std::vector

Defined in header <vector>

```
template<
    class T,
    class Allocator = std::allocator<T>
> class vector;
```

`std::vector` is a sequence container that encapsulates dynamic size arrays.

The elements are stored contiguously, which means that elements can be accessed not only through iterators, but also using offsets on regular pointers to elements. This means that a pointer to an element of a vector may be passed to any function that expects a pointer to an element of an array.	(since C++03)

The storage of the vector is handled automatically, being expanded and contracted as needed. Vectors usually occupy more space than static arrays, because more memory is allocated to handle future growth. This way a vector does not need to reallocate each time an element is inserted, but only when the additional memory is exhausted. The total amount of allocated memory can be queried using `capacity()` function. Extra memory can be returned to the system via a call to `shrink_to_fit()`. (since C++11)

Reallocations are usually costly operations in terms of performance. `reserve()` function can be used to eliminate reallocations if the number of elements is known beforehand.

The complexity (efficiency) of common operations on vectors is as follows:

- Random access - constant $O(1)$
- Insertion or removal of elements at the end - amortized constant $O(1)$
- Insertion or removal of elements - linear in distance to the end of the vector $O(n)$

`std::vector` meets the requirements of `Container`, `AllocatorAwareContainer`, `SequenceContainer`, `ContiguousContainer` (for `T` other than `bool`) (since C++17) and `ReversibleContainer`.

Template parameters

`T` - The type of the elements.

`T` must meet the requirements of `CopyAssignable` and `CopyConstructible`.	(until C++11)
The requirements that are imposed on the elements depend on the actual operations performed on the container. Generally, it is required that element type is a complete type and meets the requirements of `Erasable`, but many member functions impose stricter requirements.	(since C++11) (until C++17)
The requirements that are imposed on the elements depend on the actual operations performed on the container. Generally, it is required that element type meets the requirements of `Erasable`, but many member functions impose stricter requirements. This container (but not its members) can be instantiated with an incomplete element type if the allocator satisfies the allocator completeness requirements.	(since C++17)

`Allocator` - An allocator that is used to acquire memory to store the elements. The type must meet the requirements of `Allocator`.

Specializations

The standard library provides a specialization of `std::vector` for the type `bool`, which is optimized for space efficiency.

`vector``<bool>`	space-efficient dynamic bitset (class template specialization)

Iterator invalidation

This section is incomplete

There are still a few inaccuracies in this section. Refer to individual member function pages for more detail.

Operations	Invalidated
All read only operations, `swap`, `std::swap`	Never

`reserve`, `shrink_to_fit`, `clear`, `operator=`	Always
`erase`	Erased elements + all elements after them (including `end()`)
`push_back`, `emplace_back`	If the vector changed capacity, all of them. If not, only end().
`insert`, `emplace`, `resize`	If the vector changed capacity, all of them. If not, only those after the insertion point.
`pop_back`	The element erased and `end()`.

Member types

Member type	Definition
`value_type`	`T`
`allocator_type`	`Allocator`
`size_type`	Unsigned integral type (usually `std::size_t`)
`difference_type`	Signed integer type (usually `std::ptrdiff_t`)
`reference`	`Allocator::reference` (until C++11) `value_type&` (since C++11)
`const_reference`	`Allocator::const_reference` (until C++11) `const value_type&` (since C++11)
`pointer`	`Allocator::pointer` (until C++11) `std::allocator_traits<Allocator>::pointer` (since C++11)
`const_pointer`	`Allocator::const_pointer` (until C++11) `std::allocator_traits<Allocator>::const_pointer` (since C++11)
`iterator`	`RandomAccessIterator`
`const_iterator`	Constant random access iterator
`reverse_iterator`	`std::reverse_iterator<iterator>`
`const_reverse_iterator`	`std::reverse_iterator<const_iterator>`

Member functions

(constructor)	constructs the `vector` (public member function)
(destructor)	destructs the `vector` (public member function)
`operator=`	assigns values to the container (public member function)
`assign`	assigns values to the container (public member function)
`get_allocator`	returns the associated allocator (public member function)

Element access

`at`	access specified element with bounds checking (public member function)
`operator[]`	access specified element (public member function)
`front`	access the first element (public member function)
`back`	access the last element (public member function)
`data` (C++11)	direct access to the underlying array (public member function)

Iterators

`begin` **`cbegin`**	returns an iterator to the beginning (public member function)
`end` **`cend`**	returns an iterator to the end (public member function)
`rbegin` **`crbegin`**	returns a reverse iterator to the beginning (public member function)
`rend` **`crend`**	returns a reverse iterator to the end (public member function)

Capacity

`empty`	checks whether the container is empty (public member function)

size	returns the number of elements (public member function)
max_size	returns the maximum possible number of elements (public member function)
reserve	reserves storage (public member function)
capacity	returns the number of elements that can be held in currently allocated storage (public member function)
shrink_to_fit (C++11)	reduces memory usage by freeing unused memory (public member function)

Modifiers

clear	clears the contents (public member function)
insert	inserts elements (public member function)
emplace (C++11)	constructs element in-place (public member function)
erase	erases elements (public member function)
push_back	adds elements to the end (public member function)
emplace_back (C++11)	constructs elements in-place at the end (public member function)
pop_back	removes the last element (public member function)
resize	changes the number of elements stored (public member function)
swap	swaps the contents (public member function)

Non-member functions

operator== **operator!=** **operator<** **operator<=** **operator>** **operator>=**	lexicographically compares the values in the vector (function template)
std::swap(std::vector)	specializes the `std::swap` algorithm (function template)

std::vector::vector

`explicit vector( const Allocator& alloc = Allocator() );`	(1)	(until C++14)
`vector() : vector( Allocator() ) {}` `explicit vector( const Allocator& alloc );`	(1)	(since C++14)

`explicit vector( size_type count,`
`const T& value = T(),`
`const Allocator& alloc = Allocator());`
	(2)	(until C++11)

`vector( size_type count,`
`const T& value,`
`const Allocator& alloc = Allocator());`
	(2)	(since C++11)

`explicit vector( size_type count );`	(3)	(since C++11) (until C++14)
`explicit vector( size_type count, const Allocator& alloc = Allocator() );`	(3)	(since C++14)

`template< class InputIt >`
`vector( InputIt first, InputIt last,`
`const Allocator& alloc = Allocator() );`
	(4)	

`vector( const vector& other );`	(5)	
`vector( const vector& other, const Allocator& alloc );`	(5)	(since C++11)
`vector( vector&& other )`	(6)	(since C++11)
`vector( vector&& other, const Allocator& alloc );`	(6)	(since C++11)
`vector( std::initializer_list<T> init,` `const Allocator& alloc = Allocator() );`	(7)	(since C++11)

Constructs a new container from a variety of data sources, optionally using a user supplied allocator `alloc`.

1) Default constructor. Constructs an empty container.
2) Constructs the container with `count` copies of elements with value `value`.
3) Constructs the container with `count` default-inserted instances of `T`. No copies are made.
4) Constructs the container with the contents of the range `[first, last)`.

