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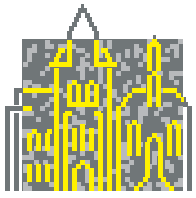
Scientific Visualization: Extracting Information and Knowledge from Scientific Data Sets

Dagstuhl Seminar 03231 – June 01 to June 06, 2003
Dagstuhl-Seminar-Report No. 381



SCHLOSS DAGSTUHL

INTERNATIONALES
BEGEGNUNGS-
UND FORSCHUNGSZENTRUM
FÜR INFORMATIK

ISSN 0940-1121

Herausgegeben von IBFI gem. GmbH, Schloss Dagstuhl, 66687 Wadern, Germany.

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Summary

Scientific Visualization is a research area that is having great impact on how computers are used in research. Scientific Visualization is concerned with techniques that allow scientists and engineers to extract knowledge from the results of simulations and computations. Advances in scientific computation are allowing mathematical models and simulations to become increasingly complex and detailed. This results in a closer approximation to reality thus enhancing the possibility of acquiring new knowledge and understanding. Tremendously large collections of numerical values, which contain a great deal of information, are being produced and collected. The problem is to convey all of this information to the scientist so that effective use can be made of the human creative and analytic capabilities. This requires a method of communication with a high bandwidth and an effective interface. Computer generated images and human vision mediated by the principles of perceptual psychology are the means used in scientific visualization to achieve this communication. The foundation material for the techniques of Scientific Visualization are derived from many areas including, for example, computer graphics, image processing, computer vision, perceptual psychology, applied mathematics, computer aided design, signal processing and numerical analysis.

The methods of visualizing data developed by Scientific Visualization researchers presented at this seminar are having broad impact on the way other scientists, engineers and practitioners are processing and understanding their data from sensors, simulations and mathematics models.

This particular seminar focused on the topic of Segmentation. Segmentation is a key issue in extracting information and knowledge from scientific data sets. The problems of developing techniques for segmentation are extremely difficult but the benefits to the fields of engineering and medicine are tremendous.

Scientific Highlights

The topic of this seminar is Scientific Visualization. This type of research has impact on how other researchers and practitioners process data obtained by collection, simulation or modeling. This area of research is approximately a dozen years old. From the very beginning of Scientific Visualization, it has been recognized that segmentation is a key issue in extracting information and knowledge from scientific data sets. The problems of developing techniques for segmentation are extremely difficult but the benefits are tremendous. Intelligent segmentation involves the qualitative understanding of scientific data and the support for qualitative enquiries about particular features or attributes. The creation of systems that identify and segment features and attributes and produce useful resulting scientific images will remain a dream until we have widely applicable automation tools for specifying, detecting, and extracting knowledge from scientific data sets. Specific areas of active current research covered during the presentations include:

- Feature and knowledge property preservation through implicit, wavelet and other methods for building hierarchical, multiresolution models.

- The description of meta features and attributes such as patterns of vortex cores found in certain characteristic complex flows for vector fields.
- Segmentation approaches to the automatic determination of transfer functions of several dimensions.
- Segmentation, feature extraction and region of interest determination with multi-dimensional curvature schemes applied through watershed techniques.
- Statistical and probability based segmentation and feature extraction techniques.
- Complex geometry representation, Morse theory and other approaches to the inference, determination and preservation of genus and other topological attributes inferred from sampled data.

Training:

A relative large number of the presentations, namely 15 out of 47 were given by young researchers. Overall there was a very good distribution of researchers from all levels of development in their careers and from various types of research environments and geographical locations. Each presentation was followed by a formal question and answer period which flowed into the breaks and evening discussions. This is a very enthusiastic community of researchers and most all participants attended most all presentations. During the breaks and evenings one would often see young PhD students having involved discussions with senior researches.

European Added Value:

There were 61 participants: 23 from Germany, 23 from USA (4 of which are of German origin) , 3 from The Netherlands, 3 from Austria, 2 from France, 2 from Japan, 2 from Great Britain, 1 from Italy, 1 from China and 1 from Russia. These participants represent some of the very best researchers in Scientific Visualization and the Dagstuhl seminar on Scientific Visualization has become an almost mandatory event for the leading experts in the field from all over the world. The position of European researchers in the field of Scientific Visualization is already considered to be particularly strong and the Dagstuhl seminar is one of the reasons for the high visibility of European research besides participation in international conferences.

Additional Information:

Some selected papers based upon the presentation at the seminar will be published in collected volume. These papers will undergo a rigorous and complete reviewing and refereeing process.

Participants

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