Visualizing and Examining Large Scientific Datasets: A Focus on the Physical and Natural Sciences

Organizer
THERESA-MARIE RHYNE
Martin Marietta/
U.S. EPA Scientific Visualization Center

Lecturers
BILL HIBBARD
University of Wisconsin at Madison

KEVIN HUSSEY
Jet Propulsion Laboratory

LLOYD TREINISH
IBM T.J. Watson Research Center

Course 28 NOTES

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ACM Siggraph95 Course #28

Visualizing and Examining Large Scientific Data Sets:

A Focus on the Physical and Natural Sciences

Course Chair:

Theresa Marie Rhyne
Lockheed Martin Services Group
U.S. EPA Scientific Visualization Center

Instructors:

Bill Hibbard
University of Wisconsin at Madison

Lloyd Treinish
IBM T.J. Watson Research Center

Kevin Hussey
NASA/Jet Propulsion Laboratory

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Abstract: The use of visualization tools and interactive techniques for the examination and interpretation of large scientific data sets are discussed in this course. Highly illustrative atmospheric, oceanographic and geographic examples are demonstrated in real time. The process of developing effective visualization paradigms for supporting high speed networking, database management, heterogenous computing platforms, user interface design, collaborative computing, science education and the application of animation techniques are highlighted.

Introduction

The visual presentation and examination of large amounts of physical and natural sciences data often requires the merging of image processing methods with computer-generated color displays. Frequently there is a need for the integration of other computational technologies with visualization methods. These include:

a) the integration of terabyte or gigabyte distributed physical and natural sciences databases with visualization systems;

b) the display and interpretation of data using cartography, statistical analyses, Computer Aided Design (CAD) and Geographic Information Systems (GIS) techniques in conjunction with visualization systems;

c) the design of visualization tools, user interfaces, and animations which support the specific needs of scientists, policy analysts, regulators, educators and the general public;

d) the development of collaborative computing tools which allow the integration of multi-disciplinary data (e.g. atmospheric, oceanographic, and geographic) into visualization systems to foster cross-disciplinary exploration and communications.

This full day course explores these issues with illustrative examples of visualization software and animations designed to support the examination of large scientific data sets. Each of the instructors has prepared a visualization demonstration based on their own customized software tools which will (hopefully) be executed (in real time) on a workstation during the course.

We have divided these course notes into four sections and have included the demonstration discussions (case studies) at the end. During the delivery of the course, each section presented will be followed by a case study demonstration. To clarify this matter, we have included both a Table of Contents for the Course Notes and an Outline of the Presentation of the Course.

We hope that you enjoy attending this course and that these notes are insightful to you. Each of us learned a great deal and expanded our own horizons in collaborating together on this course.

Theresa Marie Rhyne

Bill Hibbard

Lloyd Treinish

Kevin Hussey

Table of Contents for the Course (#28) Notes

ACM Siggraph Course #28: Visualizing and Examining Large Scientific Datasets: A Focus on the Natural and Physical Sciences
Course Outline
(August 7, 1995)

Introduction/ Course Organization Remarks: Rhyne - 5 minutes

Topic #1: Classifying and Modeling Data in the Physical and Natural Sciences
(Bill Hibbard - 45 minutes)

Case Study for Topic 1: (30 minutes)
Visualizing Photochemical Model Data- Rhyne

Morning Break

Topic #2: Solutions and Techniques for Data Management, Visual Display and Examination of Large Scientific Data Sets
(Lloyd Treinish - 45 minutes)

Case Study for Topic 2: (30 minutes)
Exploring & Probing Large Scientific Datasets - Hussey

Lunch

Topic #3: Renaissance Teams, Collaborative Computing, and Decision Support for Multi-Variable Data (Theresa Rhyne - 45 minutes)

Case Study for Topic 3: (30 minutes)
Global Ozone and Atmospheric Dynamics - Treinish

Afternoon Break

Topic #4: Animations for Researchers, Decision Makers and the General Public which Maintain Data Validity
(Kevin Hussey - 45 minutes)