This constructor has the same effect as overload (2) if `InputIt` is an integral type.	(until C++11)
This overload only participates in overload resolution if `InputIt` satisfies `InputIterator` , to avoid ambiguity with the overload (2).	(since C++11)

5) Copy constructor. Constructs the container with the copy of the contents of `other`. If `alloc` is not provided, allocator is obtained by calling `std::allocator_traits<allocator_type>::select_on_container_copy_construction(other.get_allocator())` .
6) Move constructor. Constructs the container with the contents of `other` using move semantics. If `alloc` is not provided, allocator is obtained by move-construction from the allocator belonging to `other`.
7) Constructs the container with the contents of the initializer list `init`.

Parameters

alloc	-	allocator to use for all memory allocations of this container
count	-	the size of the container
value	-	the value to initialize elements of the container with
first, last	-	the range to copy the elements from
other	-	another container to be used as source to initialize the elements of the container with
init	-	initializer list to initialize the elements of the container with

Complexity

1) Constant
2-3) Linear in `count`
4) Linear in distance between `first` and `last`

5) Linear in size of `other`

6) Constant. If `alloc` is given and `alloc != other.get_allocator()`, then linear.

7) Linear in size of `init`

Notes

The overload (3) zeroes out elements of non-class types such as `int`, which is different from the behavior of new[] , which leaves them uninitialized. To match the behavior of new[], a custom Allocator::construct (http%3A//stackoverflow.com/a/21028912/273767) can be provided which leaves such elements uninitialized.

Exceptions

1) `noexcept` specification: (since C++17)

```
noexcept(noexcept(Allocator()))
```

6) `noexcept` specification:

```
noexcept
```

Example

Run this code

```
#include <vector>
#include <string>
#include <iostream>

template<typename T>
std::ostream& operator<<(std::ostream& s, const std::vector<T>& v) {
    s.put('[');
    char comma[3] = {'\0', ' ', '\0'};
    for (const auto& e : v) {
        s << comma << e;
        comma[0] = ',';
    }
    return s << ']';
}

int main()
{
    // c++11 initializer list syntax:
    std::vector<std::string> words1 {"the", "frogurt", "is", "also", "cursed"};
    std::cout << "words1: " << words1 << '\n';

    // words2 == words1
    std::vector<std::string> words2(words1.begin(), words1.end());
    std::cout << "words2: " << words2 << '\n';

    // words3 == words1
    std::vector<std::string> words3(words1);
    std::cout << "words3: " << words3 << '\n';

    // words4 is {"Mo", "Mo", "Mo", "Mo", "Mo"}
    std::vector<std::string> words4(5, "Mo");
    std::cout << "words4: " << words4 << '\n';
}
```

Output:

```
words1: [the, frogurt, is, also, cursed]
words2: [the, frogurt, is, also, cursed]
words3: [the, frogurt, is, also, cursed]
words4: [Mo, Mo, Mo, Mo, Mo]
```

See also

assign	assigns values to the container (public member function)

operator=	assigns values to the container (public member function)

std::vector::~vector

```
~vector();
```

Destructs the container. The destructors of the elements are called and the used storage is deallocated. Note, that if the elements are pointers, the pointed-to objects are not destroyed.

Complexity

Linear in the size of the container.

std::vector::operator=

```
vector& operator=( const vector& other );                    (1)
vector& operator=( vector&& other );                         (2)  (since C++11)
vector& operator=( std::initializer_list<T> ilist );         (3)  (since C++11)
```

Replaces the contents of the container.

1) Copy assignment operator. Replaces the contents with a copy of the contents of `other`. If `std::allocator_traits<allocator_type>::propagate_on_container_copy_assignment()` is `true`, the target allocator is replaced by a copy of the source allocator. If the target and the source allocators do not compare equal, the target (`*this`) allocator is used to deallocate the memory, then `other`'s allocator is used to allocate it before copying the elements. (since C++11)
2) Move assignment operator. Replaces the contents with those of `other` using move semantics (i.e. the data in `other` is moved from `other` into this container). `other` is in a valid but unspecified state afterwards. If `std::allocator_traits<allocator_type>::propagate_on_container_move_assignment()` is `true`, the target allocator is replaced by a copy of the source allocator. If it is `false` and the source and the target allocators do not compare equal, the target cannot take ownership of the source memory and must move-assign each element individually, allocating additional memory using its own allocator as needed.
3) Replaces the contents with those identified by initializer list `ilist`.

Parameters

other - another container to use as data source
ilist - initializer list to use as data source

Return value

`*this`

Complexity

1) Linear in the size of the `other`.
2) Constant unless `std::allocator_traits<allocator_type>::propagate_on_container_move_assignment()` is false and the allocators do not compare equal (in which case linear).
3) Linear in the size of `ilist`.

Exceptions

2) `noexcept` specification: (since C++17)

```
noexcept(std::allocator_traits<Allocator>::propagate_on_container_move_assignment::value
|| std::allocator_traits<Allocator>::is_always_equal::value)
```

Example

The following code uses to assign one `std::vector` to another:

Run this code

```
#include <vector>
#include <iostream>

void display_sizes(const std::vector<int>& nums1,
                   const std::vector<int>& nums2,
                   const std::vector<int>& nums3)
{
    std::cout << "nums1: " << nums1.size()
              << " nums2: " << nums2.size()
```

```
              << " nums3: " << nums3.size() << '\n';
}

int main()
{
    std::vector<int> nums1 {3, 1, 4, 6, 5, 9};
    std::vector<int> nums2;
    std::vector<int> nums3;

    std::cout << "Initially:\n";
    display_sizes(nums1, nums2, nums3);

    // copy assignment copies data from nums1 to nums2
    nums2 = nums1;

    std::cout << "After assigment:\n";
    display_sizes(nums1, nums2, nums3);

    // move assignment moves data from nums1 to nums3,
    // modifying both nums1 and nums3
    nums3 = std::move(nums1);

    std::cout << "After move assigment:\n";
    display_sizes(nums1, nums2, nums3);
}
```

Output:

```
Initially:
nums1: 6 nums2: 0 nums3: 0
After assigment:
nums1: 6 nums2: 6 nums3: 0
After move assigment:
nums1: 0 nums2: 6 nums3: 6
```

See also

(constructor)	constructs the `vector` (public member function)
`assign`	assigns values to the container (public member function)

std::vector::assign

`void assign( size_type count, const T& value );`	(1)	
`template< class InputIt > void assign( InputIt first, InputIt last );`	(2)	
`void assign( std::initializer_list<T> ilist );`	(3)	(since C++11)

Replaces the contents of the container.

1) Replaces the contents with `count` copies of value `value`
2) Replaces the contents with copies of those in the range `[first, last)`.

This overload has the same effect as overload (1) if `InputIt` is an integral type.	(until C++11)
This overload only participates in overload resolution if `InputIt` satisfies `InputIterator`.	(since C++11)

3) Replaces the contents with the elements from the initializer list `ilist`.

Parameters

`count`	-	the new size of the container
`value`	-	the value to initialize elements of the container with
`first, last`	-	the range to copy the elements from
`ilist`	-	initializer list to copy the values from

Complexity

1) Linear in `count`
2) Linear in distance between `first` and `last`
3) Linear in `ilist.size()`

Example

The following code uses `assign` to add several characters to a `std::vector<char>`:

Run this code

```
#include <vector>
#include <iostream>

int main()
{
    std::vector<char> characters;

    characters.assign(5, 'a');

    for (char c : characters) {
        std::cout << c << '\n';
    }

    return 0;
}
```

Output:

```
a
a
a
a
a
```

See also

(constructor)	constructs the `vector` (public member function)

std::vector::get_allocator

```
allocator_type get_allocator() const;
```

Returns the allocator associated with the container.

