Week 5
C Programming

31 October 2018

CS 35L Lab 4

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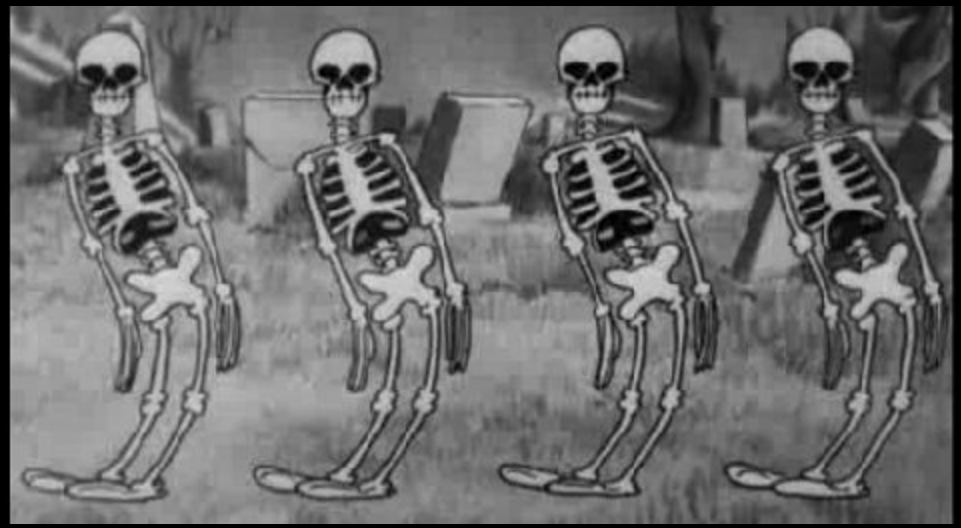
Announcements

- Assignment #4 is due Saturday by 11:55pm
- For Assignment #10
  - **Email me to tell me what story you are choosing**
  - Here is the link to see what stories people have signed up for already
    - Choose a story at least one week before you present
  - Here is the link to sign up to present
    - If you haven't signed up do it
  - Sean and Ryan will be presenting Today
    - Either send me your slides now, or have them on a USB
  - Anita and Kate are presenting next Monday
    - Please send me your story selections if you have not already

Happy Halloween!



Questions?

Outline

- C
- Homework 4

C Basic Data Types

- char
  - Holds a character
  - 1 byte
- int
  - Holds integer numbers
  - Usually 4 bytes
- unsigned int
  - Holds positive integer numbers
  - Usually 4 bytes

C Basic Data Types

- float
  - Holds floating point numbers (decimals)
  - 4 bytes
- double
  - Holds floating point numbers at higher precision
  - 8 bytes
- void
- No boolean

Pointers

- Variables that store memory addresses
  - Generally they store the memory address at which a variable is stored
- Declaration
  - *<var_data_type> *<ptr_name>*

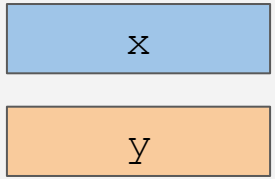
```
int* ptr;          // declares ptr as a pointer to an int variable
int var = 6;       // defines an int variable var
ptr = &var;        // sets the pointer equal to the memory address of var
```

- Dereference (access the value stored in memory) with *

```
*ptr = 15;         // sets var's value to 15
```

