Remote state estimation: a variational formulation for the data-rate limit (joint work with Alexander Pogromsky and Alexey Matveev)

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In the context of control and estimation under information constraints, restoration entropy measures the minimal required data rate above which the state of a nonlinear system can be estimated so that the estimation quality does not degrade over time and, conversely, can be improved. The remote observer here is assumed to receive its data through a communication channel of finite capacity. In this talk, we present a new characterization of restoration entropy which does not require to compute any temporal limit, i.e., an asymptotic quantity. The new formula is based on the idea of finding a specific Riemannian metric on the state space which allows to read off the decisive quantity that determines the restoration entropy – a certain type of Lyapunov exponent – from the time-one map (for discrete-time systems) or the generating vector field (for continuous-time systems), respectively. Our method for constructing Riemannian metrics adapted to the given nonlinear system exploits the geometry of the symmetric space of positive definite matrices, in particular uses the Riemannian barycenter (also known as Karcher mean) on this space. In the continuous-time case, also the theory of probability measures on spaces of non-positive curvature is used which allows to study the barycenter of a continuum of positive definite matrices.