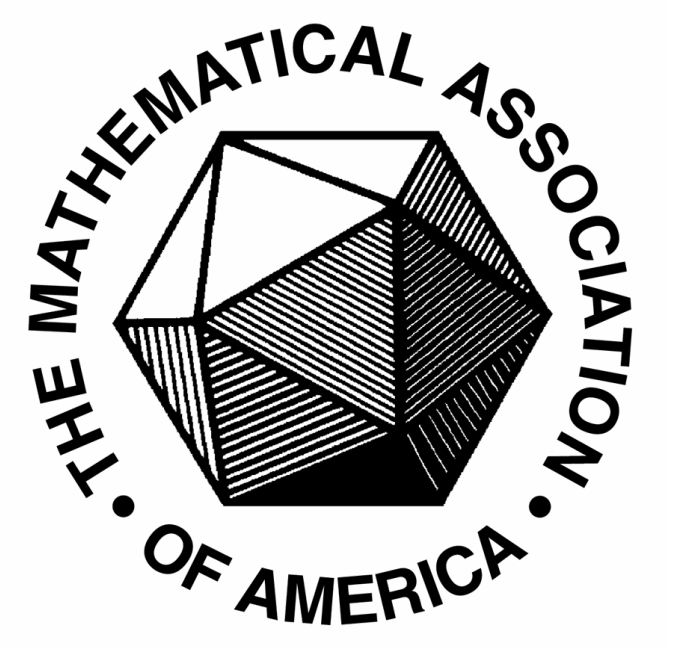
Annual Meeting
of the
Pacific Northwest Section
of the
Mathematical Association of America



University of Portland
Portland, Oregon

April 20-21, 2012

Annual Meeting
of the
Pacific Northwest Section
of the
Mathematical Association of America

Sponsored & Hosted by

University of Portland
Mathematics Department
College of Arts & Sciences
Portland, Oregon
April 20-21, 2012

Friday, April 20

<table>
<tr><td>7:45</td><td colspan="3">Packet pickup for Project NExT
Board Room
Bauccio Commons</td></tr>
<tr><td>8:00

2:15</td><td colspan="3">Project NExT Meeting
Board Room</td></tr>
<tr><td>3:00</td><td>Minicourse:
Introduction to R [1]

Shiley 206</td><td>Minicourse:
WeBWork
Implementation [2]
Shiley 249</td><td>Minicourse
Getting Started
with IBL [3]
Shiley 319</td></tr>
<tr><td>5:30</td><td rowspan="2">Student Packet Pickup
& Reception

5:30-7:30
Buckley Center 163</td><td colspan="2">Project NExT Dinner & Discussion
6:00 Pyramid Brewery
(MacTarnahans Taproom)
2730 NW 31st Ave
(503) 228-5269</td></tr>
<tr><td>7:00</td><td>Packet Pick-up[1]
BC 163</td></tr>
<tr><td>8:00</td><td colspan="3">Friday Evening Lecture: Bob Bosch
Opt Art: an Introduction [4]
Buckley Center Auditorium</td></tr>
<tr><td>9:15

10:15</td><td colspan="3">Reception
Buckley Center 163</td></tr>
</table>

[1] Packet pickup will also be available in Shiley Atrium (2nd Floor) from 2:00-3:30

Saturday, April 21

<table>
<tr><td>7:30</td><td></td><td colspan="2">Executive Committee Meeting
Murphy Room
Franz Hall (4th Floor)</td></tr>
<tr><td>8:00</td><td rowspan="2">Packet Pickup & Registration
Franz Skybridge</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>9:00</td></tr>
<tr><td></td><td></td><td colspan="2">Introduction and Welcome:
Br. Donald Stabrowski, Ph.D.,C.S.C.,
Provost

Invited Talk: Frank Morgan
Densities from Geometry to the Poincaré Conjecture [5]
Buckley Center Auditorium</td></tr>
<tr><td>10:30</td><td></td><td colspan="2">Contributed Talks
Franz Hall 106, 206, 214, 223, 231</td></tr>
<tr><td>12:30</td><td rowspan="2">Student Poster Session
Murphy Room
Franz Hall
(4th Floor)</td><td colspan="2">Lunch (provided)
Franz Atrium</td></tr>
<tr><td>1:15

1:50</td><td></td><td>Business Meeting
Franz 231</td></tr>
<tr><td>2:00

3:00</td><td colspan="3">Invited Talk: Stan Yoshinobu, Cal Poly SLO
Saving Ally: Why We Need to Transform Our Educational Paradigms [6]
Buckley Center Auditorium</td></tr>
<tr><td>3:15</td><td colspan="3">Contributed Talks
Franz Hall 106, 206, 214, 223, 231</td></tr>
<tr><td>5:45</td><td colspan="3">Social Hour
Terrace - Bauccio Commons</td></tr>
<tr><td>7:00</td><td colspan="3">Banquet Dinner - Section Awards
Board Room - Bauccio Commons</td></tr>
<tr><td>8:30</td><td colspan="3">Invited Lecture: Frank Morgan, Williams College
Optimal Pentagonal Tilings [7]

Buckley Center Auditorium</td></tr>
</table>

Program of Contributed Papers

The program of contributed papers appears on the following pages. In some cases, titles or other information are abbreviated for reasons of space; please see the full abstract for more information.

A dagger (†) indicates which contributor(s) will present when multiple contributors are listed and fewer are presenting the work. An asterisk (*) indicates the contributor is a graduate student. Double asterisks (**) indicate the contributor is an undergraduate student.

