

# Range constructor for `std::span`

Document #: P1394D1  
Date: 2019-06-07  
Project: Programming Language C++  
Audience: LEWG  
Reply-to: Corentin Jabot <[corentin.jabot@gmail.com](mailto:corentin.jabot@gmail.com)>  
Casey Carter <[casey@carter.net](mailto:casey@carter.net)>

## 1 Abstract

This paper proposes that `span` be constructible from any contiguous forwarding-range with a compatible element type. The idea was extracted from P1206.

## 2 Tony tables

Before	After
<pre>std::vector&lt;int&gt; v(42); std::span&lt;int&gt; foo =     v   view::take(3); <i>//ill-formed</i></pre>	<pre>std::vector&lt;int&gt; v(42); std::span foo = v   view::take(3); <i>//valid</i></pre>
<pre>std::vector&lt;int&gt; v(42); std::span bar(v.begin(), 3); <i>// ill-formed</i></pre>	<pre>std::vector&lt;int&gt; v(42); std::span bar(v.begin(), 3); <i>// valid</i></pre>
<pre>std::vector&lt;int&gt; get_vector(); void foo(std::span&lt;int&gt;); void bar(std::span&lt;const int&gt;); bar(get_vector()); <i>//valid</i> foo(get_vector()); <i>//ill-formed</i></pre>	<pre>std::vector&lt;int&gt; get_vector(); void foo(std::span&lt;int&gt;); void bar(std::span&lt;const int&gt;); bar(get_vector()); <i>//valid</i> foo(get_vector()); <i>//ill-formed</i></pre>

## 3 Motivation

`std::span` is specified to be constructible from `Container` types. However, while defined, `Container` is not a concept and as such `ContiguousRange` is more expressive. Furthermore, there exist some non-container ranges that would otherwise be valid ranges to construct `span` from. As such `span` as currently specified fits poorly with the iterators / ranges model of the rest of the standard library.

The intent of `span` was always to be constructible from a wide number of compatible types, whether standard contiguous containers, non-standard equivalent types, or views. This proposal ensure that

span, especially when used as parameter of a function will be constructible from all compatible types while offering stronger and more consistent (in regard to Range) lifetime guarantees.

## 4 Design considerations

We propose to specify all constructors currently accepting a container or pointers in terms of `ContiguousRange` and `ContiguousIterator` respectively as well as to add or modify the relevant deduction guides for these constructors.

## 5 Future work

- We suggest that both the wording and the implementation of span would greatly benefit from a trait to detect whether a type has a static extent. Because `std::extent` equals to 0 for types without static extent, and because 0 is a valid extent for containers, `std::extent` proved too limited. However we do not propose a solution in the present paper.

## 6 Proposed wording

The following wording assumes `std::to_address` will be specialized for `ContiguousIterator` as proposed in [P1474].

Change in [views.span] 21.7.3:

```
// [span.cons], constructors, copy, and assignment
constexpr span() noexcept;
template <ContiguousIterator It>
requires ConvertibleTo<remove_reference_t<iter_reference_t<It>>(*)[], ElementType(*)[]>
constexpr span( pointer_ptr It begin, index_type count);
constexpr span(pointer first, pointer last);
template <ContiguousIterator It, SizedSentinel<It> End>
requires ConvertibleTo<remove_reference_t<iter_reference_t<It>>(*)[], ElementType(*)[]>
constexpr span(It first, End last);

template<size_t N>
constexpr span(element_type (&arr)[N]) noexcept;
template<size_t N>
constexpr span(array<value_type, N>& arr) noexcept;
template<size_t N>
constexpr span(const array<value_type, N>& arr) noexcept;
template<class Container>
constexpr span(Container& cont);
template<class Container>
constexpr span(const Container& cont);
template <ranges::ContiguousRange R>
```

```

requires ranges::SizedRange<R> && (forwarding-range<R> || is_const_v<ElementType>)
ConvertibleTo<remove_reference_t<iter_reference_t<ranges::iterator_t<R>>>(*)[], ElementType(*)[]>
constexpr span(R&& r);

constexpr span(const span& other) noexcept = default;
template<class OtherElementType, ptrdiff_t OtherExtent>
constexpr span(const span<OtherElementType, OtherExtent>& s) noexcept;

...

}

template<class T, size_t N>
span(T (&)[N]) -> span<T, N>;
template<class T, size_t N>
span(array<T, N>&) -> span<T, N>;
template<class T, size_t N>
span(const array<T, N>&) -> span<const T, N>;
template<ContiguousIterator It, SizedSentinel<It> End>
span(It, End) -> span<remove_reference_t<iter_reference_t<It>>>>;
template<ContiguousIterator It, size_t N>
span(It) -> span<remove_reference_t<iter_reference_t<It>>>, N>;

template<class T, size_t N>
span(const array<T, N>&) -> span<const T, N>;
template<class Container>
span(Container&) -> span<typename Container::value_type>;
template<class Container>
span(const Container&) -> span<const typename Container::value_type>;
template<ranges::ContiguousRange R>
requires ranges::SizedRange<R> && forwarding-range<R>
span(R&&) -> span<remove_reference_t<iter_reference_t<ranges::iterator_t<R>>>>;

```

In 21.7.3.2 [span.cons]

```
constexpr span() noexcept;
```

*Ensures:* `size() == 0 && data() == nullptr`.

