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## CMSC216: Practice Final Exam A

Fall 2025

University of Maryland

*Exam period:* 20 minutes    *Points available:* 40

**Problem 1 (10 pts):** Pagebo Undary recently wrote a C program that is shown nearby and is startled to find that, despite his code clearly accessing out-of-bounds array indices, a Segmentation Fault does not occur unless the access is “way” out of bounds. Pagebo is confused by this apparent inconsistency but concludes that, so long as his code is only a “little” out of bounds, apparently nothing bad will happen.

```
1 #include <stdio.h>
2 int main(){
3     int arr[5]={10,20,30,40,50};
4     printf("arr[    10]: %d\n",arr[    10]);
5     printf("arr[   100]: %d\n",arr[   100]);
6     printf("arr[10000]: %d\n",arr[10000]);
7     return 0;
8 }
9 // >> gcc array_bounds.c
10 // >> a.out
11 // arr[    10]: 378735946
12 // arr[   100]: 1892438979
13 // Segmentation fault (core dumped)
```

Use your knowledge of the **Virtual Memory System** to educate Pagebo on why some out-of-bounds accesses generate Segmentation faults while others do not. Indicate whether you agree with Pagebo’s conclusion (going a little out of bounds is okay) or if there is more to it than this.

**Problem 2 (10 pts):** New programmers are often surprised to learn that once an array is allocated, its size cannot be extended. In C code, this is easily observable as calling `malloc(16)` will yield a block of 16 bytes but there are no simple calls to expand this block of memory and calls like `realloc()` indicate they may move data to another location to find enough space.

Consider a proposed function for EL Malloc called `int el_expand_block(el_blockhead_t *block)` which would expand a given block.

- (A) What conditions need to occur for the function to succeed?
- (B) Why is it impossible to expand a block in some cases?

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**Problem 3 (20 pts):** Below are two functions that augment El Malloc with block shrinking. This allows a user to specify that the originally requested size for a memory area can be adjusted down potentially creating open space. Fill in the definitions for these functions.

```
el_blockhead_t *el_shrink_block(el_blockhead_t *head, size_t newsize){  
// Shrinks the size of the given block potentially creating a new block. Computes remaining space  
// as the difference between the current size and parameter newsize. If this is smaller than  
// EL_BLOCK_OVERHEAD, does nothing further and returns NULL. Otherwise, reduces the size of the  
// given block by adjusting its header and footer and establishes a new block above it with  
// remaining space beyond the block overhead. Returns a pointer to the newly introduced blocks. Does  
// not modify any links in lists.  
  
}  
int el_shrink(void *ptr, size_t newsize){  
// Shrink the area associated with the given ptr if possible. Checks to ensure that the block  
// associated with the given user ptr is EL_USED and exits if not. Uses el_shrink_block() to  
// adjust the block size and create a block for the remaining space. If not possible to shrink,  
// returns 0. Otherwise moves the current block to the front of the Used List and places the newly  
// created block to the front of the Available List after setting its state to EL_AVAILABLE. Returns  
// 1 on successfully shrinking.  
  
}
```