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Faculty of Art and Science
Department of Mathematics and Computer Science

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Two Inverse Problems for Parabolic Equations and Two Approaches :
1. Forward Collocation Method
2. Coarse-Fine Grid Method Based on Adjoint Problem Approach

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Abstract

We study two inverse problems for parabolic type partial differential equations. First, we consider the backward parabolic problem related to the convection-diffusion operator $Au := u_t - (D(x)u_x)_x + (cu)_x$ when the diffusion coefficient $D(x)$ may be discontinuous. The forward collocation method (FC-method) is used for numerical solution of this backward transmission problem. According to the method, we approximate the unknown function $\phi(x) = u(x,t_0)$ by the piecewise linear continuous, Lagrange type of basis functions. Moreover, we solve the obtained ill-conditioned system of algebraic equations by using truncated singular value decomposition (TSVD). An efficiency and applicability of the method is demonstrated on various numerical examples.

Second, we give a numerical algorithm for determining the diffusion coefficient $k = k(x)$ in the linear parabolic equation $u_t = (k(x)u_x)_x$ from the measured output data is presented. The main distinguished feature of the proposed algorithm is the use of a fine mesh for the numerical solution of the well-posed forward and backward parabolic problems, and a coarse mesh for the interpolation of unknown coefficient $k = k(x)$. The nodal values of the unknown coefficient on the coarse mesh are recovered sequentially, solving on each step the well-posed forward and the sequence of backward initial value problems. This guarantees a compromise between the accuracy and stability of the solution of the considered inverse problem. An efficiency and applicability of the method is demonstrated on various numerical examples.

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