CS 101

Numerical Geometric Integration

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What We Will Cover...

Numerical Integration
- mostly time integration
  - frequently involved in dynamic systems
    - simulations of all kinds
    - economics, biology, computer animation
- but applicable to a slew of problems
  - we will cover a few
- but with a twist...

What We Will Cover...

Numerical Geometric Integration
- different from classical paradigm
- leverages geometric properties
  - symmetries, invariance, time reversibility
- makes for better numerics
  - mimicking continuous properties
    - sometimes exactly, sometimes just well
  - start it, and forget it... it will keep on going!

Topics Planned

- variational approach
  - flagship method in this class
    - discrete Noether's theorem, symplecticity, Legendre transform, etc
- time reversibility
- multistep integrators
- first integrals
- composition; high-order integrators

Topics Planned

- time adaptive integrators
- splitting methods
  - fast/slow evolution, volume preserving flows
- holonomic constraints
- nonholonomic constraints
- Lie group integrators
- backward error analysis

What We Will Learn

Key Concepts
- for practical numerical integration
  - a bit less of an art, a bit more of a science
  - but not a magic bullet!
- theoretical foundations
  - will be mentioned, but not fully studied
    - beautiful stuff, but not appropriate for CS

Book We Will (Kinda) Follow

Geometric Numerical Integration:
   Structure-preserving Algorithms for
   Ordinary Differential Equations
by Ernst Hairer, Christian Lubich, & Gerhard Wanner

Published by Springer, 2002
ISBN 3540430032, 9783540430032
515 pages

Before You Ask...

Grading
- 90% hmk assignments
   - some derivations, but most of it coding
- 10% class participation
   - I like the interaction...

First offering, so be ready for changes
   - personal pet project? let us know
   - seminar-style class towards the end?

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http://www.cs.caltech.edu/courses/cs101.b.3/
- to be set up some time tomorrow
   - but before ditch day