Indirect Iterator

abstract: indirect_iterator adapts an iterator by applying an extra dereference inside of operator*(). For example, this iterator adaptor makes it possible to view a container of pointers (e.g. list<foo*>) as if it were a container of the pointed-to type (e.g. list<foo>). indirect_iterator depends on two auxiliary traits, pointee and indirect_reference, to provide support for underlying iterators whose value_type is not an iterator.

Table of Contents

indirect_iterator synopsis
indirect_iterator requirements
indirect_iterator models
indirect_iterator operations
Example

indirect_iterator synopsis

template <
   class Iterator,
   class Value = use_default,
   class CategoryOrTraversal = use_default,
   class Reference = use_default,
   class Difference = use_default
>
class indirect_iterator
{
   public:
      typedef /* see below */ value_type;
      typedef /* see below */ reference;
      typedef /* see below */ pointer;
      typedef /* see below */ difference_type;
      typedef /* see below */ iterator_category;
indirect_iterator();
indirect_iterator(Iterator x);

template <
    class Iterator2, class Value2, class Category2
    , class Reference2, class Difference2
>
indirect_iterator(
    indirect_iterator<
        Iterator2, Value2, Category2, Reference2, Difference2
    > const& y
    , typename enable_if_convertible<Iterator2, Iterator>::type* = 0 // exposition
);

Iterator const& base() const;
reference operator*() const;
indirect_iterator& operator++();
indirect_iterator& operator--();

private:
    Iterator m_iterator; // exposition

The member types of indirect_iterator are defined according to the following pseudo-code, where V is iterator_traits<Iterator>::value_type

if (Value is use_default) then
    typedef remove_const<pointee<V>::type>::type value_type;
else
    typedef remove_const<Value>::type value_type;

if (Reference is use_default) then
    if (Value is use_default) then
        typedef indirect_reference<V>::type reference;
    else
        typedef Value& reference;
else
    typedef Reference reference;

if (Value is use_default) then
    typedef pointee<V>::type* pointer;
else
    typedef Value* pointer;

if (Difference is use_default)
    typedef iterator_traits<Iterator>::difference_type difference_type;
else
    typedef Difference difference_type;

if (CategoryOrTraversal is use_default)
    typedef iterator_category ( iterator_traversal<Iterator>::type, 'reference', 'value_type' ) iterator_category;
else

typedef iterator_category (  
    CategoryOrTraversal,'reference','value_type'
  ) iterator_category;

indirect_iterator requirements

The expression *v, where v is an object of iterator_traits<Iterator>::value_type, shall be valid expression and convertible to reference. Iterator shall model the traversal concept indicated by iterator_category. Value, Reference, and Difference shall be chosen so that value_type, reference, and difference_type meet the requirements indicated by iterator_category.

[Note: there are further requirements on the iterator_traits<Iterator>::value_type if the Value parameter is not use_default, as implied by the algorithm for deducing the default for the value_type member.]

indirect_iterator models

In addition to the concepts indicated by iterator_category and by iterator_traversal<indirect_iterator>::type, a specialization of indirect_iterator models the following concepts, Where v is an object of iterator_traits<Iterator>::value_type:

- Readable Iterator if reference(*v) is convertible to value_type.
- Writable Iterator if reference(*v) = t is a valid expression (where t is an object of type indirect_iterator::value_type)
- Lvalue Iterator if reference is a reference type.

indirect_iterator<X,V1,C1,R1,D1> is interoperable with indirect_iterator<Y,V2,C2,R2,D2> if and only if X is interoperable with Y.

indirect_iterator operations

In addition to the operations required by the concepts described above, specializations of indirect_iterator provide the following operations.

indirect_iterator();

Requires: Iterator must be Default Constructible.

Effects: Constructs an instance of indirect_iterator with a default-constructed m_iterator.

indirect_iterator(Iterator x);

Effects: Constructs an instance of indirect_iterator with m_iterator copy constructed from x.

template <
  class Iterator2, class Value2, unsigned Access, class Traversal
  , class Reference2, class Difference2
>
indirect_iterator(
  indirect_iterator<
    Iterator2, Value2, Access, Traversal, Reference2, Difference2
  > const& y
  , typename enable_if_convertible<Iterator2, Iterator>::type* = 0 // exposition
);
Requires: Iterator2 is implicitly convertible to Iterator.

Effects: Constructs an instance of indirect_iterator whose m_iterator subobject is constructed from y.base().

Iterator const& base() const;

Returns: m_iterator

reference operator*() const;

Returns: **m_iterator

indirect_iterator& operator++();

Effects: ++m_iterator

Returns: *this

indirect_iterator& operator--();

Effects: --m_iterator

Returns: *this

Example

This example prints an array of characters, using indirect_iterator to access the array of characters through an array of pointers. Next indirect_iterator is used with the transform algorithm to copy the characters (incremented by one) to another array. A constant indirect iterator is used for the source and a mutable indirect iterator is used for the destination. The last part of the example prints the original array of characters, but this time using the make间接_iterator helper function.

```cpp
char characters[] = "abcdefg";
const int N = sizeof(characters)/sizeof(char) - 1; // -
1 since characters has a null char
char* pointers_to_chars[N]; // at the end.
for (int i = 0; i < N; ++i)
    pointers_to_chars[i] = &characters[i];

// Example of using indirect_iterator

boost::indirect_iterator<char**, char>
    indirect_first(pointers_to_chars), indirect_last(pointers_to_chars + N);

std::copy(indirect_first, indirect_last, std::ostream_iterator<char>(std::cout, ","));
std::cout << std::endl;

// Example of making mutable and constant indirect iterators

char mutable_characters[N];
char* pointers_to Mutable_chars[N];
for (int j = 0; j < N; ++j)
    pointers_to Mutable_chars[j] = &mutable_characters[j];
```
boost::indirect_iterator<char* const*> mutable_indirect_first(pointers_to_mutable_chars),
   mutable_indirect_last(pointers_to_mutable_chars + N);
boost::indirect_iterator<char* const*, char const> const_indirect_first(pointers_to_chars),
   const_indirect_last(pointers_to_chars + N);

std::transform(const_indirect_first, const_indirect_last,
               mutable_indirect_first, std::bind1st(std::plus<char>(), 1));

std::copy(mutable_indirect_first, mutable_indirect_last,
           std::ostream_iterator<char>(std::cout, " ", " "));
std::cout << std::endl;

// Example of using make_indirect_iterator()

std::copy(boost::make_indirect_iterator(pointers_to_chars),
           boost::make_indirect_iterator(pointers_to_chars + N),
           std::ostream_iterator<char>(std::cout, " ", " "));
std::cout << std::endl;

The output is:

a,b,c,d,e,f,g,
b,c,d,e,f,g,h,
a,b,c,d,e,f,g,

The source code for this example can be found here.