MD-DC-VA Section MAA Fall 2008 Meeting at Hood College
Contributed Paper Abstracts

A stability study of three numerical schemes for a skew-dominated discretized system McCarthy Anum-Addo & Matthew Darst, George Washington University CP3	We consider nonlinear systems of differential equations that may be discretized as $\boldsymbol{B}^{n+1} = (\boldsymbol{I} - \tau \boldsymbol{G}^{n})\boldsymbol{B}^{n}$. The real matrix $\boldsymbol{G}^{n}$ can be decomposed into symmetric, $\boldsymbol{P}$, and skew-symmetric, $\boldsymbol{S}$, components. If the skew component becomes dominant, then the CFL stability condition requires the step size τ to approach zero. As a first step we introduce the scheme $\boldsymbol{G}'(\theta) = \boldsymbol{I} - \tau(1-\theta)\boldsymbol{P} - \tau\theta\boldsymbol{S}$ where $0 \le \theta \le 1$. We consider the stability of $\boldsymbol{G}'(\theta)$ and alternative schemes $\boldsymbol{M}'(\theta) = \boldsymbol{I} - (1-\theta)\tau\boldsymbol{P} - \tau\theta\boldsymbol{S} + \tau^2\theta^2\boldsymbol{S}^2$ and $\boldsymbol{C}'(\theta) = \boldsymbol{I} - (1-\theta)\tau\boldsymbol{P} - \tau\theta\boldsymbol{S} + (1-\theta)^2\tau^2\boldsymbol{P}^2$, to investigate whether a stable scheme with nonzero step size exists. We concentrate on 2 X 2 matrices and find general analytic solutions to the step-size problem using the diagonal dominance condition of $\boldsymbol{P}$-matrices. We include numerical examples that highlight these analytical results.
Tom Kirkman and his Electric Schoolgirls Ezra Brown, Virginia Tech CP2	The Kirkman schoolgirls problem, a famous gem due to T. P. Kirkman in the mid 19th century, asks for 7 distinct arrangements of 15 girls into 5 rows of 3 girls each with the condition that each girl walks in a row with every other girl exactly once. Solutions to this famous problem have connections with algebraic number fields, finite projective 3-space, error-correcting codes, and hat puzzles. This talk will be about these connections.
Properties of Midcircles Maurice Brown, Virginia State University CP2	Let a, b be two nonintersecting circles with midcircle w. We show that if p is a circle tangent to both a, b and such that either a, b lie in the interior of p or a, b lie in the exterior of p, then p is orthogonal to w. If p is orthogonal to both a, b, then we also show that p is orthogonal to w. If a, b, w are circles and a', b' are the inverses of a, b with respect to w and p is the midcircle of a, b, then p' is the midcircle of a', b'.
The Mathematics of Free Trade James Case CP6	Modern economic scholarship claims to have reduced the matter of international trade to a mathematical theorem. We shall state, prove, and critique that theorem.
A Mathematical Model of Canary Vocal System Hasan Coskun, Texas A&M University-Commerce CP3	We present a physical model of the canary (Serinus Canarius) vocal system that accounts the acoustic features of observed canary sounds.
Common misconceptions in middle school math textbooks Jerome Dancis, University of Maryland CP5	I read several middle school mathematics textbook series last year. Now, I understand better how students arrive in college with misconceptions. Many textbook writers appear to have had too little training in how to write mathematics correctly. For example: Wrong use of negative numbers in real world problems: "Death Valley is -282 feet below sea level." This type of error was made consistently; not a typo. Such conflicts between common English usage and textbook mathematics must be confusing to students.
Topology of the Universe George DeRise, Thomas Nelson Community College CP4	Einstein's field equations only give the local character of the Universe. There are three dimensional manifolds with fundamental regions which are polyhedra that can give the global topology of the Universe. These theoretical ideas are physically testable.

Circle Chains Raymond Fletcher III, Virginia State University CP2	Let a, b be circles. A circle chain on a,b is a sequence of circles with the property that each meets its predecessor in two points, one on a and the other on b. In a closed circle chain the last circle in the sequence meets the first similarly. We show how even and odd length closed circle chains of any length can be constructed demonstrate the tight structural requirements exhibited by odd closed circle chains.
What Exactly is Haley's Contribution to Newton's Method? Ilhan Izmirli, American University CP3	In this paper we will discuss a convergence acceleration process developed by the famed astronomer Edmond Haley.
The Horseshoe Map and Pulses in a PDE Russell Jackson, U.S. Naval Academy CP4	The horseshoe map is a fundamental object in the study of dynamical systems. The presence of a horseshoe serves as an indicator of chaotic behavior within a system. Moreover, the horseshoe provides a catalog of distinguished solutions via an equivalence between the dynamics on its attractor and a simple shift map on a finite symbol space. In this paper, we describe a horseshoe map that can be found in a common PDE model. This model (the nonlinear Schrodinger Equation with a periodic potential) has been used to describe optical propagation in a waveguide as well as Bose-Einstein Condensation in a lattice. The identification of this horseshoe allows an easy way to catalog nonlinear waves in this system and even provides some initial information about the stability of these waves.
Counting in Messy Polynomial Rings, Part 2 Jody Lockhart, U.S. Naval Academy CP2	In this paper, we explore concepts of reducibility and having zeros in $Z_m[x]$.
Incorporating undergraduate research into class projects Carla Martin, James Madison University CP5	One of the many reasons for exposing students to research as undergraduates is that it helps students to better define their interest areas. Though we all encourage students to do undergraduate research, there are many students who, despite encouragement from faculty, will never take the initiative to participate in an undergraduate research project. In this talk I will explain how I have incorporated research projects into the classroom. As a direct result of these projects, students have been influenced to add math as a major, change their emphasis in the math major, and/or continue on to graduate school. Several have also continued their projects beyond the course resulting in independent studies and undergraduate thesis projects. Lots of example research projects for the classroom will be shared. The examples are in the context of numerical computing courses, but the framework can be applied to any course.

