

CMSC 312 Assignment 3 – Dynamic Memory Management Schemes Report

Memory leak calculation:

The 'print_memory_leak' function goes through a linked list of memory blocks starting from the 'global_base'. It gets the total amount of memory that has been allocated by adding up the size of each block with the size of the block's 'META_SIZE'. The 'META_SIZE' is the data that's used to store information about the memory block. For each block the function checks whether it's free or not. If it's not free, and something has been allocated, then the size of the block is added to 'actual_allocated'. This value represents the total amount of memory that has been allocated but not freed. Once the while loop finish executing the function then compares 'actual_allocated' to 'total_allocated'. If 'actual_allocated' is less than 'total_allocated', then there is a memory leak. The size of the leak is calculated by subtracting 'actual_allocated' from 'total_allocated' (actual_allocated - total_allocated). The function then prints the size of the leak. If 'actual_allocated' is equal to 'total_allocated' then there's no memory leak.

Best fit algorithm:

To change the code from a first fit algorithm to a best fit algorithm I simply just changed the 'find_Free_block' function. The preliminary implementation searched through a linked list of memory blocks, starting from the 'global_base', for a free block that is large enough to accommodate the requested memory size. The improved version selects the smallest free block that can fit the requested size. It initializes a pointer 'best_fit' to NULL and 'smallest_size' to the max value, and then updates the values as it goes through the linked list. When it finds a free block that is both large enough and smaller than the current 'smallest_size', it sets 'best_fit' to that block and updates 'smallest_size' to its size.

Why Best fit algorithm is better:

The best fit algorithm is better than the first fit because it provides a more optimal memory allocation strategy, because by selecting the smallest free block that can fit the requested size, it reduces the chances of fragmentation and maximizes the use of available memory. This can result in more efficient memory usage and potentially fewer memory allocation requests.

When calling Malloc 6 times, Calloc 6 times, Realloc 6, Free 6 times, and allocating the same values in each file.

Preliminary implementation	Improved version
<pre>baezsalazaee@egr-v-cmsc312-1:~/Assignment3/oldFunctions\$./myFile Heap Start: 0x556055696000 -----Malloc----- Allocated 10 bytes at 0x556055696018 Allocated 20 bytes at 0x55605569603a Allocated 0 bytes at (nil) Allocated 50 bytes at 0x556055696066 Allocated 100 bytes at 0x5560556960b0 Allocated 30 bytes at 0x55605569612c -----Calloc----- Allocated 50 bytes at 0x556055696162 Allocated 40 bytes at 0x5560556961ac Allocated 0 bytes at (nil) Allocated 400 bytes at 0x5560556961ec Allocated 1000 bytes at 0x556055696394 Allocated 90 bytes at 0x556055696794 -----Realloc----- Reallocated 20 bytes at 0x556055696806 Reallocated 40 bytes at 0x556055696832 Reallocated 30 bytes at 0x556055696872 Reallocated 100 bytes at 0x5560556968a8 Reallocated 200 bytes at 0x556055696924 Reallocated 60 bytes at 0x5560556960b0 -----Free----- Freed pointer at 0x556055696162 Freed pointer at 0x5560556961ac Freed pointer at (nil) Freed pointer at 0x5560556961ec Freed pointer at 0x556055696394 Freed pointer at 0x556055696794 Heap End: 0x5560556969ec Memory leak detected: 1690 bytes baezsalazaee@egr-v-cmsc312-1:~/Assignment3/oldFunctions\$</pre>	<pre>baezsalazaee@egr-v-cmsc312-1:~/Assignment3/newFunctions\$./myFile Heap Start: 0x564ffdbaa000 -----Malloc----- Allocated 10 bytes at 0x564ffdbaa020 Allocated 20 bytes at 0x564ffdbaa04a Allocated 0 bytes at (nil) Allocated 50 bytes at 0x564ffdbaa07e Allocated 100 bytes at 0x564ffdbaa0d0 Allocated 30 bytes at 0x564ffdbaa154 -----Calloc----- Allocated 50 bytes at 0x564ffdbaa192 Allocated 40 bytes at 0x564ffdbaa1e4 Allocated 0 bytes at (nil) Allocated 400 bytes at 0x564ffdbaa22c Allocated 1000 bytes at 0x564ffdbaa3dc Allocated 90 bytes at 0x564ffdbaa7e4 -----Realloc----- Reallocated 20 bytes at 0x564ffdbaa000 Reallocated 40 bytes at 0x564ffdbaa02a Reallocated 30 bytes at 0x564ffdbaa85e Reallocated 100 bytes at 0x564ffdbaa05e Reallocated 200 bytes at 0x564ffdbaa0b0 Reallocated 60 bytes at 0x564ffdbaa134 -----Free----- Freed pointer at 0x564ffdbaa192 Freed pointer at 0x564ffdbaa1e4 Freed pointer at (nil) Freed pointer at 0x564ffdbaa22c Freed pointer at 0x564ffdbaa3dc Freed pointer at 0x564ffdbaa7e4 Heap End: 0x564ffdbaa87c Memory leak detected: 192 bytes baezsalazaee@egr-v-cmsc312-1:~/Assignment3/newFunctions\$</pre>
Memory leak = 1690	Memory leak = 192

When calling Malloc 2 times, Calloc 2 times, Realloc 2, Free 2 times, and allocating the same values in each file.

