Lecture No.01
Arrays and Lists

CC-213 Data Structures
Department of Computer Science
University of the Punjab

Slides modified very slightly from the late Dr. Sohail Aslam's lectures at VU

Data Structures

- Prepares the students for (and is a prerequisite for) the more advanced material students will encounter in later courses.
- Cover well-known data structures such as dynamic arrays, linked lists, stacks, queues, tree and graphs.
- Implement data structures in C++

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- Implement data structures in C++

Grading

- Quizzes 15%
- Assignments 10%
- Mid-Term Exam 35%
- Final 40%

Course webpage:
http://faculty.pucit.edu.pk/nazarkhan/teaching/CC213/CC213.html

Need for Data Structures

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- More powerful computers ⇒ more complex applications.
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  - Time

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Selecting a Data Structure

Select a data structure as follows:

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2. Determine the basic operations that must be supported. Quantify the resource constraints for each operation.
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Data Structure Philosophy

- Each data structure has costs and benefits.
- Rarely is one data structure better than another in all situations.
- A data structure requires:
  - space for each data item it stores,
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Goals of this Course

1. Reinforce the concept that costs and benefits exist for every data structure.

2. Learn the commonly used data structures.
   - These form a programmer's basic data structure “toolkit.”

3. Understand how to measure the cost of a data structure or program.
   - These techniques also allow you to judge the merits of new data structures that you or others might invent.

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Arrays

- Elementary data structure that exists as built-in in most programming languages.

```
main( int argc, char** argv )
{
    int x[6];
    int j;
    for(j=0; j < 6; j++)
      x[j] = 2*j;
}
```

Arrays

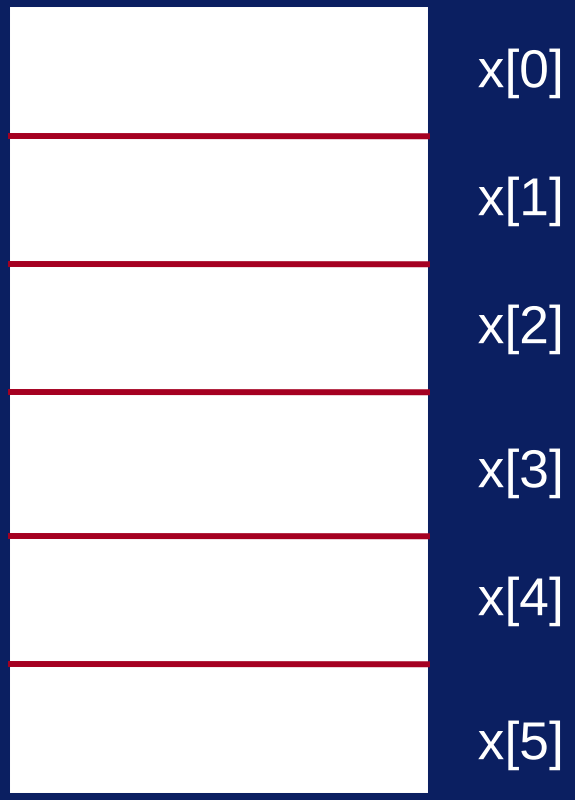
- Array declaration: int x[6];
- An array is collection of cells of the same type.
- The collection has the name ‘x’.
- The cells are numbered with consecutive integers.
- To access a cell, use the array name and an index:

x[0], x[1], x[2], x[3], x[4], x[5]

Array Layout

Array cells are contiguous in computer memory

The memory can be thought of as an array



What is Array Name?

- ‘x’ is an array name but there is no variable x. ‘x’ is not an *lvalue*.
- For example, if we have the code

```
int a, b;
```

then we can write

```
b = 2;
a = b;
a = 5;
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But we cannot write

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Array Name

- ‘x’ is not an lvalue

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int x[6];
int n;

x[0] = 5;
x[1] = 2;

x = 3;              // not allowed
x = a + b;          // not allowed
x = &n;             // not allowed
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Dynamic Arrays

- You would like to use an array data structure but you do not know the size of the array at compile time.
- You find out when the program executes that you need an integer array of size n=20.
- Allocate an array using the new operator:

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int* y = new int[20];  // or int* y = new int[n]
y[0] = 10;
y[1] = 15;          // use is the same
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- ‘y’ is a lvalue; it is a pointer that holds the address of 20 consecutive cells in memory.
- It can be assigned a value. The new operator returns as address that is stored in y.
- We can write:

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y = &x[0];
y = x;          // x can appear on the right
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// first cell of the x array
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Dynamic Arrays

- We must free the memory we got using the new operator once we are done with the *y* array.

```
delete[ ] y;
```

- We would not do this to the *x* array because we did not use new to create it.

The LIST Data Structure

- The List is among the most generic of data structures.

- Real life:

    a. shopping list,
    b. groceries list,
    c. list of people to invite to dinner
    d. List of presents to get

Lists

- A list is collection of items that are all of the same type (grocery items, integers, names)
- The items, or elements of the list, are stored in some particular order
- It is possible to insert new elements into various positions in the list and remove any element of the list

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Lists

- List is a set of elements in a linear order. For example, data values a_1, a_2, a_3, a_4 can be arranged in a list:

  (a_3, a_1, a_2, a_4)

  In this list, a_3, is the first element, a_1 is the second element, and so on

- The order is important here; this is not just a random collection of elements, it is an *ordered* collection

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List Operations

Useful operations

- createList(): create a new list (presumably empty)
- copy(): set one list to be a copy of another
- clear(); clear a list (remove all elments)
- insert(X, ?): Insert element X at a particular position in the list
- remove(?): Remove element at some position in the list
- get(?): Get element at a given position
- update(X, ?): replace the element at a given position with X
- find(X): determine if the element X is in the list
- length(): return the length of the list.

List Operations

- We need to decide what is meant by “particular position”; we have used “?” for this.

- There are two possibilities:

1. Use the actual index of element: insert after element 3, get element number 6. This approach is taken by arrays
2. Use a “current” marker or pointer to refer to a particular position in the list.

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List Operations

- If we use the “current” marker, the following four methods would be useful:
  - **start()**: moves to “current” pointer to the very first element.
  - **tail()**: moves to “current” pointer to the very last element.
  - **next**(): move the current position forward one element
  - **back**(): move the current position backward one element