MSCS Mess

Access the Mess anytime online at http://www.stolaf.edu/depts/mscs/MSCS_Mess
Or subscribe to the mscsmess@stolaf.edu mailing list in order to receive a digital copy every Friday

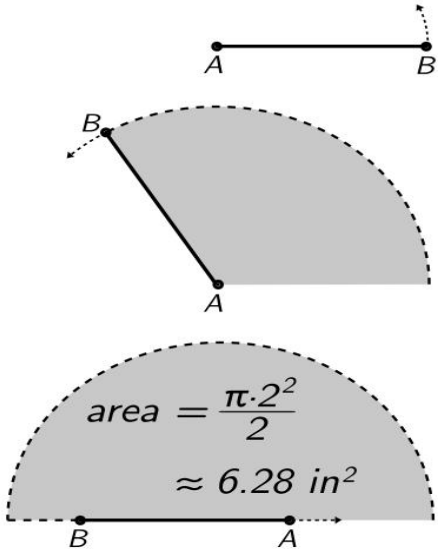
Department of Mathematics, Statistics and Computer Science — 23 September 2011
St. Olaf College, Northfield, MN 55057 — Volume 40, No 2

This Week's Colloquium

The Northfield Undergraduate Math Symposium will take place in lieu of this week's colloquium (details on the next few pages).

Problem of the Week

Consider a line segment AB in the plane that has length 2 inches. Suppose you need the segment to be in the same place, except inverted, so that endpoints A and B swap positions. Is it possible to move the segment around in the plane so that the area swept out is under 4 in²? Under 3 in²? Under 2 in²? An example that sweeps out 2π in² is shown below.



E-mail solutions to Adam McDougall (mcdougal@stolaf.edu) no later than Tuesday.

Last Week's Problem

No solutions to last week's problem have been submitted. If you have a solution, e-mail it to Paul Zorn (zorn@stolaf.edu)

Annual MSCS Tailgate Party

Mark your calendars for the Annual MSCS Tailgate Party. Thursday, October 13th. The program starts at 4:30 with food afterwards. Details will be in the Mess as the date gets closer.

Dr. Devaney Talk

Dr. Bob Devaney (yes, the Devaney from your Diff Eq textbook!) will be in town Nov 3 giving talks at both St. Olaf and Carleton. He is a leader in the world of chaos theory, a good speaker, and lovely gentleman. Plan to attend the afternoon talk at St. Olaf or the evening talk at Carleton.

Department Bulletin Board

The MSCS department will be putting up pictures of all MSCS majors and concentrators. If you are a Math major, you need to have an IMaP on file to get your photo put up. Photos will be taken by Peder Bolstad in his office (Buntrock 108) on Monday, September 26 from 1 – 3pm and Tuesday, September 27 from 2:30 to 4:30.

Attention Seniors!

Are you one of 96 senior math majors who still needs to complete a math course or two in order to graduate? If so, then please keep your

eyes open for a survey coming your way soon. We need some info from you in order to help everyone get into the classes they need and want.

Introducing Professor Blanchard

This year the MSCS has three new faculty members. Dr. Peter Floodstrand Blanchard grew up on a hobby farm in Green Bay, Wisconsin. After earning a bachelors degree at the University of Wisconsin Madison, he followed his wife to Charlottesville, Virginia where after a couple of years in construction and coaching gymnastics, he landed in graduate school. Peter's doctoral project on the topic of exceptional group ring automorphisms was given to him and supervised by Leonard L. Scott Jr. Recent projects have been in Ramsey Theory and algebraic-combinatorial-number-theory. Peter and his wife Meena have two daughters. Dr. Blanchard is a competitive numbers juggler who has recently taken up brass instruments (sometimes to juggle) and is currently focused on tuba.

Partial Information Chess

Dr. Blanchard is interested in organizing some informal partial information chess matches, either here on campus or against a team at one or more other colleges. Partial information chess usually means you only see squares you can move to. Popular variations are Dark Chess, Lao Tzu Chess, and Sun Tzu Chess, which you can find discussed on the web at a number of sites. Since these games require different kinds of analysis and deduction, they may be well-suited for team play. If you are interested, please contact Dr. Blanchard (blanchap@stolaf.edu).

