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6.1 Introduction

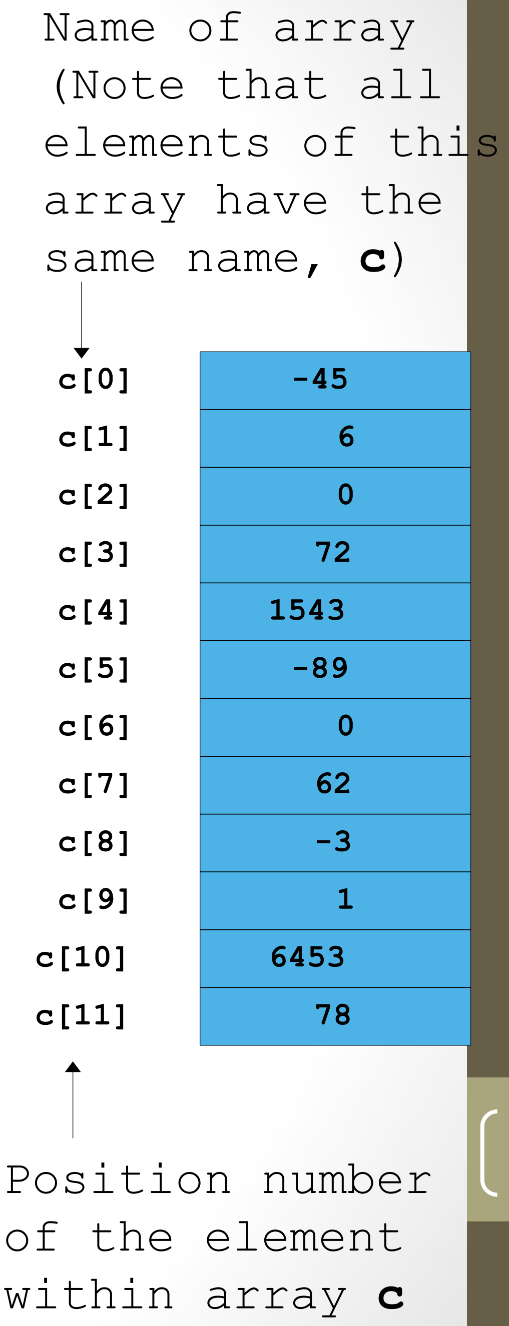
- Arrays
  - Structures of related data items
  - Static entity – same size throughout program
  - Dynamic data structures discussed in Chapter 12

6.2 Arrays

- 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**

6.2 Arrays

- 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 ]
```

6.3 Declaring Arrays

- When declaring arrays, specify
  - Name
  - Type of array
  - Number of elements

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

  - Examples:

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

- Declaring multiple arrays of same type
  - Format similar to regular variables
  - Example:

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

6.4 Examples Using Arrays

- 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 too many a syntax error is produced syntax error
  - C arrays have no bounds checking
- If size omitted, initializers determine it

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

  - 5 initializers, therefore 5 element array

6.4 Examples Using Arrays

- Character arrays
  - String “**first**” is really a static array of characters
  - Character arrays can be initialized using string literals

    ```
    char string1[] = "first";
    ```

    - Null character `'\0'` terminates strings
    - `string1` actually has 6 elements
      - It is equivalent to

```
char string1[] = { 'f', 'i', 'r', 's', 't', '\0' };
```

  - Can access individual characters

    ```
    string1[ 3 ] is character ‘s’
    ```

  - Array name is address of array, so & not needed for scanf

    ```
    scanf( "%s", string2 );
    ```

    - Reads characters until whitespace encountered
    - Can write beyond end of array, be careful

6.5 Passing Arrays to Functions

- Passing arrays
  - To pass an array argument to a function, specify the name of the array without any brackets

    ```
    int myArray[ 24 ];
    myFunction( myArray, 24 );
    ```

    - Array size usually passed to function
  - Arrays passed call-by-reference
  - Name of array is address of first element
  - Function knows where the array is stored
    - Modifies original memory locations
- Passing array elements
  - Passed by call-by-value
  - Pass subscripted name (i.e., **`myArray[ 3 ]`**) to function

6.5 Passing Arrays to Functions

- Function prototype

```
void modifyArray( int b[], int arraySize );
```

  - Parameter names optional in prototype
    - **`int b[]`** could be written **`int []`**
    - **`int arraySize`** could be simply **`int`**

6.6 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

6.7 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

6.8 Searching Arrays: Linear Search and Binary Search

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

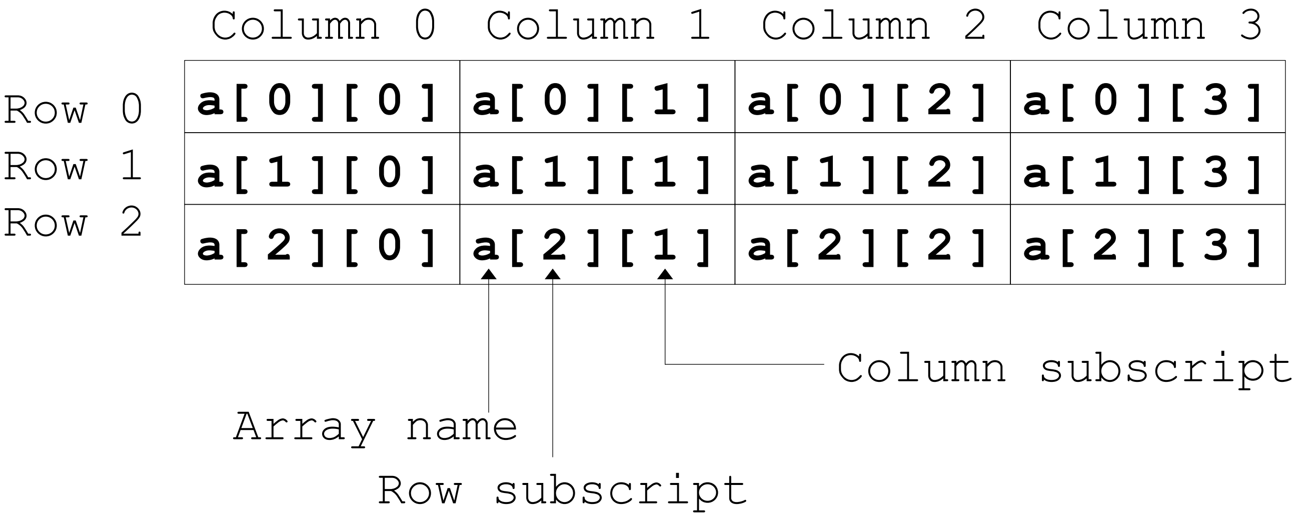
6.8 Searching Arrays: Linear Search and Binary Search

- 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 > number of elements

    5
    - 30 element array takes at most 5 steps
      - 2^5 > 30 so at most 5 steps

6.9 Multiple-Subscripted Arrays

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



	Column 0	Column 1	Column 2	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]**

Column subscript

Array name

Row subscript

6.9 Multiple-Subscripted Arrays

- 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 } };`
- Referencing elements
  - Specify row, then column

    `printf( "%d", b[ 0 ][ 1 ] );`

1	2
3	4

1	0
3	4