Structures and Union

Review

- bitwise operations
  - you need them for performance in terms of space and time
  - shifts are equivalent to arithmetics
- enumeration
  - you can define a set
  - each member is represented as an integer
- preprocessor directives
  - process your program before it is compiled

Structures

```
struct date {    /* structure declaration with a tag name */
       int  day, month, year;
       char day_name[4];       /* Mon, Tue, Wed, ... */
       char month_date[4];     /* Jan, Feb, Mar, ... */
 }
struct date yesterday, today, tomorrow;
/* variable declaration of the struct date type */
```

- Like enum, it may define a new type
- Aggregate variables of different types
- Each member of a structure can be
  - array
  - structure
  - arrays of structures

Accessing a member

- dot (.) operator
  - structure_name.member_name
  - e.g) yesterday.year

- -> operator
  - pointer_to_structure->member_name
  - is same as
  - (*pointer_to_structure).member_name

```
struct complex {
   double re;     /* real part */
   double im;     /* imag part */
} *a, *b;  /* 2 pointer variables pointing to complex structure */
```

Accessing members of a structure can be done then by

```
  a -> re = b -> re;
  a -> im = b -> im;
```

Declarations and assignments

```
struct student tmp, *p = &tmp;
tmp.grade = 'A';
tmp.last_name = "Casanova";
tmp.student_id = 910017;
```

```
struct student {
    char    *last_name;
    int     student_id;
    char    grade;
};
```

Expression	Equivalent expression	Value
tmp.grade	p -> grade	A
tmp.last_name	p -> last_name	Casanova
(*p).student_id	p -> student_id	910017
* p -> last_name + 1	(* (p -> last_name)) + 1	D
*(p -> last_name + 2)	(p -> last_name)[2]	s

Using structures

- assignment works (NOT for arrays) as long as two variables are of the same structure type

- structure is more like a primitive type when used as a function parameter
  - call by value – the whole structure is copied
    - inefficient
    - this is one of reasons why you have -> operator
  - if it contains an array, the whole array is copied

```
struct dept {  /* declaration of dept structure */
    char    dept_name[25];
    int     dept_no;
};

typedef  struct {  /* declaration of employee_data s
    char                    name[25];
    int                     employee_id;
    struct dept             department;
    struct home_address     *a_ptr;
    double                  salary;
} employee_data;
```

- to write a function to update employee information
  1. pass a structure
  2. pass a pointer to structure (this is more efficient because ...)

```
employee_data update(employee_data e)
{
 printf("Input the department number: ");
 scanf("%d", &n);
 e.department.dept_no = n;
 return e;
}
```

```
void update(employee_data *p)
{
 printf("Input the department number: ");
 scanf("%d", &n);
 p -> department.dept_no = n;
 return ;
}
```

Initialization

```
typedef struct {
    float  re;
    float  im;
} complex;
complex a[3][3] = {/* 2 dimensional array of stru
 {{1.0, -0.1}, {2.0, 0.2}, {3.0, 0.3}},/* a[0][]
 {{4.0, -0.4}, {5.9, 0.8}, {6.6, 4.7}},/* a[1][]
};  /* a[2][] is initialized to 0 */
```

Initialization 2

```
struct  home_address {
    char  *street;
    char  *city_and_state;
    long  zip_code;
} address ={"285 Old Westport Road", "North Dartmouth, Massachusetts", 02747}

struct home_address previous_address = {0};
/* All members of a structure will be initialized to zero. It causes pointer
members to be initialized with the pointer value NULL and array members (if
any) to have their elements initialized to zero. */
```

unions

```
union int_or_float {
/* union type template declaration */
      int    i;
      float  f;
};
```

- similar to structure, but
- it defines a set of alternative values that may be stored in a shared location

- The programmer is responsible for interpreting the value correctly

Unions

- to access a union member
  - .
  - ->
- the memebers of a structure and or a union can be array, structure, union

```c
#include <stdio.h>

typedef union int_or_float {
    int      i;
    float    f;
} number;

int main(void)
{
    number    n;

    n.i = 4444;
    printf("i: %10d      f: %16.10e₩n", n.i, n.f);
    n.f = 4444.0;
    printf("i: %10d      f: %16.10e₩n", n.i, n.f);
    return 0;
}
```

The output of this program is system dependent. It may print for ins

```
i:        4444      f: 6.227370375e-41
/* same bits interpreted as float */
i: 1166729216      f: 4.4440000000e+03
/* now  n.f correct but the same bits interpreted as  */
/* integer n.i give a garbled information             */
```

bit field

```
struct floating_number {
    unsigned        sign_bit : 1,
                    exponent : 8,
                    significand : 23;
} r1, r2;
```

- A bit field is an int or unsigned member of a structure or a union
- bit filed may be unnamed
- unnamed bit field of width 0 is for alignment of the next word
- restrictions
  - array of bit fields
  - address operator &

```
#include <limits.h>
#include <stdio.h>

typedef struct {
   unsigned    b0 : 8, b1 : 8, b2 : 8, b3 : 8;
} word_bytes;

typedef struct {
   unsigned
      b0 : 1, b1  : 1, b2  : 1, b3  : 1, b4  : 1, b5  : 1, b6  : 1,
      b7 : 1, b8  : 1, b9  : 1, b10 : 1, b11 : 1, b12 : 1, b13 : 1,
      b14: 1, b15 : 1, b16 : 1, b17 : 1, b18 : 1, b19 : 1, b20 : 1,
      b21: 1, b22 : 1, b23 : 1, b24 : 1, b25 : 1, b26 : 1, b27 : 1,
      b28: 1, b29 : 1, b30 : 1, b31;
} word_bits;

typedef union {
   int            i;
   word_bits     bit;
   word_bytes    byte;
} word;
```