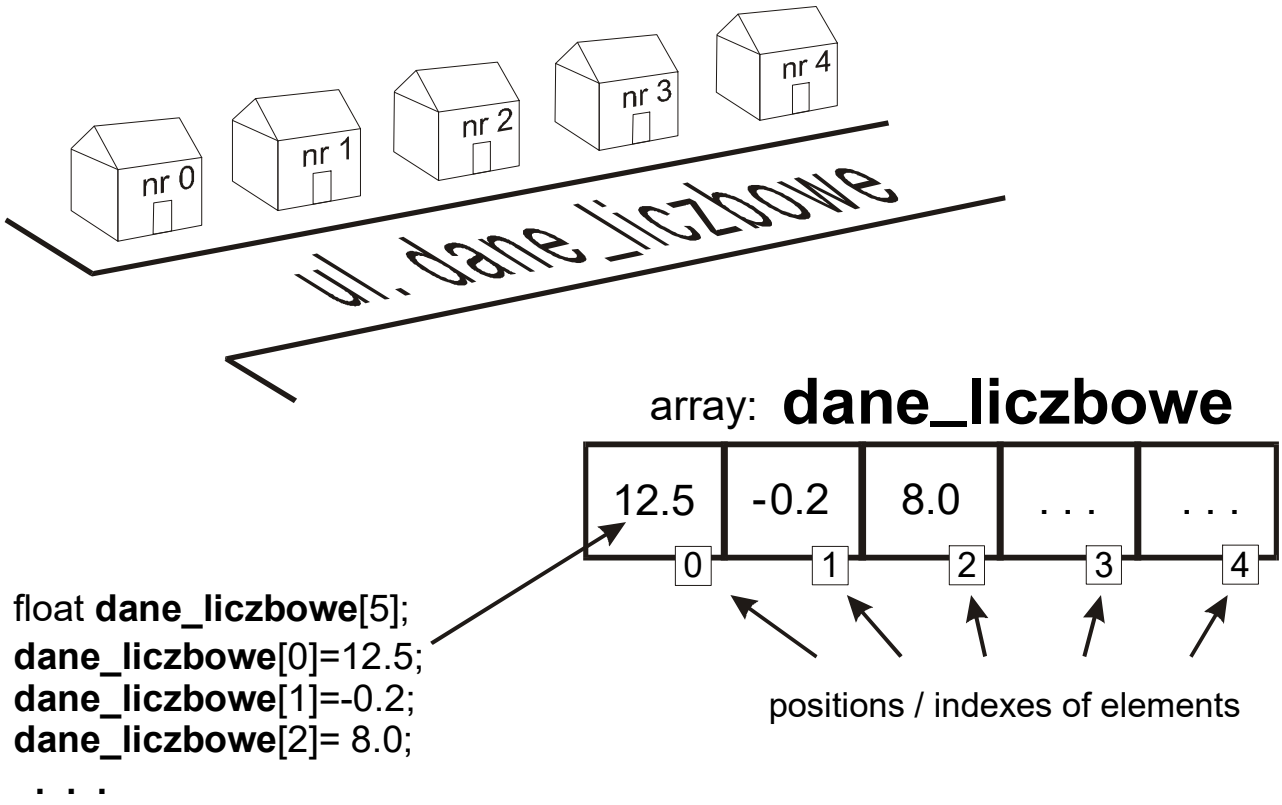
ARRAYS IN C/C++



Array → is a representation of data that allows **grouping** of several items of **the same type** and referring to them using common name.
It is one of the most commonly used data types.

The general form of array definition:

type_of_element arrayName [number_of_elements] ;

examples:

```
float  numerical_data[ 5 ];      // 5-element array of real numbers
int    tab[ 10 ];                // 10-element array of integers
char   text[ 255 ];              // 255-element array of characters

double (*functions [ 20 ]) (double,double);   // array of 20 function pointers
```

Notes on tables:

- An important feature of the table is a representation in the form of **contiguous region in memory** space and uniform distribution of subsequent components in immediate succession (directly one after the other)

  With such representation the computer can **quickly calculate the position** of an item in memory (based on its order number - index) and a significant reduction the code size, through the **use of loops**.

- Array elements are indexed starting **from zero !**

- C / C++ languages **do not check the range (correctness) of indexes!**

  This is often the cause of nasty (difficult to detect) errors. For example|,

  assuming definition: `float numerical_data [5];`

  instruction: `numerical_data [5]=10.5;`

  destroys / overwrites the memory **after** the last element of this array.

