Elliptic Equations in Anisotropic Media: Matrix Weights, Geometry, and Regularity

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Elliptic equations describe steady heat flow, electrical conduction, and diffusion. In many materials, however, these processes behave differently in different directions. Matrix weights provide a natural way to describe such directional and uneven effects. Starting from the Laplace equation and simple weighted models, I will explain how matrix weights change the geometry and behavior of elliptic equations. I will then discuss basic questions: Do solutions exist? How smooth are they when the medium is rough or highly nonuniform? Examples from anisotropic diffusion and composite materials will motivate the theory. The talk will focus on examples, pictures, and the main ideas rather than technical proofs.