CMSC 216
Introduction to Computer Systems
Lecture 8
Pointers, cont.

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Notes

- Project 1 is being graded for style
  - will be returned before Project 2 due
- Project 2 posted, due Mon., Feb. 27
  - public tests posted and submit server open
- Read Reek, Chapter 6: Pointers, Chapter 11: Dynamic Memory Allocation

Chapter 6, Reek

POINTERS

Generic pointers, cont.

- You can't dereference a `void *` - you first need to cast or assign it to a real pointer type
  - the value obtained from a dereference depends on the type of pointer
- `NULL` is really defined as `(void *) 0`
- These allow use of generic code, but misuse can lead to the kinds of errors we've seen before:

```
void *vp;
int *ip;
double a = 3.14159;
vp = &a;
ip = vp;
printf("%d\n", *ip);  /* -266631570 */
```

Type conversion with pointers

- Converting from one type to a pointer has some uses:

```
unsigned int i;
unsigned char *ch;
i = 0x543210ab;
ch = (unsigned char *) &i;
printf("%d\n", *ch);
printf("%d\n",
       * (unsigned char *) &i);
```

- Prints out either MSB or LSB of `i`, depending on architecture

Type conversion, cont.

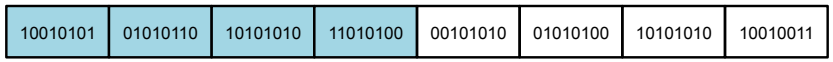
- Type conversion is very similar to what happens when we access an inactive union field

```
union {
  int i;
  double dbl;
} a;
double fp_val = 3.14159;
a.dbl = 3.14159;

printf("%d\n", a.i);  /* -266631570 */
printf("%d\n", * (int *) &fp_val);
```


Type conversion, cont.

- The two lines are the same!
- Although we stored a double-precision floating-point number at an address in memory, interpreting that address as a 4-byte integer results in a wildly different value from the floating-point number



The `const` modifier

- Indicates that a variable can't be changed, and enforced by compiler

```
int const i = 4;
const int j = 5;
i++;  /* ERROR */
j++;  /* ERROR */
```

- Order of type specifier and `const` modifier does matter when dealing with pointers:

```
int i = 4, j = 5;
const int *p = &i;  /* pointer to constant int */
int * const q = &j; /* constant pointer to int */
p = &j;    /* OK */
*p += 5;   /* ERROR */
q = &i;    /* ERROR */
*q += 23;  /* OK */
```

- The program `cdecl` can be useful for decoding some more complex declarations

Incrementing pointers

- Pointers can be incremented/decremented just like integer type variables, "moving" one element at a time
  - how much is added to the address depends on the size of the type to which the pointer points (as declared)
- Recall arrays are contiguous memory
- What does this function do?

```
int mystery(int array[]) {
  int *p = &(array[0]);
  int sum = 0;
  while (*p != -1) {
    sum += *p;
    p++;
  }
  return sum;
}
```

11	1148
22	1152
5	1156
-1	1160
2394	1164
45346	1168

Incrementing pointers, cont.

```
size_t strlen(const char *str) {
  size_t len = 0;
  while (*str) {
    len++;
    str++;
  }
  return len;
}
```

- Why can we move the `str` parameter?
- Why does this return the string's length?

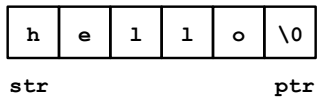
Incrementing pointers, cont.

- The postfix operators take precedence over the dereference operator and prefix operators
- `*` and prefix ops are at the same precedence level, and associate right to left
- `++*p` increments the value at the location to which `p` points, and evaluates to the incremented value
- `*p++` evaluates to the value at the location to which `p` points, and then advances `p`
- `(*p)++` evaluates to the value at the location to which `p` points, and then increments that value

Pointer arithmetic

- With two pointers in the same array, we can determine how far apart they are

```
size_t strlen(const char *str) {
  const char *ptr;
  for (ptr = str; *ptr; ptr++)
    ;
  return (size_t) (ptr - str);
}
```



Pointer arithmetic, cont.

- By adding an integer *n* to a pointer, we can get the address of the n^{th} element past the element to which the pointer currently points

```
int arr[] = {2, 3, 5, 7, 11};
int *p = &(arr[0]);
int *q = p + 4;
printf("%d\n", *q);
```

Output: `11`

- Only valid forms of pointer arithmetic:
  - pointer - pointer
  - pointer ± integer

Pointer arithmetic, cont.

- We can also use relational and equality operators when working with multiple pointers

```
void sum_subarray(int array[], int idx1, int idx2) {
  int *ptr;
  int sum = 0;
  ptr = array + idx1;
  while (ptr <= array + idx2) {
    sum += *ptr;
    ptr++;
  }
  return sum;
}
```