# CS35L – Winter 2019

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

## *What is C*

# *Basic Data Types*

| | |
|---|---|
| int | Holds integer numbers<br>Usually 4 bytes |
| float | Holds floating point numbers<br>Usually 4 bytes |
| double | Holds higher-precision floating point numbers<br>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 x = 77;     // define an int variable`
  - `ptr = &x;   // let ptr point to the variable x`

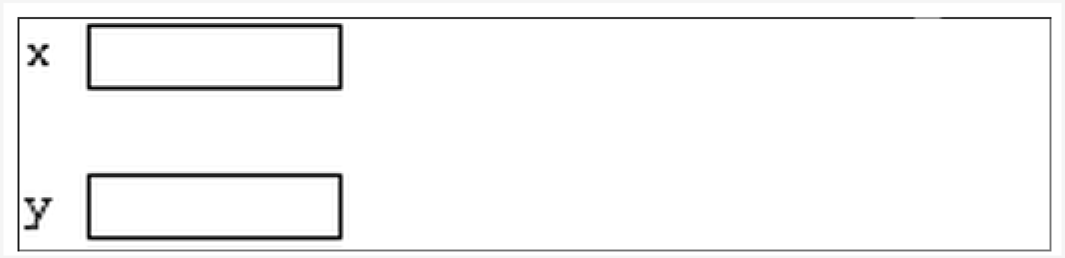
## *Dereferencing Pointers*

- Accessing the value that the pointer points to

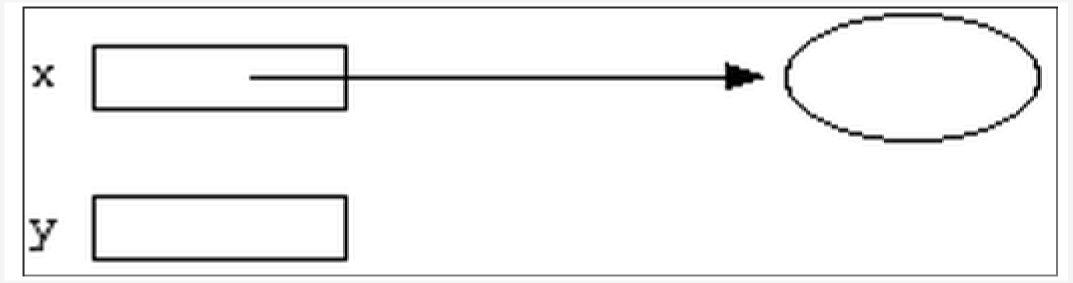
- Example:
  - `double x, *ptr;`
  - `ptr = `**`&`**`x;   // let ptr point to x`
  - **`*`**`ptr = 7.8;           // assign the value 7.8 to x`

