Abstract

The Department of Homeland Security (DHS) has sponsored the establishment of a research and development (R&D) agenda for visual analytics, which is the science of analytical reasoning facilitated by interactive visual interfaces. This agenda is intended to address the challenge of analyzing overwhelming amounts of disparate, conflicting, and dynamic information to identify and prevent emerging threats, protect our borders, and respond in the event of an attack or other disaster. Recommendations for research and development are presented in the following areas: the science of analytical reasoning; visual representations and interaction techniques; data representations and transformations; and production, presentation, and dissemination. In addition, recommendations are made for addressing several issues that sometimes impede the transfer of promising ideas from research into practice. Finally, recommendations are presented for creating an enduring capability through educational programs and partnerships.

1. Introduction

The analysis process requires human judgment to make the best possible evaluation of incomplete, inconsistent, and potentially deceptive information in the face of rapidly changing situations. Today, analysts have a select number of software programs available to help them organize their information, gain an overview of it, explore it, and examine trends. However, these tools only scratch the surface in terms of meeting analyst needs. Current technologies cannot address the needs for handling the massive, messy, and ever-changing volumes of information and the diversity of types of information. Furthermore, current analytical tools provide basic capabilities such as query and search but very little in the way of support for the complex tasks of the analysis, synthesis, and discovery process. Few current tools address the need to communicate analytical results and products to a wide variety of audiences.

DHS has sponsored the establishment of an R&D agenda for visual analytics. This agenda is intended to address the challenge of analyzing overwhelming amounts of disparate, conflicting, and dynamic information to identify and prevent emerging threats, protect our borders, and respond in the event of an attack or other disaster. To develop this agenda, experts from academia, industry, and the Department of Energy’s National Laboratory system have teamed with government agencies in an effort led by the National Visualization and Analytics Center, which was established by DHS in 2004. The resulting research and development agenda will be published in book form in 2005.

2. A Definition of Visual Analytics

Visual analytics is the science of analytical reasoning facilitated by interactive visual interfaces. People use visual analytics tools and techniques to 1) synthesize information and derive insight from massive, dynamic, ambiguous, and often conflicting data; 2) detect the expected and discover the unexpected; 3) provide timely, defensible, and understandable assessments; and 4) communicate assessments effectively for action.

3. Key Elements of the R&D Agenda

Several interrelated areas for research and development have been identified:

- Support for the analytical reasoning process to facilitate assessment, planning, and decision making
- Visual representations and interaction techniques that allow users to see, explore, and understand large amounts of information at once
Data representations and transformations that bring useful structure to dynamic and conflicting data
Techniques to support production, presentation, and dissemination of results in the appropriate context.

In addition, the R&D agenda addresses critical areas that are sometimes overlooked but are necessary to lasting success:
- Smoothing the transition of research into practice by emphasizing evaluation, proactive adherence to privacy and security laws and policies, attention to interoperability, and planning for technology insertion
- Establishing an enduring visual analytics capability through educational programs and partnerships.

4. Conclusions
The agenda outlined here is only a starting point. As our understanding of analytical needs grows and the discipline of visual analytics matures, the research challenges and priorities will evolve rapidly.

Although DHS is providing foundational support, the work outlined in this agenda cannot be accomplished through the efforts of any one organization or government program. Rather, this agenda can only be achieved by mobilizing an interdisciplinary community of researchers, software engineers, and domain experts.

Acknowledgments
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