

# Research in Information Visualization and E-Learning

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# 1.

## RESEARCH

### Information Visualization

This multidisciplinary research area focuses on the visual representation of information and knowledge. In particular, Graph Visualization studies the representation of objects and the relationships amongst them. Graph Visualization algorithms and software systems have been applied in many diverse areas such as Website Administration (Website Maps), Software Engineering and Database Systems, and Digital libraries and Document management Systems.

Two specific projects that I am involved in are:

- Development of an incremental Tree Editor for dynamic drawing of tree structures.

Applications arise when the data are dynamically generated or where there is need to interact with and edit the drawing. Dynamic techniques are also used for displaying large graphs where the entire graph cannot fit on the screen. This work is being done in collaboration with Prof. Workman, a Computer Science lecturer at the University of Central Florida. In the prototype tree editor software, the user can edit subtrees and the display is automatically readjusted with changes propagated back to the root. The algorithms attempt to find the most efficient placement of the subtrees so as to minimize the Graph Area while still preserving the user's mental map. One application of our tree editor is a tool for Software Design to represent Java Program structure and as a tool for reverse engineering Java programs. The software can be used as a plug-in to Content Management Systems to display relationships amongst content objects.

Workman, D., Bernard, M., Pothoven, S., *'An Incremental Editor for Dynamic Hierarchical Drawing of Trees'*, Lecture Notes in Computer Science, Vol. 3038, pp. 986-995, Springer-Verlag, 2004.

<http://www.informatik.uni-trier.de/~ley/db/conf/iccS/iccS2004-3.html>

- Development of Graph Drawing software for Radial Drawing of Data Structures.

These Data Structures are used for querying Database Systems and for Search Engines for the web. The Radial drawing methods have been applied to visualization of web-based course storyboards. These are dynamic structures that display navigational paths through an on-line course. They can be used in the course design or as a site map for users of the course.

Animation features are incorporated.

Mohammed, S., '*Radial Graph Visualization: An Algorithmic Framework with Applications*', M.Phil. Thesis, The University of the West Indies, 2004

Bernard, M., Mohammed, S., '*Labeled Radial Drawing of Data Structures*', Proceedings of the IEEE 7th International Conference on Information Visualization IV03, England, pp.479-484, IEEE Computer Society Press, 2003.

<http://csdl.computer.org/comp/proceedings/iv/2003/1988/00/1988toc.htm>

Bernard, M., Ramos-Bishop, D., and Smith, C., '*Radial Drawings of Index Tree Structures*', 9th International Congress on Mathematical Education, Symposium on Mathematical Modeling and Links between Mathematics and Other Subjects, Tokyo, Japan, August 2000.

Bernard, M., '*On the Automated Drawing of Graphs*' Proceedings of the Third Caribbean Conference on Combinatorics and Computing, pp.43-45, 1981.

Bernard, M., '*The Automated Design and Drawing of Graphs*', M.Phil. Thesis, The University of the West Indies, 1980

## **E- Learning**

This research area encompasses all aspects of the use of computer technology to facilitate education. In particular, I am interested in Web-based Instructional Systems. I am a founding member of the recently established E-Learning Research Group in the Department of Mathematics and Computer Science, The University of the West Indies. The group is involved in the development of Learning Content Management System called Burrokeet. Another project is the integration of web-based instruction and classroom teaching in Secondary Schools the Caribbean.

Several university courses (B.Sc.) have been developed and delivered on-line using WebCT , Burrokeet, and ATutor.

Singh, R., Bernard, M., Gardler, R., '*Creating Sharable Learning Objects from Existing Digital Course Content*', 31st Annual International Symposium on Computer Architecture Conference Proceedings, IEEE Computer Society, June 2004.

Singh, R., Bernard, M., '*A Model for Maintaining Interoperability of Coarse XML Sharable*

*learning Objects after Re-authoring in a Standards-based Editor*', Proceedings of the Winter International Symposium on Information and Communication Technologies WISICT04, Mexico, ACM International Conference Proceedings Series, 2004.

Bernard, M., Cummings, T., '*Integrating Web-based Instruction and Classroom Teaching: Case Studies from the Caribbean*', Proceedings of the IASTED International Conference Computers and Advanced Technology in Education CATE 2003, Greece, pp.96-102, ACTA Press, 2003.

<http://www.actapress.com/proceedings/2003proceedings/cate2003.htm>

Cummings, T., Bernard, M., '*A Model for the Instructional Design, Development, Delivery and Evaluation of a Web-based course in Computer Science*', Grenada Country Conference - Beyond Walls: Multidisciplinary Perspectives, January 2002.

Cummings, T. '*A Model for the Instructional Design, Development, Delivery and Evaluation of a Web-based course in Computer Science*', Ph.D. Thesis, The University of the West Indies, St. Augustine, 2003

## **Error Control Coding**

Many years ago, I was actively involved in research in the area of Error-Correcting Codes

Bernard, M., '*Error-correcting Codes with Variable lengths and Non-uniform Errors*', Ph.D. thesis, The University of the West Indies, 1987.

Bernard, M., Sharma,B., '*Linear Codes with Non-uniform Error-correction Capability*' Journal of Designs, Codes and Cryptography, Vol.10, No.3, pp.315-323, 1997.

Bernard, M., Sharma,B., '*Variable Length Perfect Codes*', Journal of Information and Optimization Sciences, Vol.13, No.1, pp.1-9, 1992.

Sharma, B., Bernard,M., '*A Search for Perfect Codes of Variable Word Lengths*', Journal of Computing and Information, Vol.1, No.1, pp.45-68, 1990.

Bernard, M., Sharma,B., '*A lower Bound on the Average Codeword Length of Variable Length Error-correcting Codes*', IEEE Transactions on Information Theory, Vol.36, No.6, pp.1474-1475, 1990.

Bernard, M., Sharma,B., '*Some Combinatorial Results on Variable Length Error-correcting Codes*', Ars Combinatoria, Vol25B, pp181-194, 1988.

Bernard, M., '*Some Combinatorial Results on Variable Length Error-correcting Codes*', Eleventh British Combinatorial Conference, University of London, England, 1987.

Bernard, M., Sharma,B., '*Optimal Variable Length Error-correcting Codes*', Proc. of Fifth Caribbean Conference on Combinatorics and Computing, The University of the West Indies, Barbados, pp.91-104, 1988.

Sharma, B., Bernard, M., '*Some Combinatorial Results on Non-uniform Error-correcting Codes*', Fourth Carbondale Combinatorics Conference, Carbondale, Ill., Nov2-4, 1989.

### **Other Publications**

Mohan, P., Yussuff, S., Crichlow, J., Posthoff, C., Bernard, M., '*Using a Rule Language to Specify Business Rules in an Object-Oriented System*', 11th Annual Meeting of The Caribbean Academy of Sciences and The Academy of Sciences of Cuba, Havana, Cuba, April, 2000.

Bernard, M., '*A Review of the Trinidad Experience in Mathematics Olympiads*', Caraib' Math 94, Mathematics Education in the Caribbean, Martinique,1994

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