North Central Section (Founded in 1916)

Mathematical Association of America

Fall Meeting • September 26-27, 2014
North Dakota State University
Fargo, North Dakota

Friday, September 26, 2014

6:30 – 8:30 **Registration** – Minard Annex Lobby
$10 Regular (Students, First time attendees, and Speakers are free)
$5 for MAA-NCS section NExT members.

6:30 – 8:10 **Book Sales**, Minard #118
Internet access: Wireless internet available upon request at registration table

Evening Session – Minard #116, Dr. Dogan Comez presiding
7:00 – 7:20 **Prof. Damiano Fulghesu, Minnesota State University, Moorhead**
Arithmetic Sets in Groups

7:25 – 7:40 **Prof. Oksana Bihun, Concordia College, Moorhead**
Senior Seminar Capstone in Mathematics

7:45 – 8:05 **Dr. Matthew Wright, IMA, University of Minnesota**
Cycles of Digits

Invited Lecture – Minard #116, Dr. Dogan Comez presiding
8:10 – 9:00 **Prof. Mark R. Hoffmann , University of North Dakota**
Quaternions and other Beasties in Quantum Chemistry

9:00 – 10:00 **Reception** - Minard 2nd floor hallway

Saturday, September 27, 2014

8:15 – 11:00 **Registration & Refreshments** – Minard Annex Lobby
8:15 – 11:00 & 12:00-1:40 **Book Sales** – Minard #118

Morning Session – Minard #116, Dr. Artem Novozhilov presiding

9:00 – 9:05 Welcome
Dr. Scott Wood, Dean of the College of Science and Mathematics

9:05 – 9:25 **Prof. Doug Anderson, Concordia College, Moorhead**
An Introduction to Conformable Fractional Derivatives

9:30 – 9:50 **Dr. Barry Cipra, Freelance Mathematics Writer**
John-Art: The Stochastic Geometry of John Shier

9:50 – 10:10 **Break –** Minard Annex Lobby

10:10 –10:30 **Prof. Nathan Axvig, Concordia College, Moorhead**
Mathematical Modeling for Sports Scheduling and Conference Alignment

10:35 – 10:50 **Prof. Tom Sibley, College of Saint Benedict and Saint John's University**
Could Cayley Have Been Loopy?

Invited Lecture – Minard #116, Dr. Maria Alfonseca presiding
11:00 – 11:50 **Prof. Paul Zorn, St Olaf College**
Why Math-speak is Hard: Syntax, Semantics, and Pragmatics

12:00 – 1:00 **Luncheon** – Hidatsa Room, Memorial Union

1:00 – 1:30 **Business Meeting** – Minard #116, Dr. Joel Iiams, Section President, presiding

Afternoon Concurrent Session I Minard #116, Dr. Maria Alfonseca presiding

1:40 – 2:00 **Liz Sattler, North Dakota State University**
Structure of Sub-Fractals

2:05 – 2:20 **Prof. James Carr, Normandale Community College**
Restructuring a Developmental Math Program: a Three Stage Process

2:25 – 2:40 **Michelle Cordier, Kent State University**
If You Can Hide Behind It (Using Rotations), Can You Hide Inside It?

2:45 – 3:05 **Nelson Lahrs, South Dakota State University**
Block Voting and the US Electoral College

3:10 – 3:25 **Bryce Christopherson, Augustana College**
Edge Nim on Trees

Afternoon Concurrent Student Session II -- Minard #112, Dr. Abraham Ayebo presiding

1:40 – 2:00 **Prof. Jung-Han Kimn, South Dakota State University**
The Time Decomposition Method and Its Applications

2:05 – 2:20 **Jordan Torgunrud, Minot State University**
On the Numerical Treatment of Water Pollution Model

2:25 – 2:40 **Nicholas Brown, South Dakota State University**
Base Runs Projection

2:45 – 3:05 **Chloe Ondracek, Minot State University**
Inverse Problem for Projectiles

