CS35L – Fall 2018

Slide set:	4.1
Slide topics:	C programming
Assignment:	4

Basic Data Types

- **int**
  - Holds integer numbers
  - Usually 4 bytes
- **float**
  - Holds floating point numbers
  - Usually 4 bytes
- **double**
  - Holds higher-precision floating point numbers
  - Usually 8 bytes (double the size of a float)
- **char**
  - Holds a byte of data, characters
- **void**

Pretty much like C++ basic data types, but NO **bool** before C99

Pointers

- Variables that store memory addresses

Declaration

- <variable_type> *<name>;
  - int *ptr;   //declare ptr as a pointer to int
  - int var = 77;   // define an int variable
  - ptr = &var;   // let ptr point to the variable var

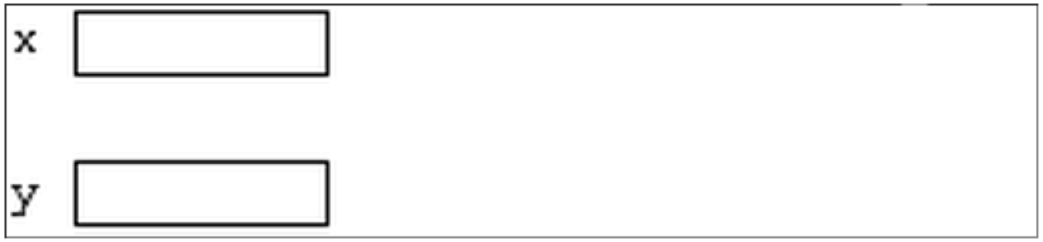
Dereferencing Pointers

- Accessing the value that the pointer points to

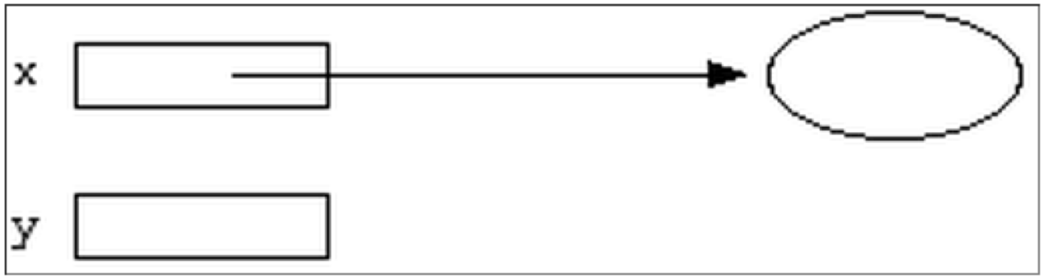
- Example:
  - double x, *ptr;
  - ptr = **&**x;   // let ptr point to x
  - *****ptr = 7.8;   // assign the value 7.8 to x

