ETH
Eidgenössische Technische Hochschule Zürich
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Informatik für Mathematiker und Physiker HS12

Exercise Sheet 6

Submission deadline: 3.15pm - Tuesday 30th October, 2012

Course URL: http://www.ti.inf.ethz.ch/ew/Lehre/Info1_12/

Assignment 1 -(6 points)

Write a program `inverse_matrix.cpp` that inverts a 3×3 matrix A with real entries. The program should read the nine matrix entries from the input, and then output the inverse matrix A^{-1} (or the information that the matrix A is not invertible). In addition, the program should output the matrix AA^{-1} in order to let the user check whether the computation of the inverse was accurate (in the fully accurate case, the latter product is the identity matrix).

Hint: For the computation of the inverse, you can employ *Cramer's rule*. Applied to the computation of the inverse, it yields that A^{-1}_{ij} (the entry of A^{-1} in row i and column j) is given by

$$A^{-1}_{ij} = \frac{(-1)^{i+j} \det(A^{ji})}{\det(A)},$$

where $\det(M)$ is the determinant of a square matrix M, and A^{ji} is the 2×2 matrix obtained from A by deleting row j and column i.

To compute the determinant of a 3×3 matrix, you might want to use the well-known *Sarrus' rule*.

Assignment 2 - (4 points)

One of the simpliest ciphers is Caesar's cipher (that you have seen in the lecture). It has been widely used for a long time. However, this cipher can be broken by a brute-force search very easily, hence, it is not secure. Therefore, in 1550, Italian mathematician Gerolamo Cardano proposed a cipher, that works in the following way.[1]

In order to encrypt a message. We are given a rectangular board of $n \times m$ squares. Into each square on the board, we can fill a *single* character. We are also given a grid of size $n \times m$. In this grid, some of the squares are full and some of them are holes. We overlay the board with the grid and write the text that we want to encrypt into the holes in the gird (again, single character per square). We remove the grid and fill the empty squares on the board with random characters. Our board is now the cipher text (encrypted text). We decrypt the text via overlaying the grid

[1] Only the person that possesses the same grid as the one used to encrypt the message is able to decrypt the message.

with the board again and reading only the characters that we can see through the holes in the grid. Figure 1 illustrates the Cardano's grill cipher.

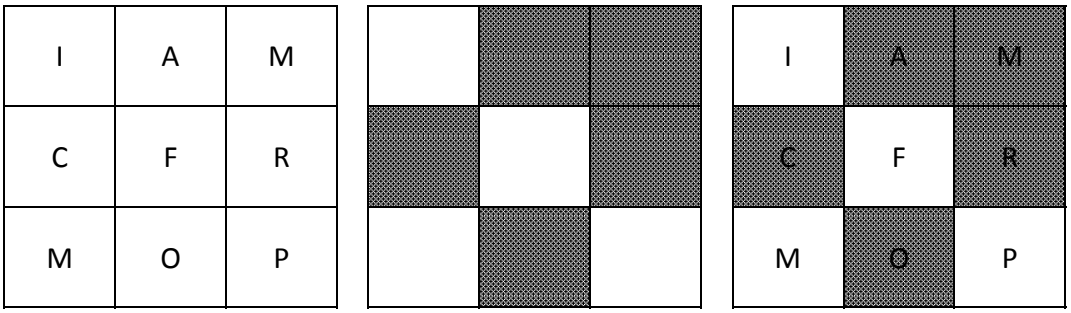

Figure 1: Overlaying the cipher text (left) with the grid (middle) we can decrypt the hidden message (right) that says IFMP.

Your task is to write a program `cardanoCipher.cpp` that outputs the deciphered message. At the input, you are given two positive integers n and m, the encrypted text and the grid (m lines of n characters for each). The characters in the grid are only `"."` or `"*"`, where `"."` represents a hole in the grid and `"*"` represents a full square through which we can not see.

Here is an example input and the corresponding output:

```
3 3

IAM
CFR
MOP

.**
*.*
.*.

The decrypted message is: IFMP
```

The cipher.in file contains an interesting message on which you can test your program.

Assignment 3 - (6 points)

On 8^{th} June 2012, Neue Zürcher Zeitung went completely digital, and what they did to visualize this was to encode the whole cover page in binary in the way that each 8-bit binary number represented a single ASCII character (e.g. 01001110 01011010 01011010 encodes NZZ). The nzz.in is a plain text input file that contains the transcript of the NZZ binary cover page. Your task is to write a program `nzzDecoder.cpp` that decodes this file and outputs the decoded text.

Challenge - (8 points)

Exercise 89 from the lecture notes.