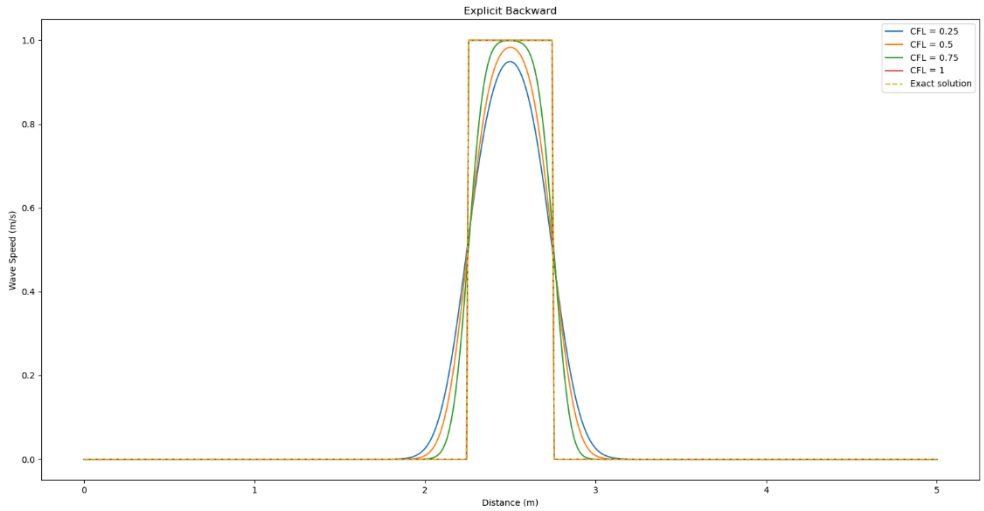
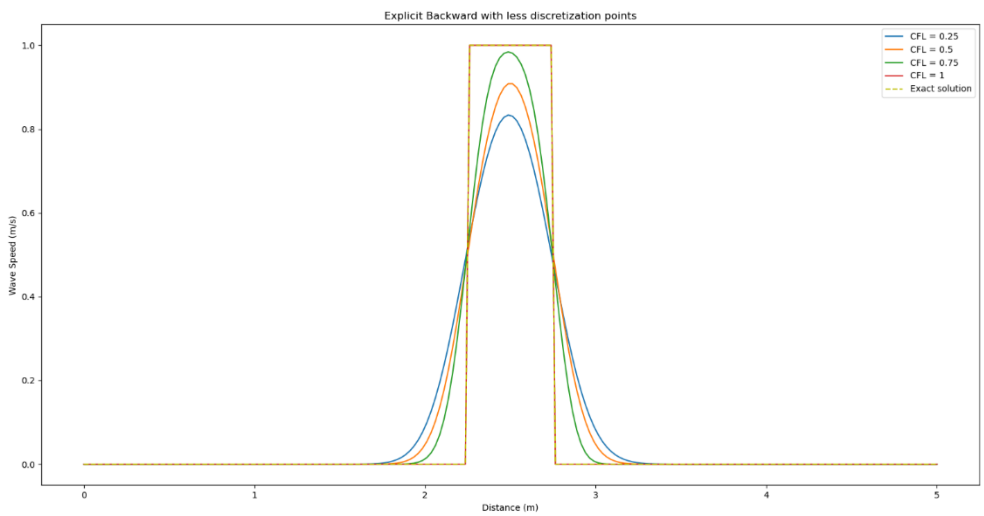
