CS 240 Programming in C

Array, Control Statements

September 15, 2022

Schedule

1. Array
2. Control Statement

Array

- Arrays are very different data type comparing to ints, floats and chars, etc.
- Though an array is also a name to a fixed memory address, but C defines its data type as a pointer data type, by which it means it represents an address value.
- Actually array is a special pointer data type that stores its own address value and it is unchangeable.
- Let's take a look.

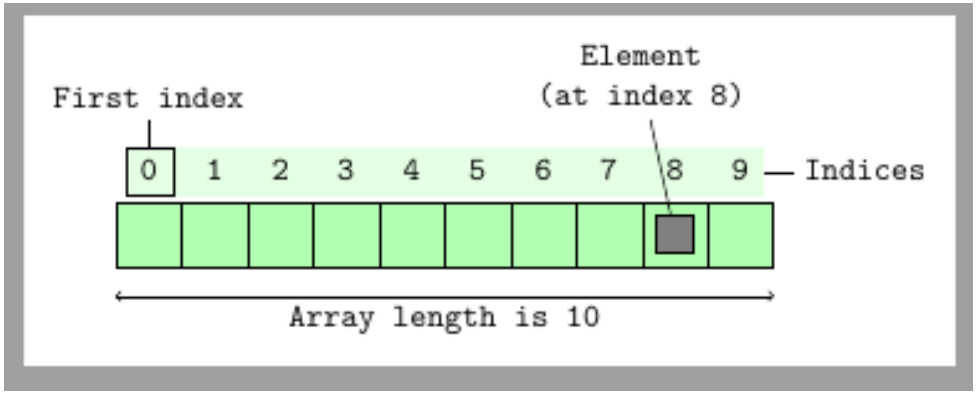
Array

```
    int a,arr[3];

printf("%p\n", &a); // a's address
printf("%d\n", a);  // a's value
printf("%p\n", arr);  // arr's value
printf("%p\n", &arr); // arr's address
printf("%d\n", arr[0]);
```

You will find out that arr's value and address are the same.

Array




```
int a[10];
```

- To define an array without initialization, you have to have 3 parts, basic data type, name and length.
- Once an array is defined, array subscripting could be used to access the element in the array like a[9].
- Array subscripting starts from 0 and can be any integer expression like a[1+2-1], or a[i+j*2-1].
- Out of range for subscripting will not cause compiling error, we have to be careful ourself.

Array Initialization

```
int a[] = {1,2,3};
a has length of 3

int b[10] = {1,2,3};
b has a length of 10 and the rest elements
will have value of 0


int c[5] = {[1]=-1,[4]=-2};
// after c99; designated initializer
```

Sizeof() Array

```
int a[3];
sizeof(a)/ sizeof(int);

//this is the length of a
```

Array Copying

To copy array a to array b, like this

```
int a[] = {1,2,3}, b[3];
b = a;   // big wrong, cannot even pass compiling
```

This is wrong, even they have same length and same type:

Why?

Array Copying

- Arrays hold constant pointers. Once they are created, they point to fixed address in the stack(which will be covered later.)
- So "b = a" tries to assign the address of a to b which can not change the address it points to is illegal.
- Even if it was legal,it will not be what the equation intends to achieve. Because b will point to the same block memory of a, instead of copying the data of a to the memory which b points to right now.

Array Copying

- Actually there are many ways to copy an array. Two are listed below.
- Write a loop, iterate every element.
- Use memcpy defined in <string.h>. Page 250.

memcpy

```
void *memcpy(s,ct,n)
//copy n characters from ct to s, and return s
```

- s and ct here are pointers, since arrays are constant pointers, so we can copy the array a into array b use memcpy as the follows:

```
memcpy(b,a,sizeof(a));
```

- Lots of programmers prefer memcpy, because it is much fast than loop, especially for large array, since there is no overhead for the computation of loop, just copying.
- By the way, can we use memcpy for basic variables ?
- Yes, but have to deal with their pointers.

memcpy

- By the way, can we use memcpy for basic variables ?
- Yes, but have to deal with their pointers

```
int a=0,b=1;

memcpy(b,a,sizeof(a)); // wrong

memcpy(&b,&a,sizeof(a)); right
```

- But nobody does this way. Just b=a.

Character Arrays (Strings)

- String constant (or literal)
  - A sequence of 0 or more characters surrounded by double quotes
  - Ended with a null character '\0'
- Quotes are not part of the string – they serve only to delimit
- Stored as an array of characters
- We can define/initialize an array to contain the string "hello" and the end of line character:
  `char str[7] = "hello\n";`
- Why do we need 7 slots in this array?

