Chapter 12

Conclusions

- Area of applications.
- Relation to discrete methods.
- Challenge to ODE techniques.
- More to do.
Area of Applications

- Numerical analysis:
  - Eigenvalue computation.
  - Singular value computation.
  - Construction of balanced realizations.
  - Inverse spectrum problems.

- Matrix theory:
  - Existence question.
  - Nearness problems.

- Mechanics:
  - Mechanical system simulation.
  - Structure analysis.
  - Multibody oscillation.

- Control theory:
  - State or output feedback pole assignment problem.
  - Multivariable system identification.
• Signal processing.
  ◦ Molecular spectroscopy.
  ◦ Antenna array processing.
  ◦ Seismic tomography.

• Multivariate statistical analysis:
  ◦ Principal component analysis.

• Mathematical programming.
  ◦ Interior point method for linear programming.
  ◦ Quadratic assignment problem.
Relation to Discrete Methods

- Offer critical insights into the understanding of the dynamics of discrete methods.
  - $QR$ algorithm.
  - SVD algorithm.
  - Jacobi algorithm.

- Unify a variety of discrete methods as special cases of different discretization.
  - $QR$-type flow.
  - Spectrally constrained flow.

- Give rise to the design of new numerical algorithms
  - Difference methods resulted from discretization of differential systems.
  - Geometric methods resulted from the underlying topology.
Challenge to ODE Techniques

• May be used as benchmark problems for testing new ODE techniques.
  ◦ Large scale computation — Size grows as $n^2$.
• New ODE techniques may further benefit the numerical computation.
  ◦ Parallel ODE methods (Burrage, ’95).
More to Do

- Enable to tackle existence problems that are seemingly impossible to be solved by conventional discrete methods.
  - Inverse eigenvalue problems.
- Usually offers a global method for solving the underlying problem.
- Analog realization:
  - Cheap and fast.
  - Discrete counterparts may not be easy to find.
  - Suffers from limited accuracy.