Rangified version of lexicographical_compare_three_way

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1 Revision History

```
- R2
    - Fixed wording accoring to mailing list comments
- R1
    - Added link to github implementation
    - Added code example
- R0
    - initial work
```

2 Motivation and Scope

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

3 Design Decisions

- We explored the following directions and decided to drop them:
  - Having restrictions on the relation between the ranges. We found it unneccessary as the comp predicate glue the ranges together to this comparison's needs.
  - Returning not only the comparison result but also the iterators to the ranges where the decision was made (return a result-struct). We couldn't find any useful implementation for these iterators and therefore decided to drop the idea.
- The chosen direction is as follows:
  - Follow the way std::lexicographical_compare_three_way is declared.
  - The Comp function is restricted to return one of the comparison categories, and nothing else. Therefore -
    - There is no reason to restrict the relation between the compared ranges in any way.
    - Functions built on top of `ranges::lexicographical_compare_three_way` may restrict their input parameters if required.
    - 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.

4 Code Example

— In [GitHub] branch P2022/master one can build and run [Tests] to experiment with the function

5 Proposed Wording

5.1 Add to [algorithm.syn]

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

  template <class T, class... U>
  concept same-as-one-of = /see below/; // exposition only

  template<
      input_iterator I1,
      input_iterator I2,
      class Comp,
      class Proj1,
      class Proj2
  >
  using lexicographical-compare-three-way-result-t = /see below/; // 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
   >
  constexpr bool is-lexicographical-compare-three-way-result-ordering = /see below/; //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<R1>, iterator_t<R2>, 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
        >;
```

5.2 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 <class T, class... U>
    concept same-as-one-of = (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,
            class projected<I1, Proj1>::value_type,
            class projected<I2, Proj2>::value_type
        >; // 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
 >
constexpr bool is-lexicographical-compare-three-way-result-ordering =
        same-as-one-of<
            lexicographical-compare-three-way-result-t<
                I1, I2, Comp, Proj1, Proj2
            >,
            strong_ordering, weak_ordering, 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<R1>, iterator_t<R2>, 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, proj1, proj2.

6 Acknowledgements


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```


7 References

[GitHub] Ran Regev. implementation.
https://github.com/regevran/IlPapersFork/tree/P2022/master

[Tests] Regev and Ran. tests.
https://github.com/regevran/IlPapersFork/tree/P2022/master/P2022/tests