Iterators and STL Containers

CMSC 202

STL

Standard Template Library

Why use it?

- Good programmers know what to write.
  - Great ones know what to reuse.
    - Paraphrase from "The Cathedral and the Bazaar"

STL provides reusable code

- Linked list, vector, map, multimap, pair, set, multiset, queue, stack, …
- Don't reinvent the wheel…

List

Linked List container

- No random access (does not support operator[] or at())

Essential operations

- insert()
- push_back()
- push_front()
- pop_front()
- pop_back()
- erase()

Set and Multiset

Set
- Sorted collection of unique elements
- Cannot change value of an element
- No random access

Multiset
- Allows duplicate elements

Essential operations
- insert()
- erase()
- count(element)
- find(element)

Pair

Pair
- Connects two items into a single object

Essential data
- first
  - gets the first member of pair
- second
  - gets the second member of pair

Example

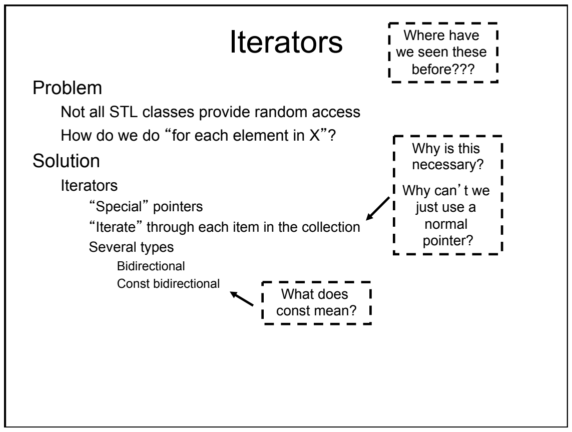
```
pair<int, string> hello( 5, “Hello”);
cout << hello.second << endl; // Hello
```

Map and Multimap

Map
- Stores key/value pairs, sorted by key
- Value is modifiable, key is not
- Key must be unique

Multimap
- Allows duplicate keys

Essential operations
- insert()
- erase()
- count(key)
- find(key)



Iterators

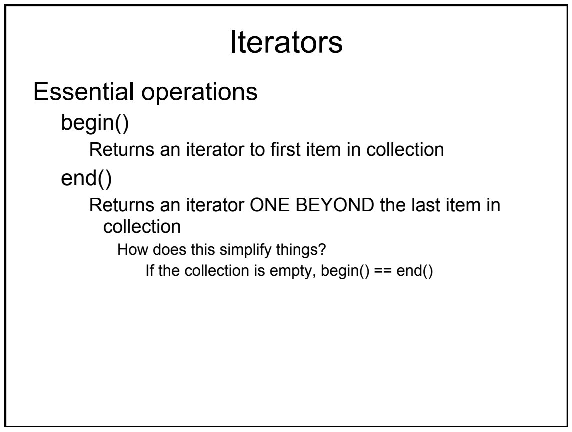
Where have we seen these before???

- Problem
  - Not all STL classes provide random access
  - How do we do “for each element in X”?
- Solution
  - Iterators
    - “Special” pointers
    - “Iterate” through each item in the collection
    - Several types
      - Bidirectional
      - Const bidirectional

Why is this necessary?

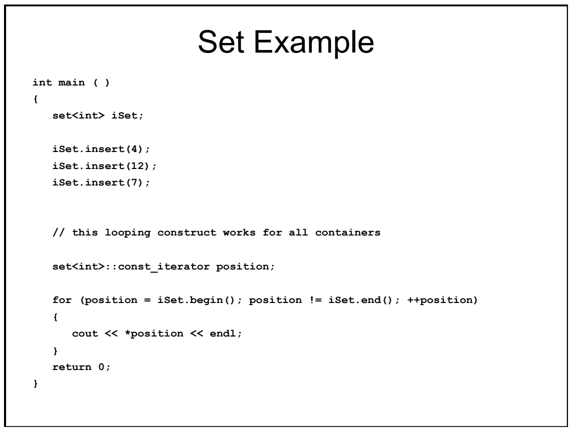
Why can’t we just use a normal pointer?

What does const mean?



Iterators

- Essential operations
  - begin()
    - Returns an iterator to first item in collection
  - end()
    - Returns an iterator ONE BEYOND the last item in collection
      - How does this simplify things?
        - If the collection is empty, begin() == end()



Set Example

```
int main ( )
{
   set<int> iSet;

   iSet.insert(4);
   iSet.insert(12);
   iSet.insert(7);


   // this looping construct works for all containers

   set<int>::const_iterator position;

   for (position = iSet.begin(); position != iSet.end(); ++position)
   {
      cout << *position << endl;
   }
   return 0;
}
```

Map Example

```
int main ( )
{
   // create an empty map using strings
   // as keys and floats as values
   map<string, float> stocks;

   // insert some stock prices
   stocks.insert( make_pair("IBM",  42.50));
   stocks.insert( make_pair("XYZ",   2.50));
   stocks.insert( make_pair("WX",    0.50));

   // instantiate an iterator for the map
   map<string, float>::iterator position;

   // print all the stocks
   for (position = stocks.begin(); position != stocks.end(); ++position)
      cout << "( " << position->first << ", " << position->second << " )\n";

   return 0;
}
```

Iterators - Overloaded Operators

`*`	Dereferences the iterator
`++`	Moves forward to next element
`--`	Moves backward to previous element
`==`	True if two iterators point to same element
`!=`	False if two iterators point to different elements
`=`	Assignment, makes two iterators point to same element

Iterators and Collection Methods

`erase( iterator )`
- Parameter is an iterator

Can have as many iterators into a collection as necessary

Practice

- Create a vector of integers
- Using an iterator and a loop
  - Change each integer to be the value of its square
- Using an iterator and a second loop
  - Print each item in reverse order

Challenge

- Using a map, create a collection of student grades
  - Key
    - Student ID
  - Value
    - Grade they want in this course
- Store 10 students and their desired grade
- Iterate through the map
  - Print each key/value pair in the map
- What sorting mechanism did the map use?
  - How would we specify that we wanted it sorted another way?