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Maximal operators for the p-Laplacian family

We prove existence and uniqueness of viscosity solutions for the following problem:

$$\max\{-\Delta_{p_1}u(x),\, -\Delta_{p_2}u(x)\} = f(x)$$

in a bounded smooth domain Ω with $u = g$ on $\partial\Omega$. Here $-\Delta_p u = (N+p)^{-1}|Du|^{2-p}\mathrm{div}(|Du|^{p-2}Du)$ is the 1-homogeneous $p-$Laplacian and we assume that $2 \leq p_1, p_2 \leq \infty$. This equation appears naturally when one considers a tug-of-war game in which one of the players (the one who seeks to maximize the payoff) can choose at every step which are the parameters of the game that regulate the probability of playing a usual Tug-of-War game (without noise) or to play at random. Moreover, the operator $\max\{-\Delta_{p_1}u(x),\, -\Delta_{p_2}u(x)\}$ provides a natural analogous with respect to $p-$Laplacians to the Pucci maximal operator for uniformly elliptic operators.

We provide two different proofs of existence and uniqueness for this problem. The first one is based in pure PDE methods (in the framework of viscosity solutions) while the second one is more connected to probability and uses game theory.

Joint work with P. Blanc and J. Pinasco