

# Arrays in C

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# Arrays

- *An array is a collection of variables of a certain type, placed contiguously in memory.*
- Array
  - Group of consecutive memory locations
  - Same name and type
- To refer to an element, specify
  - Array name
  - Position number
- Format:
  - arrayname* [ *position number* ]**
  - First element at position 0
  - n element array named c:
    - c[ 0 ], c[ 1 ]...c[ n - 1 ]

Name of array (Note that all elements of this array have the same name, c)

c[0]	-45
c[1]	6
c[2]	0
c[3]	72
c[4]	1543
c[5]	-89
c[6]	0
c[7]	62
c[8]	-3
c[9]	1
c[10]	6453
c[11]	78

Position number of the element within array c

# Arrays (Cont'd)

- Array elements are like normal variables

```
c[ 0 ] = 3;  
printf( "%d", c[ 0 ] );
```

- Perform operations in subscript. If x equals 3

```
c[ 5 - 2 ] == c[ 3 ] == c[ x ]
```

- When defining arrays, specify

- Name
- Type of array
- Number of elements

```
arrayType arrayName[ numberOfElements ];
```

- Examples:

```
int c[ 10 ];  
float myArray[ 3284 ];
```

- Defining multiple arrays of same type

- Format similar to regular variables
- Example:

```
int b[ 100 ], x[ 27 ];
```

# Arrays (Cont'd)

- Initializers

- `int n[ 5 ] = { 1, 2, 3, 4, 5 };`

- If not enough initializers, rightmost elements become 0

- `int n[ 5 ] = { 0 } ;`

- All elements 0

- If size omitted, initializers determine it

- `int n[ ] = { 1, 2, 3, 4, 5 };`

- 5 initializers, therefore 5 element array

# Arrays (Cont'd)

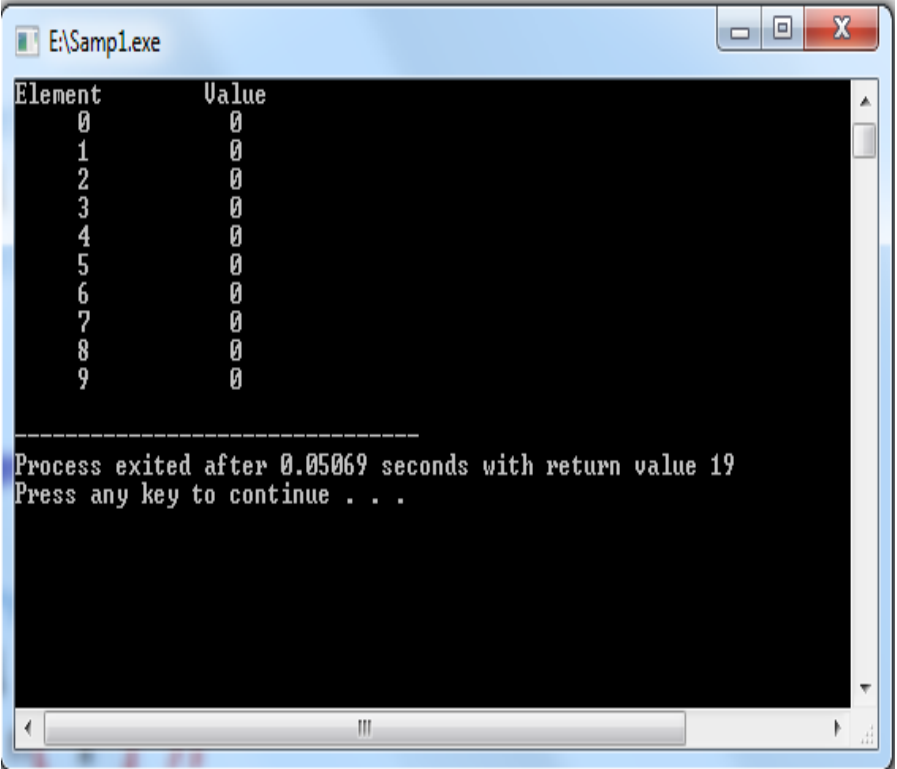
```
#include <stdio.h>

// function main begins program execution
int main( void )
{
    int n[ 10 ]; // n is an array of 10 integers
    int i;

    // initialize elements of array n to 0
    for ( i = 0; i < 10; ++i ) {
        n[ i ] = 0; // set element at location i to 0
    } // end for

    printf( "%s%13s\n", "Element", "Value" );

    // output contents of array n in tabular format
    for ( i = 0; i < 10; ++i ) {
        printf( "%6d%12d\n", i, n[ i ] );
    } // end for
}
```



```
E:\Sample.exe
Element      Value
0            0
1            0
2            0
3            0
4            0
5            0
6            0
7            0
8            0
9            0

-----
Process exited after 0.05069 seconds with return value 19
Press any key to continue . . .
```

