國立交通大學 94 學年度碩士班入學考試試題

科目名稱：資料結構與網際網路概論（0392） 考試日期：94 年 4 月 16 日 第 3 節

系所班別：資訊管理研究所 組別：甲組 第 1 頁，共 2 頁

＊作答前，請先核對試題、答案卷（試卷）與准考證上之所組別與考試科目是否相符!!

1. (a) (4%) Describe Kruskal's or Prim's algorithm for finding minimum spanning trees. Give your answer in either pseudo codes or step-by-step statements.
(b) (5%) Prove that the algorithm you present can correctly construct a minimum spanning tree.

2. (6%) To implement a min-heap, we may deploy an array or a linked list. Considering the efficiency in implementation and time complexity, which data structure will you use?

3. (a) (2%) For problem P, what does the following statement mean? "The lower bound of the time complexity of problem P is $O(n \log n)$."
(b) (2%) What is the lower bound for sorting n elements?
(c) (2%) "The best algorithm that has ever been proposed for problem P has a time complexity of $O(n^2)$. Therefore, we may try to improve the lower bound to $O(n^2)$ or to develop a new algorithm whose time complexity is $O(n \log n)$." Are the statements correct?

4. (a) (2%) List all binary trees for three elements A, B and C.
(b) (3%) How many different binary trees exist for n elements?
(c) (3%) What is the minimum height of the binary trees for n elements?

5. (7%) Given a knapsack of capacity W that is available for storing n objects $\{1, 2, \ldots, n\}$, each object i of which has a weight w_i and a value v_i, we want to determine, subject to the knapsack capacity limit, a subset of objects such that the total value of the selected objects is maximized. Write an algorithm for finding such a subset.

6. (15%) Give a simple heuristic for finding two paths through a network from a given source to a given destination that can survive the loss of any communication line (assuming two such paths exist). The routers are considered reliable enough, so it is not necessary to worry about the possibility of router crashes.

7. (15%) Many companies have a policy of having two (or more) routers connecting the company to the Internet to provide some redundancy in case one of them goes down. Is this policy still possible with NAT (Network Address Translation)? Explain your answer.

8. In Internet database systems, an end-user may use a Web browser to query a database. A Web-to-database middleware is a program that interacts directly with the Web server and the database server to handle database requests.
(a) (7%) Draw a diagram to show the interactions between the browser, the Web server, the Web-to-database middleware, and the database server. Explain the interactions.
(b) (4%) Explain how the Web-to-database middleware interacts with the CGI and ODBC, respectively.

9. Let G represent a process of e-Services executed on the Internet. (i) G is organized by nodes and directed links. Each node represents an e-Service. Each directed link is a dependency. Dependencies are used to describe the execution order and relationship between e-Services within a process. (ii) A dependency d = <X, Y> connects two e-Services X and Y, in which X is the *preceding e-Service* and Y is the *succeeding e-Service*. The dependency d is an outgoing dependency of X and an incoming dependency of Y. An e-Service may have more than one incoming dependency (predecessor) or outgoing dependency (successor). (iii) The length of a path is the number of dependencies on the path. (iv) G has one starting e-Service S. (v) A shortest path from S to V is a path that contains the minimum number of dependencies for all paths from S to V. (vi) There is no cycle in G.

(a) (9%) Use adjacency matrix to represent G, the process of e-Services. Based on the adjacency matrix representation, write an algorithm to generate the shortest paths from S to all other e-services in G.

(b) (4%) Explain how your algorithm indeed finds the shortest paths.

10. Let E represent a set of e-services (e.g. PizzaOrder, ClothesSale, CarRental, MovieRental, etc.) and P denote a set of e-service providers (e-Com1, e-Com2, e-Com3, etc.) available on the Internet. Let $|E|=L$ denote the number of e-services and $|P|=M$ denote the number e-service providers. An e-Service provider *spi* is capable of providing a subset of e-Services, Ei, where $Ei \subseteq E$ and $|Ei| <= k$. Let G represent a process of e-Services to be executed on the Internet. G contains a set of e-services, which is a subset of E. G is organized by nodes (e-services) and directed links describing the execution order between e-Services. G has one starting e-Service S. An e-service provider may be assigned at hand to execute several e-services of different processes. The workload of an e-service provider *spi* is the number of e-services assigned to *spi* at hand. Let workload[*spi*] represent the current workload of the e-service provider *spi* at hand.

(10%) Use adjacency list to represent G, the process of e-Services. Write an algorithm to assign (select) the e-service providers to execute the e-services in G according to the heuristic of selecting the e-service provider with the minimum workload policy for each assignment of an e-service in G. The assignment starts from S.