

COURSE ANNOUNCEMENT – SPRING 2009

Math 6790 Case Studies in Computational Engineering and Science

TTh 2:00-3:20, 208 JWB

Course Organizer: Aaron Fogelson (581-8150, fogelson@math.utah.edu)

Instructors: Thomas Reichler, Bob Palais, Aaron Fogelson

The computational approach to science and engineering problems will be explored through three 5 week long case studies. Each case study will involve a computing project or other assignments.

• **Chaos, predictability, and the butterfly effect: Applications to numerical weather forecasting – Thomas Reichler, Department of Meteorology, thomas.reichler@utah.edu**

Predicting the evolution of non-linear, chaotic systems like the atmosphere represents an interesting and challenging problem. This class will present techniques that are commonly used to solve such systems, including numerical solutions of partial differential equations using finite differencing. During the first half of the course we will use such techniques to explore the predictability properties of the simple 3-equation Lorenz system. Later, we will explore how these concepts can be applied to the problem of numerical weather prediction. In the main class project, each student is expected to program a simple but insightful atmospheric forecast model, which is based on the solution of the fully non-linear divergent barotropic vorticity.

• **Math and algorithms for DNA analysis - Bob Palais, Department of Mathematics, palais@math.utah.edu** We will emphasize the theory and computational methods used to detect, quantify, and identify specific DNA sequences in samples from medical research, clinical practice, forensic analyses, etc. Some specific topics will include algorithms for multiple sequence alignment, PCR primer design, quantification of DNA amplification, and melting curve analysis. We will also discuss some aspects of visualization in the context of molecular classification by gene expression patterns in microarray data.

• **Computational Modeling in Biological Fluid Dynamics - Aaron Fogelson, Department of Mathematics, fogelson@math.utah.edu** We will look at how fluid dynamic problems arise in biological systems. What is noteworthy about biofluid problems that distinguishes them from many engineering fluid dynamics problems is the occurrence of large deformations of the objects ‘containing’ (blood vessel, heart) or ‘contained’ (cells) in the fluid. The motion of the fluid and these deformable objects must be solved for simultaneously. We will discuss and use computational methods for attacking such problems.

Prerequisites: MATH 5610 and 5620 or the equivalent; some experience in mathematical modeling.

NOTE: This course fulfills a requirement of the CES MSc Program, and is open to non-CES students as well. It should be a reasonable course for any student with the stated prerequisites.