Numerical Analysis and Scientific Computing Seminar

Tensor Decomposition meets Reproducing Kernel Hilbert Spaces (RKHS)

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Abstract: Tensor decompositions require that data live on a regular d-way grid, but many real-world datasets do not have this property. For example, time-evolving data may be measured at different intervals for different subjects and adaptive meshes in simulations are irregular by design. We can handle irregular grids by treating some modes as infinite-dimension rather than finite-dimensional; we refer to such tensors as quasi-tensors. For their decompositions, this means that we want the factors in the tensor decomposition to be smooth functions rather than vectors. This basic idea has appeared in myriad forms over the years, often using different terminology and with different applications. I will recall and build on these efforts. The result is a generic framework for incorporating continuous modes into the CP tensor decomposition. We focus on learning the infinite-dimensional modes from a reproducing kernel Hilbert space (RKHS) and present an alternating least squares algorithm that is computationally efficient. Including infinite-dimensional modes (1) enables practitioners to enforce common structural assumptions about data such as smoothness, (2) extends to situations in where the measurement times do not align by utilizing the framework of missing data, and (3) provides a more principled way to interpolate between observed points.

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