- The name of the array is, at the same time, the pointer the first element, ie.

  array_name == & array_name[0]

- Standard array **does not** store information about the **number of its elements**.

  Warning! function sizeof () does not return the number of elements.

The definition of a multidimensional array:

type array_name [size_1] [size_2] [size_3] . . . ;

examples:

```
char Rubik_Cube [ 3 ][ 3 ][ 3 ];
float matrix [ 5 ] [ 2 ];        // ← two-dimensional array of 5 rows, of 2 columns,
```

0 , 0	**0 , 1**
1 , 0	**1 , 1**
2 , 0	**2 , 1**
3 , 0	**3 , 1**
4 , 0	**4 , 1**

1 , 2

matrix representation ↓ in computer memory

0 , 0	**0 , 1**	**1 , 0**	**1 , 1**	**2 , 0**	**2 , 1**	**3 , 0**	**3 , 1**	**4 , 0**	**4 , 1**

↑

matrix[1][2]

The definition can be combined with initialization:

```
int   tab[ 10 ];     // ← definition without initialization
int   initialized_array [ 10 ]  =     { 20, -3, 12, 1, 0, 7, -5, 100, 2, 5 };
char  array_of_chars[ 5 ]  =          { 'a', 'B', '\n', '1', '\0' };
float matrix_A[ 3 ][ 2 ]  =           { {1,1}, {3.5,7.0}, {-15,100} };
float matrix_B[ 3 ][ 2 ]  =           { 1, 1, 3.5, 7.0, -15, 100 };
```

⇒ Subsequent "initializers" always are inserted to the subsequent "cells" (therefore inner curly braces can be omitted).

⇒ If the list of initializers is shorter than the number of elements in the array, other elements are complemented with zeros or NULL pointers

eg.:

```
int  tab[ 10 ] = { 20, -3, 12, 1 };
```

is equivalent to:

```
int  tab[ 10 ] = { 20, -3, 12, 1, 0, 0, 0, 0, 0, 0 };
```

definition:

```
float  matrix [ 3 ][ 2 ] = { {1}, {3.5,7.0} };
```

is equivalent to:

```
float  matrix[ 3 ][ 2 ] = { {1,0}, {3.5,7.0}, {0,0} };
```

or:

```
float  macierz[ 3 ][ 2 ] = { 1, 0, 3.5, 7.0, 0, 0 };
```

⇒ In C language, the initializers must be constant,
whereas in C ++ the initializers can be both constant or variable.

The use of constants to define the amount of array elements:

```
int  array [ 100 ] ;              // the size defined directly

#define  SIZE_C  100              // the definition of a constant using C-style
int  array [ SIZE_C ] ;

const int SIZE_2 = 100 ;          // constant definition using C++ style
int  array_2 [ SIZE_2 ] ;

for( int i=0 ; i < SIZE_2 ; i++ )     // the example of using the size constant
   printf ( "%d" , array_2[ i ] );
```

Basic operations on the array elements

```
#include <stdio.h>                                   // implementation in "C"
int main( )
{
   const  SIZE = 4 ;
   int       Tab [ SIZE ] ;

   // direct assignment of values
   Tab[ 0 ] = 0 ;
   Tab[ 1 ] = 10 ;
   Tab[ 2 ] = - 20 ;
   Tab[ 3 ] = 3 ;

   // entering array content from the keyboard
   scanf( "%d" , &Tab[ 0 ] ) ;
   scanf( "%d %d" , &Tab[ 1 ] , &Tab[ 2 ] ) ;
   printf( " Enter a fourth element = " );
   scanf( "%d" , &Tab[ 3 ] ) ;

   // primitive summation of array elements
   long sum = Tab[0] + Tab[1] + Tab[2] + Tab[3] ;

   // displaying the contents of array elements
   printf( " Tab[1] = %5d " , Tab[0] );
   printf( " Tab[2] = %5d " , Tab[1] );
   printf( " Tab[3] = %5d " , Tab[2] );
   printf( " Tab[4] = %5d " , Tab[3] );

   // indirect indication of the element, using the auxiliary variable
   int  i = 2 ;
   Tab[ i ] = 10;          // is quivalent to:        Tab[ 2 ] = 10;

   // entering the index of element, from the keyboard
   printf( " Enter position of the element, whose value you want to load " );
   scanf( "%d" , &i );
   printf( " Enter a new value of  Tab[ %d ] = " , i );
   scanf( "%d" , &Tab[ i ] );

   printf( " New value of Tab[ %d ] is equal %d " , i , Tab[ i ] );
}
```