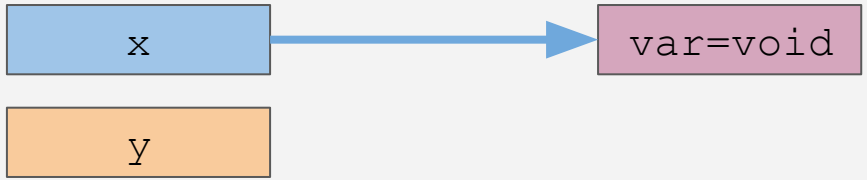
Examples

```
int* x;
int* y;
```



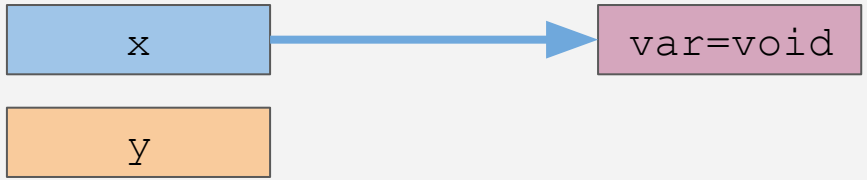
Examples

```
int var;
x = &var;
```



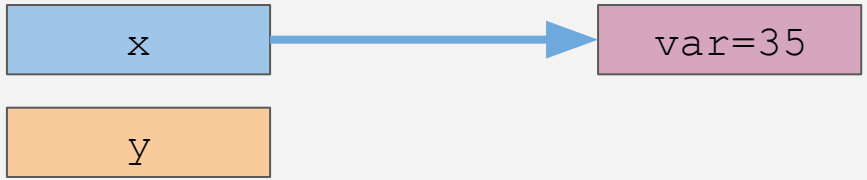
Examples

*x = 35



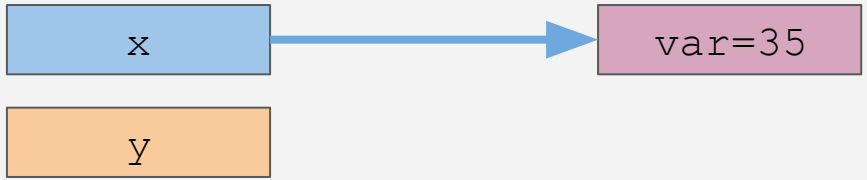
Examples

*x = 35



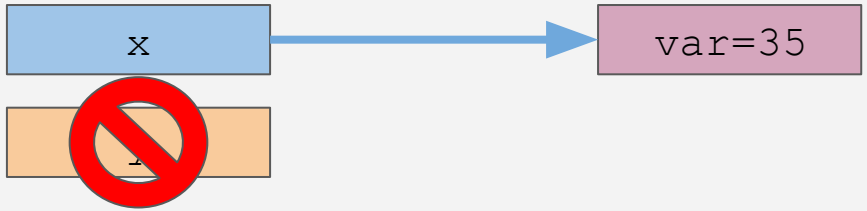
Examples

*y = 100



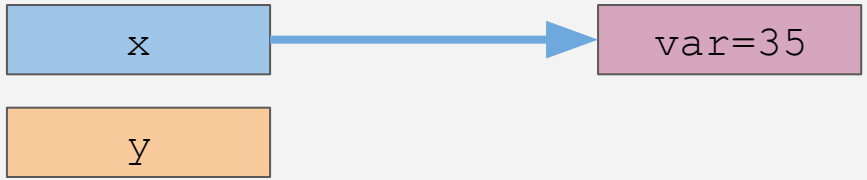
Examples

*y = 100



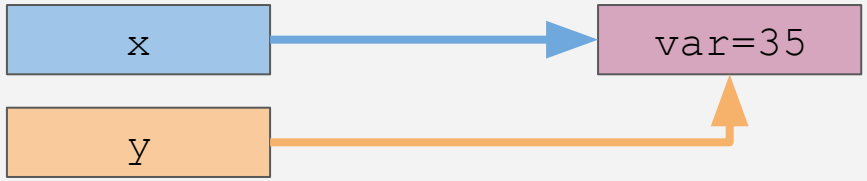
Examples

y = x



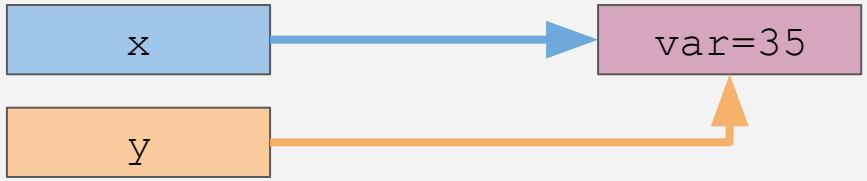
Examples

y = x



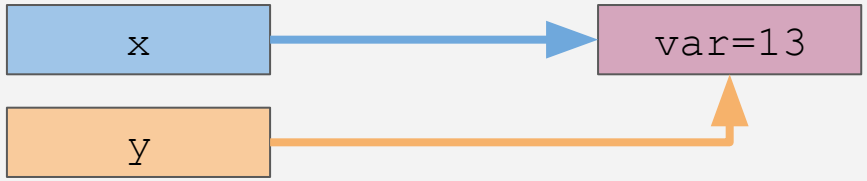
Examples

*y = 13



Examples

*y = 13



More Pointers

➔ Can a pointer point to a pointer?