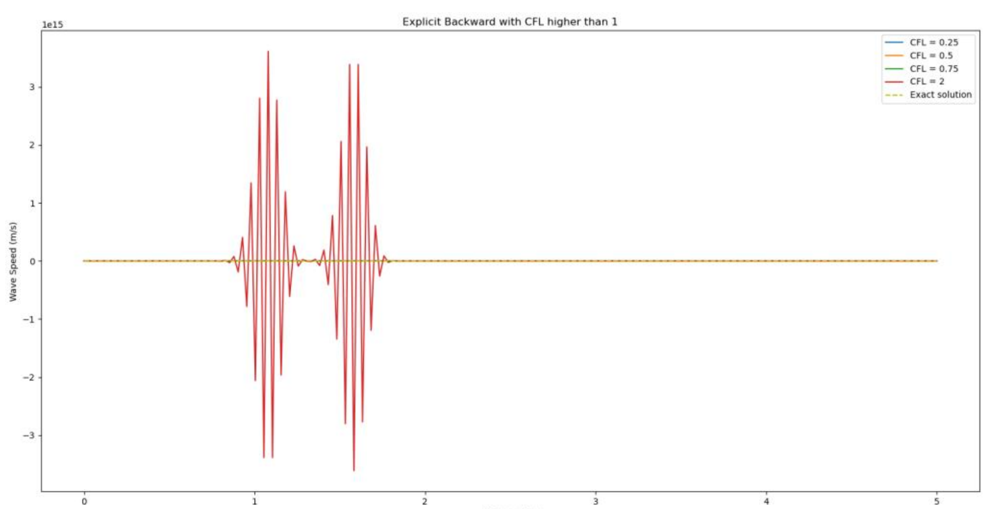
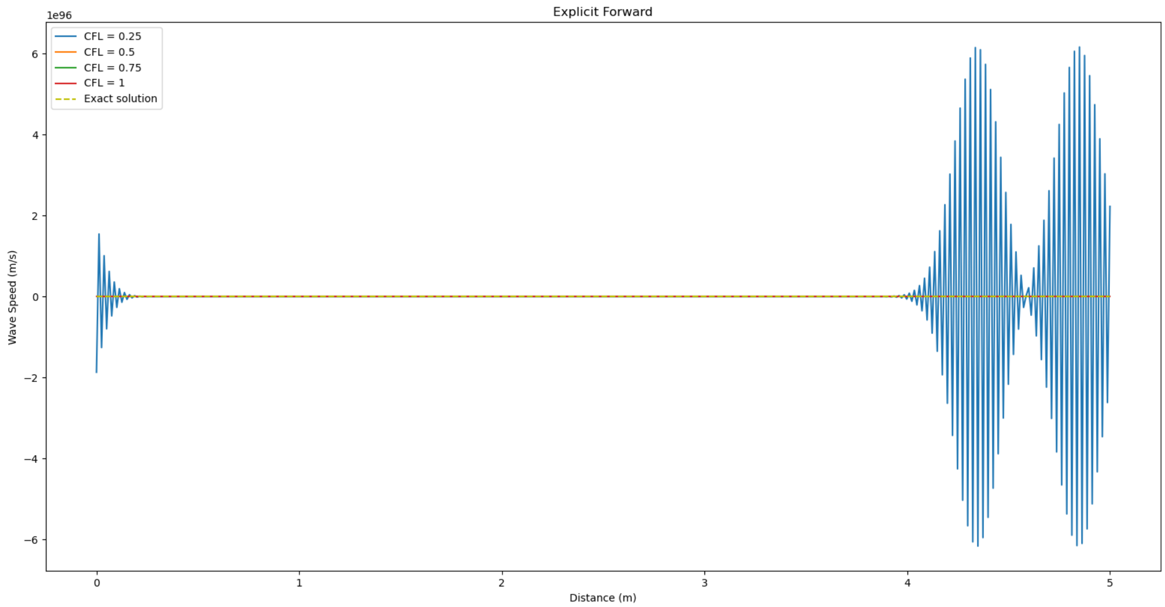