*Remarks:* This constructor shall not participate in overload resolution unless `Extent <= 0` is true.

```
constexpr span(pointer ptr, index_type count);
```

```
template<ContiguousIterator It>
requires ConvertibleTo<remove_reference_t<iter_reference_t<It>>>(*)[], ElementType(*)[]>
constexpr span(It first, index_type count);
```

*Requires:* [`ptr first`, `ptr first + count`) shall be a valid range. If `extent` is not equal to `dynamic_extent`, then `count` shall be equal to `extent`.

*Effects:* Constructs a `span` that is a view over the range [`ptr first`, `ptr first`

+ count).

*Ensures:* `size() == count` && `data() == ptr to_address(first)`.

*Throws:* Nothing.

```
constexpr span(pointer first, pointer last);
```

*Requires:* `[first, last)` shall be a valid range. If `extent` is not equal to `dynamic_extent`, then `last - first` shall be equal to `extent`.

*Effects:* Constructs a span that is a view over the range `[first, last)`.

*Ensures:* `size() == last - first` && `data() == first`.

*Throws:* Nothing.

```
template <ContiguousIterator It, SizedSentinel<It> End>  
requires ConvertibleTo<remove_reference_t<iter_reference_t<It>>(*)[], ElementType(*)[]>  
constexpr span(It first, End last);
```

*Expects:*

- If `extent` is not equal to `dynamic_extent`, then `last - first` shall be equal to `extent`.
- `[first, first + count)` shall be a valid range.

*Effects:* Constructs a span that is a view over the range `[first, last)`.

*Ensures:* `size() == last - first` && `data() == to_address(first)`.

```
template<size_t N> constexpr span(element_type (&arr)[N]) noexcept;  
template<size_t N> constexpr span(array<value_type, N>& arr) noexcept;  
template<size_t N> constexpr span(const array<value_type, N>& arr) noexcept;
```

*Effects:* Constructs a span that is a view over the supplied array.

*Ensures:* `size() == N` && `data() == data(arr)`.

*Remarks:* These constructors shall not participate in overload resolution unless:

- `extent == dynamic_extent || N == extent` is true, and
- `remove_pointer_t<decltype(data(arr))>(*)[]` is convertible to `element_type(*)[]`.

```
template<class Container> constexpr span(Container& cont);  
template<class Container> constexpr span(const Container& cont);
```

*Requires:* `[data(cont), data(cont) + size(cont))` shall be a valid range. If `extent` is not equal to `dynamic_extent`, then `size(cont)` shall be equal to `extent`.

*Effects:* Constructs a span that is a view over the range `[data(cont), data(cont) + size(cont))`.

*Ensures:* `size() == size(cont)` && `data() == data(cont)`.

*Throws:* What and when `data(cont)` and `size(cont)` throw.

*Remarks:* These constructors shall not participate in overload resolution unless:

- `Container` is not a specialization of `span`,
- `Container` is not a specialization of `array`,
- `is_array_v<Container>` is false,
- `data(cont)` and `size(cont)` are both well-formed, and
- `remove_pointer_t<decltype(data(cont))>(*)[]` is convertible to `ElementType(*)[]`.

```
template <ranges::ContiguousRange R>
requires ranges::SizedRange<R> && (forwarding-range<R> || is_const_v<element_type>) &&
ConvertibleTo<remove_reference_t<iter_reference_t<ranges::iterator_t<R>>>(*)[], element_type(*)[]>
constexpr span(R&& r)
```

*Constraints:*

- `R` is not a specialization of `span`,
- `R` is not a specialization of `array`,
- `is_array_v<R>` is false,

*Expects:* If `extent` is not equal to `dynamic_extent`, then `size(r)` shall be equal to `extent`.

*Effects:* Constructs a `span` that is a view over the range `r`.

*Ensures:* `size() == ranges::size(r) && data() == ranges::data(r)`.

*Throws:* What and when `ranges::data(r)` and `ranges::size(r)` throw.

```
constexpr span(const span& other) noexcept = default;
```

*Ensures:* `other.size() == size() && other.data() == data()`.

## 7 References

- [P1419] Casey Carter, Corentin Jabot *A SFINAE-friendly trait to determine the extent of statically sized containers*  
<https://wg21.link/P1419>
- [P1391] Corentin Jabot *Range constructor for std::string\_view*  
<https://wg21.link/P1391>
- [P1474] Casey Carter *Helpful pointers for ContiguousIterator*  
<https://wg21.link/P1474>