
JOHAN BOLLEN

Old Dominion University
Computer Science Department
Norfolk VA 23529
jbollen@cs.odu.edu
<http://www.cs.odu.edu/~jbollen>

CURRICULUM VITAE

Johan (Lambert Trudo Maria) Bollen

Office:
Old Dominion University
Computer Science Department
Norfolk VA 23259

Email:
jbollen@lanl.gov

URL:
www.cs.odu.edu/~jbollen

1 EDUCATION

2001: PhD Psychology

Institution: Free University of Brussels.

Title: "A Cognitive Model of Adaptive Web Design and Navigation – A Shared Knowledge Perspective".

Advisors: Prof. Dr. Francis Heylighen (VUB), Prof. Frank van Overwalle (VUB), Dr. Luis Rocha (LANL) and Dr. Cliff Joslyn (LANL).

WWW: <http://www.cs.odu.edu/~jbollen/diss.html>

1993: MS Experimental Psychology

Institution: Free University of Brussels.

Masters thesis: "Learning to Select Activities: a Conditionable System for an Autonomous Robot that Learns to Use Drive Reduction as Reinforcement.", research conducted at the VUB AI lab (Prof. Dr. Luc Steels), department of Autonomous Robotics.

2 PROFESSIONAL EXPERIENCE

2002 - Present:

Assistant Professor at Computer Science Department, Old Dominion University (<http://www.cs.odu.edu/>).

Research: Recommendation Systems for Federated Digital Library Systems, Bibliometric Analysis of Document Networks, HCI Models of Hypertext Navigation. Course: CS149.

1999 - 2001:

Graduate Research Assistant at Los Alamos National Laboratory (LANL) for the Active Recommendation Project (<http://arp.lanl.gov>) for the LANL Research Library.

Research: Development of Adaptive Recommendation Systems for the WWW and Digital Libraries. Development of software for data analysis. PhD dissertation.

1994 - 1999:

Research Assistant at Free University of Brussels for Principia Cybernetica Project.

Research: Algorithms for adaptive hypertext and the WWW. Models of user navigation behavior in hypertext. Web site maintenance. Implementation of adaptive hypertext and WWW demos.

3 SCIENTIFIC ACTIVITIES

3.1 RESEARCH INTERESTS:

Adaptive Information and Recommendation Systems.

Analysis of user navigation behavior in digital information systems.

Predictions of human navigation behavior.

Systems for automated information linking.

Human Computer Interaction.

Information Retrieval, Latent Semantic Analysis.

Graph-theoretical analysis of web and citation-structures.
Recommendation systems for Digital Libraries.
Distributed computing for Digital Libraries.

3.2 PUBLICATIONS:

3.2.1 Journal Articles

- 1) J. Bollen and R. Luce. Evaluation of Digital Library Impact and User Communities by Analysis of Usage Patterns. *D-Lib Magazine*, 8(6), 2002.
- 2) J. Bollen and F. Heylighen. A system to restructure hypertext networks into valid user models. *The New Review of Hypermedia and Multimedia*, 4:189-213, 1998.
- 3) P. Marsden and J. Bollen. Help advertising evolve: clone consumer thought patterns. *AdMap*, 34(3):37-39, 1998.