Explicit Backward
CFL = 0.25
CFL = 0.5
CFL = 0.75
CFL = 1
Exact solution
Wave Speed (m/s)
Distance (m)
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
5


Explicit Backward with less discretization points
CFL = 0.25
CFL = 0.5
CFL = 0.75
CFL = 1
Exact solution
Wave Speed (m/s)
Distance (m)
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
5

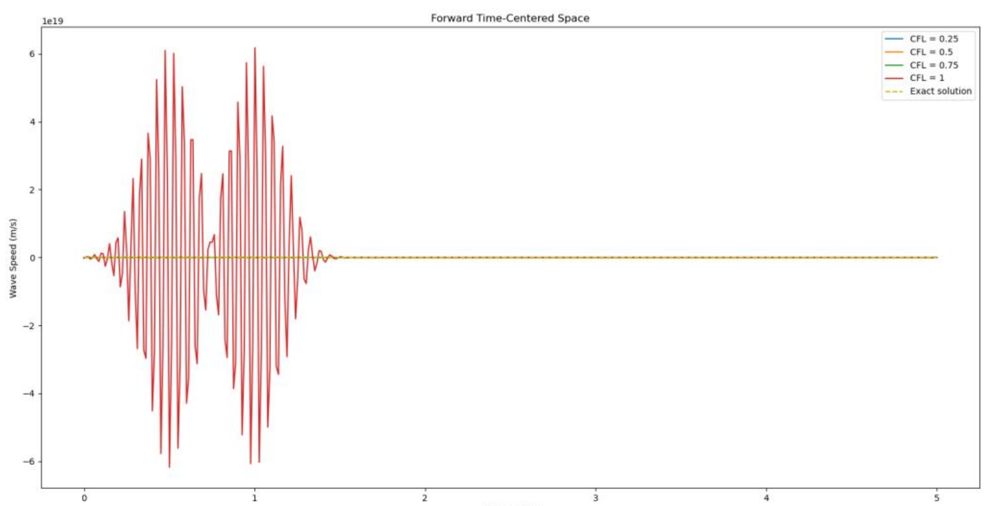

Explicit Backward with CFL higher than 1
1e15
CFL = 0.25
CFL = 0.5
CFL = 0.75
CFL = 2
Exact solution
Wave Speed (m/s)
Distance (m)
−3
−2
−1
0
1
2
3
0
1
2
3
4
5

With the Explicit Backward scheme, we have some diffusion when the CFL number tends to 0. However, when the CFL number is equal to 1, the solution is near an exact solution, without any diffusion, dispersion, or loss. We will take this result as our "Exact solution" in the following figures.

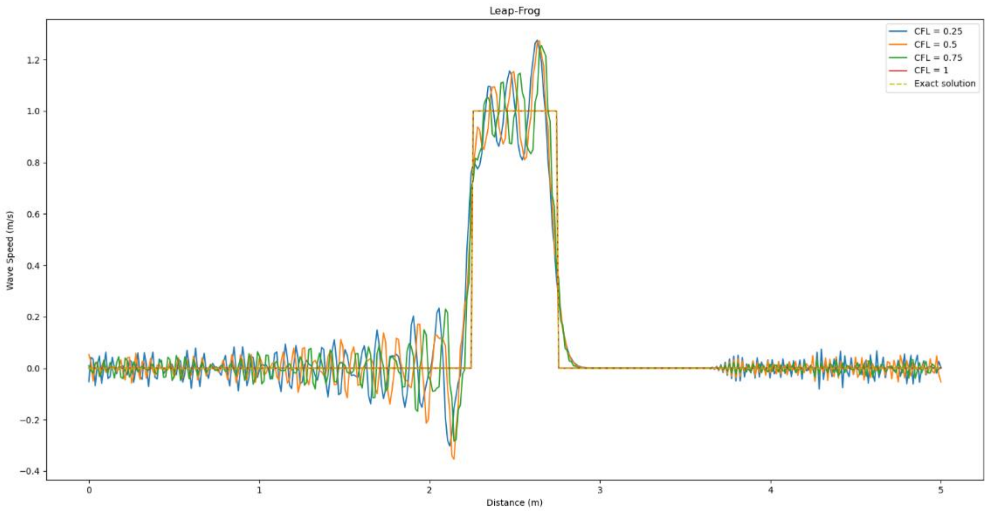
The accuracy increases with the number of discretization and the scheme is stable for CFL less than 1.



