MD-DC-VA Section MAA Fall 2009 Meeting at Goucher College
Contributed Paper Abstracts

Sudoku, Graphs and Group Actions Elizabeth Arnold, James Madison University CP5	Have you ever had a feeling of déją vu when solving a Sudoku puzzle? That maybe you have solved this one before? If one takes a Sudoku puzzle and rotates it 90 degrees or flips it on an axis, it is "essentially the same" puzzle as before. How can we classify these puzzles that are "essentially the same"? The answer involves group actions and graph theory. In this talk, we identify a symmetry group for Sudoku and its smaller 4 x 4 counterpart, Shidoku. We will say that 2 puzzles are "essentially the same" if one can be mapped to the other by the action of a group element. While the symmetry groups for both Sudoku and Shidoku are known, they are very large. In this talk, we demonstrate using graph theory that a much smaller subgroup will suffice.
The Loose Caboose: Hiding good mathematics in simple problems Jennifer Bergner, Salisbury University CP2	Building and testing conjectures is important in mathematics but can be overwhelming to the uninitiated. Come snap some cubes together and see how you can be derailed into doing some good mathematics.
Mathematical circles - what are they? Julia Brodsky, Art of Inquiry CP5	Mathematical circles provide an informal setting for advanced students to explore mathematics outside the school curriculum, develop critical thinking and logical skills, and grasp the excitement of intellectual challenges. The paper explains what a mathematical circle is and what it is not, along with the guidelines on how to start a mathematical circle.
Why Is PSL(2,7) Isomorphic To GL(3,2)? Ezra Brown, Virginia Tech CP6	We construct a straightforward, explicit bijection from the group PSL(2,7) onto the group GL(3, 2). Our proof requires only elementary facts about groups, fields, and matrices. In particular, our proof does not utilize projective geometry, block designs, or simplicity arguments. This work is joint with Nicholas Loehr.
A Matched-Pairs Study on Interactive Computer Labs in Liberal Arts Math Frederick Butler, York College of Pennsylvania CP4	We give details on a multi-year study on the effects of an interactive computer laboratory component in a large-sectioned Liberal Arts Math course. One class section received a portion of the course material via interactive labs, while the other section received the same material through traditional lecture. Forty-two pairs of students (one from each section) were matched on cumulative GPA, math SAT subscore, year in college, and college math background. Performance was compared on various course components, and on a pre and post test designed to measure change in reasoning abilities. The study found that the interactive laboratory activities may provide some benefits to the students, although the evidence is far from conclusive.
The Mathematics of International Trade II James Case CP4	The standard argument in favor of free international trade is purely mathematical, and may be found at www.FreeTradeMath.org. The talk will demonstrate that an even more standard argument from mathematical economics leads to another conclusion.
Improving the Learning of Mathematics through the Game of Chess (ILMC) Boyd Coan, Norfolk State University CP6	It is well documented that Chess can be used as a motivating vehicle for learning at the elementary school level in under-represented minority populations. In this presentation, the possibilities of using Chess and some of its relationships with Game Theory to improve the attitudes toward learning mathematics will be explored. The target group is under-represented minorities ages 17-25.

Create Symmetric Stiffness Matrix in Nonlinear Finite Element Method Ming Fang, Norfolk State University CP2	In this talk, we will discuss a method, which is frequently used by engineers, to create symmetric stiffness matrix in nonlinear finite element method. We would like to work with a symmetric stiffness matrices for computational reasons, i.e., the amount of storage needed is smaller and there are a number of very fast solvers for symmetric matrices.
What Moves You: Using Legs for Vehicular Transportation Jonathan Graf, Towson University CP4	Most vehicles are transported by the rotation of wheels. The Department of Mathematics and Statistics and Department of Engineering at James Madison University are interested in developing vehicles that will be driven by the motion of legs rather than wheels. In this talk we discuss the motion of five different legs: first, we derive the equations of motion for each leg; second, we calculate the equations for velocity, acceleration, energy and power; third, we optimize the motion by minimizing energies and forces. In order to obtain these results, we developed a differential equation, solved it using the Parker-Sochacki Method and reached the optimal solution using Maple's minimization package.
Confirmatory Factor Analysis of Mental Toughness Sport Questionnaire Hasan Hamdan, James Madison University CP1	The purpose of the present study is to assess the factor structure of the Winning Profile Athlete Inventory, WPAI, and to determine the instrument's predictive validity. In particular, exploratory factor analysis is used to determine the underlying dimensions and confirmatory factor analyses is used to determine the athletes' psychological characteristics believed to be linked with success as measured by the WPAI. ANOVA and regression are also used to examine the utility of the WPAI to predict future objective performance and career longevity in a subset of potential National Basketball Association (NBA.) We conclude that the full-scale WPAI to not be a good predictor of future objective performance players but a good predictor of career longevity in the NBA.
Patterns and Fractals from a Generalized Bitwise AND Brian Heinold, Mount St. Mary's University CP5	One way to generate an object closely related to the Sierpinski triangle is to plot {(x,y) : x AND y = 0}. This uses the bitwise AND operator, computed by converting the operands to binary, applying the logical AND operation one-by-one to the binary digits, and then converting the result back to base 10. We will suggest a natural generalization of this operation to bases other than 2 and examine the fractal-like, and occasionally bizarre, plots obtained.
Attracting Math Majors Dave Kung, St. Mary's College of Maryland CP5	The average undergraduate institution graduates six or fewer mathematics majors each year. At St. Mary's, we regularly graduate over 20, with roughly 5% of each graduating class earning a mathematics degree. Why do so many of our students choose to study mathematics? Come find out what we do.
Fractals from the Spectra of Cubic Graphs Stephen Lucas, James Madison University CP3	We shall see (and explain why) if you plot the mean versus the variance of the exponential of the eigenvalues of a cubic graph's adjacency matrix, you get a structure that is a fractal.
Thoughts on an inquiry-based learning course in undergraduate analysis Alex Meadows, St. Mary's College of Maryland CP6	This will be a discussion of a recent undergraduate analysis course that included various models of inquiry-based learning, including details of the different methods, results of student feedback on them, and some outcomes based on written reflections.

