VARIABLE STEPLENGTH

BORIS GUDIKSEN

The steplength can be varied by using the form of the explicit equations. They are all of a form where

$$\begin{aligned} dV &= f\,dm \\ V_{i+1} &= V_i + dV \end{aligned}$$

where V is the variable we are intersted in stepping forward, m is the primary variable and f is a function not dependent on dm. The question is now how large can we make dm without getting into trouble. For a constant steplength, dm is given and constant, so we can directly calculate the changes of the dependent variable dV, but by choosing dm in advance we cannot garantee that dV does not become too large, so that either the solution is imprecise of that we get a value for $V + dV$ that is unphysical.

We now make the following modification

$$\frac{dV}{dm} = f$$

and we know require that for a step forward in dm the corresping dV satisfies

$$\frac{|dV|}{V} < p$$

where $|dV|$ is the absolute value of dV and p is a fraction that V is allowed to change and p must therefore generally be less than one and 0.1 is a safe place to start.

In practice we just do the following:

Calculate f without multiplying with dm:

$$\frac{dV}{dm} = f$$

now use f and the chosen p to calculate dm

$$dm = \frac{dV}{f} = \frac{pV}{f}$$

and then V can be advanced by

$$V_{i+1} = V_i + \frac{dV}{dm}dm = V_i + f dm$$

where it is now garanteed that V does not change by more than pV.

If there are several equations that needs to be advanced, then the dm is calculated for each of them producing several dm_1,dm_2... The used dm is then the smallest value,

$$dm = \texttt{MIN}\,[dm_1, dm_2, ...]$$

where it has now been assumed that all of dm_1,dm_2... are all positive.