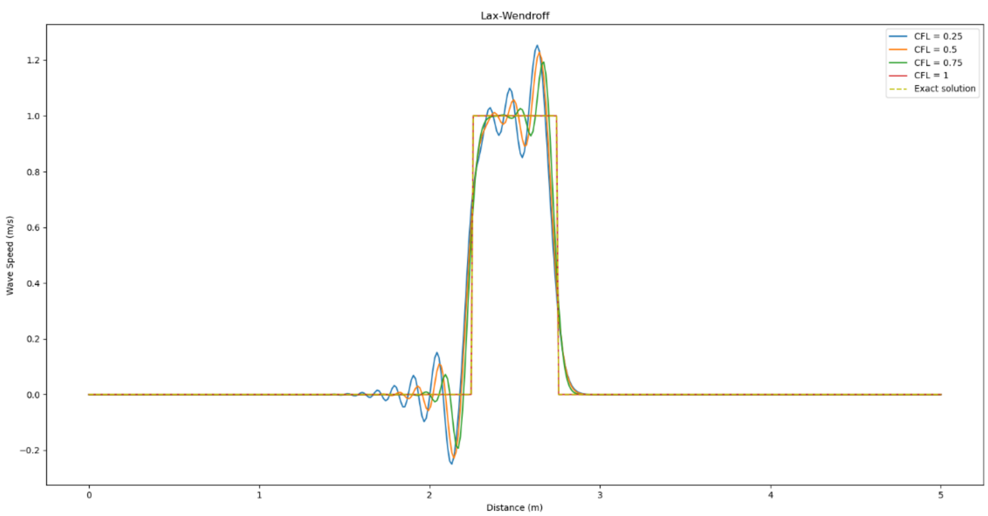
The Explicit Forward scheme is always unstable, so we cannot make any comment on the accuracy with a numerical analysis.



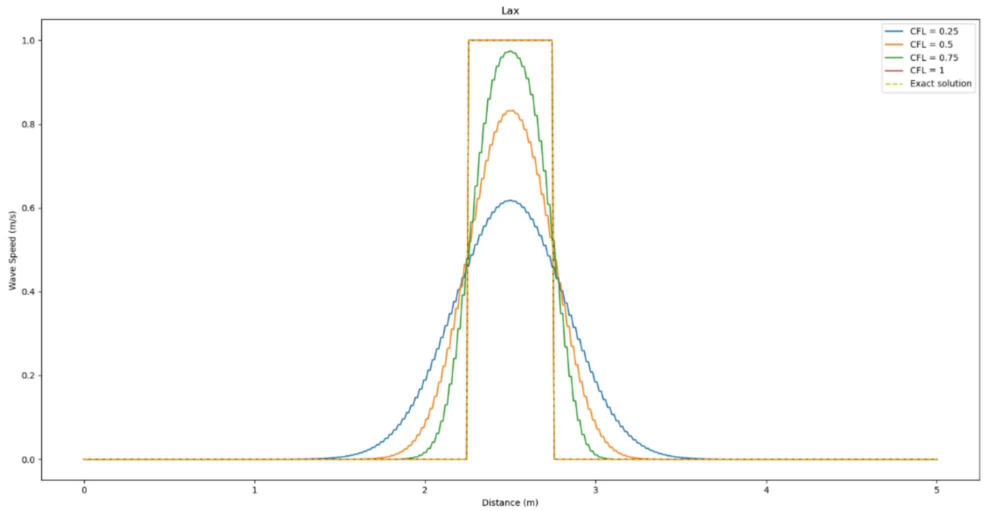
As for the Explicit Forward scheme, the Forward Time-Centered Space is always unstable and we cannot make any comment on the accuracy with a numerical analysis.



