CH-230-A

Programming in C and C++

C/C++

Tutorial 3

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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;This would directly lead to 0% for the exercise!
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;
}
```

Predefined and User Defined Functions

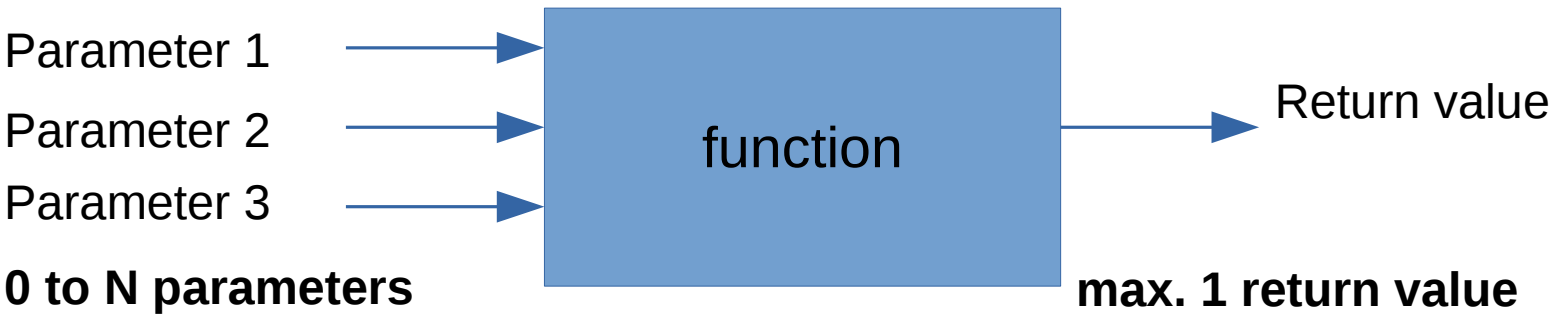
- Predefined functions are functions provided by the language or by the host
- Operating system
  - Library functions: they usually provide general purpose functionalities
- User defined functions are defined by the program
  - Usually targeted to the problem being solved

Functions: Motivation

- Writing a 50000 lines long main function can be really difficult
- Splitting the code into many small pieces has many advantages:
  - Easier to develop
  - Easier to maintain and debug
  - Increased opportunities to reuse the code
- An example: the `printf` function
  - Developed by specialists
  - Up to now we used it without knowing how it works internally
  - Should there be a bug in it, by just using an updated version you can fix your code at once

Some Analogies

- A function can be thought as a mathematical function
- A function can be thought as a black box performing some functionality



Functions in C

- **Function declaration** (prototyping)
- **Function call** (use)
- **Function definition**
- Call should be preceded by prototyping (ANSI C (American National Standards Institute) strongly advises this)
- There can be many declarations and many calls
- There must be exactly one definition

Prototyping

- The prototype is a statement declaring
  `return_type functionname(parameters);`
- Returned type is the type of the data
  - may be empty, default type is `int`
  - always declare the `return_type` explicitly
- Name follows the usual rules
- Parameters specify the number and types of the possible parameters
  - may be empty
  - always use explicit `void`, if function does not take arguments

The `void` Keyword

- `void` can be used to specify that
  - The function does not return any value
  - The function does not take any parameter
- `int unknown(void);`
  - function does not take any parameters
- `int unknown();`
  - function takes arbitrary number of parameters (to be compliant with the old Kernighan & Ritchie style)

Remember the Difference

- `void`
  - No return value
  - No parameter
- `void *`
  - Generic pointer (a pointer with no specific type which can be casted to any type)

Prototyping: Why?

- By having a prototype the compiler can check if the calls are performed correctly
  - Number of parameters, types, etc.
- It is now clear why prototypes should always appear before calls

Prototypes: Examples

- Prototypes of functions in `math.h`

```
double sqrt(double x);
double pow(double x, double y);
```

- User defined function prototypes

```
int find_max(int v[], int dim);
void print_menu(char *options[], int dim);
void do_something(void);
```

- `void` specifies no return value and empty parameters list

Function Definition

- The function definition specifies what a functions does
- Function definitions can contain everything (variables definitions, cycles, branches, etc) but NOT other function definitions
- A function terminates when
  - it executes the last instruction
  - it encounters a return statement
- Definition starts with the function header

  `return type, name, parameters info`
- Braces to define where the function starts and ends
- Business statements (instructions for carrying out the function's task)

What Happens when a Function is Called?

- The given parameters are copied into the corresponding entry in the parameters list
- The control is transferred to the function
- When the called function terminates, the control goes back to the caller function

Comment your Functions

- Every function should be commented
  - Describe what the function does
  - Describe each parameter (type and meaning)
  - Describe what the function returns
- Look at the UNIX man pages to have an idea of how function documentation should look like

  `man strcmp`