

Study notes

Math 228B

Numerical Solution of Differential Equations

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1 How to decide which fractional stepping to use?

Given a mixed PDE such as $u_t = Au + Bu$ where A, B are constant matrices.

Let standard stepping be

$$\begin{aligned} u^* &= N_A(u^n, k) \\ u^{n+1} &= N_B(u^*, k) \end{aligned}$$

Where N_A and N_B are numerical schemes to solve the problem $u_t = Au$ and $u_t = Bu$ respectively. k in the above is the time step.

Let Strang splitting be

$$\begin{aligned} u^* &= N_A(u^n, k/2) \\ u^{**} &= N_B(u^*, k) \\ u^{n+1} &= N_A(u^{**}, k/2) \end{aligned}$$

Now, assuming that N_A and N_B are each second order accurate in time. Which of the above two schemes should one select?

Algorithm

```

---- standard stepping
IF A,B commute THEN
    standard stepping is second order in time
ELSE
    standard stepping is first order in time
END IF

---- Strang
IF A,B commute THEN
    strang gives second order accuracy in time
ELSE
    strang also gives second order accuracy in time
END IF

```

Hence, from the above, the conclusion is that

```

IF A,B commute THEN
    select standard stepping (simpler)
ELSE
    select Strang (more accurate)
END IF

```

some notes from the net [HTML](#)