The Northfield Undergraduate Mathematics Symposium is Back!

Yes, that's right! You've been waiting all year for this moment to arrive. The Northfield Undergraduate Mathematics Symposium returns on Thursday, September 29. This year, St. Olaf is hosting! Students from both St. Olaf and Carleton will give talks on their summer research, plus we'll have a break for pizza and some great conversation. So come on out, support your classmates and our friends from across the river, and see some good talks! The symposium will be held from 3:30-8:00 PM in RNS 310 and RNS 410. Watch for posters around RNS for even more details, and check out the titles and abstracts below for a preview of the afternoon's talks.

τ-Factorization in the Integers
Nathan Bishop (St. Olaf)

This talk will serve as an introduction to the Theory of τ-Factorization, a generalization of Factorization Theory. The theory hinges on the relation τ: let D be an integral domain, $U(D)$ be the units of D, and $D^{\#}$ be defined as $D \setminus \{0\} \cup U(D)$. Then τ is any relation defined on $D^{\#} \times D^{\#}$. For the purposes of this talk, we will consider τ to be the relationship of modular equivalence. After laying the foundation of the theory, we will demonstrate several results, including properties of the integers under a τ-relation.

Enumerating Partitions of Generalized Stars
Robert Crandall (St. Olaf)

In graph theory, a topic of study is graph partitions of a graph G: graphs which can be obtained from G by removing vertices and/or edges. We wish to enumerate the number of partitions of certain classes of graphs. Interesting sequences arise in this study, particularly since the partitions of a path P_n on n vertices correspond to the integer partitions of n. Counting these partitions is an NP-hard problem, particularly since many partitions of G will be isomorphic. We will examine two types of generalized stars, graphs obtained by identifying the end vertices of any number of

paths of specific lengths, and will present and demonstrate formulas for the number of partitions of these graphs.

Non-negativity of Generalized Immanants of Monomial Positive Matrices

Vladimir Sotirov (St. Olaf)

On one hand, a monomial positive matrix is a (square) matrix whose entries are polynomials in some number of indeterminates, satisfying the property that the determinant of every square submatrix is a polynomial in those indeterminates with non-negative coefficients (perversely, we say that the determinant is monomial positive function on the square submatrices). Monomial positive matrices arise naturally as the weight matrices of planar networks with indeterminate weights. On the other hand, generalized immanants are functions on matrices which generalize the determinant by replacing the sign function (in the expansion of the determinant as sum) with an arbitrary function on the symmetric group. Tautologically, the determinant of a monomial positive matrix is monomial positive; little is known, however, about monomial positive immanants of monomial positive matrices. By brute force computation in Maple, it is known that for up to $n=5$ the cone of monomial positive immanants of $n \times n$ monomial positive matrices is finitely generated (unexpectedly, the number of generators for $n=5$ is 121, rather than 120=5!). Since brute force becomes computationally infeasible for $n=6$, I will describe in this talk a more systematic approach, which reduces the computational complexity to the point where a human could not only verify in an hour or two that there are finitely many generators for $n=6$, but also determine in a day or two of careful computation by hand (or a few seconds of execution on a computer after a week of careful programming) exactly how many generators there actually are.

Thompson's group *F*: A New Generating Set

Amelia Stonesifer (St. Olaf)

Thompson's group F was introduced by Richard Thompson in the 1960's in connection with questions in logic. It has since found applications in many areas of mathematics including algebra, logic and topology, and its metric properties with respect to the standard generating sets, X_n, have been studied heavily. In this talk, we introduce a new family of generating sets, which we denote as Z_n, use "wave diagrams" as tools to establish a length formula for the word metric with respect to Z_1 and apply the word length formula to demonstrate that F is not almost convex and F has a dead end of depth at least 1 with respect to Z_1.

Triangle Puzzles and Quantum Cohomology

Erik Wyatt (St. Olaf)

Young diagrams and binary strings represent Schubert varieties in a Grassmanian. One can compute Littlewood-Richardson coefficients describing the intersection of two varieties using a puzzle rule. We introduce a variation on this rule that finds any lines intersecting two given varieties.

