

Exam 2 cheatsheet

Heap allocation

- Heap divided into blocks
- Heap allocated with mmap
- Heap blocks allocated with malloc
- Heap blocks contain block header + payload
 - Block header – size_status
 - size_status contains size – bitmask ~x3
 - P bit – 1 if prev block is allocated
 - A bit – 1 if block is allocated
 - Payload
 - Data in here is put by user of the allocator
 - Allocator cannot touch this data
 - Double word aligned
 - Free block footers
 - Only on free blocks
 - Contain size
 - If using explicit free list, also contain p and n block pointers
- Allocator should only use heap memory to satisfy requests
- Allocator should not use other memory to do so
- Allocator cannot move allocated blocks
- Allocator should coalesce adjacent free blocks
- Allocator should do so immediately to improve performance when allocating.
- Allocator cannot reorder requests
- Performance metrics:
 - 1) Throughput
 - Number of allocation requests that can be satisfied per unit time
 - Next fit and first fit better for this
 - 2) Utilization
 - Ratio of non overhead to total memory
 - Best fit better for this
- Internal fragmentation
 - Occurs when the memory block allocated to an object is larger than the object itself
 - Leaves some unused space within the block
 - Can occur when the memory is divided into fixed-sized blocks, and the object size does not match the block size
- External fragmentation
 - Occurs when there is enough total free space in the heap to satisfy a memory request, but the free space is not contiguous
 - Prevents the use of the available space
 - Can occur when the memory is divided into variable-sized blocks, and the blocks are allocated and freed in different orders, creating gaps between them
- Next fit – Start from last allocation

- Allocate next block that is large enough to fit requested data
- $O(1)$ – until first pass through array
- First fit – Start from beginning and go through until block is large enough
 - $O(N)$ where N is number of blocks considered
 - Better N than best fit
- Best fit – Start from beginning and allocate in smallest block that fits
 - $O(N)$ where N is number of blocks considered