Computer Science Project: Report 2008-2010

I. GROUP MEMBERS AND VISITORS

The composition of the group:

1. Principal Investigators : Rahul Jain since November 2008), Hartmut Klauck (since April 2010), Miklos Santha (since February 2008).
2. Post-docs : Thomas Decker (since August 2009), Bill Rosgen (August 2009 – August 2010)
3. Ph.D students : Attila Pereszlenyi (since January 2009), Penghui Yao (since January 2009).
4. Visiting Researchers :Gabor Ivanyos (regularly two months per year since February 2010), Iordanis Kerenidis (regularly two months per year since January 2009), Hartmut Klauck (between January 2009 and April 2010), Shengyu Zhang (regularly two months per year since May 2009).

II. RESEARCH

A. Summary of achievements

1. Quantum Algorithms

1. We have shown that the HSP in groups of nilpotency class 2 can be solved efficiently by a quantum procedure. The algorithm is an extension of our earlier method for extraspecial groups, but it has several additional features. The quantum part of the algorithm uses well chosen group actions based on some automorphisms of nil-2 groups. The right choice of the actions requires the solution of a system of quadratic and linear equations. The existence of a solution is guaranteed by the Chevalley-Warning theorem, and we proved that it can also be found efficiently.
2. We have defined new, Monte Carlo type classical and quantum hitting times, and proved several relationships among these and the already existing Las Vegas type definitions. In particular, we have shown that both in the classical and the quantum case, for some marked elements, the two hitting times are respectively of the same order. For reversible ergodic Markov chains, we also proved that the quantum hitting time of the quantum analogue of the chain has same order as the square root of the original hitting time. We also presented new quantum algorithms for the detection and the finding problem. The complexity of both algorithms is related to the new, in some cases potentially smaller quantum hitting times. Extending Tulsi's result for the 2D grid, we have shown that for any state-transitive Markov chain with unique marked state, the quantum hitting time is of the same order for both the detection and finding problems.
3. In a survey paper we gave an intuitive treatment of the discrete time quantization of classical Markov chains. We presented Grover search and the quantum walk based search algorithms of Ambainis, Szegedy and Magniez et al. as quantum analogues of classical search procedures. From the general theory a series of applications follow easily, such as Element Distinctness, Matrix Product Verification, Restricted Range Associativity, Triangle, and Group Commutativity.

B. Selected invited talks

1. Miklos Santha, invited speaker at 5th Annual Conference on Theory and Applications of Models of Computation, Xian, 2008.
2. Miklos Santha, invited speaker at 5th 4th Workshop on Theory of Quantum Computation, Communication and Cryptography, Waterloo, 2009.

3. Miklos Santha, invited speaker at 5th International Conference on Quantum Information and Technology, Tokyo, 2009.

4. Iordanis Kerenidis, invited speaker at French-Singaporean IPAL Symposium SinFra, Singapore, 2009.

III. OTHERS

1. Organization

1. We have organized the Workshop on Quantum Algorithms and Complexity, CQT, Singapore, November 17-21, 2008.

IV. PUBLICATIONS

1. K. Friedl, F. Magniez, M. Santha and P. Sen. (2009). Quantum testers for hidden group properties. Fundamenta Informaticae, 91:2, 325-340.

2. M. Santha and M. Szegedy. (2009). Quantum and classical query complexities of local search are polynomially related. Algorithmica, 55:3, 557-575.

3. K. Friedl, G. Ivanyos, M. Santha and Y. Verhoeven (2009). On the black-box Complexity of Sperner's Lemma. Theory of Computing Systems. 45:3, 629-646.

4. G. Ivanyos, L. Sanselme and M. Santha. (2008). An efficient quantum algorithm for the Hidden Subgroup Problem in nil-2 groups. Proceedings of 8th LATIN, 759-771.

5. M. Santha. (2008). Quantum walk based search algorithms, Proceedings of 5th TAMC, 31-46.

6. S. Hemon, M. de Rougemont and M. Santha. (2008) Approximate Nash equilibria for multiplayer games. Proceedings of 1st SAGT, 267-278.

7. F. Magniez, A. Nayak, P. Richter and M. Santha. (2009). On the hitting time of quantum versus random walks, Proceedings of 20th SODA, 86-95.