More Pointers

- Can a pointer point to a pointer?
  - Yes, they can
  - Pointception

```
char c = ‘Z’
char* cPtr = &c
char** cPtrPte = &cPtr
```

Function Pointers

- ➔ Functors
- ➔ Allows you to pass a function into another function
- ➔ Why is this useful?

Function Pointers

- Functors
- Allows you to pass a function into another function
- Why is this useful?
  - It allows you to create a more generalized function
  - Conditionals can allow you to use a different function within the same function

Functors

- Declaration

```
double (*func_ptr) (double, double);
func_ptr = &pow;       // func_ptr now points to pow()
```

- Usage

```
double result = (*func_ptr)(1.5, 2.0);
```

Functor Example: qsort

```
void qsort(void* base, size_t num, size_t size,
int (*comparator) (const void*, const void*))
```

- ➔ The fourth argument of qsort is a functor to a function to use to compare the elements of base
  - ◆ This allows qsort to work on any data type provided you give it a valid comparator for the data type
  - ◆ Comparator returns
    - <0: sort the first element before the second
    - 0: means they are equal
    - >0: sort the second element before the first
- ➔ This can be passed into qsort as the function name

Structs

- C does not have classes
- But structs can package related data
  - Kind of like a “lite” version of a class

```
struct Student {
        char name[64];
        char UID[9];
        int age;
        int year;
        double panicLevel;
};
Struct Student s;
```

C Structs vs. C++ Classes

C Structs	C++ Classes

C Structs vs. C++ Classes

C Structs	C++ Classes
No member functions	Member functions
No access specifiers	Access specifiers that are private by default
No defined constructors	Must at least have default constructor

Dynamic Memory

- C allows you to allocate memory at run time
  - This gets allocated on the heap

- void* **malloc**(size_t *size*);
  - Allocates *size* bytes and returns a pointer to the allocated memory
- void* **realloc**(void* *ptr*, size_t *size*);
  - Changes the size of the memory block pointed to by *ptr* to *size* bytes
- void **free**(void* *ptr*);
  - Frees the block of memory pointed to by *ptr*

Reading and Writing Characters

- int **getchar**();
  - Returns the next character from stdin
- int **putchar**(int *character*);
  - Writes *character* to the current position in stdout
- int **fprintf**(FILE* *stream*, const char* *format*, …);
  - Print the c string *format* to *stream*
    - Stream is either a pointer to a file, or one of stdin, stdout, stderr
- int **fscanf**(FILE* *stream*, const char* *format*, …);
  - Read the c string *format* from *stream*

Formatted I/O

- fprintf and fscanf rely on file pointers and formatted strings
- File pointers
  - Generated by opening files
  - file* fp = fopen(“file.txt”, “r”)
    - Fp is now a pointer to the opened file file.txt with read permission
- Formatted String
  - Allows a string to be followed by variables to be placed into a string
  - fprintf(fp, “This class, %s, has %i students”, class_name, n_students)
  - For fscanf, the formatted string will allow you to place separate pieces of the string into variables

Homework 5

- Write a C function, frobcmp
  - Compare two objects byte-by-byte
    - In the style of memcmp
  - Return an integer, denoting which of the two arguments should come lexicographically before the other
  - The catch being that the two arguments are frobnicated
    - Frobnicate is an obfustication technique
    - Encoded by an XOR with 0x2A (hexadecimal 42)
  - You will have to manually do this byte-by-byte, because we do not want the deobfusticated objects to appear in memory

Homework 5

- Use frobcmp to write another function, sfrob
- sfrob reads frobnicated lines from stdin and outputs the sorted (still frobnicated) lines to stdout
- You can use <stdio.h> functions to do IO
  - This includes the things in the earlier slides
- Use malloc, realloc, and free to ensure you have enough space to store all of the input
- Use qsort to sort the data
- Your function must work on continually growing input
  - Do not stop until you've hit an EOF

Homework 4 Hints

- Remember a pointer to a pointer is also essentially an array of arrays (char** arr), this can help you store strings
- Use correct casting when passing frobcmp to qsort
  - qsort expects the type void** because it's generalized
  - frbcomp takes a char*, so you would need to cast void** to char** and then dereference once
- Use realloc to reallocate memory for every string, and the array of strings
- Use exit to exit with error
- Frobnicated newlines become spaces
  - Thus each string is separated by spaces

Questions?