Session Organizers

- *Smelling the Analysis Flowers*: James Bisgard, Central Washington University
- *Teaching Elementary and Applied Statistics Courses: Accidental Discoveries, Bold Innovations, and Familiar or Unfamiliar Time-tested Methods*[2] : Christopher Hay-Jayans, University of Alaska Southeast, Juneau
- *Junior Faculty Research*[2]: Christopher Hay-Jahans, University of Alaska Southeast, Juneau
- *Open-Source Textbooks in Mathematics*: Albert Schueller, Whitworth University
- *Panel Discussion: Reaching Out to the Local Middle School*: Tom McKenzie, Gonzaga University
- *Undergraduate Research*: Dominic Klyve, Central Washington University
- *General Contributed Papers*: Chad Giusti, Willamette University

Please contact the session organizer with any questions about a session.

Moderators: Please start each talk on time, but **not** early. Meeting participants often move between sessions and will want to be there when the talks is scheduled to begin.

[2]Due to limited submissions, these sessions have been combined.

Contributed Talks – Saturday Morning

	Panel Discussion: Outreach	Teaching Statistics / Junior Faculty Research	General Papers 1
	Franz 214	*Franz 223*	*Franz 231*
10:30–10:45	**Panel Discussion** **Thomas McKenzie, Gonzaga:** *Organizer* **Panelists:**	*Academic Service Learning and Model-Eliciting Activities in Introductory Statistics* [17] **Rachel Chaphalkar, UM**	*Flying Goats and Bored Tutors* [25] **Anthony Gaussoin and Augste Stiehr, UAKSE**
10:50–11:05	**Paul Casillas, Clark College** **William Harris, Tacoma School District** **Ksenija Simic-Muller, Pacific Lutheran University**	*Fostering Mathematical Reasoning in a Service Course* [37] **Robert Ely and Jennifer Johnson-Leung†, UI**	*Quilting in Geometry Class* [64] **Nick Willis, GFU**
11:10–11:25	**Christopher M. Horak, Bethel School District** **Nancy Ann Neudauer, Pacific University**	*J-Holomorphic maps and the uncertainty principle in geometric quantum mechanics* [50] **Barbara Sanborn, WWU**	*The Journey that changed the course of 19th century Italian Mathematics* [47] **Donna Pierce, WHIT**
11:30–11:45		*Surprising Benefits of Operator Splitting Techniques* [30] **R. Corban Harwood, GFU**	*Service Learning in a Qualitative Reasoning Course* [32] **Allison Henrich, SU**
11:50–12:05		*Symmetric spaces of dihedral groups* [20] **Tom Edgar, PLU**	*How Do You Tic-Tac-Toe New Variations in Positional Games?* [49] **Mary Riegel, UM**
12:10–12:25		*Application of a Proportional-Odds Cumulative Logit Model in Efficacious Introductory Mathematics Placement* [59] **Terri Torres†, Joseph Reid† and David Waite, OIT**	*Zero Divisor Graphs of Inverse Systems of Abelian Groups* [65] **Cynthia Wu, Gonzaga University** **†

Contributed Talks – Saturday Morning

	Student Papers 1	Student Papers 2
	Franz 206	*Franz 106*
10:30–10:45	*Torus knots and polynomials* [48] **Brandon Reeves** †** **and Enrique Alvarado**†**, **GU**	*A Mathematical model of Stress-Induced Insomnia* [63] **Sarah Whittemore, WHIT****
10:50–11:05	*The Three Point Ellipse* [55] **Dylan Helliwell, SU** **Everett Sullivan, SU**†**	*Genetic Algorithm for Optimized Book Embedding: A Dual Layered Approach (Part One)* [9] **Tiffany Arnold, GU****
11:10–11:25	*How Does your Triangle Like To Tile?* [21] **Tony Fernandez**, PU**	*Genetic Algorithm for Optimized Book Embedding: A Dual Layered Approach (Part Two)* [36] **Marhsall Hurson, GU****
11:30–11:45	*Dellanoy Numbers: Counting Certain Restricted Paths in an Integer Lattice* [60] **Vivan Qianru Wang, PU**†**	*Golden Tree* [41] **Hanna Landrus, PU**†** and Adri Wilburn, Pacific University** **Tony Fernandez, PU**
11:50–12:05	*Golden Fields and Polygons:A Case for the Pentagon, Heptagon and Various Applications* [38] **Heather Johnston, WOU****	*Juggling Mathematics: Counting Juggling Sequences* [62] **Travis White, PU****
12:10–12:25	*Deriving Block Designs from Transversal Matroids* [8] **Jesse Amano, PU**†**	*One Ring to Rule the Log* [19] **Zachary Davis**†**, Kyle Evitts**†**, and Anders Van Sandt**†**, Linfield College**