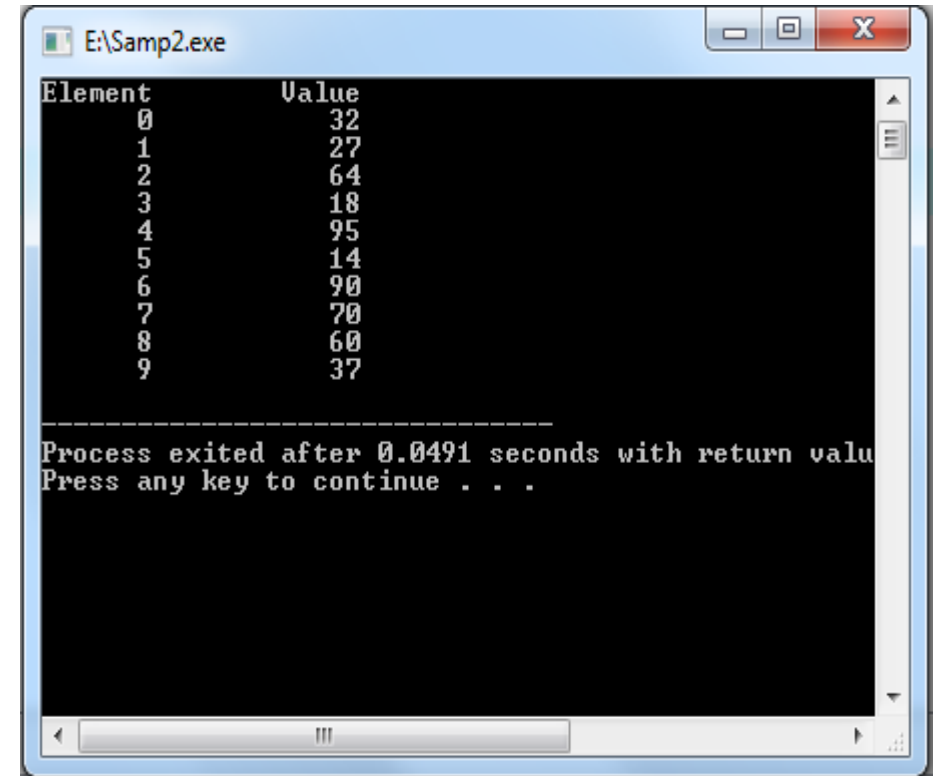
# Arrays (Cont'd)

```
#include <stdio.h>

// function main begins program execution
int main( void )
{
    int n[ 10 ]= { 32, 27, 64, 18, 95, 14, 90, 70, 60, 37 };
    int i;

    printf( "%s%13s\n", "Element", "Value" );

    // output contents of array in tabular format
    for ( i = 0; i < 10; ++i ) {
        printf( "%7u%13d\n", i, n[ i ] );
    } // end for
} // end main
```



Element	Value
0	32
1	27
2	64
3	18
4	95
5	14
6	90
7	70
8	60
9	37

Process exited after 0.0491 seconds with return value  
Press any key to continue . . .

# Arrays (Cont'd)

## **Characters Array or Strings**

A string constant is a one-dimensional array of characters terminated by a null ('`\0`').

The terminator define end of string.

