

UNDERGRADUATE MATHEMATICS SEMINAR

On **Monday, May 21st**, there will be a special undergraduate seminar, starting at 4:30 with refreshments in Bailey 204, the Math Common Room, and then moving upstairs to Bailey 312 for the lecture.

The talk will be delivered by **David Craft, Ph. D.** from Massachusetts General Hospital, Boston, MA.

TITLE: Optimization in Radiation Therapy

ABSTRACT: Treating cancer with radiation (either high energy x-rays or ionizing radiation such as protons) presents a challenging problem in practical mathematical optimization. Thousands of individual beams that can be controlled separately are shot into the patient, producing an optimization problem with thousands of variables. We give an overview of all aspects of treatment planning, including the large scale optimization problem, which is solved for each individual patient based on the geometry and clinical state of his or her disease. We end with a discussion of multi-objective optimization, a current research topic in radiotherapy that addresses the inherent tradeoffs (tumor coverage versus healthy tissue sparing) involved in radiation delivery.

A Message from the Chair: Two New Faculty to Join Department This Fall

I am pleased to announce that we will have two new faculty members, Kim Plofker and Jue Wang, joining the department in the fall term.

Kim Plofker will be coming to us from Brown University, where she received her Ph.D. in the History of Mathematics, specializing in Indian mathematics. She has conducted research on the history of mathematics in India and Islam at the University of Utrecht in the Netherlands, in Jaipur, India as a senior fellow of the American Institute for Indian Studies, and at Brown University. She has written a book, *Mathematics in India, 500 BC - 1800 BCE* that will be published by Princeton University Press this year.

Jue Wang is currently finishing her Ph.D. in applied mathematics and fluid mechanics at the University of Wisconsin at Madison. She received her B.S. in mathematics from Peking University. As an undergraduate in China she placed second in the Nationwide Universities' Mathematical Contest in Modeling. While at the University of Wisconsin, she has received several awards for her teaching, including the University's Excellence in Teaching Award.

On behalf of the department, I thank all of the students who participated in the hiring process by attending seminars, interviewing candidates, and providing us with feedback.

- Professor Brenda Johnson

Pieces from Theses: A View from Sarah Al-Husseini ('07)

For my senior thesis I studied how to determine the mean density of a primate's jawbone using computer tomography (CT) scans of a primate's jawbone. The mean density is important because once calculated, scientists will be able to examine the torsional properties of the jawbone, without causing any physical damage to the bone itself, as previous methods. The torsional properties of the jawbone are important to scientists because they provide important insight into primates eating habits. Thus, scientists need mathematicians to help them create a method to study these properties.

In order to solve this problem, the cross sections are implanted into MATLAB, where an algorithm is created, which will eventually lead to the mean density of the jawbone. The steps of the algorithm are to find the jawbone's edge, then to segment the image into equally spaced regions, and then to refine these regions. Once the regions are refined, the mean density can be calculated.

In a nutshell, my thesis was to create an algorithm, using mathematical concepts, in MATLAB. Never before have taken a computer programming class, my first task consisted of familiarizing myself and teaching myself how to work in MATLAB. It was a much harder task to work in MATLAB than I ever had imagined but after a lot of patience and Professor Kelly Black's assistance, I got the hang of it.

My first step in devising the algorithm was to take the points along the edge of the jawbone (determined by Jennifer Pangburn) and to create a function to pass through these points. Using the Lagrange Interpolant, I calculated a polynomial through these points called the Lagrange Interpolating Polynomial of degree 2: a parabola. Once the function was calculated, I calculated the unit normal vector of the Lagrange Interpolating Polynomial at the designated points along the edge. These normal vectors were the first approximation to create segmented regions in the jawbone. However, I needed to find a normal vector relative to a point along the outer edge. Thus I had to derive a parametric equation of the normal vector. However, due to the shape of the jawbone, the normal vectors did not segment the image into uniformly shaped regions. In order to minimize how distorted the regions are, the algorithm decreases the distance from a point along the outside of the image and a point along the inside by applying Newton's Method, also known as the Newton Raphson Method or Newton's Iteration.

I truly enjoyed my experience working with Professor Kelly while studying MATLAB and all the different and exciting mathematical concepts. I highly recommend any upcoming senior to look into continuing my thesis next year because I guarantee you will learn a lot and have a fun time.

Problem of the Newsletter: May 18, 2007

Congratulations to **Brandon Bartell '10**, for submitting a correct solution to last week's problem of the newsletter. You can see his winning solution, as well as the solution by problem's proposer, Professor Kelly Black, on the bulletin boards around Bailey Hall.

Here is this week's problem: Find a polynomial with integer coefficients that has $\sqrt{2} + \sqrt{5}$ as one of its roots.

Professor Friedman will accept solutions to this problem until 12:00 noon Thursday, May 24.