Research

Colloquium

Optimal Hamiltonian synthesis for quantum computing

主講人：朱天照　教授

Department of Mathematics North Carolina State University

時　間：112 年 03 月 15 日(三) 14：30

地　點：應用數學系多媒體教室(理 408 室)

摘　要：

Simulating the time evolution of a Hamiltonian system on a classical computer is hard —The computational power required to even describe a quantum system scales exponentially with the number of its constituents, let alone integrate its equations of motion. Hamiltonian simulation on a quantum machine is a possible solution to this challenge. The juxtaposition of Feynman's conjecture that, "if we could build a quantum simulator at our disposal, composed of spin-1/2 particles that we could manipulate at will, then we would be able to engineer the interaction between those particles according to the one we want to simulate, and thus predict the value of physical quantities by simply performing the appropriate measurements on the quantum simulator," and Lloyd's article in Science affirming that, "quantum computers can be programmed to simulate any local quantum system," evinces the profound gravity of the Hamiltonian simulation problem and its applications. To prepare for such a simulation, the exponential of the underlying Hamiltonian has to be described via quantum circuits representable as unitary operators, that is, it is essential to convert the unitary operators described mathematically to the unitary operators recognizable as quantum circuits. There have been immense activities and achievements in this direction, yet most current techniques are prone to approximation errors which affect the simulation authenticity. This work tackles the difficulties via the Cartan decomposition by means of the Lax dynamics. Not only that the process is numerically feasible, but also it produces in practice a genuine unitary synthesis that is optimal in both the precision with controllable integration errors and the usage of only minimally required synthesis components, by which we can gauge the quality of other approaches, draw a conclusion on the robustness of a given system, and extend the knowledge to other areas. In this talk, we aim at establishing the theoretic and algorithmic foundations by exploiting the geometric properties of Hamiltonian subalgebras and describing a common mechanism for deriving the Lax dynamics. (Lots of worked-out examples will be given. This talk does not assume a priori knowledge on quantum computing.)

國立高雄大學 應用數學系 | 理學院科算計算中心 | 智慧科技與應用跨域微學程