For example,

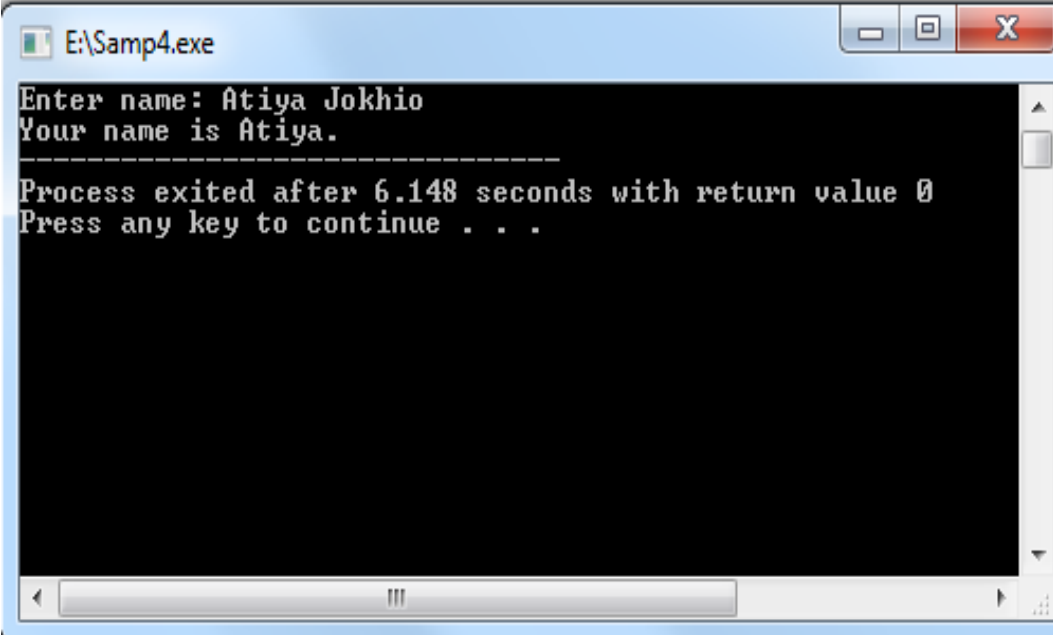
```
char name[5] = { 'F', 'A', 'S', 'T', '\0' };
```

- Input function `scanf()` can be used with `%s` format specifier to read a string input from the terminal. But there is one problem with `scanf()` function, it terminates its input on the first white space it encounters. Therefore if you try to read an input string "Hello World" using `scanf()` function, it will only read Hello and terminate after encountering white spaces.

# Arrays (Cont'd)

## Characters Array or Strings

```
#include <stdio.h>
int main()
{
    char name[20];
    printf("Enter name: ");
    scanf("%s", name);
    printf("Your name is %s.", name);
    return 0;
}
```



```
E:\Samp4.exe
Enter name: Atiya Jokhio
Your name is Atiya.
-----
Process exited after 6.148 seconds with return value 0
Press any key to continue . . .
```



# Arrays (Cont'd)

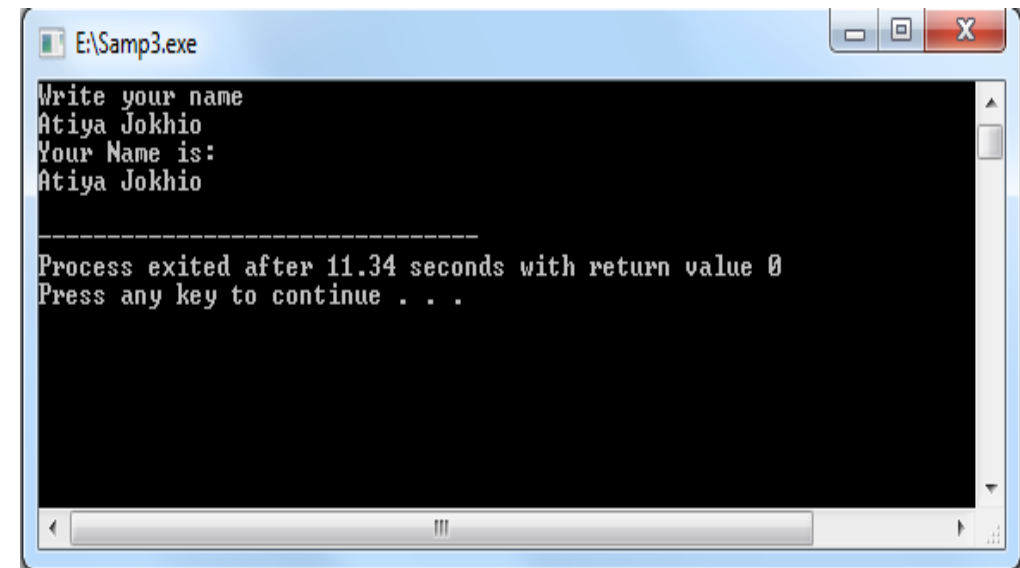
## The String I/O Function gets() & puts()

scanf() and printf() is not versatile for string I/O we can use gets() and puts() function from stdio library.

