

2017 Spring COP 3502 Exam #1 - Dynamic Memory Allocation (20 pts)

Date: 2/16/2017

Name: _____

There is a wine enthusiast club with many members. You've been tasked to store a database of information for each of these club members. On the next page you will answer two questions about this scenario.

Here is the struct that stores information about a single wine:

```
typedef struct wine {
    char type[20];
    char brand[20];
    int rating;
} wine;
```

Here is the struct that stores information for a single member:

```
typedef struct member {
    char name[20];
    int numRated;
    wine* list;
} member;
```

Here, list is a dynamically allocated array of size numRated, indicating each wine the user has rated. (The member's rating of a wine is stored in the wine struct within that member struct.)

In doing so, you will be reading in input (from standard input) with the following format:

First line stores an integer, n , the number of members in the club. The member info follows. The first line for each member stores their name (string of 1-19 letters) and, w , number of wines they've rated, separated by a space. The following w lines store information about the wines this member has rated. Each of these lines has the type (string of 1-19 letters), followed by the brand (string of 1-19 letters), followed by the rating (1-10), all separated by spaces.

For convenience, here are both structs:

```
typedef struct wine {
    char type[20];
    char brand[20];
    int rating;
} wine;

typedef struct member {
    char name[20];
    int numRated;
    wine* list;
} member;
```

and the file format information: First line stores an integer, n , the number of members in the club. The member info follows. The first line for each member stores their name (string of 1-19 letters) and, w , number of wines they've rated, separated by a space. The following w lines store information about the wines this member has rated. Each of these lines has the type (string of 1-19 letters), followed by the brand (string of 1-19 letters), followed by the rating (1-10), all separated by spaces.

1) (14 pts) Write a segment of code that allocates an array of member and reads in the input described in the format above, from standard input.

2) (6 pts) Free all of the memory allocated in question 1.

2017 Spring COP 3502 Exam #1 - Mathematical Tools (30 pts)

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3) (15 pts) Solve the following recurrence relation, **exactly**, in terms of n , using the iteration technique:

$$T(n) = 2T(n - 1) + 2^n, T(1) = 2$$

4) (7 pts) An $O(n \lg n)$ algorithm runs in 20 ms on an input of size $n = 2^{20}$. How long will it take to run on an input of size $n = 2^{25}$? (Note: The multiplication is made easier by realizing that $25 \times 4 = 100$.)

5) (8 pts) Determine the following sum in terms of n : $\sum_{i=n+1}^{n^2} i$. (Note: You can get a bonus point for fully factorizing your answer!)

2017 Spring COP 3502 Exam #1 - Recursion (30 pts)

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6) (10 pts) A geometric sequence is a sequence where each pair of consecutive terms has a common ratio. For example, 3, 6, 12, 24 is a geometric sequence of 4 terms with a common ratio of 2. Write a **recursive** function that takes in three integers: `firstTerm`, the first term of a geometric sequence, `ratio`, the common ratio of the sequence, and `numTerms`, the number of terms of the sequence and returns the sum of the geometric sequence. You may assume that the input values are such that no overflow errors occur on any necessary calculation.

```
int geoSum(int firstTerm, int ratio, int numTerms) {
```

```
}
```

7) (6 pts) The recursive function `f` is defined below. What do the expressions `f(3)`, `f(4)` and `f(5)` evaluate to?

```
int f(int n) {  
    if (n == 0) return 3;  
    int sum = 0, i;  
    for (i=0; i<n; i++)  
        sum += f(i);  
    return sum;  
}
```

`f(3)` = _____

`f(4)` = _____

`f(5)` = _____

8) (14 pts) Complete the code below so that it prints out all permutations of the string entered by the user. You may assume that the string entered by the user is comprised of 1-10 distinct lowercase letters.

```
#include <stdio.h>
#include <string.h>

void printPerms(int perm[], int used[], int k, int n, char*
letters);

int main() {
    char word[11];
    printf("Enter a word (1-10 distinct letters).\n");
    scanf("%s", word);
    int perm[10], used[10];
    int i;
    for (i=0; i<strlen(word); i++)
        used[i] = 0;
    printPerms(perm, used, 0, strlen(word), word);
    return 0;
}

void printPerms(int perm[], int used[], int k, int n, char* letters)
{

    int i;

    if (k == n) {
        for (i = ___ ; i < ___; i++)

            printf("%c", _____ );
        printf("\n");
    }

    else {
        for (i=0; i<n; i++) {
            if ( _____ ) {

                used[i] = ___;

                perm[k] = ___;

                printPerms(perm, used, _____ , _____ , _____ );

                used[i] = ___;

            }
        }
    }
}
```

2017 Spring COP 3502 Exam #1 - Sorting (20 pts)

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9) (4 pts) Show the result of running the partition function on the array below, using the item in index 0 as the partition element.

Index	0	1	2	3	4	5	6	7	8
Original	45	87	22	13	78	19	74	41	39
After 1 st Iteration									

10) (6 pts) Show the contents of the following array after each iteration of Insertion Sort.

Index	0	1	2	3	4	5	6	7
Original	99	13	76	22	78	19	3	41
After 1 st Iteration								
After 2 nd Iteration								
After 3 rd Iteration								
After 4 th Iteration								
After 5 th Iteration								
After 6 th Iteration								
After 7 th Iteration	3	13	19	22	41	76	78	99

11) (9 pts) What are the best case, worst case and average case run times of each of the following sorting algorithms, for sorting n integer?

Algorithm	Best Case	Worst Case	Average Case
Insertion Sort			
Selection Sort			
Quick Sort			

12) (1 pt) What color is the cleaning product Simple Green? _____