

## CSC209H Worksheet: Stacks and Heaps

- Trace the memory usage for the program below. We have set up both stack frames for you, and the location of the heap.

```
#include <stdlib.h>
#include <limits.h>
#include <stdio.h>
#include <errno.h>
```

```
int *mkarray1(int a, int b, int c) {
    int arr[3]; int *arr = malloc(sizeof(int) * 3);
    arr[0] = a;
    arr[1] = b;
    arr[2] = c;

    int *p = arr;
    return p;
}
```

// Code for other\_function() omitted.

```
int main() {

    int *ptr = mkarray1(10, 20, 30);
    other_function();
    printf("%d %d %d\n", ptr[0], ptr[1], ptr[2]);
    free(ptr);
}
```

Section	Address	Value	Label
Heap	0x23c	10	
	0x240	20	
	0x244	30	
	0x248		
	:	:	
stack frame for mkarray1	0x454	0x23c	arr
	0x458		
	0x45c	0x464	p
	0x460		
	0x464	10	<del>arr[0]</del>
	0x46c	20	
	0x470	30	
	0x474	30	c
	0x478	20	b
	0x47c	10	a
stack frame for main	0x480	0x464	ptr
	0x484		
	0x488		
	0x48c		

- The program in part 1 will not work correctly. Notice the call to `other_function`. Explain to your partner why the program doesn't work. Fix the `mkarray1` function, and trace it again.
- Once you've fixed the code, add a statement to your program to deallocate the memory on the heap as soon as possible.

The data previously used for arr could be overwritten. And the data of mkarray may be popped in stack

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4. Trace the memory usage for the program below. We have set up the stack frame for you, and the location of the heap.

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

/* Build an array in dynamic memory to hold
   multiples of x from x to x*x.
   Return a pointer to this array.
*/
int *multiples(int x) {
    int *a = malloc(sizeof(int) * x);
    for (int i=0; i < x; i++) {
        a[i] = (i+1) * x;
    }
    return a;
}

int main() {
    int *ptr;
    int size = 3;

    ptr = multiples(size);

    for (int i=0; i<size; i++) {
        printf("%d\t", ptr[i]);
    }
    printf("\n");
    ★ free(ptr);

    return 0;
}
```

Section	Address	Value	Label
Heap	0x224	3	
	0x228	6	
	0x22c	9	
	0x230		
	0x234		
	0x238		
	0x23c		
	0x240		
	0x244		
	⋮	⋮	
stack frame for multiples	0x470	3	x
	0x470	0x224	a
	0x474		
	0x478	0x224	i
stack frame for main	0x47c		
	0x480	0x224	ptr
	0x484	3	size
	0x488		
	0x48c		

5. Change the main function so that it calls `multiples` and prints the array in a loop with sizes of 3, 4, and 5. Besides the changes described, do not make any other changes or additions to the code.
6. Trace the memory usage of your changed program. Explain the problem to your partner and then fix it by adding calls to deallocate the memory.