Introduction to Pointers

15-123

Effective Programming in C and Unix

Announcements

- SL3 is due Thursday 1/27 midnight
- Complete the Academic Honesty Form
  - Link available from Bb->Course information
- Your current courses grades are available from
  - /afs/andrew/course/15/123/grades
- All SL and lab feedback are given at
  - /afs/andrew/course/15/123/handback

Learning Objectives

- Review of hexadecimal number system
- Understand how pointers work
- Understand how to access memory using pointers
- Understand pointer arithmetic
- Understand relation between arrays and pointers
- Understand the dangers of indirect memory access

Hexadecimals revisited

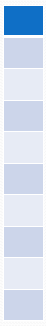
- Hexadecimal number system is a convenient way to represent binary form of data or addresses
- Hexadecimal digits vary from 0,1,…,9, a,b,c,d,e,f
- Each one is defined using 4 bits

- Hexadecimal addition can be performed using base-16 arithmetic. That is m = n mod(16)

Definition of a pointer

- A pointer is an address of a memory location
- Address of a variable is called the lvalue

- lvalue of x =
- rvalue of x =



Pointer variables

- <type>* variable_name;
  - int* ptr; char* ptr;
- Initializing
  - int* ptr = &x ;
- Dereferencing
  - *ptr = x;

Pointer Arithmetic

- **<type>* ptr;**
- **ptr** ➔ address of a memory location
- **ptr + 1** ➔ address of the next <type> variable
- **ptr1 – ptr2** ➔ number of type variables between ptr1 and ptr2

Question

- Given the address of an int variable x
  - ptr = &x = 0xFFA7B8C9
  - Find the address of the next int the memory (assuming it exists)
  - Find the address of the second byte of x (assuming x is a 32-bit int)

Accessing Memory using pointers

- Suppose an int is defined as ➔ int x = 10
- How do we print the address of x?
- How do we access the first byte of x?
- How do we access the second byte of x?
-
- How do we access the next 4 bytes after x? What are the dangers?
- Code demos

Arrays

- Defining an array
  - int A[10]
  - char* A[10]
  - int* A[10]
- Array Memory allocation
  - Allocates a Contiguous block of memory
- The name of the array A is a constant pointer to the first element of the array
  - int A[10];
  - printf("%x", A);
- Dangers
  - C Arrays are not bounded. That is, one can violate memory not allocated using pointers

Array as a pointer

Calculate the addresses of each element

Understanding Arrays

- A – address of the first element of the array
- A + i = address of A[i] = &A[i]

Dynamic Arrays

- int* A = (int*)malloc(n*sizeof(int));
  for (i=0; i<n; i++)
  A[i] = i;
- Resizing an array

More about Strings

- What is the difference between
  - char word[10]
  - char* word
- Look at the size of each of the above

Which of the following code seg faults? Explain…

- Assume we declare
  - char* word; char word2[10];
- Consider the following
  - strcpy(word, "guna");
  - strcpy(word2, "guna");
  - word = "guna";
  - Word2 = "guna";

Dangerous code

```
int* foo(int n) {
   int x = n*n;
   return x;
}

int* foo(int n) {
   int x = n*n;
   return &x;
}
```

C programming – important

- include <stdio.h> in all your programs
- Declare functions and variables before using them
- increment and decrement with ++ and – operators.
- Use x += 5 instead of x = x + 5
- A string is an array of characters ending with a '\0'.
- Don't ever forget the null character.
- Array of size n has indices from 0 to n-1. Although C will allow you to access A[n] it is very dangerous.
- A character can be represented by an integer (ASCII value) and can be used as such.
- The unary operator & produces an address
- The unary operator * dereference a pointer
- Arguments to functions are always passed by value. But the argument can be an address of just a value
- For efficiency, pointers can be passed to or return from a function.
- Logical false is zero and anything else is true
- You can do things like for(;;) or while(i++) for program efficiency and writability
- Use /* .. */ instead of //
- Always compile your program with –ansi –pedantic –Wall –std=c99 flags

Coding Examples