3.2.2 Refereed Proceedings

- 4) J. Bollen, Somasekhar Vemulapalli and Weining Xu. Digital Library Evaluation by Analysis of User Retrieval Patterns. In *Proceedings of European Conference on Digital Libraries (LNCS)*, pages 432-447, Rome, 16-18 September, 2002. Springer Verlag.
- 5) J. Bollen and M. L. Nelson. Adaptive Networks of Smart Objects. In *Proceedings of Workshop on Distributed Computing Architectures for Digital Libraries (ICPP02)*, pages 487-496, Vancouver, August 18-21, 2002. IEEE.
- 6) F. Heylighen and Johan Bollen. Hebbian Algorithms for Digital Library Recommendation Systems. In *Proceedings of Workshop on Distributed Computing Architectures for Digital Libraries (ICPP02)*, pages 439-447, Vancouver, August 18-21, 2002. IEEE.
- 7) M. Di Giacomo, D. Mahoney, J. Bollen, A. Monroy-Hernandez and C. M. Ruiz Meraz, MyLibrary. A personalization service for digital library environments. In *Proceedings of Joint DELOS-NSF Workshop on Personalisation and Recommender Systems in Digital Libraries*, Dublin, Ireland, 18-20 June, 2001.
- 8) J. Bollen and L. Mateus Rocha. An adaptive systems approach to the implementation and evaluation of digital library recommendation systems. In *LNCS - Fourth European Conference on Research and Advanced Technology for Digital Libraries (ECDL2000)*, Lisbon, pages 356-360, September 2000. Springer Verlag.
- 9) J. Bollen. Group User Models for Personalized Hyperlink Recommendations. In *LNCS 1892 International Conference on Adaptive Hypermedia and Adaptive Webbased Systems (AH2000)*, pages 39-50, Trento, August 2000. Springer Verlag.
- 10) J. Bollen, H. Van de Sompel, and L. M. Rocha. Mining associative relations from website logs and their application to context-dependent retrieval using spreading activation. In *Proceedings of the Workshop on Organizing Webspaces (ACMDL99)*, Berkeley, California, 1999.
- 11) J. Bollen, F. Heylighen, and D. van Rooy. Improving memetic evolution in hypertext and the WWW. In *Proceedings of the 15th International Congress on Cybernetics*, pages 449-454, Namur, 1998. International Association of Cybernetics.
- 12) J. Bollen and F. Heylighen. Dynamic and adaptive structuring of the world wide web based on user navigation patterns. In *Proceedings of the Flexible Hypertext Workshop*, pages 13-17, Sydney, 1997. Macquarie Computing Reports
- 13) J. Bollen. Selfstructuring hypertext networks that learn to reflect the common semantics of their users: applications to the WWW. In *Proceedings of the Annual Meeting of the Belgian Psychological Society*, Brussels, 1996. Belgian Psychological Society.
- 14) J. Bollen and F. Heylighen. Algorithms for the self-organization of distributed, multiuser networks. In R. Trappl, editor, *Proceedings of the 13th European Meeting on Cybernetics and Systems Research*, pages 911-917, Vienna, Austria, 1996. Austrian Society for Cybernetic Studies.
- 15) F. Heylighen and J. Bollen. The worldwide web as a superbrain: from metaphor to model. In R. Trappl, editor, *Cybernetics and Systems '96*, pages 917-925. Austrian Society for Cybernetic Studies, 1996.
- 16) J. Bollen. Adaptive hypertext networks that learn the common semantics of their users. In *Proceedings of the 14th Int. Congress on Cybernetics*, pages 251-255, Namur, 1995. International Association of Cybernetics.
- 17) J. Bollen. The principia cybernetica web: a knowledge base for systems research. *International Federation for Systems Research Newsletter*, 34, December 1994.

3.2.3 Books and Long Publications

- 18) J. Bollen. A Cognitive Model of Adaptive Web Design and Navigation – A Shared Knowledge Perspective”, Free University of Brussels, Faculty of Psychology, PhD Dissertation, 2001.
- 19) F. Heylighen, J. Bollen, and A. Riegler. The Evolution of Complexity. Kluwer Academic Publishers, Dordrecht, 1999

3.2.4 Book Chapters

- 20) J. Bollen and M. L. Nelson. Workshop on Distributed Computing Architectures for Digital Libraries (DCAL). In Proceedings of the 31st International Conference on Parallel Processing, pages 429-495, IEEE, 2002.
- 21) L. M. Rocha and J. Bollen. Biologically motivated distributed designs for adaptive knowledge management. In I.Cohen and L. Segel, editors, Design Principles for the Immune System and other Distributed Autonomous Systems, Santa Fe Institute Series in the Sciences of Complexity, pages pp. 305-334. Oxford University Press, Oxford, 2000.
- 22) J. Bollen. Cognitive complexity vs. connectivity: efficiency analysis of hypertext networks. In F. Heylighen, J. Bollen, and A. Riegler, editors, The Evolution of Complexity, pages 345-368. Kluwer Academic Publishers, Dordrecht, 1999.

3.2.5 Popular Science

- 23) Numerous popular publications on Internet Culture and Services "Tips en Advies" (1996-1997, issues 5/2, 11/2, 12/2, 13/3), Indicator Uitgeverij, Leuven, Belgium.

