Program

中国科学院数学与系统科学研究院--悉尼科技大学
量子计算与量子信息处理联合研究实验室年会 2013

UTS-AMSS Joint Annual Workshop on

Quantum Computing and Quantum Information Processing 2013

(QCQIP'2013)

November 20, 2013, Beijing

Chairs

Ruqian Lu， Mingsheng Ying

Organizers

Runyao Duan, Shunlong Luo, Yun Shang

Venue:

Room 110，Morningside Center of Mathematics

Academy of Mathematics and Systems Science, CAS, Beijing

55 Zhongguancun East Road, 100190, Beijing

北京中关村东路 55 号, 晨兴数学中心 110 室

Sponsors:

Academy of Mathematics and Systems Science (AMSS), CAS

National Center for Mathematics and Interdisciplinary Sciences, CAS

University of Technology Sydney (UTS)

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Morning		
08:50--09:00	Opening remarks	
09:00--9:50	Michael Bremner	Towards a proof of the classical intractability of quantum simulation
9:50 --10:10	**Tea Break**	
10:10--11:00	Giulio Chiribella	Guest Talk: The Heisenberg limit for information replication
11:00--11:50	Yun Shang	Computing power of Turing machines based on quantum logic
Afternoon		
13:30--14:20	Yuan Feng	Symbolic bisimulation for quantum processes
14:20--15:10	Bo Qi	Quantum state tomography via linear regression estimation
15:10--15:30	**Tea Break**	
15:30--16:20	Runyao Duan	Zero-error classical channel capacity and simulation cost assisted by quantum non-signalling correlations
16:20--17:00	Closing remarks and free discussions	

Abstracts

Michael Bremner (UTS)

Towards a proof of the classical intractability of quantum simulation

The information revolution is largely based on what a physicist would call a classical view of information, assuming that it can be copied freely and is not disturbed by observation. Quantum effects in information processing, which prevent the information in microscopic objects like atoms or photons from being observed or copied accurately, were long regarded as a mere nuisance, but are now known to make possible feats such as quantum cryptography, quantum teleportation and dramatic computational speedups. Although progress toward a practical quantum computer is slow, other surprising quantum informational effects continue to be discovered, and quantum cryptographic systems are already available commercially. Most importantly, the quantum approach has led to a more coherent and powerful way of thinking about how physical objects interact and influence one another, and how that interaction can be used to compute, communicate, and protect privacy. This talk will avoid mathematical complications and instead aim to explain central quantum concepts like entanglement, which at first sight seem counterintuitive.

Giulio Chiribella (Tsinghua)

The Heisenberg limit for information replication

No process in nature can perfectly copy an arbitrary quantum state. But is it possible to engineer processes that copy quantum states with vanishingly small error? And in the affirmative case, how many copies can these processes produce? In this talk I will show that the precision limits of quantum metrology determine the answer to these questions: On the one hand, the Standard Quantum Limit implies that deterministic copy machines can only produce a negligible number of high-quality extra copies. On the other hand, probabilistic copy machines need only to obey a Heisenberg Limit, which permits them to produce a large number of nearly perfect replicas. In particular, I will show the possibility of super-replication phenomena where N equally prepared quantum clocks can be transformed into a much larger number of M nearly perfect copies where M can be any number that is small compared to the square of N. Finally, I will discuss the tradeoff between the number of high-quality copies produced by a process and the probability that the process takes place, providing the exact rate at which the probability has to decrease in order to achieve super-replication.

Yun Shang (AMSS)

Computing power of Turing machines based on quantum logic

In this paper, we present recursion theoretical characterizations of the computational power of quantum Turing machines based on quantum logic. For unsharp quantum logic, let a lattice ordered quantum multiple-valued (QMV) algebra be its truth value lattice. When lattice ordered QMV algebras satisfy locally finite condition (that is, every non zero element has finite order) and its meet operation $\wedge$ is computable, it is proved that $\Sigma_1^0 \cup \Pi_1^0 \subseteq L_d^T(\mathcal{E}, \Sigma)$ (or $L_w^T(\mathcal{E}, \Sigma)) \subseteq \Pi_2^0$, where $L_d^T(\mathcal{E}, \Sigma)$ and $L_w^T(\mathcal{E}, \Sigma)$ denote the class of quantum languages accepted by these Turing machines in the depth-first method and the width-first method, respectively. For sharp quantum logic, similar results are obtained for a general orthomodular truth value lattice.

Yuan Feng (UTS)

Symbolic bisimulation for quantum processes

With the previous notions of bisimulation presented in the literature, to check if two quantum processes are bisimilar, we have to instantiate their free quantum variables with arbitrary quantum states. This makes checking bisimilarity infeasible from an algorithmic point of view, as quantum states constitute a continuum. In this talk, we introduce a symbolic operational semantics for quantum processes directly at the quantum operation level, which allows us to describe the bisimulation between quantum processes without resorting to quantum states. We show that the symbolic bisimulation defined here is equivalent to the open bisimulation for quantum processes in previous work, but allows an efficient implementation for bisimilarity check. We also give a modal logical characterisation for quantum bisimilarity based on an extension of Hennessy-Milner logic to quantum processes.

Bo Qi (AMSS)

Quantum State Tomography via Linear Regression Estimation

A simple yet efficient method of linear regression estimation (LRE) is presented for quantum state tomography. In this method, quantum state reconstruction is converted into a parameter estimation problem of a linear regression model and the least-squares method is employed to estimate the unknown parameters. An asymptotic mean squared error (MSE) upper bound for all possible states to be estimated is given analytically, which depends explicitly upon the involved measurement bases. This analytical MSE upper bound can guide one to choose optimal measurement sets. The computational complexity of LRE is $O(d^4)$ where d is the dimension of the quantum state. Numerical examples show that LRE is much faster than maximum-likelihood estimation for quantum state tomography.

Runyao Duan (UTS)

Zero-error classical channel capacity and simulation cost assisted by quantum non-signalling correlations

We study the one-shot zero-error classical capacity of quantum channels assisted by quantum non-signalling correlations, and the reverse problem of exact simulation. Both lead to simple semi-definite programmings whose solutions can be given in terms of the conditional min-entropies. We show that the asymptotic simulation cost is precisely the conditional min-entropy of the Choi-Jamiolkowski matrix of the given channel. For classical-quantum channels, the asymptotic capacity is reduced to a quantum fractional packing number suggested by Harrow, which leads to an operational interpretation of the celebrated Lovasz theta function as the zero-error classical capacity of a graph assisted by quantum non-signalling correlations. This talk is based on a joint work with Andreas Winter (UAB).

Map of Venue

北四环西路

中关村保福寺

Workshop Venue
Morningside Center for Mathematics
晨兴数学中心

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