Scientific Visualization

(Selected Topics)

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The amount of data we are dealing with in a modern world requires new analysis methodology. Besides automatic analysis methods, interactive visualization represents a well-established methodology. In this course we will focus on Scientific Visualization, a part of interactive visualization which deals with flow and volume data. Analysis of flow data, mostly from simulation, is unavoidable in modern engineering and science. The volume data comes from CT and MR devices which are standard tools in medicine nowadays. Besides medicine CT devices are also used in industry.

Visualization and visual computing use computer-supported, interactive, visual representations of (abstract) data to amplify cognition. In recent years data complexity and variability has increased considerably. This raises the need for effective visualization techniques. Examples are: visual reformations, sparse and guided interactions, comparative and ensemble visualizations, coordinated multiple views and integrated views, visual summarizations and aggregations, scalable visualizations, visual rankings, and computational steering. The main idea of computational steering is to close the loop from simulation to analysis and visualization. We will show how we developed a system for visual steering of 1D CFD simulations used in automotive industry. Furthermore we will intruduce Hybrid Visual Steering and Hierrchcal Visual Steering – two state of art approches which combine automatic and interactive analysis in order to cope with high system complexity. A few recent instances in these respects are discussed and current research challenges are sketched at the end of the course.

We will also focus on complex data, mostly from engineering examples, which need interactive visual analysis. Examples from interactive visual exploration, analysis, and optimization of injection systems, bearings, and meteorological data will be presented. Many examples originate from our collaboration with domain experts. Students will learn what scientific visualization is and will get an overview about possible applications. Many demonstrations as well as hands-on examples will be provided during the course. Some specific topics that will be covered include:

- Visualization of Medical Data
- Geospatial Data Visualization
- Interactive Visual Analysis of Complex Data: Families of Curves and Families of Surfaces
- Interactive Visual Steering
- Visual Analytics of Movement Data
- Quantitative Visual Analytics

Course Bibliography:

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