

- Ideally, all the data types in a programming language should be **first-order objects**.
  - I.e., all the data types should be manipulated in the “usual ways.”
  - They should be comparable using the normal operators, passed by value (unless explicitly stated otherwise) to functions, etc. etc.
- C++ has gone a step further than Java in this respect.
  - Indeed, even the “primitive” types can be considered classes; there is only one class of objects in the C++ discourse.
- But then take (yeas, please take) arrays (and thus strings).
  - They cannot be manipulated in the usual way.
  - Indeed, they are in fact pointers to the actual content, so they cannot be meaningfully compared using usual operators, are always passed by reference to functions, etc.
  - Tired of that `strcmp` yet?

- A vector is a relocating, expandable, polymorphic array.
  - They are polymorphic in the usual sense, not Java or Lisp sense.
  - I.e., you can declare vectors that hold any data type, but a given vector instance can hold data of a single type.
- Quick random access but slow copying and expansion.
- Before you begin:

```
#include <vector>
```
- Declaring a vector:

```
vector<int> a(3); // a vector holding ints, of (initial) size 3
vector<char> b; // a vector holding chars, of default initial size 0
```
- Accessing values in a vector:

```
a[1] = a[1] + 5;
```

  - `operator[]` does **not** check for array bounds.

## VECTORS (CONT'D)

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- Other goodies:
  - You can obtain the size of a vector by using the member function `size()`.
  - You can **resize** a vector using the member function `resize(int)`.
    - \* Expensive operation (if size increases)!
  - You **cannot** initialize a vector using a literal array or for that matter any array.
    - \* You have to use a loop to initialize the values in a vector, or be happy with the default.

```
void get_ints (vector<int> array) {
    int read_so_far = 0, input;
    while ( cin >> input ) {
        if ( read_so_far == array.size() )
            array.resize(array.size() * 2 + 1);
        array[read_so_far++] = input;
    }
    array.resize(read_so_far);
}
```

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  - You can obtain the size of a vector by using the member function `size()`.
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  - You **cannot** initialize a vector using a literal array or for that matter any array.
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```
void get_ints (vector<int>& array) {
    int read_so_far = 0, input;
    while ( cin >> input ) {
        if ( read_so_far == array.size() )
            array.resize(array.size() * 2 + 1);
        array[read_so_far++] = input;
    }
    array.resize(read_so_far);
}
```

## SIZE, CAPACITY, PUSHING

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- There are two “sizes”: how many elements are stored in the vector (`size()`) and how many elements can be held (`capacity()`).
  - **But** don't get excited, when you declare `vector<int> a(3)` the **size** is set to 3, even if you did not put anything in there explicitly.
  - In most of the cases, you should forget the existence of `capacity()`.
- Another version of `get_ints`:

```
void get_ints (vector<int>& array) {  
    array.resize(0);  
    while ( cin >> input ) {  
        array.push_back(input);  
    }  
}
```

- The member function `push_back` increases the size by 1, and adds the argument as the last element in the vector.
  - \* Capacity is also increased if needed.

## STRINGS AS FIRST-ORDER OBJECTS

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- Before you begin: `#include <string>`
- Declaring strings:

```
string s; // an (initially empty) string  
string s1("hello"); // a string initialized by means of a string literal
```

Operation on string <code>s</code>	Result
<code>s.length()</code>	returns the length of <code>s</code>
<code>s[2]</code>	accesses the third character in <code>s</code>
<code>s = "hi";</code>	assignment operator
<code>s == "hi"</code>	<b>true!</b> ; special functions no longer needed
<code>s &gt;= "hello"</code>	<b>true!</b>
<code>s = s + " there"</code>	<code>s</code> becomes "hi there"
<code>s += " there"</code>	same as above
<code>s.c_str()</code>	returns a pointer to the <b>C string</b> held by <code>s</code> ( <code>const char*</code> , null-terminated)