Informatik für Mathematiker und Physiker   HS16

Exercise Sheet 8

Submission deadline: 15:15 - Tuesday 15th November, 2016
Course URL: http://lec.inf.ethz.ch/ifmp/2016/

Assignment 1 - NZZ-Decoder (4 points)

On 8th June 2012, Neue Zürcher Zeitung went completely digital, and what they did to visualize this was to encode the whole cover page in binary (see image to the right) in the way that each 8-bit binary number represented a single ASCII character (e.g. 01001110 01011010 01011010 encodes NZZ, since for example 01001110 is 78 which is the ASCII code for N). Your task is to write a program nzz_decoder.cpp that decodes the input and outputs the decoded text. To tell your program that the input is complete, the user will input a 2.

Hint: In Codeboard you will find a file nzz.in which contains the text of the NZZ front page. You can input the text by copy-pasting it into the input field when running your program.

I/O-Examples	(Explanation: http://lec.inf.ethz.ch/ifmp/2016/codeboard.html)
01001000 01101001 00100000 01100001 01101100 01101100 00100001 2 *Hi all!*	
Submission: https://codeboard.ethz.ch/ifmp16E8T1	

Assignment 2 – Lindenmayer-Systems (3 points)   [based on: Skript-Aufgabe 105]

Compute the Lindenmayer words as asked in each subtask for the given L-systems.

a) Given the L-system (Σ, P, s_0) for

$$\Sigma := \{F, +, -\}, \quad P(F) := F + F, \quad P(+) := +, \quad P(-) := -, \quad s_0 := F-$$

Compute the words w_0, w_1 and w_2.

b) Given the L-system (Σ, P, s_0) for

$$\Sigma := \{a, b, c, d\}, \quad P(a) := b, \quad P(b) := c, \quad P(c) := d, \quad P(d) := a, \quad s_0 := ac$$

Compute the words w_0, w_1, w_2, w_3, w_4.

c) Given the L-system (Σ, P, s_0) for

$$\Sigma := \{F, B\}, \quad P(F) := FB, \quad P(B) := FFF, \quad s_0 := B$$

Compute the words w_0, w_1, w_2, w_3.

This exercise can be handed in via Codeboard! To do so, click on the **Submission**-link at the bottom of this box. This opens a Codeboard-project. There, click on `ex2.txt` on the left side and write your answers. **When you are done, first save your file, then click on `Compile`, and then click on `Submit`.**

However, if you prefer, you can also hand in your solutions on paper as before.

Submission: https://codeboard.ethz.ch/ifmp16E8T2

Assignment 3 – Multidimensional Arrays (3 points)

Determine the following outputs!

a) What does the following code output?

```cpp
char mat[2][3] = {{'a', 'b', 'c'}, {'d', 'e', 'f'}};
mat[0][1] = 'H';
mat[1][2] = 'H';
mat[0][0] = 'T';
mat[1][1] = 'T';
mat[0][2] = 'E';
mat[1][0] = 'E';

for (int i = 0; i < 2; ++i) {
    for (int j = 0; j < 3; ++j)
        std::cout << mat[i][j] << " ";
    std::cout << "\n";
}
```

b) What does the following code output?

```cpp
std::vector<std::vector<int> > mat (2, std::vector<int>(3, 1));
for (int i = 0; i < 2; ++i)
    for (int j = 0; j < 3; ++j)
        mat[i][j] = i + j;

for (int i = 0; i < 2; ++i) {
    for (int j = 0; j < 3; ++j)
        std::cout << mat[i][j] << " ";
    std::cout << "\n";
}
```

c) What does the following code output?

```cpp
int mat[3][3];
for (int i = 0; i < 3; ++i)
    for (int j = 0; j < 3; ++j) {
        if (i == j)
            mat[i][j] = 1;
        else
            mat[i][j] = 0;
    }

for (int i = 0; i < 3; ++i) {
    for (int j = 0; j < 3; ++j)
        std::cout << mat[i][j] << " ";
    std::cout << "\n";
}
```

This exercise can be handed in via Codeboard! To do so, click on the **Submission**-link at the bottom of this box. This opens a Codeboard-project. There, click on `ex3.txt` on the left side and write your answers. **When you are done, first save your file, then click on Compile, and then click on Submit.**

However, if you prefer, you can also hand in your solutions on paper as before.

Submission: https://codeboard.ethz.ch/ifmp16E8T3

Assignment 4 – Using Matrices (3 points)

Write programs that solve the given tasks. The idea of this task is to let you work with matrices, therefore **build corresponding matrices and output them in a separate step for this exercise.**

a) Write a program `diagonal.cpp` that builds an $n \times n$-diagonal matrix with entries `d` on the diagonal for given `int n` ($n > 0$) and a `double d`. The user inputs are first `n` and then `d`.

I/O-Examples   (Explanation: http://lec.inf.ethz.ch/ifmp/2016/codeboard.html)

```
3
5
5 0 0
0 5 0
0 0 5
```

Submission: https://codeboard.ethz.ch/ifmp16E8T4a

b) Write a program `mat_product.cpp` that computes the matrix-matrix-product of two 3×3-matrices with entries of type `double`. The user first inputs the left matrix (row-wise) and then the right matrix (also row-wise).

c) For given numbers $x_1, ..., x_m$ a Vandermonde-matrix of dimension $m \times n$ is defined as:

$$\begin{pmatrix} 1 & x_1 & x_1^2 & \ldots & x_1^{n-1} \\ 1 & x_2 & x_2^2 & \ldots & x_2^{n-1} \\ \vdots & \vdots & \vdots & & \vdots \\ 1 & x_m & x_m^2 & \ldots & x_m^{n-1} \end{pmatrix}$$

Write a program `vandermonde.cpp` which constructs a Vandermonde-matrix with entries of type `double`. The user first inputs `m` ($m > 0$), then `n` ($n > 0$), and then the numbers $x_1, ..., x_m$.

Challenge – Lindenmayer Pictures (8 points)

Did you always dream of producing a picture that will be shown in front of 400 students, and that has the chance to become famous through its appearance in the lecture's podcast? Well, now you can! This challenge asks you to make beautiful fractal images using Lindenmayer systems. All submissions (or a large selection thereof if there are too many) will be made into a video to be shown during a later lecture. This link contains explanations for how to coordinate the turtle.

Don't forget to write some recommended parameter settings (for instance the number of iterations) as a comment in your cpp-files, and also include your name. Handing in the pictures to us works just as for the regular exercises in Codeboard by first uncommenting the line

```
//#include "tests.h"
```

then by clicking on the *Compile*-button and then by clicking on the `Submit`-button. You can also hand in multiple submissions!
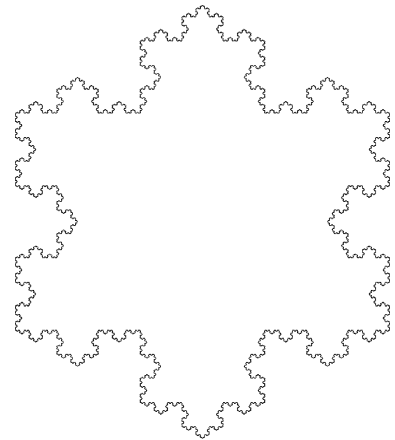
Click on the **Submission**-link at the bottom of this box to open Codeboard.

Submission: https://codeboard.ethz.ch/ifmp16E8L