Algorithms 資格考

1.(30%) (1) (15%) The matrix-chain multiplication problem can be stated as follows: Given a chain $\langle A_1, A_2, \ldots, A_n \rangle$ of n matrices, where for $i=1,2,\ldots,n$, matrix A_i has dimension $p_{i-1} \times p_i$, fully parenthesize the product $A_1 A_2 \cdots A_n$ in a way that minimizes the number of scalar multiplications. Give a dynamic-programming algorithm to solve the problem and analyze its time complexity.

(2) (15%) Suppose that you have 6 matrices: A_1 has dimension 30×35, A_2 has dimension 35×15, A_3 has dimension 15×5, A_4 has dimension 5×10, A_5 has dimension 10×20, A_6 has dimension 20×25. Please use your algorithm to calculate the minimum number of scalar multiplications.

2.(20%) Illustrate the operation of BUCKET-SORT on the array $A = \langle 0.79, 0.13, 0.16, 0.64, 0.39, 0.20, 0.89, 0.53, 0.71, 0.42 \rangle$.

3.(20%) Determine which one of the **0-1 knapsack problem** and the **fractional knapsack problem** cannot be solved using the greedy strategy? Give an example to explain that.

4.(30%) Give an asymptotic solution for $T(n) = 9T(\frac{n}{3}) + n$.

2009 March NCKU CSIE PH.D. Qualification Examination
Computer Archtecture

1. Explain why the cache miss penalties increase as the processor becomes much more faster than DRAMs? Briefly describe five optimizations to reduce cache miss penalty. (15 points)

2. Some operations on two operands (e.g., subtraction) are not commutative. What are the advantages and disadvantages of the stack, accumulator, and load-store architectures when executing noncommutative operations? (15 points)

3. In the memory-hierarchy design, please answer the following questions: (Assuming the cache is n-way set associative and there are $S = 2^s$ sets, and each block is of size $B = 2^b$ bytes) (20 points)
   a. Where can a block with variable *v* be placed in a cache? (assume v has the address *addr*)
   b. How is a block with variable v found if it is in the cache? (describe the general tag design)
   c. Which block should be replaced on a cache miss? (make your assumption)
   d. What happens on a write operation? (describe two basic write policies)

4. Describe the cache coherency problem for a distributed shared memory multiprocessor. In a cache coherent non-uniform memory access machine (CC-NUMA), the existing directory schemes fall into two categories, bit-map and linked list protocols. For each category, describe one popular protocol and its read and write operations for hits and misses in the local cache. (20 points)

5. Describe what are the RAW, WAW, and WAR hazards. (15 points)

6. Give the following loop. Assume that x, y, and z are distinct and non-overlapping arrays. What are the data dependences among the statements S1 and S2 in the loop? (15 points)

```
for (i=1; i<100; i++) {
    x[i+1] = x[i] + z[i];       /* S1 */
    y[i+1] = y[i] + x[i+1];     /* S2 */
}
```

3/2009 博士班資格考: 機率與統計 Show All Details.

1. (10%)

   Given the prior distribution $f(p)$ and the joint distribution of the sample $f(x_1, x_2, .., x_n; p)$. Give the Bayes estimate of p.

2. (20%)

   Based on your answer in Problem #1, let the prior distribution of the portion of defective products be $f(0.1) = 0.8$ and $f(0.2) = 0.2$. If a random sample show that one out of three samples yields one defective. Find the Bayes estimate of the defective portion.

3. (30%) Show all details.

   (a) A random sample of *n* observations, X_i for *I=1,2,..,n,* is taken from a normal population with mean μ and variance σ^2. Let $\overline{X} = \frac{X_1 + X_2 + \Lambda + X_n}{n}$. Find the pdf of $\overline{X}$.

   (b) Let $S^2 = \frac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}$. Find the pdf of S^2.

   (c) Let *F* be uniformly distributed with pdf, $f(x) = \begin{cases} 1/2 & ,0 \le x \le 2 \\ 0 & ,otherwise \end{cases}$. Let F_1 and F_2 be 2 observations of *F* and $G = F_1 + F_2$. Find the pdf of *G*.

4. (20%)

   Prove that $E[E[Y|X]] = E[Y]$.

5. (20%)

   Let X be a random variable of *N(0, 1)*. Let $y = 2x^2$. Find the *pdf* of Random variable Y.

