1. **(20%, Camera Model)**

    (a) If the camera sensor size is 1/3 inch with resolution $w*h=800*600$ pixels, based on 1.0X lens magnification (i.e., image resolution is 800*600 pixels) please find the pixel size = _____ um * _____ um? **(10%)** (Hint: Please check Figure 1.)

Figure 1

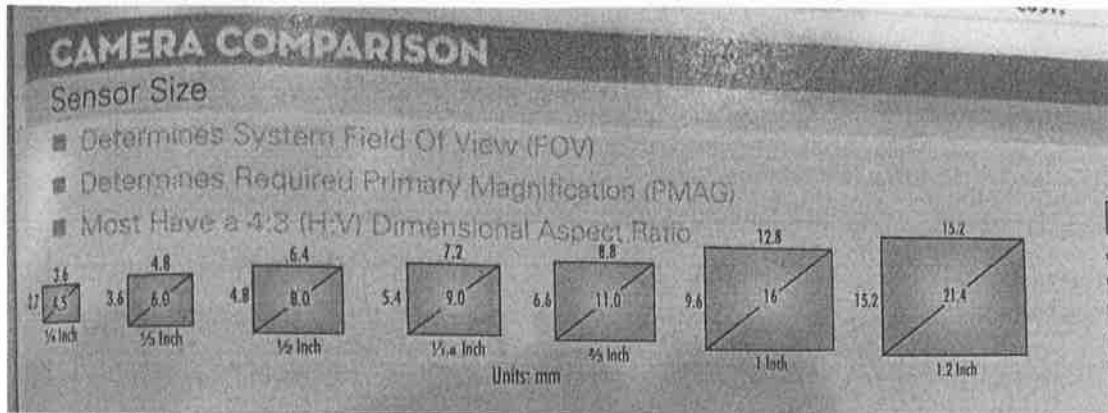   (b) As shown in Figure 2, please find focal length f =function of (w, θ)? **(5%)** = ? mm **(5%)**
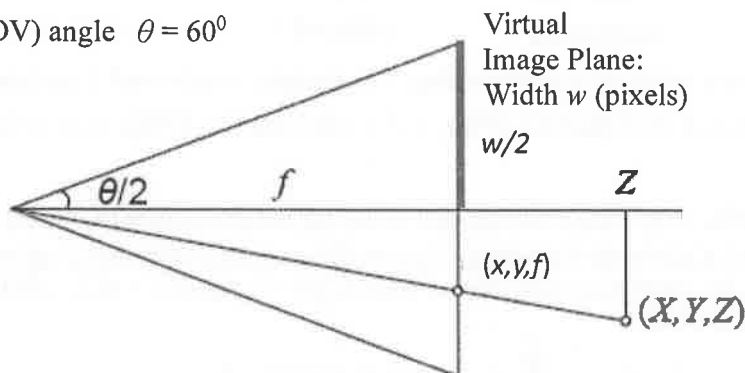

Figure 2

2. **(20%, PCA)** For principal component analysis (PCA) computation, first the covariance matrix C is created. Second, the Singular Value Decomposition (SVD) is applied to C (i.e., $C = UDV^T$) to obtain eigenvalue matrix D with corresponding eigenvector matrix U. Here, there are five data samples $x=\{x_1, x_2, x_3, x_4, x_5\}$ as shown in table 1 and corresponding low-dimensional (projected) data is represented by $y=\{y_1, y_2, y_3, y_4, y_5\}$. Suppose the unsorted eigenvalues and corresponding eigenvectors of covariance matrix are shown in the table 2. If we want to reduce the dimension of data vector x from 5 to 2.

    (a) What is the projection matrix w? **(4%)**

    (b) What is the projection data (weight) vector $\{y_2, y_3\}$? (Please show all calculations) **(4%+4%)**

    (c) PCA belongs to _____ model. (Hint: Gaussian, non-Gaussian, or Markov) **(4%)**

    (d) PCA belongs to _____ learning. (Hint: Supervised, semi-supervised, or unsupervised, reinforcement) **(4%)**
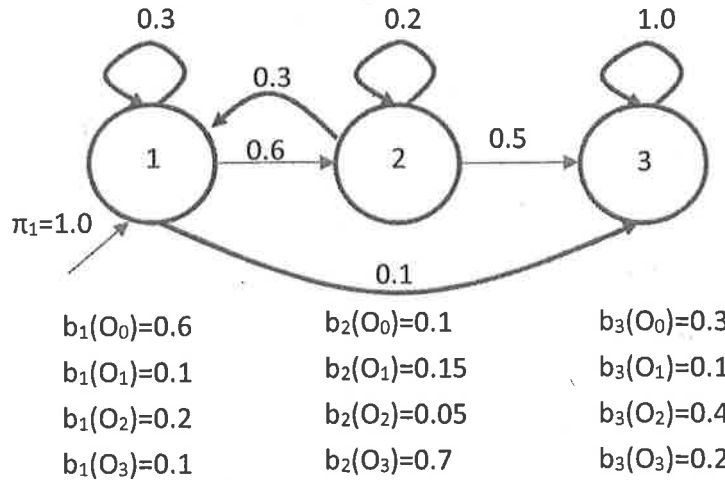
Table1	
x_1	$[1, 2, -7, 5, 3]^T$
x_2	$[4, -2, 6, 0, 3]^T$
x_3	$[-7, 5, -1, -2, 1]^T$
x_4	$[3, -3, 4, -2, -5]^T$
x_5	$[-1, -2, -2, -1, -2]^T$

Table2	
eigenvalues	eigenvectors
1	(4, 3, 6, -2, 0)
9	(-3, 5, 0, 0 7)
4	(1, 8, -4, 5, 6)
7	(2, -1, 0, 4, 1)
3	(5, 5, 9, -1, 2)

3. **(20%, HMM)** A HMM topology and parameters are as following graph.

