MSCS Mess

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This Week's Colloquium

There will be no colloquium this week, but check out the information about NUMS on the second page of this issue!

This Week's Seminar

Title:	Vicious and Osculating Walkers
Speaker:	Kaisa Taipale
Date:	Friday, November 1st
Time:	3:35 PM
Location:	RNS 204

About the Seminar: Vicious and osculating walkers are tools from combinatorics that have fun names and presentations (paths on cylindrical grid) and applications in statistical physics. I am learning about vicious and osculating walkers because they also describe certain ideas in string theory, and may help me solve some problems in an area called "quantum cohomology". In this talk, I'll introduce the walkers, talk about their meaning in mathematical physics, and then discuss some combinatorial formulas that can be obtained from them. You will not need to know anything beyond precalculus for this talk!

LaTeX and Mathematica Help

The Math Clinics will now also be offering Mathematica and LaTeX help. See the following schedule for the times and people to talk to at the clinics:

- Basic Mathematica Help
  - Sun, Tue, Thu - 7:30 - 9:00p.m. - TOH184 - find Josh
  - Tue, Thu - 3:30 - 5:00 - TOH184 - find Nick
- Basic LaTeX Help
  - Sun, Tue, Thu - 7:30 - 9:00 - TOH186 - Any 'Regular' Clinic Consultant
  - Tue, Thu - 3:30 - 5:00 - TOH184 - find Nick

Hey, Hey, Hey, Hey, Hey
The Real Analysis Exchange
Needs You!!

Are you a first or second year student, interested in mathematics, not computer phobic and would like a solid, good paying job for your next three years at St. Olaf? Then does Humke have the deal for you!!!

The *Real Analysis Exchange* is a research journal that he edits, and he needs help. This job will involve 8-12 hours of editing work per month. If you think you might be interested, drop Humke an email note at analysisr@gmail.com. Hey, what can you lose? This could be great!

Do you want to teach mathematics?

Are you interested in becoming a math teacher? Have you thought about it, but are unsure if it's the right career path for you? Or are you looking for a fun class to take and satisfy a GE at the same time? If you've answered "yes" to any of these questions, consider taking EDUC 290: Educational Psychology. It offers a nice introduction to our Education Department and to the world of education in general. You'll also get some "field experience," where you'll spend some time in actual schools. And you'll come out

of each course with a GE credit (HBS) – so you really can't go wrong. In fact, convince a couple of friends (or more) into taking these courses with you! If you have any questions, contact Prof. Matsuura (matsuura@stolaf.edu).

More Course Descriptions!

Education 290: Educational Psychology

This course is offered during spring semester and it satisfies HBS. Only sophomores or above can take the course. Students study theories of and research into human behavior, growth, and development. Through lectures, discussions, case studies and field experiences, students analyze the impact of applied psychology upon schools, teachers, and students. Students also examine the interaction between individual characteristics and needs and political, economic and philosophical issues confronting contemporary American students. Required 20-hour field experience.

Bio 291B: Exploring BioMath

Interested in mathematics and biology? Wondering what each subject can contribute to the other? This spring there is a 0.25 credit course entitled Exploring BioMath that addresses these questions in a very low intensity environment. The class meets Thursday evenings for two hours, from 7:00pm to 9:00pm. Faculty from Mathematics, Computer Science, Biology and Physics each teach one to three week segments of the course, giving students a very broad idea of how mathematics and biology inform each other. Each segment is typically organized around a journal article and a specific application of mathematics to a problem in biology. Topics vary from year to year and have, in the past, included cyclical population explosions in forest pests, evolution of virus strains, neurological systems and other applications. The course also has a history of providing good evening snacks to its participants, but that fact should play no role in your decision to enroll in the class. The prerequisites for the course are two: at least one semester of college level biology at St. Olaf or elsewhere, and mathematics through the first term of calculus. If you have questions about the Exploring BioMath course, (Bio 291B, don't let the Bio scare you) please feel free to contact Becky Vandiver or Anne Walter.

MSCS Jokes!