Contributed Talks – Saturday Afternoon

	Smelling the Analysis Flowers	**Open Source Textbooks**	**General Papers 2**
	Franz 214	*Franz 223*	*Franz 231*
3:15–3:30	*Revisiting the Lipschitz Uniqueness Theorem for ODEs* [44] **Cristina Negoita, OIT** †	*Open Textbook for Precalculus and Trig* [42] **David Lippman, PC** †	*Broken Ray Transform and Inversion* [53] **Brian Sherson, OSU**†*
3:35–3:50	*But it fails the alternating series test!* [28] **Chris Hallstrom, UP**†	*Open-Source First-Year Calculus* [33] **Dale Hoffman, BC**†	*Cores and Prime Numbers: A Connection* [52] **Michael Severino, UM***†
3:55–4:10	*Chebyshev's Inequality and Types of Convergence* [57] **Kathy Temple, CWU** †	*Yet another free calculus book* [27] **David Guichard**†	*Fitting Mitscherlich Exponential and Verhulst Logistic Curves to Data by Generalized Non-Linear Least Squares* [45] **Yves Nievergelt, EWU** †
4:15-4:30	*Mean and Median Values of Continuous Functions and Connections to Partial Differential Equations* [29] **David Hartenstine, WWU**†	*A HOWTO on Producing and Promoting an Open Source Mathematics Textbook* [10] **Robert A. Beezer, UPS**†	*A characterization of probe interval* 2*-trees* [23] **David Brown, USU** **Breeann Flesch, WOU**† **Richard Lundgren, UCD**
4:35-4:50	*An elegant proof of the chain rule* [13] **Jeff Boersema, SU** †	*The AIM Open Textbook Initiative* [43] **Kent E. Morrison, American Institute of Mathematics**†	*Polynomial Representation for the Expected Length of Minimal Spanning Trees* [46] **Peter T. Otto, WU** † **Colin Starr, WU** **Jared Nishikawa, UCB***
4:55-5:10	*The Lebesgue Integration Made Easy Through Henstock-Kurzweil* [58] **Elena Toneva, EWU**	*Real Math Archive* [22] **Ryan Bauer, BC**† **Mark Fitch, UAKA**†	*Spectral conditions for composition operators on algebras of functions* [39] **Jeffrey Johnson, UM**
5:15-5:30	*The Breakdown of the Only Critical Point in Town Test* [11] **James Bisgard, CWU**†	*Publishing math texts directly to the web–some fantastic free tools* [51] **Albert Schueller, WC** †	

Contributed Talks – Saturday Afternoon		
	Student Papers 3	**Student Papers 4**
	Franz 206	*Franz 106*
3:15–3:30	*Some interesting facts about the logistic map* [31] **Amber Heath, UP**[†**]	*Is NFL overtime fair? A Markov Chain analysis* [40] **Keenan Kriegel, WOU**[**]
3:35–3:50	*Social Dynamics of Gang Involvement: A Mathematical Approach* [54] **Emily Smith, LC**[**†]** **(for other authors, see abstract)**	*Digging through the NFL Draft: What Determines Drafting Success?* [34] **Jason Hortsch, UP**[**]
3:55–4:10	*Analyticity of Modified Dirichlet Series* [18] **Liam Dalton, PU** [†**]	*Measuring Food Web Robustness* [14] **Sebastian Bozlee, UP**[†**] **Chris Hallstrom, UP**
4:15–4:30	*Fourier Transforms* [66] **Kelli Zerh**[†**]**, WOU**	*Mathematics in Music, The Theory Behind Intonation* [26] **Jamie Gilman, WOU**[**]
4:35–4:50	*Outwitting the Lying Oracle* [15] **Brittney Brigtrup, WOU**[**]	*The United States vs. Austraulia: A Comparison of High School Math Curricula* [56] **Kellie Takamori, PU**[**]
4:55–5:10	*Mathematical Modeling of Integin Dynamics in Cell Movement* [12] **Aurora Blucher, UP**[**]	*Differentiating integers modulo n* [16] **Matt Bruck, WOU,**[†**]
5:15–5:30	*Investigating Infinite Exponentials* [61] **Gabriel Wechter, UAKSE**[**]	

Social Events

Thursday Project NExT Gathering
6:30 Pizza Mia, 1915 N. Anchor Way, (503) 285-8889

Friday Project NExT Dinner
6:00 Pyramid Brewery (MacTarnahans Taproom), 2730 NW 21st Ave, (503) 228-5269
Sponsored by the MAA

Friday Student Reception
5:30-8:00 Buckley Center 163

Friday Invited Lecture
Opt Art: an Introduction
Bob Bosch [4]
8:00 Buckley Center Auditorium

Friday Reception
9:15 Buckley Center 163

Coffee, Pastries, & Fruit
8:00-11:00 Franz Skybridge, 2nd Floor

Saturday Lunch
12:30 Franz Atrium

Student Poster Session
12:30 Franz Murphy and Siegfried Rooms, 3rd Floor

Coffee and Refreshments
2:00- 5:00 Franz Skybridge, 2nd Floor

Saturday Evening Social Hour
Awards Ceremony and Banquet Dinner
5:45 Terrace & Board Room, Bauccio Commons

MC: Hans Nordstrom

Introduction of new Section Project NExT Fellows

Presentation of 25- and 50-year MAA membership certificates

PNW MAA Distinguished Teaching Award

Saturday Evening Invited Lecture
Optimal Pentagonal Tilings
Frank Morgan [7]
8:30 Buckley Center Auditorium

Minicourse Descriptions

Friday, April 13

1 *An Introduction to R*

Christopher Hay-Jahans, University of Alaska, SE

R is a powerful public domain computational statistics platform that is gaining popularity among applied and research statisticians, as well as educators. The goal of this course is to lay a functional foundation in the use of R, illustrated mainly using topics encountered in a generic elementary statistics course. As such, the content presented requires no background in R, and is designed to provide a flavor of R by way of four broad modules:

- Navigating R and its resources;
- Computational capabilities of R;
- Graphical capabilities of R; and
- Programming features in R.

R's computational platform is geared toward working with multivariate data. Consequently, its capabilities can easily be extended to many tasks encountered in computational linear algebra, and even some simpler numerical methods. Some simple applications in these areas will also be considered.

2 *WeBWork Implementation*

Robin Cruz, Linda Danielson, University of Idaho; Aaron Wootton, University of Portland

WeBWorK is an open source online homework/quiz delivery system created by faculty members at the University of Rochester. With hundreds of contributors worldwide and literally tens of thousands of homework problem stored in the national problem library, with a little practice, it is easy to create an online homework companion to almost any course in the undergraduate mathematics curriculum.

