

COP 3502 Section 2 Exam #1 - Part A (Dynamic Memory Allocation)

Date: 6/8/2020

Start Time: 4:00 pm EST

End Time: 4:25 pm EST

Directions: Please type up answers in either a Word Document (.doc, docx) or a Text Document (.txt) and upload your document **AND SUBMIT IT** to the appropriate assignment in Webcourses COP 3502 Section 2. It is strongly suggested you directly type into a document in your computer and don't recopy the questions due to the time constraints. On the document you submit, put your first and last name in the top left hand corner. On the following line, write "My Exam 1-DMA Answers", centered. Following that, place your answers, numbered, in order (1, 2).

1) (15 pts) Pascal's Triangle stores the values called binomial coefficients. The triangle has rows, and each subsequent row has 1 more item than the previous row, and each subsequent row can be calculated from the previous row. Specifically, we calculate the next row of the triangle given the previous row as follows:

- a) Put 1 in the first and last entry of the new row.
- b) For every other entry in the new row, the entry in column i is the sum of the entries in column $i-1$ and column i of the previous row.

Consider the following example:

Row 5 of the triangle has the following six entries:

1	5	10	10	5	1
---	---	----	----	---	---

To create row 6, we will have 7 entries (1 more than the number of entries in row 5), putting 1 on both ends:

1						1
---	--	--	--	--	--	---

Now, to calculate the rest of the entries, add $1+5$, $5+10$, $10+10$, $10+5$, and $5+1$, respectively, yielding:

1	6	15	20	15	6	1
---	---	----	----	----	---	---

For this question, write a function that takes in an integer array storing a row of Pascal's Triangle (curRow), and the length of that array (length) and does the following:

1. Dynamically allocates a new array of size $length + 1$.

2. Fills this new array with the appropriate values of the next row of Pascal's Triangle, given that curRow contains the current row of Pascal's Triangle.

3. Frees the array pointed to by curRow.

4. Returns the newly created row of Pascal's Triangle.

The function prototype is provided below:

```
int* getNextRow(int* curRow, int length) {  
    // Fill in answer here.  
}
```

Note: You may assume that the input array is at least length 1.

2) (10 pts) For the purposes of this question, assume that an integer is stored using 4 bytes, a character is stored using 1 byte and a `char*` is stored using 4 bytes. The code below dynamically allocates some memory. If the input entered by the user is:

```
6  
apple  
banana  
cantaloupe  
dragonfruit  
egg  
fruit
```

how many bytes of memory are **dynamically** allocated by this code segment?

```
int n;  
scanf("%d", &n);  
int* sizes = malloc(n*sizeof(int));  
char** words = malloc(n*sizeof(char*));  
  
for (int i=0; i<n; i++) {  
    char temp[100];  
    scanf("%s", temp);  
    sizes[i] = strlen(temp)+1;  
    words[i] = malloc(sizes[i]*sizeof(char));  
    strcpy(words[i], temp);  
}
```

Note: Your response will be graded as if you don't have access to a calculator. Thus, please show the work you would normally show if you didn't have a calculator. Nearly all of the points for this question are based on the work and logic and not the final answer.

COP 3502 Section 2 Exam #1 - Part B (Linked Lists)

Date: 6/8/2020

Start Time: 4:25 pm EST
End Time: 4:55 pm EST

Directions: Please type up answers in either a Word Document (.doc, docx) or a Text Document (.txt) and upload your document AND SUBMIT IT to the appropriate assignment in Webcourses COP 3502 Section 2. It is strongly suggested you directly type into a document in your computer and don't recopy the questions due to the time constraints. On the document you submit, put your first and last name in the top left hand corner. On the following line, write "My Exam 1-LL Answers", centered. Following that, place your answers, numbered, in order (1).

1) (25 pts) In the first part of this exam, you wrote a function that took in a row of Pascal's Triangle stored in an integer array, used it to dynamically allocate a new array and calculate the following row of Pascal's Triangle, freed the memory for the current row and returned a pointer to the newly created array storing the next row. For this question, you'll do the exact same task, but a row of Pascal's Triangle will be stored in a linked list. Thus, your function will take in a pointer to the front of the linked list storing the current row, will create a linked list storing the next row, free the memory associated with the linked list for the current row, and return a pointer to the front of the list storing the next row. To accomplish this task, you'll use the following struct (note the different names of the components):

```
typedef struct node {  
    int coeff;  
    struct node* next;  
} node;
```

and write a function with the following prototype:

```
node* getNextRow(node* curRowPtr);
```

Since solving this problem requires the help of two utility functions we wrote in class, you may call both of these functions in your solution. These functions (with their internal code) are given below:

```
node* makeNewNode(int value) {  
    node* res = malloc(sizeof(node));  
    res->coeff = value;  
    res->next = NULL;  
    return res;  
}
```

```
void freeList(node* listPtr) {  
    if (listPtr != NULL) {  
        freeList(listPtr->next);  
        free(listPtr);  
    }  
}
```

This question is reasonably challenging, so I'll provide some hints for coding it:

1. Create separate new nodes storing 1 for the front and the back of the new list.
2. Save a pointer to the front of the original list.
3. Create a current pointer, which will "stitch" the list together, starting at the front 1.
4. Loop through the input list, accessing consecutive values in the list, and create a new node storing their sum, and incorporating each new node into the list, updating the current pointer of the new list as well as the pointer into the current list.
5. After the loop stitch together the last node you created to the back of the list.
6. Free the old list.
7. Return a pointer to the front of the newly created list.

