Applied Mathematics and Modeling (AMM)

Applications of mathematics to the applied sciences

Department of Mathematics
University of Nebraska-Lincoln

4th March 2006

Outline

Faculty

- **Steve Cohn** – partial differential equations, Schrodinger equations, engineering applications (Courant Institute)
- **Steve Dunbar** – differential equations, financial mathematics, biology, stochastic analysis (Minnesota)
- **Glenn Ledder** – asymptotic analysis and perturbations, ecology, hydrogeology (Rensselaer Polytechnic Institute)
- **David Logan** – differential equations, mathematical ecology, effects of global climate change on ecosystems and eco-physiology (Ohio State)
- **Irakli Loladze** – differential equations, environmental stoichiometry (Arizona State)
- **Tom Shores** – numerical analysis, inverse theory, scientific computation (Kansas)
- **Brigitte TenHumberg** – invasion ecology, optimal decision in insect behavior and life history (Göttingen) ; joint appointment with Mathematics and School of Biological Sciences

Eclectic Faculty

- **Bo Deng** – dynamical systems, chaos, neuroscience, ecology (Michigan State)
- **Wendy Hines** – dynamical systems, gene propagation models (Georgia Institute of Technology)
- **Richard Rebarber** – distributed parameter control theory and population ecology (Wisconsin)

Students

Undergraduate:

We involve numerous undergraduate students in our research programs via programs such as:

- Summer REUs
- UNL UCARE program
- Undergraduate honors theses
- The RUTE project directed by Glenn Ledder

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Make Titles Informative.

Graduate

Doctoral Students:

- Amy Frederick (David Logan)
- Joan Lubben (Richard Rebarber)
- Anastasia Mshvidobadze (David Logan)
- Brian Bockelman – joint CS/Math program (Tom Shores)
- Dan Buettner – joing CS/Math program (Tom Shores)
- In addition, we have a number of pre-doctoral students.

What We Want our Students to Acquire/Learn

- Basic real analysis (825-826) and complex variables (823)
- Applied mathematics (842-843)
- Linear algebra (817) and numerical linear algebra (847)
- Linear and nonlinear optimization (832-833)
- Mathematical programming skills in MATLAB, Maple, Mathematica and/or other computing platforms
- Probability and statistics
- Differential equations (ODE, PDE, difference equations,control theory)
- Specialty courses outside the department
- Collaboration with other students and science faculty

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What we read – Where we Publish

- Journal of Mathematical Biology
- Bulletin of Mathematical Biology
- Journal of Theoretical Biology
- Ecological Modelling
- Inverse Theory
- Journal of Differential Equations
- Applicable Analysis
- Applied Mathematics and Computation
- Mathematical and Computer Modelling
- Water Resources Research
- Journal of Hydrology
- SIAM Journal of Applied Mathematics
- SIAM Journal of Mathematical Analysis
- International Journal of Bifurcation and Chaos
- Mathematical Biosciences

Problem 1: Temperature Dependent Arthropod Interactions

- How does increased CO_2 levels and temperature changes associated with global climate change affect predator-prey interactions? Herbivore-plant interactions?
- Do these levels cause shifts in their phenologies (development)
- Use differential and difference equations to model the interactions, predict populations, include stochastic effects, stability (?), etc.

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- Mechanistic understanding of chaos generation, cycles, equilibrium
- Requires global and geometrical multi-timescale analysis from dynamical systems and bifurcation theory
- Computation and visualization are essential

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Problem 3: Invasion Ecology and Thistle Spread in Nebraska

- Model the spread of a particular species of thistle (monocarpic Eurasian Cirsium vulgare).
- Determine the reliability of the model given that data measurements are uncertain.
- Requires knowledge of linear algebra (eigenvalue theory), sensitivity and elasticity analysis, statistics

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- Is the system completely integrable?
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Problem 5: Detecting Diffusive Behavior in Criminal Statistics

- Certain criminal activities have been observed to have diffusive characteristics. Can such data be fitted to a predictive mathematical model?
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Conclusion

No matter what area you choose, Nebraska is a great place to learn and do mathematics!