Introduction to Computer Science-103

Quiz_3

1. In an Internet, we change the LAN technology to a new one. Which layer in the TCP/IP protocol suite need to be changed? (6%)

   The only two layers that need to be changed are the data-link layer and the physical layer. The new hardware and software need to be installed in all host, routers, and link-layer switches. As long as the new data-link layer can encapsulate and dencapsulate datagrams from the network layer, there is no need to change any protocol in the upper three layers. This is one of the characteristics of the protocol layering.

2. An operating system uses virtual memory but requires the whole program to be in physical memory during execution (no paging or segmentation). The size of physical memory is 100 MB. The size of virtual memory is 1 GB. How many programs of size 10MB can be run concurrently by this operating system? How many of them can be in memory at any time? How many of them must be on disk? (10%)

   Total memory = 1000 + 100 = 1100 MB.
   Number of program = 1100 / 10 = 110.

3. Using the insertion sort algorithm, manually sort the following list and show your work in each pass using a table: (10%)

   7 23 31 40 56 78 9 2

Pass	List							
	7	23	31	40	56	78	9	2
1	7	23	31	40	56	78	9	2
2	7	23	31	40	56	78	9	2
3	7	23	31	40	56	78	9	2
4	7	23	31	40	56	78	9	2
5	7	23	31	40	56	78	9	2
6	7	9	23	31	40	56	78	2
7	2	7	9	23	31	40	56	78

4. (1) Write an algorithm in pseudocode for the binary search algorithm.

(2) A list contains the following elements. Using the above algorithm, trace the steps followed to find 88. At each step, show the value of first, last, and mid. (10%)

8	13	17	26	44	56	88	97

```
Algorithm: BinarySearch (list, target, n)
Purpose: Apply a binary search a list of n sorted numbers
Pre: list, target, n
Post: None
Return: flag, i        // flag shows the status of the search
{
    flag ← false
    first ← 1
    last ← n
    while (first ≤ last)
    {
        mid = (first + last) / 2
        if (target < A mid)
            Last ← mid − 1      // A i is the ith number in the list
        if (target > A mid)
            first ← mid + 1
        if (target = A mid)        // target is found
            first ← Last + 1
    }
    if (target > A mid)
        i = mid + 1
    if (x ≤ A mid)
        i = mid
    if (x = A mid)
        flag ← true
    return (flag, i)
}
```

first	*last*	*mid*
1	*8*	*4*
5	*8*	*6*
7	*8*	*7*

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	
8	13	17	26	44	56	88	97	target > 44
				44	56	88	97	target > 56
						88	97	target = 88

5. A multiprogramming operating system uses paging. The available memory is 60 MB divided into 15 frames, each of 4 MB. The first program needs 13 MB. The second program needs 12 MB. The third program needs 27 MB. (10%)

   a. How many frames are used by the first program?

   b. How many frames are used by the third program?

   c. How many frames are unused?

   d. What is the total memory wasted (not considering memory lost inside each frame)?

   e. What percentage of memory wasted (not considering memory lost inside each frame)?

a. 13 / 4 = 3.25 → 4 pages.
b. 27 / 4 = 6.75 → 7 pages.
c. 15 - (4 + 12/4 + 7) = 1 frame.
d. Not considering memory lost inside each frame, one frame (4 MB) is unused.
e. (4 / 60) × 100 = 6.66%.

6. (1) How does starvation differ from deadlock? What is their similarity? (6%)

Deadlock happens when processes are all waiting for resources held by other processes: they are all waiting for each other. This happens when the operating system does not put resource restrictions on processes. Starvation happens when the operating system puts too many resource restrictions on a process. If a process must wait until it can get all of the resources that it needs before it starts to execute, it may never start.

Deadlock	Starvation
一組 processes 形成 circular waiting，導致 processes 無法往下執行。	某(些)processes 形成 infinite Blocking ∵長期無法取得完成工作所需資源。
不允許資源 preemptive	易發生在不公平、preemptive 的環境
CPU utilization 及 Throughput 會大幅下降	與此無關聯

similarity：皆為資源分配及協調出了問題

7. Write an algorithm in pseudocode for the selection sort using a subalgorithm to find the smallest integer in the unsorted sublist. (12%)

a. Algorithm P8-31a is the selection sort algorithm. To do its task, it needs another algorithm defined in part b.

Algorithm P8-31a *Selection sort algorithm calling smallest subroutine*

```
Algorithm: SelectionSort (list, n)
Purpose: to sort a list using selection sort method
Pre: A list of numbers
Post: None
Return:
{
    wall ← 1                                  // Set wall at the left of first element
    while (wall < n)
    {
        smallest ← FindSmallest (list, wall, n)   // Call FindSmallest
        Temp ← A_wall      // The next three lines perform swapping
        A_wall ← A_smallest
        A_smallest ← Temp
        wall ← wall + 1          // Move wall one element to the right
    }
    return SortedList
}
```

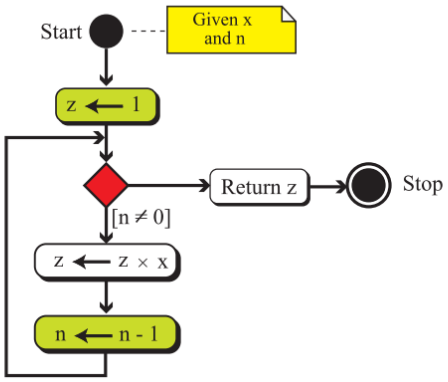
b. Algorithm P8-31b is find-smallest routing that is called by the selection sort algorithm.

Algorithm P8-31b *Smallest subroutine*

```
Algorithm: FindSmallest (list, wall, n)
Purpose: To find the smallest number in an unsorted list
Pre: A list of numbers
Post: None
Return: The location of the smallest element in the unsorted list
{
    smallest ← wall          // Assume the first element is the smallest one
    cur ← wall               // The current item is the one left to the wall
    while (cur < n)
    {
        if (A_cur < A_smallest)
            smallest ← cur
        cur ← cur + 1                     // Move the current element
    }
    return smallest
}
```

8. Using the UML diagram for the product algorithm, draw a diagram to calculation the value of x^n, when x and n are two given integers. (6%)

Figure P8-38 *Power*



9. Write a recursive algorithm in pseudocode to find the combination of n objects taken k at a time using the definition in the following equation. (10%)

$$C(n, k) = \begin{cases} 1 & \text{if } k = 0 \text{ or } n = k \\ C(n-1, k) + C(n-1, k-1) & \text{if } n > k > 0 \end{cases}$$

Algorithm P8-19 *Combination*

```
Algorithm: Combination (n, k)
Purpose: Finds the combination of n objects k at a time
Pre: n and k
Post: None
Return: C (n, k)
{
    If (k = 0 or n = k)
        return 1
    else
        return C (n – 1, k) + C (n – 1, k – 1)
}
```

10. Why the virtual memory can seem bigger for the physical memory? Please illustrate the concept. (10%)

This technique virtualizes a computer architecture's various forms of computer data storage (such as random-access memory and disk storage), allowing a program to be designed as though there is only one kind of memory, "virtual" memory, which behaves like directly and contiguous addressable read/write memory

11. What is the status (show as following figure) of a process in each of the following situations? (10%)

    a. The process is using the CPU.

    b. The process has been stopped because its time slot is over.

    c. The process is reading data from the keyboard.

    d. The process is printing data.

    a. running

    b. ready

    c. waiting

    d. waiting