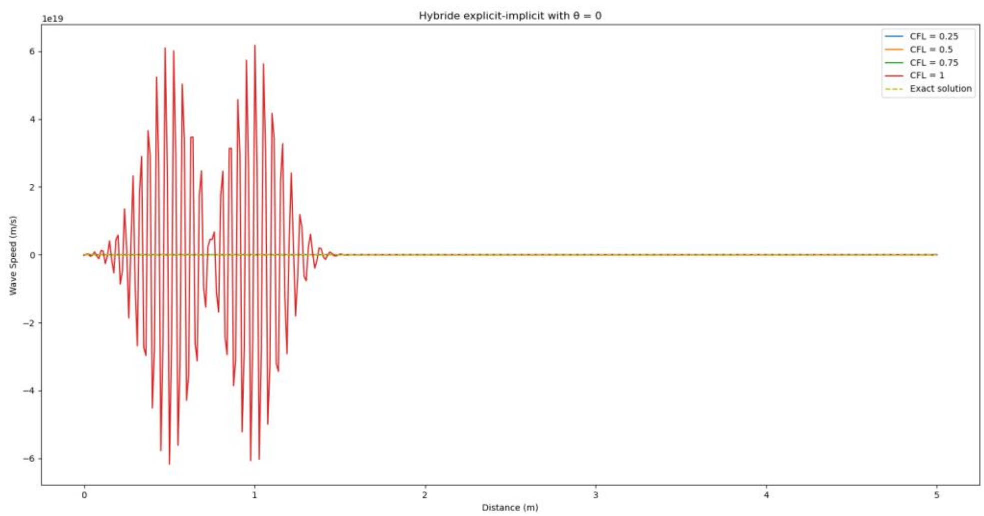
The Leap-Frog scheme has a lot of dispersion in its numerical solutions, resulting in a lot of oscillations. But with CFL equal one, we get the "Exact solution". This scheme is stable for CFL less than 1.



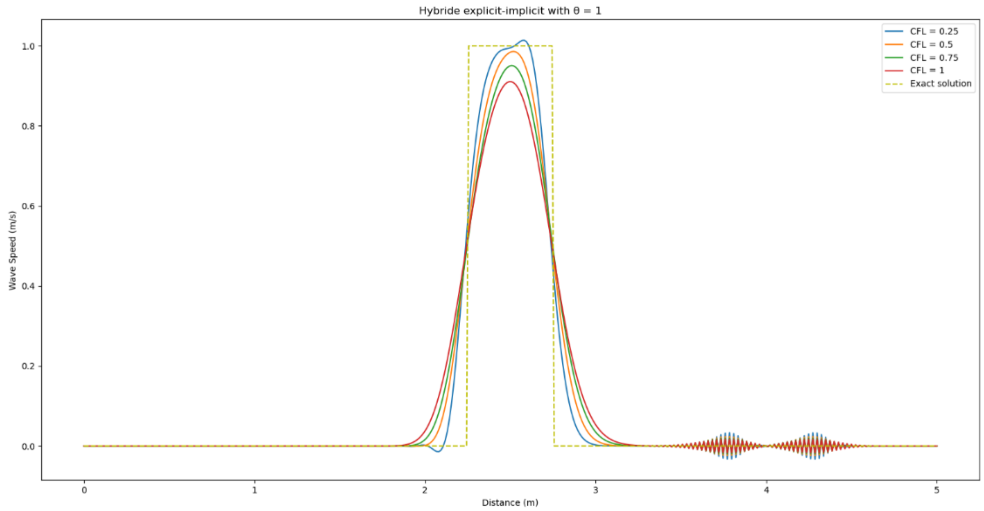
Like the previous scheme, Lax-Wendroff triggers some oscillations (dispersion), but they are more concentrated on the edges of the wave, resulting in a solution more accurate. It is also unstable for CFL higher than 1.

