The Standard C++ Library – Algorithms

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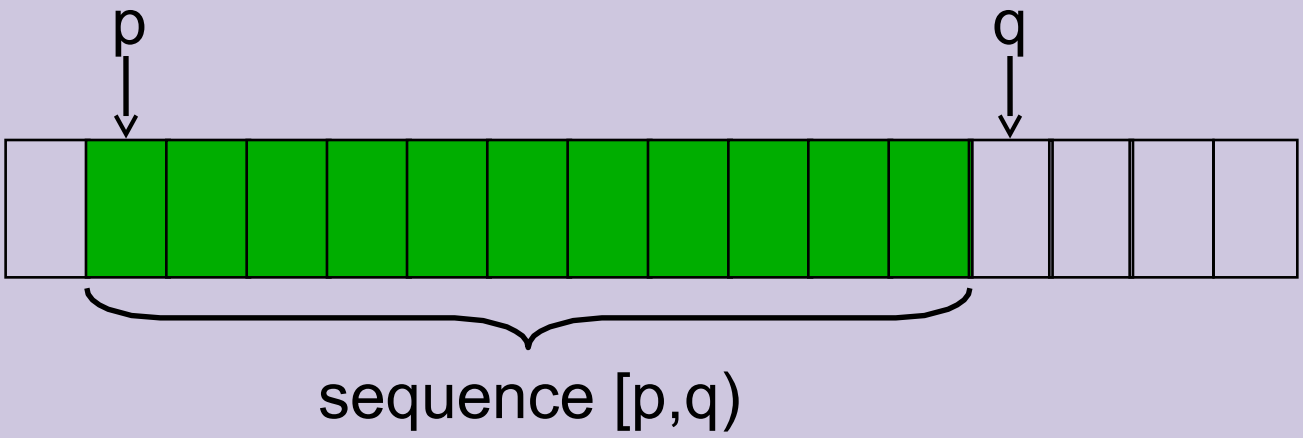
Algorithms

- Most STL algorithms works on sequences
- Sequences are passed as two iterators:
  - beginning element
  - element one after last



- Algorithms depend on iterator type

  not on container type

Example – merge documentation

copy

```
template< typename In, typename Out>
Out copy(In first, In last, Out res)
{
  while (first != last)
    *res++ = *first++;
  return res;
}
```

copy

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template< typename In, typename Out>
Out copy(In first, In last, Out res)
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  while (first != last)
    *res++ = *first++;
  return res;
}
```

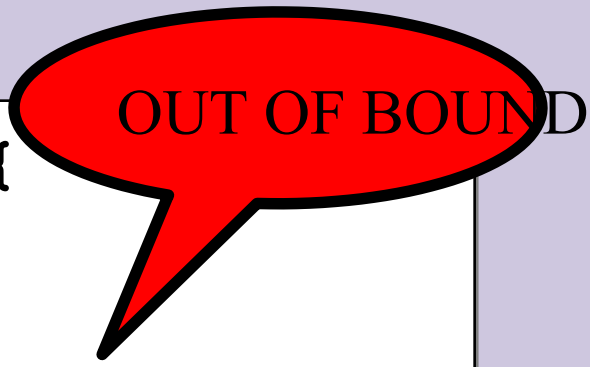
What's wrong with this ?

```
void foo(const vector<char>& v) {
   vector<char> v2;
   ...
   copy(v.begin(),v.end(), v2.begin());
```

copy

```
template< typename In, typename Out>
Out copy(In first, In last, Out res)
{
  while (first != last)
    *res++ = *first++;
  return res;
}
```

What's wrong with this ?




```
void foo(const vector<char>& v) {
   vector<char> v2;
   ...
   copy(v.begin(),v.end(), v2.begin());
```

So how can we copy and insert ?

Solution #1: Use insert explicitly

```
void foo(const vector<char>& v) {
   vector<char> v2;
   ...
   v2.insert(v2.end(),v.begin(),v.end());
```

So how can we copy and insert ?

Solution #2: Use back_inserter, which returns an iterator that knows to “push_back”. See folder 6.

