Computational Fluid Dynamics 1 - HW1

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1 General Discussions

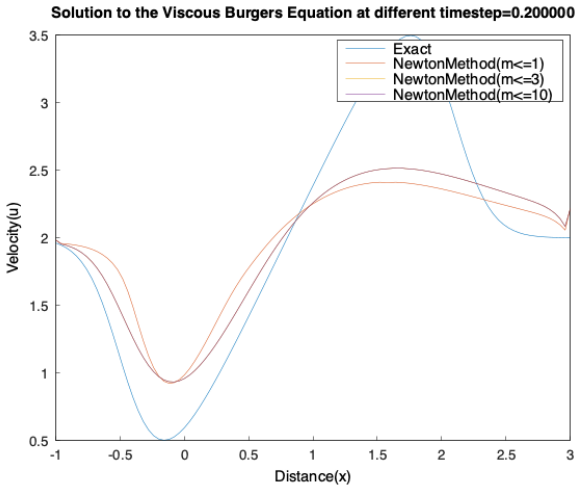
My observation is that the accuracy of the numerical solution is dependent on the time step. The smaller the time step, the closer the results approaches the exact solution. This because for a smaller time step the number of iterations increases and has nothing to do with the stability since the implicit Euler Method is unconditionally stable.

When newton's method is applied to the implicit Euler Method, the results are slightly improved for higher iterations. However, the results remain the same for iterations above 3.

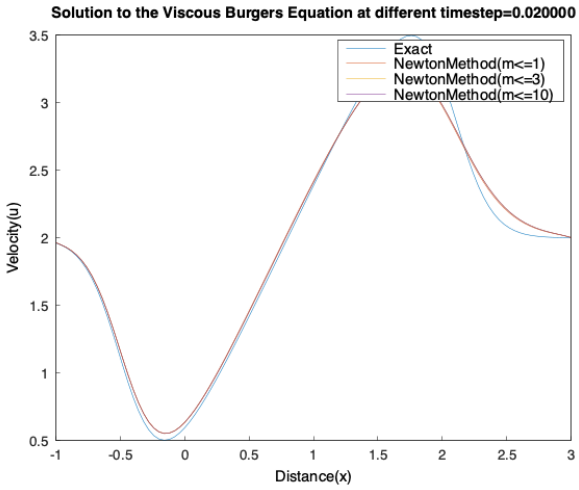
Below are the plots of the results

2 Solution Plots

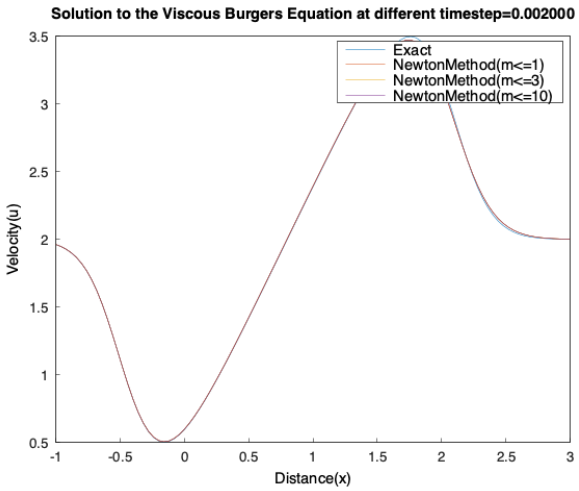
The graphs below show the solution to the delta form of the implicit Euler Method used to solve the Viscous Burgers Equation numerically.



(a) time step= 0.2



(b) time step= 0.02

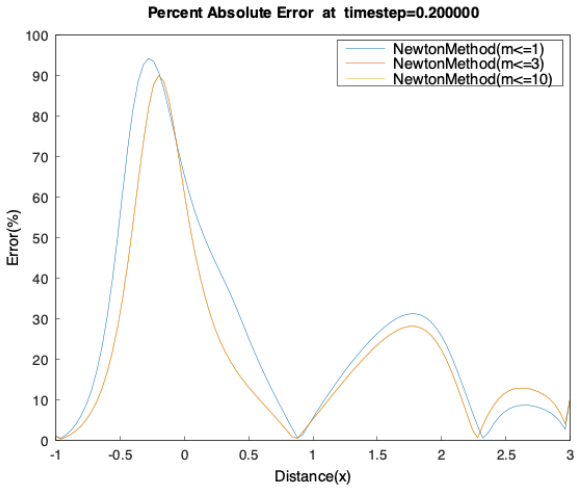


(c) time step= 0.002

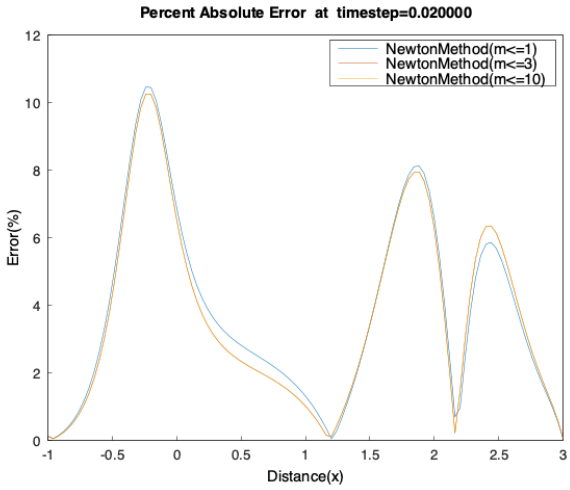
Figure 1: Velocity plots for the Viscous Burgers Equation at various time steps with $\mu = 0.2$ and $\Delta x = 0.04$ at $t = 0.4$ and different newton iterations

3 Error Plots

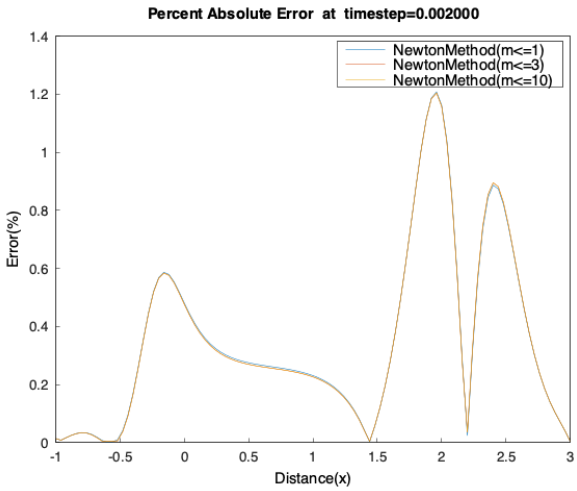
The graphs below show the percent absolute errors to the delta form of the implicit Euler Method used to solve the Viscous Burgers Equation numerically utilizing newton method .



(a) time step= 0.2



(b) time step= 0.02



(c) time step= 0.002

Figure 2: Error plot over the length x plots for the Viscous Burgers Equation at various time steps with $\mu = 0.2$ and $\Delta x = 0.04$ at $t = 0.4$ and different newton iterations. This shows that the errors are higher for smaller timesteps and smaller number of iterations.