

## Course 2:

# Advanced Concepts & Techniques for Visualizing Large, Complex Data

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### Abstract

Supercomputing and advanced image acquisition technologies enable scientists to study natural phenomena at unprecedented precision, resulting in an explosive growth of data. Furthermore, the size of the collected information about the Internet and mobile device users is expected to be even greater, a daunting challenge we must address in order to make sense and maximize utilization of all the available information for critical decision making and knowledge discovery.

Visualization, transforming data into meaningful pictures, is fundamental to the understanding and communication of complex phenomena and relations hidden in multidimensional, multivariate data. To many, visualization is considered a maturing technology and an indispensable tool for exploring and explaining data. However, many of the existing visualization techniques and software toolkits break when applied to large data. As data growth rate will not slow down, innovations in treating large data using visual means are in urgent need.

My lectures will introduce new concepts and strategies for solving the large data visualization problem and development of next-generation visualization technology. I will give seven lectures to present and discuss some of the representative data visualization problems, algorithms, techniques, and results. The seven topics are:

1. Large data visualization: an overview
2. Scalable parallel rendering algorithms  
Introduce parallel rendering and present three parallel volume rendering algorithms
3. Particle data visualization  
Present a filtering interface for visualizing multidimensional particle data and a visual-based strategy for studying particle trajectories.
4. Vector field visualization  
Introduce new ways for visualizing 3D vector fields.
5. Visual analytics techniques for large, complex network data  
Present a fast layout method and a simplification technique for visualizing large networks.
6. Visualization by proxy  
Introduce a new data reduction and visualization strategy that can effectively support remote visualization of large time-varying volume data.
7. In-situ visualization  
Discuss design considerations for realizing in-situ visualization and present a few case studies.

In hands-on sessions, software prototypes will be provided for the attendees to assess some of the designs and techniques introduced in class.