Recitation 12: More Malloc Lab

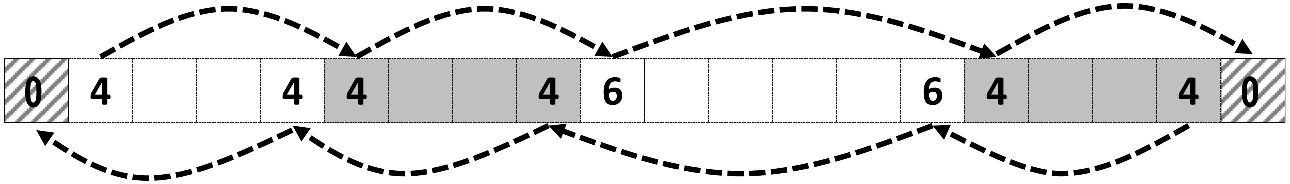
Instructor: TA(s)

Understanding Your Code

- Sketch out the heap
- Add Instrumentation
- Use tools

Sketch out the Heap

- Start with a heap, in this case implicit list



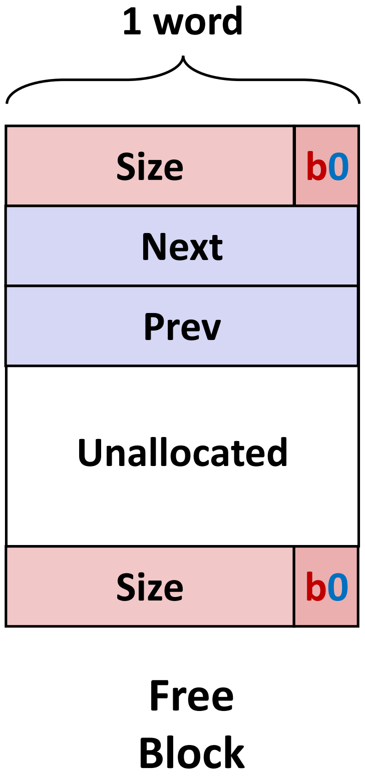
- Now try something, in this case, extend_heap

```
block_t *block = payload_to_header(bp);
write_header(block, size, false);
write_footer(block, size, false);
// Create new epilogue header
block_t *block_next = find_next(block);
write_header(block_next, 0, true);
```

Sketch out the Heap

- **Here is a free block based on lectures 19 and 20**
  - Explicit pointers (will be well-defined see writeup and Piazza)
  - Optional boundary tags

- **If you make changes to your design beyond this**
  - Draw it out.
  - If you have bugs,
    pictures can help the staff help you



Add Instrumentation

- **Remember that measurements inform insights.**
  - Add temporary code to understand aspects of malloc
  - Code can violate style rules or 128 byte limits, because it is temporary
- **Particularly important to develop insights into performance before making changes**
  - What is expensive throughput-wise?
  - How much might a change benefit utilization?

Add Instrumentation example

- **Looping in find_fit takes most of the time**
- **How efficient is your code? How might you know?**
  - Compute the ratio of blocks viewed to calls

```
static block_t *find_fit(size_t asize)
{
    block_t *block;  call_count++;
    for (block = heap_listp; get_size(block) > 0;
                             block = find_next(block))
    {   block_count++;
        if (!(get_alloc(block)) && (asize <= get_size(block)))
        {
            return block;
        }
    }
    return NULL; // no fit found
}
```

Add Instrumentation cont.

- **What size of requests?**
  - How many 8 bytes or less?
  - How many 16 bytes or less?
  - What other sizes?

- **What else could you measure? Why?**

- **Remember that although the system's performance varies**
  - The mdriver's traces are deterministic
  - Measured results should not change between runs

Use tools

- **Write your own – mm_checkheap()**
  - What conditions are true in a valid heap?
  - Discuss.

- **Use gdb**
  - Sometimes augmented with checkheap or printfs
  - Always valuable insights

Garbled Bytes

- **Malloc library returns a block**
  - mdriver writes bytes into payload (using memcpy)
  - mdriver will check that those bytes are still present
  - If malloc library has overwritten any bytes, then report garbled bytes
- **Now what?**
- **The mm_checkheap call is catching it right?**
- **If not, we want to find the garbled address and watch it**

Garbled Bytes and gdb

- **Get out a laptop**

- **Login to shark machine**
- **wget http://www.cs.cmu.edu/~213/activities/rec12.tar**
- **tar xf rec12.tar**

- **This is an explicit list mdriver with a bug.**
  - No source code is provided.

GDB Exercise

- **gdb --args ./mdriver-rec12 -c ./traces/syn-array-short.rep**

```
(gdb) r
// Sample output follows
Throughput targets: min=6528, max=11750, benchmark=13056
Malloc size 9904 on address 0x800000010.
...
ERROR [trace ././traces/syn-array-short.rep, line 12]:
block 0 has 8 garbled bytes, starting at byte 0
...
Terminated with 2 errors
[Inferior 1 (process 13470) exited normally]
(gdb)
```

GDB Exercise cont.

- **What is the first address that was garbled?**
  - Use gdb watch to find out when / what garbled it.

```
(gdb) watch * 0x800000010
(gdb) run

// Keep continuing through the breaks:
// mm_init()
// 4 x memcpy
Hardware watchpoint 1: *0x800000010

Old value = -7350814
New value = 0
0x00000000004041b7 in mm_malloc ()
```

We just broke in after overwriting

MallocLab

- Due Thursday
- 8% of final grade (+ 4% for checkpoint)
- Read the writeup
- Ask for help after a few hours or take a break