The Lipschitz Matrix for Dimension Reduction

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The curse of dimensionality presents a fundamental challenge when trying to approximate, integrate, or optimize functions with many parameters throughout science and engineering. In this talk, we trace one origin of the curse of dimensionality to the number of epsilon-balls required to cover the domain---a quantity growing exponentially as the dimension increases. To mitigate the curse in this setting, we introduce a function-dependent metric on the input domain. This metric provided by the Lipschitz matrix, a generalization of the scalar Lipschitz constant. By altering the topology of the input domain we can reduce the number of epsilon-balls required to cover domain, mitigating the curse of dimensionality. The Lipschitz matrix has a wide range of additional applications. For example, if a function has a low-rank Lipschitz matrix, then the function is a ridge function—a function that depends on a few linear combination of the input variables. The Lipschitz matrix also provides notions of uncertainty that are far sharper than those of the Lipschitz constant. Finally, the Lipschitz matrix motivates a minimax space-filling design of experiments that yields worst-case optimal results for approximation, integration and optimization.

Using uncertain measurement information in data assimilation and reduced order models

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For many applications, measurement information is available but noisy. Current reduced order modelling approaches might use measurement data for validation purposes, but could more be done with this information when constructing a reduced order model? In data assimilation noisy measurements are used to pull PDE models back towards reality. In this talk I'll provide a broad overview of some of the main data assimilation approaches, including the vital role played by observations. I'll also discuss some of my ideas about how noisy observations could be used in a reduced order model framework.