Calculation of Levenshtein Distance with Dynamic Array Sizes

Learning Objectives

- new and delete, new[], delete[]
- Testing (Test-First, i.e. Think, Red-Bar, Green-Bar, Refactor)
- Code and files
- Command line parameters (argv, argc)
- Detecting memory leaks

Exercise at a glance

- Re-Implement your class `Levenshtein` now with dynamic array sizes, so that the internal matrix is not restricted any more to 1000 elements
- Split your implementation into different files.
- Use command line parameters for main

Detailed Exercise Descriptions

In this exercise we do not implement new functionality to reach the final aim of extraction of waypoint names from ATC transcriptions, but just learn how to implement dynamic C-arrays and split the code into different files.

Exercise 2.1

Re-implement your code from the previous exercise, so that dynamic C-Arrays are possible inside the Levenshtein distance class. Do not use the STL-template class `vector` for the matrix. For the rest of the code you may use the vector template class.

```
class Levenshtein
{
public:
   // astr1
   Levenshtein(
      const std::vector<char>& astr1,  // first string compared to astr2
      const std::vector<char>& astr2); // i.e. LD between
                                       // astr1 and astr2 is calculated
   /* … */

private:
   // contains the matrix, used for LD calculation as a vector
   int* mpi_mat; // Use here a pointer to int and not a C-Array
   /*… */
};[1]
```

Do not forget to implement suitable tests.

Do not forget to free all Heap-memory allocated by new or new[] with delete and delete[], respectively.

- Did you implement tests which show the functionality of dynamic array sizes (e.g. calling Resize or something similar) so that the array sizes is **dynamically increased** (three times is enough)?
- Did you implement tests, which show the functionality of dynamic array sizes (e.g. calling Resize or something similar) so that the array size can be **decreased at runtime**?
- Did you implement tests, which show that array size can be **decreased and increased** and runtime?

You need add some new methods to the interface of the class Levenshtein. There is no method Resize.

Implement the new method void SetNewWords(
    const std::vector<char>& astr1, // first string compared to astr2
    const std::vector<char>& astr2);

The new call of backtrace or CalcLevenshteinDistance will use the new vectors. SetNewWords should update the internal matrix `mpi_mat`.

`The new method int GetCurrentMatrixSize() const might ease testing.`

Exercise 2.2

Split your code into different files, e.g.

- One main file, which executes the tests
- Header and Source-Code file for the class Levenshtein distance calculation
- Header and Source-Code files for the different tests

[1] It might be easier to implement it as a vector<vector<int>>, but for learning progress and future exercise, we just use this approach.

- …

Use include guards (#ifndef, #define or/and #pragma once).

Exercise 2.3

Split your main program into two parts. If it is called with the command line parameter `--test` all the tests are executed.

