C ARRAYS

-a collection of same type data-

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- An array is a collection of elements of the same type that are referenced by a common name.
- Compared to the basic data type (`int`, `float` & `char`) it is an aggregate or derived data type.
- All the elements of an array occupy a set of contiguous memory locations.
- Why need to use array type?
- Consider the following issue:

"We have a list of 1000 students' marks of an integer type. If using the basic data type (int), we will declare something like the following…"

```
int  studMark0, studMark1, studMark2, ..., studMark999;
```

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- Can you imagine how long we have to write the declaration part by using normal variable declaration?

```
int main(void)
{
    int studMark1, studMark2, studMark3,
    studMark4, …, …, studMark998, stuMark999,
    studMark1000;
    …
    …
    return 0;
}
```

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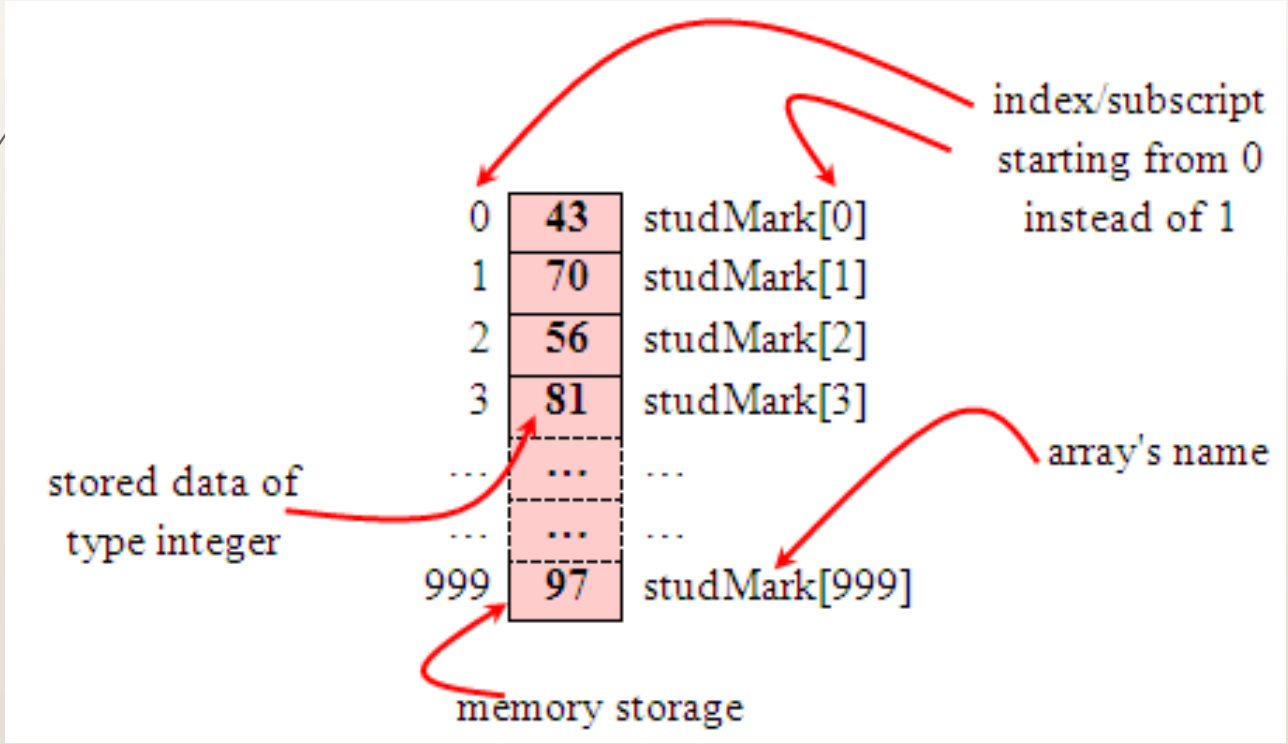
- By using an array, we just declare like this,

```
int  studMark[1000];
```

- This will reserve 1000 contiguous memory locations for storing the students' marks.
- Graphically, this can be depicted as in the following figure.



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- This absolutely has simplified our declaration of the variables.
- We can use index or subscript to identify each element or location in the memory.
- Hence, if we have an index of `jIndex`, `studMark[jIndex]` would refer to the *`jIndexth`* element in the array of `studMark`.
- For example, `studMark[0]` will refer to the first element of the array.
- Thus by changing the value of `jIndex`, we could refer to any element in the array.
- So, array has simplified our declaration and of course, manipulation of the data.

