Iterators and Lists

In C++, the data structure that implements an array list is called std::vector. When it comes to linked lists, C++ provides two options: std::list and std::forward_list.

The C++ Standard Template Library (STL) makes heavy use of iterators. Iterators are typically used in pairs: a begin iterator, and an end iterator. An operation is then conducted on all elements, starting at the begin iterator, and ending at the end iterator. The end iterator is typically placed one past the final element in a collection.

<algorithm> header

The <algorithm> header in the STL contains most of the function that we will use in this lab.

C++20

In C++20, the concept of ranges was introduced. A range is simply a pair of begin and end iterators to improve the usability of iterators. Because C++20 compiler support is incomplete at the time of writing, we will not be dealing with ranges in this lab. Be sure to check out the documentation though, since compiler support may be complete by the time you are taking this lab.

Code

1. Write two functions that fill respectively a std::vector<std::string> and a std::list<string> with random names. Make sure that the user of your function can specify a seed for the random number generator and the number of names!
2. Write a couple of unit tests that check that the random names that are generated are always generated the same when using the same seed. Also check that the correct number of names is generated, and that your generation procedure works.
3. Write the following functions, using functionality present in the <algorithm> header. Each of these functions should take a pair of iterators as an argument. The best way to implement this, is to make each function a templated function on the iterator types you take as arguments. std::copy is a function in the standard library that's been built this way.
   - A function that prints all the given names to the console.
   - A function that returns all names that start with a given prefix. The prefix is given as an argument to the function and contains at least 1 character. The function should also take an output iterator as argument, similar to std::copy.
   - A function that prints a set of names to the console in reverse order. For this function, you can temporarily store the names in another data structure.

Report

1. What are the differences between array-backed lists (std::vector) and linked lists (std::forward_list and std::list)? When would you use an array-backed list and when would you use a linked list?
2. Why do we need to be able to seed our random number generator?
3. The documentation for std::vector::push_back mentions that under certain conditions, all iterators and references are invalidated. What does this mean?
4. We notice that almost every algorithm in the <algorithm> header takes a begin and end iterator as an argument. Why do you think the writers of the C++ standard chose to do this?