Departamento de Matemática Aplicada

Instituto de Matemática Interdisciplinar

SEMINARIO DE MATEMÁTICA APLICADA

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Finite element methods for the porous medium equation with variable exponents

In this work, we study and implement the finite element method to the following nonlinear parabolic equation:

$$u_t = div\left(|u|^{\gamma(x,t)}\nabla u\right) + \lambda|u|^{\sigma(x,t)-2}u + f(x,t), \qquad x \in \Omega \subset R^d, t \in]0,T]$$

First we consider the problem in a domain with fixed boundaries. Since the equation may be of degenerate type, we utilize an approximate problem, regularized by introducing a parameter ε. We prove, under certain conditions on γ, σ and f, that the weak solution of the approximate problem converges to the weak solution of the initial problem, when the parameter ε tends to zero. The approximate equation is then discretized with the continuous finite element method in space and with the discontinuous finite element method in time, using piecewise polynomial functions of degree $r \geq 1$ and $s \geq 1$ respectively. The convergence of the discrete solutions for the weak solutions of the approximate problem is also proved. Some numerical results of a MatLab implementation of the method are presented.

Next we consider the problem in a domain with moving boundaries. The boundary's movement is governed by an equation prompted by the Darcy law. The spatial descretization is defined by the continuous finite element method with piecewise polynomial functions of degree $r \geq 1$ using Lagrange interpolating polynomials in área coordinates. The vértices of the triangles move according to a system of differential equations which is added to the equations of the problem. The resulting system of ordinary differential equations, in time variable, is solved using a suitable integrator. We also present some numerical results of a MatLab implementation of this technique.

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