$b_1(O_0)=0.6$ $b_2(O_0)=0.1$ $b_3(O_0)=0.3$

$b_1(O_1)=0.1$ $b_2(O_1)=0.15$ $b_3(O_1)=0.1$

$b_1(O_2)=0.2$ $b_2(O_2)=0.05$ $b_3(O_2)=0.4$

$b_1(O_3)=0.1$ $b_2(O_3)=0.7$ $b_3(O_3)=0.2$

Please write its corresponding 1 parameter vector and 2 parameter matrixes, π (1x3 vector) **(6%)**, A (3x3 matrix) **(7%)**, and B (4x3 matrix) **(7%)**, with values?

4. **(20%, VQ)** Please set the sort order for the procedure of Vector Quantization algorithm:

Step : Codebook Updating - Update the codeword (symbol) o^i of each cluster C^i by computing new cluster centers $c^i(l+1)$ where $i = 0,1,...,M-1$ at the $l+1$th iteration.

$$c^i(l+1) = \frac{1}{N}\sum_{n=1}^{N} x_n^i \text{ where } x^i \in C^i(l+1)$$

N is the number of feature vectors in cluster $C^i(l+1)$ at the $l+1$th iteration. And

$$q(x) = o^i \text{ where } 0 \le o^i \le M-1$$

where $q(.)$ is the quantization operator.

Step : Termination 1 - If the difference between the current overall distortion $D(l+1)$ and that of the previous iteration $D(l)$ is below a selected threshold,

$$\begin{cases} if \ |D(l+1)-D(l)| \ < \ threshold, \ then \ Goes \ to \ Step \ \underline{?1} \\ if \ |D(l+1)-D(l)| \ \ge \ threshold, \ then \ Goes \ to \ Step \ \underline{?2} \end{cases}$$

(where *threshold* is 0.0001 in our study.)

Step : Termination 2 -

Is the codebook size M equal to the VQ codebook size required ?

$$\begin{cases} if \ Yes, \ then \ \underline{?3} \\ if \ No, \ then \ Goes \ to \ Step \ \underline{?4} \end{cases}$$

Step : Classification - At the lth iteration, according to following equation, classify each k-dimensional sample x of training feature vectors into one of the clusters C^i.

$$x \in C^i(l) \quad if \ \|x - c^i(l)\| < \|x - c^j(l)\| \text{ where } i \ne j, \ i, j = 0,1,...,M-1$$

Step : Initialization - Assume all N k-dimensional training vectors to be one cluster C^0, i.e., codebook size $M = 1$ and codeword $o^0 = 0$, and find its k-dimensional cluster centroid $c^0(1)$ where 1 is the initial iteration.

$$c^0(1) = \frac{1}{N}\sum_{n=1}^{N} x_n^0$$

where x is one sample of all N k-dimensional feature vectors at cluster C^0.

Step : Splitting - Double the size M of the codebook by splitting each cluster into two. The current codebook size M is split into $2M$. Set $M = 2M$ by

$$\begin{cases} c_+^i(l) = c^i(l) + \varepsilon \\ c_-^i(l) = c^i(l) - \varepsilon \end{cases} \quad where \ \ 0 \le i \le M - 1$$

c^i is the centroid of the ith cluster C^i, M is the size of current codebook, ε is a k-dimensional splitting parameter vector and is value 0.0001 for each dimension in our study. l is the initial iteration.

(a) Set the sort order above 6 steps? **(12%)**

(b) Which step includes the nearest neighbor rule? **(4%)**

(c) Vector quantization belongs to _____ learning. (Hint: Supervised, semi-supervised, or unsupervised, reinforcement) **(4%)**

5. **(20%, DL)** Based on the deep learning lecture:

(a) For each neuron as following, if a_i is the given (known) input image pixel, w_i is the weight parameter of neural network, b is the bias parameter, and z is it output result. Please write its $AX=B$ format? Here A is unknown parameter vector, X is the known input pixel vector and B is the output result. **(7%)** After activation function, the output of $\sigma(z)$ is the _____ result **(3%)** (Hint: Linear Discrimination, Non-Linear Discrimination)
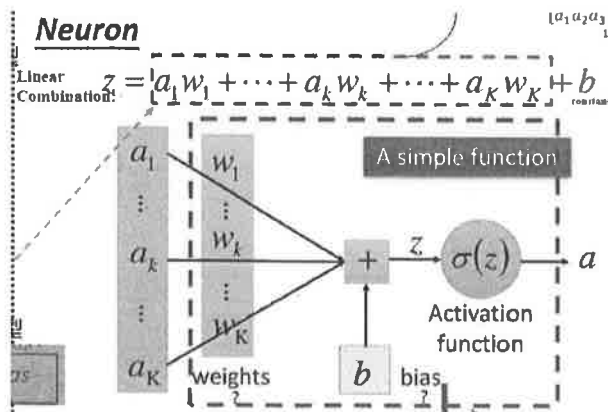
(b) Each of following answers for physical meaning has only one answer selection:

(b.1) Deep learning, which is the same as AdaBoost, has the property of _____? **(2%)**

(b.2) Deep learning, which is the same as Supported Vector Machine, has the property of _____? **(2%)**

(b.3) Convolution process has the property of _____? **(2%)**

(b.4) Max Pooling has the property of _____? **(2%)**

(b.5) Softmax function has the property of _____? **(2%)**

(Hint: Non-linear discrimination, subsampling, feature extraction, cascade, output normalization)

NCKU CSIE PhD Qualifying Exam
Biostatistics
Spring 2021

1. Data collection [20%, 10% for each]
1.1 In data collection, please state the meaning of accuracy and precision.
1.2 Please give examples for measures of central tendency and measures of variability in a dataset (one measure for each). Please explain how these measures work.

2. Probability distribution [20%, 10% for each]
2.1 A box of chocolate contains 5 pieces of milk chocolate, 3 pieces of dark chocolate, and 2 pieces of white chocolate. If an experiment is designed to draw one piece of chocolate each time to check its flavor with replacement (檢視完放回). The experiment will be repeated for 100 times. With a total of 100 draws, please model total number of milk chocolate x_{milk}, total number of dark chocolate x_{dark}, and total number of white chocolate x_{white} with a probability distribution. Please clearly define parameters of the probability distribution.
2.2 A customer service center, on average, receives 30 calls per day assuming that occurrences of calls follow a Poisson process. Please show how to calculate the probability that, in three consecutive days, the service center will receive between 70 to 80 calls inclusive (包含 70 與 80 通 電話). There is no need to find out exact probability values (不需算出機 率值，只需詳細寫出算式及公式).

3. Confidence Interval [20%, 10% for each]
3.1 Please explain how can we calculate confidence interval of population mean from sample mean in both cases that you know and that you don't know population variance (解釋如何操作公式即可). In addition, please derive confidence interval of population mean when you know population variance (推導出公式).
3.2 Please explain how can we calculate 95% confidence interval of population variance from sample variance assuming that population follows normal distribution (解釋如何操作公式即可).

4. Hypothesis testing [30%, 10% for each]
4.1 In hypothesis testing, please explain Type-I error, Type-II error and

power of the test.

4.2 A scientist would like to compare average height of 12 years old boys between an urban area and a rural area. A random sample of size m is drawn from the urban area which consists of data $(u_1, u_2, \ldots, u_m)$. On the other hand, a random sample of size n is drawn from the rural area which consists of data $(r_1, r_2, \ldots, r_n)$. It is known that distributions of urban population and rural population have very similar shape. Now, please explain procedures of performing the Wilcoxon Rank Sum Test to examine the null hypothesis that two population means μ_u and μ_r are the same. There is no need to find out exact probability values (不需算出機率值，只需詳述假設檢定之步驟及寫出公式).

4.3 Following 4.2, if it is known that distributions of urban population and rural population are both normal with the same variance of σ^2. Please describe the general procedures to examine the null hypothesis that two population means μ_u and μ_r are the same (by a parametric method). There is no need to find out exact probability values (不需算出機率值，只需詳述假設檢定之步驟及寫出公式).

5. Regression [10%]

Please explain the concept of linear regression. Please describe the general procedure to fit a linear regression model between an independent variable X and a dependent variable Y. Please explain a linear regression model, its parameters, and how to fit the model. In addition, how do we usually interpret the relationship between X and Y?

- This examination is closed books.

- Please turn off your cell phones.

- Remember that there are 2 pages of the qualify examination.

- Answer all questions as possible. You may have a partial score if you answer the correct direction.
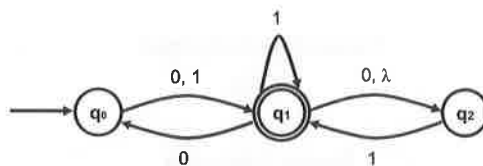
1. Deterministic Finite Acceptor (DFA) (10 pts)

   For $\Sigma = \{a, b\}$, construct a DFA that accepts the set consisting of:
   All strings with an even number of a's.

2. Nondeterministic Finite Acceptor (NFA) (10 pts)

   Find an NFA with the specified number of states to accept the following set:
   The language $0^*1^*0^*0$. (use a "3 states" solution)

3. Convert the following NFA into an equivalent DFA: (10 pts)

4. Constract a dfa that accepts the language generated by the grammar. (10 pts)

$$S \rightarrow abA,$$
$$A \rightarrow baB,$$
$$B \rightarrow aA | bb.$$

5. Find a regular grammar for the language on $\Sigma = \{a, b\}$: (10 pts)
   $L = \{w : n_a(w) \text{ and } n_b(w) \text{ are both odd}\}$.

6. Please use the pumping lemma to prove that the language is nonregular: (10 pts)
   $L = \{a^n ba^n : n \geq 0\}$.

7. Show that the following grammar is ambiguous. (10 pts)

$S \rightarrow aSbS|bSaS|\lambda$.

8. Construct a nondeterministic pushdown automata for the following language: (10 pts)

$L = \{a^n b^m c^{n+m} : n \geq 0, m \geq 0\}$.

