



CMSC 106 Lecture Set #10

Set Started:
Tuesday, October 30, 2007



Data Structures

- Holds a collection of data
- several individual variables
 - each stores its own value
 - each is independent of the other
 - but the group can be allocated as a whole
- Many Data Structures
 - arrays, stacks, queues
 - structures
 - linked list, tree, hash table, graph, ...
- Classifications
 - Homogeneous data structure vs Heterogeneous data structure
 - Statically sized or Dynamically sized
 - Single Unit or Linked Data Structures



Array Indexing

- C provides a special syntax for accessing cells in an array
 - Allocation of space for array named a:

```
int a[5];
```

 - This creates five int variables "named"::a[0],a[1],a[2],a[3],a[4]
 - To modify contents of cell #2 to 6 and cell #1 to 74:

```
a[2] = 6;  
a[1] = 74;
```
 - To use the contents of cell #2 and cell #1 :

```
printf("value = %d\n", {a[1]-a[2]});
```
- This access mechanism to the individual elements is called **array indexing**
 - In Java / C / C++, array cells are indexed beginning at 0 and going up to n-1 (n is number of cells)
 - Beware: start at 0! and end at one less than the size!!



Square Brackets: [] and specifying the length

- Two independent uses in C:
 - Array object creation
`int a[10];`
 - Array indexing
`a[0]`
- Nothing in the array or about the array to indicate size of the array after it is created
- Often we use a symbolic constant to specify the size of the array

```
#define SIZE 10
int main(){
    int a[SIZE];
```



Summary of Arrays

- Arrays are:
 - Sequences of cells holding values of the same type ("base type")
 - All arrays are declared and access based on that base type – all arrays are of a type
- To define an array variable:
`int a[SIZE]; //an array with base type int`
assuming SIZE was previously #defined as 10
- To access individual array cells: use indexing
 - `a[0], a[1], ..., a[9]`
 - Cells are just like variables:
 - They may be read: `x = a[3];`
 - They may be written: `a[2] = 7;`



A Common Programming Idiom

- To process all elements in array a...
- Do following:

```
int j = 0;
for (j = 0; j < SIZE; j++){
    ...process the one element at a[j]...
}
```
- Remember:
 - The lowest index is always 0
 - So use `i < SIZE`, not `i <= SIZE`



Examples

- filling an integer array using scanf
- counting elements in a character array
- adding and averaging values in a floating point array



Array Initializers

- Use curly braces and commas to list elements the array contains at startup:

```
#define SIZE 10
int main(){
    int arr1[5] = {3,2,1,8,4};
    char arr2[3] = {'J','a','\n'};
    float arr3[4] = {2.4,3.6,1,5};
```

- If there are too many values given, compilation error is given.
- If there are too few values given, the array elements for which no value is given are assigned 0.
- If no array size is specified, it will assume you meant the exact number of the number of initializing values.



Passing Arrays as arguments

- The name of an array is a reference to (address of) the space where the array is stored
 - the [] dereference that address and add the offset determined by the value inside the brackets
 - an array argument is always a copy of that address
 - so when you modify the array argument, you do modify the original array
- An array contains elements of a base type
- The element of the array is treated like that base type if passed



Parallel Arrays

- Multiple arrays used to store related data

```
int id[MAXSIZE];  
float score[MAXSIZE];  
char grade[MAXSIZE];
```

- index determines which person's information : student with id 91 has an 82.22 average which is calculated to be a B

63	67.32	D
94	92.14	A
12	87.54	B
91	82.22	B
14	74.13	C
99	58.40	F
42	80.11	B



2-Dimensional Arrays

- Declared with two dimensions of size
 - rows and columns
 - two pair of square brackets
- Indexed with two individual indexes

```
#define ROWMAX 5  
#define COLMAX 6  
int main(){  
    int matrix[ROWMAX][COLMAX];  
    ...  
    for (row = 0; row < ROWMAX; row++)  
        for (col = 0; col < COLMAX; col++)  
            matrix[row][col] = row * col;  
    ...  
}
```



Array Initializers

- Two methods
 - indicating rows and columns
 - as one list of values
- like single dimensional arrays – uninitialized values set to 0 when an initializer is used



n-Dimensional Arrays

- Three or more dimensions

```
#define SIZE1 5
#define SIZE2 3
#define SIZE3 4
...
int arr[SIZE1][SIZE2][SIZE3];
for (row = 0; row < SIZE1; row++){
    for (col = 0; col < SIZE2; col++){
        for (depth = 0; depth < SIZE3; depth++){
            printf("%.2f ",arr[row][col][depth]);
        }
        printf("\n");
    }
    printf("-----\n");
}
```



Passing to Functions

- In the Parameter List
 - For a single dimensional array – the size does not need to be indicated in the parameter list.
 - For a multi dimensional array – only the first dimension of size can be omitted in the parameter list.
- In the Argument List
 - For the argument when passing a whole array – no indices are given at all.
 - For the argument when passing a single element – all indices need to be indicated (in the correct range).
- Can not be used as the return type of a function.



In class Example

- Fill a SIZExSIZE matrix
- Print a SIZExSIZE matrix
- multiply two SIZExSIZE matrices
- in both orders to show that it isn't commutative
