

國立交通大學 101 學年度碩士班考試入學試題

科目：計算機概論 (5131)

考試日期：101 年 2 月 16 日 第 2 節

系所班別：資訊管理研究所 組別：資管所乙組

第 1 頁, 共 2 頁

【不可使用計算機】*作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符!!

1. Consider the following set of requirements for a *Social_Network* database that is used to keep track of Social Relationships between users and the products that users recommended.

(i) Each user has a name, e-mail address and a unique user-ID. A user may add several users as his/her friends, and may be added as a friend of several other users. The friendships between users are unidirectional. X adds Y as a friend of X, and Y may not add X as a friend of Y.

(ii) The database stores each product's name, description and a unique product-id. A user may recommend several products. The database keeps track the timestamp that a user recommended a product. A product may be recommended by several users in different timestamps.

(a) (6%) Draw an ER (Entity-Relationship) schema diagram for this application. You need to clearly indicate the cardinality ratio (1:1, 1:N, or M:N) and participation constraints (total or partial) of each relationship. (State clearly any additional assumptions you make)

(b) (6%) Map the ER schema into the corresponding relational database schema diagram. Specify all the primary keys and foreign keys.

2. Assume that you are designing an Item-Sharing Website on the Internet. The data structure *pushedItems* links the items that each user had recommended (pushed). Let N be the total number of users and M be the total number of items, respectively. An array *users[]* is used to record the pushed items for N users. The pushed items of each user are stored as a link list. The popularity of an item is the number of users that had pushed the item. Assume that each user has a unique user ID from 0 to $N-1$; each item has a unique item ID in the range of 0 to $M-1$.

(a) (7%) Write an algorithm to compute the popularity of each item according to the data stored in *users[]*. Use the data structure *itemPopularity[]* to store the popularity of each item.

(b) (10%) The similarity of two users X and Y is defined as the ratio of the number of items pushed by both users to the number of items pushed by either user X or user Y. $Sim(X, Y) = \frac{|Push(X) \cap Push(Y)|}{|Push(X) \cup Push(Y)|}$, where $Push(X)$ is the set of items pushed by user X. Write an algorithm to compute the similarity of two users. Analyze the time complexity of your algorithm for computing $Sim(X, Y)$.

```
struct item_info {
    char name[30];
    int itemID;
};
struct itemListNode {
    struct item_info item;
    struct itemListNode *link;
};
typedef struct itemListNode * pushedItems;
pushedItems users[N];
struct push_info {
    char name[30];
    int numPushes;
} itemPopularity[M];
```

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第 2 頁, 共 2 頁

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3. Suppose that several bidders are bidding for an iPad product on a 3C auction Website. Only one bidder at a time is allowed to update the price of the iPad.
- (a) (4%) Explain the concepts of critical region and mutual exclusion for this auction scenario.
- (b) (3%) Explain one possible solution to control the competition for updating the price of iPad among bidders.
4. (a) (5%) Successful Web portals have a high degree of stickiness. Please explain how a Web portal would increase its stickiness.
- (b) (5%) Suppose an array Y (its base address is 1200) is declared in C language as follows: `int Y [8][8]`. Assume that each integer occupies 4 bytes, what is the address of the array element `Y[4][2]`?
5. (9%) The Fibonacci numbers are the numbers in the following integer sequence:
0, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144 ...
- The seed values $F_0=0$, $F_1=1$ and the recurrence relation is $F_n = F_{n-1} + F_{n-2}$, for $n \geq 2$
- Please provide an efficient algorithm to solve the Fibonacci numbers.
6. (a) (3%) The computers at NCTU are on a network with id '140.113'. So the campus IP addresses are in the form of 140.113.X.X. If you are the system administrator, do you know how many NCTU computers could concurrently access the Internet if you assign every computer a real IP address?
- (b) (3%) How many bits are set to 1 for the binary representation of the number 2^n-1 ?
7. (9%)
- (a) $F(1)=1$, $F(n)=2F(n/2)+1$, please solve $F(2^k)=?$ (5%)
- (b) What is the result of $2^4 \bmod 5$? (1%)
- (c) Use the knowledge of (a) and (b), please solve $2^{400} \bmod 5$. (3%)
8. 雲端資訊科技與人工智慧資訊科技技術近年被廣泛談論，而其整合的領域可稱為智慧雲端科技。請以智慧雲端科技的創新運用分別回答下列三問題。
- (a) (10%) 智慧雲端科技在校園中的運用創新，舉例並說明之。
- (b) (10%) 智慧雲端科技在宅急配運送的運用創新，舉例並說明之。
- (c) (10%) 智慧雲端科技在金融市場的運用創新，舉例並說明之。