*Algorithms* Term Projects

Notice：In this project, each team **need do Problem 1**, and **must implement one set of programs from Problem 2**. **Problem 1 should be submitted before the deadline 5/22. The others should be submitted before the deadline 6/19.**

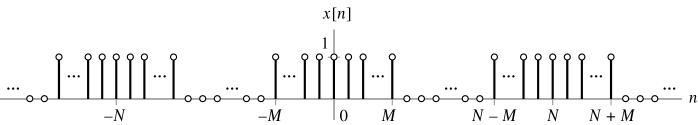
1. The discrete time periodic signals, with period *N*, can be represented as the superposition of sinusoidal complex signals as follows.



where *X*[*k*] is the weighting for the complex signal, and is called the Discrete Time Fourier Series (DTFS) of *x*[*n*], and it can be verified to be given by



1. Please use the Divide-and-Conquer approach to design an efficient algorithm for computing all *X*[*k*], for 
2. Please implement your algorithm by writing a programming for calculate the DTFS of the periodic signal *x*[*n*] with (*N*, *M*)= (32768, 10000), where *x*[*n*] is given by



Plot the results of all *X*[*k*], for 

(c) Compare the computation time of your algorithm with that of the direct computation scheme for the input given in (b).

1. Programming Implementations: Sets A, B, C, D, E, F, G, and H are as follows.

**A.** (1) Write a program to implement the Mergesort algorithm for sorting a list *A* with *n* elements.

(2) Write a program to find the shortest paths from *v*1 to all other vertices, for the graph *G* with adjacency matrix *W* by using Dijkstra’s algorithm. (1)

**B.** (1) Write a program to implement the Quicksort algorithm for sorting a list *A* with *n* elements.

(2) Write a program to find the minimum spanning tree, for the graph *G* with adjacency matrix *W* by using Kruskal’s algorithm. (7)

**C.** (1) Write a program to do the Strassen’s Matrix Multiplication for multiplying**.

(2) Write a program to implement the Heapsort algorithm (Algorithm 7.5). (5)

**D.** (1) Write a program to find the optimal binary search tree with the number of keys *n*, and an array of real numbers *P* indexed from 1 to *n*, where *P*[*i*] is the probability of searching for the *i*th key. You need also to build the optimal binary search tree.

(2) Write a program to implement the Radix Sort algorithm (Algorithm 7.6). (2)

**E.** (1) Write a program to solve the following problem and determine its time complexity. Given a lists of *n* distinct positive integers, partition the lists into two sublists, each of size *n*/2, such that the difference between the sums of the integers in the two sublists is minimized. You may assume that *n* is a multiple of 2.

(2) Write a program to find the minimum spanning tree, for the graph *G* with adjacency matrix *W* by using Prim’s algorithm. (8)

**F.** (1) Write a program to solve the following problem and determine its time complexity. Given a list of *n* distinct positive integers, partition the lists into two sublists, each of size *n*/2, such that the difference between the sums of the integers in the two sublists is maximized. You may assume that *n* is a multiple of 2.

(2) Write a program to find all-sources all-destinations shortest paths, for the graph *G* with adjacency matrix *W* by using Floyd’s algorithm. You should find all the shortest distances and paths for all source-destination pairs. In the adjacency matrix, the value 1024 indicates that the distance is infinite (∞). (3)

**G.** (1) Use the divide-and-conquer approach to write a recursive program that finds the maximum sum in any contiguous sublist of a given list of *n* real values. Analyze your algorithm, and show the results in order function.

(2) Write a program to calculate the Binomial Coefficient  (Algorithm 3.2). (6)

**H.** (1) There are a set of *n* points,, on the *x-y* plane. Please write a program to find the closest pair of points. Analyze your algorithm, and show the results in order function.

(2) Write a program to find the greatest common divisor of two integers (*a*, *b*). (9~14, choose (1) or (2), or both)

**I.** (1) Write a program to implement the backtracking algorithm for the *n*-Queens problem (Algorithm 5.1).

(2) Write a program to solve the 0-1 Knapsack problem. (4)

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