Visual Analytics Education

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ABSTRACT
Visual Analytics is a newly evolving field that spans across several more established disciplines. This panel will discuss how VA system developers and researchers are best educated at the MS and PhD levels. This paper describes several ways in which VA can be characterized – with the goal of using these characterizations to identify knowledge domains that can be used to define VA curricula. Also, a digital library of VA educational resources is described.

CR Categories and Subject Descriptors: H.5 Information Interfaces and Presentation; K.3.2 [Computers and Education]: Computer and Information Science Education.

Keywords: Visual Analytics Education, Visual Analytics Curricula

1 INTRODUCTION
The purpose of this panel is to begin a community dialogue on graduate education in the emerging and broadly interdisciplinary field of Visual Analytics (VA). Where does VA fit into the broader set of academic disciplines on which it draws? What is at its intellectual core? How should MS and PhD students be educated to become productive VA developers and researchers?

We begin with an overview of several ways one might conceptualize the body of knowledge that is Visual Analytics, drawing on Illuminating the Path [1] and an initial taxonomy developed by the UNC-C and GT Regional Visual Analytics Center.

Next, we pose some of the questions that the panel is expected to address. But, we note that as with any fledgling discipline, the answers to these questions will be, at best, tentative. Only time and experience and experimentation will provide us with some confidence as to the adequacy of these tentative answers.

Finally, we describe the Visual Analytics Digital Library, being developed by the Southeastern RVAC, designed to help educators teach and students learn Visual Analytics.

2 WAYS OF THINKING ABOUT VISUAL ANALYTICS

2.1 Illuminating the Path
Perhaps the most straightforward way to think about the intellectual content of VA is by using the structure developed in Illuminating the Path [1], a report representing the thinking of a group of nearly 30 researchers. Figure 1, adapted from [1], depicts the four major report chapters as four quadrants. I have added the “?” to “Core” to reflect one question our panel will address: Is there a set of core VA knowledge, and if so, what is it?

2.2 A Starting Taxonomy of Visual Analytics
Education is one emphasis of the Southeastern RVAC at UNC-Charlotte and Georgia Tech. In the process of developing our VA Digital Library (Section 4), we developed a VA taxonomy in a two-step process. The first step used the research agenda of Illuminating the Path as a starting point, restructuring some of the material to take more of a pedagogical approach. This ultimately led to the seven top-level categories in the taxonomy (Figure 2).

At the same time, we developed a list of about 300 keywords drawn from Illuminating the Path and from a VAST Symposium keyword list developed by the program committee. We went through a card-sorting exercise to cluster those keywords into meaningful chunks that became the second-level and third-level categories in the taxonomy.

1 Overview/Courses
   Introductory/General
   Uses of Visual Analytics
   Courses
2 Analytical Reasoning & Processes
   Introduction/General
   Models of Analytical Reasoning Processes
   Decision Sciences
   Uncertainty management
   Collaborative reasoning
3 Cognition, Perception & Social Processes
   Introductory/General
   Knowledge Representation & Ontologies
   Perception
Social Processes
Introductory/General
Data Representations
Databases
Data Transformations
Knowledge Discovery, Representation & Management
Introductory/General
Fundamentals
Specific Types of Data/Application Systems
Test & Sample Databases
5 Visualizing Data, Information & Knowledge
Introductory/General
Design Principles
Methods & Techniques
Interacting with Visual Representations
Introductory/General
Taxonomies of Interaction Techniques
Uses & Methods of Interaction
Visualization Types
Introductory/General
Taxonomies of Types of Visualizations
Geospatial (Mapping)
Graphs & Networks
Sequenced & Time Series Data
Statistical (Multidimensional) Data
Visualization Domains
Introductory/General
Text & Documents
Financial Data
Networks
Reasoning, Argumentation & Knowledge
Automatic & Semi-automatic Generation of Visualizations

6 Production, Presentation & Dissemination
Introductory/General
Data/evidence collection
Analytical sandbox
Developing a story within audience context
Production technologies & management
Dissemination contexts & dynamics

7 Human Concerns in Use of Technology for Visual Analytics
Introductory/General
Integration within analytic work methods
Collaboration
Evaluation of Effectiveness
Privacy, Security & Legal Issues

8 Software & Hardware for Visual Analytics Systems
Introductory/General
Architectures & Systems
Interaction Devices
Display Technologies

Figure 2. A Visual Analytics Taxonomy

2.3 Leveraging HCI
A common Mantra in Human-Computer Interaction is “People perform Tasks using Computers.” The pedagogical implication is that HCI developers and researchers need to know about people, the tasks the people perform, and the computer technologies used to provide a User Interface through which users can perform their tasks. Visual Analytics, to my mind, is a specialized HCI domain, implying that the same Mantra might be applied here. This would lead to a structure along the lines of Figure 3.

Task
Analytical Processes
Applications of Visual Analytics
People

Cognition, Perception
Knowledge Representation & Ontologies
Social Processes
Human Concerns in the use of Technology for Visual Analytics
Computers
Data and Knowledge
Visualizing Data, Information and Knowledge
Software & Hardware for Visual Analytics Systems

Figure 3. Structure of Visual Analytics based on an HCI-oriented decomposition

3 Typical Questions the Panel Will Address
- Why is/is not VA a field ready for its own MS degree, distinct from a “standard” degree in one of its supporting disciplines, such as computing, HCI, or geography?
- Can a VA M.S. student gain appropriate preparation by appropriate specialization in one of these or some other discipline?
- Is there a core of knowledge that every VA M.S. students should know? Ph.D. student?
- What courses might a VA minor or certificate or specialization at the MS or PhD level include?
- Defining the intellectual content of VA is hard because it draws on so many disciplines. What are some simple criteria to help decide what topics should be explicitly considered as part of a VA curriculum, as opposed to being pre-requisite to VA studies?