In this workshop, we will explain the basics behind using WeBWorK. Specifically, we will explain how you can run a course without running into the problem of convincing your IT department to install it on your own University server, how to construct problem sets, and how to effectively use the statistics available in WeBWorK to determine student weaknesses. Depending upon time, we may also demonstrate how to write your own problems

3 *Getting Started with Inquiry-Based Learning*

Stan Yoshinobu, Cal-Poly SLO[†]

This minicourse is a hands-on, practical introduction to IBL. Discussion topics include:

- What is IBL and Hybrid IBL?
- What does IBL look like?
- How do I get started with IBL?
- Where can I find IBL materials?
- How do I set up an IBL course?

Abstracts of Invited Talks

(in chronological order)

4 *Opt Art: an Introduction*

Bob Bosch, Oberlin College†

Optimization is the branch of mathematics concerned with optimal performance—finding the best way to complete a task. It has been put to good use in a great number of diverse disciplines: advertising, agriculture, biology, business, economics, engineering, manufacturing, medicine, telecommunications, and transportation (to name but a few). In this lecture, we will showcase its amazing utility by demonstrating its applicability in the area of visual art, which at first glancewould seem to have no use for it whatsoever! We will begin by describing how to use integer programming to construct a portrait out of complete sets of double nine dominoes. We will then describe how high quality solutions to certain large-scale traveling salesman problems can lead to beautiful continuous line drawings. We will conclude by presenting other examples of Opt Art—art constructed with the assistance of mathematical optimization techniques.

5 *Densities from Geometry to the Poincaré Conjecture*

Frank Morgan, Williams College

Many insights in geometry, including Perelman's 2003 proof of the Poincaré Conjecture, come from putting a positive weighting or "density" on volume and perimeter. The talk will include some open questions and progress by undergraduates.

6 *Saving Ally: Why We Need to Transform Our Educational Paradigms*

Stan Yoshinobu, Cal-Poly SLO

Mathematics Education research results suggest that traditional instructional practices are not meeting the needs of many students. One question that arises is: "What does this really mean?" In this talk the real costs of not meeting students' needs will be discussed, along with the challenges we face as teachers of mathematics.

7 *Optimal Pentagonal Tilings*

Frank Morgan, Williams College

In 2001 Thomas Hales proved that regular hexagons provide the least-perimeter way to tile the plane with unit-area tiles. What is the optimal tiling by pentagons? Joint work with undergraduates. Fundamental questions remain open.

Abstracts of Contributed Talks

(in alphabetical order, by presenter)

8 *Deriving Block Designs from Transversal Matroids*
Jesse Amano, Pacific University **†

In this talk we describe the use of t-designs in experiment control and introduce the concept of a matroid, an abstract construct that connects multiple areas of discrete mathematics. We show how block designs can arise naturally from either the bases or the hyperplanes of certain classes of matroids. Particular attention is given to transversal matroids and 2-designs, also called block designs.

9 *Genetic Algorithm for Optimized Book Embedding: A Dual Layered Approach (Part One)*
Tiffany Arnold, Gonzaga University **†

In terms of mathematics and graph theory, book embedding is an NP-complete problem which involves a collection of half-planes in 3-space called pages. These pages meet to form the spine of the book, which is formed by a common line. Vertices of a graph are then embedded on this spine such that each edge connects to vertices on a single page, and no two edges may cross. Every type of graph has a distinct minimum number of pages associated with it, some being known, others being theoretical. So far, through manipulating the order for which the edges are placed in the book, as well as the order of the vertices along the spine, we have been able to generate several minimal book embeddings for graphs with known lower bounds. We are ultimately working towards finding lower book embeddings for graphs which only have theoretical bounds. So far, we have found optimal solutions for graphs up to K_{19}.

10 *A HOWTO on Producing and Promoting an Open Source Mathematics Textbook*
Robert A. Beezer, University of Puget Sound †

I began writing my open source linear algebra textbook, *A First Course in Linear Algebra*, in January 2004. Since Summer 2008 I have helped Tom Judson with the production of his open source abstract algebra textbook, *Abstract Algebra: Theory and Applications*.

My textbook has been a test bed for various experiments, some successful, some not. Conversely, Judson's book is very traditional and has become a popular choice for abstract algebra courses. From these experiences, I will provide practical advice on production and promotion of self-published textbooks, in addition to previewing some new developments for open source mathematics publishing.

Both texts have recently become available as Sage worksheets, with live embedded code. Time permitting, I will give a short demonstration of this functionality.

11 *The Breakdown of the Only Critical Point in Town Test*
James Bisgard, Central Washington University †

The Only Critical Point in Town Test is a useful result for determining global maxima or minima of a function of one variable. However, it only works in one dimension. We will present some examples of its failure in two dimensions, as well as give a general condition under which the conclusion of the only critical point in town test.

12 *Mathematical Modeling of Integrin Dynamics in Cell Movement*
Aurora Blucher, University of Portland

Cell movement and migration are important functions for a cell to perform. Processes which require cell movement include embryonic development, the immune system response, and the repair of damaged tissue. Our focus lies in modeling recepetor proteins, known as integrins, which play a major role in this movement. Understanding how integrains function in an individual cell can provide insight into the behavior of not just one, but many cells. Through the development of a mathematical model we investigate the dynamic relationship between integrins, extracellular ligands and talin, a key intracellular adhesion protien in the motility process. First we, will describe our method of stochastic simulation of integrin dynamics and discuss our numerical reults from both Matlab and COPASI. Next we will discuss our theoretical analysis of the model, including existence and uniqueness of a solution to our nondimensionalized model. We will also share results from our sensitivity analysis, using standardized regression coefficients as measures of model output sensitivity to input parameters.

