CH-230-A

Programming in C and C++

C/C++

Tutorial 3

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for: Example Revised

```
1  #include <stdio.h>
2  int main() {
3    int idx, n, sum = 0;
4    printf("Type a positive number ");
5    scanf("%d", &n);
6    for (idx = 1; idx <= n; idx++) {
7      printf("Processing %d..\n", idx);
8      sum += idx;
9    }
10   printf("The sum is %d\n", sum);
11   return 0;
12 }
```

Boolean Operators and if

```
1  for (n = 0; n < 3; n++) {
2    for (i = 0; i < 10; i++) {
3      if (n < 1 && i == 0) {
4        printf("n is < 1, i is 0\n");
5      }
6      if (n == 2 || i == 5) {
7        printf("HERE n: %d i:%d\n", n, i);
8      }
9      else {
10       printf("n:%d, i:%d\n", n, i);
11     }
12   }
13 }
```

Easier or Harder to Read?

```
1 for (n = 0; n < 3; n++)
2   for (i = 0; i < 10; i++) {
3     if (n < 1 && i == 0) {
4       printf("n is < 1, i is 0\n"); }
5       if (n == 2 || i == 5) {
6        printf("HERE n: %d i:%d\n", n, i); }
7       else {
8         printf("n:%d, i:%d\n", n, i); }}}
```

Iterations: do ... while

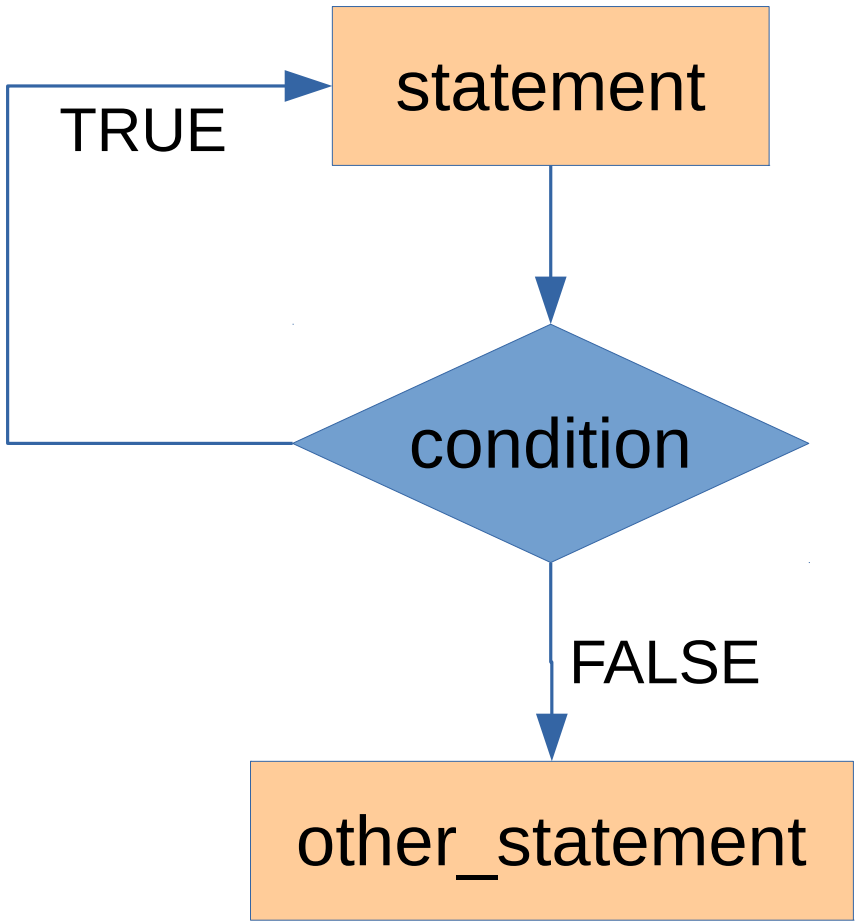
- General syntax:

```
1  do
2     statement;
3  while (condition);
```

```
1 do {
2    statement1;
3    statement2;
4 } while (condition);
```

- In this case the end condition is evaluated at the end
- The body is always executed at least once

`do ... while`: Flow Chart



do ... while: Example

```
1  #include <stdio.h>
2  int main() {
3    int n, sum = 0;
4    do {
5      printf("Enter number (<0 ends)");
6      scanf("%d", &n);
7      sum += n;
8    } while (n >= 0);
9    sum -= n; /* Remove last negative value */
10   printf("The sum is %d\n", sum);
11   return 0;
12 }
```

Jumping Out of a Cycle: `break`

- The keyword `break` allows to jump out of a cycle when executed
- We have already seen this while discussing `switch`

```
1 int num, i = 0;
2 scanf("%d", &num);
3 while (i < 50) {
4   printf("%d\n", i);
5   i++;
6   if (i == num)
7     break;
8 }
```

Jumping Out of a Cycle: `continue`

- `continue` jumps to the expression governing the cycle
- The expression is evaluated again and so on

```
1  char c;
2  /* code assumes that the input is
3     provided in one line like:
4     "abf23cdef" followed by enter */
5  while ((c = getchar()) != '\n') {
6    // ignore the letter b
7    if (c == 'b')
8      continue;
9    printf("%c", c);
10 }
```

Jumping Out of a Cycle

- Do not abuse `break` and `continue`
- You can always obtain the same result without using them
  - This at the price of longer coding
- By using them your code gets more difficult to read
- When you are experienced you will master their use
  - Meanwhile, learn the basics

Iterations: General Comments

- Inside the body of the loop you must insert an instruction that can cause the condition to become false
- If you do not do that, your program will fall into an infinite loop and will be unable to stop (Press `Ctrl-C` to stop such a program)
- `do ... while` is far less used than `while` and `for`
- The same constructs are provided in the majority of other programming languages