Parameters

(none)

Return value

The associated allocator.

Complexity

Constant.

std::vector::at

```
reference       at( size_type pos );
const_reference at( size_type pos ) const;
```

Returns a reference to the element at specified location `pos`, with bounds checking.

If `pos` not within the range of the container, an exception of type `std::out_of_range` is thrown.

Parameters

`pos` - position of the element to return

Return value

Reference to the requested element.

Exceptions

`std::out_of_range` if `!(pos < size())`.

Complexity

Constant.

See also

`operator[]`	access specified element (public member function)

std::vector::operator[]

```
reference       operator[]( size_type pos );
const_reference operator[]( size_type pos ) const;
```

Returns a reference to the element at specified location `pos`. No bounds checking is performed.

Parameters

pos - position of the element to return

Return value

Reference to the requested element.

Complexity

Constant.

Notes

Unlike `std::map::operator[]`, this operator never inserts a new element into the container.

Example

The following code uses `operator[]` to read from and write to a `std::vector<int>`:

Run this code

```
#include <vector>
#include <iostream>

int main()
{
    std::vector<int> numbers {2, 4, 6, 8};

    std::cout << "Second element: " << numbers[1] << '\n';

    numbers[0] = 5;

    std::cout << "All numbers:";
    for (auto i : numbers) {
        std::cout << ' ' << i;
    }
    std::cout << '\n';
}
```

Output:

```
Second element: 4
All numbers: 5 4 6 8
```

See also

at	access specified element with bounds checking (public member function)

std::vector::front

```
reference front();
const_reference front() const;
```

Returns a reference to the first element in the container.

Calling `front` on an empty container is undefined.

Parameters

(none)

Return value

reference to the first element

Complexity

Constant

Notes

For a container `c`, the expression `c.front()` is equivalent to `*c.begin()`.

Example

The following code uses `front` to display the first element of a `std::vector<char>`:

Run this code

```
#include <vector>
#include <iostream>

int main()
{
    std::vector<char> letters {'o', 'm', 'g', 'w', 't', 'f'};

    if (!letters.empty()) {
        std::cout << "The first character is: " << letters.front() << '\n';
    }
}
```

Output:

```
The first character is o
```

See also

back	access the last element (public member function)

std::vector::back

```
reference back();
const_reference back() const;
```

Returns reference to the last element in the container.

Calling `back` on an empty container is undefined.

Parameters

(none)

Return value

Reference to the last element.

Complexity

Constant.

Notes

For a container `c`, the expression `return c.back();` is equivalent to
`{ auto tmp = c.end(); --tmp; return *tmp; }`

Example

The following code uses `back` to display the last element of a `std::vector<char>`:

Run this code

```
#include <vector>
#include <iostream>

int main()
{
    std::vector<char> letters {'o', 'm', 'g', 'w', 't', 'f'};
    if (!letters.empty()) {
        std::cout << "The last character is: " << letters.back() << '\n';
    }
}
```

Output:

```
The last character is f
```

See also

`front`	access the first element (public member function)

std::vector::data

```
T* data();                    (since C++11)
const T* data() const;        (since C++11)
```

Returns pointer to the underlying array serving as element storage. The pointer is such that range `[data(); data() + size())` is always a valid range, even if the container is empty.

Parameters

(none)

Return value

Pointer to the underlying element storage. For non-empty containers, returns `&front()`

Complexity

Constant.

Exceptions

`noexcept` specification: `noexcept`

See also

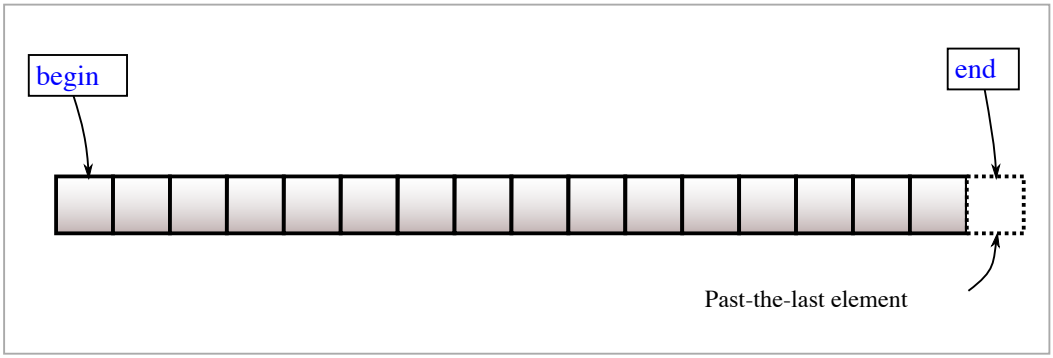
front	access the first element (public member function)
back	access the last element (public member function)

std::vector::begin, std::vector::cbegin

```
iterator begin();
const_iterator begin() const;
const_iterator cbegin() const;     (since C++11)
```

Returns an iterator to the first element of the container.

If the container is empty, the returned iterator will be equal to `end()`.



Parameters

(none)

Return value

Iterator to the first element

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant

Example

This section is incomplete
Reason: no example

See also

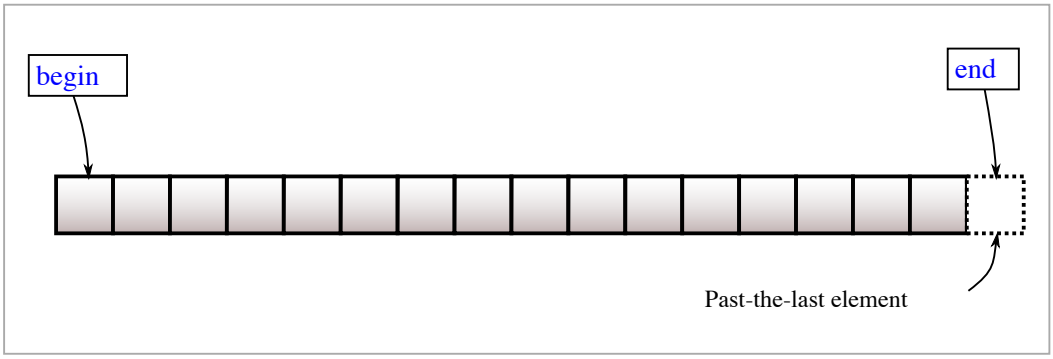
end **cend**	returns an iterator to the end (public member function)

std::vector::end, std::vector::cend

```
iterator end();
const_iterator end() const;
const_iterator cend() const;     (since C++11)
```

Returns an iterator to the element following the last element of the container.

This element acts as a placeholder; attempting to access it results in undefined behavior.



Parameters

(none)

Return value

Iterator to the element following the last element.

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant.

