2013 SUMS 9 SUDOKU

Fill in the grid so that each row, column, 3x3 block, and main diagonal contains the characters in "2013 SUMS 9".

That is, each region, including diagonals, contains *0*, *1*, *2*, *3*, *U*, *M*, and *9* exactly once and *S* exactly *twice*.

2								
	0			1	9	S		
		1					U	
9			3			0		M
0				S				U
S		3			U			S
	S					M		
		M	9	2			S	
								9

2013 brainfreezepuzzles.com

Jawbreakers Contest!

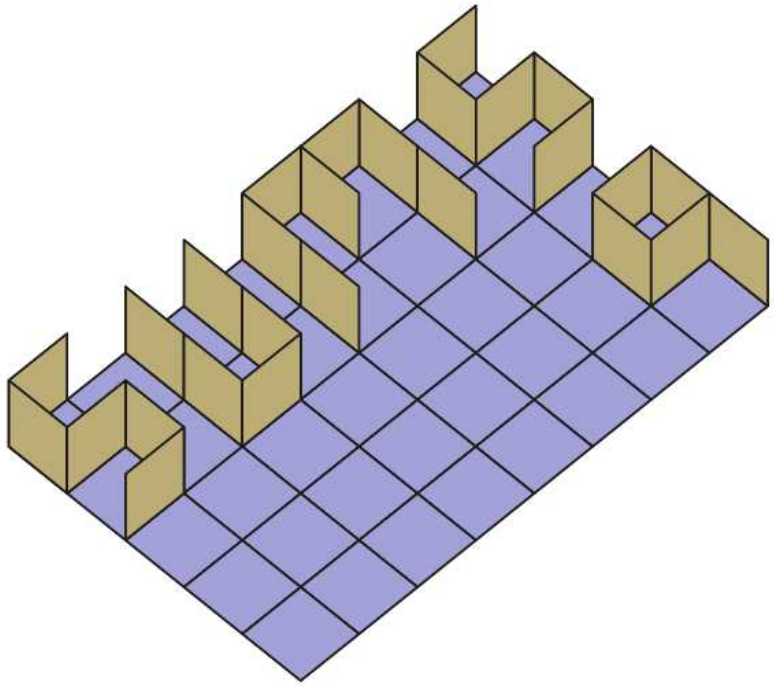
At the puzzle table near the registration area is a container of Jawbreakers. Guess how many and you will win a prize!

Rules: Each person may enter only one time. Your guess must consist of a connected *interval* of real numbers. The winning entry will be the smallest interval containing the actual number of fireballs, with any ties broken using the distance from the center of the interval to the actual number. The winner will be announced at the prize session at the end of the day.

Hint: If a knight and a knave were discussing the number of jawbreakers, one would say there were more than 600 and the other would disagree. In fact this is true for any possible number of jawbreakers. Good luck.

Join us next fall for SUMS 2014!
To be added to the SUMS mailing list, contact one of the conference organizers:
Dr. Elizabeth Brown (brownet@jmu.edu) or Dr. Laura Taalman (taalmala@jmu.edu)

JAMES MADISON UNIVERSITY



9th Shenandoah Undergraduate Mathematics and Statistics Conference

Saturday, September 28, 2013

All events are on the second floor of the JMU HHS Building

Support for the Shenandoah Undergraduate Mathematics and Statistics Conference is provided by:

National Science Foundation grant DMS-0846477
Mathematical Association of America
Regional Undergraduate Mathematics Conferences Program

SUMS is also supported by many offices of James Madison University:

Department of Mathematics and Statistics
College of Science and Mathematics
General Education Program
College of Integrated Science and Engineering
Office of the Special Assistant to the President for Diversity
Office of Admissions
Mathematics and Statistics Club
Pi Mu Epsilon Chapter
Association for Women in Mathematics Chapter
Leigh Ann Bowles-Riggleman

Contributions of books, puzzles, games, and other prizes came from the following generous sponsors of SUMS:

Schedule

9:00-10:00 Registration and Breakfast

2nd floor hallway

If you have not registered online, please visit the registration table in the foyer. Those who pre-registered can find printed nametags at the registration table.

Poster presenters should check in to room 2201. Be sure to stick around for the Prize Session at the end of the day; all talk and poster presenters and all volunteers will be awarded prizes at the session.

