentially limiting the genetic algorithm’s ability to generate diverse and innovative solutions across generations.  
Hence, Option (4) is the right answer.  
  
36. In a distributed database system, a deadlock situation occurred involving four transactions across different nodes. Each transaction was awaiting a resource held by another, forming a circular wait. The system architect plans to implement a solution that involves preemption of resources, transaction rollbacks, and a priority-based resource allocation mechanism.   
Which of the following methods would be least effective in addressing the deadlock situation described?  
(1) Using a timeout mechanism to detect deadlocks and roll back transactions based on priorities.  
(2) Implementing a deadlock avoidance algorithm, such as Banker's Algorithm, which preempts and reallocates resources dynamically.  
(3) Enabling a deadlock detection system that periodically checks for cycles in the resource allocation graph and resolves them by transaction rollback.  
(4) Applying a strict two-phase locking (2PL) protocol which might intensify the deadlock situation by increasing the number of lock conversions.  
Answer Key: 2  
Solution:  
• (Correct): A timeout mechanism is a simple yet effective way to break deadlocks by determining which transactions to rollback based on their priorities and how long they have been waiting.  
• (Incorrect): While the Banker's Algorithm is effective in preventing deadlocks by ensuring that resource allocation never enters an unsafe state, it might not be suitable in a distributed environment where resource states can change dynamically and unpredictably.  
• (Correct): Deadlock detection systems that identify cycles in the resource allocation graph can effectively resolve deadlocks by selectively rolling back transactions involved in the deadlock.  
• (Correct): Two-phase locking can cause more deadlocks as it requires transactions to hold on to all locks acquired in the first phase until all operations are completed, thereby increasing the risk of circular waits.  
Hence, Option (2) is the right answer.  
  
4. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
Assertion (A): The problem of determining if there exists a subset of numbers that sums up to a given number is NP-complete.  
 Reason (R): NP-complete problems are those for which no polynomial-time algorithm is known and for which a solution can be verified quickly.  
 Answer Key: 1  
 Solution:  
 • (Assertion is Correct): The subset sum problem is a classic example of an NP-complete problem, meaning it is hard to solve but easy to verify a solution.  
 • (Reason is Correct): The definition of NP-complete aligns with the characteristics described in the reason, including the verification of solutions in polynomial time.  
 Hence, Option (1) is correct.  
  
1. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
Assertion (A): The worst-case time complexity of an optimized merge sort algorithm is O(n log n).  
Reason (R): Merge sort is a divide-and-conquer algorithm that divides the input array into two halves, sorts them separately, and then merges them in a linear traversal, which ensures minimum time complexity for sorting operations.  
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): The worst-case time complexity for merge sort, even when optimized, remains O(n log n) due to the nature of its divide-and-conquer approach.  
• (Reason is Incorrect): Although the description of merge sort is correct, the claim that this ensures minimum time complexity for sorting operations is not accurate, as "minimum" implies it is the best possible among all sorting algorithms, which isn't necessarily true.  
Hence, Option (3) is the right answer.  
  
37. A network administrator is configuring a corporate network that includes various devices and services across multiple subnets. The configuration involves assigning IP addresses, setting up DNS for name resolution, and implementing VLANs for departmental segmentation. The administrator must also ensure communication across different network layers and between heterogeneous network protocols.  
Which aspect of the network setup does not directly contribute to inter-layer communication and protocol interoperability?  
(1) Assigning IP addresses to ensure proper logical addressing within the network.  
(2) Utilizing the OSI model to guide the setup and integration of network protocols.  
(3) Implementing VLANs to segment the network according to departmental needs.  
(4) Configuring routers to perform network address translation between subnets.  
Answer Key: 2  
Solution:  
• (Correct): IP addresses are crucial for logical addressing and routing across the network, facilitating layer 3 (Network Layer) activities.  
• (Incorrect): While the OSI model provides a theoretical framework for understanding and implementing layered network architectures, it does not directly involve the configuration tasks needed for protocol interoperability or actual data flow.  
• (Correct): VLANs are primarily used for segmenting a physical network into multiple logical networks at layer 2 (Data Link Layer), which affects intra-layer communication but not inter-layer communication.  
• (Correct): Routers, especially when configured for network address translation, play a critical role in managing traffic between different subnets and facilitating layer 3 communications.  
Hence, Option (2) is the right answer.  
  
3. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
In a computer architecture course, students are tasked with developing an assembler that translates assembly language programs into machine code. The project includes handling symbolic labels, translating mnemonics to opcodes, and managing storage directives. The students also need to implement error detection for syntax and semantic errors in the assembly programs.  
Which of the following tasks is least associated with the core functions of an assembler?  
(1) Translating assembly language mnemonics into corresponding machine code opcodes.  
(2) Resolving addresses for symbolic labels used in the assembly program.  
(3) Generating a detailed listing file that includes the original assembly code and corresponding machine code.  
(4) Creating a user interface for the assembler program to facilitate code editing and debugging.  
\*\*Answer Key: 4\*\*  
\*\*Solution:\*\*  
• (Correct): Translating mnemonics to opcodes is a fundamental task of an assembler, directly involved in the conversion from assembly to machine language.  
• (Correct): Resolving symbolic labels to their respective addresses is crucial for correct code generation and is a primary function of an assembler.  
• (Correct): Generating a listing file is helpful for debugging and verifying the assembly to machine code translation, thus integral to the assembler’s functionality.  
• (Correct): While a user interface enhances the usability of the assembler, it is not directly related to the core computational functions of translating assembly code or handling storage directives.  
Hence, Option (4) 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 a distributed system, achieving consensus among multiple nodes often requires complex algorithms.  
Reason (R): Consensus in distributed systems is necessary to ensure that all nodes agree on a single data value, which is critical for maintaining the integrity of operations across the system.  
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: 2  
Solution:  
• (Assertion is Correct): Consensus algorithms, such as Paxos or Raft, are indeed complex due to the need to ensure reliability and agreement despite potential node failures or network issues.  
• (Reason is Correct): The purpose of achieving consensus is crucial for data consistency and integrity, particularly in operations that involve multiple nodes.  
Hence, Option (2) is the right answer.  
  
39. In a computer architecture course, students are tasked with developing an assembler that translates assembly language programs into machine code. The project includes handling symbolic labels, translating mnemonics to opcodes, and managing storage directives. The students also need to implement error detection for syntax and semantic errors in the assembly programs.  
Which of the following tasks is least associated with the core functions of an assembler?  
(1) Translating assembly language mnemonics into corresponding machine code opcodes.  
(2) Resolving addresses for symbolic labels used in the assembly program.  
(3) Generating a detailed listing file that includes the original assembly code and corresponding machine code.  
(4) Creating a user interface for the assembler program to facilitate code editing and debugging.  
Answer Key: 1  
Solution:  
• (Incorrect): Translating mnemonics to opcodes is a fundamental task of an assembler, directly involved in the conversion from assembly to machine language.  
• (Correct): Resolving symbolic labels to their respective addresses is crucial for correct code generation and is a primary function of an assembler.  
• (Correct): Generating a listing file is helpful for debugging and verifying the assembly to machine code translation, thus integral to the assembler’s functionality.  
• (Correct): While a user interface enhances the usability of the assembler, it is not directly related to the core computational functions of translating assembly code or handling storage directives.  
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).  
Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).  
Assertion (A): SQL injection is a code injection technique that exploits a security vulnerability occurring in the database layer of an application.  
Reason (R): The vulnerability is exploited by manipulating SQL commands through the input data from the client to the application.  
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: 1\*\*  
\*\*Solution:\*\*  
• (Assertion is Correct): SQL injection indeed exploits vulnerabilities primarily in the database layer of an application, where SQL commands can be executed.  
• (Reason is Correct): The manipulation of SQL commands through client-supplied data is a key method by which SQL injection attacks are carried out.  
Hence, Option (1) is the right answer.  
  
