1. In a hierarchical planning system, suppose the high-level goals are decomposed into sub-goals, which further decompose into primitive actions. If during the planning process, a conflict arises where a sub-goal contradicts a higher-level goal, which of the following best describes the most appropriate resolution strategy, considering the complexities of partial order planning?
(1) Reordering actions to satisfy the conflicting goals independently
(2) Backtracking to revise the higher-level goal specifications before proceeding
(3) Ignoring the conflict if it appears at a lower level to maintain plan completeness
(4) Applying goal stack pruning to eliminate the conflicting goal permanently
Answer Key: (2)
Solution:
Option (2) is correct: In hierarchical planning, when a sub-goal contradicts a higher-level goal, the appropriate method involves revising the high-level goal specifications before continuing, as the conflict indicates a fundamental inconsistency in the plan structure. Backtracking allows for re-evaluation of the goal hierarchy, ensuring that the plan remains coherent and goals are achievable within the constraints. This process preserves plan integrity and aligns with the principles of layered goal refinement.
Option (1) is incorrect: Reordering actions without addressing the fundamental goal contradiction may lead to partial solutions that are inconsistent or incomplete, especially in partial order planning where dependencies are critical.
Option (3) is incorrect: Ignoring conflicts at lower levels risks producing plans that violate essential high-level objectives, potentially leading to infeasible or invalid plans.
Option (4) is incorrect: Goal stack pruning is a technique used to avoid exploring certain goals during planning but does not resolve conflicts once they are detected; it is more of a heuristic than a resolution strategy for contradictions.
Hence, the correct answer is Option (2).
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2. Consider a GSM network operating in a city with high-rise buildings affecting signal propagation. Given the architecture of GSM and the use of multiple cell towers, analyze how the concept of frequency reuse and cell topology impacts the overall network capacity and interference management. Which of the following statements best captures this relationship?
(1) Increasing the cell size reduces frequency reuse, thereby decreasing interference but also decreasing capacity.
(2) A hexagonal cell topology with optimal frequency reuse patterns maximizes capacity while minimizing interference in dense urban environments.
(3) Using omnidirectional antennas in all cells eliminates interference but significantly reduces network capacity.
(4) Implementing higher frequency bands always results in better capacity regardless of cell topology or reuse patterns.
Answer Key: (2)
Solution:
Option (2) is correct: Hexagonal cell topology with carefully planned frequency reuse patterns optimizes capacity by allowing multiple cells to reuse the same frequencies without causing excessive interference, especially in dense urban environments with high building density affecting signal propagation. This spatial separation minimizes interference and maximizes spectrum efficiency, which is fundamental in cellular network design.
Option (1) is incorrect: Increasing cell size actually decreases the number of cells per area, reducing frequency reuse opportunities and potentially increasing interference, contrary to the statement.
Option (3) is incorrect: Omnidirectional antennas can actually increase interference because they radiate signals equally in all directions, leading to more signal overlap between cells, reducing overall capacity.
Option (4) is incorrect: Higher frequency bands often suffer from higher path loss and poor penetration in buildings, which can decrease overall capacity unless compensated by other network design strategies. Capacity improvements depend on multiple factors, not just frequency.
Hence, the correct answer is Option (2).

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3. In the context of formal languages, consider a language L that is defined by a context-free grammar G. Suppose you are tasked with proving that L is non-regular by using the Pumping Lemma. If the language involves nested structures such as balanced parentheses, which of the following analytical approaches best demonstrates that L cannot be regular, considering the constraints of the Pumping Lemma?
(1) Showing that for an appropriately chosen string, any division into parts violates the pumping condition due to the nesting depth
(2) Constructing a deterministic finite automaton that accepts L, thereby proving it cannot be regular
(3) Applying the diagonalization argument to the strings in L to establish non-regularity
(4) Demonstrating that L is context-free by constructing a pushdown automaton, which implies non-regularity
Answer Key: (1)
Solution:
Option (1) is correct: When dealing with languages like balanced parentheses, the nesting depth can grow arbitrarily large. The Pumping Lemma for regular languages states that sufficiently long strings can be decomposed into parts where one part can be "pumped" to produce new strings in the language. However, for balanced structures, pumping the middle section disrupts the nesting balance, violating the language's structural constraints. Thus, choosing a string with a large nesting depth and showing that any segmentation fails the pumping condition effectively demonstrates non-regularity.
Option (2) is incorrect: Constructing a deterministic finite automaton (DFA) for such languages is impossible because DFAs cannot handle unbounded nesting, but this approach is not an analytical proof via the Pumping Lemma.
Option (3) is incorrect: The diagonalization argument is not typically used to prove non-regularity; it is more suited for proofs involving infinite sets and hierarchy arguments.
Option (4) is incorrect: While constructing a PDA shows the language is context-free, it does not directly prove non-regularity; the Pumping Lemma provides the analytical tool for that.
Hence, the correct answer is Option (1).