10:00-10:10 Opening Remarks

auditorium 2301

President Jonathan R. Alger, James Madison University

10:10-11:00 Opening Address

auditorium 2301

From flapping birds to space telescopes: The mathematics of origami

Dr. Robert Lang,
Robert J. Lang Origami

The last decade of this past century has been witness to a revolution in the development and application of mathematical techniques to origami, the centuries-old Japanese art of paper-folding. The techniques used in mathematical origami design range from the abstruse to the highly approachable. In this talk, I will describe how geometric concepts led to the solution of a broad class of origami folding problems – specifically, the problem of efficiently folding a shape with an arbitrary number and arrangement of flaps, and along the way, enabled origami designs of mind-blowing complexity and realism, some of which you'll see, too. As often happens in mathematics, theory originally developed for its own sake has led to some surprising practical applications. The algorithms and theorems of origami design have shed light on long-standing mathematical questions and have solved practical engineering problems. I will discuss examples of how origami has enabled safer airbags, Brobdingnagian space telescopes, and more.

Robert J. Lang is recognized as one of the foremost origami artists in the world as well as a pioneer in computational origami and the development of formal design algorithms for folding. With a Ph.D. in Applied Physics from Caltech, he has, during the course of work at NASA/Jet Propulsion Laboratory, Spectra Diode Laboratories, and JDS Uniphase, authored or co-authored over 80 papers and 45 patents in lasers and optoelectronics as well as authoring, co-authoring, or editing 12 books and a CD-ROM on origami. He is a full-time artist and consultant on origami and its applications to engineering problems but keeps his toes in the world of lasers, most recently as the Editor-in-Chief of the IEEE Journal of Quantum Electronics from 2007–2010. He

received Caltech's highest honor, the Distinguished Alumni Award, in 2009 and was elected a Fellow of the American Mathematical Society in 2013.

11:10-11:25 Parallel Talks Session 1

(choose one of six talks)

2203 ***Mathematical Modeling in Ecology: What Killed the Mammoth?***
Anneliese Slaton, Mary Baldwin College

Human overhunting is one extinction theory of the Columbian mammoth. We employ two approaches to test this theory: analyze the equilibria of a modified predator-prey model and simulate a stochastic extension of an ODE system into a metapopulation model. These approaches show evidence that human-mammoth interaction affected the mammoths' extinction.

2204 ***Generalized Affine Permutation Pattern Avoidance Sequences***
Traymon Beavers, James Madison University
Karina Bekova, James Madison University

We have constructed a program which outputs affine permutation pattern avoidance sequences, given any base window size as well as any pattern. This allowed us to prove Wilf Equivalences for input patterns as well as that all affine permutations containing the pattern 4321 produce unbounded affine permutation pattern avoidance sequences.

2208 ***Properties of Common Knowledge***
Jeffrey Kane, McDaniel College

Common knowledge is defined as a scenario in which each member of a group knows something, knows that everyone else in the group knows it, knows that everyone else knows that everyone else knows it, and so on. This talk will discuss properties of common knowledge on a communication networks.

2209 ***The Blinking Cycle and Pre-Lens Tear Film Dynamics***
Jonathan Horton, George Mason University

The blinking cycle replenishes the tear film and causes motion of the contact lens. With assumptions based on lubrication theory, fluid dynamics equations are reduced to an evolution PDE describing the tear film's thickness. Further research will explore numerical solutions useful for treating dry eye in contact lens wearers.

2210 ***Rigid Tilings of Quadrants by L-ominoes and Notched Rectangles***
Aaron Calderon, University of Nebraska-Lincoln
Sam Fairchild, Houghton College
Sam Simon, Carnegie Mellon University

We examine tilings of the first quadrant by n-squares cut into notched rectangles and L-tiles. Using a gap argument, we prove rigidity for mn by n tilesets for multiple cuts and quadrants. Furthermore, we examine different cuts for rectangles of coprime dimension and give descriptions of nonrigid tilings.

11:30-11:45 Parallel Talks Session 2

(choose one of five talks)

2203 ***Support Vector Machines (SVMs)***
Ben Howard, George Mason University

SVMs require solving a nonlinear optimization problem with quadratic objective function and linear constraints. Exterior-point methods (EPM) enable iterations to approach the solution of a constrained nonlinear optimization problem from the exterior of a feasible set. We discuss the fundamentals of SVMs and advantages that the EPM relies on.

2204 ***Warings Problem and Quaternion Algebras***
Samuel Whitfield, McDaniel College

Waring's Problem has a long history and has been generalized to a number of new contexts with the notable exception of Quaternion Algebras, beyond their base case. We have generalized Waring's Problem for squares to several different classes of Quaternion Algebras, doing so using solely elementary methods.

