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Nonlinear inversion and the information barrier

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It is often said that Monte Carlo methods are less efficient than deterministic methods when applied to the solution of inverse problems. This statement is rather imprecise, but its vagueness hides at least two interesting properties of inverse problems. Firstly, the shortest possible computation time needed to solve an inverse problem depends on the information we (or rather: the solution algorithm) has on the problem. The more information we have, the fewer iterations we need. Secondly, the use of prior information plays a special role for nonlinear problems. It is not only a way of stabilizing the solution or a way of making the solution more realistic. It provides critical information to the solution algorithm, potentially making the search for a solution orders of magnitudes faster. We shall give rigorous demonstrations of these facts for certain classes of nonlinear problems, and use the results to describe limitations and prospects of current and future algorithms.