38. A computer engineering student is designing a microprocessor as part of their thesis. The design includes specifying microoperations for arithmetic calculations, memory access, and control signal generation. The student plans to implement complex instruction set computing (CISC) architecture, which includes a variety of specialized instructions.  
Which aspect of microprocessor design is least related to defining and implementing microoperations for arithmetic and control?  
(1) Choosing register transfer language (RTL) to specify the exact sequence of control signals for each operation.  
(2) Deciding on the bus architecture to facilitate data transfers between registers and memory units.  
(3) Implementing a hardware multiplier to speed up arithmetic operations involving multiplication.  
(4) Selecting a suitable set of machine instructions that allow for versatile programming and application development.  
Answer Key: 1  
Solution:  
• (Incorrect): Register transfer language is directly related to microoperations as it defines the precise control and timing of data transfers and operations within the CPU.  
• (Correct): While the bus architecture is crucial for data movement across different parts of the microprocessor, it does not directly influence the specific microoperations performed during arithmetic and control tasks.  
• (Correct): A hardware multiplier is an essential component for efficient arithmetic microoperations, especially in CISC architectures where multiple arithmetic tasks need to be accelerated.  
• (Correct): The choice of machine instruction set impacts the overall flexibility and capability of the processor, influencing how effectively it can perform a wide range of tasks, including microoperations.  
Hence, Option (2) is the right answer.  
  
34. A logistics company uses a centralized planning system to manage its supply chain. The system incorporates various planning techniques to optimize route schedules and inventory levels. Considering the complexity of handling multiple warehouses and transportation modes, which planning model might introduce inefficiencies in adapting to sudden changes in supply chain demands?  
(1) Linear planning focused on cost minimization through straightforward linear relationships.  
(2) Goal stack planning, which organizes tasks in a LIFO manner to address goal conflicts.  
(3) Hierarchical planning, which decomposes problems into subproblems and solves them sequentially.  
(4) Partial order planning that allows for flexibility in the sequence of actions.  
Answer Key: 1  
Solution:  
• (Incorrect): Linear planning is efficient for problems with direct, predictable relationships but may not adapt well to dynamic environments with complex, non-linear interactions typical in a multi-modal supply chain.  
• (Correct): Goal stack planning effectively resolves goal conflicts by prioritizing tasks, useful in dynamic environments.  
• (Correct): Hierarchical planning helps in managing complexity by breaking down the supply chain into manageable segments, though it may sometimes be slow to adapt to sudden changes.  
• (Correct): Partial order planning offers flexibility by not enforcing a strict order of operations, suitable for dynamic adjustments.  
Hence, Option (1) is the right answer.  
  
33. In the context of implementing virtual machines within a corporate data center, an IT specialist is considering the impact of different virtualization techniques on system performance and management. Which virtualization approach might complicate the management and monitoring of virtual machines due to its inherent complexity and overhead?  
(1) Full virtualization that completely simulates hardware, allowing unmodified guest OS to run.  
(2) Paravirtualization where the guest OS is aware of the virtualization and is optimized accordingly.  
(3) OS-level virtualization, which allows for multiple isolated user-space instances.  
(4) Hardware-assisted virtualization that leverages CPU features to enhance performance.  
Answer Key: 4  
Solution:  
• (Correct): Full virtualization provides a high level of isolation and compatibility, but may introduce performance overhead due to complete emulation of hardware.  
• (Correct): Paravirtualization reduces overhead by allowing the guest OS to interact with the host, simplifying management.  
• (Correct): OS-level virtualization offers efficient resource use and simpler management by avoiding full emulation of hardware.  
• (Incorrect): Hardware-assisted virtualization improves performance by utilizing specific CPU extensions; however, it can introduce complexity in setup and monitoring, especially when integrating with existing systems without these capabilities.  
Hence, Option (4) is the right answer.  
  
