

HW16 - STL Algorithms & Function Objects [100 pts]

Answer the following questions by modifying the hw16.cpp source file and/or answering the question directly:

1. [read sgi.com - intro to stl, read wikipedia - stl, read learncpp.com - stl algorithms overview, read cplusplus.com - standard algorithms, read sgi.com - find algorithm] The *find* algorithm will find the first element in $[first, last)$ that equals *value* where *first*, *last* are iterators. *find* returns an iterator pointing to *value* if a value is found or *last* if value has not been found. Recall *last* is one past the final element in a sequence. What kinds of operations must type [InputIterator](#) and type [EqualityComparable](#) support (i.e. what are the type requirements) such that *find* is able to work? Complete the implementation of the *find_improved* algorithm. Replace *for/if* logic in *find* with a *while* loop containing a logical `&&` conditional. This will eliminate the temporary variable *p* improving the efficiency of the algorithm.
2. [read sgi.com - find_if algorithm] Rather than finding a sequence value directly, *find_if*, locates the first value which satisfies a specified condition. *find_if* uses a [Predicate](#) argument for the conditional. A predicate is a function which returns true or false depending upon a condition. Complete the implementation of the *find_if* algorithm. Hint: use logic from *find_improved*; this time sequence values are passed to the predicate for a conditional test (i.e. replace `!(*first==val)` with `!pred(*first)`). Complete the definitions for predicates: *even*, *less_than_31*, *less_than_v*.
3. [read sgi.com - function objects] Write a function object *Less_than* whose call operator compares argument *x* with class data member *v* of type `int`, $x < v$. *v* is initialized when class *Less_than* is instantiated.

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4. [read [sgi.com - sort algorithm](#), read [sgi.com - function objects](#)] Complete the implementation for the *Cmp_by_id* function object. *Cmp_by_id* compares two shapes by *id* via shape pointers (*Shape **). Write additional function objects *Cmp_by_perimeter*, *Cmp_by_area* which compare pointers to shapes (*Shape **) by *perimeter* and *area* respectively.
5. [read [sgi.com - copy algorithm](#), read [sgi.com - function objects](#)] The *copy_if* algorithm requires type parameters [Input_iterator](#)<In>, [Output_iterator](#)<Out>, [Predicate](#)<Pred, [Value_type](#)<In>>. Explain what this means in terms of operations *copy_if* type parameters must support. What operations must these types have such that *copy_if* will work? Referring to *copy* complete the implementation of the *copy_if* algorithm. Include an *if* statement with a conditional based upon whether the predicate is satisfied to decide if a copy is made (i.e. **result++ = *first* only if predicate is true). Complete the definition of the *Range_low_to_high* function object. The call operator() will only return true when element is \geq low and \leq high. Note:
Range_low_to_high requires [LessThan_comparable](#)<Val> meaning the range must be determined by using operator <. Refer to *LessThan_comparable* equivalence semantics.

Include comments in your code to indicate which code segment answers which question. Appended written answers to the bottom of the hw16.cpp source file (as source comments via //).

Use the command script to capture your interaction compiling and running the program, including all operations, as shown below:

CS1C Spring 2023 TTH HW16 100 pts **Due: Tu 5/16/2023**

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ script hw16.scr
```

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Script started, file is hw16.scr

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ date
```

```
...
```

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ ls -l
```

```
...
```

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ make all
```

```
...
```

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ ls -l
```

```
...
```

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ ./hw16
```

... // print out output from steps 1 thru 5

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ exit
```

Script done, file is hw16.scr

```
cs1c@cs1c-VirtualBox ~/cs1c/hw/16 $ make tar
```

```
...
```

Submit the tar package file hw16.tar by Tuesday May 16, 2023.