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One Dimensional Array: Declaration

- Dimension refers to the array's size, which is how big the array is.
- A single or one dimensional array declaration has the following form,

```
array_element_data_type array_name[array_size];
```

- Here, *array_element_data_type* define the base type of the array, which is the type of each element in the array.
- *array_name* is any valid C / C++ identifier name that obeys the same rule for the identifier naming.
- *array_size* defines how many elements the array will hold.

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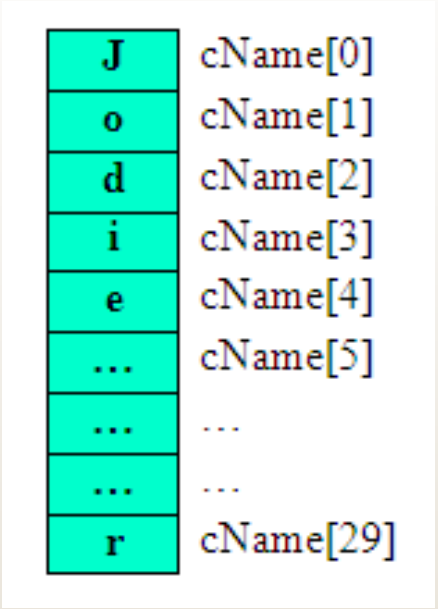
- For example, to declare an array of 30 characters, that construct a people name, we could declare,

```
char    cName[30];
```

- Which can be depicted as follows,



- In this statement, the array character can store up to 30 characters with the first character occupying location `cName[0]` and the last character occupying `cName[29]`.
- Note that the index runs from `0` to `29`. In C, an index always starts from `0` and ends with array's (size-1).
- So, take note the difference between the array size and subscript/index terms.

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- Examples of the one-dimensional array declarations,

```
int       xNum[20], yNum[50];
float     fPrice[10], fYield;
char      chLetter[70];
```

- The first example declares two arrays named `xNum` and `yNum` of type `int`. Array `xNum` can store up to 20 integer numbers while `yNum` can store up to 50 numbers.
- The second line declares the array `fPrice` of type `float`. It can store up to 10 floating-point values.
- `fYield` is basic variable which shows array type can be declared together with basic type provided the type is similar.
- The third line declares the array `chLetter` of type char. It can store a string up to 69 characters.
- Why 69 instead of 70? Remember, a string has a null terminating character (`\0`) at the end, so we must reserve for it.

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Array Initialization

- An array may be initialized at the time of declaration.
- Giving initial values to an array.
- Initialization of an array may take the following form,

```
type   array_name[size] = {a_list_of_value};
```

- For example:

```
int    idNum[7] = {1, 2, 3, 4, 5, 6, 7};
float  fFloatNum[5] = {5.6, 5.7, 5.8, 5.9, 6.1};
char   chVowel[6] = {'a', 'e', 'i', 'o', 'u', '\0'};
```

- The first line declares an integer array `idNum` and it immediately assigns the values 1, 2, 3, ..., 7 to `idNum[0]`, `idNum[1]`, `idNum[2]`,`...`, `idNum[6]` respectively.
- The second line assigns the values 5.6 to `fFloatNum[0]`, 5.7 to `fFloatNum[1]`, and so on.
- Similarly the third line assigns the characters 'a' to `chVowel[0]`, 'e' to `chVowel[1]`, and so on. Note again, for characters we must use the single apostrophe/quote (') to enclose them.
- Also, the last character in `chVowel` is `NULL` character (`'\0'`).

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- Initialization of an array of type char for holding strings may take the following form,

```
char    array_name[size] = "string_lateral_constant";
```

- For example, the array `chVowel` in the previous example could have been written more compactly as follows,

```
char    chVowel[6] = "aeiou";
```

- When the value assigned to a character array is a string (which must be enclosed in double quotes), the compiler automatically supplies the `NULL` character but we still have to reserve one extra place for the `NULL`.
- For unsized array (variable sized), we can declare as follow,

```
char chName[ ] = "Mr. Dracula";
```

- C compiler automatically creates an array which is big enough to hold all the initializer.