2208 ***Exploration of 3D Printed Environments for Caenorhabditis elegans***
Jeff Kopsick, James Madison University

Using 3D printers in the JMU Maker Lab, we have developed a protocol for printing 3D environments for the study of C. elegans swimming in environments of different geometries and fluids of different viscosities. This project involves experimental and theoretical components as well as techniques in image segmentation and processing.

2209 ***The Dynamics of Nucleation in Stochastic Cahn-Hilliard Systems***
Mahmoud Namazi, George Mason University

The stochastic Cahn-Hilliard PDE describes phase separation in a binary alloy. One phenomena that occurs is nucleation where one metal forms droplets in the other metal. This research utilizes various homological tools to count the droplets. We show that these tools are effective and prove certain qualities about Cahn-Hilliard model.

2210 ***Composition of Solutions for the n+k Queens Separation Problem***
Biswas Sharma, Morehead State University

The n+k Queens Problem requires the placing of n+k Queens and k Pawns on an n x n chessboard in such a way that no two Queens attack each other. It has been proven that the problem has a solution when $n > \max\{87+k, 25k\}$. We attempt to obtain nice patterns and lower this bound on nby composing solutions and partial solutions for smaller values of n to obtain solutions for larger values of n.

11:50-12:05 Parallel Talks Session 3

(choose one of five talks)

2203 ***Mathematical Modeling of Dynamic Social Processes***
Alexandra Zeller, George Mason University

This project models the social interactions of human immigration and emigration within regions. Potential applications are discussed and include disease outbreaks, regulatory influences, and language differences. Mathematical modeling is combined with quantitative sociology in a system of differential equations that accurately projects a dynamic social process.

2204 ***Sierpinski Numbers in Quadratic Equations.***
David McKennon, Washington and Lee University

Studying infinitely Sierpinski numbers of the form k*2^m+1 in quadratic equations of the form k^2+bk+c. By using the Chinese Remainder Theorem and developing a generalization for different values of b and c.

2208 ***Derivatives/Integration***
Parissa Joukar, John Handley High School

With Calculus, the environment can become a safer, cleaner, and more efficient place.

2209 ***Black Holes are Cool***
Josh Mitri, James Madison University

Once there was a star. Named Bill. Bill enjoyed spewing radiation into the universe. One day Bill's energy ran out. He promptly collapsed in a dainty heap. He awoke more powerful than ever before. He laughed a mighty laugh and started to accrete nearby objects into his path.

2210 ***K-potent Groebner bases and Sudoku***
Lacey Johnson, James Madison University

Sudoku can be described as a system of polynomials which can then be solved using Groebner basis techniques. A Boolean idempotent approach restricts degree growth of intermediate polynomials, but increases the number of variables. We use a k-potent approach which restricts degree growth, but minimizes the number of variables.

12:10-1:10 Lunch and Poster Session

2nd floor hallway and foyer

Lunch: Those who registered for lunches have stars on their nametags and can pick up lunches near registration at 12:30. At 12:40, those who did not reserve a lunch may take a box lunch if any remain. You may eat in any of the talk rooms or side rooms.

Poster Session: Students will be near their posters during lunch. Please stop by and see their excellent work! Poster judging will start at 12:25.

Rigid Tilings of Quadrants by L-ominoes and Notched Rectangles
Aaron Calderon, University of Nebraska-Lincoln

Differential Invariants of Curves and Surfaces in Nil3
Joseph Gills, Longwood University

Proving the Three Trigonometric Identities
Rachael Hazlett, Mountain Vista Governor School

Hilbert's Third Problem
Alexander Hicks, Mountain Vista Governor's School

K-potent Groebner bases and Sudoku
Lacey Johnson, James Madison University

Why .99 Repeated Equals 1
Brian McGuire, Mountain Vista Governer's School

The Law Of Continuity
Ashley Heuser, Lord Fairfax Community College
Ryan McKenna, Lord Fairfax Community College

Quadratics in Trigonometric Identities
Jennie Cuddeback, Mountain Vista Governor's School
Jiyon Kim, Mountain Vista Governor's School
Ro Provost, Mountain Vista Governor's School

1:10-1:25 Parallel Talks Session 4

(choose panel or one of five talks)

2202 ***Panel Session on REU and Summer Programs***
Edwin O'Shea, James Madison University, moderator
Aaron Calderon, University of Nebraska-Lincoln
Biswas Sharma, Morehead State University
Sunrose Shrestha, Hamilton College

Want to learn more about Research Experience for Undergraduates programs and other summer opportunities in mathematics? Find out from this panel of students and faculty.