COP 3502 Section 2 Exam #1 - Part C (Queues)

Date: 6/8/2020

Start Time: 4:55 pm EST
End Time: 5:25 pm EST

Directions: Please type up answers in either a Word Document (.doc, docx) or a Text Document (.txt) and upload your document AND SUBMIT IT to the appropriate assignment in Webcourses COP 3502 Section 2. It is strongly suggested you directly type into a document in your computer and don't recopy the questions due to the time constraints. On the document you submit, put your first and last name in the top left hand corner. On the following line, write "My Exam 1-Queue Answers", centered. Following that, place your answers, numbered, in order (1, 2, 3).

1) (4 pts) In a linked list implementation of a queue, the queue struct contains two pointers instead of one.

(a) Are both pointers ***necessary*** to implement the queue?

(b) What is the purpose of having both pointers?

2) (12 pts) In class, a queue was used in a live coding exercise to find the shortest path out of a maze, where a single move was moving up (subtracting 1 from the row), moving left (subtracting 1 from the column), moving right (adding 1 to the column) or moving down (adding 1 to the row). The queue stored integers, which represented row-column coordinates into the maze, which was represented as a two dimensional character array. The characters in the array were as follows:

'S' : starting location
'X' : illegal location
'-' : valid location to travel to
'~' : maze border

Given the following input maze (6 rows, 8 columns), determine the first 12 integers enqueued into the queue, and ALSO state which 0-based row, column coordinates those integers represent. Note that there are different correct answers to this question, but all correct answers have the same set of integers/ordered pairs, just in slightly different orders. In order to receive full credit, you must provide your list in one of the valid orderings.

6 8
~ ~ ~ ~ ~ ~ ~ ~ ~ ~
~ - - - - - - - ~
~ - - - X X - - ~
~ - - - S - X ~
~ - - X X - - - ~
~ ~ ~ ~ ~ ~ ~ ~ ~ ~

Please present your answer in the following format:

1. Value 18, Location (4, 2), row 4, column 2
2. Value 19, Location (4, 3)
3. ...
- ...
12. Value 9, Location (2, 1)

Note that in my description above, both the values and locations listed are dummy values and not the correct answers for this particular problem. They have just been put in to make the format I want clear.

3) (9 pts) Consider an array implementation of a queue where the size of the array is 5 and the following operations have occurred (assume that queue is the variable storing the queue and that the queue has just been initialized to be empty right before this code segment executes):

```
enqueue (&queue, 5);  
enqueue (&queue, 3);  
enqueue (&queue, 2);  
int a = dequeue (&queue);  
int b = dequeue (&queue);  
enqueue (&queue, 7);  
int c = dequeue (&queue);  
enqueue (&queue, 4);  
enqueue (&queue, 9);  
enqueue (&queue, 1);
```

Answer the following questions:

- (a) In which array index (of the array in the array in the queue struct) is the value 9 stored?
- (b) In the array implementation of a queue, the variable front keeps track of the index into the array of the front of the queue. What is the value of front after this code segment is completed?
- (c) How many elements are in the queue right after this code segment completes?

COP 3502 Section 2 Exam #1 - Part D (Stacks)

Date: 6/8/2020

Start Time: 5:25 pm EST
End Time: 5:55 pm EST

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1) (10 pts) Evaluate the following postfix expression, showing the state of the operand stack at the three points A, B and C indicated below:

2 7 * 18 4 5 + / / 6 4 * 3 / + 3 /

A

B

C

Value of the Expression: _____

Note: If you are not using Word, please just draw each of the stacks in your document, and clearly label the bottom of each stack and also clearly label your final answer. If you are using Word, just copy and paste the question and fill in the result in red so it is easy to see your answer.

2) (10 pts) Convert the following infix expression to postfix using a stack. Show the contents of the stack at the indicated points (A, B, and C) in the infix expression and provide the corresponding postfix expression as well.

((3 + 13) / 4 + ^A 6 * 5) ^B / 2 + 8 / (6 - 2)

A

B

C

Resulting postfix expression:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Note: If you are not using Word, please just draw each of the stacks in your document, and clearly label the bottom of each stack and also clearly label your final answer. If you are using Word, just copy and paste the question and fill in the result in red so it is easy to see your answer.

3) (5 pts) The Miami Dolphins are named after what marine creature that can be seen frequently off the coast of Miami?
