# CS 61C Spring 2022

# C Basics

Discussion 2

## 1 Pre-Check

This section is designed as a conceptual check for you to determine if you conceptually understand and have any misconceptions about this topic. Please answer true/false to the following questions, and include an explanation:

1.1 True or False: C is a pass-by-value language.

1.2 What is a pointer? What does it have in common to an array variable?

1.3 If you try to dereference a variable that is not a pointer, what will happen? What about when you free one?

1.4 When should you use the heap over the stack? Do they grow?

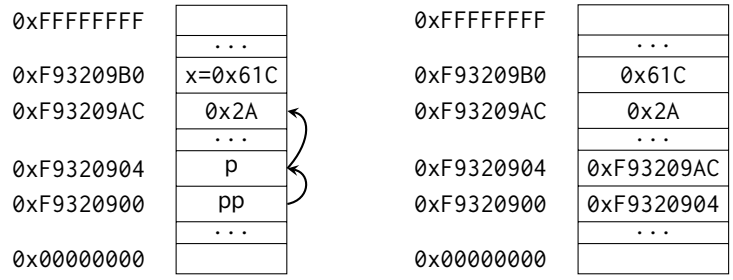
## 2 C

C is syntactically similar to Java, but there are a few key differences:

1. C is function-oriented, not object-oriented; there are no objects.
2. C does not automatically handle memory for you.
   - Stack memory, or *things that are not manually allocated*: data is garbage immediately after the *function in which it was defined* returns.
   - Heap memory, or *things allocated with* `malloc`, `calloc`, *or* `realloc`: data is freed only when the programmer explicitly frees it!
   - There are two other sections of memory that we learn about in this course, *static* and *code*, but we'll get to those later.
   - In any case, allocated memory always holds garbage until it is initialized!
3. C uses pointers explicitly. If `p` is a pointer, then `*p` tells us to use the value that `p` points to, rather than the value of `p`, and `&x` gives the address of `x` rather than the value of `x`.

   On the left is the memory represented as a box-and-pointer diagram.

   On the right, we see how the memory is really represented in the computer.




Let's assume that **int*** p is located at `0xF9320904` and **int** x is located at `0xF93209B0`. As we can observe:

- `*p` evaluates to `0x2A` ($42_{10}$).
- `p` evaluates to `0xF93209AC`.
- `x` evaluates to `0x61C`.
- `&x` evaluates to `0xF93209B0`.

Let's say we have an **int** `**pp` that is located at `0xF9320900`.

2.1 What does `pp` evaluate to? How about `*pp`? What about `**pp`?

2.2 The following functions are syntactically-correct C, but written in an incomprehensible style. Describe the behavior of each function in plain English.

(a) Recall that the ternary operator evaluates the condition before the `?` and returns the value before the colon (`:`) if true, or the value after it if false.

```
1  int foo(int *arr, size_t n) {
2      return n ? arr[0] + foo(arr + 1, n - 1) : 0;
3  }
```

(b) Recall that the negation operator, `!`, returns 0 if the value is non-zero, and 1 if the value is 0. The `~` operator performs a *bitwise not* (NOT) operation.

```
1  int bar(int *arr, size_t n) {
2      int sum = 0, i;
3      for (i = n; i > 0; i--)
4          sum += !arr[i - 1];
5      return ~sum + 1;
6  }
```

(c) Recall that `^` is the *bitwise exclusive-or* (XOR) operator.

```
1  void baz(int x, int y) {
2      x = x ^ y;
3      y = x ^ y;
4      x = x ^ y;
5  }
```

(d) (Bonus: How do you write the *bitwise exclusive-nor* (XNOR) operator in C?)

# 3 Programming with Pointers

3.1 Implement the following functions so that they work as described.

(a) Swap the value of two **int**s. *Remain swapped after returning from this function.*
Hint: Our answer is around three lines long.

```
void swap(_________________, _________________) {




}
```

(b) Return the number of bytes in a string. *Do not use* `strlen`.
Hint: Our answer is around 4 lines long.

```
int mystrlen(_________________) {




}
```

3.2 The following functions may contain logic or syntax errors. Find and correct them.

(a) Returns the sum of all the elements in `summands`.

```
1  int sum(int *summands) {
2      int sum = 0;
3      for (int i = 0; i < sizeof(summands); i++)
4          sum += *(summands + i);
5      return sum;
6  }
```

(b) Increments all of the letters in the `string` which is stored at the front of an array of arbitrary length, `n >= strlen(string)`. Does not modify any other parts of the array's memory.

```
1  void increment(char *string, int n) {
2      for (int i = 0; i < n; i++)
3          *(string + i)++;
4  }
```

(c) Copies the string `src` to `dst`.

```
void copy(char *src, char *dst) {
    while (*dst++ = *src++);
}
```

(d) Overwrites an input string `src` with "61C is awesome!" if there's room. Does nothing if there is not. Assume that `length` correctly represents the length of `src`.

```
void cs61c(char *src, size_t length) {
    char *srcptr, replaceptr;
    char replacement[16] = "61C is awesome!";
    srcptr = src;
    replaceptr = replacement;
    if (length >= 16) {
        for (int i = 0; i < 16; i++)
            *srcptr++ = *replaceptr++;
    }
}
```