Robust control of quantum systems

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Robust control is a well-established field in classical control theory that addresses the need for designing controllers capable of maintaining desired system performance despite uncertainties and disturbances. Approaches like H-infinity control and mu-synthesis have been widely used in robust control for classical systems. However, these techniques face challenges when applied to quantum control systems due to the non-linear and time-domain nature of the latter, as well as the problem of marginal stability.

Stability is generally considered a crucial property of control systems and often a prerequisite for robust control, but in the context of quantum control systems, stability is often not desirable. This motivates the exploration of achieving robust performance without stabilization, i.e., maintaining control at the edge of stability. To achieve this, conventional measures for robust performance need to be adapted to the quantum setting.

In this talk we will investigate the applicability of classical robust performance measures to quantum control systems. We explore the limitations of techniques such as singular value analysis, log-sensitivity, and robustness infidelity measures based on the Wasserstein distance. These measures provide insights into the system's sensitivity to uncertainties and disturbances, but they may not be sufficient for fully capturing the complexities of quantum control systems.

Achieving robust performance without stabilization and quantifying it will require innovative approaches tailored to the specific characteristics of quantum systems. Further research is needed to develop new techniques and metrics that can effectively address the robustness requirements of quantum control systems.