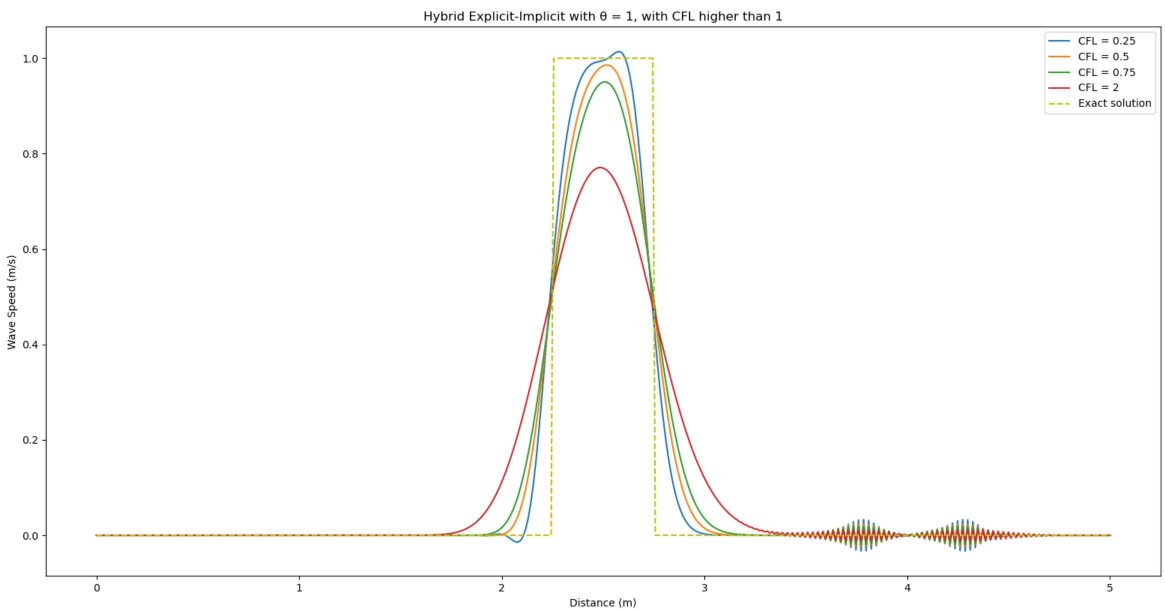


The Lax scheme is closer to the first scheme studied, the Explicit Backward. Indeed, there are some diffusions in the results, but they are larger than the Explicit Backward scheme. It is also stable for CFL less than 1.