模糊邏輯資格考 (考試時間: 100 分鐘)

1. 解釋名詞：(每題 3 分；合計 15 分)
   (a) ambiguity of dissonance in evidence
   (b) type 2 fuzzy set
   (c) fuzziness 量測函數之基本公設
   (d) equilibrium
   (e) cylindric extension

2. Solve the following fuzzy relation equation for the max-min composition: (15 分)

$$\mathbf{P} \circ \begin{bmatrix} .9 & .6 & 1 \\ .8 & .8 & .5 \\ .6 & .4 & .6 \end{bmatrix} = \begin{bmatrix} .6 & .6 & .5 \end{bmatrix}$$

3. (a) 今擬將本課程之成績百分數轉換爲 4 等級分數（優、佳、中、差），請依你個人的標準定義 4 個合理的 fuzzy numbers 代表此 4 等級分數，並繪出或列出它們的 membership functions。(7 分)
   (b) 若本課程係依兩次考試計算學期成績，且每次考試的權重相同，假設你兩次考試的成績分別是佳、差，請利用 interval arithmetic 算出你的學期成績，並列出其 membership function。(8 分)

4. Let A and B be fuzzy sets defined on the universal set X = Z (integers) whose membership functions are given by
   $A(x) = .5/(-1) + 1/0 + .7/1 + .4/2$ and
   $B(x) = .9/2 + .1/3 + .5/4 + .3/5$
   Let a function $f : X \times X \to X$ be defined for all $x_1, x_2 \in X$ by $f(x_1, x_2) = x_1 \cdot x_2$.
   Calculate $f(A, B)$. (15 分)

5. Consider a fuzzy automaton with $\boldsymbol{X} = \{x_1, x_2\}$, $\boldsymbol{Y} = \{y_1, y_2, y_3\}$, $\boldsymbol{Z} = \{z_1, z_2, z_3, z_4\}$ whose output relations $\boldsymbol{R}$ and state-transition relation $\boldsymbol{S}$ are defined, respectively, by the matrix

$$\mathbf{R} = \begin{array}{c} \\ z_1 \\ z_2 \\ z_3 \\ z_4 \end{array} \begin{array}{c} \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ .5 & 1 & .3 \end{bmatrix} \end{array}$$

and the three-dimensional array

$$S = \begin{array}{c} \\ z_1 \\ z_2 \\ z_3 \\ z_4 \end{array} \begin{array}{c} \begin{array}{cccc} x_1 & & & \\ z_1 & z_2 & z_3 & z_4 \end{array} \\ \begin{bmatrix} 0 & .4 & .2 & 1 \\ .3 & 1 & 0 & .2 \\ .5 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{array} \begin{array}{c} \begin{array}{cccc} x_2 & & & \\ z_1 & z_2 & z_3 & z_4 \end{array} \\ \begin{bmatrix} 0 & 0 & 1 & 0 \\ .2 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & .3 & 0 & .6 \end{bmatrix} \end{array}$$

Please generate sequences of three fuzzy internal and output states under the following condition: the initial fuzzy state $C' = [1 \quad 0 \quad 0 \quad 1]$, the input states are $A^1 = [.2 \quad 1]$, $A^2 = [1 \quad 0]$, $A^3 = [1 \quad .4]$. (10 分)

6. (15 分) By referencing the data in Table 14.1, answer
   (a) Which sociologists or economists are in considerable agreement with Feldman concerning option *Y*?"
   (b) "Which experts who are not sociologists are somewhat in agreement with Fee regarding option *X*?" (Assume that a threshold similarity of 0.5 represents the condition of "somewhat in agreement.")
   (c) "Which sociologists are in considerable agreement with any economists concerning option *Y*?"

Table 14.1 EXAMPLES OF RELATIONS IN RELATIONAL DATABASE

RELATION: EXPERT	
NAME	FIELD
Cohen	sociologist
Fadem	economist
Fee	attorney
Feldman	economist
Kass	physician
Osborn	sociologist
Schreiber	sociologist
Specterman	sociologist

RELATION: ASSESSMENT		
OPTION	NAME	OPINION
X	Osborn	favorable
X	Fee	negative
X	Fadem	slightly favorable
X	Feldman	highly favorable
Y	Cohen	slightly favorable
Y	Osborn	slightly favorable
Y	Fee	highly favorable
Y	Schreiber	favorable
Y	Kass	favorable
Y	Fadem	negative
Y	Specterman	highly favorable
Y	Feldman	slightly favorable
Z	Osborn	negative
Z	Kass	slightly favorable
Z	Fee	slightly favorable

7. Let $X = \{a, \quad b, \quad c, \quad d\}$. Given the basic assignment $m(\{a, \quad b, \quad c\}) = .5$, $m(\{a, \quad b, \quad d\}) = .2$, and $m(X) = .3$, determine the corresponding belief and plausibility measures. (15 分)

Computer Networks – Qualified Exam

(2009/Spring)

系別 _____ 年級 _____ 學號 _____ 姓名 _____

1. (10%)

   Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following question, briefly justifying your answer:

   a. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

   b. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

2. (10%)

   Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queuing delay for the N packets?