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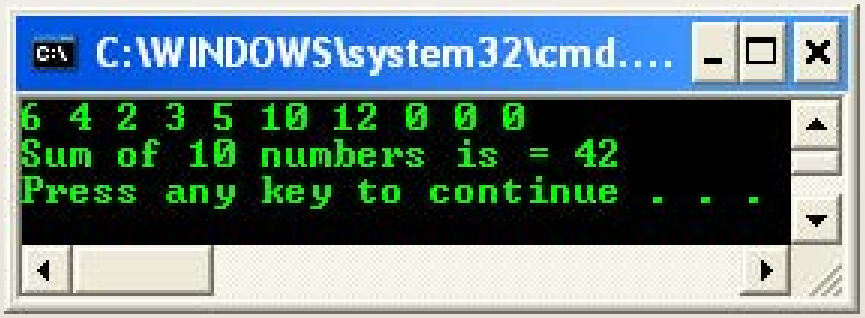
- Arrays allow programmers to group related items of the same data type in one variable.
- However, when referring to an array, one has to specify not only the array or variable name but also the index number of interest.
- Program example 1: Sum of array's element.
- Notice the array's element which is not initialized is set to 0 automatically.



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- Program example 2: Searching the smallest value.
- Finding the smallest element in the array named `fSmallest`.
- First, it assumes that the smallest value is in `fSmallest[0]` and assigns it to the variable `nSmall`.
- Then it compares `nSmall` with the rest of the values in `fSmallest`, one at a time.
- When an element is smaller than the current value contained in `nSmall`, it is assigned to `nSmall`. The process finally places the smallest array element in `nSmall`.

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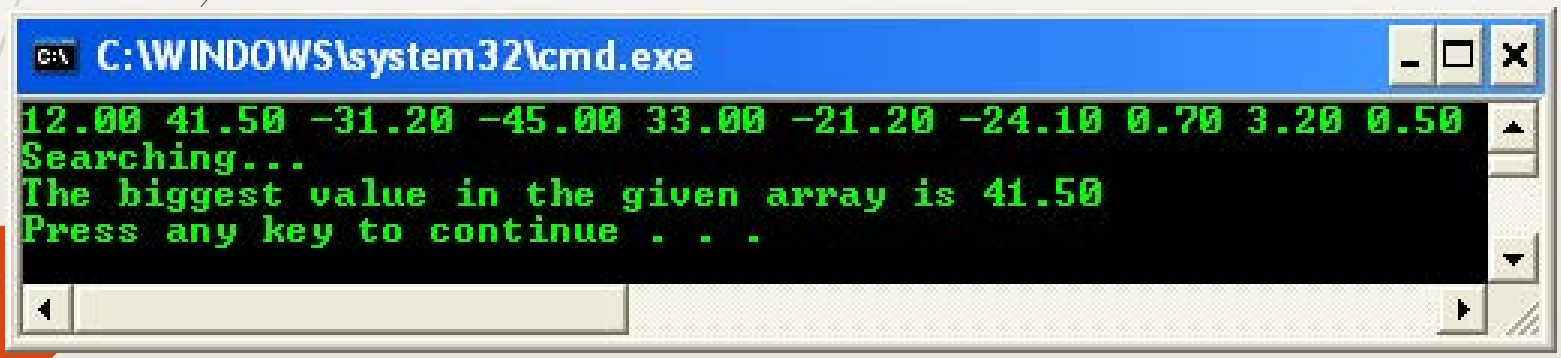
- Program example 3: Searching the biggest value. By modifying the previous example we can search the biggest value.



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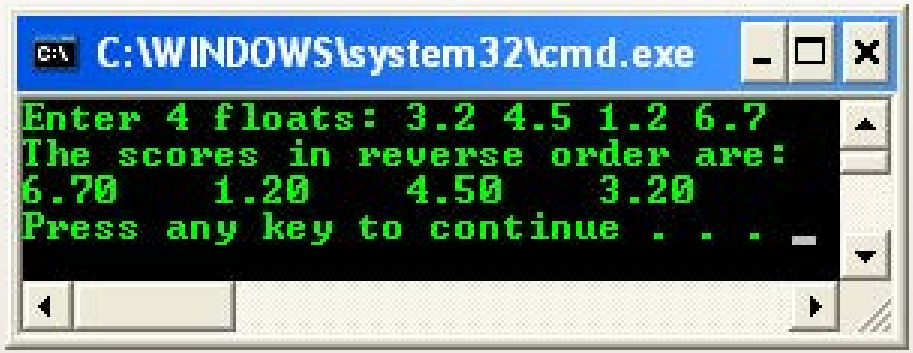
- Program example 4: Searching the location for the given value in an array



