

UNDERGRADUATE MATHEMATICS SEMINAR(S!)

On **Thursday, April 24th** there will be a special day - afternoon DOUBLEHEADER of math seminars! Consistent with this double theme, these are joint Math and Computer Science seminars. Before the first seminar, you are invited to **lunch in the Math Common Room at 12:00**.

Thursday, April 24th: First Seminar

- Lunch at **12:00** in the Math Common Room
- Talk at **12:50** in Bailey 207
- Speaker: **Lane A. Hemaspaandra**, Department of Computer Science, University of Rochester

TITLE: Llull's Thirteenth-Century Election System Computationally Resists Bribery and Control

ABSTRACT: Can computational complexity theory be used as a shield to prevent bribery and control of elections? We show that an election system developed by the 13th-century Catalan mystic Ramon Llull and the closely related Copeland election system are both resistant to all standard types of (constructive) electoral control. This is the most comprehensive resistance to control yet achieved by any natural election system whose winner problem is in polynomial time. In addition, we show that Llull and Copeland voting are broadly resistant to bribery attacks, we show how network flows can be used to find bribery attacks in certain settings, and we integrate the potential irrationality of voter preferences into many of our results.

Joint work with Piotr Faliszewski, Edith Hemaspaandra, and Joerg Rothe (University of Düsseldorf).

Thursday, April 24th: Second Seminar

- Refreshments at **3:45** in the Math Common Room
- Talk at **4:00** in Bailey 207
- Speaker: **Edith Hemaspaandra**, Department of Computer Science, University of Rochester

TITLE: Anyone but Him: The Complexity of Precluding an Alternative

ABSTRACT: Preference aggregation in a multiagent setting is a central issue in both human and computer contexts. We study in terms of complexity the vulnerability of preference aggregation to destructive control. That is, we study the ability of an election's chair to, through such mechanisms as voter/candidate addition/suppression/partition, ensure that a particular candidate (equivalently, alternative) does not win. And we study the extent to which election systems can make it impossible, or computationally costly (NP-complete), for the chair to execute such control. Among the systems we study--plurality, Condorcet, and approval voting--we find cases where systems immune or computationally resistant to a chair choosing the winner nonetheless are vulnerable to the chair blocking a victory. Beyond that, we see that among our studied systems no one system offers the best protection against destructive control. Rather, the choice of a preference aggregation system will depend closely on which types of control one wishes to be protected against. We also find concrete cases where the complexity of or susceptibility to control varies dramatically based on the choice among natural tie-handling rules.

Joint work with Lane Hemaspaandra, and Joerg Rothe (University of Düsseldorf).

Pieces from Theses: A View from Bilal Mahmood ('08)

Like most math thesis journeys, mine started in the spring of my junior year. The coveted e-mail I had longed for since August 20th, 1986 was sent sometime during April 2007 and it informed mathematics majors of the class of 2008 that the Thesis Topics webpage had been updated for the 2007-2008 academic year. I clicked my way towards the math department website and quickly began browsing through the various topics. The topic that caught my eye was "Tilings in Medieval Islamic Geometry and Art". Lo and behold, my first choice for a thesis

topic did become my thesis topic for the fall and winter terms of my senior year. This is what I'll write about.

First of all, even though the thesis topic I picked seemed specific, I still had a lot of flexibility in picking the direction I wanted to go in. After the first couple meetings with Professor Plofker, we decided that we would first search for primary sources on Islamic Geometry written in Urdu, the official language of Pakistan. As I am fluent in Urdu, I realized I had the unique opportunity to work with a primary source. Furthermore, if we could find such a source, I would have done original work in an understudied area of mathematics. After a lot of searching, we could not locate the type of source we were looking for and had to rethink the direction I was going to take. So, I did extensive reading on medieval Islamic mathematics and absorbed all I could on the subject. What I found particularly interesting about medieval Islamic mathematics was the interactions between craftsmen and mathematicians. Such relationships led to the development of tile art geometry. Within this topic, I decided to study the works of the mathematician Abu l'Wafa. Wafa wrote a book called *Geometrical Constructions for Craftsmen* that came about because of interactions between craftsmen and mathematicians.

Abu l'Wafa was a gifted astronomer and mathematician who lived in Baghdad during the tenth century. One of his most famous books is the *Book on What is Necessary From the Science of Arithmetic for Scribes and Businessmen*. The first half of the book deals with mathematical calculations, and he brings in practical problems in the second half of the book. These contain problems of payments to employees, estimating construction costs, and trade concerns of merchants. The book contains problems that are simple and necessary to solve on a daily basis for a large number of people. His book *Geometrical Constructions for Craftsmen* is similar in that Wafa keeps his audience in mind as he writes. After attending various meetings with craftsmen in Baghdad he realizes the large gap between mathematicians and artisans. Mathematicians are focused too much on proving certain geometrical constructions, while artisans are looking for patterns that are possible and easy to construct. Thus, Abu l'Wafa writes a work consisting of 11 books that does not show any proofs, but contains mathematically correct geometrical constructions shown step by step that artisans can construct.

Working on my thesis, I was lucky enough to have an Arabic version of Wafa's work, and just as important I had an advisor who could translate sections of the work. Thus, I began studying various constructions in the book. The work starts off very simply, making it useful for craftsmen during the tenth century. However, everything mentioned builds off the previous material. I looked at constructions Wafa writes about in Books 9 and 10 of his work. Chapter 9 is titled "On Division of Squares" and chapter 10 is titled "On Division of Squares and their Composition". I proved some of the constructions, which he shows step by step, including his instructions for adding a square centered on a given square with either half or double the area of the given square. I also look into his instructions for cutting off from a circle a third or fourth or any such part by using two parallel chords in the circle. I continued with the study of path diagrams, which involve drawing paths of given widths and areas. Here, I also found mistakes in the Arabic copy that we had. After years of copying by scribes who were not mathematicians, mistakes were bound to occur in copies of Wafa's work.

In chapter 10 I studied Abu l'Wafa's methods for creating one large square from a given number of small squares of equal size. I continued to prove his step-by-step instructions that he neglected. This chapter is also interesting in that Abu l'Wafa writes about his own thoughts of the different challenges that mathematicians and craftsmen face. So, I looked at his explanation of making a square from three equal squares and how this varied from the simpler but incorrect way craftsmen would achieve this.

Studying a specific work that came out of medieval Islamic mathematics after reading about the general state of science in the Islamic empire at the time was really interesting. Many of the general history books write about the academic atmosphere of the time and provide countless examples of scientists and their works. Translating one such work from Arabic and working through it was definitely worthwhile and provided much more insight into the similarities and differences of mathematics during medieval times.

Problem of the Newsletter: April 18, 2008

Here is this week's problem: Find all x such that $1!+2!+3!+\dots+x!$ is a perfect square.

Professor Friedman will accept solutions to this problem until 12:00 noon Thursday, April 26th. Email your solution to him (friedmap@union.edu) or put it in his mailbox in the Math Department's office on the second floor of Bailey Hall.