Assignment 2

PDE-Toolbox

Computational Mechanics Tools

Ana Salas Ordóñez
DNI 77196118E

2nd December 2015

1. Solve the problem and refine the initial mesh up to 4 times. Verify that the theoretical convergence order holds.

After solving the following problem with different mesh sizes h (Table 1).

$$u_t - \Delta u = -3e^{-3t} \quad \text{in} \quad \Omega = [0,1]^2$$

Element size (h)	Error
0.1	0.0067
0.05	0.002
0.025	5.6787×10^{-4}
0.0125	1.6003×10^{-4}
0.00625	4.4423×10^{-5}

Table 1: Maximum absolute value of errors for each element size.

it can verified that the evolution of the infinite norm, as a function of h, follows the trend in the Figure 1:

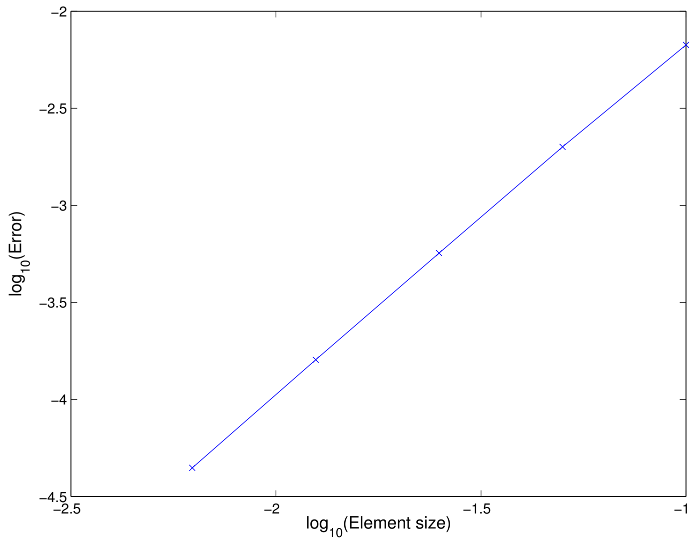
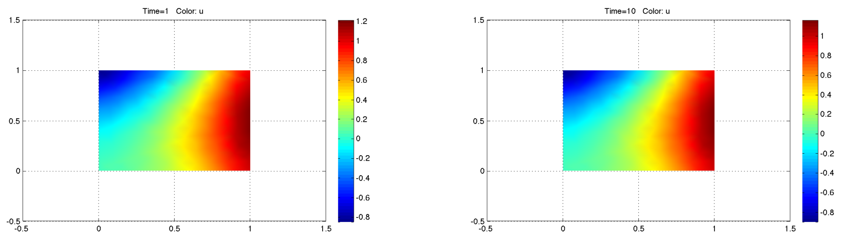


Figure 1: Convergence analysis.

2. How is the solution affected when we modify the final time?

Computing the solution for t=1s and t=10s we can not appreciate much difference between the contours, as we can see in the Figure 2.



(a) $t = 1s$ (b) $t = 10s$

Figure 2: Contour of the solution u for different times t.

In order to see how the solution is affected when we modify the final time, we have plotted the value of U at a random point for different times t (Figure 3). We can see that as time increases, the solution is becoming stationary.

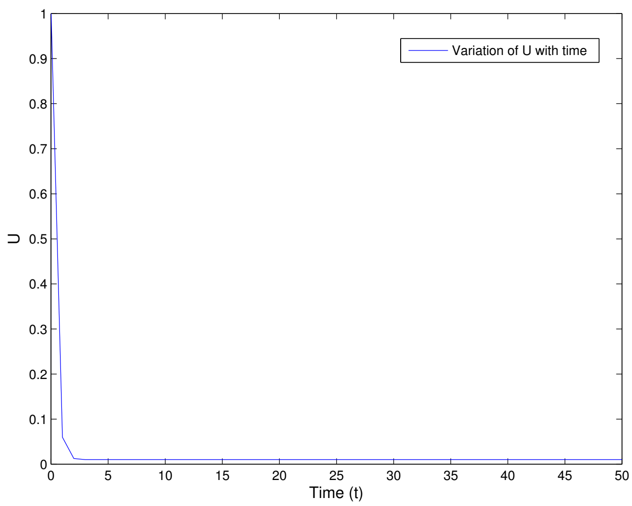


Figure 3: Variation of the solution U with time.

3. We are interested in obtaining the solution at time $t_{end} = 50$ s. Find a more efficient manner to solve this problem.

At time $t = 50\ s$ the solution is almost stationary, because $e^{-50} \approx 0$, so we can solved with PDE-ToolBox the same problem but considering it steady (eliptic).

In order to check the validity of this assumption, we compute the maximum error between the two solutions, the value of this error is 8.4155×10^{-14}, which means that at t=50 s the problem can be considered stationary.