Application of command "for" to automate operations on arrays

```
#include <stdio.h>                                   // implementation in "C"
int main( )
   {
      #define  LENGTH  10
      float  numbers[ LENGTH ];        // the definition of an array of real numbers
      int  i ;


      // --- initialization of an array with successive  even numbers: 0,2,4,6 ,...

      for( i = 0 ; i < LENGTH ; i++ )
         numbers[ i ] = 2*i ;


      // --- loading the contents of array elements from the keyboard
      for( i = 0 ; i < LENGTH ; i++ )
         {
            printf( " Enter  Number [%2d] = ", i+1 );
            scanf( " %f " , &numbers[ i ] );
         }


      // --- control display of the table contents
      for( i = 0 ; i < LENGTH ; i++ )
         printf( " Number[%2d] = %10.3f ", i+1 , numbers[ i ] );


      // --- summing the elements of an array
      float sum = 0 ;
      for( i = 0 ; i < LENGTH ; i++ )
         sum = sum + numbers[ i ];              //   sum += numbers[ i ];
      printf( " The sum of the array elements is: %.2f " , sum );


      // --- counting the number of elements with positive values
      int counter = 0 ;
      for( i = 0 ; i < LENGTH ; i++ )
         if(numbers[ i ] > 0 )
            counter = counter + 1 ;       //  counter += 1;     or    counter ++;

      if( counter > 0 )
         printf( " Number of positive elements = %d " , counter );
      else
         printf( " No positive values in the array " );
}
```

continued examples of array processing with loops „for”

```
#include <iostream>                                   // implementation in "C++"
using namespace std;
int main( )
   {
      const int LENGTH = 10;
      int  array[ LENGTH ];

      for( int i = 0 ; i < LENGTH ; i++ )     //------- entering values from keyboard
         {
            cout << ”Array[” << (i+1) << ”] = ”;
            cin >> array[ i ];
         }

      int counter=0;              //------------------------- counting of nonzero elements
      for( int i = 0 ; i < LENGTH ; i++ )
         if( array[ i ] )
            counter ++;

      int sum = 0;            //---------------------------- an average of negative values
      counter =0;
      for( int i = 0 ; i < LENGTH ; i++ )
         if( array[ i ] < 0 )
            {
               sum += array[ i ];
               counter++;
            }
      if( counter )
         {
            double average = (double)sum / counter;
            cout << endl << "Average of negatives = " << average ;
         }
      else
         cout << endl << " There are no elements with negative values " ;

      int max = array[0];           // determine the maximum (value & position)
      int position = 0;
      for( int i=1; i< LENGTH ; i++ )
         if( max < array[ i ] )
            {
               max = array[ i ];
               position = i ;
            }
      cout << endl << "The biggest value is equal to: " << max;
      cout << endl << "Its position is: " << (position+1);
   }
```

Examples of functions that operate on arrays

```
#include <stdio.h>                                        // implementation in "C"
#define  LENGTH  10

void readArray ( double array[ ] )
{
   int i;
   printf( " Enter values of the array elements \n" );
   for( i = 0 ; i < LENGTH ; i++ )
      {
         printf( "Array[%2d] = ", i+1 );
         scanf( "%lf" , &array[ i ] );
      }
} //---------------------------------------------------------------------------- readArray


void displayArray( double array[ ] )
{
   int i;
   printf( " The values of array elements are equal: \n" );
   for( i = 0 ; i < LENGTH ; i++ )
      printf( "Array[%2d] = %f", i+1 , array [ i ] );
   printf( " Press any key " );
   fflush(stdin);
   getchar();
} //---------------------------------------------------------------------------- displayArray


void addArrays(double input_1[ ], double input_2[ ], double result[ ])
{
   int i;
   for( i = 0 ; i < LENGTH ; i++ )
      result[ i ] = input_1[ i ] + input_2[ i ] ;
} //---------------------------------------------------------------------------- addArrays


int main( void )
   {
      double  A[ LENGTH ] ;
      double  B[ LENGTH ],  C[ LENGTH ] ;

      readArray( A );
      displayArray( A );

      readArray ( B );
      addArrays( A, B, C );
      displayArray ( C );
}
```