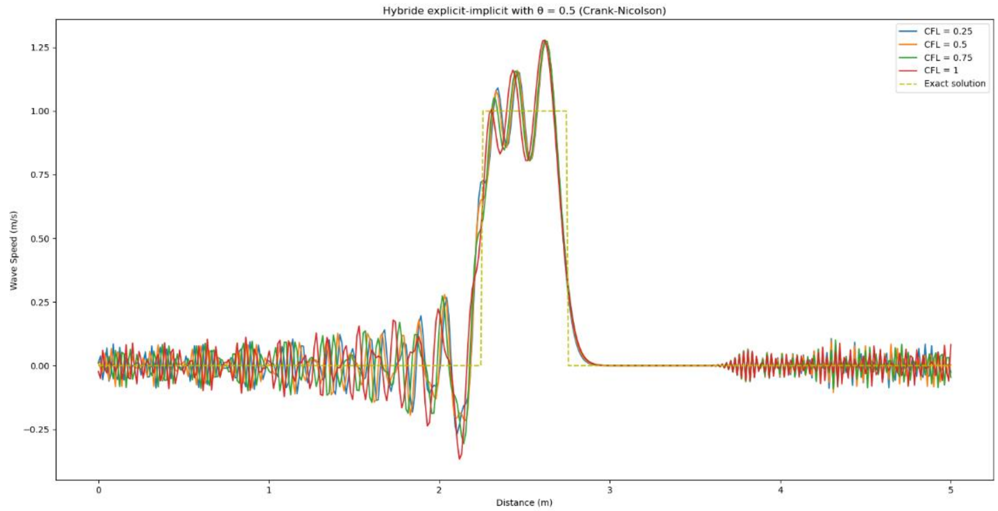


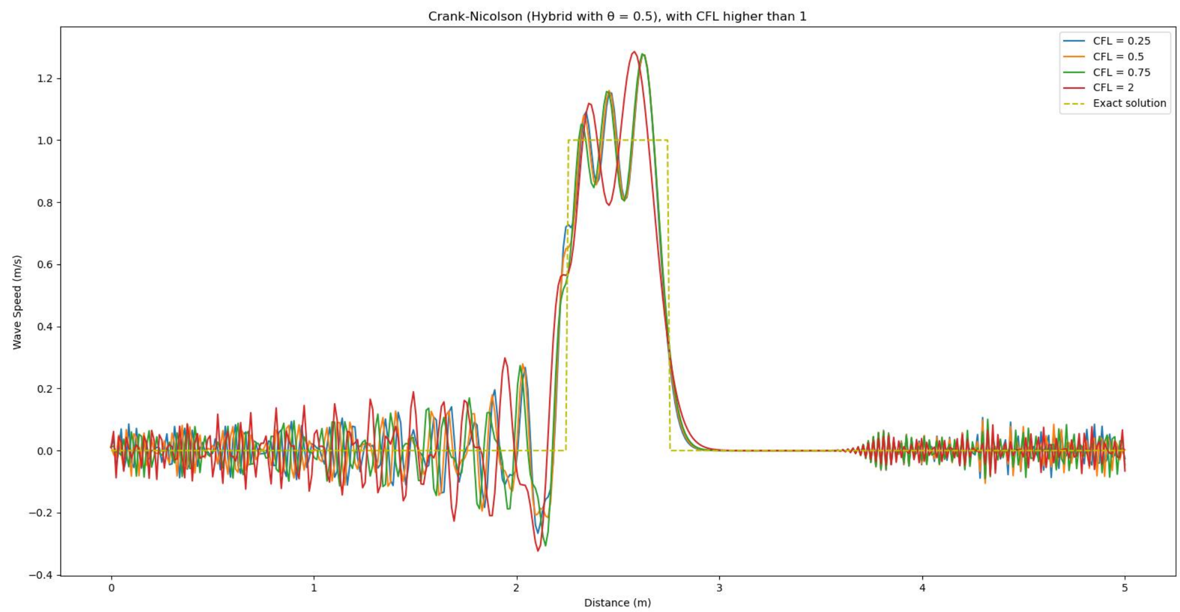
The Hybrid Explicit-Implicit with θ equal to 0 scheme is always unstable, as it is the same scheme as the Explicit Forward one.



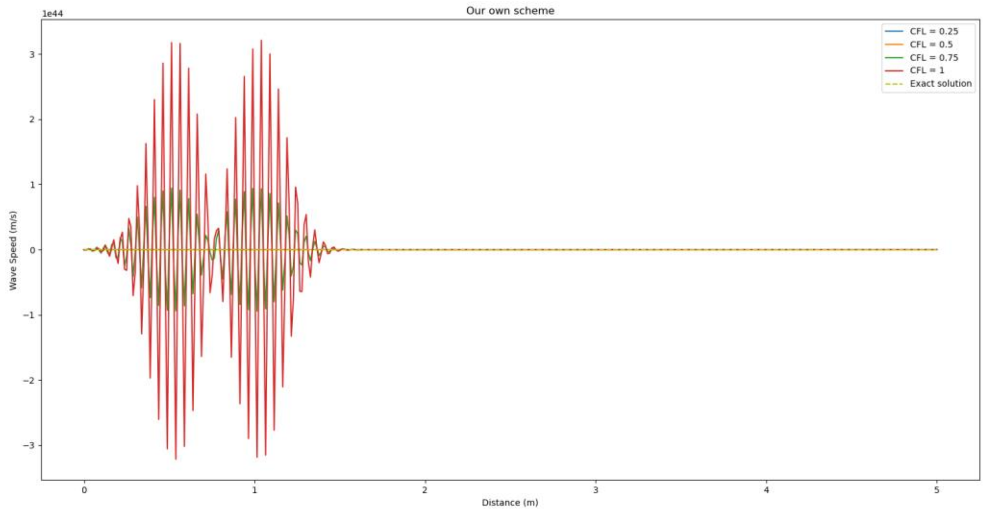


The Hybrid Explicit-Implicit with θ equal to 1 scheme is always stable. This scheme has some diffusion and some dispersion (after the wave we can see some oscillations). The accuracy is better near CFL equal 1.





Crank-Nicolson is stable for all CFL. Is it not what we have found in our derivation (we found a growth-rate always equal to 1). There are a lot of dispersion in the results and changing the CFL number seems to have no effect on the results.



The scheme we studied (4th order in time and 2nd order in space) is unstable for all CFL number. Therefore we cannot analyse the accuracy of the scheme with numerical analysis.