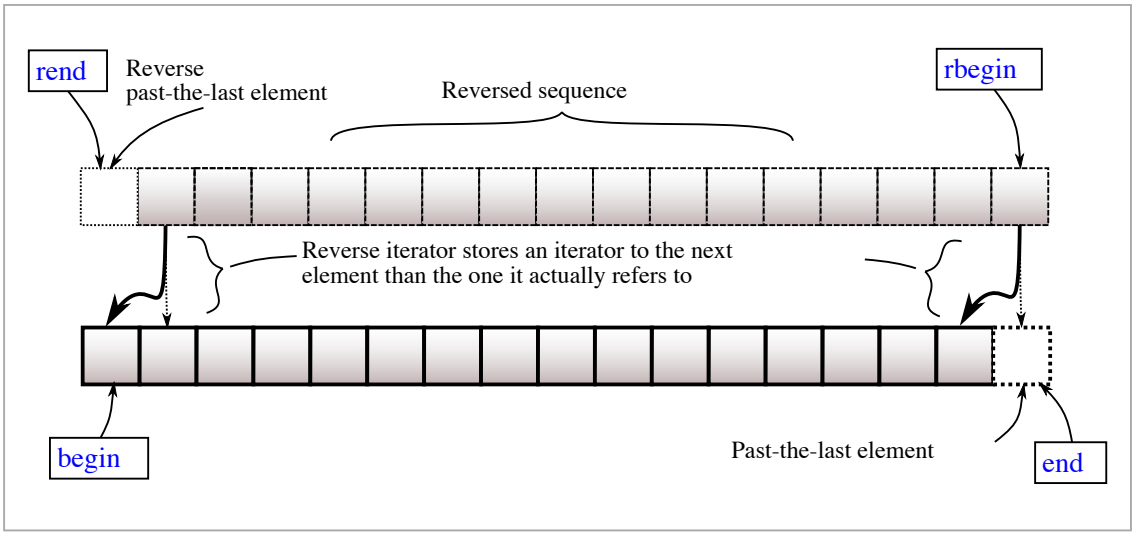
See also

`begin` **`cbegin`**	returns an iterator to the beginning (public member function)

std::vector::rbegin, std::vector::crbegin

```
reverse_iterator rbegin();
const_reverse_iterator rbegin() const;
const_reverse_iterator crbegin() const;    (since C++11)
```

Returns a reverse iterator to the first element of the reversed container. It corresponds to the last element of the non-reversed container.



Parameters

(none)

Return value

Reverse iterator to the first element.

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant.

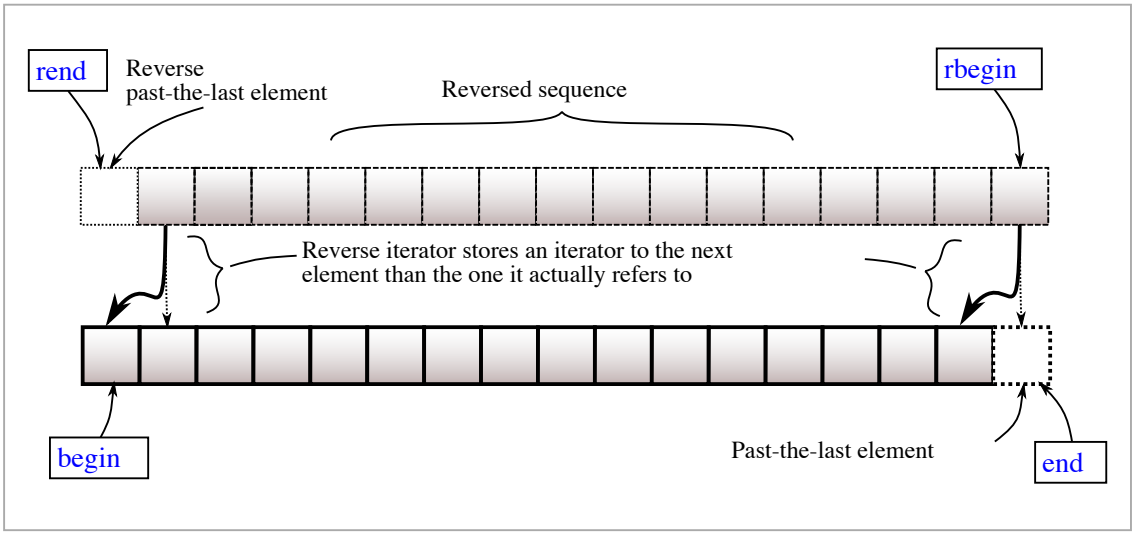
See also

`rend` **`crend`**	returns a reverse iterator to the end (public member function)

std::vector::rend, std::vector::crend

```
reverse_iterator rend();
const_reverse_iterator rend() const;
const_reverse_iterator crend() const;     (since C++11)
```

Returns a reverse iterator to the element following the last element of the reversed container. It corresponds to the element preceding the first element of the non-reversed container. This element acts as a placeholder, attempting to access it results in undefined behavior.



Parameters

(none)

Return value

Reverse iterator to the element following the last element.

Exceptions

(none)		(until C++11)
noexcept specification:	noexcept	(since C++11)

Complexity

Constant.

See also

rbegin **crbegin**	returns a reverse iterator to the beginning (public member function)

std::vector::empty

```
bool empty() const;
```

Checks if the container has no elements, i.e. whether `begin() == end()`.

Parameters

(none)

Return value

`true` if the container is empty, `false` otherwise

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant.

Example

The following code uses `empty` to check if a `std::vector<int>` contains any elements:

Run this code

```
#include <vector>
#include <iostream>

int main()
{
    std::vector<int> numbers;
    std::cout << "Initially, numbers.empty(): " << numbers.empty() << '\n';

    numbers.push_back(42);
    numbers.push_back(13317);
    std::cout << "After adding elements, numbers.empty(): " << numbers.empty() << '\n';
}
```

Output:

```
Initially, numbers.empty(): 1
After adding elements, numbers.empty(): 0
```

See also

`size`	returns the number of elements (public member function)

std::vector::size

```
size_type size() const;
```

Returns the number of elements in the container, i.e. `std::distance(begin(), end())`.

Parameters

(none)

Return value

The number of elements in the container.

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant.

Example

The following code uses `size` to display the number of elements in a `std::vector<int>`:

Run this code

```
#include <vector>
#include <iostream>

int main()
{
    std::vector<int> nums {1, 3, 5, 7};

    std::cout << "nums contains " << nums.size() << " elements.\n";
}
```

Output:

```
nums contains 4 elements.
```

See also

capacity	returns the number of elements that can be held in currently allocated storage (public member function)
empty	checks whether the container is empty (public member function)
max_size	returns the maximum possible number of elements (public member function)
resize	changes the number of elements stored (public member function)

std::vector::max_size

```
size_type max_size() const;
```

Returns the maximum number of elements the container is able to hold due to system or library implementation limitations, i.e. `std::distance(begin(), end())` for the largest container.

Parameters

(none)

Return value

Maximum number of elements.

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant.

Notes

This value is typically equal to `std::numeric_limits<size_type>::max()`, and reflects the theoretical limit on the size of the container. At runtime, the size of the container may be limited to a value smaller than `max_size()` by the amount of RAM available.