9. Fill the following languages into the language hierarchy (If L_i is a regular language and also a context-free language, please fill L_i in the set of regular languages): (20 pts)

$L_1 = \{a^n b^m : n \geq m\}$,

$L_2 = L(a^*b^*)$,

$L_3 = \{a^n b^n c^n : n \geq 0\}$,
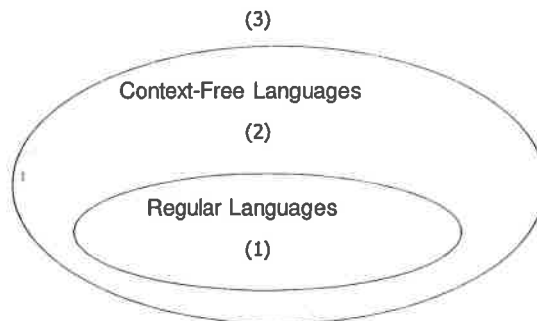
$L_4 = \{ww^R w : w \in \{a, b\}^*\}$,

$L_5 = \{ab, ad, a\}$,

$L_6 = \{ww : w \in \{a, b\}^*\}$,

$L_7 = \{a^{n!} : n \geq 0\}$,

$L_8 = \{a^n b^m : m = 2^n\}$,

$L_9 = \{a^n b^j c^k : k = jn\}$,

$L_{10} = \{a^n b^j a^j b^n : n \geq 0, j \geq 0\}$.

(3)

Context-Free Languages

(2)

Regular Languages

(1)

NCKU CSIE PhD Qualifying Exam
Probability and Statistics
Spring 2021

1. Probability [10%]

A producer of a certain type of electronic component ships to suppliers in lots of twenty. Suppose that 60% of all such lots contain no defective components, 30% contain one defective component, and 10% contain two defective components. A lot is picked, two components from the lot are randomly selected and tested, and neither is defective. Then, what is the probability that two defectives exist in the lot? [10%]

2. Random variables [total 40%]

2.1 X is a random variable following a continuous uniform distribution on the interval [A, B]. Please derive mean and variance of X. [20%, 10% for each]

2.2 Suppose that $U_1, U_2, U_3 \cdots U_n$ are independent random variables, each following a continuous uniform distribution on the interval [0, 1] (i.e., the standard uniform distribution). Then, it is known that $X_n = \sum_{i=1}^{n} U_i$ follows the Irwin-Hall distribution of order n, where n is a positive integer. Please use results in 2.1 to derive mean and variance of X_n. [10%, 5% for each]

2.3 Following 2.2, for a random variable $W_n = \frac{X_n}{n}$, please derive an approximated probability density function of W_n when $n > 30$. [10%]

3. Probability distribution [total 20%]

3.1 The moment-generating function of a Poisson variable X is $M_x(t) = e^{k(e^t-1)}$, where k is a real number. Please use $M_x(t)$ to derive mean and variance of X. [10%]

3.2 On average, 8 traffic accidents per month occur at a certain intersection. What is the probability that, in any given month, exactly 6 accidents will occur at this intersection? (Please use the attached tables to find probability values.) [10%]

4. Estimation [10%]

$\bar{x}$ is the mean of a random sample of size n from a normal population, which is with mean of μ and variance of σ^2. Please prove that $\bar{x}$ is an unbiased estimator of population mean μ. [10%]

5. Hypothesis testing [20%]

5.1 In hypothesis testing, please explain Type-I error, Type-II error, and power of a test. [10%]

5.2 Px Mart (全聯社) is selling pineapples both from Guanmiao (關廟鳳梨) and from Gaoshu (高樹鳳梨). A salesperson at Px mart would like to compare average weight of pineapples from these two origins (產地). It is known that standard deviations of pineapple weight from both origins are both 90 grams. Now, a sample of 72 Guanmiao pineapples is randomly selected and its average weight is 1530 grams. Similarly, a sample of 72 Gaoshu pineapples is randomly selected with average weight of 1500 grams. Please test a null hypothesis that average weight of Pineapples from these two origins are equal (i.e., $\mu_{Guanmiao} = \mu_{Gaoshu}$) against a two-sided alternative hypothesis at 0.05 level of significance. (Please use the attached tables to find probability values.) [10%]

NCKU CSIE Ph.D. Qualify Examination 2021 Spring
Algorithm

1. (20 %) Give asymptotic tight bound (Θ) for $T(n)$ where $T(n) = T(\sqrt{n}) + \lg n$. (Assume that $T(n)$ is a constant for sufficiently small n.)

2. (20 %) What are the minimum and maximum numbers of elements in a heap of height h? (*Hint*: Height of heap = number of edges on a longest simple path from root down to a leaf.)

3. (20 %) Given two sequences $X = \langle x_1, x_2, \ldots, x_m \rangle$ and $Y = \langle y_1, y_2, \ldots, y_n \rangle$, define $c[i,j]$ to be the length of an LCS (longest common subsequence) of the sequences $X_i = \langle x_1, x_2, \ldots, x_i \rangle$ and $Y_j = \langle y_1, y_2, \ldots, y_j \rangle$. Write the recursive formula to compute $c[i,j]$.

4. (20 %) Find the minimum number of scalar multiplications and an optimal parenthesization of a matrix-chain product whose sequence of dimensions is $\langle 5, 10, 3, 12, 5, 50, 6 \rangle$.