Pointer Example

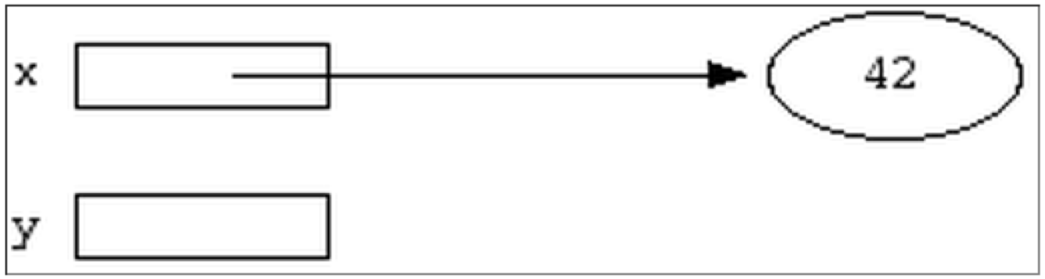
```
int *x;

int *y;
```



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

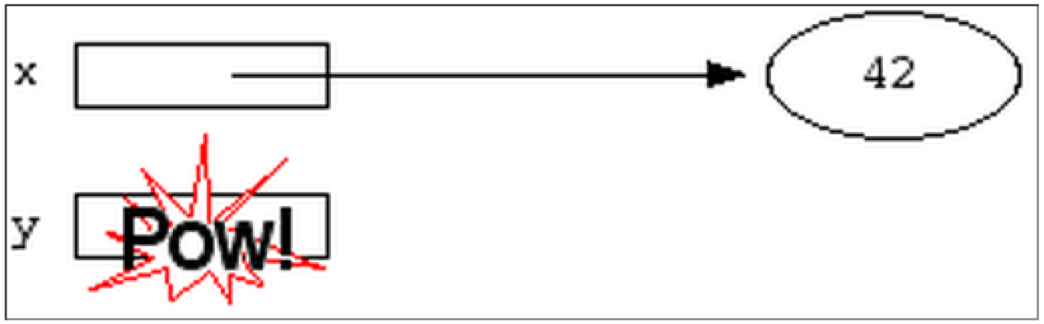


```
*x = 42;
```

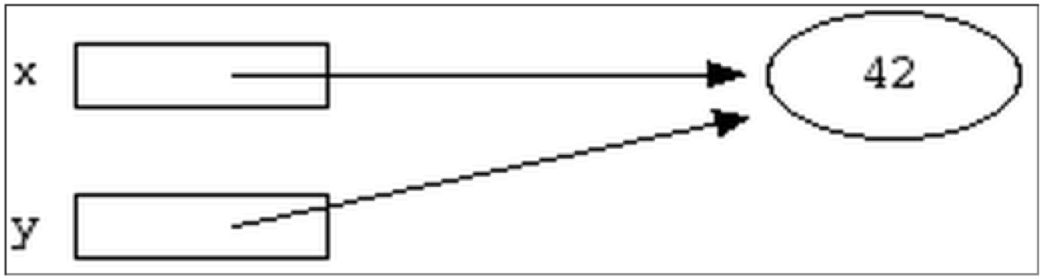


Pointer Example

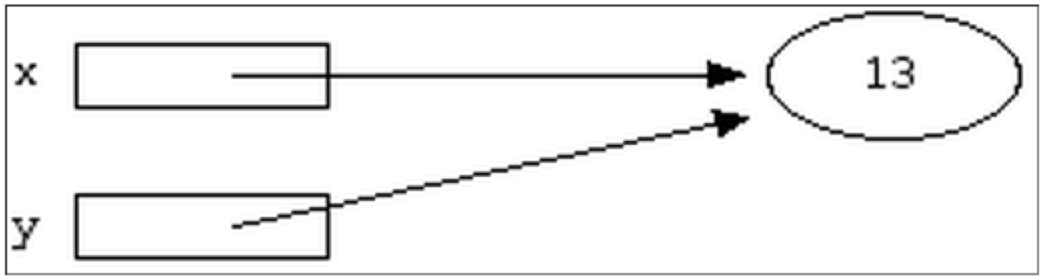
*y = 13;



y = x;

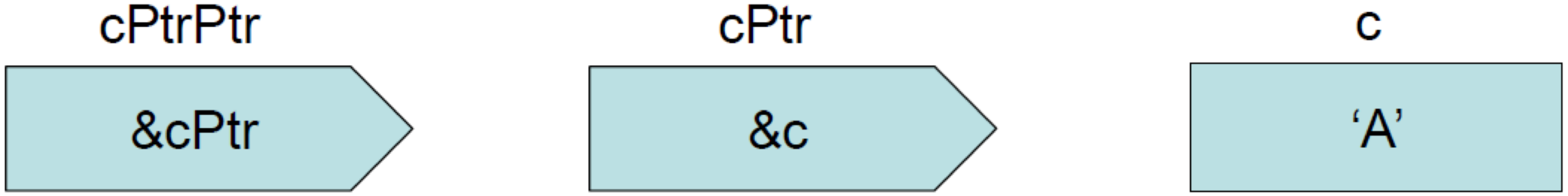


*x = 13; or
*y = 13;