Example

Run this code

```
#include <iostream>
#include <vector>

int main()
{
    std::vector<char> s;
    std::cout << "Maximum size of a 'vector' is " << s.max_size() << "\n";
}
```

Possible output:

```
Maximum size of a 'vector' is 18446744073709551615
```

See also

size	returns the number of elements (public member function)
capacity	returns the number of elements that can be held in currently allocated storage (public member function)

std::vector::reserve

```
void reserve( size_type new_cap );
```

Increase the capacity of the container to a value that's greater or equal to `new_cap`. If `new_cap` is greater than the current `capacity()`, new storage is allocated, otherwise the method does nothing.

If `new_cap` is greater than `capacity()`, all iterators and references, including the past-the-end iterator, are invalidated. Otherwise, no iterators or references are invalidated.

Parameters

`new_cap` - new capacity of the container

Type requirements

- `T` must meet the requirements of `MoveInsertable`.

Return value

(none)

Exceptions

`std::length_error` if `new_cap > max_size()`.

Complexity

At most linear in the `size()` of the container.

Notes

`reserve()` cannot be used to reduce the capacity of the container, to that end `shrink_to_fit()` is provided.

Example

Run this code

```
#include <cstddef>
#include <new>
#include <vector>
#include <iostream>

// minimal C++11 allocator with debug output
template <class Tp>
struct NAlloc {
    typedef Tp value_type;
    NAlloc() = default;
    template <class T> NAlloc(const NAlloc<T>&) {}
    Tp* allocate(std::size_t n) {
        n *= sizeof(Tp);
        std::cout << "allocating " << n << " bytes\n";
        return static_cast<Tp*>(::operator new(n));
    }
    void deallocate(Tp* p, std::size_t n) {
        std::cout << "deallocating " << n*sizeof*p << " bytes\n";
        ::operator delete(p);
    }
};
template <class T, class U>
bool operator==(const NAlloc<T>&, const NAlloc<U>&) { return true; }
template <class T, class U>
bool operator!=(const NAlloc<T>&, const NAlloc<U>&) { return false; }

int main()
{
```

```
    int sz = 100;
    std::cout << "using reserve: \n";
    {
        std::vector<int, NAlloc<int>> v1;
        v1.reserve(sz);
        for(int n = 0; n < sz; ++n)
            v1.push_back(n);
    }
    std::cout << "not using reserve: \n";
    {
        std::vector<int, NAlloc<int>> v1;
        for(int n = 0; n < sz; ++n)
            v1.push_back(n);
    }
}
```

Possible output:

```
using reserve:
allocating 400 bytes
deallocating 400 bytes
not using reserve:
allocating 4 bytes
allocating 8 bytes
deallocating 4 bytes
allocating 16 bytes
deallocating 8 bytes
allocating 32 bytes
deallocating 16 bytes
allocating 64 bytes
deallocating 32 bytes
allocating 128 bytes
deallocating 64 bytes
allocating 256 bytes
deallocating 128 bytes
allocating 512 bytes
deallocating 256 bytes
deallocating 512 bytes
```

See also

capacity	returns the number of elements that can be held in currently allocated storage (public member function)
max_size	returns the maximum possible number of elements (public member function)
resize	changes the number of elements stored (public member function)
shrink_to_fit (C++11)	reduces memory usage by freeing unused memory (public member function)

std::vector::capacity

```
size_type capacity() const;
```

Returns the number of elements that the container has currently allocated space for.

Parameters

(none)

Return value

Capacity of the currently allocated storage.

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Constant.

See also

`size`	returns the number of elements (public member function)
`reserve`	reserves storage (public member function)

std::vector::shrink_to_fit

```
void shrink_to_fit();    (since C++11)
```

Requests the removal of unused capacity.

It is a non-binding request to reduce `capacity()` to `size()`. It depends on the implementation if the request is fulfilled.

All iterators, including the past the end iterator, are potentially invalidated.

Parameters

(none)

Type requirements

- `T` must meet the requirements of `MoveInsertable`.

Return value

(none)

Complexity

At most linear in the size of the container.

Notes

If an exception is thrown other than by T's move constructor, there are no effects.

Example

Run this code

```
#include <iostream>
#include <vector>

int main()
{
    std::vector<int> v;
    std::cout << "Default-constructed capacity is " << v.capacity() << '\n';
    v.resize(100);
    std::cout << "Capacity of a 100-element vector is " << v.capacity() << '\n';
    v.clear();
    std::cout << "Capacity after clear() is " << v.capacity() << '\n';
    v.shrink_to_fit();
    std::cout << "Capacity after shrink_to_fit() is " << v.capacity() << '\n';
}
```

Possible output:

```
Default-constructed capacity is 0
Capacity of a 100-element vector is 100
Capacity after clear() is 100
Capacity after shrink to fit() is 0
```

See also

size	returns the number of elements (public member function)
capacity	returns the number of elements that can be held in currently allocated storage (public member function)

std::vector::clear

```
void clear();
```

Removes all elements from the container.

Invalidates any references, pointers, or iterators referring to contained elements. May invalidate any past-the-end iterators.

Leaves the `capacity()` of the vector unchanged.

Parameters

(none)

Return value

(none)

Exceptions

(none)		(until C++11)
`noexcept` specification:	`noexcept`	(since C++11)

Complexity

Linear in the size of the container.

`clear` is defined in terms of `erase`, which has linear complexity.	(until C++11)
complexity of `clear` is omitted	(since C++11) (until C++14)
`clear` has linear complexity for sequence containers.	(since C++14)

See also

`erase`	erases elements (public member function)

std::vector::insert

`iterator insert( iterator pos, const T& value );`	(1)	(until C++11)
`iterator insert( const_iterator pos, const T& value );`		(since C++11)
`iterator insert( const_iterator pos, T&& value );`	(2)	(since C++11)
`void insert( iterator pos, size_type count, const T& value );`	(3)	(until C++11)
`iterator insert( const_iterator pos, size_type count, const T& value );`		(since C++11)
`template< class InputIt >` `void insert( iterator pos, InputIt first, InputIt last);`	(4)	(until C++11)
`template< class InputIt >` `iterator insert( const_iterator pos, InputIt first, InputIt last );`		(since C++11)
`iterator insert( const_iterator pos, std::initializer_list<T> ilist );`	(5)	(since C++11)

Inserts elements at the specified location in the container.

1-2) inserts `value` before `pos`

3) inserts `count` copies of the `value` before `pos`

4) inserts elements from range `[first, last)` before `pos`.

This overload has the same effect as overload (3) if `InputIt` is an integral type.	(until C++11)
This overload only participates in overload resolution if `InputIt` qualifies as `InputIterator`, to avoid ambiguity with the overload (3).	(since C++11)

The behavior is undefined if `first` and `last` are iterators into `*this`.

5) inserts elements from initializer list `ilist` before `pos`.

Causes reallocation if the new `size()` is greater than the old `capacity()`. If the new `size()` is greater than `capacity()`, all iterators and references are invalidated. Otherwise, only the iterators and references before the insertion point remain valid. The past-the-end iterator is also invalidated.