5. (20 %) Consider the given directed graph.
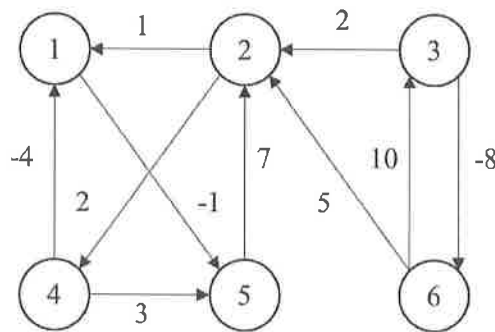
The Floyd-Warshall algorithm can solve the all-pairs shortest-paths problem on a directed graph $G = (V, E)$. Answer the following questions.

(a) (4%) What is the time complexity of Floyd-Warshall algorithm?

(b) (6%) Let $d_{ij}^{(k)}$ be the weight of a shortest path from vertex i to vertex j for which all intermediate vertices are in the set $\{1, 2, \ldots, k\}$ and $D^{(k)} = \left(d_{ij}^{(k)} \right)$ be a $n \times n$ matrix. Floyd-Warshall algorithm computes $D^{(k)}$ from $D^{(k-1)}$ as the following formula.
$d_{ij}^{(k)} = $_____
Please complete the above formula.

(c) (10%) Let $dist(i,j)$ be the length of the shortest path from node i to node j. What is $dist(1,5) + dist(2,5) + dist(3,5) + dist(4,5) + dist(6,5)$?

1

109 年度第 2 學期「模糊邏輯」資格考

1. Explain the following terms (每小題 4 分)
   (1) semantic ambiguity
   (2) fuzzy number
   (3) cylindric closure
   (4) strong homomorphism
   (5) τ -degree connected fuzzy graph
   (6) consonant body of evidence

2. (10 分) Let A, B and C be fuzzy sets defined on the universal set $X = Z$(integers) whose membership functions are given by
   $A(x) = .5/(-1) + .7/1$
   $B(x) = .5/1 + .3/2$
   $C(x) = .9/(-1) + .1/0$
   Let a function $f: X \times X \times X \to X$ be defined for all $x_1, x_2, x_3 \in X$ by
   $f(x_1, x_2, x_3) = x_1 \cdot x_2 + x_3$
   Calculate $f(A, B, C)$.

3. (12 分) Solve the following fuzzy relation equation for the max-min composition:
$$P \circ \begin{bmatrix} .9 & .6 & 1 \\ .8 & .8 & .5 \\ .6 & .4 & .6 \end{bmatrix} = \begin{bmatrix} .6 & .7 & .5 \end{bmatrix}$$

4. (10 分)請利用 standard fuzzy complement 及 Hamming distance，計算下列 fuzzy set 的 fuzziness:
$$\begin{bmatrix} .9 & .6 & 1 \\ .8 & .8 & .5 \\ .6 & .4 & .6 \end{bmatrix}$$

5. (10 分) Consider the *if-then* rules
   If X is A_1, then Y is B_1,
   If X is A_2, then Y is B_2,
   where $A_j \in \mathcal{F}(X)$, $B_i \in \mathcal{F}(Y)$ $(j = 1, 2)$ are fuzzy sets
   $A_1 = .9/x_1 + .1/x_2 + .5/x_3$; $A_2 = .4/x_1 + 1/x_2 + .7/x_3$;
   $B_1 = 1/y_1 + .2/y_2$; $B_2 = .9/y_1 + .3/y_2$

   Given the fact X is A', where $A' = .1/x_1 + .9/x_2 + .5/x_3$, use the method of interpolation to calculate the conclusion B'.

6. (10 分) Let A, B be two fuzzy numbers whose membership functions are given by

$$A(x) = \begin{cases} (x+2)/2 & for -2 < x \le 0 \\ (2-x)/2 & for \ 0 < x < 2 \\ 0 & otherwise \end{cases}$$

$$B(x) = \begin{cases} (x-2)/2 & for \ 2 < x \le 4 \\ (6-x)/2 & for \ 4 < x \le 6 \\ 0 & otherwise \end{cases}$$

Calculate the fuzzy number $A+B$.

7. (12 分) Consider the following fuzzy automaton.

$$R = \begin{bmatrix} & y_1 & y_2 & y_3 \\ z_1 & 1 & .4 & 0 \\ z_2 & 0 & 1 & .1 \\ z_3 & 0 & 0 & 1 \\ z_4 & .5 & 1 & .3 \end{bmatrix}$$

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

Generate sequences of three fuzzy internal and output states under the following condition: the initial fuzzy state is $C^1=[1\ .8\ 0\ .4]$, the input fuzzy states are $A^1=[.3\ .7]$, $A^2=[.5\ .2]$.

8. (12 分)

Let basic probability assignments m_1 and m_2 on X={a, b, c, d}, which are obtained from two independent sources, be defined as follows: $m_1(\{a,b\}) = .2$, $m_1(\{b,c\}) = .2$, $m_1(\{b,c,d\}) = .6$, $m_2(\{a,d\}) = .2$, $m_2(\{b,c\}) = .7$, $m_2(\{a,b,c,d\}) = .1$. Calculate the combined basic probability assignment $m_{1,2}$ and $Bel_{1,2}$ by using the Dempster rule of combination.

