Increasing the rate of convergence to steady-state by using multiple penalties applied in a domain

Hannes Frenander and Jan Nordström

Department of Mathematics

Division of Computational Mathematics, Linköping University

May 23, 2014
Introduction

- We consider a finite difference approximation with summation-by-parts operators and weakly imposed boundary conditions.

- The boundary conditions are imposed with the simultaneous approximation terms (SAT).

- Given a well-posed problem, the numerical approximation is made stable with appropriate choices of penalty terms.
Introduction

- The method has been extended to cover a close-boundary domain,

where the solution is assumed to be known.
Introduction

- The multiple penalty technique adds flexibility to the scheme.
- Stability can easily be guaranteed.
- Straight-forward to implement and generalize to multiple dimensions.
- Puts new demands on the knowledge of the problem: the solution needs to be known in the extended domain.
Results
Results
Results
Results

![Graph showing the norm of error over time for different values of p: p=0, p=0.2, and p=0.4. The x-axis represents time (t) ranging from 0 to 50, and the y-axis represents the norm of error ranging from $10^{-16}$ to $10^0$. The graph demonstrates that as time increases, the norm of error decreases for all values of p, with p=0 showing the steepest decrease.]