Case Study for Topic 4: (30 minutes)
Interactively Visualizing & Examining Computations- Hibbard

Wrap-Up Discussion: (All Instructors) (10 minutes)

Speakers' Biographical Information:

Bill Hibbard: University of Wisconsin at Madison
Researcher
Space Science and Engineering Center
University of Wisconsin-Madison
postal address: SSEC, 1225 W. Dayton St., Madison, WI 53706
phone: 608-263-4427
fax: 608-263-6738
email: whibbard@macc.wisc.edu

Bill Hibbard is the principal author of the 4-D McIDAS system, VIS-5D and VIS-AD. The 4-D McIDAS system, begun in 1984, is an early effort to apply three-dimensional animated graphics to earth science data. The VIS-5D system, available by anonymous ftp, extended this in 1988 to interactive 3-D animations of numerical weather simulations, using high-performance graphics workstations. The VIS-AD system provides interactive visualization of scientific algorithms, through a technique for deriving graphical depictions for algorithm data types. The VIS-5D and VIS-AD systems have been adapted to run in distributed computing environments.

Kevin J. Hussey: Jet Propulsion Laboratory
Technical Group Supervisor
Visualization & Earth Science Applications Group
postal address: 4800 Oak Grove Dr.
Mail Stop 168/522
Pasadena, California 91109
phone: (818) 354-4016
fax: (818) 393-6962
email: Kevin_Hussey@iplmail.jpl.nasa.gov

Kevin J. Hussey is currently the Technical Group Supervisor of the Visualization and Earth Science Applications group within the Image Processing Applications and Development Section at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California. He joined the Jet Propulsion Laboratory in 1979, working in the Earth Resources Applications group as an analyst of LANDSAT imagery and geographic information systems. He has performed research in the areas of monitoring regional population exposure to airborne contaminants, global climatology mapping and animation, three dimensional terrain rendering and a number of other environmentally related applications. Since 1984 he has been primarily involved in the visualization of scientific data utilizing image processing technology and has produced several innovative animations to illustrate new approaches to data analysis.

Lloyd Treinish: IBM T.J. Watson Labs
Researcher
International Business Machines Corporation
Thomas J. Watson Research Center
postal address: P. O. Box 704, Yorktown Heights, NY 10598
phone: 914-784-5038
fax: 914-784-5077
email: lloydt@watson.ibm.com

Lloyd A. Treinish is a research staff member in the Visualization Systems Group of the Computer Science Department at IBM's Thomas J. Watson Research Center in Yorktown Heights, NY. He works on techniques, architectures and applications of data visualization for a wide variety of scientific disciplines within this group, that developed the IBM POWER Visualization System and the IBM Visualization Data Explorer. His research interests range from computer graphics, data storage structures, data representation methodologies, data base management, computer user interfaces, and data analysis algorithms to middle atmosphere electrodynamics, planetary astronomy and climatology. Particularly, Mr. Treinish is interested in generic or discipline-independent techniques for the storage, manipulation, analysis and display of data, and has, for example, applied these ideas to the study of global atmospheric dynamics and ozone depletion.

Theresa Marie Rhyne: Lockheed Martin/ U.S. EPA Visualization Center
Lead Scientific Visualization Researcher
Lockheed Martin Technical Services
U.S. EPA Scientific Visualization Center
postal address: U.S. EPA Mail Drop 24,
79 Alexander Drive
Research Triangle Park, North Carolina 27709
phone: 919 - 541 - 0207
fax: 919 - 541 - 3967
email: trhyne@vislab.epa.gov

Theresa Marie Rhyne is currently a Lead Scientific Visualization Researcher for the U.S. EPA's High Performance Computing and Communications Initiatives and employed by Lockheed Martin Technical Services at the U.S. EPA Scientific Visualization Center. From 1990 - 1992, she was the technical leader of the U.S. EPA Scientific Visualization Center and was responsible for building the Center since its founding in 1990. Her research interests include visualization toolkit development, collaborative computing in a networked environment and the integration of geographic information systems with scientific visualization methods. She is also a practicing fine artist and art educator in computer graphics.