13 *An elegant proof of the chain rule*
Jeff Boersema, Seattle University †

We present a proof of the chain rule that is more concise and more transparent than those commonly found presented in the literature. The proof relies on extending the different quotients continuously and using the result that the product of continuous functions is continuous.

14 *Measuring Food Web Robustness*
Sebastian Bozlee, University of Portland †**
Chris Hallstrom, University of Portland

In this talk we will discuss the modelling of food webs—collections of predator/prey relationships—with directed graphs. We will further discuss how the structure of these food webs determines the likelihood of secondary extinctions and introduce a measure of robustness to secondary extinctions as well as methods for its calculation.

15 *Outwitting the Lying Oracle*
Brittney Brigtrup, Western Oregon University **†

Imagine an oracle asking if you would like to play a coin toss game where you can always obtain some information about the result before you place a wager. The oracle tells you he will always say what the result of the flip will be, but he reserves the right to lie at least once. This paper discovers what strategy, always agreeing with the oracle or trying to outwit the oracle, will yield the greatest profit. We use game theory and probability to determine what the optimal wager is, which leads to an interesting conclusion about which strategy is the optimal strategy.

16 *Differentiating integers modulo n*
Matt Bruck, Western Oregon University **†

This presentation is on differentiating integers modulo n. We all think of differentiation as something familiar, but what if we take that familiar concept and apply it in a new setting? What form will the elements of these groups take once they have been differentiated? This presentation explores those possibilities as we derive and prove new theorems and lemmas for differentiating in $\mathbb{Z}_n$. After these initial theorems and lemmas we will then explore the image of a *number derivative* on $\mathbb{Z}_n$.

17 *Academic Service Learning and Model-Eliciting Activities in Introductory Statistics*
Rachel Chaphalkar, University of Montana *†

Students often fail to see the relevance of what they are learning in a course to their future careers. We incorporated two different projects into four classes of our introductory statistics course, an Academic Service Learning (ASL) project and Model-Eliciting Activities (MEA) with the goal of rectifying this issue. ASL projects involve students working with an organization to help solve problems involving the expertise students are currently learning in a course while MEAs encourage students to create certain important concepts in a course through an activity presented in real-world context. We then looked at the changes in student attitudes toward statistics and their ability to use elementary statistics to solve problems.

18 *Analyticity of Modified Dirichlet Series*
Liam Dalton, Pacific University **†

The Riemann Zeta Hypothesis is a long outstanding problem in mathematics. It is in our best interest to come up with tools that will make its solution easier. To this end Caleb Emmons proposed a family of representations of the Riemann Zeta Function ζ for study. We spent the summer of last year exploring this family and producing useful results surrounding it. One of the most important results was the convergence and analyticity of a certain modified Dirichlet series that shows up in this family of solutions.

19 *One Ring to Rule the Log*
Zachary Davis, Linfield College **†**, Kyle Evitts, Linfield College** **†**, and Anders Van Sandt, Linfield College**** **†**

The goal of this competition was to answer the following questions:

1. Why do leaves have the shapes they have?
2. How can you estimate the leaf mass of a tree?
3. Is there a relationship between leaves and tree architecture?

The underlying assumption of the models was that simple three-dimensional solids could represent the crown of a tree. In the paper, we focused mainly on deciduous trees and their leaves. We first assert that leaf distribution among the volume of a tree is dependent upon the light intensity of the trees primary habitat, and note that the complex shapes of leaves play a crucial role in this distribution. These literary findings are extended in our first model, which exhibits a statistically significant correlation between leaf shape and tree architecture. In our second model, we calculate the leaf mass of a tree using a volume density approach and prove its accuracy by comparing it to observed values in the literature. The third model takes a more abstract approach to the leaf mass problem using the Fibonacci sequence, intensity of incident light, and the diameter of a leaf. In conclusion, we provided diverse methods for determining the leaf mass of a tree, possible evolutionary motives for leaf shape, and the relationship between leaf shape and tree architecture.

20 *Symmetric spaces of dihedral groups*
Tom Edgar, Pacific Lutheran University †

Symmetric spaces play an important role in the representation theory of algebraic groups. In this talk, we discuss the notion of a generalized symmetric space for a finite group. We proceed by investigating generalized symmetric spaces for the dihedral groups, D_n. In particular, we

discuss equivalence of automorphisms of D_n and describe the structure of the fixed subgroup and symmetric space of any given automorphism. Furthermore, we explain deeper results when we restrict our attention to involutions. Throughout the presentation, we will explain the many connections between our results and ideas from elementary number thoery.

21 *How Does Your Triangle Like To Tile?*
Tony Fernandez, Pacific University **†

We investigated which triangles can tile the Euclidean or hyperbolic plane without overlapping and determine exactly which triangles tile without overlapping. Euclidean triangles have different properties than hyperbolic triangles and this leads to contrasting results about tiling. In particular, while the Euclidean plan can be tiled by an arbitrarily small triangle, we show that there is a smallest triangle, which tiles the hyperbolic plane.

22 *Real Math Archive*
Ryan Bauer, Bellevue College†
Mark Fitch, University of Alaska Anchorage†

Applications are an integral part of many mathematics classes. Students must learn to apply their knowledge, and they are often motivated by seeing some contexts for their studies. For some math classes including many lower division courses the applications in standard textbooks are contrived achieving neither goal. The Real Math Archive is a website designed as a repository for applications that come from the real world. By collecting these we hope to increase the relevance of mathematics to our students and decrease the workload of faculty looking for better applications.