Statements: if, else if, else

```
if (condition 1)
 { branch 1 }
else if (condition 2)
 { branch 2}
[...]
else
 { branch n}
```

The curly braces are optional when the branch only contains 1 statement.

Statements and Blocks

- Recall that an expression is a combination of values, constants, variables, operators, and functions that evaluates to another value
- An expression becomes a statement when it is followed by a semicolon
  For example, `x = 0;`
- Curly braces are used to group statements into a compound statement, or block

```
{
  x = 0;
  y = 1;
}
```

  which acts like one statement to the outside.
- Note that the closing brace is not followed by a semicolon

Statements and Blocks

- Syntactically, the grouped statements are equivalent to a single statement
- In control statements, there are often curly braces being used for grouping statements to one of those branches
- These are other use cases for blocks, when we later talk about scopes.

If Statements

- Things to note:
- The `if` condition is just testing a numeric value
- We can use a shortcut in this test:
  - `if (expression)` is the same as `if (expression != 0)`
  - `if (!(expression))` is the same as `if (expression == 0)`

Else-If

- Things to note:
- Can have as many as you want
- They are evaluated in order
- If the condition evaluates to be true for one, its statement is executed, and we don't look at the rest
- An `else` at the end is equivalent to "none of the above"

Relational Operators

- Check the relationship between the values of their operands
- The expression always evaluates to 1 (true) or 0 (false)
- `x == y`: the values of x and y are equal
- `x != y`: the values of x and y are not equal
- `x > y`: x is greater than y
- `x < y`: x is less than y
- `x >= y`: x is greater than or equal to y
- `x <= y`: x is less than or equal to y

Assignment Versus Equality Operators

- = assignment operator (not a statement)
- == equality operator
- `(c == 9)` tests whether c is the newline character
- `(c = 9)` this has the value of 9
- It is better for you to write `(9 == c)` instead of `(c == 9)`, since if you forgot the double equal sign, the first will throw out an error, however the later will always assume the value of 9, which can be a big trouble.
- Let's see a demo.

Switch Statements

- Another way to do multi-way decisions

```
switch (expression) {
    case constant-expr1:
        statements
    case constant-expr2:
        statements
    default:
        statements
}
```

Switch Statements

- This will test whether expression matches each of the constant expressions and execute the corresponding statements
- if there is no case being matched, the default statements will be executed.
- The constant expressions must be integer-valued
- Execution will fall through a switch (which means goes to the next switch statement) unless you add `break` after statements.
- That is to say an end of one case statement is not an end of one switch unless it is the last case statement.
- Compare to if-else, this is a big difference. Since in if-else one branch ends, the next if-expression will be evaluated, however switched case will just fall through.
- Let's see a demo.

If-Else vs. Switch

- Suppose we need to test the value of a status variable, and there are 20 different values
- With `if-else`, we test `(status == 1)`, then `(status == 2)`, etc.
- By the time we reach 20, we have tested 19 times
- With `switch`, it is usually compiled into assembly as a *jump table*
- An array of `goto` instructions subscripted by the value of `status`
- If status is 20, we look up the `goto` at address 20 in the table
- This way we only execute that one `goto`
- Good practice is to always use `break`
- Falling through can be useful, but you should be careful with it as it may create unintended behavior if the program is modified later

Loops

- These are equivalent

```
for (expr1; expr2; expr3)
  statements;
```

```
expr1;
while (expr2) {
    statements;
    expr3;
}
```

- Note that any part of a for loop can be left out
  `for(init; loop-test; steps)`
- If `init` is left out, you must initialize somehow
- If `steps` is left out, you must manage steps
- If `loop-test` is left out, you must break in some case

Comma Operator

- Most often usage is in the for-loop statements
- Pairs of expressions separated by a comma , are evaluated left-to-right
- Value of comma expression is the value of the rightmost comma-separated expression

Comma Operator

- Example of using the comma operator in a for-loop:

```
int a[] = {1,2,3}, i,j,temp;
for(i = 0, j = sizeof(a)/sizeof(int)-1;
                        i < j; i++, j--){

        temp = a[i];
        a[i] = a[j];
        a[j] = temp;
 }
```

Do While

```
do {
  statements;
} while (expression);
```

- Guaranteed to execute the statements at least once, regardless of whether expression is true or false
- Used infrequently

Break and Continue

- `break`
  - Allows departure from a loop
  - Can be used in for, while, and do loops (similar to its use in switch)
  - Allows you to exit the current loop
    one level only; remember this when you use break in nested loops
- `continue`
  - Skips to the next iteration of the loop
  - It is used to selectively execute statements in a loop iteration