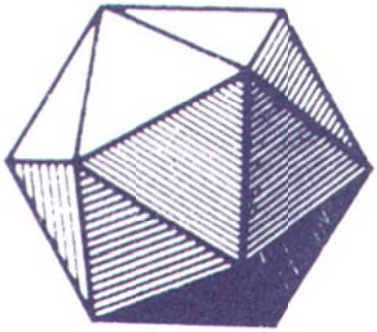
North Central Section

Mathematical Association of America



Fall Meeting • October 18-19, 2013
South Dakota State University
Brookings, South Dakota

Friday, October 18, 2013

6:30 – 9:15 **Registration** – Crothers Hall first floor Lobby
$10 Regular (Students, first time attendees, and speakers are free)
$5 for MAA-NCS section NExT members.

6:30 – 8:00 **Book Sales**, Crothers Hall 205

Internet access: wireless access throughout campus

Evening Session – Crothers Hall # 204, Dr. Kurt Cogswell, Presiding

7:05 – 7:25 **Prof. Donna Flint, South Dakota State University**
Magic Squares - A Student Project

7:30 – 7:50 **Prof. Wally Sizer, Minnesota State University, Moorhead**
Formation of the North Central Section

Invited Lecture
8:00 – 8:50 **Prof. Cedric Neumann, South Dakota State University**
A Statistical Model for the Quantification of the Weight of Fingerprint Evidence
9:00 –10:15 **Reception** - Walder Room on the second floor of the Student Union

Saturday, October 19, 2013

8:15 – 11:00 **Registration** – Crothers Hall first floor lobby

8:15 – 11:00, 12:00-1:40 **Book Sales** – Crothers Hall 205

Morning Session – Crothers Hall # 204, Dr. Donna Flint, Presiding

9:00 – 9:05 Welcome
Dr. Laurie Nichols, Provost and Academic Vice-President, SDSU

9:05 – 9:25 **Prof. Tom Sibley, St. John's University, College of St. Benedict**
When Is a Cube like a Tetrahedron?

9:30 – 9:50 **Prof. Jennifer Galovich, St. John's University**
Mathematical Modeling for the (Mathematically) Faint of Heart

9:50 – 10:10 **Break –** Crothers Hall first floor lobby

10:10 –10:30 **Prof. Don Vestal, South Dakota State University**
The Discrete and Continuous 2-Color Rado Numbers for the Equation
$x_1 + x_2 + \cdots + x_m = ax_0$

10:35 – 10:55 **Prof. Robert Campbell, St. John's University, College of St. Benedict**
A Winning Strategy for the Game of Antonim

Invited Lecture – Crothers Hall #204, Dr. Donna Flint, Presiding
11:00 – 11:50 **Prof. Frank Farris, Santa Clara University**
Polyhedral Symmetry in the Plane?

12:00 – 1:00 **Luncheon** – Campanile Room/Hobo Day Gallery on the 1st floor of the Student Union

1:00 – 1:30 **Business Meeting** – Crothers Hall #204, Dr. Randy Westoff, Presiding

Afternoon Concurrent Session I Crothers Hall #204, Dr. Matt Biesecker, Presiding

1:40 – 1:55 **Patrick Durkin, University of North Dakota**
What is Homotopy Type Theory?

2:00 – 2:15 **Chloe Ondracek, Minot State University**
Identification Problem in Parabolic Partial Differential Equation

2:20 – 2:40 **Nicholas Taylor, Minot State University**
Markov Chain Applications to Baseball Run Forecasting

2:40 – 3:00 **Johannah Miller, Minot State University**
Modelling the Energy Levels of the Hydrogen Atom using the Schrödinger Equation

3:05 – 3:20 **Mitra Devkota, South Dakota State University,** Comparing Autocorrelation of residuals for Ordinary Least Squares and Geographically Weighted Regression models

Afternoon Concurrent Student Session II -- Crothers Hall #217, Dr. Jung-Han Kimn, Presiding

1:40 – 1:55 **Brian Vachta, South Dakota State University**
Numerical Study for Macroscopic Traffic Flow

2:00 – 2:15 **Hyun Lim, South Dakota State University**
A Numerical Implementation of the 1+1 Nonlinear Klein-Gordon Equation

2:20 – 2:35 **Isaac Lyngaas, South Dakota State University**
Parallel Monte Carlo Integration Using GPUs

2:40 – 3:00 Prof. **Namyong Lee, Minnesota State University, Mankato**
Superconvergence in Discrete Dynamical System

Local Organizing Committee:
Dan Kemp (chair), Linda Wendt (departmental Assistant), Matt Biesecker, Jung-Han Kimn

