ACM Siggraph96 Course #16

Visualizing Scientific Data and Information:

Focusing on the Physical and Natural Sciences

Course Organizer:

Theresa Marie Rhyne
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U.S. EPA Scientific Visualization Center

Instructors:

Mike Botts
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Bill Hibbard
University of Wisconsin at Madison

Lloyd Treinish
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Abstract: This course focuses on the application of visualization tools and interactive techniques for the examination and interpretation of scientific data sets. 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 implementation of animation techniques are highlighted. The convergence of visualization methods with the World Wide Web and the relationship between animation techniques and scientific information exploration are also discussed.

Introduction

The visual presentation and examination of physical and natural sciences data often require merging image processing methods with computer-generated color displays. Networking and World Wide Web tools also assist in this information exploration. 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 scientific databases and digital libariaries with visualization systems ;

b) the display and interpretation of data and information using statistical analyses, cartography, 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 and information (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 scientific data and information. 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

Mike Botts

Table of Contents for the Course (#16) Notes

ACM Siggraph Course #16: Visualizing Scientific Data and Information:
Focusing on the Physical and Natural Sciences
Course Outline -- (August 5, 1996)

Introduction/Course Organization Remarks: Rhyne - 5 minutes

Topic #1: Classifying and Modeling Scientific Data
(Bill Hibbard - 45 minutes)

Case Study/Hands-on Demo for Topic 1: (30 minutes)
Photochemical Modeling (Air Pollution) - Rhyne
(AVS & WWW demonstrations for examining air pollution control, policy analysis and decision making.)

Morning Break

Topic #2: Techniques for Examining Multiple Data Sets and
Solutions for Data Management
(Lloyd Treinish - 45 minutes)

Case Study/Hands-on Demo for Topic 2: (30 minutes)
The InterUse Experiment: an interactive tool for Geolocation and Visually comparing data - Botts

Lunch

Topic #3: Collaborative Computing and Integrated Decision Support
Tools for Scientific Visualization
(Theresa Rhyne - 45 minutes)

Case Study/Hands-on Demo for Topic 3: (30 minutes)
Correlative Visualization Techniques for Disparat Data - Treinish
(IBM Data Explorer based demonstration for looking at ozone depletion and its relationship to other characteristics of the earth's atmosphere.)

Afternoon Break

Topic #4: Maintaining Interactivity in Visualizing Large Data Sets
(Mike Botts - 45 minutes)

Case Study/Hands-on Demo for Topic 4: (30 minutes)
Interactively Visualizing and Steering Computations - Hibbard
(Vis5D and/or VisAD demonstration for examining atmospheric and oceanographic models and data sets.)

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

Speakers' Biographical Information:

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Mike Botts is a Senior Research Scientist in the Earth System Science Laboratory at the University of Alabama in Huntsville. In 1992, he served on temporary assignment, at NASA Headquarters, to evaluate the state of scientific visualization for NASA's EOS Mission. Botts' report, entitled "The State of Scientific Visualization with Regard to the NASA EOS Mission to Planet Earth", established many of the guidelines for visualization requirements for NASA EOS. He is presently Principal Investigator on an EOS/Pathfinder grant (The Interuse Experiment) and is responsible for directing the interuse activities of three teams of developers at the University of Alabama in Huntsville and NASA/JPL. Botts' is also Co-Investigator on a grant to extend the JPL LinkWinds visualization package to meet the demands of EOS, particularly with regard to geolocation of data and comparative analysis of disparate data.

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Bill Hibbard is a Scientist at the Space Science and Engineering Center of the University of Wisconsin at Madison. He is the principal author of the 4-D McIDAS system, Vis5D and VisAD. The 4-D McIDAS system, begun in 1984, is an early effort to apply three-dimensional animated graphics to earth science data. The Vis5D system, available by anonymous ftp, extended this in 1988 to interactive 3-D animations of numerical weather simulations, using high-performance graphics workstations. The VisAD system provides interactive visualization of scientific algorithms, through a technique for deriving graphical depictions for algorithm data types. The Vis5D and VisAD systems have been adapted to run in distributed computing environments.

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Lloyd A. Treinish is a research staff member in the Data Explorer group at the IBM Thomas J. Watson Research Center in Yorktown Heights, NY. He works on techniques, architectures and applications of data visualization and methods of data management for a wide variety of scientific disciplines with a particular focus on earth, environmental and space sciences. 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. In particular, he 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.

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Theresa Marie Rhyne is currently a Lead Scientific Visualization Researcher and is responsible for the Research and Development activities at the U.S. EPA Scientific Visualization Center. She is employed by Lockheed Martin Technical Services. 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. Rhyne authored the "Portrait of a Computer Artist" discussion which appears in the 1991 edition of the ACM/SIGGRAPH Computer Graphics Career Handbook.