Math: A Math student asks another,"What's your favorite thing about mathematics?" The other student replies,"Knot theory". "Yeah, me neither".

Computer Science: What did C++ say to C when asked out on a date? "I can't date someone with no class!"

Statistics: Smoking is one of the leading causes of statistics.

NUMS Returns

Yes, thats right! Youve been waiting yet another year for this moment to arrive. The Northfield Undergraduate Mathematics Symposium (NUMS) returns on Tuesday, October 29. Students from both St. Olaf and Carleton will give talks on their summer research, plus well have a break for pizza dinner and some great conversation. So come on out, support your classmates and our friends from across the river, and see some good talks! This year, St. Olaf is hosting! The symposium will be held from 3:30-7:35 PM in RNS 310. Check out the titles and abstracts below for a preview of the afternoons talks. Hope to see you there!

Abstracts

3:30-3:50 Joey Dickens (St. Olaf)
Finite Dynamical Systems: A Probabilistic Approach

Since the behavior of large finite dynamical systems is difficult to observe and characterize, we approach these number theoretic objects from a probabilistic point of view. By doing so, we develop expectations about large random finite dynamical systems. We find and prove several explicit and asymptotic formulas describing the growth of the set of periodic elements as set size becomes arbitrarily large. We conclude with several additional conjectures concerning the asymptotic behavior of the set of periodic elements when we have a d-to-one function.

3:55-4:15 Harrison Reeder (Carleton)
Evaluating an Adaptive Clinical Trial with Quantitative Endpoints, Sample Size Re-estimation, Sequential Monitoring for Efficacy, and Monitoring for Futility

Clinical trials are an essential component to modern evidence-based medicine, and biostatisticians are continually developing new trial designs to maximize their safety, efficiency, and value. This research focuses on exploring the characteristics of a particular Phase II trial design with three key properties: adaptive sample size recalculation, interim monitoring for efficacy, and monitoring for futility. Using a simulation study, we evaluate the performance

of the design and compare the value of trials with some or all of these characteristics. Our comparison measures include the accuracy of the designs' estimation of treatment effect, the error rates of the trials, as well as the robustness of the designs to inaccurate assumptions about the treatment. Our research also compares the merit of three different interim monitoring schemes in this design, observing that O'Brien-Fleming boundaries are most suitable. Our overall findings conclude that compared to a simple design with interim monitoring for efficacy, the complete design is an improvement; our design shows comparable performance under most conditions and improved overall performance under conditions where initial design estimates are inaccurate.

4:20-4:40 Jared Brown (St. Olaf)
An Analysis of the Trojan Y-Chromosome Method of Invasive Species Management

Management of invasive species towards the goal of preserving native biodiversity and preventing economic damage has traditionally been one of the most challenging problems faced by modern ecological scientists. The introduction of modified members of the invasive species, carrying extra trojan y-chromosomes, may offer a much less harmful, and thus less expensive technique for controlling or eliminating wild populations of undesired, sexually reproducing organisms. This talk presents both deterministic and Stochastic models of the reaction of the wild population to such trojan introduction. Results upon arbitrary species parameters support the potential validity of this technique, and give insight into more environmentally specific interactions.

4:45-5:05 Martin Bobb (Carleton)
Volumes of Hyperbolic Knot Complements

A knot is an embedding of a circle in a sphere. Many knots, including 2-bridge knots, have complements with a hyperbolic structure determined by the knot. We explore the hyperbolic volumes of knot complements for 2-bridge links obtained by Dehn fillings. We build on work by Purcell to more accurately explore how the geometry of universal covers and gluing operations affect hyperbolic volumes.

5:10-5:30 Cora Brown (Carleton) and Nathanael Cox (St. Olaf)
Digraphs, Zero Forcing, and Maximum Nullity

A simple digraph, Γ, is a set of vertices and arcs whose elements are ordered pairs of vertices. The zero forcing number for a digraph Γ is the minimum number of blue vertices needed to force all the vertices of Γ to become blue by the color change rule. This rule states that for Γ with all vertices colored blue or white, a blue vertex,v, can force an adjacent white neighbor, w, to become blue if w is the only white out-neighbor of v. The maximum nullity of a digraph, $M(\Gamma)$, is the maximum nullity of any of these matrices described by Γ. We will present results on maximum nullity, zero forcing number, and other properties of digraphs including techniques for finding the minimum rank of digraphs, results for oriented graphs (digraphs that allow no doubly directed arcs), and results for directed graphs in general.

