

# CSC 209 Review 8 Solution

August 28, 2020

1. I need to create a wrapper function `my_malloc` that does the following:

- ask `my_malloc` it to allocate `n` bytes
- call `malloc`
- test `malloc` doesn't have a null pointer
- return pointer from `malloc`

The solution to this problem is:

```
1  void *my_malloc(int n) {  
2      void *p;  
3  
4      p = malloc(n);  
5  
6      if (!p) {  
7          printf("ERROR: Malloc allocation failed");  
8      }  
9  
10     return p;  
11 }
```

## Notes

- Learned that void function can return value
- **Dynamic Storage Allocation**
  - Allows to allocate storage during program execution
  - Allows to create data structures and shrink and grow array as needed
  - e.g. `malloc`, `calloc`, `realloc`
- **Memory Allocation Functions**
  - `malloc` - Allocates a block of memory but doesn't initialize it
    - \* doesn't initialize the allocated memory

- \* more efficient than `calloc`
  - \* accessing the content → segmentation fault (accessing value at invalid mem. location) or garbage values
  - `calloc` - Allocates a block of memory and clears it
    - \* allocates memory and initializes the memory block to zero
    - \* accessing the content of blocks would return 0
  - `realloc` - Resizes a previously allocated block of memory
- **Null Pointer**
    - is returned when it fails to allocate a block of memory large enough to satisfy the request

### Example

```
p = malloc(10000);
if (p == NULL) {
    /* allocation failed; take appropriate action */
}
```

2. I need to write a function named `duplicate` that uses dynamic storage allocation to create a copy of a string.

The requirements of the function are

- `duplicate` allocates space for a string of the same length as `str`
- `duplicate` copies the contents of `str` into the new string
- `duplicate` returns a pointer to it
- `duplicate` returns a null pointer if the memory allocation fails

The solution to this problem is:

```
1  #include <stdio.h>
2  #include <stdlib.h> // malloc
3  #include <string.h> // strlen
4
5  char *duplicate(const char *str);
6
7  int main(void) {
8      char s[] = "hello world", *p;
9
10     p = duplicate (s);
```

```
11     printf("Duplicate: %s\n", p);
12
13     free(p);
14     return 0;
15 }
16
17
18
19 char *duplicate(const char *str) {
20     char *p, *q;
21     const char *r;
22
23     int n = strlen(str);
24
25     p = (char *)malloc(n + 1);
26
27     if (!p) {
28         return p;
29     }
30
31     r = str;
32     q = p;
33     while (r < str + n) {
34         *q = *r;
35         q++;
36         r++;
37     }
38
39     *q = '\0';
40
41     return p;
42 }
```

### Correct Solution:

```
1  #include <stdio.h>
2  #include <stdlib.h> // malloc
3  #include <string.h> // strlen
4
5  char *duplicate(const char *str);
6
7  int main(void) {
8      char s[] = "hello world", *p, *q;
9      ;
10     p = duplicate (s);
11
12     printf("Duplicate: %s\n", p);
13
14     free(p);
15     return 0;
16 }
17
```

```

18
19 char *duplicate(const char *str) {
20     char *p, *q;
21     const char *r;
22
23     int n = strlen(str);
24
25     p = (char *)malloc(n + 1);
26
27     if (!p) {
28         p = ((void*)0);
29         return p;
30     }
31
32     r = str;
33     q = p;
34     while (r < str + n) {
35         *q = *r;
36         q++;
37         r++;
38     }
39
40     *q = '\0';
41
42     return p;
43 }

```

### Note

- Null pointer has value `((void*)0)`
- `const` tag in parameter prevents the function from modifying what its pointer variable is pointing to.
  - value is modifiable
  - changes the parameter to pass by value

```

31 int *create_array(int n, int initial_value) {
2     int *array;
3
4     array = malloc(n * sizeof(int));
5
6     if (array == NULL) {
7         return array;
8     }
9
10    for(int i = 0; i < n; i++){
11        array[i] = initial_value;
12    }
13
14    return array
15 }

```

## Notes

- **Dynamically Allocated Arrays**

- **Syntax:**

```
int *a;  
a = malloc(n * sizeof(int));
```

- returns null pointer if allocation fails

```
41  #include <stdio.h>  
2   #include <stdlib.h>  
3   #include <string.h>  
4  
5   struct point {int x, y;};  
6   struct rectangle {struct point upper_left, lower_right;};  
7  
8   int main(void) {  
9  
10      struct rectangle *p;  
11  
12      p = malloc(sizeof(struct rectangle));  
13  
14      p->upper_left.x = 10;  
15      p->upper_left.y = 25;  
16      p->lower_right.x = 20;  
17      p->lower_right.y = 15;  
18  
19      printf("%d %d %d %d",  
20             p->upper_left.x,  
21             p->upper_left.y,  
22             p->lower_right.x,  
23             p->lower_right.y  
24      );  
25  
26      return 0;  
27  }
```

## Notes

- -> doesn't carry over to accessing nested members

- **Linked Lists**


- **Declaring Node Type**

- \* **Syntax (Node structure):**

```
struct node {  
    int value;          /* data stored in the node */  
    struct node *next;  /* pointer to the next node */  
};
```

```
struct node *first = NULL;
```

Pointer to first node  
in the linked list



### – Creating a Node

#### \* Syntax (Allocating using malloc):

```
struct node *new_node;  
new_node = malloc(sizeof(struct node));
```

#### \* Assigning value

```
(*new_node).value = 10;
```

### – -> Operator

\* is a short form of (\*STRUCT\_NAME).MEMBER\_NAME

#### Example

```
(*new_node).value = 10;
```

Is the same as

```
new_node->value = 10;
```