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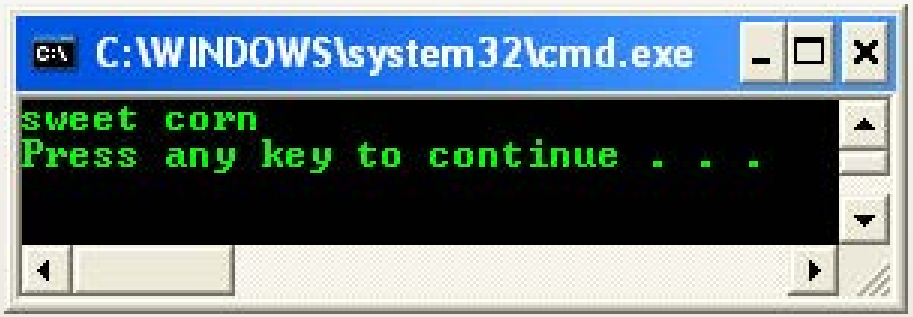
- Program example 5: Storing and reading a string



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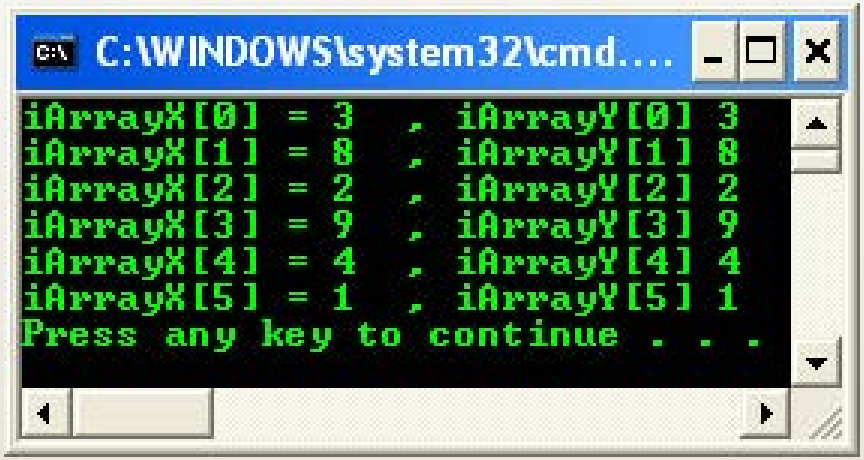
- Program example 6: Storing and reading array content and its index



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Two Dimensional/2D Arrays

- A two dimensional array has two subscripts/indexes.
- The first subscript refers to the row, and the second, to the column.
- Its declaration has the following form,

```
data_type    array_name[1st dimension size][2nd dimension size];
```

- For examples,

```
int      xInteger[3][4];
float    matrixNum[20][25];
```

- The first line declares `xInteger` as an integer array with 3 rows and 4 columns.
- Second line declares a `matrixNum` as a floating-point array with 20 rows and 25 columns.