For Example:

```
#include <stdio.h>

int main( void )
{
    char name[20];
    printf("Write your name\n");
    gets( name);
    printf("Your Name is:\n");
    puts(name);
}
```



# Case Study: Computing Mean, Median and Mode Using Arrays

- Mean – average
- Median – number in middle of sorted list
  - 1, 2, 3, 4, 5
  - 3 is the median
- Mode – number that occurs most often
  - 1, 1, 1, 2, 3, 3, 4, 5
  - 1 is the mode

# Sorting Arrays

- **Sorting data**
  - Important computing application
  - Virtually every organization must sort some data
- **Bubble sort (sinking sort)**
  - Several passes through the array
  - Successive pairs of elements are compared
    - If increasing order (or identical ), no change
    - If decreasing order, elements exchanged
  - Repeat
- **Example:**
  - original: 3 4 2 6 7
  - pass 1: 3 2 4 6 7
  - pass 2: 2 3 4 6 7
  - Small elements "bubble" to the top

# Searching Arrays: Linear Searching

- Search an array for a *key value*
- Linear search
  - Simple
  - Compare each element of array with key value
  - Useful for small and unsorted arrays

# Searching Arrays: Binary Searching

- Binary search
  - For sorted arrays
  - Compares `middle` element with `key`
    - If equal, match found
    - If `key < middle`, looks in first half of array
    - If `key > middle`, looks in last half
    - Repeat
  - Very fast; at most  $n$  steps, where  $2^n > \text{number of elements}$ 
    - 30 element array takes at most 5 steps
      - $2^5 > 30$  so at most 5 steps

## Using Arrays to Summarize Survey Results

- Forty students were asked to rate the quality of the food in the student cafeteria on a scale of 1 to 10 (1 means awful and 10 means excellent). Place the 40 responses in an integer array and summarize the results of the poll.

# Using Arrays to Summarize Survey Results

```
// Analyzing a student poll.
#include <stdio.h>
#define RESPONSES_SIZE 40 // define array sizes
#define FREQUENCY_SIZE 11

// function main begins program execution
int main( void )
{
    size_t answer; // counter to loop through 40 responses
    size_t rating; // counter to loop through frequencies 1-10

    // initialize frequency counters to 0
    int frequency[ FREQUENCY_SIZE ] = { 0 };

    // place the survey responses in the responses array
    int responses[ RESPONSES_SIZE ] = { 1, 2, 6, 4, 8, 5, 9, 7, 8, 10,
        1, 6, 3, 8, 6, 10, 3, 8, 2, 7, 6, 5, 7, 6, 8, 6, 7, 5, 6, 6,
        5, 6, 7, 5, 6, 4, 8, 6, 8, 10 };

    // for each answer, select value of an element of array responses
    // and use that value as subscript in array frequency to
    // determine element to increment
    for ( answer = 0; answer < RESPONSES_SIZE; ++answer ) {
        ++frequency[ responses [ answer ] ];
    } // end for

    // display results
    printf( "%s%17s\n", "Rating", "Frequency" );

    // output the frequencies in a tabular format
    for ( rating = 1; rating < FREQUENCY_SIZE; ++rating ) {
        printf( "%6d%17d\n", rating, frequency[ rating ] );
    } // end for
} // end main
```

Rating	Frequency
1	2
2	2
3	2
4	2
5	5
6	11
7	5
8	7
9	1
10	3

# Passing array to function :

- Array can be passed to function by two ways :
  - **Pass Entire array**
  - **Pass Array element by element**



# Passing array to function :

- 1 . Pass Entire array

- Here entire array can be passed as a argument to function .
- Function gets complete access to the original array .
- While passing entire array Address of first element is passed to function , any changes made inside function , directly affects the Original value .
- Function Passing method : “Pass by Address”

# Passing array to function :

- 1 . Pass Entire array

Now, consider the following function, which takes an array as an argument along with another argument and based on the passed arguments, it returns the average of the numbers passed through the array as follows –

```
double getAverage(int arr[], int size) {  
  
    int i;  
    double avg;  
    double sum = 0;  
  
    for (i = 0; i < size; ++i) {  
        sum += arr[i];  
    }  
  
    avg = sum / size;  
  
    return avg;  
}
```