6:00-6:20 Dylan Peifer (Carleton)
Difference Set Transfers

Given a finite group G of order v, a subset $D \subseteq G$ is called a $\langle v, k, \lambda \rangle$-difference set if $|D| = k$ and the set $\{d_i d_j^{-1} | d_i, d_j \in D\}$ contains λ copies of each nonidentity element of G. The fundamental question in the study of difference sets is determining which groups contain difference sets and which do not, and a related question involves finding all difference sets in a group or set of groups. Though exhaustive search can easily determine all difference sets in groups of order 16, there are still many patterns to be found in what we term *difference set transfers* - where a difference set in one group of order 16 can be transferred to a difference set in a different group of order 16 using power-commutator presentations of these groups. In this talk we will examine and prove many of the difference set transfers found in groups of order 16 and apply transfers to groups of order 64 and 144, where exhaustive search is infeasible and other standard methods for finding difference sets fail.

6:25-6:45 Lora Weiss (St. Olaf)
Nosé-Hoover Thermostats

The equilibrium statistical properties of molecular systems is important to applied subjects such as biology, chemistry, computational physics and materials science. These equilibrium statistical properties are obtained as phase space integrals that depend on q as the position of the system, p as the momentum of the system, and have $H(q, p)$ as the total energy of the system. In 1984 S. Nosé introduced a thermostat to mimic the effect of a heat bath on a mechanical system. W. Hoover simplified this model and

showed that even for the simple harmonic oscillator the system can exhibit complicated dynamics. In this presentation, we attempt to find exact solutions of the Nosé-Hoover thermostat; we look for periodic solutions to make a conjecture about the existence of invariant tori; we determine orbit averages along the solution curves; we analyze various numerical methods to solve the system; and we look at the existence of a first integral for the system, building on the work of Legoll, Luskin, and Moeckel.

6:50-7:10 Greg Michel (Carleton)
Cayley Graphs and the Cayley-Isomorphism Property

For a finite group G and a subset S of G, the Cayley graph $\mathrm{Cay}(G, S)$ is the graph whose vertex set is G such that two vertices x and y are adjacent if $x^{-1}y$ is in S. A Cayley graph $\mathrm{Cay}(G, S)$ is called a CI-graph if for any $\mathrm{Cay}(G, T)$ graphically isomorphic to $\mathrm{Cay}(G, S)$, there is a corresponding group automorphism σ of G with $\sigma(S) = T$. A finite group G is called a CI-group if every Cayley graph of G is a CI-graph. We show that G is not CI if it admits a non-CI subgroup or if it admits two non-isomorphic subgroups of the same order. We show that this completely classifies the effect of subgroups on non-CI Abelian groups. That is, if an Abelian group is non-CI and its subgroups do not meet the conditions above, then any non-CI graph will be connected.

7:15-7:35 Taisa Kushner (St. Olaf)
Non-Mass Action Modeling for the Binding of Phosphorylated Gli1 with SUFU

Our goal in this research project was to construct a mathematical model to accurately simulate Gli1-Erk2-SUFU interactions that were observed biologically. Gli1 is a protein associated with the Hedgehog (Hh) signaling pathway, which is involved in embryonic development and stem cell differentiation. Overexpression of the Gli1 protein has been linked to many cancers, most notably glioblastoma multiforme (GBM), the most common and aggressive brain tumor. To create our model, we proposed the novel incorporation of Holling Type-II interactions from ecology into a biochemical model constructed using differential equations and a multiple-time-scale system. We compare this with other models, such as the mass-action protein interaction model and a Gli1-dimerization model and show that these are insufficient for explaining the observed dynamics.

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If you would like to submit an article or math event to be published in the Math Mess, e-mail jacobsoj@stolaf.edu