

# Brown/Paris Numerical Analysis: Problem set 8

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## 1 Fundamental concepts of stability

In class today we learned the concepts of stability and that for any consistent discretization stability and convergence are equivalence through the Lax-Ritchmyer equivalence theorem. The assignment today will check verify analysis for the following schemes:

- Forward Euler
- Backward Euler
- Crank-Nicholson

The first task will be to verify the stability analysis for the model problem

$$\dot{y} = \lambda y \tag{1}$$

$$y(0) = y_0 \tag{2}$$

### Tasks:

- First, analyze the schemes to determine the region of stability (i.e. generate a plot in MATLAB showing the region where  $\left| \frac{u^{n+1}}{u^n} \right| < 1$ ).
- Next, use the three methods to solve the ODE

$$\dot{y} = \arctan(3y) - 3y + t$$

$$y(0) = 1$$

For this problem, which methods are stable? How does this line up with your analysis of the stability region?