3. (10%)

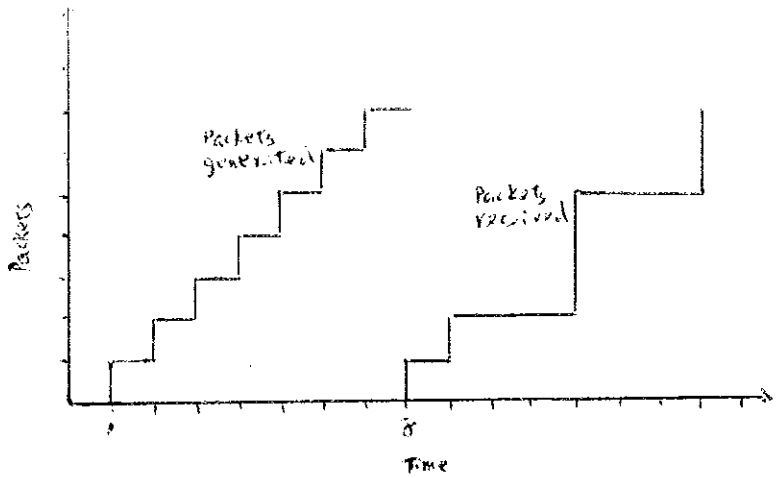
   Suppose two nodes, A and B, are attached to opposite ends of a 900 m cable, and that they each have one frame of 1,000 bits (including all headers and preambles) to send to each other. Both nodes attempt to transmit at time $t = 0$. Suppose there are four repeaters between A and B, each inserting a 20-bit delay. Assume the transmission rate is 10 Mbps, and CSMA/CD with backoff intervals of multiples of 512 bits is used. After the first collision, A draws $K = 0$ and B draws $K = 1$ in the exponential backoff protocol. Ignore the jam signal and the 96-bit time delay.

   a. What is the one-way propagation delay (including repeater delays) between A and B in seconds? Assume that the signal propagation speed is $2 \cdot 10^8$ m/sec.

   b. Now suppose that only A has a packet to send and that the repeaters are replaced with switches. Suppose that each switch has a 20-bit processing delay in addition to a store-and-forward delay. At what time, in seconds, is A's packet delivered at B?

4. (10%)

Consider the figure below (which is similar to Figure 7.5). A sender begins sending packetized audio periodically at $t = 1$. The first packet arrives at the receiver at $t = 8$.



a. What are the delays (from sender to receiver, ignoring any playout delays) of packets 2 through 8? Note that each vertical and horizontal line segment in the figure has a length of 1, 2, or 3 time units.
b. If audio playout begins as soon as the first packet arrives at the receiver at $t = 8$, which of the first eight packets sent will *not* arrive in time for playout?
c. If audio playout begins at $t = 9$, which of the first eight packets sent will not arrive in time for playout?
d. What is the minimum playout delay at the receiver that results in all of the first eight packets arriving in time for their playout?

5. (10%)

i) Which fields of the IP header change from router to router?

ii) A datagram is carrying 1024 bytes of data. If there is no option information, what is the values of the header length field? What is the value of the total length field?

iii) A host is sending 100 datagrams to another host. If the identification number of the first datagram is 1024, what is the identification number of the last?

iv) An IP datagram arrives with fragmentation offset of 0 and an *M* bit (more fragment bit) of 0. Is this a first fragment, middle fragment, or last fragment?

6. (10%)

i) What is the minimum size of a UDP datagram?

ii) What is the maximum size of a UDP datagram?

iii) What is the minimum size of the process data that can be encapsulated in a UDP

datagram?

iv) What is the maximum size of the process data that can be encapsulated in a UDP datagram?

v) A client has a packet of 68,000 bytes. Show how this packet can be transferred using only one UDP user datagram.