23 *A characterization of probe interval* 2*-trees*
David Brown, Utah State University
Breeann Flesch, Western Oregon University†
Richard Lundgren, University of Colorado Denver

Probe interval graphs are a generalization of interval graphs: G is a probe interval graph if and only if vertices can correspond to intervals and can be partitioned into P and N such that vertices are adjacent if and only if their corresponding intervals intersect and at least one of them belongs to P. Probe interval graphs were introduced as a model for the human genome project by Zhang 1994. Since then much work has been towards characterizing them, including a forbidden subgraph chacterization of probe interval trees by Sheng in 1999. In 2005 Prẑulj and Corneil investigated probe interval 2-trees, which are a natural extension of trees. They found the forbidden subgraph list is large, with at least 62 graphs. We characterize probe interval 2-trees as sparse spiny interior 2-lobsters and add to the list of forbidden subgraphs.

24 *Some new taxicab conics*
Emily Frost, Seattle University †**
Dylan Helliwell, Seattle University

A taxicab conic is often considered to be the set of points satisfying a given formula for a conic section where the taxicab metric is substituted for the Euclidean metric. In this talk we consider an alternative definition for taxicab conics. In so doing, we discover some new taxicab conics and also find that some older taxicab conics aren't anymore.

25 *Flying Goats and Bored Tutors*
Anthony Gaussoin, University of Alaska Southeast †, Auguste Stiehr, University of Alaska Southeast

In this paper we examine a grazing problem involving a goat tethered to a silo. The solutions involve Riemann sums, parameterizations and Green's theorem. We then give the goat wings, expand the problem to three dimensions and examine the interesting results.

26 *Mathematics in Music, The Theory Behind Intonation*
Jamie Gilman Western Oregon University†**

This paper will explore the relationship between continued fractions and the piano. We will explore the development of the mathematical aspects of the piano scale, and further explain how the scale cannot truly be in tune on a piano. Time permitting we will explore an alternative scale to the 13 note octave.

27 *Yet another free calculus book*
David Guichard†

I will discuss my continuing journey toward a (finished) open source calculus book. My rather modest initial project has turned into a three semester book with material that I don't teach and is still evolving based on my own experience and feedback from others. While the book is not what I would call interactive, it does have some interactive features that I will demonstrate and discuss.

28 *But it fails the alternating series test!*
Chris Hallstrom, University of Portland †

In this talk I'll discuss examples of alternating series that converge despite failing the alternating series test. Since proofs of convergence typically involve Dirichlet's test, a topic not typically covered in a first-year calculus course, series of these kind are not typically encountered until a course in real analysis. I will discuss (and hope to solicit) ideas for incorporating these topics into calculus.

29 *Mean and Median Values of Continuous Functions and Connections to Partial Differential Equations*
David Hartenstine, Western Washington University

The mean value of a continuous function is often presented in calculus courses as an interpretation of the definite integral. Later in a standard undergraduate analysis curriculum, the well-known and amazing mean value property of harmonic functions appears in courses on complex variables and partial differential equations. The median of a continuous function is harder to define and is not usually part of analysis courses. This idea, as well as a median value property and connections to partial differential equations, will be discussed.

30 *Surprising Benefits of Operator Splitting Techniques*
R. Corban Harwood, George Fox University†

Solving partial differential equations by splitting the operators is known to introduce error, but operator splitting can be used to reduce complexity, enhance stability, provide computational speed-up, and sometimes even increase the accuracy of the overall numerical method. This talk will analyze a decoupled operator splitting technique for semilinear parabolic partial differential equations and demonstrate these benefits through example applications.

31 *Some Interesting Facts About the Logistic Map*
Amber Heath, University of Portland †**

In this talk, I will describe a few interesting results about the logistic map $x_{n+1} = rx_n(1-x_n)$ including a derivation of the bifurcation value $r = 1+\sqrt{8}$ at which the map undergoes a tangent bifurcation leading to the mysterious period-3 window. This work was done as part of a semester project in nonlinear dynamics.

32 *Service Learning in a Quantitative Reasoning Course*
Allison Henrich, Seattle University†

In most college-level math courses, the goals of the course revolve around the acquisition of knowledge in a particular area of math. In quantitative reasoning courses, however, it is not uncommon for one of the primary course goals to be reducing the level of math phobia of the students. Many students who take quantitative reasoning courses are students who have decided at some point that they are bad at math and that it is okay to be bad at reasoning quantitatively because this skill is probably not useful for their lives. Incorporating service learning into a QR course can help to address these issues. A quantitative reasoning course with service learning can help students gain confidence in their abilities, overcome their fears of math, become more proficient at reasoning quantitatively and see how this skill is useful in their lives. We will discuss the benefits to students of QR courses in general and, in particular, QR courses with a service learning component that requires students to tutor children in math.

33 *Open-Source First-Year Calculus*
Dale Hoffman, Bellevue College †

This presentation includes a description of the Open Course Library project in Washington State that has resulted in open course materials for algebra, statistics, pre-calculus, and a year of calculus. The calculus materials, text and WAMAP online practice/homework, will be described, as well as faculty and student options: free pdf files, modifiable (MS Word) files, and printed versions from Lulu.com for less than $20 for each quarter. The calculus text has been class tested and is in use at a few colleges in Washington.

34 *Digging through the NFL Draft: What Determines Drafting Success?*
Jason Hortsch, University of Portland**†

How can a team maximize its success in the National Football League (NFL) draft? The draft is the means by which NFL teams select new players every spring. Historically, much of the NFLs elite talent has been drafted in the first round of the draft (out of seven). The goal of this study was to discern how teams can have the most success drafting in this first round of the draft. To do so, a variety of statistical methods were utilized, including using a regression analysis to develop a model for predicting player success. Consideration was first given to figuring out how to best evaluate a players skill, something that is not an easy task within the sport of football. The presentation will focus on how to most effectively increase a teams chances of drafting a player that will be successful in the future. Topics covered will include talent considerations, financial concerns and placement (by selection number) within the draft.

