

Department of Computer Science and Engineering
National Sun Yat-sen University
First Semester of 2023 PhD Qualifying Exam

Subject : Algorithms

1. Please give the analysis of the average time complexity of the *quicksort* method. (15%)
2. (a) Explain the *minimum spanning tree* in a graph. (5%)
(b) Present an algorithm for solving the *minimum spanning tree* problem. And analyze the time complexity of your algorithm (15%)
3. The *divide-and-conquer* strategy can be used to solve some geometry problems efficiently. Please give the *merging* process in the divide-and-conquer method for solving the *Voronoi diagram* problem. (15%)
4. Prove that the *partition* decision problem polynomially reduces to the *0/1 knapsack* decision problem. (15%)
5. (a) *Transpose*, *move-to-front* and *count* are three heuristic methods used in the self-organizing sequential search. Please explain each of them. (12%)
(b) What is the *pairwise independent* property in the move-to-the-front heuristic method? (8%)
6. Suppose that the value of each symbol is given as: $A=1$, $B=2$, $C=1$ and $D=3$. The value of a permutation is the total sum of the used symbols. The values of some example permutations are shown: $A=1$, $B=2$, $BC=3$, $CB=3$, $ACDB=7$, $BACD=7$, $BBD=7$, $BDB=7$, $ABCDABCD=14$. Let $f(n)$ denote the number of permutations whose value is exactly n . For example, $f(1)=2$, from the 2 permutations: A , C ; $f(2)=5$, from the 5 permutations: AA , CA , AC , CC , B ; $f(3)=13$, from the 13 permutations: AAA , CAA , ACA , CCA , BA , AAC , CAC , ACC , CCC , BC , AB , CB , D . Initially, we set $f(0)=1$. The value of $f(n)$, $n \geq 4$, can be calculated with the dynamic programming as $f(n)=a \times f(n-3)+b \times f(n-2)+c \times f(n-1)$. Please give the values of a , b , c , and explain your reasons. (15%)