OS 資格考題 (109 學年度第二學期)

1. [20%] Please describe the tradeoff between processor affinity and load balancing in a multi-processor system.

2. [20%] In the many-to-1 threading model, please describe
   (a) why the thread creation is typically faster than the 1-to-1 model
   (b) why the process blocks when one of its threads makes a blocking system call

3. [20%] (a) What is TLB reach? (b) Please describe two ways to increase the TLB reach.

4. [20%] Which of the following memory mechanisms can avoid the problem of internal fragmentation? Please explain your answers briefly.
   (a) segmentation
   (b) demand paging
   (c) pre-paging
   (d) TLB

5. [10%] What are the difference(s) between deadlock prevention and deadlock avoidance? Which one you prefer, and why?

6. [10%] Please describe how a traditional UNIX inode keeps track of the data blocks of a file.

NCKU CSIE PhD Qualifying Exam
Anatomy & Physiology for Engineers
Spring 2021

1. Please give the Goldman equation for a cell membrane where sodium, potassium and chloride ions are involved. Please define related variables and explain the meaning of the equation. [15%]

2. Please describe the contraction process of a skeletal muscle fiber, the sliding filament mechanism, after the muscle is depolarized. [15%]

3. Please draw a human visual system to explain visual perception of left and right visual fields in human brain. [15%]

4. Please draw figures to show distribution of the following nerves, their functions, and spinal nerves that contribute to these nerves. (a) Phrenic nerve (b) Median nerve (c) Femoral nerve. [15%]

5. What are the vessels that form the circle of Willis? In addition, please draw figures to explain territories supplied by the vessels. [20%]

6. Please describe pulmonary circulation and body circulation. Please draw a simple anatomical diagram for each type of circulation for better explanation. [20%]

Discrete-Time Signal Processing 資格考

1. **(20%)** Determine if the systems described by the following input-output equations are (1) linear, (2) stable, and (3) causal.
   (a) $y[n] = 4x[n]+5$
   (b) $y[n] = \log(x[n])$
   Justify your answer.

2. **(20%)** A discrete-time causal LTI system has the system function
$$H(z) = \frac{(1+0.2z^{-1})(1-9z^{-2})}{(1+0.81z^{-2})}.$$
   (a) Is the system stable?
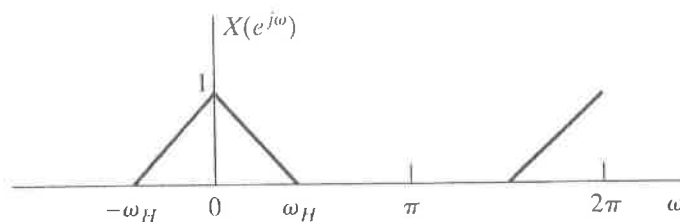   (b) Determine expressions for a minimum-phase system $H_l(z)$ and an all-pass system $H_{ap}(z)$ such that
$$H(z) = H_l(z) \, H_{ap}(z)$$

3. **(20%)** Consider the sequence x[n] whose Fourier transform $X(e^{j\omega})$ is shown in the following figure.
   Define
$$x_s[n] = \begin{cases} x[n], & n = Mk, \ k = 0, \pm 1, \pm 2, \dots \\ 0, & \text{Otherwise} \end{cases}$$
   and $\quad x_d[n] = x_s[Mn] = x[Mn]$

   (a) Sketch $X_d(e^{j\omega})$ for $M=3$ and for $\omega_H = \dfrac{\pi}{2}$.
   (b) What is the minimum value of ω_H that will avoid aliasing when $M=3$?

4. **(20%)** Let $X(e^{j\omega})$ denote the Fourier transform of the sequence $x[n] = (\frac{1}{2})^n u[n]$.
   Let $y[n]$ denote a finite-duration sequence of length 10; i.e., $y[n] = 0$, $n < 0$, and $y[n] = 0$, $n \geq 10$. The 10-point DFT of $y[n]$, denoted by $Y[k]$, corresponds to 10 equally spaced samples of $X(e^{j\omega})$; i.e., $Y[k] = X(e^{j2\pi k/10})$. Determine $y[n]$.

5. (20%) The following figure shows two finite-length sequences $x_1[n]$ and $x_2[n]$. What is the smallest N such that the N-point circular convolution of $x_1[n]$ and $x_2[n]$ are equal to the linear convolution of these sequences, i.e., such that $x_1[n]\,(\!N\!)\,x_2[n] = x_1[n]*x_2[n]$?
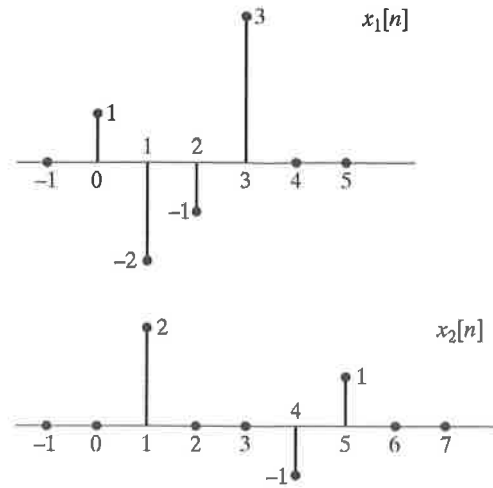
2021 Ph.D. Program Qualify Examination – Information Retrieval

1. (25%) Please explain what is the *Zipf Distribution* for indexing scheme. What is the linear and log scale?

