Counting Iterator

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abstract: How would you fill up a vector with the numbers zero through one hundred using `std::copy()`? The only iterator operation missing from builtin integer types is an `operator*()` that returns the current value of the integer. The counting iterator adaptor adds this crucial piece of functionality to whatever type it wraps. One can use the counting iterator adaptor not only with integer types, but with any incrementable type.

`counting_iterator` adapts an object by adding an `operator*` that returns the current value of the object. All other iterator operations are forwarded to the adapted object.

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`counting_iterator` synopsis

```
template <
    class Incrementable
  , class CategoryOrTraversal = use_default
  , class Difference = use_default
>
class counting_iterator
{
public:
    typedef Incrementable value_type;
    typedef const Incrementable& reference;
    typedef const Incrementable* pointer;
    typedef /* see below */ difference_type;
    typedef /* see below */ iterator_category;
```

```
    counting_iterator();
    counting_iterator(counting_iterator const& rhs);
    explicit counting_iterator(Incrementable x);
    Incrementable const& base() const;
    reference operator*() const;
    counting_iterator& operator++();
    counting_iterator& operator--();
private:
    Incrementable m_inc; // exposition
};
```

If the `Difference` argument is `use_default` then `difference_type` is an unspecified signed integral type. Otherwise `difference_type` is `Difference`.

`iterator_category` is determined according to the following algorithm:

```
if (CategoryOrTraversal is not use_default)
    return CategoryOrTraversal
else if (numeric_limits<Incrementable>::is_specialized)
    return iterator-category(
        random_access_traversal_tag, Incrementable, const Incrementable&)
else
    return iterator-category(
         iterator_traversal<Incrementable>::type,
         Incrementable, const Incrementable&)
```

[*Note:* **implementers are encouraged to provide an implementation of** `operator-` and a `difference_type` that avoids overflows in the cases where `std::numeric_limits<Incrementable>::is_specialized` is true.]

`counting_iterator` requirements

The `Incrementable` argument shall be Copy Constructible and Assignable.

If `iterator_category` is convertible to `forward_iterator_tag` or `forward_traversal_tag`, the following must be well-formed:

```
Incrementable i, j;
++i;         // pre-increment
i == j;      // operator equal
```

If `iterator_category` is convertible to `bidirectional_iterator_tag` or `bidirectional_traversal_tag`, the following expression must also be well-formed:

```
--i
```

If `iterator_category` is convertible to `random_access_iterator_tag` or `random_access_traversal_tag`, the following must must also be valid:

```
counting_iterator::difference_type n;
i += n;
n = i - j;
i < j;
```

counting_iterator models

Specializations of `counting_iterator` model Readable Lvalue Iterator. In addition, they model the concepts corresponding to the iterator tags to which their `iterator_category` is convertible. Also, if `CategoryOrTraversal` is not `use_default` then `counting_iterator` models the concept corresponding to the iterator tag `CategoryOrTraversal`. Otherwise, if `numeric_limits<Incrementable>::is_specialized`, then `counting_iterator` models Random Access Traversal Iterator. Otherwise, `counting_iterator` models the same iterator traversal concepts modeled by `Incrementable`.

`counting_iterator<X,C1,D1>` is interoperable with `counting_iterator<Y,C2,D2>` if and only if `X` is interoperable with `Y`.

counting_iterator operations

In addition to the operations required by the concepts modeled by `counting_iterator`, `counting_iterator` provides the following operations.

```
counting_iterator();
```

Requires: `Incrementable` is Default Constructible.

Effects: Default construct the member `m_inc`.

```
counting_iterator(counting_iterator const& rhs);
```

Effects: Construct member `m_inc` from `rhs.m_inc`.

```
explicit counting_iterator(Incrementable x);
```

Effects: Construct member `m_inc` from `x`.

```
reference operator*() const;
```

Returns: `m_inc`

```
counting_iterator& operator++();
```

Effects: `++m_inc`

Returns: `*this`

```
counting_iterator& operator--();
```

Effects: `--m_inc`

Returns: `*this`

```
Incrementable const& base() const;
```

Returns: `m_inc`

```
template <class Incrementable>
counting_iterator<Incrementable> make_counting_iterator(Incrementable x);
```

Returns: An instance of `counting_iterator<Incrementable>` with `current` constructed from `x`.

Example

This example fills an array with numbers and a second array with pointers into the first array, using `counting_iterator` for both tasks. Finally `indirect_iterator` is used to print out the numbers into the first array via indirection through the second array.

```
int N = 7;
std::vector<int> numbers;
typedef std::vector<int>::iterator n_iter;
std::copy(boost::counting_iterator<int>(0),
          boost::counting_iterator<int>(N),
          std::back_inserter(numbers));

std::vector<std::vector<int>::iterator> pointers;
std::copy(boost::make_counting_iterator(numbers.begin()),
           boost::make_counting_iterator(numbers.end()),
           std::back_inserter(pointers));

std::cout << "indirectly printing out the numbers from 0 to "
           << N << std::endl;
std::copy(boost::make_indirect_iterator(pointers.begin()),
           boost::make_indirect_iterator(pointers.end()),
           std::ostream_iterator<int>(std::cout, " "));
std::cout << std::endl;
```

The output is:

```
indirectly printing out the numbers from 0 to 7
0 1 2 3 4 5 6
```

The source code for this example can be found here.