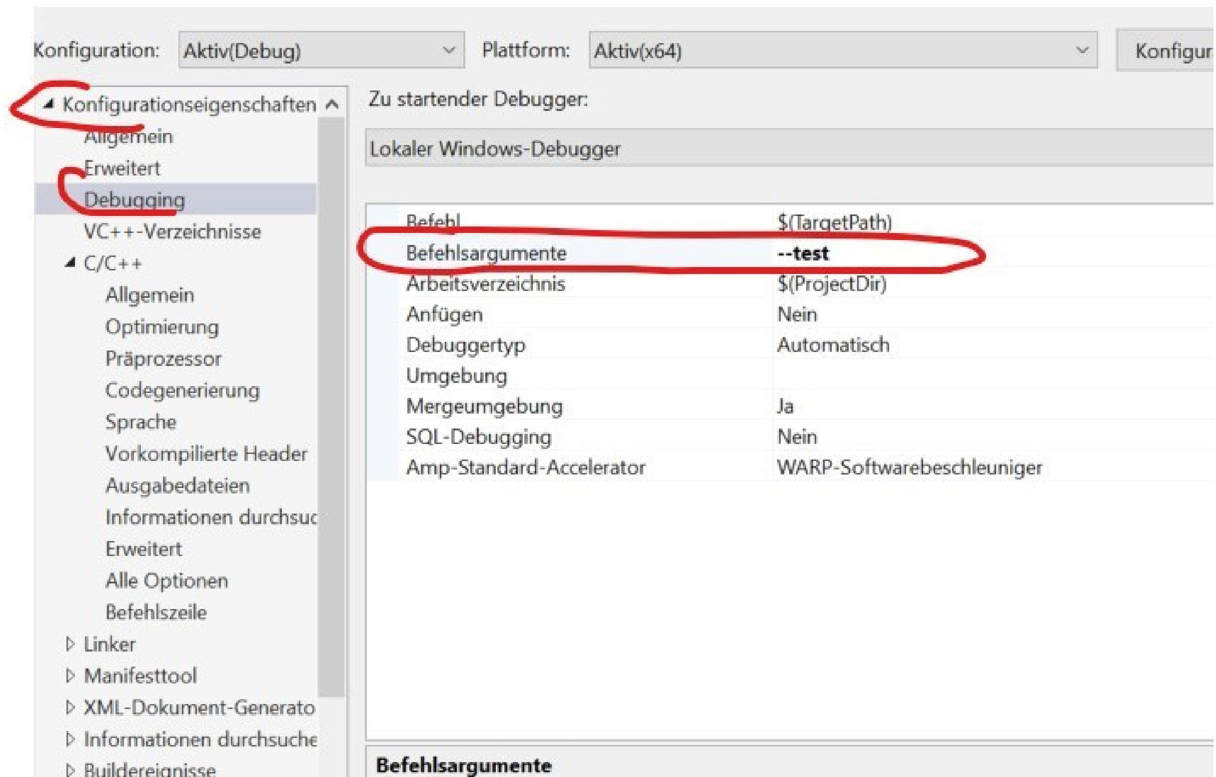
Otherwise a test file (you decide which) with some ATC utterances is read in and the contents is output to cout or a file. Later you will also output the extracted callsigns. Currently it is enough to just use the `--test` parameter in main.

Your `main` could look like this:

```
int main(int argc, char* argv[])
{
   if (argc > 1 && string(argv[1]) == "--test")
   {
      bool result = true;
      PERFORM_AND_OUTPUT(checkTop8InBigFile); // or other tests
      PERFORM_AND_OUTPUT(checkTop5InMediumFile); // or other tests
      if (true == result) {
         printScreenColorOnceVal(cout,
                GREEN_SCREEN_COLOR, "Tests erfolgreich\n");
         return 0;
      }
      else {
         printScreenColorOnceVal(cout, RED_SCREEN_COLOR,
              " Fehler in Tests aufgetreten! ***\n");
         return -1;
      }
   }
   ReadFileAndPrintContents();
   return 0;
}
```

The above program benefits from the possibility that you can pass parameters via the command line, when you call a C++program.

You can provide parameters via the IDE of Visual Studio as shown in the following Figure



Execute your program now in test mode (parameter --test) and create a screen dump. The screen dump could look like shown in Figure \ref{exercise5-3-ProgramRunsTest}

```
Microsoft Visual Studio-Debugging-Konsole
Tests erfolgreich

R:\VorlesungsUnterlagen\Betreuer\Uebungen\CodeDerAufgabenLoesungen\03
84") wurde mit Code "0" beendet.
```

Execute your program now NOT in test mode and create a screen dump, when you would execute your normal code (currently not existing, so create a suitable cout call..

Extend the functionality so that you can pass “--test N”. N is an integer between 1 and 1000000000. If N is 10, all the tests are passed in a loop 10 times etc.

If N is not specified explicitly the default value is 1. If N is 0 or less, than no tests are executed, but the normal behaviour (here still empty) is performed.