Pointers to Pointers

char c = ‘A’   char *cPtr = &c   char **cPtrPtr = &cPtr



Pointers to Functions

- Also known as: **function pointers**
- Goal: write a sorting function
  - Has to work for ascending and descending sorting order + other
- How?
  - Write multiple functions
  - Provide a flag as an argument to the function
  - Polymorphism and virtual functions
  - Use function pointers!!

Pointers to Functions

- User can pass in a function to the sort function
- Declaration
  - double (*func_ptr) (double, double);
  - func_ptr = &pow; // func_ptr points to pow()
- Usage
  - // Call the function referenced by func_ptr

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

qsort Example

void qsort (void* base, size_t num, size_t size, int (*compar)(const void*,const void*));

Return value meaning for comparator function:

< 0	The element pointed by p1 goes before the element pointed by p2
= 0	The element pointed by p1 is equivalent to the element pointed by p2
> 0	The element pointed by p1 goes after the element pointed by p2

```
#include <stdio.h>
#include <stdlib.h>
int compare (const void * a, const void * b){
        return ( *(int*)a - *(int*)b );
}
int main () {
        int values[] = { 40, 10, 100, 90, 20, 25 };
        qsort (values, 6, sizeof(int), compare);
        int n;
        for (n = 0; n < 6; n++)
                printf ("%d ",values[n]);
        return 0;
}
```

Structs

- No classes in C
- Used to package related data (variables of different types) together
- Single name is convenient

```
struct Student {
        char name[64];
        char UID[10];
        int age;
        int year;
};
struct Student s;
```

```
typedef struct {
        char name[64];
        char UID[10];
        int age;
        int year;
  } Student;
  Student s;
```

C structs vs. C++ classes

- C structs cannot have member functions
- There's no such thing as access specifiers in C
- C structs don't have constructors defined for them

- C++ classes can have member functions
- C++ class members have access specifiers and are **private** by default
- C++ classes must have at least a default constructor

Dynamic Memory

- Memory that is allocated at runtime
- 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/Writing Characters

- **int getchar();**
  - Returns the next character from stdin
- **int putchar(int character);**
  - Writes a character to the current position in stdout

Formatted I/O

- int fprintf(FILE * fp, const char * format, …);
- int fscanf(FILE * fp, const char * format, …);
  - FILE *fp can be either:
    - A file pointer
    - stdin, stdout, or stderr
  - The format string
    - int score = 120; char player[] = “John”;
    - fp = fopen(“file.txt”, “w+”)
    - fprintf(fp, **“%s has %d points.\n”, player, score**);

Homework 4

- Write a C program called *sfrob*
  - Reads stdin byte-by-byte **(getchar)**
    - Consists of records that are newline-delimited
    - Each byte is frobnicated (XOR with dec 42)
  - Sort records without decoding (**qsort, frobcmp**)
  - Output result in frobnicated encoding to stdout **(putchar)**
  - Error checking (**fprintf**)
  - Dynamic memory allocation (**malloc, realloc, free**)

Example

- Input: printf 'sybjre obl'
  - $ printf 'sybjre obl**\n**' | ./sfrob
- Read the records: sybjre, obl
- Compare records using *frobcmp* function
- Use *frobcmp* as compare function in *qsort*
- Output: obl sybjre

Homework Hints

- Start as soon as possible
- Array of pointers to char arrays to store strings (char** arr)
- Use the right cast while passing frobcmp to qsort
  - cast from void ** to char ** and then dereference because frobcmp takes a char *
- Use realloc to reallocate memory for every string and the array of strings itself, dynamically
- Use *exit*, not *return* when exiting with error
- *memfrob() function for own test cases*