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Exploring Roughness in Stochastic Processes: From Weierstrass Bridges to Volatility Estimation

Motivated by the recent success of rough volatility models, we introduce the notion of a roughness exponent to quantify the roughness of trajectories. It can be computed in a straightforward manner for many stochastic processes and fractal functions and also inspired the introduction of a new class of stochastic processes, the so-called Weierstrass bridges. After taking a look at Weierstrass bridges and their sample path properties, we discuss the relations between the roughness exponent and other roughness measures. We show furthermore that the roughness exponent can be statistically estimated in a model-free manner from direct observations of a trajectory but also from discrete observations of an antiderivative—a situation that corresponds to estimating the roughness of volatility from observations of the realized variance. This is joint work with Xiyue Han and Zhenyuan Zhang.