3:10 – 3:25 **Semere Habtemicael, North Dakota State University**
Variance and Volatility swap

Local Organizing Committee:
Maria Alfonseca (committee chair), Abraham Ayebo, Dogan Comez, Artem Novozhilov

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Abstracts

Invited Addresses

- **Mark Hoffmann ,** University of North Dakota,
  Quaternions and other Beasties in Quantum Chemistry

The overwhelming majority of computational methods of molecular electronic structure theory used in modern quantum chemistry are expressible in terms of low-rank algebraic objects composed of real numbers. This development was driven, or at least facilitated, by early advances in computer hardware and software. An unintended consequence is that modern quantum chemistry is generally plagued by outrageously large data sets and often difficult to interpret qualitatively results. In the past decade, there has been renewed interest in more complex (no pun intended) objects, including tensors of higher rank and/or other number systems. This talk will describe some of the experiences that the UND quantum chemistry group had and is having in these areas.

Bio: Mark Hoffmann received his B.A. with a double major in Astronomy and Chemistry, with honors in Physics, from Northwestern University and then his PhD in Theoretical Physical Chemistry from the University of California, Berkeley. He was a postdoc at the University of Chicago for a year and then at the University of Utah for 2 years. He joined UND as an Assistant Professor in 1988 and was promoted through the ranks, being designated a Chester Fritz Distinguished Professor in 2006. He served as Chemistry Department Chair from 2003 to 2010, and has been an Assistant and now Associate Vice President in the Office of Research since 2008. His principal research interests are the development of new methods of molecular electronic structure theory, especially those that are hybrids of variational and perturbational approximations, and their application to unusual chemical problems.

- **Paul Zorn,** St Olaf College,
  Why Math-speak is hard: Syntax, Semantics, and Pragmatics

Mathematics is famously difficult, especially for students first seriously encountering theory and proofs. The problem is not only that "math is hard" ---which indeed it is---but also that the special language of mathematics is especially hard.

This is not surprising: communicating technical ideas and fine distinctions quite naturally requires extra linguistic effort, and that effort is generally well-requited. The special difficulty of reading, writing, teaching, and learning mathematics stems, I'll argue, only partly from the genuinely complicated syntax and semantics of mathematical language. It arises also from linguistic "pragmatics": what's "heard" depends not only on what's said but also on what "hearers" bring to the "conversation". I'll illustrate with examples connecting the pragmatics and the syntactical and semantic issues, and suggest some possible "mathematico-linguistic "strategies for teaching and learning.

Bio: Born and raised in India, Paul Zorn is now in his fourth decade of professing mathematics at St. Olaf College. His professional interests include complex analysis, mathematical exposition, textbook writing, and the role of mathematics among the liberal arts. His 1986 paper "The Bieberbach Conjecture" was awarded the 1987 Carl B. Allendoerfer Award for mathematical exposition. He has co-authored several calculus textbooks with his St. Olaf colleague, Arnold Ostebee. His most recent book is Understanding Real Analysis (AK Peters, 2010). From 1996 to 2000, he was editor of Mathematics Magazine, and he recently completed a 2-year term as President of the Mathematical Association of America.

Contributed Talks

- **Doug Anderson,** Concordia College, Moorhead,
  An Introduction to Conformable Fractional Derivatives

There are two common definitions of fractional derivatives, the Riemann-Liouville version and the Caputo version, both of which involve an integral and the gamma function. Recently, several Jordanian mathematicians introduced a new fractional derivative that is point based and uses a limit definition only. We will briefly explore this idea.