The Isoperimetric Inequalities on Constant Gauss Curvature Surfaces

Xin Chen (Carleton)

We give a new proof for the isoperimetric inequalities on spheres and hyperbolic planes using metacalibration. Unlike the classical optimization approach calculus of variations, metacalibration compares competitors directly to the proposed minimizer via vector fields and the divergence theorem. It paves the way to solve open problems such as multiple bubbles and isoperimetric problems with boundary on constant Gauss curvature surfaces.

The Dirichlet Process Prior in a Hierarchical Catch-Effort Model for Animal Abundance
Prasit Dhakal and Jun Young Park (Carleton)

The Dirichlet Process Prior (DPP) in Bayesian Statistics offers useful insight in studying animal abundance if heterogeneity of animal abundance has been unobserved. Consider N_i, the animal abundance in region i, follows a Poisson distribution with mean of $A_i\ \varphi_i$, where A_i is the area of region i. Then it would be one way to assume φ_i to come from one single distribution in the model, such as $N(\mu_\varphi, \sigma_\varphi)$, but the model with the DPP would not make this assumption and estimate the animal abundance better. This talk includes a brief review of previous work (without the DPP) and its comparison with the model with the DPP.

Extremal Graphs Without 4-Cycles or, Why It's Hip To Have No Squares
Frank Firke (Carleton)

Extremal graph theory deals with two main questions: what is the maximum number of edges a graph on n vertices can have before it must contain a given subgraph, and what graphs achieve that maximal condition? In this talk we will examine the question of extremal graphs when we forbid 4-cycles. While the problem remains unsolved in general, we will consider a result that answers the question for infinitely many n. The problem, while graph theoretic in nature, also has a significant connection to finite geometry that will be touched on briefly.

Classifying f-vectors of Manifolds with Boundary
Jonathan Hahn (Carleton)

A 3-dimensional manifold with boundary, such as a ball or solid torus, can be represented by sets called simplicial complexes made of faces of various dimension—points, line segments, triangles, and tetrahedrons. For a given simplicial complex, we can count the number of faces in each dimension, and encode this information in its f-vector. So far, we know all the f-vectors for very few 3-dimensional manifolds with boundary. In this talk, I will discuss how to characterize f-vectors for the simplest case, a ball.

Restricted Symmetric Signed Permutations
Andy Hardt (Carleton)

The symmetry group $D_4+\mathbf{Z}_2$ acts on the set of signed permutations by rotations, reflections, and bar operations (flip the sign of each entry). Following Egge's work on unsigned permutations, we enumerate the signed permutations that, given a symmetry subgroup H and a set R of length-2 signed patterns, are invariant under H and avoid R. Mansour and West began this work by enumerating the signed permutations that avoid R, not taking symmetries into account. Dukes and Mansour continued by enumerating signed involutions that avoid R. This talk considers the remaining subgroups of $D_4+\mathbf{Z}_2$, thus completing the enumeration. The resulting sequences include the Catalan numbers and the central binomial coefficients, and some of them are given recursively. We present some of these results in the talk, and the rest are in our accompanying paper.

A Method of Word Recognition
Reid Whitaker (Carleton)

Automated word recognition is extremely critical in a wide variety of human machine interactions. Some examples include automated voice answering systems, automated dialing, and direct voice input in airplanes. A method of word recognition was developed using Fourier and wavelet analysis to determine the error of an unknown word compared to the known words in a small library. Semi-reliable results

were achieved at identifying an unknown word from a speaker not included in the library.

Prediction by Iterative Supervised Principal Components
Sen Zhao (Carleton)

In this statistical genetics project, we tried to classify people based on their gene expressions. We found that existing methods, including LASSO, Tibshirani's Nearest Shrunken Centroids, Supervised Principal Components (PCA), and 2-Means did not work well with datasets which were unbalanced and had high mislabeling rate. However, unbalancedness and mislabeling are common in the real world. Therefore, we developed an iterative method which extends the algorithm of Supervised PCA proposed by Bair, Hastie, Paul, and Tibshirani (2006). This method worked better than traditional Supervised PCA in terms of error rate, sensitivity, and specificity.

Editor-in-Chief:	Josh Jacobson
Faculty Advisor:	Peter Blanchard
Mess Czar:	Donna Brakke

If you would like to submit an article or math event to be published in the Math Mess, e-mail jacobsoj@stolaf.edu.