C Advanced Topics

Structures, Unions, Bit Fields, Make and Makefiles

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Enumerations

- Enums are a set of constants
  - Represented as integers in memory (starting from 0 by default)

```
#include <stdio.h>
enum days { MONDAY, TUESDAY, WEDNESDAY,
            THURSDAY, FRIDAY, SATURDAY, SUNDAY };
int main()
{
    enum days d = WEDNESDAY;
    printf("%d\n", d);          // 2
    printf("%lu", sizeof(d));   // 4

    return 0
}
```

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Declaring Enumerations

Live demos

Structures

- Structures are a set of related variables under one name
  - Declared with the keyword **`struct`**
  - Structure variables may be of different type

```
struct Person
{
    char *name;
    int age;
};
```

Same as enclosing code in include guard

Accessing Structure Members

- There are two ways to access structure members
  - `.` returns the value of the member

```
struct Person p;
p.name = strdup("Emily");
p.age = 18;
```

  - `->` dereferences a struct pointer and returns the member

```
struct Person *p = malloc(sizeof(struct Person));
p->name = strdup("Emily");
p->age = 18;
```

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Declaring Structures

Live demos

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Unions

Unions

- A union is a special data type that stores multiple variables in the same memory location
  - Only one member should be used at a time
  - Used to save up memory
  - Example:

```
union Data {
   int i;
   float f;
   char str[20];
};
```

Unions – Example

```
union Data {
    int i;
    float f;
    char str[20];
};

int main() {
    union Data data;
    data.i = 10;
    data.f = 220.5;
    strcpy( data.str, "C Programming");

    printf( "data.i : %d\n", data.i); // 1917853763
    printf( "data.f : %f\n", data.f); // 41223605803277948604527599...
    printf( "data.str : %s\n", data.str) // C Programming

    return 0;
}
```

Changing one variable corrupts the value of others

Bit Fields

- Bit fields allow packing data into memory less than a byte
  - The memory will always be at least 1 byte in size

```
struct Status {
   unsigned char isValidUsername : 1; // Can be 0 or 1
   unsigned char isValidPassword : 1;
};
```

Values are stored in 2 bits of memory

  - Used to save up memory
  - Slower than usual, the processor needs to make bit manipulations to access the exact bits

Bit Fields – Example

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```
typedef struct {
    unsigned char health : 4; // 0..10
    unsigned char direction : 2;  // 0-North, 1-West, 2-South, 3-East
    unsigned char lives : 2;  // 0..3
} CharacterInfo;

int main() {
   CharacterInfo charInfo;
   charInfo.health = 10;
   charInfo.lives = 3;
   charInfo.direction = 3;

   printf("Direction: %d, Lives: %d, Health: %d\n",
        charInfo.direction, charInfo.lives, charInfo.health);
   printf("Memory: %lu", sizeof(CharacterInfo)); // 1
   ...
```

Makefile – Example

Tab (not space) indent is required

Makefile

```
program: main.o functions.o
	gcc main.o functions.o -o program
```

- Usually named Makefile
- Tells the compiler to:
  - Compile **`main.c`** and **`functions.c`** into object files
  - Link **`main.o`** and **`functions.o`** into a single executable – **`program`**
- Executed with the `make` command (no additional arguments)

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Questions?

https://softuni.bg/trainings/1212/C-Programming-October-2015

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