Course C^{++}, Exercise 2

Deadline: 13.03.2017

Topic of this exercise is the general structure of a C++ program. You have to create a program that consists of different files, and use **make** to compile it. Make a separate directory for the task.

1. Download the files **rational.h**, **rational.cpp**, **vector.h**, **matrix.h**, **matrix.cpp** and **main.cpp** from `http://www.ii.uni.wroc.pl/~nivelle/teaching/cpp2015/`. There is also a **Makefile** that you can use. Make sure that you understand what is in this Makefile.

2. The usual structure of a C^{++} program is as follows: Each class has two files, a file **class.h** and a file **class.cpp**. The **.h** file contains the declarations of the fields, and the declarations of the methods. The **.cpp** file contains the actual implementations of the methods.

   My experience is that nearly all code belongs to some class. If some code does not belong to a class, you should still make two files for it. Don't invent artificial class names.

   The **.cpp** files are compiled separately. This is important, so we insist on this from the beginning. Each **.cpp** file is compiled separately into a **.o** file. When all **.o** files are created, they are combined into a single, executable file. This process is called *linking*. The task of the linker is to check for identifiers that are used in one of the **.o** files, and that are defined in another file. When such identifiers exist, they are replaced by the address reference. If the linker cannot find a definition, it will produce an (generally incomprehensible) error message.

   When you type 'make', you get a wall of linker errors. We deal with this in the next task. Still it should be possible to type `make matrix.o` and compile the matrix class.

3. The linker errors are caused by methods that are declared in **rational.h**, but not defined in **rational.cpp**. Complete the missing functions.

4. Now it should be possible to run the complete program. Compute

$$\begin{pmatrix} \frac{1}{2} & \frac{1}{3} \\ -\frac{2}{7} & \frac{2}{8} \end{pmatrix} \times \begin{pmatrix} -\frac{1}{3} & \frac{2}{7} \\ \frac{2}{5} & -\frac{1}{7} \end{pmatrix}.$$

Compute the inverse of

$$\begin{pmatrix} \frac{1}{2} & \frac{1}{3} \\ -\frac{2}{7} & \frac{2}{8} \end{pmatrix}$$

5. Verify, using examples, the properties below. The easiest way to compare two matrices is to compute $m_1 - m_2$ and print the result.

   - Matrix multiplication is associative:

     $$(m_1.m_2).m_3 = m_1.(m_2.m_3).$$

   - Matrix multiplication with addition are distributive:

     $$m_1.(m_2{+}m_3) = m_1.m_2{+}m_1.m_3 \text{ and } (m_1{+}m_2).m_3) = m_1.m_3{+}m_2.m_3.$$

   - Matrix multiplication corresponds to composition of application:

     $$m_1(m_2(v)) = (m_1.m_2)(v).$$

   - Determinant commutes over multiplication:

     $$\det(m_1).\det(m_2) = \det(m_1.m_2).$$

   - Inverse is indeed inverse:

     $$m.\mathrm{inv}(m) = I \text{ and } \mathrm{inv}(m).m = I.$$