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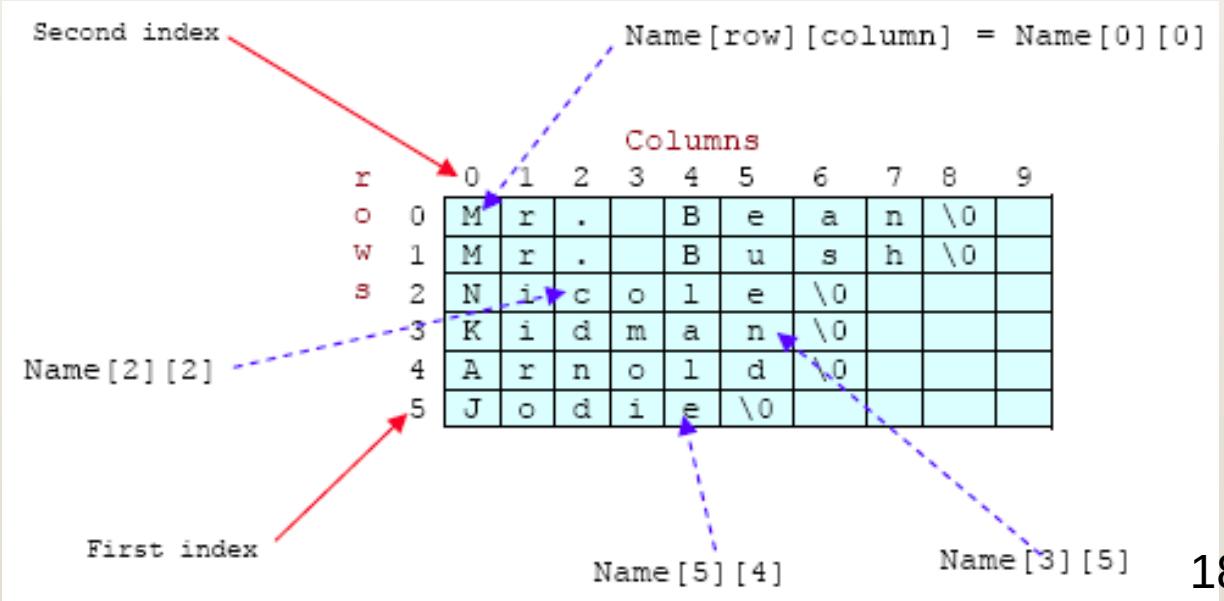
- If we assign initial string values for the 2D array it will look something like the following,

```
char Name[6][10] = {"Mr. Bean", "Mr. Bush", "Nicole",
    "Kidman", "Arnold", "Jodie"};
```

- Here, we can initialize the array with 6 strings, each with maximum 9 characters long.
- If depicted in rows and columns it will look something like the following and can be considered as contiguous arrangement in the memory.



row	0	1	2	3	4	5	6	7	8	9
0	M	r	.		B	e	a	n	\0	
1	M	r	.		B	u	s	h	\0	
2	N	i	c	o	l	e	\0			
3	K	i	d	m	a	n	\0			
4	A	r	n	o	l	d	\0			
5	J	o	d	i	e	\0				

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- Take note that for strings the null character (`\0`) still needed.
- From the shaded square area of the figure we can determine the size of the array.
- For an array `Name[6][10]`, the array size is 6 x 10 = 60 and equal to the number of the colored square. In general, for

```
array_name[x][y];
```

- The array size is = First index **x** second index = xy.
- This also true for other array dimension, for example three dimensional array,

`array_name[x][y][z];` => First index **x** second index **x** third index = xyz

- For example,

`ThreeDimArray[2][4][7]` = 2 x 4 x 7 = 56.

- And if you want to illustrate the 3D array, it could be a cube with wide, long and height dimensions.

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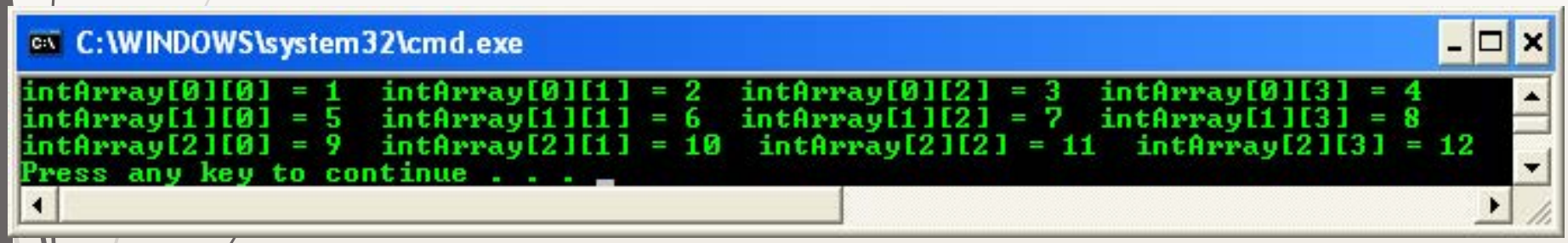
- Program example 7: Storing and reading array content and its index



