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一、Data Structures (50%)

1. (15%)

(a) If A=2, B=3, C= 4, D=5, E=6, then what is the value of evaluating the postfix expression AB+C*DE-/? (10%)

(b) A is a two dimensional array, the location of A(3,2) is 1110 and A(2,3) is 1115. Assume that each element occupies one address, and the size declaration is A(m,n), then what is the value of m? (5%)

2. (10%) Which of the following statements are true.

(a) A d-ary heap is like a binary heap, but non-leaf nodes have d children instead of 2 children. The running time of the efficient implementation of Extract-Max in a d-ary max-heap with n elements is $\Theta(log_d n)$.

(b) A Hamiltonian Path in graph G passes through each node $v \in V$ exactly once. Given a directed acyclic graph $G=(V, E)$, its Hamiltonian path $v_1, v_2, \ldots, v_n$ must be a topological ordering of G.

(c) In an undirected graph G, if there is a path between two vertices x and y then in the DFS tree of G, either x is a descendant of y or y is a descendant of x.

(d) In a directed graph G, if vertex x has both incoming and outgoing edges, its tree in the DFS forest contains more than one vertex.
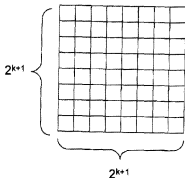
(e) None of the above

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3. (25%)

Consider a checkerboard of size $2^{k+1} \times 2^{k+1}$ consisting of 1x1 squares, $k \in N$.

Checkerboard

2^{k+1}

2^{k+1}

And we define two types of sub-blocks consisting of three and two squares, respectively, i.e., tromino and domino.

Tromino   Domino

(a)Can we cover the checkerboard after removing any one square with non-overlapping trominoes? If yes, please show the pseudo code to construct the covering procedure. If no, please explain the reason. (15%)

(b) Can you cover any 8x8 checkerboard with non-overlapping dominoes if we remove any two squares? If yes, please show the pseudo code to construct the covering procedure. If no, please explain the reason. (10%)

二、Algorithms (50%)

4. (10%) Solving the recurrence $T(n) = T(n-2) + 2\lg n$ using Θ notation.

5. (20%) Present a linear-time algorithm to solve the single-source shortest paths in directed acyclic graphs.

6. (10%) Unweighted longest simple path problem: Find a simple path from u to v consisting of the most edges. Prove or disprove: unweighted longest simple path problem exhibits optimal substructure.

7. (10%) Determine whether an input graph for the single-source shortest path problem can contain a negative-weight cycle? Please provide your reason.