2.

3. (25%) Please explain the model of "word to vector" for an information retrieval system.

4. (25%) Please describe the detailed procedure of how to obtain the 11-point *precision* and *recall rates* curve. Given you have a test data set consists of *n* documents for the purpose of information retrieval, and illustrate how to draw the curve from the retrieving results. Also, explain the *sensitivity* and *specificity* in terms of positive/negative results.

5. (25%) How to use rules to determine how many sentences in documents (number of sentences)? Following is a sample of examples.

NOT-END-OF-SENTENCE	119	l viewpoint , as David	C. Robinson has recently shown , t
NOT-END-OF-SENTENCE	128	evealed , '' by Arthur	C. Clarke , Gentry Lee (Bantam)
NOT-END-OF-SENTENCE	136	E . The group led by	C. Delores Tucker , head of the NA
NOT-END-OF-SENTENCE	147	ence and Electronics ;	C. Scott Kulicke , on behalf of Se
NOT-END-OF-SENTENCE	184	g Committee chaired by	C. Rubbia . The report covers stat
END-OF-SENTENCE	192	occurs at 440 degrees	C. A hydrogenation test was carrie
END-OF-SENTENCE	210	ystem at 25 and 50 deg	C. Isotherms consist of five branc
END-OF-SENTENCE	239	C while not at 40 deg	C. Minima on the S/sub Pu / vs. C/
NOT-END-OF-SENTENCE	247	ellulases . Culture of	C. thermocellum will be optimized
NOT-END-OF-SENTENCE	255	the cellulase genes of	C. cellulolyticum and those from t
END-OF-SENTENCE	258	anging from 200 to 300	C. A system developed by the autho
END-OF-SENTENCE	262	ourse on programming in	C. Finally, those who are interest
END-OF-SENTENCE	300	a house on 2213 Perry	Dr. Then the Thomases were seen in
NOT-END-OF-SENTENCE	330	. <P> Early in 1980	Dr. Thomas B. Reed of SERI and Pro

2021 無線通訊網路　資格考

1. Please explain the below terms in details.　[20%] (Each 4 points)
   A. TDMA / FDMA / CDMA
   B. Frequency Hopping
   C. Multi-path Effect
   D. Hidden Terminal Problem
   E. Cell Sectoring

2. Consider a cruise boat with two passengers. Each passenger will make 2 calls per hour with each call of 3-minute duration. There is only one telephone set on the boat. Please calculate the probability of the phone being occupied by one person while the other person wishes to make a call. (Namely, please calculate the blocking probability.) (In your answer, please provide the drawing of Markov Chain as well.) [20%]

3. Please describe the following protocol in Pseudo code. [30%] (Each 10 points)
   A. Slotted Aloha
   B. *1*-persistent CSMA
   C. Exponential Back-off Mechanism in IEEE 802.11

4. Please describe the system architecture of GSM. In your answer, please provide detailed functional description of each hardware component in the system architecture.　[15%]

5. Define the <u>first-meter path loss</u> as the received signal strength (in dB) when the receiver stands one meter away from the transmitter. Now, consider the case when the first-meter path loss is 10 dB . Please calculate the free-space path loss for a receiver if the distance between the transmitter and receiver is: [15%] (each 5 points)
   A. 10 meters,
   B. 100 meters,
   C. 1 KM.

計算機組織資格考題（Spring 2021）

1. (20%) Amdahl's law
    a. Describe the definition of Amdahl's law.
    b. Suppose we enhance a machine making all floating-point instructions run eight times faster. If the execution time of some benchmark before the floating-point enhancement is 60 seconds, what will the speedup be if 48 seconds are spent executing floating-point instructions?

2. (30%) Refer the following instruction sequence:

Instruction sequence	
lw	$1,40($2)
add	$2,$3,$3
add	$1,$1,$2
sw	$1,20($2)

    a. Find all data dependences in this instruction sequence.
    b. Find all hazards in this instruction sequence for a 5-stage pipeline with and without forwarding.
    c. To reduce clock cycle time, we are considering a split of the MEM stage into two stages. Repeat (b) for this 6-stage pipeline.

3. (20%) Explain the following synchronization primitives: atomic exchange, test-and-set, and fetch-and-increment. Also, explain the following pair of instructions, load linked (LL) and store conditional (SC) and how this pair of instructions can be used to implement atomic exchange and fetch-and-increment.

4. (30%) Caches are important to providing a high-performance memory hierarchy to processors. Below is a list of 32-bit memory address references, given as word addresses.
    35, 149, 43, 90, 191, 91, 148, 14, 42, 190, 69, 15

    a. For each of these references, identify the tag and the index given a direct-mapped L1 cache with two-word blocks and a total size of 16 words. Also list if each reference is a hit or a miss, assuming the cache is initially empty.
    b. For each of these references, identify the tag and the index given a four-way set-associative L1 cache with two-word blocks and a total size of 16 words. Also list if each reference is a hit or a miss, assuming the cache is initially empty and LRU replacement is used.
    c. Given the above memory address reference, what is the average memory access time (AMAT) if the hit time of the directed-mapped L1 is one cycle and main memory access takes 200 cycles. What is the AMAT if the hit time of the four-way set-associative cache is 2 cycles and main memory access also takes 200 cycles?