```
void foo(const vector<char>& v) {
   vector<char> v2;
   ...
   copy(v.begin(),v.end(), back_inserter(v2));
```

generate, bind

generate –
- Accepts two iterators and a function without arguments;
- Fills the space between the iterators by iteratively calling the function.

bind -
- Accepts a function f and an argument x.
- Returns a functor without arguments that returns f(x).

Application example:
- Fill a vector with random numbers *(folder 7)*.

sort – using operator <

```
template <class RandomAccessIterator>
void sort(RandomAccessIterator first,
          RandomAccessIterator last);
```

Example usage(the hard way):

```
sort< vector<int>::iterator >
                    (vec.begin(), vec.end());
```

sort – using operator <

```
template <class RandomAccessIterator>
void sort(RandomAccessIterator first,
          RandomAccessIterator last);
```

Example usage:

```
sort(vec.begin(), vec.end());
```

sort – using operator <

```
template <class RandomAccessIterator>
void sort(RandomAccessIterator first,
          RandomAccessIterator last);
```

Example usage with primitive arrays:

```
int arr[5];
...
sort(arr, arr+5);
```

sort – using operator <

```
template <class RandomAccessIterator>
void sort(RandomAccessIterator first,
          RandomAccessIterator last);
```

Example usage with primitive arrays (C++11):

```
int arr[5];
...
sort(begin(arr), end(arr));
```

sort – using comparator

```
template <class RandomAccessIterator,
          class StrictWeakOrdering>
void sort(RandomAccessIterator first,
          RandomAccessIterator last,
          StrictWeakOrdering comp);
```

Example usage:

```
sort(vec.begin(), vec.end(), greater<int>());
```

sort – compile error

```
list<int> l(nums, nums+SIZE);
sort(l.begin(), l.end());
```

sort – compile error

```
list<int> l(nums, nums+SIZE);
sort(l.begin(), l.end());
```

list iterators are bidirectional and not random a

g++

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h: In function ‘void std::sort(_RandomAccessIterator, _RandomAccessIterator) [with _RandomAccessIterator = std::_List_iterator<int>]’:

Main.cpp:17: instantiated from here

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h:2713: error: no match for ‘operator-’ in ‘__last - __first’

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_bvector.h:182: note: candidates are: ptrdiff_t std::operator-(const std::_Bit_iterator_base&, const std::_Bit_iterator_base&)

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h: In function ‘void std::__final_insertion_sort(_RandomAccessIterator, _RandomAccessIterator) [with _RandomAccessIterator = std::_List_iterator<int>]’:

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h:2714: instantiated from ‘void std::sort(_RandomAccessIterator, _RandomAccessIterator) [with _RandomAccessIterator = std::_List_iterator<int>]’

Main.cpp:17: instantiated from here

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h:2357: error: no match for ‘operator-’ in ‘__last - __first’

. . .

g++

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h: In function ‘void std::sort(_RandomAccessIterator, _RandomAccessIterator) [with _RandomAccessIterator = std::_List_iterator<int>]’:

Main.cpp:17: instantiated from here

/usr/lib/gcc/i486-linux-g... 3: error: no match for ‘operator-’ in ‘__last

/usr/lib/gcc/i486-linux-g... 82: note: candidates are: ptrdiff_t std::operato... ator_base&)

/usr/lib/gcc/i486-linux-g... unction ‘void std::__final_insertior... ator) [with _RandomAccessIter...

???

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h:2714: instantiated from ‘void std::sort(_RandomAccessIterator, _RandomAccessIterator) [with _RandomAccessIterator = std::_List_iterator<int>]’

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. . .

g++

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h: In function ‘void std::sort(_RandomAccessIterator, _RandomAccessIterator) [with **_RandomAccessIterator = std::_List_iterator<int>**]’:

Main.cpp:17: instantiated from here

/usr/lib/gcc/i486-linux-gnu/4.1.2/../../../../include/c++/4.1.2/bits/stl_algo.h:2713: error: no match for ‘operator-’ in ‘__last - __first’

...

g++ -D_GLIBCXX_CONCEPT_CHECKS and STLFilt

```
BD Software STL Message Decryptor v2.47a for gcc
stl_algo.h: In function ‘void sort(_List_iterator<int>,
_List_iterator<
          int>)’:
Main.cpp:17:   instantiated from here
stl_algo.h:2713: error: no match for ‘operator-’ in ‘__last - __first’
stl_algo.h: In function ‘void __final_insertion_sort(
       _List_iterator<int>, _List_iterator<int>)’:
stl_algo.h:2714:   instantiated from ‘void sort(
       _List_iterator<int>, _List_iterator<int>)’
Main.cpp:17:   instantiated from here
```

• • •

g++ -D_GLIBCXX_CONCEPT_CHECKS and STLFilt

…
Main.cpp:17: instantiated from here
boost_concept_check.h:223: error: **conversion from ‘**
bidirectional_iterator_tag’ to non-scalar type ‘
random_access_iterator_tag’ requested

Cryptic error messages

STLFilt:

An STL Error Message Decryptor for C++:

http://www.bdsoft.com/tools/stlfilt.html

Cryptic error messages

Different compilers:

- clang++ (free)
- intel c++ (not free)

More?

- Lots of other features, especially in c++11 (threads,…)

- Other libraries:
  - Boost
  - opencv, dlib, armadillo, zlib, …