Array Rotation

A properly implemented **`rotate`** will prompt the following program to generate the provided output.

And here's that properly implemented function!

```
void rotate(void *front, void *separator, void *end) {
    int width = (char *)end - (char *)front;
    int prefix_width = (char *)separator - (char *)front;
    int suffix_width = width - prefix_width;

    char temp[prefix_width];
    memcpy(temp, front, prefix_width);
    memmove(front, separator, suffix_width);
    memcpy((char *)end - prefix_width, temp, prefix_width);
}
```

memset

memset is a function that sets a specified number of bytes at one address to a certain value.

```
void *memset(void *s, int c, size_t n);
```

It fills n bytes starting at memory location **s** with the byte **c**. (It also returns **s**).

```
int counts[5];
memset(counts, 0, 3);     // zero out first 3 bytes at counts
memset(counts + 3, 0xff, 4)    // set 3rd entry's bytes to 1s
```

Key Idea: Locating i-th Elem

A common generics idiom is getting a pointer to the i-th element of a generic array. From last lecture, we know how to locate the **last** element:

```
void swap_ends(void *arr, size_t nelems, size_t elem_bytes) {
    swap(arr, (char *)arr + (nelems - 1) * elem_bytes, elem_bytes);
}
```

How can we generalize this to get the location of the i-th element?

```
void *ith_elem = (char *)arr + i * elem_bytes;
```

Function Pointers

A function pointer is the variable type for passing a function as a parameter. Here is how the parameter's type is declared.

```
bool (*compare_fn)(void *a, void *b)
```

Function parameters
(two `void *`s)

Function Pointers

Here's the general variable type syntax:

```
[return type] (*[name])([parameters])
```

Function Pointers

```
bool integer_compare(void *ptr1, void *ptr2) {
    ...
}

int main(int argc, char *argv[]) {
    int nums[] = {4, 2, -5, 1, 12, 56};
    int nums_count = sizeof(nums) / sizeof(nums[0]);
    bubble_sort(nums, nums_count, sizeof(nums[0]), integer_compare);
    ...
}
```

`bubble_sort` is generic and works for any type. But the **caller** knows the specific type of data being sorted and provides a comparison function specifically for that data type.

Comparison Functions

- Function pointers are used often in cases like this to compare two values of the same type. These are called **comparison functions**.
- The standard comparison function in many C functions provides even more information. It should return:
  - < 0 if first value should come before second value
  - > 0 if first value should come after second value
  - 0 if first value and second value are equivalent
- This is the same return value format as **`strcmp`**!

```
int (*compare_fn)(void *a, void *b)
```

Generic C Standard Library Functions

- **`qsort`** – I can sort an array of any type! To do that, I need you to provide me a function that can compare two elements of the kind you are asking me to sort.
- **`bsearch`** – I can use binary search to search for a key in an array of any type! To do that, I need you to provide me a function that can compare two elements of the kind you are asking me to search.
- **`lfind`** – I can use linear search to search for a key in an array of any type! To do that, I need you to provide me a function that can compare two elements of the kind you are asking me to search.
- **`lsearch`** - I can use linear search to search for a key in an array of any type! I will also add the key for you if I can't find it. In order to do that, I need you to provide me a function that can compare two elements of the kind you are asking me to search.

Generic C Standard Library Functions

- **`scandir`** – I can create a directory listing with any order and contents! To do that, I need you to provide me a function that tells me whether you want me to include a given directory entry in the listing. I also need you to provide me a function that tells me the correct ordering of two given directory entries.