2203 ***Determining Future Genotype Proportions***
Shaun Miller, Winona State University

Given the current proportion of genotype distribution in a given population, we can use linear algebra and Markov chains to predict the genotype proportions in future generations. This presentation discusses practical importance for scientists and researchers who want to limit undesired genes, or increase beneficial genes in future generations.

2204 ***Differential Invariants of Curves and Surfaces in Nil3***
Joseph Gills, Longwood University

In this talk, we study the three dimensional geometry Nil3 in the geometric spirit of Felix Klein. Viewing Nil3 as 3-space equipped with an alternative group of ``rigid motions," we employ the Fels-Olver moving frame method to find a complete set of differential invariants for curves and surfaces in Nil3.

2208 ***Approximating the products of multi-parameterized functions***
Alexander Goldstone, George Mason University

We consider a newly proposed algorithm for approximating products of parametrized functions. The algorithm applies the Gram-Schmidt method to generate a subspace representative of the parameterized function. A two-

step procedure is applied for evaluating products in higher dimensions. The cost and error of the algorithm are analyzed across multi-parameter cases.

2209 ***Estimating the Size of a Closed Population Using Capture & Recapture Methods***
Rebecca Neal, James Madison University

We aim to improve over the current approaches in estimating the size of a closed population. We use loglinear models to model dependence among samples. We further use model averaging techniques to reduce model selection uncertainty. Simulations show a weighting method based on BIC generally perform better than other methods.

2210 ***K-potent Groebner bases and Sudoku***
Lacey Johnson, James Madison University

Sudoku can be described as a system of polynomials which can be solved using Groebner basis techniques. We use a k-potent approach allowing each variable to take on k values. The approach restricts degree growth, but minimizes the number of variables. Preliminary results show this approach produces the fastest results.

1:30-1:45 Parallel Talks Session 5 *(choose panel or one of five talks)*

2202 ***Panel Session on REU and Summer Programs CONTINUED***
This panel began in the previous session. People should feel free to enter or leave during the break as the discussion continues.

2203 ***Multilevel Monte Carlo for Financial Options***
Kole Reddig, George Mason University

Multilevel Monte Carlo is a computational method for financial option pricing that achieves improved accuracy over the normal Monte Carlo method. In this talk, I give an introduction to financial options and the Black-Scholes formula, speak briefly about Monte Carlo estimates, and explain and implement the Multilevel Monte Carlo algorithm.

2204 ***M^3: Design, control and optimization of a walking robot***
Lisha White, James Madison University

Constructing an autonomous walking robot requires engineering and mathematical components, and was the focus of this summer's NREUP M^3 project. We'll first talk engineering; the programming, design, and construction using an Arduino, cardboard, Popsicle Sticks, and a 3-D Printer. We'll also talk math; the kinematics and optimization of leg design.

2208 ***Using Affine Matrices to Navigate a Virtual Space***
William Hollingsworth, Longwood University

Undesirable characteristics of sound (noise), produced by aircraft, are disruptive to communities. NASA's Langley Research Center has developed virtual reality software that simulates aircraft flyovers to determine an psychologically acceptable noise level. We explore how affine matrices can be used to transform the graphics of the simulation.

2209 ***Large Network Analysis***
Skyler Stasiewicz, Hood College
Tarang Hirani, Hood College

We will present our analysis of two networks, the yeast genome and air traffic, which were studied using methodologies from graph theory. Using results from the research of past data analysts, we developed algorithms to calculate a new measure of the randomness of each data set.

2210 ***Sandpile Models on Fractal Graphs***
Ilse Haim, University of Maryland, College Park

The Abelian Sandpile Model involves placing chips on a graph's vertices. If a vertex has more chips than its degree, then it must topple and distribute one chip to each neighboring vertex. This talk presents patterns that arise when simulating toppling on fractal graphs, with emphasis on the Sierpinski Gasket.

1:50-2:05 Parallel Talks Session 6 *(choose panel or one of five talks)*

2202 ***Panel Session on Graduate School***
Eva Strawbridge, James Madison University, moderator
Rao Chaganty, Old Dominion University
Joyati Debnath, Winona State University
Jill Dunham, Hood College
Julia Spencer, Mary Baldwin College

What is graduate school really like? What makes a good graduate school application? What schools should you consider? How important is the GRE subject test? Find out from this panel of faculty members.