Exercise 2.4

Also implement a stress test, which shows that you have (very probably) no memory leaks (Tests can only show the presence of error, but never/seldom their absence) and show that your idea

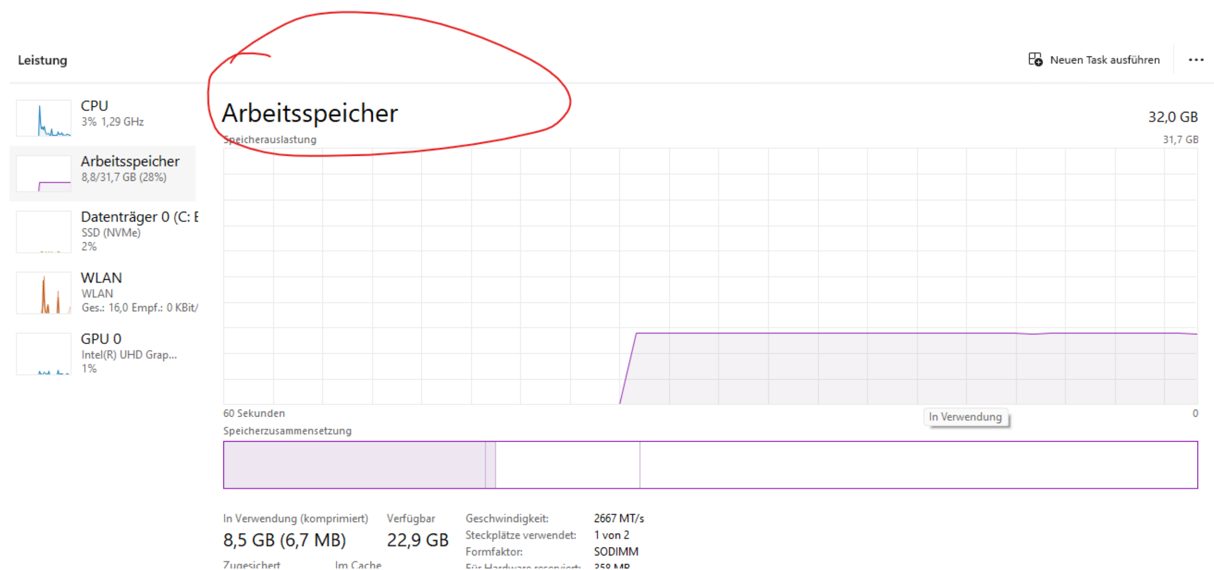
works, i.e. if you have a memory (which you introduce by intension for demonstration), it is detected.

Make suitable screen dumps and store them in Images folder, see also the next section with “Tipp, Tricks and Constraints”.

Tipps, Tricks and Constraints

An idea to detect memory leaks could to just use the task manager of your operation system on Windows, see figure below, to visualize the usage of memory when you call your program e.g. with “--test 10000”.

If usage of memory gets bigger and bigger, you might have a problem.



If you are not developing under Windows (e.g. Linux) and not with Visual Studio, please make sure that all your files are in one directory (header, source, data files)[2] or provide a cmake file.[3],

Do not use path dependent file paths at different places in your program, i.e. do not write

```
ofsteam str("C:\\VorlesungsUnterlagen\\Betreuer\\Uebungen\\"
            "CodeDerAufgabenLoesungen\\03b_ExeManyFiles\\x.txt";
```

[2] I will always try to run and compile on my Windows system. If your code is split in different directories, creating a Visual Studio project is too difficult for me.
[3] Do not forget to test, that your project also compiles and runs under Windows on my system. Ask a colleague with Windows Visual Studio installation.

better use a function as e.g. `AppendFilenameToPath`, shown in the following code fragments:

```
bool checkBlaBla()
{
   string filename =
     AppendFilenameToPath("data\\BigWordSeqPlusCmdsFile.txt");
/* … */
```

You could use the following implementation[4] (of course your basic path is different):

```
string GetPathPrefix()
{
#ifdef _WIN32  // on Windows system
   return "R:\\Uebungen\\CodeDerAufgabenLoesungen\\03b_ExeManyFiles";
#else
   // \toDo not implemented
   return "./";
#endif
}

string AppendFilenameToPath(std::string astr_filename)
{
#ifdef _WIN32  // on Windows system
   return GetPathPrefix() + "\\" + astr_filename;
#else
   return GetPathPrefix() + "/" + astr_filename;
#endif
}
```

[4] In that case I might have a chance to make your code running on my system, if you did not implement directory independent file names.