Information Visualization Learning Modules

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Overview

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- Discussion & Future Work

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The Need for Learning Modules: Information Visualization Research and Education

Information Visualization (IV) combines aspects of scientific visualization, human-computer interaction, data mining, imaging, and graphics techniques, etc. to transform data that is not inherently spatial (e.g., document collections, network traffic logs, customer behavior, etc.) into a visual form.

Well designed visualizations reduce visual search time, improve understanding of complex data sets, reveal relations otherwise not noticed, enable data sets to be seen from several perspectives simultaneously, facilitate hypothesis formulation, and are effective sources of communication.

There exist a number of excellent textbooks that can be used to teach IV. Several come with accompanying web sites containing screen-sized snapshots of user interfaces as well as animations and movies. However, there exists no toolkit or learning resource that facilitates the exploration, application, evaluation, and comparison of algorithms.

The Need for Learning Modules: Desirable Teaching Style

Since Spring 2001, Börner has been teaching the L579 Information Visualization course at the School of Library and Information Science at Indiana University. The course comprises lecture and lab sections as well as project work.

Lectures equip students with working knowledge about visual perception principles, theoretical approaches to IV design, a variety of existing data mining and visualization techniques, algorithms, and systems.

During lab, students run, discuss, and evaluate different information visualizations and gain hands-on experience with diverse IV algorithms.

In project work, they constructively apply their knowledge to design novel IVs and develop skills in critiquing and evaluating visualization techniques.
The InfoVis Toolkit

This website provides access to different software packages easing the exploration, modification, comparison, and extension of data mining and information visualization algorithms. Diverse software packages were bundled into learning modules. Links to diverse databases, compute resources, and references are provided as well. It is our hope that the community will adopt this resource to foster Information Visualization education and research. This site is in work in progress. A very first version was released at IEEE InfoVis in October 2003.

Acknowledgements

The Information Visualization Software Repository was created in 2002 and has since then been used to teach the Information Visualization class at Indiana University. Kyri Elefter, Yuezhang Zhou, and Jason Baumpartner implemented the very first algorithms. In Summer 2003, Jason Baumpartner, Nihar Sheeth, and Nathan J. Deckard lead a project to design a JNLP toolkit that enables the serialization and parallelization of commonly used data analysis and visualization algorithms. Contributions of software packages and implementation work are acknowledged on the respective software pages.

Support comes from the School of Library and Information Science, Indiana University’s High Performance Network Applications Program, an Academic Equipment Grant by SUN Microsystems, SRC (formerly America) Fellow Grant, and the National Science Foundation under DUE-0333629 and IIS-0230281.
InfoVis Toolkit

The Team

Master Minds/Programmers
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Bruce William Herr, CS
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Algorithm Development and Integration
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Sidharth Thakur, CS
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Todd Holloway, CS

Graphic Design
Caroline Courtney, Fine Art

Project Start
2001

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InfoVis Toolkit

Software

- XML Toolkit
- Preprocessing
- Data Mining
- Layout Algorithms

- Social Visualizations
- Interaction Algorithms
- Other Resources

This page provides pointers to commonly used data analysis and visualization algorithms. An XML Toolkit was implement to facilitate the efficient visualization of diverse data sets as well as easy comparison of visualizations generated by different algorithms. The toolkit provides a unified architecture in which algorithms can be easily incorporated. Many software packages are available in Java and hence can be run on any platform that supports Java 1.4.

Most software packages come with:
- Algorithm Description
- Pros & Cons
- Sample Applications
- Implementation Details
- Usage Hints
- References
- Acknowledgements

Web Site: http://iv.slis.indiana.edu/sw

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Preprocessing

- Parse & Correct
- Stop Word Removal
- Porter Stemming Algorithm
- NICE stemmer

Data Mining

Vector Space Model
Developed by Gerard Salton
Soon to be in the NL Toolkit

Latent Semantic Analysis
Developed by Tom Landauer and Susan Dumais
Code in NL Toolkit
Original code by Michael Berry

Topic Model
Developed by Tom Griffith & Mark Steyvers
Soon to be available via the NL Toolkit

Burst Detection
Developed by Jon Henberg
Soon to be available via NL Toolkit

Pathfinder Network Scaling
Developed by Roger Schreiber
KNOP Tools for Pathfinder Network Analysis are available via treedefluc.com
Multidimensional Scaling
Developed by Roger N. Shepard
Fast nonlinear MDS algorithm by Matthew Chalmers and Alistair McGregor will soon be available in the OML Toolkit

Self Organizing Maps
Developed by Terje Kvalheim
Original code from the VERSCOM research group

Clustering: Ward's Algorithm
Developed by Ward
Code in OML Toolkit

Clustering: Betweenness Centrality
Developed by Urli Baudot
Code in OML Toolkit

Layout Algorithms

Parallel Coordinates
Developed by A. Inselberg
Soon to be available via OML Toolkit

SinVis
Developed by Yuezhe Zhou
Code in OML Toolkit

Spring Embedding Algorithm
Developed by Eades
Code in OML Toolkit
Interaction Algorithms

Hierarchical Clustering Explorer
Developed by Jinwook Seo and Ben Shneiderman
Original code available via HCIL@UMD

Fish-eye Menus
Developed by Ben Bederson
Original code available via HCIL@UMD

Piccolo
Developed by Jesse Grossman and Ben Bederson
Original code available via HCIL@UMD
InfoVis Toolkit Architecture

ANALYSIS ALGORITHMS
generate models from parsing other data structures and/or processing on the data

LAYOUT ALGORITHMS
run graphical processes on the appropriate model

DATA MODEL PERSISTENCE
factory to persist a model to a particular data store (i.e. XML format, database)

