CSCI-1200 Data Structures — Fall 2025
Lab 4 — `Vec` Implementation

Checkpoint 1

estimate: 30-45 minutes

> Checkpoint 1 (Diagramming Dynamic Memory) is a pencil-and-paper *3-4 person group activity* and will be available at the start of Wednesday's lab.

Checkpoints 2 and 3 explore our implementation from lecture of the STL `vector` class. Please download:

http://www.cs.rpi.edu/academics/courses/fall25/csci1200/labs/04_vec_implementation/vec.h
http://www.cs.rpi.edu/academics/courses/fall25/csci1200/labs/04_vec_implementation/test_vec.cpp

Checkpoint 2

estimate: 10-25 minutes

Write a templated non-member function `remove_matching_elements` that takes in two arguments, a `Vec<T>` and an element of type `T`, and returns the number of elements that matched the argument and were successfully removed from the vector. The order of the other elements should stay the same. For example, if `v`, a `Vec<int>` object contains 6 elements: `11 22 33 11 55 22` and you call `remove_matching_elements(v,11)`, that call should return 2, and `v` should now contain: `22 33 55 22`.

Add several test cases to `test_vec.cpp` to show that the function works as expected. Think about the efficiency of your solution relative to the size of the vector, and the number of occurrences of the input element in the vector. Make sure that the function is not unnecessarily wasteful of CPU or memory resources.

NOTE: Your implementation should use the `Vec` *subscript (*`[]`*) member operator and the* `resize()` *member function. It should not use iterators or the* `erase` *function that is part of the full STL* `vector` *implementation. We will cover iterators and the erase member function in lecture Friday. Your implementation should NOT create a new* `Vec` *object or use an additional helper array or STL* `vector` *as a helper structure.*

To complete this checkpoint, show a TA your debugged solution for `remove_matching_elements` and be prepared to discuss the efficiency of the function.

Checkpoint 3

estimate: 20-40 minutes

Add a public `print` member function to `Vec` to aid in debugging. (Note, neither `remove_matching_elements` nor `print` are not part of the STL standard for `vector`). You should print the current information stored in the variables `m_alloc`, `m_size`, and `m_data`. Use the `print` function to confirm your `remove_matching_elements` function is debugged. Also, write a test case that calls `push_back` many, many times (hint, use a `for` loop!) and observe how infrequently re-allocation of the `m_data` array is necessary.

To verify your code does not contain memory errors or memory leaks, use Valgrind and/or Dr. Memory on your local machine – see instructions on the course webpage: Memory Debugging.

Also, submit your code to the homework server (in the practice space for lab 4), which is configured to run the memory debuggers for this exercise. To verify that you understand the output from Valgrind and/or Dr. Memory, temporarily add a simple bug into your implementation to cause a memory error or memory leak.

IMPORTANT NOTE: Please ask for help if you have trouble installing or running a memory debugger on your laptop. Future homeworks must be memory error free and memory leak free for full credit!

To complete this checkpoint, show a TA your tested & debugged program. Be prepared to demo and discuss the Valgrind and/or Dr. Memory output: with and without memory errors and memory leaks *AND* on your local machine and on the homework server.