1. (20 points) Please briefly describe the following terminologies. (1) specificity (2) Apriori property (in Apriori Algorithm), (3) False Negative (4) closed itemset (5) k-medoids.

2. (16 points) (a) What is the relationship between the value of F_1-measure and the break-even point (R-Precision)? (b) Show that the F_1-measure is equal to the Dice coefficient of the retrieved and relevant document sets in the evaluation of search engines.

3. (14 points) What is "overfitting" and "underfitting" problem in classification modeling? and what are the relations between these two problems and bias and variance? Please also explain how to reduce their effects when you are training models in DNN and decision tree, respectively.

4. (25 points) Please apply FP-growth algorithm to find large itemsets in the following transaction data, if mini_support=3.

TID	Items bought
100	{a, c, d, f, g, i, m, p}
200	{a, b, c, f, i, m, n, o, p}
300	{b, f, h, i, j, o}
400	{b, c, k, s, m, p}
500	{a, c, e, f, l, n, o}

5. (25 points) A simple labeled data with 4 attributes shown in the right table. (a) Please use **naïve Bayes** method to calculate the class probability of a test instance with "Give Birth"=Yes, "Can Fly"=no, "Live in Water"=no, and "Have Legs"=yes. (b) Please discuss why naïve Bayes has bias on instances with attribute "Give Birth"=no, "Can Fly"=no, "Live in Water"=sometimes, "Have Legs"=no and "Give Birth"=no, "Can Fly"=no, "Live in Water"=yes, and "Have Legs"=yes.

Name	Give Birth	Can Fly	Live in Water	Have Legs	Class
human	yes	no	no	yes	mammals
python	no	no	no	no	non-mammals
salmon	no	no	yes	no	non-mammals
whale	yes	no	yes	no	mammals
frog	no	no	sometimes	yes	non-mammals
komodo	no	no	no	yes	non-mammals
bat	yes	yes	no	yes	mammals
pigeon	no	yes	no	yes	non-mammals
cat	yes	no	no	yes	mammals
leopard shark	yes	no	yes	no	non-mammals
turtle	no	no	sometimes	yes	non-mammals
penguin	no	no	sometimes	yes	non-mammals
porcupine	yes	no	no	yes	mammals
eel	no	no	yes	no	non-mammals
salamander	no	no	sometimes	yes	non-mammals
gila monster	no	no	no	yes	non-mammals
platypus	no	no	no	yes	mammals
owl	no	yes	no	yes	non-mammals
dolphin	yes	no	yes	no	mammals
eagle	no	yes	no	yes	non-mammals

Biomedical Signal Processing

1. (25%) An optimal wiener filter as shown in Fig. 1 is to minimize the difference between the filtered output and the desired response. Derive the Wiener-Hopf equation. Assume the error function is the sum of squared error between the filter output and the desired output.
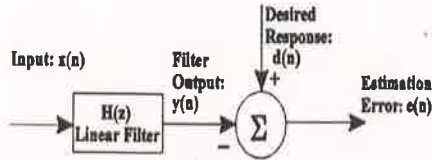

$$y(n) = \sum_{k=0}^{L-1} b(k)x(n-k)$$

$$\varepsilon = \sum_{n=0}^{N-1} e^2(n) = \sum_{n=0}^{N-1}\left[d(n) - \sum_{k=0}^{L-1} b(k)x(n-k)\right]^2$$

Fig. 1

2. (25%) Analog-to-digital converter (ADC) converts an analog voltage to an equivalent digital number. (a) What is the resolution of a 3-volt and 12-bit ADC system? (b) Explain the aliasing effect and propose two strategies to deal with aliasing. Give examples.

3. (20%) A group, or ensemble, of time responses averaged together on a point to point basis means ensemble averaging or synchronized averaging. (a) Given two essential requirements to apply ensemble averaging. (b) For the signal with additive random noise of zero mean that is uncorrelated with the signal. Explain and derive the change of SNR corresponding to M epochs or trials of synchronized signals are averaged.

4. (30%) The function of a filter is to retain the components in certain frequency ranges and reject components in other ranges. There are various types of filters such as low-pass, high-pass, band-pass filters, etc. (a) For the noisy ECG signals in Figs. 4-1 and 4-2, which type of filter should be applied to each noisy signal? Explain the frequency characteristics of the signal and noise for each case. (b) For a physiological signal with sampling rate of 1000 Hz, design a digital notch filter by placing the zeros at 60 and -60 Hz in the z-plane to remove 60Hz power-line noise.
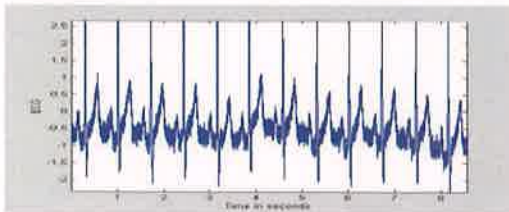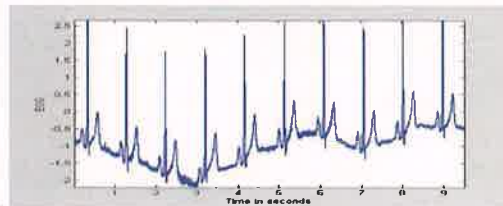

Fig. 4-1

Fig. 4-2