3.3 SCIENCE PRESS:

- 1) Simon Ings (1999) Irresistible – Opinion Essay. New Scientist, 163(2197):56, July
- 2) Marcelo Cordova (2000). Ya viene la Internet que piensa y decide por usted. La Tercera (Argentina), Ciencia y Tecnologia. July 02.
- 3) Dirk Draulans (2000). Het Wereldwijde Brein. Knack (Belgium). July 12.
- 4) Micheal Brooks (2000).The Coming Global Brain. New Scientist. June 24.
- 5) Rick Luce (2001). Evolution and scientific literature: towards a decentralized adaptive web. Nature, May Issue.
- 6) Wolfgang Blum (2000). Das globale Gehirn. Die Zeit, August, edition 40.
- 7) Ariana Eunjung Cha (2002). Web May Hold the Key to Achieving Artificial Intelligence, Washington Post, September 6, 2002, Page A01.

3.4 INVITED LECTURES:

Atmospheric Sciences Data Center Digital Library Seminar Series, March 2002

“Generation of Large Hypertext and Document Networks from Collective User Retrieval Patterns”
organized by NASA Langley Research Center, Atmospheric Sciences Data Center, VA

The Intelligent Web Conference (Barcelona, Spain),October 2001

“Adaptive Distributed Information Systems: a Shared Knowledge Perspective”
organized by en.red.ando: <http://jornada.enredando.com/>

Free University of Brussels (Belgium), July 2001

"Adaptive Hyperlinking for the WWW" at the Intelligent Networks 2001 Conference

Los Alamos National Laboratory (USA), August 1998:

"The selforganization of human knowledge on the WWW " at the Workshop on Emergent Semantic and Computational Processes in Distributed Information Systems.

Catholic University of Leuven (Belgium), 9 December 1997:

"A model of human hypertext browsing." at the KUL Faculty of Psychology, department of Experimental Psychol-

ogy.

University of Edinburgh (UK), 23 October 1997:

"Heuristic browsing strategies in hypertext: a connectionist system for adaptive hypertext." at the Department of Artificial Intelligence.

Goddard Space Flight Center (USA), June 1996:

"The brain metaphor for Global Networking" at NASA's Agents research Group.

3.5 RESEARCH PROJECTS:

Assistant Editor for the Principia Cybernetica Project since 1994

The project has implemented a collaborative, dynamical hypertext-based knowledge network (<http://pespmc1.vub.ac.be/>) to represent a philosophy of systems science. My responsibilities as Assistant Editor included: assistance in the maintenance of the web site, development and implementation of the web site's search engine, implementation of PCP's adaptive hypertext experiments, implementation of the sites online research demonstrations .

"Fragmentation in Science and Society: policy-orienting research in the framework of the sciences of complexity"

Submitted 1995 to the Belgian "Federal Office for Scientific, Technical and Cultural Affairs".

"Applications of models of implicit learning on hypertext and hypermedia."

Submitted in 1998 to the Free University of Brussels' Collective Research Effort Program.

"Evaluation of Recommendation Systems with Shared Knowledge Model"

Submitted in 2000 to the Los Alamos National Laboratory LDRD program.

3.6 CONFERENCES AND WORKSHOPS

Symposium on Theories and Metaphors of Cyberspace

Reviewer.

Chaired by F. Heylighen and Stuart Umpleby at the 13th European Meeting on Cybernetics and Systems Research (Vienna, April 1996).

Workshop on Intelligent Networks

Member of scientific and technical committee.

Chaired by F. Heylighen, at the Vrije Universiteit Brussel (Brussels, July 2001).

URL: <http://pespmc1.vub.ac.be/Conf/GB-0.html>

Workshop on Distributed Computing Architectures for Digital Libraries

Chaired by Johan Bollen and Michael Nelson at the 31st International Conference on Parallel Processing (Vancouver, Canada, August 20-22, 2002).

URL: <http://www.cs.odu.edu/~jbollen/icpp2002/>

3.7 STUDENTS:

Rajanikanth Vasista (Old Dominion University), Computer Science Department, 2002:

Independent study of Methods and Principles of Information Retrieval.

Somasekhar Vemulapalli (Old Dominion University), Computer Science Department, 2002:

Implementation of Digital Library web log analysis tools and recommendation systems.

Weining Xu (Old Dominion University), Computer Science Department, 2002:
Recommendation systems and distributed computing for digital libraries.

Wilfried Cools (Catholic University of Leuven), Faculty of Psychology, 1997:
Apprenticeship on "Reciprocal Effects of Adaptive Hypertext and User Mental Models"

3.8 REVIEWER:

Special Issue of "The Journal of Artificial Societies and Social Simulation" (ISSN 1460-7425),
"Starting from Society: the Application of Social Analogies to Computational Systems".
Ed. Bruce Edmonds, Centre for Policy Modelling, Manchester Metropolitan University (UK).

