MA4011/MA7091 - Computer Class 3 – 08.02.2018

Remember to save all of your programs for future use!

Computer Class 3

We shall be concerned with the implementation of the explicit Euler method, described in Section 4.1 of the notes (Lecture 11) for the the numerical approximation of the solution of the initial/boundary value problem

$$\begin{aligned} u_t(t,x) &= u_{xx}(t,x) + f(t,x) \quad \text{for all } t \in [0,T_f] \text{ and } x \in [0,1], \\ u(0,x) &= u_0(x), \qquad \text{for all } x \in [0,1], \\ u(t,0) = u(t,1) &= 0, \qquad \text{for all } t \in [0,T_f], \end{aligned}$$

for some known function f.

Task 1.
Let $f(t,x) = 0$. Write a MATLAB program implementing the explicit Euler method for the above problem with

$$u_0(x) = \begin{cases} 2x, & 0 \le x \le 1/2; \\ 2-2x, & 1/2 < x \le 1. \end{cases}$$

This is the same function as in Example 4.1 in the notes. This function can be implemented in MATLAB as follows:

```
function y=u0(x)

for i=1:length(x);
   if x(i)<= 0.5
     y(i)= 2*x(i);
   else
       y(i) = 2- 2*x(i);
   end
 end
```

(Use a different file, to the one of your main program, to save this function; the name of this separate file should be `u0.m`)

Fix $T_f = 1$ and calculate the approximation for $N_x = 19$ and $N_t = 800$, and for $N_x = 19$ and $N_t = 770$, using the notation of Section 4.1. Plot the approximations for $n = 0, 1, 25, 50, 100$ in each case. (In this task you are asked to reproduce the plots in Example 4.1 and a bit more.)

Task 2.
Let $f(t,x) = \sin(t+x)$. Write a MATLAB program implementing the explicit Euler method for the above problem with

$$u_0(x) = x(1-x).$$

Fix $T_f = 1$ and calculate the approximation for $N_x = 19$ and $N_t = 800$, using the notation of Section 4.1. Plot the approximations for $n = 0, 1, 25, 50, 100, 200, 400, 800$.