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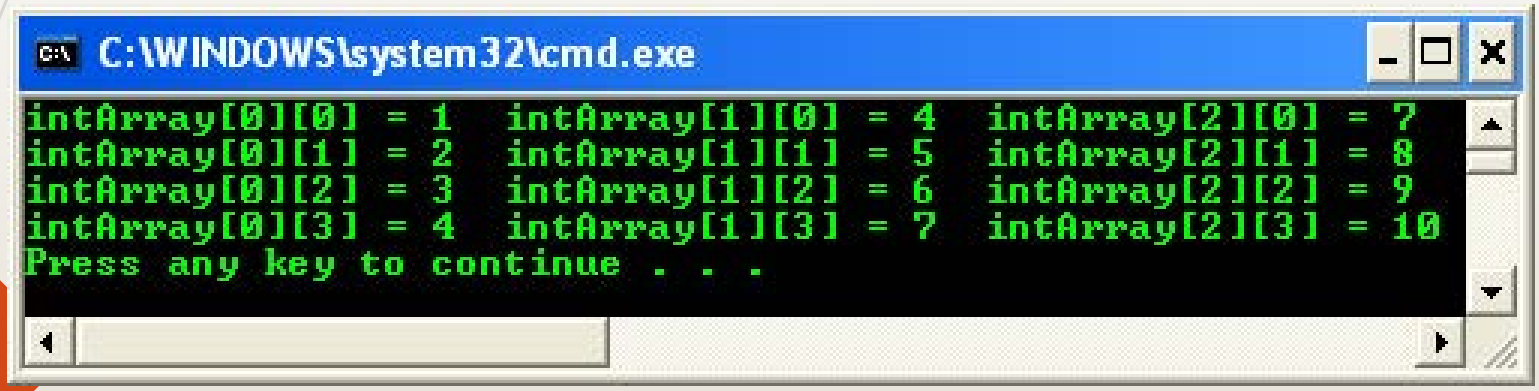
- Program example 8: Swapping iIndex (iRow) with jIndex (iColumn) in the previous program example



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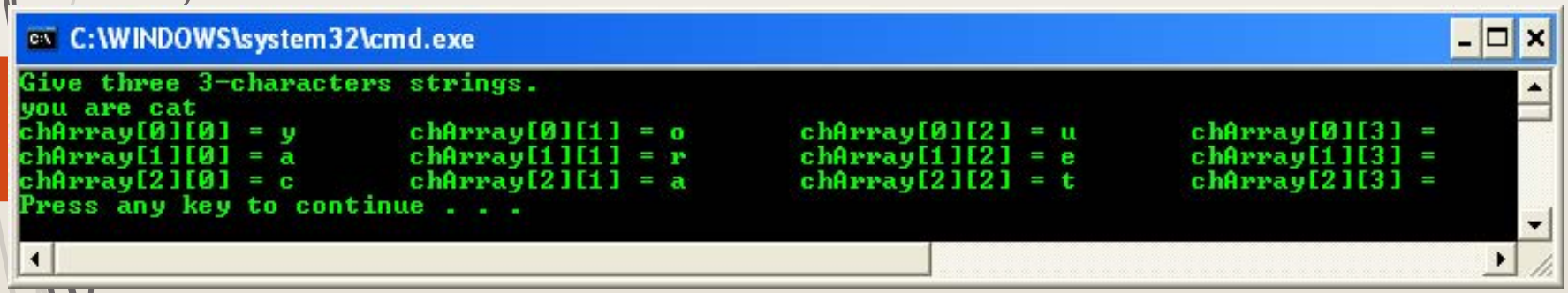
1. Program example 9: Strings are read in by the rows.
2. Each row will have one string. Enter the following data: “you”, “are”, “cat” for the following example.
3. Remember that after each string, a null character is added.
4. We are reading in *strings* but printing out only *characters*.



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- The contents of the array in memory after the three strings are read in the array.

	0	1	2	3
0	y	o	u	\0
1	a	r	e	\0
2	c	a	t	\0

- Re-run the program, enter the following data: “you”, “my”. Illustrates the content as done previously.

	0	1	2	3
0	y	o	u	\0
1	m	y	\0	
2	l	u	v	\0

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1. Does your output agree?
2. How is the null character, `'\0'` printed?
3. Is there a garbage character in `a[1][3]`? If so, why?

a) The output matched, except the *garbage*.
b) Just an empty space.
c) Yes. This slot has been reserved but not filled so whatever the previous data that has been stored here would be displayed (if possible).

End-of-C-arrays