35 *An Augmented Lagrangian Optimization Technique for Support Vector Machine Image Classification*
Marylesa Howard, The University of Montana†

A quick introduction to image classification is presented along with a conceptual look at the support vector machine classifier. Optimization for support vector machines will include a new augmented Lagrangian technique for solving the equality and bound contrained quadratic program. Examples will include various images for classification.

36 *Genetic Algorithm for Optimized Book Embedding: A Dual Layered Approach (Part Two)*
Marshall Hurson, Gonzaga University **†

The genetic algorithm is an algorithm which attempts to find near-optimal solutions to optimization problems by modeling biological evolution in the form of genetic crossover and mutation. The algorithm works with a population of solution sets, and uses a survival of the fittest method to converge upon a solution. We apply the genetic algorithm to the book embedding problem in an attempt to generate minimum book embeddings. There are two aspects which affect the page count for an embedding: [1] the ordering of the vertices along the spine, and [2] the order in which the edges are placed in the book. We use a multi-level genetic algorithm in order to tackle both of these aspects of the problem. On the higher level, we determine a "good vertex ordering for a graph, and on the lower level, for a given vertex ordering, we determine a "good edge ordering. We are also doing research into various mating algorithms to determine which are best suited to the book embedding problem. Our goal is to find solutions for certain types of graphs, such as complete bipartite, which are lower than their current theoretical bounds.

37 *Fostering Mathematical Reasoning in a Service Course*
Robert Ely and Jennifer Johnson-Leung†**, University of Idaho**

This is a preliminary report on an ongoing experiment in teaching service courses to a diverse audience. We modify the linear algebra curriculum to provide daily opportunities, through well-crafted examples and exercises, for students to use mathematical reasoning in order to make the generalizations which comprise the core content of the course. This provides students with a deeper understanding of the mathematics that they are learning and enables them to make broad applications independent of the instructor.

The talk will cover techniques as well as student and instructor observations. This project was motivated by our work on the NSF MSP project Making Mathematical Reasoning Explicit.

38 *Golden Field and Polygons: A case for the pentagon, heptagon and various applications*
Heather Johnston, Western Oregon University **†

The Golden Ratio is an age-old proportion of wonder and beauty. One instance in which this ratio makes an important appearance is in polygons. The ratio of a regular pentagon's diagonals to its side happens to be the golden proportion. In this presentation we consider the traditional problem of roots of polynomials constructed from ratios of lengths of diagonals to lengths of sides of the pentagon, then extend this to the heptagon and in fact the case of any n-gon for which n is odd. We will use the Diagonal Product Formula of Steinbach to find polynomials of which these special diagonal ratios are roots.

39 *Spectral Conditions for Composition Operators on Algebras of Functions*
Jeffrey Johnson, University of Montana*†, T. Tonev, University of Montana

We establish sufficient conditions for maps between function algebras to be composition or weighted composition operators. Let X be a locally compact Hausdorff space. A function algebra A is a Banach algebra of continuous functions which separates points, that is for each $x, y \in X$, there exists $f \in A$ such that $f(x) \neq f(y)$. Recall that a boundary of A is a subset of X where each function is maximized. The Shilov boundary, ∂A, is the smallest closed boundary. The Choquet boundary, δA, is the set of all generalized peak peak points, that is, all points x such that for every neighborhood V of x there exists a function $h \in A$ with (1) $\|h\| = 1$, (2) $|h(x)| = 1$ implies that $h(x) = 1$, (3) $x \in h^{-1}(1) \subset V$. Also for each $f \in A, \sigma_\pi(f)$ are the elements of $Range(f)$ with maximum modulus.

Let $A \subset C(X)$ be a function algebra, not necessarily with unit, such that $X = \partial A$ and $p(A) = \delta A$, where ∂A is the Shilov boundary, δA – the Choquet boundary, and $p(A)$ – the set of p-points of A. IF $T : A \to B$ is a surjective map onto a function algebra $B \subset C(T)$ such that either $\sigma_\pi(Tf \cdot Tg) \subset \sigma_\pi(fg)$ for all $f, g \in A$ or, alternatively $\sigma_\pi(fg) \subset \sigma_\pi(Tf \cdot Tg)$ for all $f, g \in A$, then there is a homeomorphism $\psi : \delta B \to \delta A$ and a function α on δB so that $(Tf)(y) = \alpha(y) f(\psi(y))$ for all $f \in A$ and $y \in \delta B$.

40 *Is NFL Overtime Fair? A Markov Chain Analysis*
Keenan Kriegel, Western Oregon University†

For more than 50 years, the National Football League had utilized a "Sudden-Death" rule for when games go to overtime. However, less than two years ago, the NFL decided to change their rules for overtime, but only during the postseason. Using Markov Chains and linear algebra, we will discover if the postseason rules are in fact an improvement in fairness, but also compare those to another proposed set of rules as well as the NCAA's rules governing overtime in football all in the hope of finding the most fair way to find a winner while maintaining a reasonable length of game.

41 *Golden Tree*
Hanna Landrus, Pacific University†, Adri Wilburn, Pacific University, Tony Fernandez, Pacific Univeristy**

Trees are complex living organisms that grow in a continuous world. This presentation, however, will explore how to model a tree that has been constrained to a discrete time frame. This model uses the Fibonacci sequence to model this growth in relationship to the number of branches, the number of leaves, the mass of the total leaves of a tree and the distribution of leaves and branches. This presentation demonstrates how different uses of the Fibonacci sequence can model two types of trees; multilayer and monolayer.

42 *Open Textbook for Precalculus and Trig*
David Lippman, Pierce College †

This talk with share the open textbook for precalculus and trigonometry the presenter co-authored, along with the free and open online homework and other course resources built around that text as part of the Washington Open Course Library project. Experiences authoring and promoting the text will also be shared.