- **Nathan Axvig,** Concordia College, Moorhead
  Mathematical Modeling for Sports Scheduling and Conference Alignment

The Great Lakes Lacrosse League is a collegiate club league consisting of about 40 teams from the upper Midwest. Our objective was to optimize this league's scheduling procedures in order to reduce travel costs as well as to promote equal competition throughout the league. Prior to our project, a league executive scheduled games by hand – a protocol that, while well-intended, has led to sub-optimal schedules in the past. Through the use of clustering algorithms and linear programming, we demonstrate a method of constructing better schedules. This is joint work with my students Mitchell Campion and Nathan Stanelle.

- **Oksana Bihun,** Concordia College, Moorhead, **Senior Seminar Capstone in Mathematics**

I will share my experience in developing a senior seminar capstone course in mathematics. We will discuss the objectives of the course and the specific ways in which they

were pursued. We will also look at the process of adjustments informed by student feedback as well as practices in the community of college teachers of science mathematics.

- **Nicholas Brown,** South Dakota State University, **Base Runs Projection**

Sabermetrics is a growing and increasingly complicated sector of statistics related to the game of baseball. Base Runs Projection is a statistical modeling approach to projecting the mean number of runs scored in a baseball game. Using prior game statistics like, Doubles, Home Runs, Walks, and Hit by Pitch, among others, a multiple linear regression model is created to estimate an "Advancement Factor" that is the main parameter of a sabermetric baseball statistic called Base Runs. Original data was gathered for this project from the White Wildcats Amateur Baseball Team. This projection of runs scored per game is an important part of team decision making when deciding team hitting and pitching strategies.

- **James Carr,** Normandale Community College,
  Restructuring a Developmental Math Program: a Three Stage Process

An account of Normandale Community College's very successful restructuring of our developmental math program. This includes changing to ALEKS as the delivery tool, a novel course structure which addresses all of the problems developmental programs encounter, and some data on the success of the program so far. Normandale has approximately 3000 developmental math students a year and is now enjoying a dramatic improvement in content mastery, retention, and completion times. This could be the new paradigm for developmental math.

- **Bryce Christopherson*** and **Lindsay Erickson,** Augustana College, **Edge Nim on Trees**

Edge Nim is a combinatorial game played on regular graphs with positive, integrally weighted edges. Starting from a positional piece, players alternate moving to an adjacent vertex, decreasing the weight of the incident edge to a strictly non-negative integer as they travel across it. The game ends when a player is unable to move. Fukuyama described the normal form using maximal matchings to determine the Grundy number for a given position. We present an alternative, algebraic approach to edge Nim on trees for both the normal and Misère forms via a computationally inexpensive algorithm completely solving the game.

- **Barry Cipra,** Freelance Math Writer, **John-Art: The Stochastic Geometry of John Shier**

I will describe the mathematical underpinnings of an algorithmic approach to producing fractal-like works of art developed by John Shier, a retired physicist at Normandale Community College in Bloomington, Minnesota.

- **Michelle Cordier*,** Kent State University**, M. Angeles Alfonseca,** North Dakota State University, and **Dmitry Ryabogin,** Kent State University,
If You Can Hide Behind It (Using Rotations), Can You Hide Inside It?

Let K, L be convex sets in R^3. If every projection of K can be rotated to be contained in the corresponding projection of L, does that imply that K is contained in L ?

- **Damiano Fulghesu,** Minnesota State University, Moorhead, **Arithmetic Sets in Groups**

We introduce the notion of arithmetic set for an arbitrary, finitely generated group. Every tile of a group is an arithmetic set, while arithmetic sets form a larger class of subsets. In negatively curved groups, such as free groups of rank at least two, being arithmetic is a loose condition on sets, while in groups at the other extreme, such as cyclic groups, it imposes very strong conditions with number-theoretic flavor. This is a joint work with Azer Akhmedov.

- **Semere Habtemicael,** North Dakota State University, **Variance and Volatility swap**

Derivatives traders are exposed to changes in the level of volatility and variance swap. Volatility swaps are forward contracts on future realized stock volatility and variance swaps are similar to contract on variance, the square of the future volatility. Both these instruments provide an easy way for investors to gain exposure to the future level of volatility. A stock volatility is the simplest measure of its risk less or uncertainty. Realized volatility is the annualized standard deviation of the stock returns during the period of interest.

