CS 35L Software Construction Lab
Week 4 - C Programming

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**

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

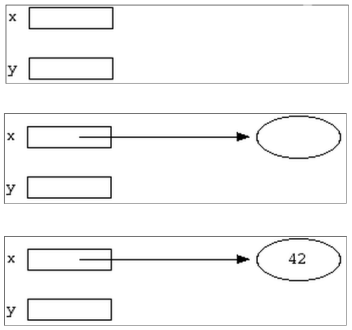
Pointer Example

int *x;

int *y;

int var; x = &var;

*x = 42;

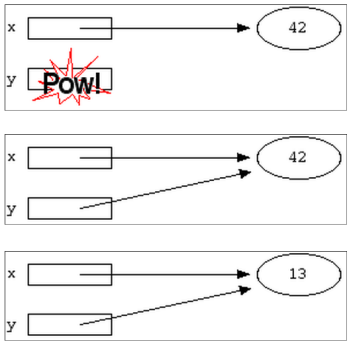


Pointer Example

*y = 13;

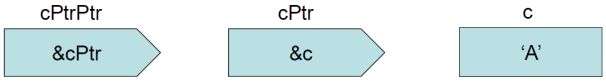
y = x;

*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** or **functors**
- 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
  - 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);
  - // The same function call
    result = func_ptr(1.5, 2.0);

qsort Example

```
#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;
```

typedef Declarations

- Easy way to use types with complex names

```
typedef struct { double x, y; } Point_t;

typedef struct
{
  Point_t top_left;
  Point_t bottom_right;
} Rectangle_t;
```

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. EOF when input ends or error encountered.
- **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[] = "Mary";
    - 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)**
  - 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

- 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