Delaunay tessellation for the elucidation of protein structure-function relationships Majid Masso, George Mason University CP6	Amino acids are the building blocks of proteins, the workhorse macromolecules of all organisms responsible for undertaking a host of structural, regulatory, and catalytic tasks. There are 20 distinct types of amino acids, and each protein consists of an unbroken sequential linear linkage of several dozen to several hundred amino acid residues (beads on an unclasped necklace), which subsequently folds into a precise three-dimensional structure. Protein structure dictates function, and we describe how the computational geometry technique of Delaunay tessellation, combined with application of the inverse Boltzmann principle, can be utilized for modeling protein structure. The approach naturally provides a way to empirically quantify the structural impact that a mutation, due to an amino acid substitution, has on a protein. We show that these measured relative structural changes correlate well with published experimental relative functional changes due to mutation. As such, we implement cutting-edge supervised classification and regression statistical machine learning algorithms to train models capable of accurately predicting functional changes associated with unexplored mutations in proteins.
Competition in Two-Dimensional Heterogeneous Environments Aurelia Minut, U.S. Naval Academy CP3	A model is presented for competition between two competing species in a heterogeneous environment within two dimensional space. Analysis is performed on a modified Lotka-Volterra system with diffusion, with emphasis on periodic waves and boundary conditions.
Putting on the PGA Tour Roland Minton, Roanoke College CP5	Even the best golfers in the world miss a high percentage of short putts. Actual percentages from 2007 will be given. A model of green imperfections explains many of the misses. A system for ranking the best putters will be given.
A hole through a cube Phillip Poplin, Longwood University CP6	In this talk we will derive the volume remaining when a hole is drilled through a cube along the diagonal of the cube; and view some graphs of the remaining part of the cube.
On the Stability Properties of a Dynamical System Associated with Cardiac Arrhythmias Irina Popovici, U.S. Naval Academy CP5	We study a two-dimensional dynamical system introduced by Baker and Kline to model the connection between membrane currents, action potential duration, and cardiac rhythm. These continuous, but not C1, plane systems can have rich dynamical portraits. Depending on the five parameters governing the system, the orbits may be as simple as those of a one-dimensional unimodal system, or they may lead to intricate dynamics, with several (co-existing) basins of attractions.
Extremely Villainous Graph Colorings Robert Rubalcaba, Department of Defense CP1	Suppose you have a minimum proper coloring of the vertices of a graph, and a villain rearranges your coloring so that it is no longer proper. Different methods of restoring this rearranged coloring to some minimum proper coloring are discussed. Measures of two such methods are the villainy and weak villainy of a graph. The villainy and weak villainy are computed for some classes of graphs including complete multipartite graphs, Mycielski graphs, and Cartesian products. Some new extreme examples are presented, and open problems posed.

The Soddy Axis Andrea Sims, Virginia State University CP4	We begin with three circles, α, β, and δ, that we consider the original circles, and they are either nonintersecting or tangent to each other at strictly one point. Our objective is to prove the radical center, the concurrence of the radical axes of the three circles α, β, and δ taken in pairs, is collinear with the centers of two circles tangent to each of α, β, and δ which we call σ_1 and σ_2. We also will show that the radical center is collinear with the points of intersection of the midcircles of α, β, and δ taken in pairs called ω, ω ', and ω ''. We will call this line the soddy axis.
The Linear Package and its Integration into an Undergraduate Linear Algebra Course Don Spickler, Salisbury University CP4	Linear is a Java application designed and written as a collaborative project between the students and faculty at Salisbury University. It was designed to be both a learning and exploration tool for the student as well as a demonstration tool for in-class examples and discussions. Linear has many standard facilities for matrix manipulations and calculations and some specialized facilities for concept visualization. In this talk we will demonstrate some of its capabilities and discuss its integration into an undergraduate Linear Algebra course. Linear can be found on my website at http://faculty.salisbury.edu/~despickler/personal/Linear.html.
The Wheel of Time, in sand Roger Thelwell, James Madison University CP6	The chaotic waterwheel is a fairly well known experiment which captures the dynamics of the Lorenz system. A group of four JMU NREUP funded students explored this experiment and then devised their own. Driving the wheel with sand instead of water subtly changes the mathematics, and reveals new questions about both systems. In this talk, I'll present our recent results and discuss some of our surprising conjectures.
Reconstructing Hyperplane Arrangements William Traves, U.S. Naval Academy CP1	A collection of lines in the plane intersect at several points. Given the points and the number of lines meeting there, can we reconstruct the configuration of lines? I'll provide an elementary answer to this question and offer several extensions.
Counting in Messy Polynomial Rings, Part 1 William Wardlaw, U.S. Naval Academy (ret) CP1	In this paper, we explore concepts of reducibility and having zeros in $Z_m[x]$.