MOD 600 B
ASSIGNMENT 3

TORE FLÅTTEN

1. Description

This document describes the mandatory assignment of Part B. The equation numbers refer to the Lecture Notes [1]. In this assignment, you are asked to use the numerical method (303), based on the Roe matrix described in Section 3.4, and the Definitions from equations (290), (298) and (299) of the Lecture Notes to solve the shallow water equations.

The number of computational cells are not specified, but I suggest using 100 cells as the default (i.e. each cell is 50 cm long) and then experiment with varying the number of cells when your program is finished.

The simulation time is not specified, as a default your program may halt after 100s of simulated time.

Ideally, your program should plot animations of the time development of the liquid height and liquid velocity as demonstrated in the week 9 video lecture "Week09_Intro_to_partB".

I consider this to be a difficult assignment. Therefore, collaboration between students is encouraged. Seeking assistance from the TAs is encouraged. In particular, seeking assistance from the teacher (Tore Flåtten) is encouraged.

You will need to pass the assignment to be eligible to take the exam. Acceptance of the submitted assignments will be based on your success, or if your efforts are not successful, your sincere efforts to solve the problem. The deadline is April 25 23:59. To make sure you are able to complete the assignment, you are all responsible to seek the necessary assistance in due time if you get stuck.

To prepare for Assignment 3, you are adviced to solve exercises 3.1, 2.8, 3.2, 3.6 and 3.4 in [1] first, as these will gradually build your understanding towards solving the full problem. In addition, much of the code from these problems may be reused for the assignment.

If done properly, your final program does not need to be very complex. I have received excellent submissions consisting of only about 50 lines of code. It is of course perfectly acceptable to submit longer programs.

Everyone must submit a file before the deadline, even if you solve the assignment in collaboration with other students. Then you are of

course allowed to submit identical files, but you must list the names of the students you collaborated with. You are not allowed to simply copy the work of other students.

Your submission should be in the form of a file containing runable MATLAB or Python code.

Good luck!!

Assignment 3. Write a MATLAB (or Python) program to solve the shallow water equations (312) and (313) using the Roe scheme (303). In particular, consider the *dam break* problem specified as follows:

$$h(x,0) = h_0(x) = \begin{cases} 2 & \text{if} \quad x < 0, \\ 1 & \text{otherwise} \end{cases},$$

$$v(x,0) = v_0(x) = 0.$$

Consider a computational domain of 50 m, i.e.

$$x \in [-25, 25].$$

Assume *reflective* boundary conditions (treating the edges of the domain as solid walls). More precisely, if you solve for the cell values $\boldsymbol{u}_j \quad j \in \{1, \ldots, N\}$ then set before each time step

$$\boldsymbol{u}_0^n(h,u) = \boldsymbol{u}_1^n(h,-v)$$

and

$$\boldsymbol{u}_{N+1}^n(h,u) = \boldsymbol{u}_N^n(h,-v).$$

(In other words, just reverse the sign of the velocity). This gives you the boundary conditions to use in (303).

References

[1] T. Flåtten, Systems of Conservation Laws, *MOD 600 Part B Lecture Notes*, (2022).