THE UNIVERSITY OF THE SOUTH PACIFIC

CS214: Design & Analysis of Algorithms
SCIMS, FSTE

Final Examination
Semester II, 2018

F2F/Blended Mode

Duration of Exam: 3 hours + 10 minutes

Reading Time: 10 minutes

Writing Time: 3 hours

Total Marks: 40

Instructions:

1. Write your answers in the space provided in this Question Paper.
2. Answer all questions. There are 12 questions and all questions are compulsory.
3. This exam is worth 40% of your overall mark. The minimum mark to pass the final exam is 16/40.
4. Total number of pages including this cover sheet is 16.
5. This is a closed book exam. No printed materials and electronic devices are allowed.

ID:_____ **Name:**_____

SeatNo: _____

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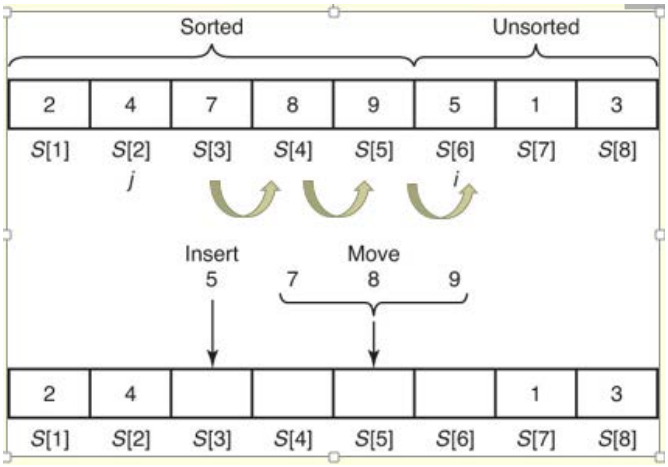
1. Suppose Fiji Tattslotto uses a computerized system to pick up a winner with an unbiased random number generator. It also automatically sends sms & email notification to the winners (if any). It has following categories of the winners:

Division	Category	Amount
1st Division	6 winning Numbers	$1,000,000 / total winners of 1st Division
2nd Division	5 winning Numbers	$100,000 / total winners of 2nd Division
3rd Division	4 winning Numbers	$10,000 / total winners of 3rd Division

Players are supposed to pick 6 out of 36 numbers per game. No registration is required, however, every player must provide valid email and mobile number. What is the best data structure for this scenario without using a database? Justify your answer. (1+3 marks)

2. What is the Big O order of the average time complexity for the insertion sort? The algorithm and an example illustrating what insertion sort does when $i = 6$ are shown below: (2 marks)

```
/*Function to sort array using insertion sort*/
void sort(int arr[])
{
    int n = arr.length;
    for (int i=1; i<n; ++i)
    {
        int key = arr[i];
        int j = i-1;

        /* Move elements of arr[0..i-1], that are
           greater than key, to one position ahead
           of their current position */
        while (j>=0 && arr[j] > key)
        {
            arr[j+1] = arr[j];
            j = j-1;
        }
        arr[j+1] = key;
    }
} //Ref: https://www.geeksforgeeks.org/insertion-sort
```



3. What is the best case time complexity of binomial coefficient algorithm given below? (3 marks)

▶ Algorithm 3.2 **Binomial Coefficient Using Dynamic Programming**

Problem: Compute the binomial coefficient.

Inputs: nonnegative integers n and k, where $k \leq n$.

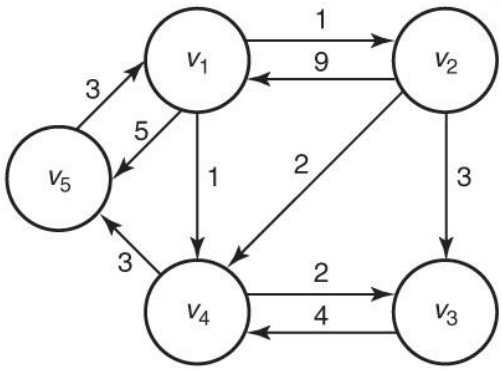
Outputs: *bin2*, the binomial coefficient $\binom{n}{k}$.

```
int bin2 (int n, int k)
{
  index i, j;
  int B[0..n][0..k];

  for (i = 0; i <= n; i++)
     for (j = 0; j <= minimum(i,k); j++)
        if (j == 0 || j == i)
           B[i][j] = 1;
        else
           B[i][j] = B[i-1][j-1] + B[i-1][j];
  return B[n][k];
}
```

