Big Data Challenges for Predictive Modeling of Complex Systems
The University of Hong Kong, Pokfulam, Hong Kong
November 26-30, 2018

DEEP LEARNING MEETS FLOW VISUALIZATION

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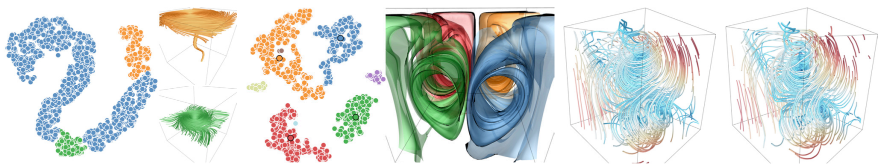

The visualization research community has witnessed a growing interest in applying machine learning techniques to solve previously-thought hard problems. We present two of our recent projects that leverage deep learning for flow visualization: representative streamline and stream surface selection, and streamline-based flow field representation and reduction.

Our first project designs a single deep learning framework for visualizing and exploring both integral flow lines and surfaces. Given a large collection of streamlines or stream surfaces generated from a flow field data set, our approach converts them into low-resolution binary volumes and employs an autoencoder to learn their respective latent feature representations. We then perform dimensionality reduction of these feature descriptors and cluster the projection results accordingly. This leads to a visual interface for exploring the collection of streamlines or stream surfaces via clustering, filtering, and selection of representatives. Intuitive user interactions are provided for visual reasoning of the collection and generation of customized results.

Our second project on flow field representation and reduction can work in the setting of in situ visualization where streamlines are traced from each time step of the simulation and stored in a compressed form. During post hoc analysis, users can afford longer reconstruction time for higher reconstruction quality using decompressed streamlines. The crux lies in a deep learning method for vector field reconstruction that takes the streamlines traced from the original vector fields as input and applies a two-stage process to reconstruct high-quality vector fields. To demonstrate the effectiveness of our approach, we show qualitative and quantitative results with several data sets and compare our method against the de facto method in terms of speed and quality tradeoff.

We conclude by highlighting prominent directions and open problems in the big emerging area of machine learning+scientific visualization research, whose impact spans a diverse range of domains.