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February 8, 2010

Research

Areas

Artificial Intelligence, Natural Language Processing, Machine Learning, Cognitive Science

Dissertation Proposal

Intention Recognition of Grouped Bar Charts in Multimodal Documents

Abstract: Grouped bar charts are a type of information graphic often utilized by graphic designers as a tool for visually displaying quantifiable relationships of values that hold over a set of dependent entities in two dimensions. Usually their presence in popular media is to communicate to the graph viewer a high-level contextual message which involves the graphed elements. Most information graphics in popular media contain these high-level intended communications. However, the high-level content of an information graphic is often not repeated in the accompanying text or caption of the graphic. Thus, it is necessary to integrate the high-level message conveyed by an information graphic with the article's text in order to completely understand a multimodal document.

This proposal will present a methodology for automatically recognizing the high-level intentions from grouped bar chart information graphics and will demonstrate it via a prototype system by utilizing the graphical features in grouped bar charts as communicative signals and use them as evidence in a Bayesian network.

The communicative signals used include the salient coloring of bars, their ordering and positioning, as well “signal” evidence from the caption of the graphic. Additional evidence can be found by estimating the relative cognitive effort of recognizing each possible high-level message.

Future work of this proposal includes the exploration of secondary messages in grouped bar charts—additional high-level messages which may also be intended to be conveyed in the graphic—as well as how the article text can be exploited to also provide evidence.

Education

- **University of Delaware**

Department of Computer and Information Sciences

Fourth Year Ph.D. Candidate

Passed Qualifying Examination (Dissertation Proposal)

Passed Preliminary Examination

Advisor: Dr. Sandra Carberry

February 2010

January 2008

- **University of Delaware**

Department of Computer and Information Sciences

M.S., Computer Science

May 2008

GPA: 3.83 [10 courses]

- **Saint Joseph's University**

Department of Mathematics and Computer Science

B.A., Computer Science

May 2006

Minor: Mathematics

GPA: 3.68/3.81 (cumulative / major [16 courses])

Departmental Honors

Thesis: "Use of natural language processing to improve use cases"

Dean's List: Spring 2003 - Spring 2004, Spring 2005, Spring 2006

Honors and Awards

- 2009 Cognitive Science Society Travel Award
- University of Delaware Alumni Enrichment Award
- University of Delaware Graduate Office Professional Development Award
- Full graduate support provided by University of Delaware
- Saint Joseph's University: graduated Cum Laude with Departmental Honors

Publications

- Sandra Carberry, Stephanie Elzer, **Richard Burns**, Peng Wu, Daniel Chester, Seniz Demir. Information Graphics in Multimodal Documents. To appear in *Multimedia Information Extraction*. Mark T. Maybury ed. 2010. (AAAI/MIT Press)
- **Richard Burns**, Stephanie Elzer and Sandra Carberry. Modeling Relative Task Effort for Grouped Bar Charts. Proceedings of the 31th Annual Conference of the Cognitive Science Society, pp. 2292-2297, 2009.

Abstract: The overall goal of our research is a system which can recognize the intended message of a grouped bar chart by reasoning about the communicative signals contained in the graphic. One such communicative signal is the relative effort required to perform different perceptual tasks on the graphic. This paper presents our methodology for estimating relative task effort. Based on graph comprehension research and our motivational eye tracking experiments, we hypothesize a set of factors that should be taken into account in a model of task effort. We present our model, implemented in the ACT-R framework, and discuss the results of a nal set of eye tracking experiments that validate our model as a predictor of relative task effort.

- **Richard Burns**, Sandra Carberry and Stephanie Elzer. Processing Information Graphics in Multimodal Documents. Papers from the AAAI Fall Symposium: Multimedia Information Extraction, Technical Report FS-08-05, 2008. 5-9.

Abstract: Information graphics, such as bar charts, grouped bar charts, and line graphs, are an important component of multimodal documents and cannot be ignored. When such graphics appear in popular media, such as magazines and newspapers, they generally have an intended message. We argue that this message represents a brief summary of the graphic's high-level content, and thus can serve as the basis for more robust information extraction from multimodal documents. The paper describes our methodology for automatically recognizing the intended message of an information graphic, with a focus on grouped bar charts.

- **Richard Burns**, Stephanie Elzer and Sandra Carberry. Estimating Effort for Trend Messages in Grouped Bar Charts. Proceedings of the International Conference on the Theory and Application of Diagrams, pp. 353-356, 2008.

Abstract: Information graphics found in popular media contain communicative signals which help the viewer infer the graphic designer's intended message. One signal is the relative effort required for different recognition tasks. This paper presents a model of the effort required to recognize a trend in a grouped bar chart. The model is developed using the ACT-R cognitive framework and validated via eye tracking experiments.

- Stephanie Elzer, **Richard Burns** and Sandra Carberry. The Role of Cognitive Modeling in an Automated System for Understanding Bar Charts. Spatial Cognition (SC '08), Proceedings of the Workshop on Cognitive Models of Human Spatial Reasoning, pp. 1-6, 2008.