4. The floyd's algorithm given below in Figures 1 (a) has generated the path table in Figure 1 (c) from the given graph in Figure 1 (b) to determine the shortest path. What is the shortest path from node 4 to node 2? Show your working. (3 marks)

```
void floyd2 (int n,
             const number W[][],
                   number D[][],
                   index  P[][])
{
  index, i, j, k;

  for (i = 1; i <= n; i++)
     for (j = 1; j <= n; j++)
        P[i][j] = 0;
  D = W;
  for (k = 1; k <= n; k++)
     for (i = 1; i <= n; i++)
        for (j = 1; j <= n; j++)
           if (D[i][k] + D[k][j] < D[i][j]){
              P[i][j] = k;
              D[i][j] = D[i][k] + D[k][j];
           }
}
```

(a)



(b)

	1	2	3	4	5
1	0	0	4	0	4
2	5	0	0	0	4
3	5	5	0	0	4
4	5	5	0	0	0
5	0	1	4	1	0

(c)

Figure 1: (a) Floyd algorithm (b) a sample graph (c) path table

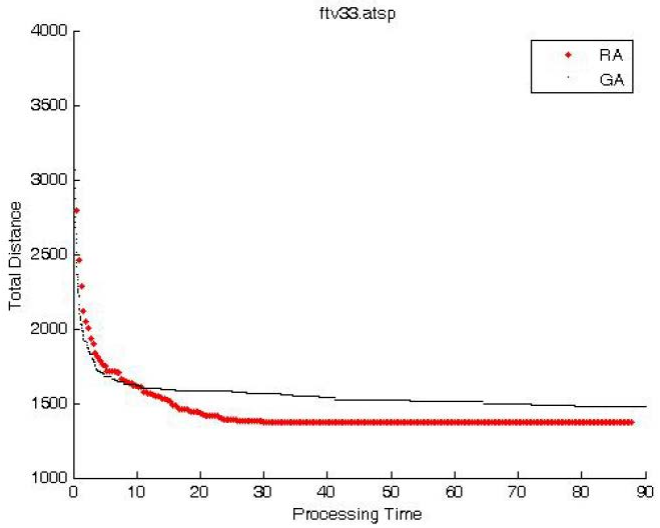
5. The binomial coefficient can be written in the following recursive form:

$$\binom{n}{k} = \begin{cases} \binom{n-1}{k-1} + \binom{n-1}{k}, & 0 < k < n \\ 1, & k = 0 \text{ or } k = n \end{cases}$$

where k and n are integer values.
Would chose dynamic programming or divide & conquer approach to solve this problem? Please explain your reasoning. (2 marks)

6. A student in CS214 wants to compare the efficiency of two algorithms empirically. How can he find or approximate the every-case $T(n)$, best-case $B(n)$, average-case $A(n)$ and the worst-case $W(n)$ time complexity? (4 marks)

7. The following graph shows the efficiency comparison graph of GA algorithms versus RA algorithm tested on a travelling salesman problem ftv33.atsp. Which one is more efficient and why? (2 marks)



8. Consider the 0-1 knapsack problem with four different item having different weight and profit value;
   item 1 (4kg, $10)
   item 2 (3kg, $7)
   item 3 (7kg, $16)
   item 4 (6kg, $11)

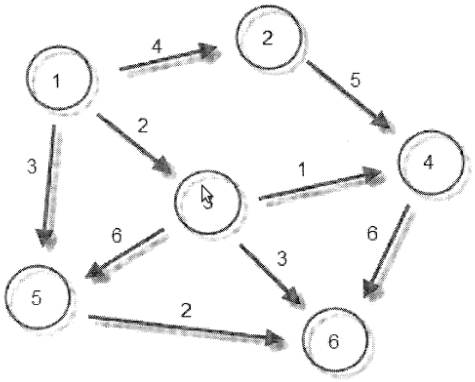
The knapsack has a capacity of 13 kg.

(a) Use the greedy approach to compute the optimal profit in filling the knapsack (2 marks)

(b) Use backtracking to solve the knapsack problem. Show the State Space tree. (4 marks)

(c) Which is the better of the two approaches above. Explain your answer? (1 marks)

9. Use Kruskal's Algorithm to find the Minimum Spanning Tree of the following Graph (2 marks)



10.

(a) Design a greedy algorithm for a change giving vending machine. Assume coin information data is stored in an array. You can use pseudo code provided adequate details are given. (3 marks)

(b) Given the following data and a change of $1.10, what is the solution your algorithm provide on this data? What is wrong with this approach? (1 marks)

Coins {$0.90, $0.60, $0.50, $0.10}
NumCoins {1, 1, 2, 5}

(c) Design the improved algorithm and give the pseudo code that tries to fix the problem you identified in step (b). Apply the algorithm on the data given above (3 marks)

11. Use Huffman's Algorithm to encode the phrase; "i love design and analysis". Show all necessary working. (2 marks)

12. What is supervised learning and when should we use it? (2 marks)

Extra sheet:

THE END