Interaction between multiple species in heterogeneous environments Aurelia Minut, US Naval Academy CP1	A model is presented for interaction between species in a heterogeneous environment. Analysis is performed on a modified Lotka-Volterra system with diffusion, with emphasis on periodic waves and boundary conditions.
Wavelet Shrinkage Lynette Obiero and Brian Dadson, Virginia State University CP2	An image is often corrupted by noise in its acquisition and transmission stage. Image denoising is used to remove the additive noise while retaining as much as possible the important signal features. The method used for denoising is commonly known as wavelet threshholding or shrinkage. In this talk, we will present two kinds of wavelet shrinkage: Sureshrink and VisuShrink.
Periodic Fractions James Parson, Hood College CP6	We all learned about repeating decimals in elementary school, and most of us probably haven't thought about them since. There are many nice patterns in the digits of the period, which alert 5th graders could notice. I will explain some patterns with elementary number theory and leave a few for the audience to puzzle out.
Geometry of Fractal Squares Kristine Roinestad, Virginia Tech CP4	This talk will examine analogues of Cantor sets, called fractal squares, and some of the geometric ways in which fractal squares raise issues not raised by Cantor sets. Also discussed will be a technique using directed graphs to prove bilipschitz equivalence of two fractal squares.
Defending the Roman Empire Robert Rubalcaba, Department of Defense CP3	A Roman dominating function is a coloring of the nodes of a graph with the colors {0,1,2} such that every node colored 0 is adjacent to at least one node colored 2. The colors represent the number of Roman legions stationed at a given node. A vertex is called unsecured if no legions are stationed there, i.e. $f(u) = 0$. An unsecured node (u) can be secured by sending a legion to u from an adjacent node (v). However, Emperor Constantine the Great decreed that a legion cannot be sent from a node if doing so leaves that node unsecured (i.e. if $f(v) = 1$). Thus, two legions must be stationed at a node ($f(v) = 2$) before one of the legions can be sent to an adjacent node. Thus, there are two types of legions, stationary and traveling. Stationary legions only secure the node they are stationed at, while traveling legions only secure neighboring nodes. Each unsecured node (no legions) must have a neighboring node with a traveling and stationary legion. In this talk we prove a new bound on the Roman domination number and present several visual examples of Roman defenses.
Two Interesting Differential Equations for Upper Level Students James Sochacki, James Madison University CP3	I present two interesting and simple ordinary differential equations in the (x,y) plane. The ODE's are simple in the sense that the RHS are quadratic in x and y. The first has an infinite number of equilibrium points and periodic solutions for a specific set of coefficients for the quadratic polynomials. The second has exactly two equilibrium points, but shows sensitive dependence on initial conditions, again for a specific set of initial conditions. Phase portraits possessing artistic beauty will be presented.

A New Connection Between the Triangles of Stirling and Pascal Emily Sullivan, York College of PA CP2	Pascal's triangle is presented as the limit of a sequence of triangles that begins with the triangle for Stirling numbers of the second kind. The triangles in the sequence are of interest in their own right, representing the solutions to a sequence of enumeration problems involving partial permutation matrices (or, equivalently, rook theory). The sequence of triangles has connections with Fibonacci numbers and triangular numbers. The triangles also produce fractals when shaded according to remainders modulo n for various n. Many open problems related to these triangles are presented. Among these are the formation of a difference equation to solve the general case. So far, only special cases have verified formulas and all but a few of the triangles must be generated by brute force.
Easy-to-use tools for online classes Jennifer Szczesniak, Hagerstown Community College CP3	During the last year I have taught Precalculus and Differential Equations online. After receiving a Wacom tablet from my school, I used it, along with Camtasia and OneNote, to make video notes to post online. I have also begun to hold online office hours, using the tablet to make communication easier. In this talk, we will discuss the technology and also see a demonstration of the steps involved in making a video. All of these tools can be used for online courses or to supplement traditional courses.
A Sum Theorem for (FPV) Operators and Normal Cones M.D. Voisei, Towson University CP1	In a recent book by S. Simons (on maximal monotone operators in general Banach spaces) the author mentions that the proof of a lemma (from a previous version of the book) is incorrect and one does not know whether it or its consequences are true. The goal of this talk is to provide a result that improves upon the lemma in question.
Session on College Preparedness Moderators: Denny Gulick, University of Maryland Lee May, Salisbury University Robert Sachs, George Mason University	This is a follow-up to spring discussion. The question that is being asked in many circles and task forces is: What are important indicators relative to student readiness for college? The session will focus on this topic. Indicators could include student attitude of wanting to learn, a curriculum in K-12 that is coherent and learnable, and grading policies that assess student learning. In mathematics itself, indicators can also include student ownership and ready access to arithmetic facts and basic algebra facts, and calculator use only for enhancement of particular mathematical concepts. In the session, we hope to be able to come to agreement on a set of indicators that can be communicated publicly.