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Computer Programming

Dr. Deepak B Phatak
Dr. Supratik Chakraborty
Department of Computer Science and Engineering
IIT Bombay

Session : Template Class “vector” – Part 2

Quick Recap of Relevant Topics

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- Object-oriented programming with structures and classes
- C++ Standard Library
  - The “string” class
  - The “vector” class – some features of it

Overview of This Lecture

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- More features of the template class “vector”

Acknowledgment

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- Much of this lecture is motivated by the treatment in

An Introduction to Programming Through C++

by Abhiram G. Ranade

McGraw Hill Education 2014

The “vector” class

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- For representing and manipulating one dimensional arrays of objects
  - Uses dynamically allocated array to store elements

    Array can grow or shrink in size
  - Dynamic memory management built in
- “vector” objects are container objects
- Must use **#include <vector>** at start of program
- Large collection of member functions
  - We’ll see only a small subset

Vectors of Complex Data Types

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- "vector" is a template class
  - So why restrict to vector<int>, vector<float>, vector<char> … ?
- Recall

```
class V3 {
   private: double x, y, z;
                double length() const { … }
   public:   operator+(V3 const &b) const {…}
                … Other member functions …
};
```

- We can have **vector<V3> v3Vector(10);**

Vectors of Complex Data Types

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- Vectors of pointers

```
vector<int *>  intPtrVec;
vector<V3 **> v3PtrPtrVec;
```

Each element of intPtrVec is an object of type int *

Each element of v3PtrPtrVec is an object of type V3**

- Vectors of vectors !

```
vector <vector<int> > x;
```

Each element of x is a vector of integers

Multi-dimensional Vectors

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- Vectors of pointers

```
vector<int *>  intPtrVec;
vector<V3 **> v3PtrPtrVec;
```

- Vectors of vectors !

```
vector <vector<int> > x;
```

Note the space

Multi-dimensional Vectors

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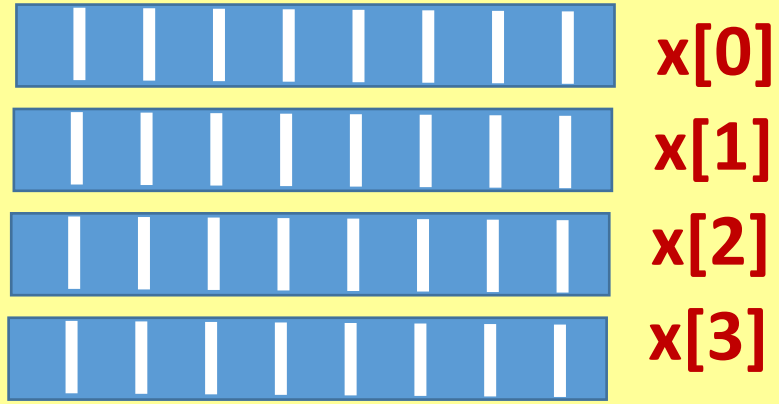
```
vector<vector<int> >  x(4, vector<int>(9));
```

Vector of (vector of integers)



Multi-dimensional Vectors

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```
vector<vector<int> >  x(4, vector<int>(9));
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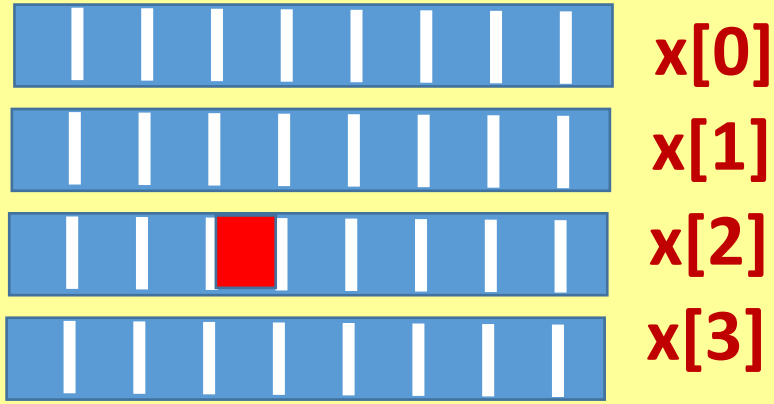
Vector of (vector of integers)

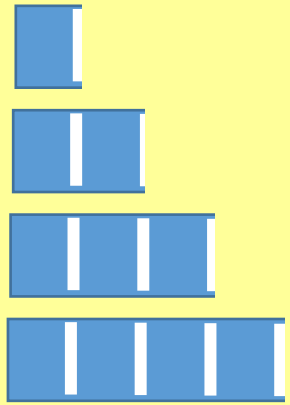


Access:
(x[2])[3] or simply x[2][3]

Multi-dimensional Vectors

```
vector<vector<int> >  x(4);
x[0] = vector<int>(1);
x[1] = vector<int>(2);
x[3] = vector<int>(3);
x[4] = vector<int>(4);
```

Lower triangular matrix



x[0]
x[1]
x[2]
x[3]

A User-defined Matrix Class using Vectors

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```
class matrix2D {
  private:  vector<vector<int> > elemer
  public:
      matrix2D(size_t m, size_t n) : elem
      int &operator() (size_t i, size_t j) { r
      size_t nrows() { return elements.siz
      size_t ncols() {return elements[0].s
};
```

alias for unsigned int

Preferred type for sizes of objects in memory

Also used for indices in string, vector, …

A User-defined Matrix Class using Vectors

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```
class matrix2D {
  private:  vector<vector<int> > elements;
  public:
      matrix2D(size_t m, size_t n) : elements(m, vector<int>(n)) { }
      int &operator() (size_t i, size_t j) { return elements[i][j]; }
      size_t nrows() { return elements.size(); }
      size_t ncols() {return elements[0].size(); }
};
```

Overloaded () operator

A User-defined Matrix Class using Vectors

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```
int main() {
   matrix2D M(5, 5);
   for (size_t i = 0;  i < M.nrows(); i++) {
      for (size_t j = 0; j < M.ncols(); j++) {
         M(i, j) = i*i + j*j;
      }
   }
   … Some other code …
}
```

Summary

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- Additional features of the "**vector**" class
- Multi-dimensional vectors
- Many more member functions of the "**vector**" class exist