4 SKILLS

4.1 NATURAL LANGUAGES:

Fluent (Spoken and Written): Dutch, Afrikaans, English and French
Advanced knowledge: German and Italian

4.2 PROGRAMMING LANGUAGES:

Java1.2: Applications for networking (clientserver applications, servlets), Applets, XML parsing
C and C++: Numerical programming, LSI, CLAPACK, etc.
Perl: Data parsing, CGI-scripts
AWK/SED/Tcl/Tk: General UNIX scripting
SQL: MySQL and PostgreSQL applications, JDBC and DBI interfaces
JavaScript/DHTML: Animation for web sites
Scheme/LISP: Basic knowledge, neural network control programs for autonomous agents

4.3 GENERAL COMPUTER SKILLS:

Network: HTML, CGI-scripting, Java applets, HTTP server setup
Software: SPSS, Matlab, Statistica, R, LaTeX2E, Ucinet
Systems: Extensive experience managing Linux, Windows, UNIX, and MacOS systems

5 COMMERCIAL ENDEAVOURS.

1996-1997: Lo! Web Design

Activities: WWW consulting, design and implementation of small-scale web sites.
Main achievements: "Erasmushogeschool Brussel web site": <http://www.ehb.be/>
and the WWW agendas (public password secured agenda's for travelers): <http://wim.heuninck.2be.net/>
and <http://wim.heuninck.2be.net/cgi-bin/putcalendar.cgi>.

6 RESEARCH OVERVIEW

6.1 RESEARCH POSITION:

My research is situated in the domain of adaptive hypertext and the analysis of user behavior in digital information systems such as the WWW or Digital Libraries, which in its turn can be considered a subdomain of Human-Computer Interaction (HCI). The aim of HCI is to model and improve the interaction between humans and electronic (information) systems. The domain of adaptive hypertext more specifically focuses on how hypertext systems and the WWW can be made to adapt their behavior to the needs of specific groups of users. My research attempts to address the theoretical issues concerning design and navigation of document networks such

as the WWW as well as the implementation and engineering of specific systems for adaptive information systems. It is strongly influenced by cognitive science, connectionist models of human memory, information retrieval, Digital Library science and human factors.

6.2 BASIC PREMISES:

The study of author-defined document relations, e.g. hyperlinks and citations, has yielded important insights into the general graph-theoretical structure and characteristics of document networks. However, the investigated document network represent the explicitly designed efforts of authors, not those of the large community of readers. For example, citation networks are the result of the explicit efforts of article authors to cite other publications. These document relations need not necessarily correspond to the preferences of the larger group of non-authors. My research is based on the premisses that document relations can be derived from a temporal analysis of collective user retrieval sequences. This approach induces a general perspective on the study of document networks like the WWW, Digital Libraries and bibliographical databases which juxtaposes document relations implicitly derived from usage to those explicitly designed by authors. The analysis of user retrieval sequence data can be applied to systems for the automated linking of collections of documents (automated information linking), comparisons of usage vs. author defined document relations (e.g. impact factors based on citation analysis) and the general study of user retrieval behavior.

6.3 SHORT OVERVIEW OF RESEARCH ACTIVITIES:

My present research consists of four main lines:

1. Automated Generation of Document Relations from Temporal Patterns of Usage
2. Modelling Individual User Navigation Behavior for Hypertext and the WWW
3. Spreading Activation Recommendation Systems for Usage Derived Document Networks
4. Comparison of Usage Derived Document Relations to Citation Networks

6.3.1 Automated Generation of Document Relations from Temporal Patterns of Usage

A series of exploratory experiments was conducted throughout 1996 in which an experimental hypertext network reorganized its hyperlinks according to user hyperlink traversals. A set of learning rules changed hyperlink weights according to the frequency with which they were traversed. Large groups of participants were asked to navigate the networks on the WWW. By their traversals, the structure of hyperlinks in the network would gradually change and evolve to a representation of the hyperlink preferences for that specific group of users.

Simulations of user hyperlink selections were used to measure the retest reliability and validity of network development. The results indicated that network structure for a given community of users reliably converges to a stable and valid representation of the hyperlink preferences of those users.

The same methodology for the generation of hyperlinks has recently been applied to document collections such as journals in the Los Alamos National Laboratory Research Library, and the Principia Cybernetica web site (Free University of Brussels). Rather than online user hyperlink traversal patterns, the system operates on user retrieval sequences as they can be reconstructed from a web site's log files. Large document networks can thus be generated which represent the preferences and views of very specific user communities. Furthermore, since the system relies on usage, rather than explicit authorship or document content, it can operate on extremely heterogeneous collections containing documents in different formats, languages, etc.