Arrays in C

- See first lecture for introduction
- In C you declare an array by specifying the size between square brackets
- Example: `int my_array[50];`
- The former is an array of 50 elements
- The first element is at position 0, the last one is at position 49

Accessing an Array in C

- To write an element, you specify its position

```
1   my_array[2] = 34;
2   my_array[0] = my_array[2];
```

- Pay attention: if you specify a position outside the limit, you will have unpredictable results segmentation fault, bus error, etc.
- And obviously wrong
- Note the different meaning of brackets
- Brackets in declaration describe the dimension, while in program they are the index operator

Arrays with Initialization

- C allows also the following declarations:

```
1   int first_array[]    = {12, 45, 7, 34};
2   int second_array[4] = {1, 4, 16, 64};
3   int third_array[4]   = {0, 0};
```

- It is not possible to specify more values than the declared size of the array
- The following is wrong:

```
1   int wrong[3] = {1, 2, 3, 4};
```

Typical Structure of a C Program

```
1  #include <stdio.h>
2  int rect_area(int length, int width);
3  float b_func(int a, int b);
4  int main() {
5    ...
6    c = rect_area(5, 7);
7    b_func(11, 6);
8    return 0;
9  }
10 int rect_area(int length, int width) {
11   ...    /* do some operations */
12   return area;
13 }
14 float b_func(int a, int b) {
15   ...    /* do some operations */
16   return c;
17 }
```

Calling a Function

- To call a function you insert its name
  - Function call is a statement
- You have to provide suitable parameters
  - Number and type of parameters must match function declaration
- The result of a function can be ignored

An Example

```
1  #include <math.h>
2  #include <stdio.h>
3  int main() {
4    double number, root;
5    scanf("%lf", &number);
6    if (number >= 0) {
7      root = sqrt(number);
8      printf("Square root is %f\n", root);
9      sqrt(number); /* useless but legal */
10     /* What can I print now? */
11   }
12   else
13     printf("Cannot calc square root\n");
14   return 0;
15 }
```

```
gcc -Wall -lm -o example example.c
```

Finding the Maximum Value in an Array

```
1  /*  v[100]: array of ints
2      dim: number of elements in v
3      Returns the greatest element in v
4  */
5  int findmax(int v[100], int dim) {
6    int i, max;
7
8    max = v[0];
9    for (i = 1; i < dim; i++) {
10     if (v[i] > max)
11       max = v[i];
12     }
13   return max;
14 }
```

Looking for an Element

```
1  /*  v[100]: array of ints
2      dim: number of elements in v
3      t: element to find
4      Returns -1 if t is not present in v or
5      its position in v
6  */
7  int find_element(int v[100], int dim, int t)  {
8    int i;
9    for (i = 0; i < dim; i++) {
10     if (v[i] == t)
11       return i;
12   }
13   return -1;
14 }
```

Flow of Execution

```
1  #include <stdio.h>
2
3  int main() {
4    int array[] = {2, 4, 8, 16, 32};
5    int result;
6
7    result = find_element(array, 5, 37);
8    if (result == -1)
9      printf("37 is not present\n");
10
11   return 0;
12 }
```

Pointers and Address Arithmetic

- The arithmetic operators for sum and difference (+, -, ++, --, etc) can be applied also to pointers
  - After all a pointer stores an address, which is an integer
- These operators are subject to the "address arithmetic".
- Increasing a pointer means that the pointer will point to the following element
  - You can also add a number other than 1
- From a logic point of view the pointer is increased by one. From a physical point of view, the increment depends on the size of the pointed type

Address Arithmetic: Example (1)

```
1  int main() {
2    char a_string[] = "This is a string\0";
3    char *p;
4    int count = 0;
5    printf("The string: %s\n", a_string);
6    for (p = &a_string[0]; *p != '\0'; p++)
7      count++;
8    printf("The string has %d chars.\n", count);
9    p--;
10   printf("Printing the reverse string: ");
11   while (count > 0) {
12     printf("%c", *p);
13     p--;
14     count--;
15   }
16   printf("\n");
17   return 0;
18 }
```

Address Arithmetic: Example (2)

```
1  int main() {
2    char a_string[] = "This is a string\0";
3    char *p;
4    int count = 0;
5    printf("The string: %s\n", a_string);
6    p = a_string;
7    while (*p != '\0') {
8      p++;
9      count++;
10   }
11   printf("The string has %d characters.\n", count);
12   printf("Printing the reverse string: ");
13   p--;
14   while (count > 0) {
15     printf("%c", *p);
16     p--;
17     count--;
18   }
19   printf("\n");
20   return 0;
21 }
```

Increasing a Pointer will Increase the Memory Address Depending on the Size of Type

```c
#include <stdio.h>
#include <stdlib.h>
int main() {
  char ch_arr[2] = {'A', 'B'};
  char *ch_ptr;
  float f_arr[2] = {1.1, 2.2};
  float *f_ptr;

  ch_ptr = &ch_arr[0];          /* same as ch_ptr = ch_arr */
  printf("%p\n", ch_ptr);   /* address of 1st elem */
  ch_ptr++;                 /* increase pointer   */
  printf("%p\n", ch_ptr);   /* address of 2nd elem */
  printf("%c\n", *ch_ptr);  /* content of 2nd elem */

  f_ptr = f_arr;            /* same as &f_arr[0]  */
  printf("%p\n", f_ptr);    /* address of 1st elem */

  f_ptr++;                  /* increase pointer   */
  printf("%p\n", f_ptr);    /* address of 2nd elem */
  printf("%f\n", *f_ptr);   /* content of 2nd elem */
  return 0;
}
```