# Passing array to function :

- 1 . Pass Entire array

Now, let us call the above function as follows –

```
#include <stdio.h>

/* function declaration */
double getAverage(int arr[], int size);

int main () {

    /* an int array with 5 elements */
    int balance[5] = {1000, 2, 3, 17, 50};
    double avg;

    /* pass pointer to the array as an argument */
    avg = getAverage( balance, 5 ) ;

    /* output the returned value */
    printf( "Average value is: %f ", avg );

    return 0;
}
```

# Passing array to function :

- 2 . Pass Array element by element

- Here individual elements are passed to function as argument.
- Duplicate carbon copy of Original variable is passed to function .
- So any changes made inside function does not affects the original value.
- Function doesn't get complete access to the original array element.
- Function passing method is "Pass by Value"

# Passing array to function :

- 2 . Pass Array element by element

```
main( )
{
int i ;
int marks[ ] = { 55, 65, 75, 56, 78, 78, 90 } ;
for ( i = 0 ; i <= 6 ; i++ )
display ( marks[i] ) ;
}

display ( int m )
{
printf ( "%d ", m ) ;
}
```

# Const Qualifier:

- The const type qualifier can be applied to an array parameter in a function definition to prevent the original array from being modified in the function body.

```
// Using the const type qualifier with arrays.  
#include <stdio.h>
```

```
void tryToModifyArray( const int b[] ); // function prototype
```

```
// function main begins program execution  
int main( void )
```

```
{  
    int a[] = { 10, 20, 30 }; // initialize array a  
  
    tryToModifyArray( a );  
  
    printf("%d %d %d\n", a[ 0 ], a[ 1 ], a[ 2 ] );  
} // end main
```

```
// in function tryToModifyArray, array b is const, so it cannot be  
// used to modify the original array a in main.
```

```
void tryToModifyArray( const int b[] )  
{  
    b[ 0 ] /= 2; // error  
    b[ 1 ] /= 2; // error  
    b[ 2 ] /= 2; // error  
} // end function tryToModifyArray
```

```
error C2166: l-value specifies const object  
error C2166: l-value specifies const object  
error C2166: l-value specifies const object
```

# Multiple-Subscripted Arrays

- Multiple subscripted arrays
  - Tables with rows and columns (m by n array)
  - Like matrices: specify row, then column

	Column	Column 1	Column	Column 3
Row 0	a[0][0]	a[0][1]	a[0][2]	a[0][3]
Row 1	a[1][0]	a[1][1]	a[1][2]	a[1][3]
Row 2	a[2][0]	a[2][1]	a[2][2]	a[2][3]

Array name Row subscript

Column subscript

# Multiple-Subscripted Arrays (cont'd)

- Initialization

- `int b[2][2] = { { 1, 2 }, { 3, 4 } };`
- Initializers grouped by row in braces
- If not enough, unspecified elements set to zero  
`int b[2][2] = { { 1 }, { 3, 4 } };`

1	2
3	4

- Referencing elements

- Specify row, then column  
`printf( "%d", b[0][1] );`

1	0
3	4



# Multiple-Subscripted Arrays (cont'd)

```
#include <stdio.h>

int main () {

    /* an array with 5 rows and 2 columns*/
    int a[5][2] = { {0,0}, {1,2}, {2,4}, {3,6},{4,8}};
    int i, j;

    /* output each array element's value */
    for ( i = 0; i < 5; i++ ) {

        for ( j = 0; j < 2; j++ ) {
            printf("a[%d][%d] = %d\n", i,j, a[i][j] );
        }
    }

    return 0;
}
```

```
a[0][0]: 0
a[0][1]: 0
a[1][0]: 1
a[1][1]: 2
a[2][0]: 2
a[2][1]: 4
a[3][0]: 3
a[3][1]: 6
a[4][0]: 4
a[4][1]: 8
```

# Exercise

- Write a C program to read through an array of any type. Write a C program to scan through this array to find a particular value.
- Write a program to copy the contents of one array into another in the reverse order.
- Write a program to pick up the largest number from any 5 row by 5 column matrix.
- Write a program to add two 6 \* 6 matrices.