Introduction to Computer Science   Final Exam. June 13, 2001

1. (analysis and prototyping, software engineering)(10%)

    (a) What is the difference between system requirements and system specifications?

    (b) What is prototyping? How is the incremental model for software development related to prototyping?

2. (heuristic search) (10%)Using the heuristic

    number of tiles out of position

to guide the search to solve the following eight-puzzle problem. Draw the search tree.

1		3
4	2	5
7	8	6

And the goal state is as follows.

1	2	3
4	5	6
7	8	

3. (Complexity, Computation Theory) (10%)

    (a) Suppose a problem can be solved by an algorithm in $O(n^2)$ as well as another algorithm in $O(2^n)$. Will one algorithm always outperform the other?

    (b) Give an example of a polynomial problem.

    (c) Give an example of a nonpolynomial problem.

    (d) Give an example of an NP problem that as yet has not been shown to be a polynomial problem.

4. (Database structures) (10%)

    Identify the level within a database system (user, programmer of application software, designer of the database management system software) at which each of the following concerns or activities occur:

    (a) How should data be stored on a disk to maximize efficiency?

    (b) Is there a vacancy on flight UA243?

    (c) Does a relation be better stored as a sequential file or an indexed file?

    (d) How many times should a user be allowed to mistype a password before the conversation is terminated?

    (e) How can the PROJECT operation be implemented?

5. (Data Structures) (10%)

What is so-called heapsort? Describe the heapsort using a pseudo code.

(b) What kind of data structures is used in the heapsort? Explain.

6. (OS role in opening and closing a file) (10%)

(a) What role would an operating system's file manager play when opening a file?

(b) What is a file descriptor? What information items are put in a file descriptor?

(c) What is the purpose of closing a file?

7. (Hashing) (10%)

(a) Suppose a hashed file is constructed using the division hash algorithm (mod operation) as presented in our textbook but with four storage buckets. For each of the following key field values, identify the bucket in which the record with that key field value is placed. What goes wrong and why?

24, 32, 3, 19, 15, 23, 8, 36, 27, 0

(b) Propose an improved hashing function for the above problem.

(c) If the division hash algorithm is being used, why is clustering (i.e., collisions) more likely to occur when the file storage space is divided into 60 buckets rather than 61?

(d) The division hash algorithm is to be constructed with 50, 51, 52, or 53 buckets. Which of these choices is best? Why?

8. (Stack) (10%)

The table below represents a stack stored in a contiguous block of memory cells as discussed in the next. The stack is described using the following C++ code.

```
const int MaxStack = 25;
class StackOfIntegers
{
int StackPointer;
int StackEntries[MaxStack];
public:
    stackOfIntegers() {StackPointer = MaxStack;}
    void push (int Entry)
        {if (StackPointer > 0) StackEntries[--StackPointer] = Entry;}
    void pop (void)
        {
        if (StackPointer < MaxStack) return StackEntries[StackPointer++] ;
        else return 0;
        }
};
```

(a) If the base of the stack is at address 10 and the stack pointer contains the value 18, what value is retrieved by a pop instruction? What value is then in the stack pointer?

10	F
11	C
12	A
13	B
14	E
15	P
16	R
17	V
18	X
19	Y
20	Z
21	U
22	T
23	S
24	Q

(b) Define the member function isFull and isEmpty for the calss StackOfIntegers.

9. (algorithm time complexity) (10%)

An algorithm that does cn^2 units of work for any constant c is order of magnitude n^2, denoted as $\Theta(n^2)$.

(a) An algorithm that is $\Theta(n)$ takes 10 seconds to execute on a particular computer when n=1000. How long would you expect it to take when n=10000?

(b) An algorithm that is $\Theta(n^2)$ takes 10 seconds to execute on a particular computer when n=1000. How long would you expect it to take when n=10000?

(c) An algorithm that is $\Theta(\lg n)$ takes 10 seconds to execute on a particular computer when n=1000. How long would you expect it to take when n=10000? (lg is defined to be $\log_2$)

(d) An algorithm that is $\Theta(2^n)$ takes 10 seconds to execute on a particular computer when n=1000. How long would you expect it to take when n=10000?

10. (SQL statement) (10%)

(a) Translate the SQL statement

    select JOB.JobTitle

    from ASSIGNMENT, JOB

    where ASSIGNMENT.JobId = JOB.JobId and ASSIGNMENT EmplId = Y3470"

into a sequence of SELECT, PROJECT, and JOIN operations.

(b) What is the result of the query in (a), if the ASSIGNMENT and JOB relation are given as follows?

ASSIGNMENT relation

EmplID	JobID	StartDate	TermDate
Y2334	S25X	3-1-1997	4-30-1999
Y3470	F5	10-1-1998	*
X2515	S26Z	5-1-1997	*

JOB relation

JobID	JobTitle	SkillCode	Dept
S25X	Secretary	T5	Personnel
D20	Dept. Head	D2	Accounting
S26Z	Secretary	T6	Sales
F5	Floor Manager	FM3	Information