Parameters

pos	-	iterator before which the content will be inserted. `pos` may be the `end()` iterator
value	-	element value to insert
first, last	-	the range of elements to insert, can't be iterators into container for which insert is called
ilist	-	initializer list to insert the values from

Type requirements

- `T` must meet the requirements of `CopyAssignable` and `CopyInsertable` in order to use overload (1).
- `T` must meet the requirements of `MoveAssignable` and `MoveInsertable` in order to use overload (2).
- `T` must meet the requirements of `CopyAssignable` and `CopyInsertable` in order to use overload (3).
- `T` must meet the requirements of `EmplaceConstructible` in order to use overload (4,5).
- `T` must meet the requirements of `MoveAssignable` and `MoveInsertable` in order to use overload (4). required only if `InputIt` satisfies `InputIterator` but not `ForwardIterator`. (until C++17)
- `T` must meet the requirements of `Swappable`, `MoveAssignable`, `MoveConstructible` and `MoveInsertable` in order to use overload (4,5). (since C++17)

Return value

1-2) Iterator pointing to the inserted `value`

3) Iterator pointing to the first element inserted, or `pos` if `count==0`.

4) Iterator pointing to the first element inserted, or `pos` if `first==last`.

5) Iterator pointing to the first element inserted, or `pos` if `ilist` is empty.

Complexity

1-2) Constant plus linear in the distance between `pos` and end of the container.

3) Linear in `count` plus linear in the distance between `pos` and end of the container.

4) Linear in `std::distance(first, last)` plus linear in the distance between `pos` and end of the container.

5) Linear in `ilist.size()` plus linear in the distance between `pos` and end of the container.

Exceptions

If an exception is thrown when inserting a single element at the end, and T is `CopyInsertable` or `std::is_nothrow_move_constructible<T>::value` is `true`, there are no effects (strong exception guarantee).

Example

Run this code

```
#include <iostream>
#include <vector>

void print_vec(const std::vector<int>& vec)
{
    for (auto x: vec) {
         std::cout << ' ' << x;
    }
    std::cout << '\n';
}

int main ()
{
    std::vector<int> vec(3,100);
    print_vec(vec);

    auto it = vec.begin();
    it = vec.insert(it, 200);
    print_vec(vec);

    vec.insert(it,2,300);
    print_vec(vec);

    // "it" no longer valid, get a new one:
    it = vec.begin();

    std::vector<int> vec2(2,400);
    vec.insert(it+2, vec2.begin(), vec2.end());
    print_vec(vec);

    int arr[] = { 501,502,503 };
    vec.insert(vec.begin(), arr, arr+3);
    print_vec(vec);
}
```

Output:

```
100 100 100
200 100 100 100
300 300 200 100 100 100
300 300 400 400 200 100 100 100
501 502 503 300 300 400 400 200 100 100 100
```

See also

emplace (C++11)	constructs element in-place (public member function)
push_back	adds elements to the end (public member function)

std::vector::emplace

```
template< class... Args >
iterator emplace( const_iterator pos, Args&&... args );
```
(since C++11)

Inserts a new element into the container directly before `pos`. The element is constructed through `std::allocator_traits::construct`, which typically uses placement-new to construct the element in-place at a location provided by the container. The arguments `args...` are forwarded to the constructor as `std::forward<Args>(args)...`.

If the new `size()` is greater than `capacity()`, all iterators and references are invalidated. Otherwise, only the iterators and references before the insertion point remain valid. The past-the-end iterator is also invalidated.

Parameters

pos - iterator before which the new element will be constructed

args - arguments to forward to the constructor of the element

Type requirements

- `T (the container's element type)` must meet the requirements of `MoveAssignable`, `MoveInsertable` and `EmplaceConstructible`.

Return value

Iterator pointing to the emplaced element.

Complexity

Linear in the distance between `pos` and end of the container.

Exceptions

If an exception is thrown (e.g. by the constructor), the container is left unmodified, as if this function was never called (strong exception guarantee).

Notes

The specialization std::vector<bool> did not have `emplace()` member until C++14.

See also

insert	inserts elements (public member function)

std::vector::erase

`iterator erase( iterator pos );`	(1)	(until C++11)
`iterator erase( const_iterator pos );`		(since C++11)
`iterator erase( iterator first, iterator last );`	(2)	(until C++11)
`iterator erase( const_iterator first, const_iterator last );`		(since C++11)

Removes specified elements from the container.

1) Removes the element at `pos`.
2) Removes the elements in the range `[first; last)`.

Invalidates iterators and references at or after the point of the erase, including the `end()` iterator.

The iterator `pos` must be valid and dereferenceable. Thus the `end()` iterator (which is valid, but is not dereferencable) cannot be used as a value for `pos`.

The iterator `first` does not need to be dereferenceable if `first==last`: erasing an empty range is a no-op.

Parameters

pos	-	iterator to the element to remove
first, last	-	range of elements to remove

Type requirements

- `T` must meet the requirements of `MoveAssignable`.

Return value

Iterator following the last removed element. If the iterator `pos` refers to the last element, the `end()` iterator is returned.

Exceptions

Does not throw unless an exception is thrown by the copy constructor, move constructor, assignment operator, or move assignment operator of `T`.

Complexity

1) Linear in distance between `pos` and the end of the container.
2) Linear in the distance between `first` and `last`, plus linear in the distance between `last` and end of the container.

Example

Run this code

```
#include <vector>
#include <iostream>


int main( )
{
    std::vector<int> c{0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
    for (auto &i : c) {
        std::cout << i << " ";
    }
    std::cout << '\n';

    c.erase(c.begin());

    for (auto &i : c) {
        std::cout << i << " ";
    }
    std::cout << '\n';
```

```
    c.erase(c.begin()+2, c.begin()+5);

    for (auto &i : c) {
        std::cout << i << " ";
    }
    std::cout << '\n';
}
```

Output:

```
0 1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9
1 2 6 7 8 9
```

See also

clear	clears the contents (public member function)

std::vector::push_back

```
void push_back( const T& value );     (1)
void push_back( T&& value );          (2)  (since C++11)
```

Appends the given element `value` to the end of the container.

1) The new element is initialized as a copy of `value`.
2) `value` is moved into the new element.

If the new `size()` is greater than `capacity()` then all iterators and references (including the past-the-end iterator) are invalidated. Otherwise only the past-the-end iterator is invalidated.

Parameters

`value` - the value of the element to append

Type requirements

- `T` must meet the requirements of `CopyInsertable` in order to use overload (1).
- `T` must meet the requirements of `MoveInsertable` in order to use overload (2).

Return value

(none)

Complexity

Amortized constant.

Exceptions

If an exception is thrown, this function has no effect (strong exception guarantee).

If `T`'s move constructor is not `noexcept` and T is not `CopyInsertable` into `*this`, vector will use the throwing move constructor. If it throws, the guarantee is waived and the effects are unspecified. (since C++11)

Example

Run this code

```
#include <vector>
#include <iostream>
#include <iomanip>

int main()
{
    std::vector<std::string> numbers;

    numbers.push_back("abc");
    std::string s = "def";
    numbers.push_back(std::move(s));

    std::cout << "vector holds: ";
    for (auto&& i : numbers) std::cout << std::quoted(i) << ' ';
    std::cout << "\nMoved-from string holds " << std::quoted(s) << '\n';
}
```

Output:

```
vector holds: "abc" "def"
Moved-from string holds ""
```

See also

emplace_back (C++11)	constructs elements in-place at the end (public member function)
pop_back	removes the last element (public member function)

std::vector::emplace_back

```
template< class... Args >
void emplace_back( Args&&... args );
```
(since C++11)

Appends a new element to the end of the container. The element is constructed through `std::allocator_traits::construct`, which typically uses placement-new to construct the element in-place at the location provided by the container. The arguments `args...` are forwarded to the constructor as `std::forward<Args>(args)...`.

