Liberating the Dimension - Quasi Monte Carlo Methods for High Dimensional Integration

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High dimensional problems are coming to play an ever more important role in applications, including, for example, option pricing problems in mathematical finance, maximum likelihood problems in statistics, and porous flow problems in computational physics and uncertainty quantification. High dimensional problems pose immense challenges for practical computation, because of a nearly inevitable tendency for the cost of computation to increase exponentially with dimension. Effective and efficient methods that do not suffer from this "curse of dimensionality" are in great demand, especially since some practical problems are in fact infinite dimensional.

In this talk I will start with an introduction to "quasi-Monte Carlo methods", focusing on the theory and construction of "lattice rules" (order one) and "interlaced polynomial lattice rules" (higher order) developed in the past decade. Then I will showcase our very latest work on how this modern theory can be "tuned" for a given application. The motivating example will involve an elliptic PDE with a random coefficient, which is based on a simplified porous flow problem where the permeability is modeled as a random field.