# *Pointer Example*

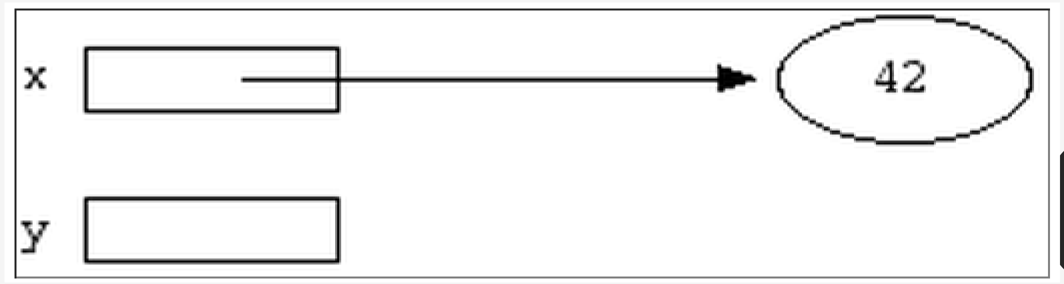
```
int *x;
int *y;
```



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

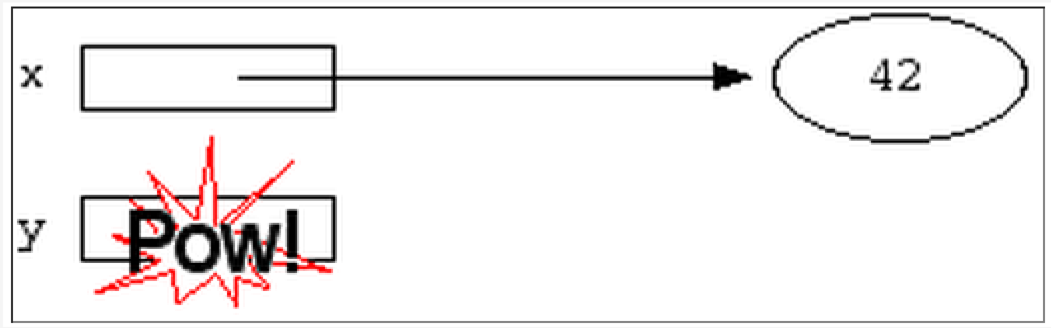


```
*x = 42;
```

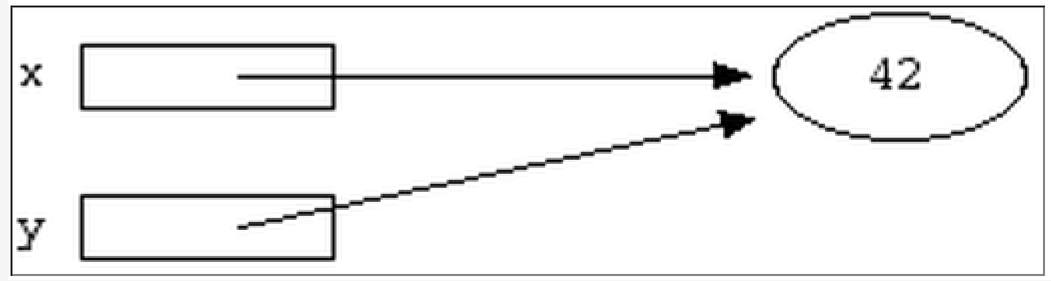


## *Pointer Example*

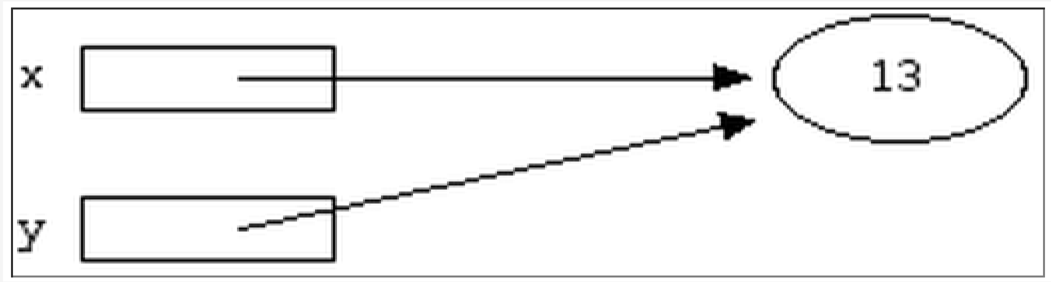
```
*y = 13; //error
```



```
y = x;
```

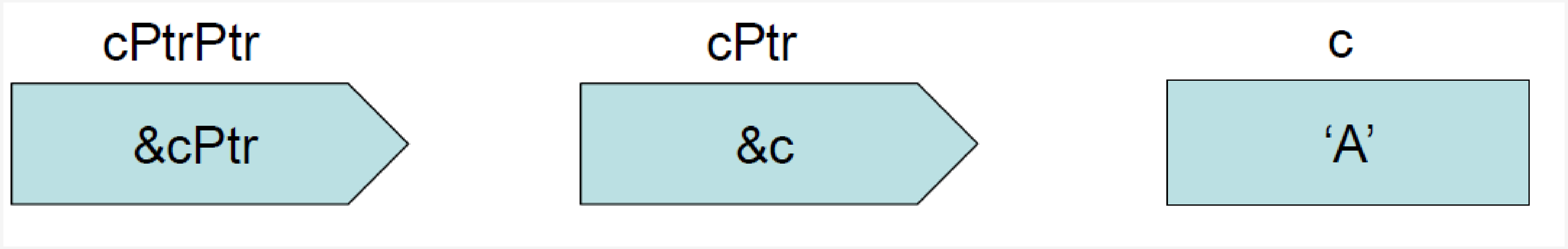


```
*x = 13;       or
*y = 13;
```



## *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*

- 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

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

```c
typedef struct Student {
    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*