Quantum Control and Quantum Estimation Theory

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2.5 Control Mechanisms (constructive/destructive interferences)
2.5.1. Bang-bang and singular controls
2.5.2. Resonant controls
2.6 Open systems
2.7 Infinite-dimensional, chaotic systems

Chapter 3. *Quantum control landscapes*

3.1 Topology (regular extremals)
3.1.1 Observables
3.1.2 Gates
3.2 Singular extremals in quantum control
3.2.1 Local surjectivity Gramian
3.3 Optimization complexity
3.3.1 Bounds on the Gramian
3.3.2 Linear programming complexity

Chapter 4. *Numerical methods for quantum control*

4.1 Stochastic search algorithms
4.1.1 Genetic, evolutionary algorithms (GA, EA)
4.1.2 Multiobjective evolutionary algorithms (MOEA)
4.2 Deterministic search algorithms
4.2.1 Steepest ascent/Conjugate gradient
4.2.2 Iterative algorithms
4.2.3 Homotopy tracking (continuation) algorithms

Chapter 5. *Applications of (open loop) quantum optimal control*

5.1 Single observable control
5.1.1 Single observable maximization (controlled fragmentation)
5.2 Multiobservable/multiobjective control
5.2.1 Pareto optimal control
5.2.2 Chemical reaction selectivity/Optimal dynamical discrimination
5.3 Gate control (quantum computation)
5.4 Example problems

Chapter 6. *Experimental methods for (open loop) quantum optimal control*

6.1 Radiofrequency nuclear spin control
6.2 Femtosecond laser control of molecular dynamics
6.3 Open loop architectures

Part II: Quantum estimation theory and stochastic control

Intro: Transition from deterministic to stochastic control

Chapter 7. *Concepts of quantum probability*

- 7.1 Noncommutative probability spaces
- 7.2 Quantum de Finetti representation
- 7.3 Quantum Fisher information
- 7.4 Quantum Bayesian Decision Theory
- 7.5 Quantum state estimation (stationary)

Chapter 8. *Quantum stochastic processes*

- 8.1 Quantum Wiener processes (quantum noise)
- 8.2 Ito/Stratnovich quantum stochastic differential equations (QSDE)
- 8.3 Master equation (Markov)
- 8.4 Equivalence with completely positive maps
- 8.5 Quantum non-Markovian stochastic processes

Chapter 9. *Quantum measurement*

- 9.1 Continuous (generalized) quantum measurement/detection, back action
- 9.2 Sequential measurements: time-ordered correlation fns
- 9.3 Imprecise measurements

Chapter 10. *Quantum filtering and forecasting*

- 10.1 Observability
  - 10.1.1 Duality with controllability
  - 10.1.2 Stochastic observability
  - 10.1.3 Sequential measurements on same or diff systems
  - 10.1.4 Coherent observability
- 10.2 Kalman filter; maximum likelihood estimate (frequentist)
- 10.3 Filtering of dynamical parameters, latent variables
- 10.4 Bayesian vs frequentist filtering: accuracy, efficiency
- 10.5 Forecasting: Bayesian and frequentist
- 10.6 Example: two-level systems; quantum optics

Chapter 11. *Closed loop quantum feedback*

- 11.1 Classical vs coherent feedback controllers
- 11.2 Optimal feedback control
  - 11.2.1 Feedback control law: Hamilton-Jacobi-Bellman