Computational Mechanics Tools

PdeToolBox Assignment

Exercise 1: Consider t_{end} = 10, solve the problem, and refine the initial mesh up to 4 times. Verify that the theoretical convergence order holds.

If we take into consideration that the problem lasts for 10 seconds instead of 1, and we refine the mesh we obtained in the first case 4 times, in order to appreciate a more accurate solution of the problem, we get the following meshes

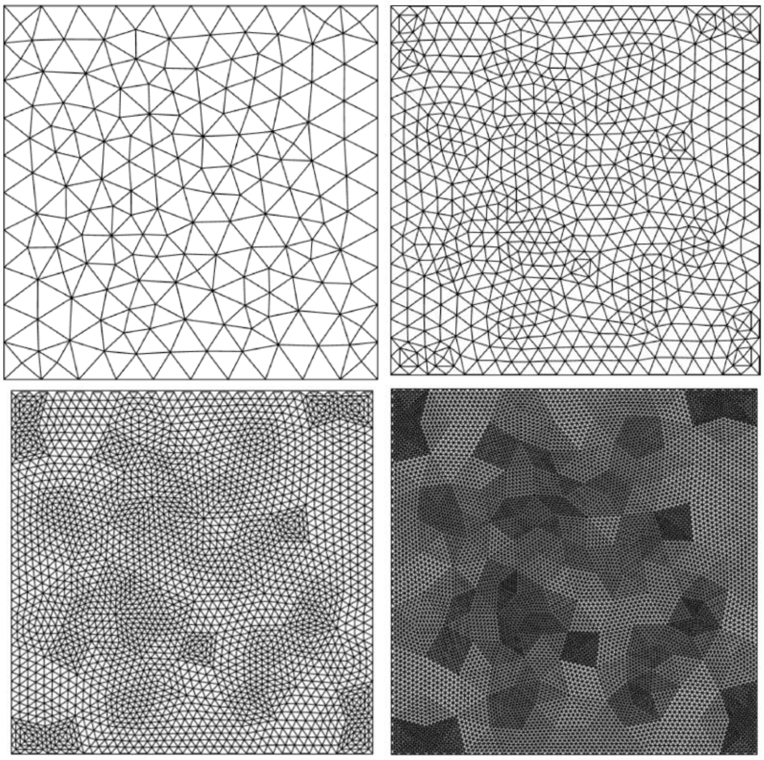

Figure 1 Different mesh sizes taken into consideration for the problem

Now, we take a look at the convergence of the solution and show that it holds.

The following figure shows how the solution converges in a log log scale by using the meshes displayed above:

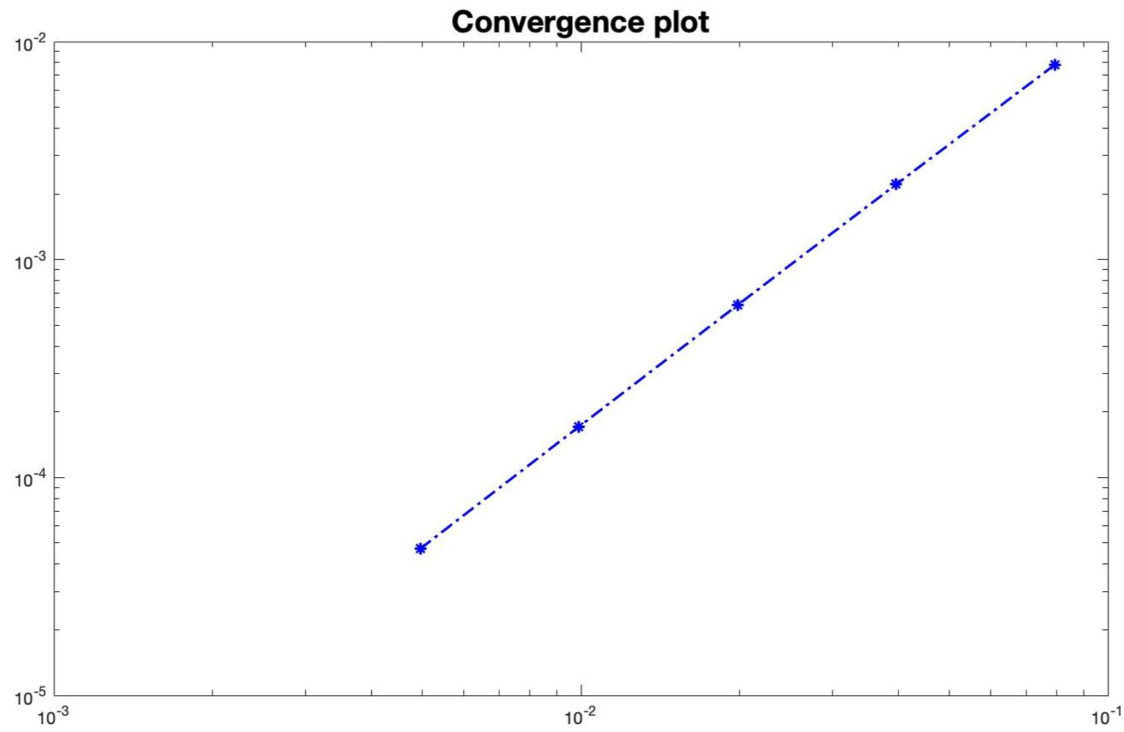

Figure 2 Convergence of the error against mesh size

As we can see, the error (vertical) against the number of elements (horizontal) shows a clear linear behavior in a log log plot. This shows that the convergence of the error holds.

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

In this case we are testing different t_{end} in order to see how this will effect on the solution. We take 2 different time

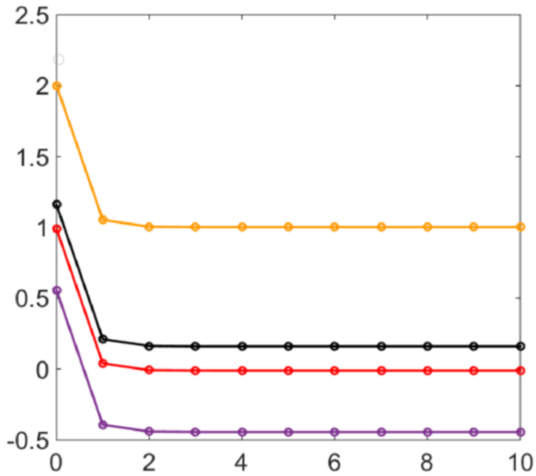

Figure 3 Solution at different nodes

As we can aprecciate in the figure, the yellow curve shows the solution at the node 80, the black curve shows the solution for the node 70, the red one for the 40 and finally the purple curve shows the solution at the 100 node.

As we can see, the curve becomes constant at t=2, this means, even if we change the t_{end}, solution will be the same from t=2 till infinite.

Exercise 3: We are interested in obtaining the solution at time tend = 50. Find a more efficient manner to solve this problem. You do not need to prove the equivalence mathematically, but you need to provide numerical evidence of the new method.

As we saw in the previous exercise, the solution from t=2 becomes practically static, this means that, even if we consider a t_{end}= 2000, the solution will have a negligible variance, thus, considering that e^{-50} is close to 0, we can consider that my means of saving in computational costs and considering a low tolerance in the error, the solution can be computed in a much earlier time.