Recent research has focussed on the implementation of an automated system for the generation and integration of document relations from large collections of Digital Library web logs. This research could lead to the establishment of a standardized data set used to complement traditional citation analysis.

6.3.2 Modelling Individual User Navigation Behavior for Hypertext and the WWW

Another line of research involves the development of an associative optimization model of human hypertext navigation. The model is based on the assumption that hypertext navigators apply a strategy in which each hyperlink

is selected to optimize proximity to a predetermined target or set of target documents. Users are furthermore assumed to base these proximity assessments on commonsense knowledge of concept associations. Results indicate the model can accurately predict user navigation paths in hypertext.

Future research will focus on the following:

1. Relating success/fail ratios for model predictions to usability measures for WWW sites
2. Verification of results by controlled experiments with human subjects
3. Cross-validation of document relation model and sensitivity analysis on prediction results

6.3.3 Spreading Activation Recommendation Systems for Usage Derived Document Networks

The use of document to document Spreading Activation (SA) for recommendation systems has a troubled history. The inability to construct adequate document networks either by automated IR-based techniques or manual design has severely hampered the development of SA recommendation systems. SA nevertheless offers a number of advantages over traditional IR techniques: it operates independently from document text content, document language, media formats and allows querying by example. The developed methodology to generate document relations from patterns of usage offers an alternative to existing approaches to document network generation, and enables the application of SA recommendation systems to arbitrarily large and heterogeneous document collections. A number of SA prototypes have been developed for the LANL Research Library. A network of journal relations was constructed from an automated analysis of sequences of article retrievals registered in the Los Alamos National Laboratory's Research Library web logs. The prototype consists of a Java Servlet that is intended to run as a thirdparty system to other recommendation systems.

6.3.4 Comparison of Usage Derived Document Relations to Citation Analysis

Citation analysis is based on networks of author-defined document relations, i.e. citations, which represent the preferences of document authors. Document relations derived from citations need not necessarily reflect the preferences of users. Measures of journal impact or recommendation systems based on citations may therefore not address the preferences of a specific user community.

The above described methodology can be used to generate journal networks from digital library usage records or log files. Journal Impact measures can be derived from the graph-theoretical properties of these networks. These measures (e.g. network centrality or authority) represent a journal's impact to its users rather than the citation preferences of authors. A recent analysis of such data reveals striking dissimilarities between usage-based journal impact factors and those based on citation counts. Future efforts will focus on the analysis of temporal shifts in user preferences and journal impacts, the automated gathering and integration of library usage data, and the definition of a combined citation and usage-determined impact factor database.

7 REFERENCES:

Prof. Dr. Francis Heylighen

Director Centrum Leo Apostel for Transdisciplinary Research
Vrije Universiteit Brussel
Krijgskundestraat 33,
1160 Brussels,
Belgium
Phone +3226442677; Fax +3226440744
Email: fheylich@vub.ac.be

Richard Luce

Research Library Director
Library Without Walls Project Leader
Research Library, MS P362
Los Alamos National Laboratory

PO Box 1663
Los Alamos, NM, 87544-7113
USA
Phone: 5056674448; Fax 5056656452;
Email: Rick.luce@lanl.gov

Dr. Herbert Van de Sompel
Digital Library Research & Prototyping
Research Library, MS P362
Los Alamos National Laboratory
PO Box 1663
Los Alamos, NM, 87544-7113
Phone: + 1 (505) 667 1267
Email: herbertv@lanl.gov
WWW: <http://lib-www.lanl.gov/herbertv/>

Dr. Luis Mateus Rocha
Complex Systems Research
Modeling, Algorithms, and Informatics Group (CCS3)
Los Alamos National Laboratory, MS B256
Los Alamos, NM 87545, USA
Phone: 5056655328; Fax: 5056671126;
Email: rocha@lanl.gov or rocha@santafe.edu
WWW: <http://www.c3.lanl.gov/~rocha>

Dr. Cliff Joslyn
Distributed Knowledge Systems Team
Modeling, Algorithms, and Informatics Group (CCS3)
Los Alamos National Laboratory, MS B256
Los Alamos, NM 87545, USA
Phone: 5056679096
Email: joslyn@lanl.gov
WWW: www.c3.lanl.gov/~joslyn