Abstract: Information graphics (such as line graphs, bar charts, and pie charts) are an inherently visual medium which relies on a viewer's spatial reasoning abilities to facilitate the comprehension of complex data. Our research group has developed an automated system for understanding the intended message of simple bar charts, and we are currently working to expand this system to handle more complex types of information graphics. A key component of our system is a cognitive model for estimating the effort required to perform various tasks within a given information graphic. This novel application of cognitive modeling (including spatial reasoning) within an artificial intelligence framework represents a promising example of the potential synergy between these fields.

Presentations

- 2009 Cognitive Science (31st Annual Conference of the Cognitive Science Society) in Amsterdam, Netherlands
- 2009 Cognitive Science Graduate Student Conference, University of Delaware
- 2008 AAAI Fall Symposium on Multimedia Information Extraction in Arlington, Virginia

Posters

- 2009 Computer Science Research Day, University of Delaware
- 2008 (Fall) Computer Science Research Day, University of Delaware
- 2008 Diagrams (Fifth International Conference on the Theory and Application of Diagrams) in Herrsching, Germany
- 2008 (Spring) Computer Science Research Day, University of Delaware

Meetings Attended

- 2009 Computer Science Research Day, University of Delaware
- 2009 Cognitive Science (31st Annual Conference of the Cognitive Science Society) in Amsterdam, Netherlands
- 2009 Cognitive Science Graduate Student Conference, University of Delaware
- 2008 (Fall) Computer Science Research Day, University of Delaware
- 2008 AAAI Fall Symposium on Multimedia Information Extraction in Arlington, Virginia

- 2008 Diagrams (Fifth International Conference on the Theory and Application of Diagrams) in Herrsching, Germany
- 2008 ACT-R Summer School at Carnegie Mellon University in Pittsburgh, Pennsylvania
- 2008 (Spring) Computer Science Research Day, University of Delaware
- 2006 CSEET (19th Conference on Software Engineering Education and Training) in Oahu, Hawaii

Service

- 2010 Association of Computational Linguistics, Student Research Workshop (Program Committee)

Teaching, Academics

- **Teaching Assistant** **Spring 2010**
University of Delaware
 CISC 355: Ethics (Undergraduate).
Instructor: Dr. Christopher Rasmussen
- **Teaching Assistant** **Spring 2010**
University of Delaware
 CISC 361: Operating Systems (Undergraduate).
Instructor: Dr. Michela Taufer
- **Teaching Assistant** **Winter 2010**
University of Delaware
 CISC 101: Introduction to Computers (Undergraduate).
Instructor: Prof. Debra Yarrington
- **Teaching Assistant** **Fall 2009**
University of Delaware
 CISC 367: Service Learning: Programming with XO Laptops (Undergraduate).
Instructor: Dr. Terry Harvey and Dr. Lori Pollock
- **Teaching Assistant** **Fall 2009**
University of Delaware
 CISC 662: Computer Architecture (Graduate).
Instructor: Dr. Michela Taufer
- **Research Assistant** **Summer 2009**
University of Delaware
Advisor: Dr. Sandra Carberry
- **Teaching Assistant** **Spring 2009**
University of Delaware
 CISC 489/689: Information Retrieval.
Instructor: Dr. Benjamin Carterette
- **Teaching Assistant** **Spring 2009**
University of Delaware
 CISC 320: Introduction to Algorithms (Undergraduate).
Instructor: Dr. Jingyi Yu
- **Research Assistant** **Spring 2007 - Fall 2008**
University of Delaware
Advisor: Dr. Sandra Carberry

- **Teaching Assistant** **Fall 2006**
University of Delaware
 CISC 105: Introduction to Computer Science (CS1).
Instructor: Dr. Terry Harvey
- **Graduate Assistant** **Summer 2006**
Center of Visualization, Saint Joseph's University
 Authored test bank for *Learning to Program with Alice* textbook.
- **Teaching Assistant** **Spring 2006**
Saint Joseph's University
 CSC 2301: Data Structures.
- **Teaching Assistant** **Fall 2005**
Saint Joseph's University
 CSC 1401: Introduction to Java.
- **Teaching Assistant** **Spring 2005**
Saint Joseph's University
 CSC 1601: Intermediate Computer Science.
- **Teaching Assistant** **Fall 2004**
Saint Joseph's University
 CSC 1401: Introduction to Java.

Membership in Societies

- Cognitive Science Society
- AAAI, Association for the Advancement of Artificial Intelligence
- Member of Upsilon Pi Epsilon, Saint Joseph's University Chapter
- Member of Sigma Xi, Saint Joseph's University Chapter
- Vice President of Upsilon Pi Epsilon, Saint Joseph's University Chapter, 2005

Hobbies

- Liturgical organist.
- Part-time musician: keyboard and piano.
- Little league baseball umpire, and men's adult softball aspiring athlete.
- Graduated member of SJU Pep Band, SJU Jazz Ensemble.

References

- Dr. Sandra Carberry, carberry@cis.udel.edu, Professor, Computer and Information Sciences Department, University of Delaware
- Dr. Jonathan Hodgson, jhodgson@sju.edu, Professor, Computer Science Department, Saint Joseph's University
- Dr. Stephen Cooper, scooper@sju.edu, Associate Professor, Computer Science Department, Saint Joseph's University