4 VA Digital Library
The Southeastern RVAC has started a Digital Library of educational material to help teachers develop courses that are relevant to VA, and to help students learn about VA. The library can be accessed at vdl.cc.gatech.edu. It is patterned after, and uses the same software infrastructure, as the Human-Centered Computing Education Digital Library at hcc.cc.gatech.edu. The library contains course syllabi, videos, PowerPoint lectures, lectures created with Microsoft Producer [2], exams, assignments and some reference material.

Content is organized according to the taxonomy of Section 2.3; a content item can be placed under several categories in the taxonomy. The user can browse through the taxonomy to get the “big picture” of what types of information are present, or can use a standard text content search to obtain a ranked (by relevance) list of items, Google-style. Submissions to the library are encouraged, the home page links to an easy-to-use submission interface. Submissions are encouraged!

5 Panel Participants
Jim Foley is a professor in the College of Computing at Georgia Tech, and holds the Fleming Chair in Telecommunications. While on Georgia Tech leave from 1996-99, he was CEO and Chairman of MERL – Mitsubishi Electric Research Labs where he was responsible for corporate R&D in North America. He joined Georgia Tech in 1991 as the founding director of the Graphics, Visualization and Usability Center in the College of Computing. Foley is co-author of three computer graphics texts and is a Fellow of AAAS, ACM and IEEE. He received SIGGRAPH's biannual Steven Coons award for contributions to computer graphics, and is one of seven inaugural members of the SIGCHI Academy for contributions to Computer-Human Interaction. He was chairman (2001-2005) of the Computing Research Association.
David Ebert is a Professor in the School of Electrical and Computer Engineering at Purdue University and directs the Purdue University Regional Visualization and Analytics Center. His research interests include volume rendering, information visualization, perceptually based visualization, illustrative visualization, and procedural abstraction of complex, massive data. Ebert has been very active in the visualization community, teaching courses, presenting papers, co-chairing many conference program committees, serving on the ACM SIGGRAPH Executive Committee, serving as Editor in Chief of IEEE Transactions on Visualization and Computer Graphics, and serving on the National Visualization and Analytics Center's National Research Agenda Panel.

Stuart Card is a Senior Research Fellow and the manager of the User Interface Research group at the Palo Alto Research Center. His study of input devices led to the Fitts's Law characterization of the mouse and was a major factor leading to the mouse's commercial introduction by Xerox. His group has developed theoretical characterizations of human-machine interaction, including the Model Human Processor, the GOMS theory of user interaction, information foraging theory, and statistical descriptions of Internet use. These theories have been put to use in new paradigms of human-machine interaction including the Rooms workspace manager, papertronic systems, and the Information Visualizer. Card is co-author of The Psychology of Human-Computer Interaction, co-editor of Human Performance Models for Computer-Aided Engineering and of Readings in Information Visualization. He has served on many editorial boards, government panels, and university review boards. He has been an adjunct faculty member at Stanford University. He is currently developing a supporting science of human-information interaction and visual-semantic prototypes to aid sensemaking. Card is a Fellow of the ACM, the first recipient of the ACM CHI Lifetime Achievement Award, and the first member of the ACM CHI Academy.

Alan MacEachren is 2004-2007 E. Willard and Ruby S. Miller Professor of Geography and Director of the GeoVISTA Center at Pennsylvania State University. He also directs the new North-East Regional Visualization & Analytics Center. MacEachren’s research foci include geovisualization, geocollaboration, interfaces to geospatial information technologies, human spatial cognition as it relates to use of those technologies, human-centered systems and user-centered design. He served as chair of the International Cartographic Association Commission on Visualization and Virtual Environments (1999-2005) and was named honorary fellow of that organization in 2005. He has been a member of the National Research Council Computer Science and Telecommunications Board Committee on the Interfaces Between Geospatial Information and Information Technology (2001-2002) and of the National Visualization and Analytics Center R&D Agenda panel (2004-2005). MacEachren is author of How Maps Work: Representation, Visualization and Design, and Some Truth with Maps, and is co-editor of several additional books (including Exploring Geovisualization) and journal special issues (including a recent issue of IEEE Computer Graphics and Applications on Geovisualization, and a forthcoming special issue of the International Journal of Geographical Information Science on Visual analytics & spatial decision support).

William Ribarsky is the Bank of America Endowed Chair in Information Technology at UNC Charlotte, is founding director of the Charlotte Visualization Center, and director of the Southeastern Regional Visualization & Analytics Center. His research interests include visual analytics, 3D multimodal interaction, bioinformatics visualization, virtual environments, visual reasoning, and interactive visualization of large-scale information spaces. Formerly, he was the Associate Director for External Relations of the Georgia Tech GVU Center. Dr. Ribarsky is the former Chair and a current Director of the IEEE Visualization and Graphics Technical Committee, and chairs the Steering Committees for the IEEE Visualization Conference and the IEEE Virtual Reality Conference. He is an Associate Editor of IEEE Transactions on Visualization and Computer Graphics. Dr. Ribarsky co-founded the Eurographics/IEEE visualization conference series (now called EG/IEEE EuroVis) and led the effort to establish the Virtual Reality Conference series. For the above efforts on behalf of IEEE, Dr. Ribarsky won the IEEE Meritorious Service Award in 2004.

REFERENCES