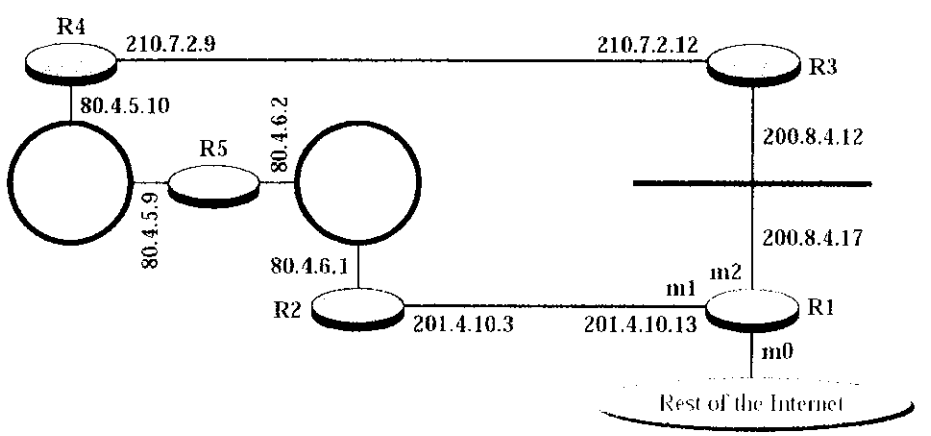
7. (10%)

A client uses TCP to send data to a server. The data is 16 bytes. Calculate the efficiency of this transmission at the TCP level (ratio of useful bytes to total bytes). Calculate the efficiency of transmission at the IP level. Assume no options for the IP header. Calculate the efficiency of transmission at the data link layer. . Assume no options for the IP header and use Ethernet at the data link layer.

8. (10%)

Show the routing table for router R4 in Figure 6.11.

Figure 6.11



9. (10%)

Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address form DNS; the successive visits incur an RTT of $RTT_1,\ldots,RTT_n$. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT_0 denote the RTT between the local host and the server containing the object. Assuming zero

transmission time of the object, how much time elapses from when the client click on the link until the client receives the object?

10. (10%)

Consider sending a large file from a host to another over a TCP connection that has no loss.

a. Suppose TCP uses AIMD for its congestion control without slow start. Assuming CongWin increases by 1 MSS every time a batch of ACK_s is received and assuming approximately constant round-trip times, how long does it take for CongWin to increase from 1 MSS to 6 MSS(assuming no loss event)?
b. What is the average throughout (in terms of MMS and RTT) for this connection up through time = 5 RTT?

Digital Image Processing

Ph.D. Qualification Examination

Department of CSIE, NCKU

March, 2009

1. If you want to remove noises from given image, you usually can do filtering in spatial or frequency domains. Please describe the procedures of filtering in spatial and frequency domains. Are there differences between the two filtering methods? How can you evaluate the filtering results in signal noise ratio (give equation)? (20%)

2. Hough transform is well known for line detection; please describe its concept and mathematics. (12%) Please also describe the Hough transform algorithm that can be used for circle detection? (8 %)

3. In edge detection, we usually utilize the non-maximal suppression and the hysteresis procedures to modify the detected edges? Please describe the purposes and the algorithms of the two procedures. (20%)

4. Watershed algorithm and active contour model are two popular methods used in medical image segmentation. Please describe the ideas and models that are used in these two methods. (8% for each) Please also compare the two methods and give some comments on their merits and drawbacks. (4%)

5. Please describe the scaling and rotation properties in discrete Fourier transform. (10%) The origin of an image is usually on the upper-left corner, please explain the procedure to move the origin of the Fourier image to the center of image. (10%)

高效能網路技術

1. For a given prefix set {0*, 000*, 010*, 01001*, 01011*, 011*, 0110*, 11*, 111*}, (a) Please draw the binary tries. (10%) (b) Please list the most specific prefixes. (5%) (c) Please find the longest matching prefix for address 01011010. (5%)

2. Binary Prefix Search (BPS) is an efficient IP address lookup scheme that provides us a comparison method to sort prefixes. According to BPS and the same prefix set in question 1, (a) Please sort the prefixes. (10%) (b) Please give an example to illustrate why it might cause a failed lookup when we directly perform a binary search on these sorted prefixes. (5%) (c) How to perform IP lookup by using BPS? (10%)

3. For the given filters F = {101*, 1110*}, Z = {10*, 11*}, Y = {0*, 100*}. (a) Please illustrate markers and pre-computation in a 5 x 5 2-Dimension tuple space. (10%) (b) Please describe Rectangle Search algorithm in the tuple space? (10%)

4. (a) Please list the pro's and con's of Ternary Content Addressable Memories (TCAMs). (10%) (b) Please convert a 4-bit range [1, 14] to the format that can be stored in TCAMs. (5%)