- **Jung-Han Kimn,** South Dakota State University,
  The Time Decomposition Method and Its Applications

For certain formulations of partial differential equations, proper time-parallel preconditioners can be successfully applied in space-time finite element simulations. Such an approach may enable the extraction of more parallelism to better utilize high performance computing resources. In this work, we examine the behavior of solutions of the semilinear wave equation for formation of singularity, and the Dirac equation using the space-time finite element method. We discretize space and time together for the entire domain using a finite element space which does not separate time and space basis functions. Also, we present parallel implementation of the Dirac equation and effects of an additive Schwarz preconditioner based on a time decomposition method and KSP (Krylov Subspace) solver.

- **Nelson Lahrs,** South Dakota State University**, Block Voting and the US Electoral College**

The calculation of voting power of an individual and the formation of voting blocks to increase ones power is explained. In an effort to shed light on a widely held misconception about voting power in the US, the powers of voters in each of the states is addressed. A more fair distribution of the votes in the Electoral College is found.

- **Chloe Ondracek,** Minot State University, **Inverse Problem for Projectiles**

In this project, we develop a model to launch a projectile by taking into account the drag on the projectile proportional to the velocity due to air resistance. A system of second order ordinary differential equations with initial values will be considered to model the motion of the projectile. Mathematical tools from the ordinary differential equations will be used to solve the system of differential equations. Least square estimation will be carried out to minimize the functional related with the sum of squared errors between predicted and observed data. MATLAB routine will be used to estimate parameters.

- **Liz Sattler,** North Dakota State University**, Structure of Sub-Fractals**

Fractals constructed with an iterated function system (IFS) containing *N* maps are closely related to a symbolic space consisting of infinite stings on *N* letters. This talk will focus on the connections between sub-shifts of finite type on the symbolic space and sub-fractals associated with the corresponding IFS. We will describe a method used to calculate fractal dimensions of the sub-fractals. We will also examine specific fractals to demonstrate these properties. This talk will be easily accessible to undergraduate students who have background in basic linear algebra and real analysis.

- **Thomas Q. Sibley,** College of St. Benedict and St. John's University,
  Could Cayley Have Been Loopy?

Cayley devised a beautiful representation of groups using directed graphs (or digraphs). But there are digraphs that look superficially similar that don't match with groups. We search for a way to build plausible algebraic structures starting from appropriate digraphs.

- **Jordan Torgunrud,** Minot State University**,**
  On the Numerical Treatment of Water Pollution Model

Water quality management is a critical component of overall integrated water resources management. Mathematical models are now vital tools in water resources management and are currently applied for the solution of environmental problems around the globe. In this talk, a second order partial differential equation model as an Initial Boundary Value Problem (IBVP) will be developed for the estimation of water pollution. Both analytical and numerical solutions of the model will be presented.

- **Matthew Wright,** IMA, University of Minnesota**, Cycles of Digits**

The decimal representations of 1/7, 2/7, ..., 6/7 display cyclic permutations of digits -- that is, the same repeating sequence of six digits, each multiple starting with a different digit. Knowledge of this pattern allows one to quickly determine the decimal representation of any multiple of 1/7. Yet the pattern prompts many questions: Why does this pattern exist? Do other fractions exhibit similar patterns? What happens in other bases? In this talk, I will show how a bit of abstract algebra can help answer these questions, and also provide a case study that illuminates important concepts in abstract algebra.

18th NCS MAA Team Contest: November 15, 2014

http://sections.maa.org/northcen/teamcomp.html

NCS MAA Spring 2015 Meeting: April 24-25, 2015 at Winona State University

MAA MathFest 2015 Meeting: August 5-8, 2015 at Washington, DC

North Central Section Website: http://sections.maa.org/northcen/