Preliminary implementation	Improved version
<pre>baezsalazaee@egr-v-cmsc312-1:~/Assignment3/oldFunctions\$./myFile Heap Start: 0x55bf62ee4000 -----Malloc----- Allocated 161 bytes at 0x55bf62ee4018 Allocated 180 bytes at 0x55bf62ee40d1 -----Calloc----- Allocated 1380 bytes at 0x55bf62ee419d Allocated 672 bytes at 0x55bf62ee4719 -----Realloc----- Allocated 269 bytes at 0x55bf62ee49d1 Allocated 12 bytes at 0x55bf62ee40d1 -----Free----- Freed pointer at 0x55bf62ee419d Freed pointer at 0x55bf62ee4719 Heap End: 0x55bf62ee4ade Memory leak detected: 2213 bytes baezsalazaee@egr-v-cmsc312-1:~/Assignment3/oldFunctions\$</pre>	<pre>baezsalazaee@egr-v-cmsc312-1:~/Assignment3/newFunctions\$./myFile Heap Start: 0x558a703f2000 -----Malloc----- Allocated 161 bytes at 0x558a703f2020 Allocated 180 bytes at 0x558a703f20e1 -----Calloc----- Allocated 1380 bytes at 0x558a703f21b5 Allocated 672 bytes at 0x558a703f2739 -----Realloc----- Allocated 269 bytes at 0x558a703f2000 Allocated 12 bytes at 0x558a703f20c1 -----Free----- Freed pointer at 0x558a703f21b5 Freed pointer at 0x558a703f2739 Heap End: 0x558a703f29d9 Memory leak detected: 64 bytes baezsalazaee@egr-v-cmsc312-1:~/Assignment3/newFunctions\$</pre>

Memory leak = 2213

Memory leak = 64

When calling Malloc 10 times, Calloc 4 times, Realloc 1, Free 4 times, and allocating the same values in each file.

Preliminary implementation

```
baezsalazae@egr-v-cmsc312-1:~/Assignment3/oldFunctions$ ./myFile
Heap Start: 0x5620e8121000

-----Malloc-----
Allocated 3 bytes at 0x5620e8121018
Allocated 26 bytes at 0x5620e8121033
Allocated 13 bytes at 0x5620e8121065
Allocated 72 bytes at 0x5620e812108a
Allocated 127 bytes at 0x5620e81210ea
Allocated 86 bytes at 0x5620e8121181
Allocated 180 bytes at 0x5620e81211ef
Allocated 137 bytes at 0x5620e81212bb
Allocated 56 bytes at 0x5620e812135c
Allocated 272 bytes at 0x5620e81213ac

-----Calloc-----
Allocated 300 bytes at 0x5620e81214d4
Allocated 25 bytes at 0x5620e8121618
Allocated 65 bytes at 0x5620e8121649
Allocated 336 bytes at 0x5620e81216a2

-----Realloc-----
Allocated 59 bytes at 0x5620e81211ef

-----Free-----
Freed pointer at 0x5620e81214d4
Freed pointer at 0x5620e8121618
Freed pointer at 0x5620e8121181
Freed pointer at 0x5620e81211ef

Heap End: 0x5620e81217f2
Memory leak detected: 591 bytes
baezsalazae@egr-v-cmsc312-1:~/Assignment3/oldFunctions$
```

Memory leak = 591

Improved version

```
baezsalazae@egr-v-cmsc312-1:~/Assignment3/newFunctions$ ./myFile
Heap Start: 0x55fb4a436000

-----Malloc-----
Allocated 3 bytes at 0x55fb4a436020
Allocated 26 bytes at 0x55fb4a436043
Allocated 13 bytes at 0x55fb4a43607d
Allocated 72 bytes at 0x55fb4a4360aa
Allocated 127 bytes at 0x55fb4a436112
Allocated 86 bytes at 0x55fb4a4361b1
Allocated 180 bytes at 0x55fb4a436227
Allocated 137 bytes at 0x55fb4a4362fb
Allocated 56 bytes at 0x55fb4a4363a4
Allocated 272 bytes at 0x55fb4a4363fc

-----Calloc-----
Allocated 300 bytes at 0x55fb4a43652c
Allocated 25 bytes at 0x55fb4a436678
Allocated 65 bytes at 0x55fb4a4366b1
Allocated 336 bytes at 0x55fb4a436712

-----Realloc-----
Allocated 59 bytes at 0x55fb4a436207

-----Free-----
Freed pointer at 0x55fb4a43652c
Freed pointer at 0x55fb4a436678
Freed pointer at 0x55fb4a4361b1
Freed pointer at 0x55fb4a436227

Heap End: 0x55fb4a436862
Memory leak detected: 320 bytes
baezsalazae@egr-v-cmsc312-1:~/Assignment3/newFunctions$
```

Memory leak = 320

Limitations:

The only limitation that I came across is that if I called realloc more than ten times then for some reason it gave a segmentation fault. I tried debugging but unfortunately I could not solve this issue.