If the new `size()` is greater than `capacity()` then all iterators and references (including the past-the-end iterator) are invalidated. Otherwise only the past-the-end iterator is invalidated.

Parameters

`args` - arguments to forward to the constructor of the element

Type requirements

- `T (the container's element type)` must meet the requirements of `MoveInsertable` and `EmplaceConstructible`.

Return value

(none)

Complexity

Constant.

Exceptions

If an exception is thrown, this function has no effect (strong exception guarantee). If `T`'s move constructor is not `noexcept` and is not `CopyInsertable` into `*this`, vector will use the throwing move constructor. If it throws, the guarantee is waived and the effects are unspecified.

Notes

The specialization std::vector<bool> did not have `emplace_back()` member until C++14.

Example

The following code uses `emplace_back` to append an object of type `President` to a `std::vector`. It demonstrates how `emplace_back` forwards parameters to the `President` constructor and shows how using `emplace_back` avoids the extra copy or move operation required when using `push_back`.

Run this code

```
#include <vector>
#include <string>
#include <iostream>

struct President
{
    std::string name;
    std::string country;
    int year;

    President(std::string p_name, std::string p_country, int p_year)
        : name(std::move(p_name)), country(std::move(p_country)), year(p_year)
    {
        std::cout << "I am being constructed.\n";
    }
    President(President&& other)
        : name(std::move(other.name)), country(std::move(other.country)), year(other.year)
    {
        std::cout << "I am being moved.\n";
```

```
    }
    President& operator=(const President& other) = default;
};

int main()
{
    std::vector<President> elections;
    std::cout << "emplace_back:\n";
    elections.emplace_back("Nelson Mandela", "South Africa", 1994);

    std::vector<President> reElections;
    std::cout << "\npush_back:\n";
    reElections.push_back(President("Franklin Delano Roosevelt", "the USA", 1936));

    std::cout << "\nContents:\n";
    for (President const& president: elections) {
        std::cout << president.name << " was elected president of "
                  << president.country << " in " << president.year << ".\n";
    }
    for (President const& president: reElections) {
        std::cout << president.name << " was re-elected president of "
                  << president.country << " in " << president.year << ".\n";
    }
}
```

Output:

```
emplace_back:
I am being constructed.

push_back:
I am being constructed.
I am being moved.

Contents:
Nelson Mandela was elected president of South Africa in 1994.
Franklin Delano Roosevelt was re-elected president of the USA in 1936.
```

See also

push_back	adds elements to the end (public member function)

std::vector::pop_back

```
void pop_back();
```

Removes the last element of the container.

Calling `pop_back` on an empty container is undefined.

No iterators or references except for `back()` and `end()` are invalidated.

Parameters

(none)

Return value

(none)

Complexity

Constant.

Exceptions

(none)

See also

`push_back`	adds elements to the end (public member function)

std::vector::resize

```
void resize( size_type count, T value = T() );                          (until C++11)
void resize( size_type count );                                  (1)    (since C++11)
void resize( size_type count, const value_type& value );         (2)    (since C++11)
```

Resizes the container to contain `count` elements.

If the current size is greater than `count`, the container is reduced to its first `count` elements.

If the current size is less than `count`, additional elements are appended and initialized with copies of `value`. (until C++11)
If the current size is less than `count`, 1) additional default-inserted elements are appended 2) additional copies of `value` are appended (since C++11)

Parameters

`count` - new size of the container

`value` - the value to initialize the new elements with

Type requirements

- `T` must meet the requirements of `MoveInsertable` and `DefaultInsertable` in order to use overload (1).
- `T` must meet the requirements of `CopyInsertable` in order to use overload (2).

Return value

(none)

Complexity

Linear in the difference between the current size and `count`.

Exceptions

If an exception is thrown, this function has no effect (strong exception guarantee).

In overload (1), if `T`'s move constructor is not `noexcept` and T is not `CopyInsertable` into `*this`, vector will use the throwing move constructor. If it throws, the guarantee is waived and the effects are unspecified. (since C++11)

Notes

If value-initialization in overload (1) is undesirable, for example, if the elements are of non-class type and zeroing out is not needed, it can be avoided by providing a custom Allocator::construct (http%3A//stackoverflow.com/a/21028912/273767) .

Vector capacity is never reduced when resizing to smaller size because that would invalidate all iterators, rather than only the ones that would be invalidated by the equivalent sequence of pop_back() calls.

Example

Run this code

```
#include <iostream>
#include <vector>
int main()
{
    std::vector<int> c = {1, 2, 3};
    std::cout << "The vector holds: ";
    for(auto& el: c) std::cout << el << ' ';
```

```
    std::cout << '\n';
    c.resize(5);
    std::cout << "After resize up 5: ";
    for(auto& el: c) std::cout << el << ' ';
    std::cout << '\n';
    c.resize(2);
    std::cout << "After resize down to 2: ";
    for(auto& el: c) std::cout << el << ' ';
    std::cout << '\n';
}
```

Output:

```
The vector holds: 1 2 3
After resize up 5: 1 2 3 0 0
After resize down to 2: 1 2
```

See also

size	returns the number of elements (public member function)
insert	inserts elements (public member function)
erase	erases elements (public member function)

std::vector::swap

```
void swap( vector& other );
```

Exchanges the contents of the container with those of `other`. Does not invoke any move, copy, or swap operations on individual elements.

All iterators and references remain valid. The past-the-end iterator is invalidated.

If `std::allocator_traits<allocator_type>::propagate_on_container_swap::value` is true, then the allocators are exchanged using an unqualified call to non-member `swap`. Otherwise, they are not swapped (and if `get_allocator() != other.get_allocator()`, the behavior is undefined). (since C++11)

Parameters

`other` - container to exchange the contents with

Return value

(none)

Exceptions

(none) (until C++17)

`noexcept` specification: (since C++17)

```
noexcept(std::allocator_traits<Allocator>::propagate_on_container_swap::value
|| std::allocator_traits<Allocator>::is_always_equal::value)
```

Complexity

Constant.

See also

`std::swap``(std::vector)`	specializes the `std::swap` algorithm (function template)

Example

Run this code

```
#include <vector>
#include <iostream>

void printVector(std::vector<int>& vec)
{
    for (int a : vec)
    {
        std::cout << a << " ";
    }
}

int main()
{
    std::vector<int> v1{1, 2, 3};
    std::vector<int> v2{7, 8, 9};
```

```
    std::cout << "v1: ";
    printVector(v1);

    std::cout << "\nv2: ";
    printVector(v2);

    std::cout << "\n-- SWAP\n";
    v2.swap(v1);

    std::cout << "v1: ";
    printVector(v1);

    std::cout << "\nv2: ";
    printVector(v2);
}
```

Output:

```
v1: 1 2 3
v2: 7 8 9
-- SWAP
v1: 7 8 9
v2: 1 2 3
```

std::vector<bool>

Defined in header <vector>

```
template<class Allocator>
class vector<bool, Allocator>;
```

`std::vector<bool>` is a space-efficient specialization of `std::vector` for the type `bool`.

