# Lecture 19:
# Memory Allocation Implementation

CSE 29: Systems Programming and Software Tools

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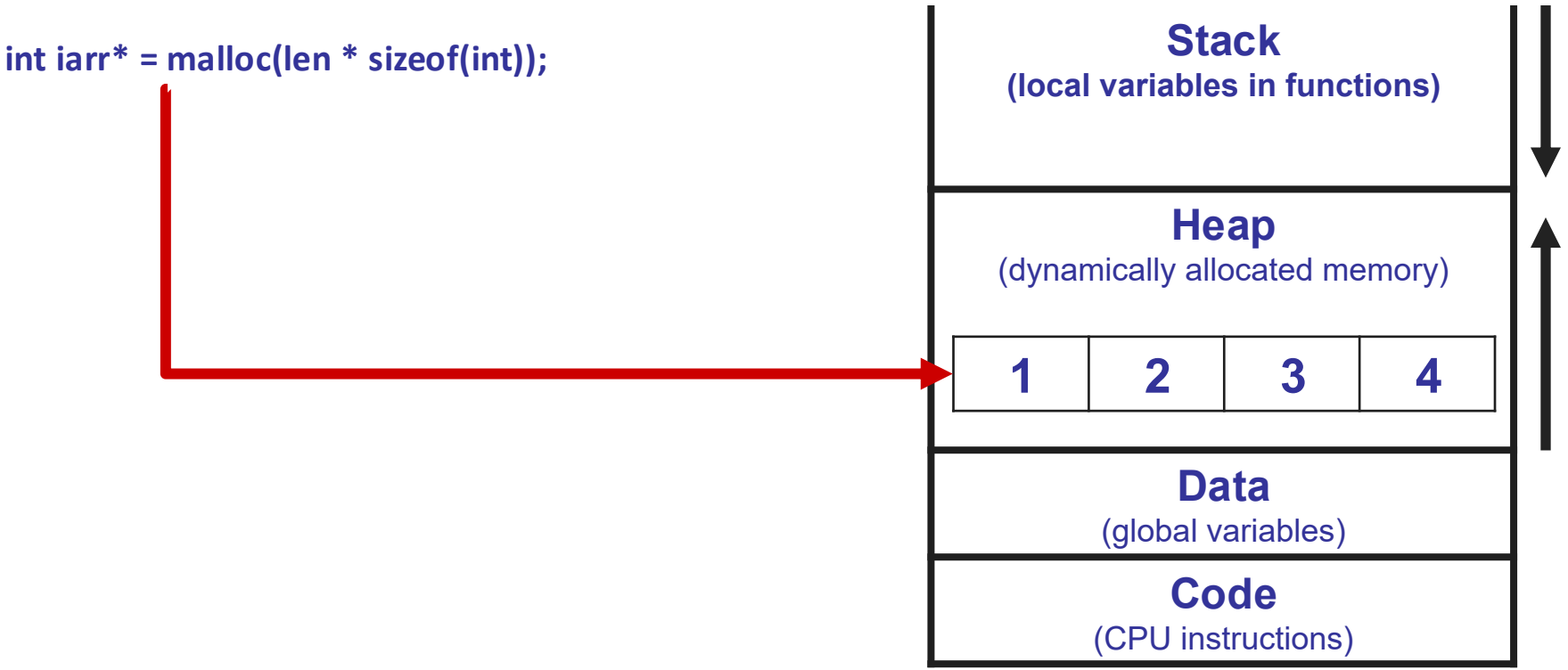
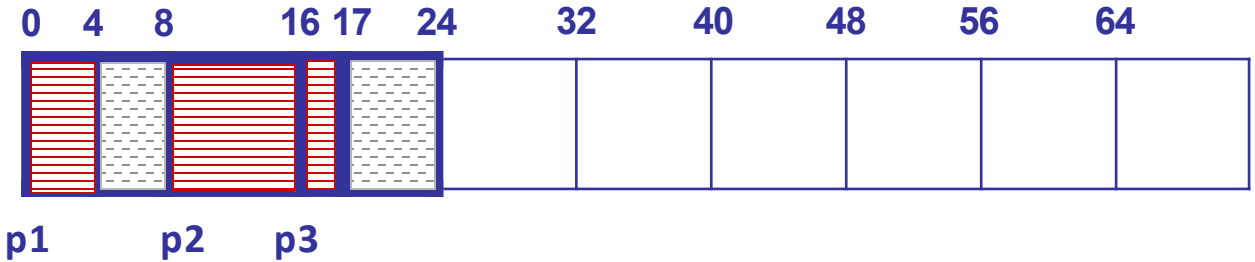
# Logistics

- *Beginning a new phase of the class today:*
  - First half of the class was focused on **low-level programming in C**
  - Second half of the class is focused on **how a computer system works ("systems")**
    - How does memory allocation work?
    - How does information get stored on a disk?
    - Intro to Networking and OS: How do you build a webserver?