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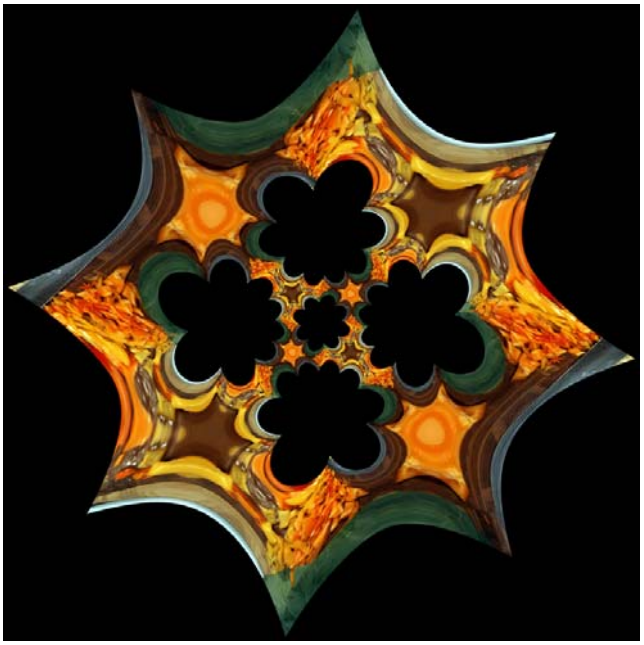
Abstracts

Invited Addresses

- **Frank Farris,** Santa Clara University**, Polyhedral Symmetry in the Plane?**

When we classify plane patterns by their symmetries, we meet a time-honored trichotomy: These patterns may be rosettes, friezes, or wallpaper patterns. The symmetries of a rosette all share a single fixed point; a frieze pattern is invariant under translation in one direction, a wallpaper pattern in two. In this talk, we undercut tradition, which normally insists that symmetries must preserve distances, by allowing certain distance-deforming transformations to play the role of symmetries. In particular, we show how the polyhedral groups can act on the plane. To make patterns with these new transformations as symmetries, we construct functions invariant under the polyhedral actions. One of these is shown below. Do you believe that it has the same symmetry as a tetrahedron? This talk, accessible to undergraduate mathematics students, combines a little group theory, a little complex analysis, and several other ingredients in the service of mathematics and art.



- **Cedric Neumann,** South Dakota State University**,**

A Statistical Model for the Quantification of the Weight of Fingerprint Evidence

Forensic Science has been described as the "science of individualization". For most of the past century, forensic scientists have exclusively relied on the idea that nature doesn't duplicate itself to form categorical conclusions on the source of evidence recovered from crime scenes, and to report them with absolute certainty. The introduction of DNA profiling 20 years ago has led scientific and legal scholars to increasingly challenge the lack of scientific foundations of pattern-based evidence such as fingerprint, shoe impressions and tool marks. The determination of the source of prints recovered on crime scene is essentially a probabilistic inferential process, which can be supported by statistical models quantifying the weight of evidence of fingerprint comparisons. An ongoing research project, aiming at developing and validating a model to support fingerprint examiners in casework, has resulted in several iterations of such model. This presentation will report the latest development of our model and will address the implications of its use for forensic practice. More generally, some myth in the purpose of statistical research in forensic science will also be discussed.

Contributed Talks

- **Robert Campbell,** College of St. Benedict & St. John's University, **A Winning Strategy for the Game of Antonim**

Antonim is a variant of the classic game of Nim. We will look at the previous work and open problem involving the winning strategy for Antonim. We then will look at the winning strategy for Antonim which was developed by Zach Silbernick, an undergraduate in a summer research program.

- **Mitra L. Devkota,** South Dakota State University, **Comparing Autocorrelation of residuals for Ordinary Least Squares and Geographically Weighted Regression models**

In this talk, we consider spatial autocorrelation of Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR) models. Moran's I and Geary's C for these residuals will be calculated and comparative study will be performed. We will show that degree of autocorrelation of OLS residuals will be higher than that of GWR residuals.

- **Patrick Durkin,** University of North Dakota, **What is Homotopy Type Theory?**

Homotopy Type Theory gives a way of viewing type theory from a topological perspective. The subject has been steadily increasing in popularity since 2006, and is considered by many to be promising as a foundational system. Foundational questions aside, the homotopy interpretation gives an elegant view of type theory. This talk, accessible to anyone with some knowledge of homotopies, will briefly cover some of the major ideas, including the homotopy interpretation and univalence property, dependent and function types, identity types, and some of the nice computational properties.

- **Donna Flint,** South Dakota State University, **Magic Squares- A Student Project**

Recently, a student came to me asking about a topic for a Senior Paper. After some misfires, I tossed out the idea of Magic Squares. Doing some research, the student found a formula on Wikipedia for generating a Magic Square of odd order. After searching through books, internet, and library databases, we could find no information about the origin or validity of this formula. The student project became: Verify that this formula generates a Magic Square of odd order. In this talk, I will talk about the formula, the proof, and the journey for this challenging, yet fun student project.

- **Jennifer Galovich,** College of St. Benedict & St. John's University, **Mathematical Modeling for the (Mathematically) Faint of Heart**

Modern problems in biology are extraordinarily complex; mathematical modeling has proven very useful in reducing that complexity. However the traditional tools of ODEs and PDEs, while useful for mathematicians, are not very accessible to biologists. Tools for analyzing discrete models, however, can be

made very accessible, and at the same time rely on some deep and interesting results from modern algebra. I will describe some of these tools and how they can be used, and point to some of the deep mathematical results on which they are based.