2203 ***Realistic Agent Behavior in Economic Games***
Edison Bailey, George Mason University

Standard economic and financial models assume strongly rational behavior for all agents. We develop a model for how people might actually behave in two economic games, the symmetric Minority Game and its asymmetric counterpart (the El Farol problem). We compare various measures of efficiency against theoretical results and experimental data.

2204 ***One-Singular Knots***
Ryan Stees, James Madison University

We describe the three methods we used to create knots with a lone singularity, methods we used to distinguish these one-singular knots, and surprising difficulties encountered along the way.

2208 ***Reconstruction of video using SVD with delays***
Wonjun Lee, George Mason University

Singular Value Decomposition (SVD) is a matrix factorization that can be used to compress or filter data. We apply this idea to reconstruct video acquired with noise. We find the idea of time delay is essential to achieve optimal noise cancellation.

2209 ***Finite Element Methods for the Axisymmetric Maxwell Equations***
Justin Hall, James Madison University

A three-dimensional problem defined on an axisymmetric domain can be reduced to a sequence of two-dimensional problems. Due to the Jacobian arising from change of variable, however, one must work in weighted Sobolev spaces. We will then analyze the finite element method applied to the axisymmetric Maxwell equations.

2210 ***Finding cycles in the kth power diagraphs over integers modulo a prime***
Wenda Tu, Washington and Lee University

Given p prime and k a positive integer, we define G^(k)_p to be the diagraph whose set of vertices is {0,1,..., p-1}. There is a directed edge from vertex a to vertex b if a^k=b mod p. Our research concerns the existence of a length-t cycle in G^(k)_p.

2:10-2:25 Parallel Talks Session 7 *(choose panel or one of five talks)*

2202 ***Panel Session on Graduate School CONTINUED***
This panel began in the previous session. People should feel free to enter or leave during the break as the discussion continues.

2203 ***Matrix Population Model for Monarch Butterflies***
Emily Hunt, James Madison University

The monarch butterfly exhibits a unique migration phenomenon by leaving Mexico in the spring and traveling to Canada; later generations return to the same location in Mexico the following fall. We use periodic population matrices to model the life cycle of the eastern monarch and incorporate other potential dangers.

2204 ***Equivalence of the Quantum and Homological Braid Group Representations***
Onyebuchi Ekenta, Washington and Lee

In 2001, Stephen Bigelow showed the braid groups are can be represented faithfully as sets of linear operators on the second homology module of a topological space. Jackson and Kerler demonstrated an equivalence between this representation and the quantum representation. This project extended the equivalence to higher homology representations.

2208 ***Dimensionality Reduction of Video Data using SVD***
Brian Notarianni, George Mason University

We give a quick overview of Singular Value Decomposition SVD and how it can be used for dimensionality reduction. Our approach separates out temporal and spatial data from videos by breaking it down into subimages. We apply our approach to track a Brownian ball.

2209 ***Finite Element Methods for the Poisson Equation and its Applications***
Charles Crook, James Madison University

We visualize the finite element approximation to the solution of the Poisson equation on different domains and observe the corresponding order of convergence. For a real-world application, we use this approximation to distinguish different cartoon characters. Furthermore, the weighted Poisson equation is then used to distinguish three-dimensional objects as well.

2210 ***Universal State Transfer on Graphs during Quantum Walks***
Sunrose Shrestha, Hamilton College

This talk introduces the concept of perfect and pretty good state transfers during quantum walks on graphs. It then provides an infinite family of graphs which have pretty good state transfers from one to every other vertex and gives a method to construct other families with such properties.

2:25-2:55 Afternoon Tea *2nd floor hallway*

Please join us for tea, coffee, and tasty treats in the HHS foyer. The start of tea is your last chance to enter the jawbreaker contest!

3:00-3:10 Prize Session *auditorium 2301*

After tea please join us in congratulating all of our student presenters and the winners of the poster competition and the candy corn contest.

3:10-4:00 Closing Address *auditorium 2301*

Beautifying life with mathematics

Dr. Carolyn Yackel,
Mercer University

This talk presents a partial classification of issues that arise in using abstract mathematical structures to model artwork and hinged objects. Examples are taken from the fiber arts and flexagons.

Carolyn Yackel earned her bachelors at the University of Chicago, and her Master's and Doctorate at the University of Michgan. She now works at Mercer University where she studies the mathematics of beautiful artwork and fascinating objects. In addition to popularizing the field of mathematical fiber arts through the books Making Mathematics with Needlework and Crafting by Concepts, she enjoys teaching, reading, gardening, cooking, and hanging out with her dog, Zeke.