# What does malloc() do?



# Malloc Implementation: Heap structure



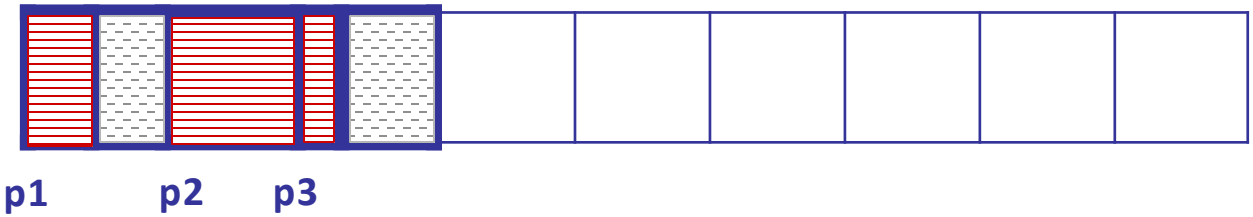

```
int* p1 = malloc(4); // 0x00
int* p2 = malloc(8); // 0x08
int* p3 = malloc(1); // 0x10
```

**Alignment Requirement for 64-bit machine:**
8 bytes (every heap allocation should be aligned to 8 bytes)

# Malloc Implementation: Requirements

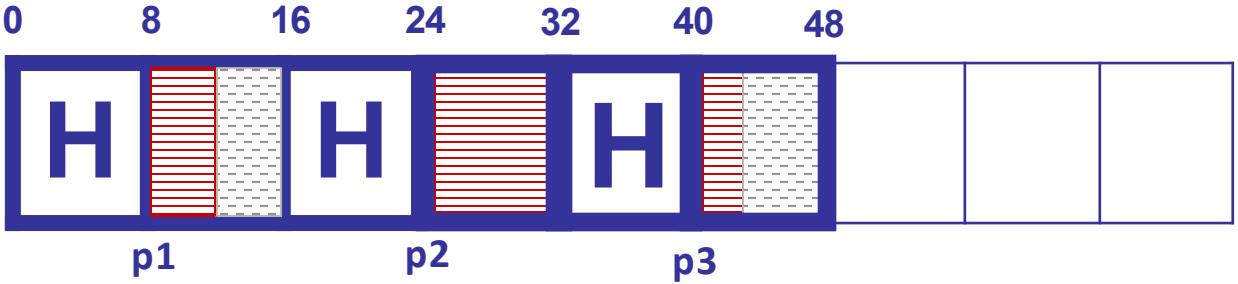
**Requirements:**

1. Only use information in the heap to manage the heap
2. Can not modify previously allocated blocks




We **also** need to store metadata also in the heap about each allocation

# Headers: How to store metadata on the hea




**Add 8 byte headers before each allocation on the heap**

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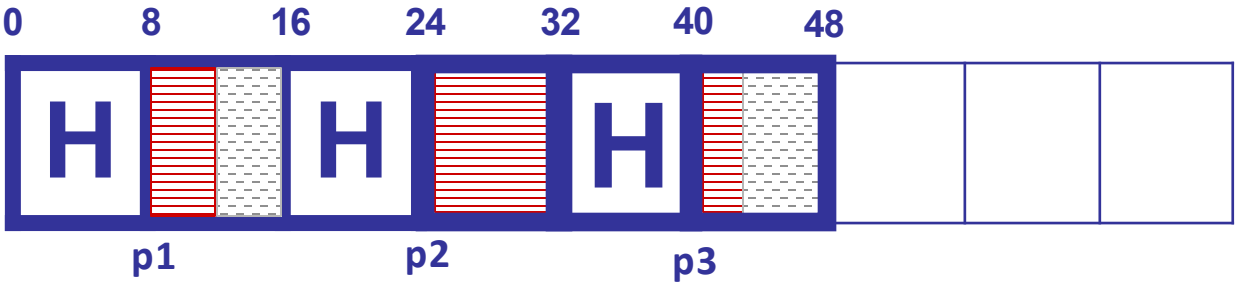
# Headers: Storing metadata on the heap

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# Header implementation

- Header contains a length and a flag bit representing free/allocated
  - Even number: representing a *free block*
  - Odd number: representing a *malloc'd, allocated, busy block*
- In both cases, the number with LSB set to 0 is the block size in bytes
- header = 33 → allocated block of 32 bytes (24 byte payload)
- header = 108 → free block of 108 bytes (100 byte payload)
- "size of block" = full size including header
- Always make block sizes divisible by 8 (or 8-byte aligned)