- **Namyong Lee,** Minnesota State University, Mankato, **Superconvergence in Discrete Dynamical System,**

One of the basic questions in scientific computing is the convergence and the efficiency of the convergence of a given numerical scheme. A superconvergent scheme is one which converges faster than generally expected. In this talk, we show how simple geometric idea can derive a classical result of superconveregence. We also demonstrate how this idea can be applied to higher dimensional discrete dynamical system.

- **Hyun Lim[1], Matthew Anderson[2],** and **Jung-Han Kimn[1],** 1. South Dakota State University, 2. Indiana Unversity, **A Numerical Implementation of the 1+1 Nonlinear Klein-Gordon Equation**

We implement a fully implicit numerical approach based on the space-time finite element method for the nonlinear Klein-Gordon equation in the 1(space) + 1(time) dimension. We test $p = 7$th term as the nonlinear term, and show critical collapse near $r = 0$ boundary. The time additive Schwarz preconditioner is implemented to make successful simulation with Krylov Subspace Method solvers. We show that adaptive mesh refinement with respect to space dimension improve our efficiency in simulation.

- **Isaac Lyngaas, Adam Schmitz,** and **Jung-Han Kimn,** South Dakota State University,
Parallel Monte Carlo Integration Using GPUs

Graphics Processing Units (GPUs) represent a promising technology for accelerating parallel computational science applications and a possible alternative for those without access to HPCs. Monte Carlo integration was simulated to show how GPUs implemented with CUDA perform compared to MPI, a system for utilizing multiple Central Processing Units (CPUs). Multiple GPUs in an HPC cluster machine were used simultaneously to further accelerate simulations. The random number generators SPRNG and GASPRNG were used in all simulations to allow random number generation to be done in parallel. Results from the study along with programming and parallelization methods will be discussed.

- **Johannah Miller,** Minot State University, **Modelling the Energy Levels of the Hydrogen Atom using the Schrödinger Equation**

The hydrogen atom is modeled in spherical polar coordinates as an electron orbiting a proton due to an electric coulomb potential. The time independent Schrodinger equation for hydrogen is then solved by using separation of variables method. The radial, azimuthal, and magnetic quantum numbers are calculated. The total wave function describing the quantum states of hydrogen atom is derived.

- **Chloe Ondracek,** Minot State University, **Identification Problem in Parabolic Partial Differential Equation?**

In this work, we consider an inverse problem involving the identification and estimation of distributed parameters in parabolic type initial boundary value problem. Unique solution of the initial boundary value problem is derived. The time dependent parameter is determined by using observational data.

- **Tom Sibley,** College of St. Benedict & St. John's University, **When Is a Cube like a Tetrahedron?**

A colorful use of graphs allows us to infuse the formal beauty of abstract algebra into the visual beauty and intuition of geometry. Geometric analogs to algebraic concepts give different insights of familiar geometric objects and suggest new areas to explore. For example, homomorphisms, substructures and direct products link a cube to a tetrahedron.

- **Wally Sizer,** Minnesota State University, Moorhead**, Formation of the North Central Section**

Searching the history of the NCS I have come up with three possible dates for the beginning of the section. I'll explain their historical importance and fill in other details, then let you choose when you want to think the NCS was established.

- **Nicholas Taylor,** Minot State University**, Markov Chain Applications to Baseball Run Forecasting**

We apply the Stochastic Process of Markov Chains to the game of baseball to calculate a team's expected run scoring potential and analyze significant forecasters of a team's offensive output.

- **Brian Vachta, Jung-Han Kimn,** and **Xiao Qin,** South Dakota State University**, Numerical Study for Macroscopic Traffic Flow**

We conduct a study of numerical methods to the Lighthill, Whitham, and Richards (LWR) model in their applications to macroscopic traffic flow. The first method is a finite difference method based on Lax-Friedrichs idea. The other method is a cell transmission method based on stochastic time headway between vehicles. These algorithms are used in an attempt to create efficient, accurate, and useful models. Historical data for flow and density of traffic on roads are used as a parameter to predict future queuing of traffic in the stochastic model.

- **Don Vestal,** South Dakota State University**, The discrete and continuous 2-color Rado numbers for the equation** $x_1 + x_2 + \cdots + x_m = ax_0$

The 2-color Rado number for an equation is the smallest number *R* such that for any coloring of the numbers from 1 to *R*, there is a solution to the equation with all numbers having the same color. In the discrete case, we only color the integers from 1 to *R*, and in the continuous case, we color all real numbers from 1 to *R*. In this talk, we'll look at the equation $x_1 + x_2 + \cdots + x_m = ax_0$ and what Rado numbers are known.

Spring 2014, MAA NCS Meeting Announcement

April 25-26, 2014

St. Cloud State University, St. Cloud, MN