

Making `std::priority_queue` `constexpr`

Document #: P1926R0
Date: 2019-10-07
Project: Programming Language C++
Audience: LEWGI
Reply-to: Alexander Zaitsev <zamazan4ik@tut.by, zamazan4ik@gmail.com>

1 Revision history

- R0 – Initial draft

2 Abstract

`std::priority_queue` is not currently `constexpr` friendly. With the loosening of requirements on `constexpr` in [P0784R1] and related papers, we can now make `std::priority_queue` `constexpr`, and we should in order to support the `constexpr` reflection effort (and other evident use cases).

3 Motivation

`std::priority_queue` is not so widely-used standard container as `std::vector` or `std::string`. But there is no reason to keep `std::priority_queue` in non-`constexpr` state since one of the main directions of C++ evolution is compile-time programming. And we want to use in compile-time as much as possible from STL. And this paper makes `std::priority_queue` available in compile-time.

4 Proposed wording

We basically mark all the member and non-member functions of `std::priority_queue` `constexpr`.

Direction to the editor: please apply `constexpr` to all of `std::priority_queue`, including any additions that might be missing from this paper.

In [support.limits.general], add the new feature test macro `__cpp_lib_constexpr_priority_queue` with the corresponding value for header `<queue>` to Table 36 [tab:support.ft].

Change in [queue.syn] 22.6.2:

```

#include <initializer_list>

namespace std {
    [...]
    template<class T, class Container = vector<T>,
             class Compare = less<typename Container::value_type>>
        class priority_queue;

    template<class T, class Container, class Compare>
        constexpr void swap(priority_queue<T, Container, Compare>& x,
                             priority_queue<T, Container, Compare>& y) noexcept(noexcept(x.swap(y)));
    template<class T, class Container, class Compare, class Alloc>
        struct uses_allocator<priority_queue<T, Container, Compare>, Alloc>;
}

```

[...]

Change in [\[priority_queue.overview\]](#) 22.6.5.1:

```

namespace std {
    template<class T, class Container = vector<T>,
             class Compare = less<typename Container::value_type>>
        class priority_queue {
        public:
            using value_type      = typename Container::value_type;
            using reference       = typename Container::reference;
            using const_reference = typename Container::const_reference;
            using size_type       = typename Container::size_type;
            using container_type   = Container;
            using value_compare    = Compare;

        protected:
            Container c;
            Compare comp;

        public:
            constexpr priority_queue() : priority_queue(Compare()) {}
            constexpr explicit priority_queue(const Compare& x) : priority_queue(x, Container()) {}
            constexpr priority_queue(const Compare& x, const Container&);
            constexpr priority_queue(const Compare& x, Container&&);
            template<class InputIterator>
                constexpr priority_queue(InputIterator first, InputIterator last, const Compare& x,
                                         const Container&);
            template<class InputIterator>
                constexpr priority_queue(InputIterator first, InputIterator last,
                                         const Compare& x = Compare(), Container&& = Container());
            template<class Alloc> constexpr explicit priority_queue(const Alloc&);
            template<class Alloc> constexpr priority_queue(const Compare&, const Alloc&);
            template<class Alloc> constexpr priority_queue(const Compare&, const Container&, const Alloc&);
            template<class Alloc> constexpr priority_queue(const Compare&, Container&&, const Alloc&);
            template<class Alloc> constexpr priority_queue(const priority_queue&, const Alloc&);
            template<class Alloc> constexpr priority_queue(priority_queue&&, const Alloc&);
        };
}

```

```

[[nodiscard]] constexpr bool empty() const { return c.empty(); }
constexpr size_type size() const { return c.size(); }
constexpr const_reference top() const { return c.front(); }
constexpr void push(const value_type& x);
constexpr void push(value_type&& x);
template<class... Args> constexpr void emplace(Args&&... args);
constexpr void pop();
constexpr void swap(priority_queue& q) noexcept(is_nothrow_swappable_v<Container> &&
    is_nothrow_swappable_v<Compare>)
    { using std::swap; swap(c, q.c); swap(comp, q.comp); }
};

template<class Compare, class Container>
priority_queue(Compare, Container)
    -> priority_queue<typename Container::value_type, Container, Compare>;

template<class InputIterator,
        class Compare = less<typename iterator_traits<InputIterator>::value_type>,
        class Container = vector<typename iterator_traits<InputIterator>::value_type>>
priority_queue(InputIterator, InputIterator, Compare = Compare(), Container = Container())
    -> priority_queue<typename iterator_traits<InputIterator>::value_type, Container, Compare>;

template<class Compare, class Container, class Allocator>
priority_queue(Compare, Container, Allocator)
    -> priority_queue<typename Container::value_type, Container, Compare>;

// no equality is provided

template<class T, class Container, class Compare>
constexpr void swap(priority_queue<T, Container, Compare>& x,
    priority_queue<T, Container, Compare>& y) noexcept(noexcept(x.swap(y)));

template<class T, class Container, class Compare, class Alloc>
struct uses_allocator<priority_queue<T, Container, Compare>, Alloc>
    : uses_allocator<Container, Alloc>::type { };
}

```

Change in [priority_queue.cons] 22.6.5.2:

```

constexpr priority_queue(const Compare& x, const Container& y);
constexpr priority_queue(const Compare& x, Container&& y);

[...]

template<class InputIterator>
constexpr priority_queue(InputIterator first, InputIterator last,
    const Compare& x, const Container& y);
template<class InputIterator>
constexpr priority_queue(InputIterator first, InputIterator last,
    const Compare& x = Compare(), Container&& y = Container());

```

Change in [priority_queue.cons.alloc] 22.6.5.3:

```
template<class Alloc> constexpr explicit priority_queue(const Alloc& a);  
[...]  
template<class Alloc> constexpr priority_queue(const Compare& compare, const Alloc& a);  
[...]  
template<class Alloc>  
    constexpr priority_queue(const Compare& compare, const Container& cont, const Alloc& a);  
[...]  
template<class Alloc>  
    constexpr priority_queue(const Compare& compare, Container&& cont, const Alloc& a);  
[...]  
template<class Alloc> constexpr priority_queue(const priority_queue& q, const Alloc& a);  
[...]  
template<class Alloc> constexpr priority_queue(priority_queue&& q, const Alloc& a);  
[...]
```

Change in [priority_queue.members] 22.6.5.4:

```
constexpr void push(const value_type& x);  
[...]  
constexpr void push(value_type&& x);  
[...]  
template<class... Args> constexpr void emplace(Args&&... args)  
[...]  
constexpr void pop();  
[...]
```

Change in [priority_queue.special] 22.6.5.5:

```
template<class T, class Container, class Compare>  
    constexpr void swap(priority_queue<T, Container, Compare>& x,  
        priority_queue<T, Container, Compare>& y) noexcept(noexcept(x.swap(y)));
```

5 Implementation

Possible implementation can be found here: [LLVM fork](#). Notice that when proposal was written `constexpr` destructors were not supported in Clang.

6 References

[P0784R1] Multiple authors, *Standard containers and constexpr*
<http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2018/p0784r1.html>