KRYSTA SVORE

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TECHNICAL INTERESTS

My research has concentrated on quantum computation, particularly quantum fault tolerance and quantum error correction. However, my technical interests include the broader fields of data mining, intrusion detection, and classical fault tolerance. In my research, I have developed a fault-tolerant software architecture for quantum computers that maps a high-level program into fault-tolerant machine-level instructions, along with methods and tools to analyze and simulate quantum circuits and determine component failure thresholds. This work represents the first design flow for a quantum computer, and includes the development of a quantum assembly language, QASM, and a suite of tools for its compilation and simulation. In addition, I have investigated various nearest-neighbor quantum computer architectures and developed several fault-tolerance threshold estimation techniques. Threshold estimation is necessary for the engineering and realization of a reliable, scalable quantum computer. Specifically, my research contributions are:

- A layered software architecture for quantum computers. The design flow fault-tolerantly maps a quantum algorithm written in a high-level language to technology-specific instructions for a quantum computer or for use in a quantum simulator.

- A quantum assembly language, QASM, and a toolsuite for its compilation and simulation. QASM allows easy expression of quantum circuits, which with the toolsuite, provides a platform for the evaluation and simulation of fault-tolerant circuit components.

- A semi-analytical analysis of fault-tolerance thresholds for a nearest-neighbor quantum computer. Our fault-tolerance analysis is the first explicit model for a nearest-neighbor architecture (an architecture which requires movement). Our work also corrects previous inaccurate fault-tolerant threshold estimation techniques.

- A new host-based intrusion detection system for Windows registry anomaly detection. We use one-class support vector machines (OCSVMs) to detect anomalous registry behavior in the Windows registry.

EDUCATION

Columbia University   New York, NY
Advisors: Alfred Aho and Joseph Traub
Ph.D. Department of Computer Science, expected May 2006.
Thesis: Software Tools and Failure Thresholds for Reliable, Scalable, Fault-tolerant Quantum Computation.

Columbia University   New York, NY
Masters of Philosophy, Computer Science, October 2005.

Massachusetts Institute of Technology   Cambridge, MA
Mentor: Issac Chuang
Visiting research scholar. Worked with Dr. Isaac Chuang in the Center for Bits and Atoms on quantum error correction and numerical simulation of quantum circuits. (September 2004 - June 2005).

Columbia University   New York, NY
Masters of Science, Computer Science, October 2003.

Princeton University   Princeton, NJ
Advisor: Ingrid Daubechies
Bachelors of Arts, Mathematics, May 2001. Minor in Computer Science and French.
Thesis: Multiscale Image Processing using Single and Double Gaussian Techniques, and Hidden
Markov Models.

Universite de Paris X, l'Institut Catholique   Paris, France
Foreign exchange student. Studies included Probability and Statistics, French Literature, Modernity
and Identity in 19th and 20th Century Art, Sociology of the Modern French Family. Lived with a
French family. (January - August 1999).

HONORS AND AWARDS

1. National Physical Science Consortium Fellow (2001-present)
2. Westinghouse Science Competition National Semi-Finalist (1997)
3. Tandy Technology Scholar (1997)
4. Alliance Francais de Seattle Distinguished French Student Award ('97)
5. Member of the National Honor Society ('96-'97)
6. Student Body Vice President ('96-'97)
7. Class President ('94-'95)
8. Yearbook Editor ('96-'97)
9. Member of the Society for Women in Mathematics

WORK EXPERIENCE

IBM T.J. Watson Research Center   Yortown Heights, NY
Mentor: David DiVincenzo
Researched quantum error correction schemes and quantum error thresholds for a 2D lattice archi-
tecture and ion trap quantum computers. Developed a quantum assembly language, QASM, and
a corresponding tool suite, QASM Tools, for quantum circuit compilation and simulation. (June-
September 2005).

IBM T.J. Watson Research Center   Yortown Heights, NY
Mentor: David DiVincenzo
Researched quantum error correction schemes and quantum error thresholds for an arbitrary local
setting. Developed a semi-analytical failure probability map to estimate quantum error thresh-
olds. Demonstrated previous results in the literature used an inaccurate method for fault-tolerance
threshold estimation. (May-August 2004).

Center for Communications Research   Princeton, NJ
Institute for Defense Analyses
Summer program. Researched classified advanced mathematical problems. (June-August 2003).

Laboratory for the Physical Sciences   College Park, MD
United States National Security Agency
Advisor: Marvin Kruger
Researched quantum computation and development of quantum algorithms. Studied advanced clas-
sified problems. (June-August 2002).

7C Limited   London, UK

Programmed databases in Microsoft Access. Implemented programs for increased efficiency in utilization of database applications. Acquired knowledge of networking and voice systems. (June-August 2000).

Fred Hutchinson Cancer Research Center   Seattle, WA

Worked under a mentor developing methods for the prevention of the spread of cancer cells. Named Westinghouse Semi-Finalist for a research paper on T-cell development. Assisted in studies on cancer research in mice. Researched the role of T-cells in cancer development for a team at Bristol-Meyers Squibb. (September 1996-September 1997).