40. During a computer science seminar, a discussion arises about the application of artificial intelligence in strategic game playing. The conversation focuses on advanced algorithms used in games like chess and Go, particularly those involving heuristic evaluations and decision trees. A new algorithm is proposed that combines deep learning with traditional min-max strategies to enhance predictive accuracy and speed.  
Which of the following considerations is least relevant to improving the performance of AI algorithms in game playing?  
(1) Enhancing the heuristic function to provide deeper analysis of possible moves.  
(2) Optimizing the search algorithm to prune irrelevant branches and reduce computational load.  
(3) Incorporating real-time player feedback to adjust AI strategies during the game.  
(4) Implementing alpha-beta cutoff techniques to minimize the number of nodes evaluated in the search tree.  
Answer Key: 4  
Solution:  
• (Correct): Improving the heuristic function directly impacts the AI’s ability to evaluate and prioritize moves, essential for strategic depth.  
• (Correct): Optimizing search algorithms, such as implementing effective pruning strategies, is crucial for managing the complexity and enhancing the speed of AI decision-making processes.  
• (Incorrect): While real-time player feedback can be useful in interactive applications, it is generally irrelevant in the context of AI algorithms designed for autonomous strategic game playing, where decisions are precomputed based on possible game states rather than player input.  
• (Correct): Alpha-beta pruning is a well-known technique in game theory that significantly reduces the search space, thereby improving the efficiency of the AI’s decision-making process.  
Hence, Option (3) is the right answer.  
  
36. During the design phase of a new cloud-based application, a software architect is evaluating different cloud services to ensure efficient resource management, scalability, and compliance with the service level agreement (SLA). Which of the following scenarios would likely pose the greatest challenge in meeting the SLA requirements?  
(1) Utilizing a public PaaS solution for rapid development and deployment.  
(2) Employing a private IaaS cloud to maintain control over physical hardware resources.  
(3) Outsourcing database storage to a cloud service with elastic scalability.  
(4) Relying solely on virtual servers for dynamic resource allocation and scaling.  
Answer Key: 4  
Solution:  
• (Correct): Public PaaS provides managed services that can speed up development and handle many operational aspects, aiding in SLA compliance.  
• (Correct): Private IaaS gives the organization control over physical resources, potentially enhancing security and performance consistency, aligning with SLA specifics.  
• (Correct): Cloud databases that offer elastic scalability can quickly adjust resources to meet varying loads, thus supporting SLA adherence.  
• (Incorrect): Virtual servers offer flexibility, but relying solely on them without integrating other scalability and redundancy measures such as load balancing or multi-region deployments may fall short in meeting SLA requirements during peak loads or failover scenarios.  
Hence, Option (4) is the right answer.  
  
29. Consider a social networking platform that has implemented a variety of NoSQL storage systems to manage different types of data such as user profiles, connections, posts, and messages. Given the diverse nature of queries, ranging from simple lookups to complex aggregations and graph traversals, which of the following approaches would be least effective in optimizing query performance across these varied data models?  
(1) Implementing a polyglot persistence architecture that uses the most appropriate data model for each type of query.  
(2) Using a single NoSQL system that supports secondary indexing to handle all types of data uniformly.  
(3) Applying denormalization and embedding documents where possible to reduce the need for joins.  
(4) Leveraging data partitioning and sharding techniques to distribute queries and data across multiple servers.  
Answer Key: 2  
Solution:  
• (Correct): Polyglot persistence tailors the database technology to the specific needs of each data type and query, optimizing performance.  
• (Incorrect): While secondary indexing helps in improving the performance of some queries, relying solely on one type of NoSQL system for diverse data types and queries can lead to suboptimal performance, as not all systems are equally efficient for all kinds of operations.  
• (Correct): Denormalization and embedding can significantly enhance read performance by eliminating the need for complex joins, which are costly in NoSQL systems.  
• (Correct): Sharding and partitioning effectively distribute data and workload across several nodes, thereby improving query responsiveness and scalability.  
Hence, Option (2) is the right answer.