Rangified version of lexicographical_compare_three_way

Document #:	P2022R0
Date:	2023-01-29
Project:	Programming Language C++
Audience:	SG9
	LEWG

Reply-to:	Ran Regev
	<ran.regev@beyeonics.com>

1 Motivation and Scope

This document adds the wording for `ranges::lexicographical_compare_three_way`

2 Design Decisions

— There is no reason to restrict the relation between the compared ranges in any way (e.g. three_way_comparable_with).
— The Comp function is restricted to return one of the comparison categories, and nothing else.
— functions built on top of `ranges::lexicographical_compare_three_way` such as (the yet to be defined) `ranges::sort_three_way()` should benefit from the additional information that can be found in the return value of `ranges::lexicographical_compare_three_way`, and even use it to indicate the user that the function ended in a specific state. E.g. sort_three_way() may report that the resulted sorted range is sorted from smallest to largest (or largest to smallest), all element are equal or even that the given range is unsortable.

3 Proposed Wording

3.1 Add to [algorithm.syn]

```
template<class InputIterator1, class InputIterator2>
  constexpr auto
    lexicographical_compare_three_way(InputIterator1 b1, InputIterator1 e1,
                                      InputIterator2 b2, InputIterator2 e2);

  template <typename T, typename… U>
  concept same-as-any-of = (std::same_as<T, U> or …); // exposition only

  template<
      input_iterator I1,
      input_iterator I2,
      class Comp,
      class Proj1,
      class Proj2
  >
  using lexicographical-compare-three-way-result-t =
      invoke_result_t<
          Comp,
          typename projected<I1, Proj1>::value_type,
          typename projected<I2, Proj2>::value_type
      >; // exposition-only
```

```
constexpr bool is-lexicographical-compare-three-way-result-ordering =
        std::same-as-any-of<
            lexicographical-compare-three-way-result-t<
                I1, I2, Comp, Proj1, Proj2
            >,
            std::strong_ordering, std::weak_ordering, std::partial_ordering>; //exposition-only
template<
    input_iterator I1, sentinel_for S1,
    input_iterator I2, sentinel_for S2,
    class Comp = compare_three_way,
    class Proj1 = identity,
    class Proj2 = identity
>
requires
    is-lexicographical-compare-three-way-result-ordering<
        I1, I2, Comp, Proj1, Proj2
    >

constexpr auto
    ranges::lexicographical_compare_three_way(
        I1 first1,
        S1 last1,
        I2 first2,
        S2 last2,
        Comp comp = {},
        Proj1 proj1 = {},
        Proj2 proj2 = {}
) -> common_comparison_category_t<
            decltype(
                comp(proj1(first1), proj2(first2))
            ),
            strong_ordering
     >;

template<
    ranges::input_range R1,
    ranges::input_range R2,
    class Comp = compare_three_way,
    class Proj1 = identity,
    class Proj2 = identity
>
requires
    is-lexicographical-compare-three-way-result-ordering<
        iterator_t, iterator_t, Comp, Proj1, Proj2
    >
constexpr auto
    ranges::lexicographical_compare_three_way(
        R1&& r1,
        R2&& r2,
        Comp comp = {},
        Proj1 proj1 = {},
        Proj2 proj2 = {}
) -> common_comparison_category_t<
```

```
            decltype(
                comp(proj1(ranges::begin(r1)), proj2(ranges::begin(r2)))
            ),
            strong_ordering
        >;
```

3.2 Add to §27.8.12 [alg.three.way]

```
template<class InputIterator1, class InputIterator2>
  constexpr auto
    lexicographical_compare_three_way(InputIterator1 b1, InputIterator1 e1,
                                      InputIterator2 b2, InputIterator2 e2);
```

```
template <typename T, typename... U>
concept same-as-any-of = (std::same_as<T, U> or ...); // exposition only

template<
    input_iterator I1,
    input_iterator I2,
    class Comp,
    class Proj1,
    class Proj2
>
using lexicographical-compare-three-way-result-t =
    invoke_result_t<
        Comp,
        typename projected<I1, Proj1>::value_type,
        typename projected<I2, Proj2>::value_type
    >; // exposition-only

constexpr bool is-lexicographical-compare-three-way-result-ordering =
        std::same-as-any-of<
            lexicographical-compare-three-way-result-t<
                I1, I2, Comp, Proj1, Proj2
            >,
            std::strong_ordering, std::weak_ordering, std::partial_ordering>; //exposition-only
template<
    input_iterator I1, sentinel_for S1,
    input_iterator I2, sentinel_for S2,
    class Comp = compare_three_way,
    class Proj1 = identity,
    class Proj2 = identity
>
requires
    is-lexicographical-compare-three-way-result-ordering<
        I1, I2, Comp, Proj1, Proj2
    >

constexpr auto
    ranges::lexicographical_compare_three_way(
        I1 first1,
        S1 last1,
        I2 first2,
        S2 last2,
        Comp comp = {},
```

```
        Proj1 proj1 = {},
        Proj2 proj2 = {}
) -> common_comparison_category_t<
            decltype(
                comp(proj1(first1), proj2(first2))
            ),
            strong_ordering
    >;

template<
    ranges::input_range R1,
    ranges::input_range R2,
    class Comp = compare_three_way,
    class Proj1 = identity,
    class Proj2 = identity
>
requires
    is-lexicographical-compare-three-way-result-ordering<
        iterator_t, iterator_t, Comp, Proj1, Proj2
    >
constexpr auto
    ranges::lexicographical_compare_three_way(
        R1&& r1,
        R2&& r2,
        Comp comp = {},
        Proj1 proj1 = {},
        Proj2 proj2 = {}
) -> common_comparison_category_t<
            decltype(
                comp(proj1(ranges::begin(r1)), proj2(ranges::begin(r2)))
            ),
            strong_ordering
    >;
```

1 — Let N be the minimum integer between distance(first1,s1) and distance(first2,s2). Let E(n) be comp(proj1(*(first1 + n)), proj2(*(first2 + n))).

2 — Returns: E(i), where i is the smallest integer in [0, N) such that E(i) != 0 is true, or (distance(first1,s1) <=> distance(first2, s2) if no such integer exists.

3 — Complexity: At most N applications of comp, porj1, porj2. > :::

4 Acknowledgements


```
Alex Dathskovsky <calebxyz@gmail.com>
Avi Korzac <Avi.Korzac@beyeonics.com>
Lee-or Saar <Leeor.Saar@beyeonics.com>
Mor Elmaliach <Mor.Elmaliach@beyeonics.com>
Yaron Meister <Yaron.Meister@beyeonics.com>
```