5. Let R be a set of five 5-bit ranges, where R = {[3, 15], [7, 7], [20, 25], [8, 19], [25, 31]}. (a). Please list all the elementary intervals induced by *R*. (10%) (b). Please draw a balanced binary segment tree that is constructed according to *R*. (10%)

DBMS Qualify Exam

1. (30%) Consider the following schema for a suppliers-and-parts database:

SUPPLIER(SupNo, SName, Status, City)

PART(PartNo, Color, Weight, City)

PROJECT(ProjNo, PName, City)

SHIPMENT(SupNo, PartNo, ProjNo, Qty)

Answer the following queries in SQL.

(a) Get the total weight for the parts that are NOT a "red" part.

(b) Get the total quantity for ALL red parts.

(c) Get the projects whose parts are ALL less than 100.

2.(20%) Answer the questions.

(a) Draw the ER diagram of the schema given in Question 1.

(b) If two more relations are added to Question 1's schema, what will the ER schema be? The two added relations are as follows.

Store(SNo, SName, City)

Sale(SNo, PartNo, Price)

3. (10%) R(A, B, C, D, E, F) is a relation with functional dependencies:

(A -> B), (E -> F), (DE -> ABCF).

Normalize the above relation to make it satisfy

(a) 2NF

(b) 3NF

4. (10%) Why a relation satisfying BCNF must also satisfy 3NF? State the reason.

5.(15%)

(a) What does ACID means in transaction processing?

(b) What is "write-ahead log"?

(c) Compare the advantages and disadvantages of the two-phase locking protocol with the time-stamping protocol.

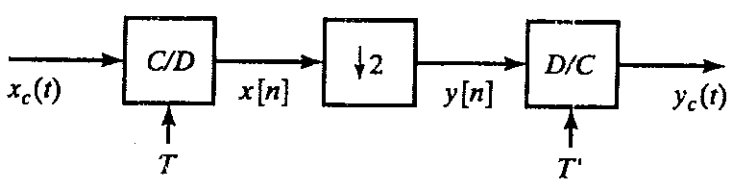
6. (15%) Give a formal definition of the relational join operation. /* 說明: 我們都知道 join operation 是什麼。現在假如要你用學術論文裡給定義的方式，來正式的給出 **join** 的定義。這個定義你該如何寫? */

Discrete-Time Signal Processing 資格考

March 2009

1. **(20%)** Determine if the systems described by the following input-output equations are (1) linear, (2) stable, and (3) causal.
   (a) y[n] = 3x[n]+5
   (b) y[n] = log(x[n-5])
   Justify your answer.

2. **(20%)** In the following figure, $x[n] = x_c(nT)$ and $y[n] = x[2n]$
   (a) Assume that $x_c(t)$ has a Fourier transform such that $X_c(j\Omega) = 0,\ |\Omega| > 2\pi(100)$. What value of T is required so that
   $$X(e^{j\omega}) = 0, \quad \frac{\pi}{2} < |\omega| \le \pi ?$$
   (b) How should T' be chosen so that $y_c(t) = x_c(t)$?



3. **(20%)** Consider a right-sided sequence x[n] with z-transform
   $$X(z) = \frac{2z^2 - z}{2z^2 + \frac{3}{2}z + \frac{1}{4}}$$
   Determine the inverse z-transform using each of the following methods

4. **(20%)** Consider a stable linear time-invariant system with input x[n] and output y[n]. The input and output satisfy the difference equation.
   $$y[n-1] - \frac{5}{2}y[n] + y[n+1] = x[n]$$
   (a) Plot the poles and zeros in the z-plane.
   (b) Find the impulse response h[n].

5. **(20%)**. Suppose that we wish to design a highpass filter satisfying the following specification:
   $$-0.04 < |H(e^{j\omega})| < 0.04, \qquad 0 \le |\omega| \le 0.2\pi,$$
   $$0.995 < |H(e^{j\omega})| < 1.005, \qquad 0.3\pi \le |\omega| \le \pi.$$
   The filter will be designed using the bilinear transformation and T=2 ms with a prototype continuous-time filter. State the specification that should be used to design the prototype continuous-time filter to ensure that the specification for the discrete-time filter are met. The following equations are for your reference :
   $$s = \frac{2}{T}\left(\frac{1 - z^{-1}}{1 + z^{-1}}\right), \qquad \Omega = \frac{2}{T}\tan(\omega/2), \qquad \omega = 2\arctan(\Omega T/2)$$