STANDARD MODEL INTERFACES
based on Java 2 Swing standard models

CODE INTEGRATION
new algorithms can be easily integrated by supporting one or more of the models

- Framework can run different data analysis and IV algorithms on a standard set of input data formats (tree, matrix, network, table, list).
- Models from the algorithms can be serialized through the persistence layer; and it is generic enough for plugging in various persistence options (XML, SQL database, etc).
- Based on Model-View-Controller (MVC) by focusing on standard data model interfaces for data exchange.
Demo InfoVis Toolkit

InfoVis Learning Modules

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Acknowledgements

The Information Visualization Software Repository was created in 2002 and has since then been used to teach the Information Visualization class at Indiana University. Hady Ramezani, Yuancheng Zhou, and Jason Baumpartner implemented the very first algorithms. In Summer 2003, Jason Baumpartner, Nilan Sheh, and Nathan J. Decker led a project to design a JML toolkit that enables the serialization and parallelization of commonly used data analysis and visualization algorithms. Contributions of software packages and implementation work are acknowledged on the respective software pages. Support comes from the School of Library and Information Science, Indiana University’s High Performance Network Applications Program, an Academic Equipment Grant by IBM Microsystems, SBC (formerly Ameritech) Fellow Grant, and the National Science Foundation under DUE-0339623 and IIS-0238281.
InfoVis Learning Modules: Design

Learning Modules

Modern information visualizations are highly interactive. While a number of excellent textbooks exist, the two-dimensional printouts on paper often cannot convey their true visual appearance and interactive performance. Several textbooks come with accompanying web sites that contain snapshots of their interfaces as well as animations and movies. However, none of these facilitates the exploration, application, evaluation, and comparison of algorithms.

This web page will provide access to a number of learning modules. Each learning module comes with an:

- Description of the data analysis and visualization tool
- Usage hints on how to run and use a particular algorithm or tool
- Learning task - a challenging scenario to use an algorithm or to analyze and/or visualize a data set
- Discussion of the results, and
- References to research papers, online demos, (commercial) applications
- Acknowledgements

http://iv.slis.indiana.edu/lm/lm-trees.html

Visualizing Tree Data

A tree graph is a set of straight tree segments (edges) connected at their ends containing no intersections (cycles). You can also call it a simple, undirected, connected, acyclic graph (or, equivalently, a connected forest). A tree with n nodes has n - 1 graph edges. All trees are bipartite graphs.

Many trees have a root node and are called rooted trees. There will be at most one root node in a rooted tree. Subsequently, we will only consider rooted trees. In rooted trees, all nodes except the root node have only one parent node. Nodes which have no children are called leaf nodes. All other nodes are referred to as intermediate nodes.

http://iv.slis.indiana.edu/lm/lm-trees.html
Student's Project Results

Visualizing and Evaluation of Tree Data Layouts

- Visualizing the structure of IU’s Decision Support System
- Visualizing the co-occurrences of keywords in DLib Magazine articles.
- Visualization of the Java API
- Visualizing the Library of Congress Classification System to retrieve legal materials in a library.

See Handin pages at http://ella.slis.indiana.edu/~katy/handin/1579-S04/cgi/handinlogin.cgi

Image by Peter Hook and Rongke Gao

Validation:
Teaching InfoVis using the Learning Modules

Time Series Analysis & Visualization

http://iv.slis.indiana.edu/lm/lm-time-series.html

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Student's Project Results

**Time Series Analysis & Visualization**

- Using Timesearcher and the Burst Detection Algorithm to Analyze the Stock Market from 1925 to 1945
- Applying Burst and TimeSearcher to Chat Data
- Lab Access Trends
- Quest Atlantis Chat Log Data

See Handin pages at
http://ella.slis.indiana.edu/~katy/handin/L579-S04/cgi/handinlogin.cgi

**Visualizing the Work of the United States Supreme Court Based on Time Data and Top Level West Topics**

*by Peter A. Hook & Rongke Gao*

Top fifteen most occurring topics from 1944 to 2004 in Timesearcher

All topics by West Category and Sub-Category grouped over the entire lengths of the data set

All topics by West Category and Sub-Category grouped corresponding to the five chief justices
Visualizing Niches of the Blog Universe

BY Mike Tyworth and Elijah Wright

Discussion

The Learning Modules are currently used in training students to master large scale data mining, modeling and visualization projects

L597 Structural Data Mining and Modeling
   Fall 2004  (http://ella.slis.indiana.edu/~katy/L597)

L579 Information Visualization
   Spring 2004 and 2005  (http://ella.slis.indiana.edu/~katy/L579)

Since Fall 2003, the IVR was downloaded from about 50 institutions, organizations and companies in US, 14 institutions in Europe and 16 unidentifiable units.

Please consider using them in your classes!
Future Work

This summer, six data modeling, several data analysis and some new visualization algorithms will be integrated into the InfoVis Toolkit.

Implement programmer-friendly Java API that allows researchers to pipeline data between analysis algorithms and visualization tools within and outside the IVR.

Learning Modules will be updated and expanded.

There will be Tutorials on the InfoVis CyberInfrastructure and associated Learning Modules at the

- IEEE Visualization 2004 (Vis04) conference in Austin, Texas.

Acknowledgements

The Information Visualization Software Repository was created in 2000 and has since been used to teach the Information Visualization class at Indiana University. Katy Borer, Yuezheng Zhou, and Jason Baumgartner implemented the very first algorithms. In Summer 2003, Jason Baumgartner, Nihar Sheth, and Nathanael J. Deckard lead a project to design a XML toolkit that enables the serialization and parallelization of commonly used data analysis and visualization algorithms. Contributions of software packages and implementation work are acknowledged on the respective software pages.

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