TEACHING EXPERIENCE

Columbia University   New York, NY

Numerical Algorithms and Complexity. Head Teaching Assistant. Helped create and grade problem sets and exams. Assisted graduate students individually with difficult concepts. Supervised other teaching assistants. Gave guest lecture on quantum computation. (January-May 2003).

Scientific Computation. Head Teaching Assistant. Prepared teaching materials, homework, and exams. Helped students master the subject area through individual meetings. Managed other teaching assistants. Gave two guest lectures. (January-May 2002).

Princeton University   Princeton, NJ

Tutor in Chemistry and French. Assisted students individually to help them master the subject area. (September 1998-June 2001).

PUBLICATIONS

"A Layered Software Architecture for Quantum Computing Design Tools". K. Svore, A. Cross, A. Aho, I. Chuang, and I. Markov. To appear in *IEEE Computer*, January 2006.

"A Flow-map Model for Analyzing Pseudothresholds". K. Svore, A. Cross, I. Chuang, and A. Aho. To appear in *Quantum Information and Computation*, 2006. LANL ArXiv: quant-ph/0508176.

"A Logarithmic-Depth Quantum Carry-Lookahead Adder". T. Draper, S. Kutin, E. Rains, and K. Svore. To appear in *Quantum Information and Computation*, 2006. LANL ArXiv: quant-ph/0406142.

"Local Fault-tolerant Quantum Computation". K. Svore, B. Terhal, and D. DiVincenzo. *Phys. Rev. A* 72, 022317 (2005). LANL ArXiv: quant-ph/0410047.

"A Comparative Evaluation of Two Algorithms for Windows Registry Anomaly Detection". S. Stolfo, F. Apap, E. Eskin, K. Heller, S. Hershkop, A. Honig, K. Svore. To appear in *Journal of Computer Security*, 2005.

CONFERENCE PRESENTATIONS

"Local Fault-tolerant Quantum Computation". K. Svore, B. Terhal, and D. DiVincenzo. Invited Speaker, IBM Workshop on Fault-tolerant Quantum Computation 2005, Yorktown Heights, NY, August 29-30, 2005.

"Local Fault-tolerant Quantum Computation". K. Svore, B. Terhal, and D. DiVincenzo. Quantum Information Processes (QIP) 2005, Cambridge, MA, January 13-18, 2005.

"Compiling Quantum Circuits into Elementary Unitary Operations". K. Svore. In *Proceedings of the Grace Hopper Conference for Women in Computing* (GHC), Chicago, IL, October 2004.

"A Logarithmic-Depth Quantum Carry-Lookahead Adder". T. Draper, S. Kutin, E. Rains, and K. Svore. In *Proceedings of the ERATO Conference on Quantum Information Sciences* (EQIS), Tokyo, Japan, September 2004.

"Toward a Software Architecture for Quantum Computing Design Tools". K. Svore, A. Cross, A. Aho, I. Chuang, and I. Markov. In *Proceedings of the Workshop on Quantum Programming Languages* (QPL), Turku, Finland, July 2004.

"Compiling Quantum Circuits into Elementary Unitary Operations" K. Svore. Quantum Information Processes (QIP) 2004, Waterloo, Canada, January 17-19, 2004.

"One Class Support Vector Machines for Detecting Anomalous Windows Registry Accesses". K. Heller, K. Svore, A. Keromytis, and S. Stolfo. In *Proceedings of the ICDM Workshop on Data Mining for Computer Security* (DMSEC), Melbourne, FL, November 19, 2003.

"The Design and Optimization of Quantum Circuits using the Palindrome Transform". A. Aho and K. Svore. In *Proceedings of the ERATO Conference on Quantum Information Sciences* (EQIS), Kyoto, Japan, September 5-7, 2003. LANL ArXiv: quant-ph/0311008.

PROFESSIONAL ACTIVITIES

1. Organizer of IBM Workshop on Fault-tolerant Quantum Computation 2005 (August 2005)
2. Referee for 4th International Symposium on Code Generation and Optimization (CGO) 2006
3. Referee for IEEE Transactions on Computers
4. Referee for IEEE Transactions on Computer-Aided Design of Circuits and Systems
5. Referee for Theoretical Computer Science
6. Referee for Quantum Information and Computation
7. Member, Women in Computer Science (January 2002-present)

COMMUNITY ACTIVITIES

1. Departmental Representative, Graduate Student Advisory Council (January 2002-present)
2. Volunteer in New York City public schools and homeless shelters
3. Member of Student Volunteer Council at Princeton University
4. Founder of Student Volunteer Opportunities in HS
5. Participated in Summer Immersion Projects on Homelessness in New York, Boston, and Seattle
6. Volunteer in Seattle area homeless shelters and youth centers

TECHNICAL SKILLS

C/C++, Python, HTML, Visual Basic, JAVA, Perl, Matlab, Mathematica, UNIX, LINUX, WINDOWS, YACC, LEX

LANGUAGES

French

REFERENCES

Available upon request.