Talks on Quantum Computing

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Tutorial 1: A Rosetta Stone for Quantum Computing

Abstract. This talk will give an overview of quantum computing in an intuitive and conceptual fashion. No prior knowledge of quantum mechanics will be assumed.

The talk will begin with an introduction to the strange world of the quantum. Such concepts as quantum superposition, Heisenberg's uncertainty principle, the "collapse" of the wave function, and quantum entanglement (i.e., EPR pairs) are introduced. This part of the talk will also be interlaced with an introduction to Dirac notation, Hilbert spaces, unitary transformations, quantum measurement, and the density operator.

Simple examples will be given to explain and to illustrate such concepts as quantum measurement, quantum teleportation, quantum dense coding, and the first quantum algorithm, i.e., the Deutsch-Jozsa algorithm.

The PowerPoint slides for this talk will be posted at the URL: http://www.csee.umbc.edu/~lomonaco/Lectures.html

Tutorial 2: Quantum Algorithms: Past, Present, and Future

Abstract. The talk begins with the present, i.e., with an overview of the current status of quantum algorithms. The talk then moves to the past by explaining and illustrating two quantum algorithms, i.e., Grover's Search Algorithm and Shor's Factoring Algorithm. Shor's algorithm is then generalized to the larger class of quantum hidden subgroup algorithms. In this context, Grover's algorithm is then shown to be very similar to Shor's. Finally, the talk ends with future predictions, i.e., with a discussion as to how one might find and create new quantum algorithms.

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Invited Talk: Quantum Knots and Mosaics

Abstract. In this talk, we give a precise and workable definition of a quantum knot system, the states of which are called quantum knots. This definition can

W. Hodges and R. de Queiroz (Eds.): WoLLIC 2008, LNAI 5110, pp. 26–27, 2008.

be viewed as a blueprint for the construction of an actual physical quantum system.

Moreover, this definition of a quantum knot system is intended to represent the ”quantum embodiment” of a closed knotted physical piece of rope. A quantum knot, as a state of this system, represents the state of such a knotted closed piece of rope, i.e., the particular spatial configuration of the knot tied in the rope. Associated with a quantum knot system is a group of unitary transformations, called the ambient group, which represents all possible ways of moving the rope around (without cutting the rope, and without letting the rope pass through itself.)

Of course, unlike a classical closed piece of rope, a quantum knot can exhibit non-classical behavior, such as quantum superposition and quantum entanglement. This raises some interesting and puzzling questions about the relation between topological and quantum entanglement. The knot type of a quantum knot is simply the orbit of the quantum knot under the action of the ambient group. We investigate quantum observables which are invariants of quantum knot type. We also study the Hamiltonians associated with the generators of the ambient group, and briefly look at the quantum tunneling of overcrossings into undercrossings.

A basic building block in this paper is a mosaic system which is a formal (rewriting) system for symbol strings. We conjecture that this formal system fully captures in an axiomatic way all of the properties of tame knot theory.

The PowerPoint slides for this talk will be posted at the URL: `http://www.csee.umbc.edu/ lomonaco/Lectures.html`