The manner in which `std::vector<bool>` is made space efficient (as well as whether it is optimized at all) is implementation defined. One potential optimization involves coalescing vector elements such that each element occupies a single bit instead of `sizeof(bool)` bytes.

`std::vector<bool>` behaves similarly to `std::vector`, but in order to be space efficient, it:

- Does not necessarily store its elements as a contiguous array (so `&v[0] + n != &v[n]`)
- Exposes class `std::vector<bool>::reference` as a method of accessing individual bits. In particular, objects of this class are returned by `operator[]` by value.
- Does not use `std::allocator_traits::construct` to construct bit values.

Member types

Member type	Definition
`value_type`	`bool`
`allocator_type`	`Allocator`
`size_type`	implementation-defined
`difference_type`	implementation-defined
`reference`	proxy class representing a reference to a single bool (class)
`const_reference`	`bool`
`pointer`	implementation-defined
`const_pointer`	implementation-defined
`iterator`	implementation-defined
`const_iterator`	implementation-defined
`reverse_iterator`	`std::reverse_iterator<iterator>`
`const_reverse_iterator`	`std::reverse_iterator<const_iterator>`

Member functions

(constructor)	constructs the `vector` (public member function of `std::vector`)
(destructor)	destructs the `vector` (public member function of `std::vector`)
`operator=`	assigns values to the container (public member function of `std::vector`)
`assign`	assigns values to the container (public member function of `std::vector`)
`get_allocator`	returns the associated allocator (public member function of `std::vector`)

Element access

`at`	access specified element with bounds checking (public member function of `std::vector`)
`operator[]`	access specified element (public member function of `std::vector`)
`front`	access the first element (public member function of `std::vector`)
`back`	access the last element (public member function of `std::vector`)

Iterators

`begin` **`cbegin`**	returns an iterator to the beginning

(public member function of `std::vector`)

end **cend**	returns an iterator to the end (public member function of `std::vector`)
rbegin **crbegin**	returns a reverse iterator to the beginning (public member function of `std::vector`)
rend **crend**	returns a reverse iterator to the end (public member function of `std::vector`)

Capacity

empty	checks whether the container is empty (public member function of `std::vector`)
size	returns the number of elements (public member function of `std::vector`)
max_size	returns the maximum possible number of elements (public member function of `std::vector`)
reserve	reserves storage (public member function of `std::vector`)
capacity	returns the number of elements that can be held in currently allocated storage (public member function of `std::vector`)

Modifiers

clear	clears the contents (public member function of `std::vector`)
insert	inserts elements (public member function of `std::vector`)
emplace (since C++14)	constructs element in-place (public member function of `std::vector`)
erase	erases elements (public member function of `std::vector`)
push_back	adds elements to the end (public member function of `std::vector`)
emplace_back (C++14)	constructs elements in-place at the end (public member function of `std::vector`)
pop_back	removes the last element (public member function of `std::vector`)
resize	changes the number of elements stored (public member function of `std::vector`)
swap	swaps the contents (public member function of `std::vector`)

`vector<bool>` specific modifiers

flip	flips all the bits (public member function)
swap [static]	swaps two `std::vector<bool>::reference`s (public static member function)

Non-member functions

operator== **operator!=** **operator<** **operator<=** **operator>** **operator>=**	lexicographically compares the values in the vector (function template)
std::swap(`std::vector`)	specializes the `std::swap` algorithm (function template)

Helper classes

std::hash<`std::vector<bool>`> (C++11)	hash support for `std::vector<bool>` (class template specialization)

Notes

If the size of the bitset is known at compile time, `std::bitset` may be used, which offers a richer set of member functions. In addition, boost::dynamic_bitset (http%3A//www.boost.org/doc/libs/release/libs/dynamic_bitset/dynamic_bitset.html) exists as an alternative to `std::vector<bool>`.

Since its representation may by optimized, `std::vector<bool>` does not necessarily meet all `Container` or `SequenceContainer` requirements. For example, because `std::vector<bool>::iterator` is implementation-defined, it may not satisfy the `ForwardIterator` requirement. Use of algorithms such as `std::search` that require `ForwardIterator`s may result in either compile-time or run-time errors (http%3A//www.boost.org/doc/libs/1_52_0/libs/dynamic_bitset/dynamic_bitset.html#rationale) .

---

operator==,!=,<,<=,>,>=(std::vector)

```
template< class T, class Alloc >
bool operator==( const vector<T,Alloc>& lhs,      (1)
                 const vector<T,Alloc>& rhs );
template< class T, class Alloc >
bool operator!=( const vector<T,Alloc>& lhs,      (2)
                 const vector<T,Alloc>& rhs );
template< class T, class Alloc >
bool operator<( const vector<T,Alloc>& lhs,       (3)
                const vector<T,Alloc>& rhs );
template< class T, class Alloc >
bool operator<=( const vector<T,Alloc>& lhs,      (4)
                 const vector<T,Alloc>& rhs );
template< class T, class Alloc >
bool operator>( const vector<T,Alloc>& lhs,       (5)
                const vector<T,Alloc>& rhs );
template< class T, class Alloc >
bool operator>=( const vector<T,Alloc>& lhs,      (6)
                 const vector<T,Alloc>& rhs );
```

Compares the contents of two containers.

1-2) Checks if the contents of `lhs` and `rhs` are equal, that is, whether `lhs.size() == rhs.size()` and each element in `lhs` compares equal with the element in `rhs` at the same position.

3-6) Compares the contents of `lhs` and `rhs` lexicographically. The comparison is performed by a function equivalent to `std::lexicographical_compare`.

Parameters

`lhs, rhs` - containers whose contents to compare

- `T` must meet the requirements of `EqualityComparable` in order to use overloads (1-2).
- `T` must meet the requirements of `LessThanComparable` in order to use overloads (3-6). The ordering relation must establish total order.

Return value

1) `true` if the contents of the containers are equal, `false` otherwise
2) `true` if the contents of the containers are not equal, `false` otherwise
3) `true` if the contents of the `lhs` are lexicographically *less* than the contents of `rhs`, `false` otherwise
4) `true` if the contents of the `lhs` are lexicographically *less* than or *equal* the contents of `rhs`, `false` otherwise
5) `true` if the contents of the `lhs` are lexicographically *greater* than the contents of `rhs`, `false` otherwise
6) `true` if the contents of the `lhs` are lexicographically *greater* than or *equal* the contents of `rhs`, `false` otherwise

Complexity

Linear in the size of the container

std::swap(std::vector)

```
template< class T, class Alloc >
void swap( vector<T,Alloc>& lhs,
           vector<T,Alloc>& rhs );
```

Specializes the `std::swap` algorithm for `std::vector`. Swaps the contents of `lhs` and `rhs`. Calls `lhs.swap(rhs)`.

Parameters

`lhs, rhs` - containers whose contents to swap

Return value

(none)

Complexity

Constant.

Exceptions

(since C++17)

`noexcept` specification:

```
noexcept(noexcept(lhs.swap(rhs)))
```

See also

`swap`	swaps the contents (public member function)