43 *The AIM Open Textbook Initiative*
Kent E. Morrison, American Institute of Mathematics

The American Institute of Mathematics sees the fostering of excellent non-commercial mathematics textbooks as a natural extension of its primary mission to encourage mathematical progress through focused collaborative research. AIM has created an editorial board to evaluate and identify open textbooks that are suitable for standard undergraduate courses in mathematics in American colleges and universities. During the first year the board developed evaluation criteria and has now placed seven books on the approved list. Now in its second year the board is starting the outreach efforts to the university mathematics faculty. The website for the project is ¡http://www.aimath.org/textbooks¿.

44 *Revisiting the Lipschitz Uniqueness Theorem for ODEs*
Cristina Negoita, Oregon Institute of Technology †

Nearly every student in a differential equation class has experienced the uneasiness of the fact that some differential equations $\frac{dy}{dx} = f(x,y)$ have more than one solution, depending on the continuity of the derivative $f_y(x,y)$. In fact, only if f_y is Lipschitz continuous can we make the promise of a unique solution $y(x)$ on a given open interval I. This is a rather strong condition on f. In this talk, we show a weaker condition that guarantees uniqueness of solutions and relies on the continuity of f_x.

45 *Fitting Mitscherlich Exponential and Verhulst Logistic Curves to Data by Generalized Non-Linear Least Squares*
Yves Nievergelt, Eastern Washington University †

Despite two centuries of study, practical difficulties still arise in fitting Mitscherlich's shifted exponential curves or Verhulst's logistic curves to data. Obstacles include divergent iterations, negative values for theoretically positive parameters, or the absence of any best-fitting curve. A theory with examples and counter-examples for median curves appears in the March 2012 issue of the American Mathematical Monthly. In contrast, focusing on generalized non-linear least-squares regression, which allows for correlated data, the present analysis reveals that such obstacles occur near removable singularities of the objective function to be minimized for the regression. Such singularities lie at the transition to different types of curves, including exponentials, hyperbolae, lines, and step functions. Removing the singularities — in the sense of complex analysis — encompasses all such curves into a connected compactified topological space, which guarantees the existence of a global minimum for the continuous objective function, and which also provides a smooth and transparent transition from one type of curve to another: The type of the fitted curve is automatically determined by the location of the minimum. However, the location and type may be an artifact of the objective selected for the regression. Examples range from agronomy to zoology.

46 *Polynomial Representation for the Expected Length of Minimal Spanning Trees*
Peter T. Otto, Willamette University †
Colin Starr, Willamette University
Jared Nishikawa, Univeristy of Colorado, Boulder*

We investigate the polynomial integrand of an integral formula that yields the expected length of the minimal spanning tree of a graph whose edges are uniformly distributed over the interval $[0,1]$. In particular, we derive a general formula for the coefficients of the polynomial and apply it to express the first few coefficients in terms of the structure of the underlying graph; e.g. number of vertices, edges and cycles..

47 *The Journey that changed the course of 19th century Italian Mathematics*
Donna Pierce, Whitworth University †

"In the fall of 1858, three young Italian mathematicians set out on a scientific trip to visit foreign Universitiesthe trip undertaken by Betti, Brioschi and Casorati marks a date well worth remembering: Italy was about to construct her unity and take part in international scientific proceedings, making her own contributions. So begins Vito Volterras presentation at the inaugural session of the Second International Congress of Mathematicians held in Paris in 1900. In this talk we will hear about that important scientific journey and how it transformed Italian mathematics in the 19th century.

48 *Torus knots and polynomials*
Brandon Reeves, Gonzaga University †**
Enrique Alvarado, Gonzaga University†**

In the study of knots, there are several polynomial invariants that are used to classify and study the structure of knots. One of these polynomial invariants, a particular version of the Alexander Polynomial, requires one to construct an oriented diagram of the knot, then use a basic procedure to construct a matrix for the knot. One then uses the determinant of this matrix in order to determine the Alexander polynomial of the knot. While this polynomial is useful in studying knots, the calculation of this polynomial is labor intensive. For torus knots, we develop an algorithm for calculating the Alexander polynomial that allows us to avoid much of the work involved in the construction of the Alexander polynomial.

49 *How Do You Tic-Tac-Toe? New Variations in Positional Games*
Mary J. Riegel. University of Montana †*

Tic-Tac-Toe is a well know, often played, and frequently studied game. As the prototypical positional game, its analysis highlights many of the characteristics that one looks for in the study of positional games. Many variations to the game exist, and in this talk we will explore a new one. It is very rare in a two player game that one player would wish to help his opponent. In this new variation a player will in a single turn be able to improve his own position and forced to improve his opponent's position. It would seem that this would be detrimental to both players; however we will see that playing the variation on the traditional Tic-Tac-Toe board results in the surprising ability of the first player to always win under optimal play by both players. We will also prove the game result on two infinite classes of boards: affine and projective planes. Finally we will describe a second more restrictive variation and some preliminary results for its use.

50 *J-Holomorphic maps and the uncertainty principle in geometric quantum mechanics*
Barbara Sanborn, Western Washington University †

The theory of geometric quantum mechanics describes a quantum system as a Hamiltonian dynamical system, with a complex projective Hilbert space regarded as the phase space. The Kähler structure of the projective space provides quantum mechanics with a Riemannian metric in addition to the symplectic structure characteristic of classical mechanics, and geometric quantum mechanics identifies this additional structure as the source of the uncertainty principle specific to quantum systems. This talk extends the theory by including an aspect of the symplectic topology of the quantum phase space. It is shown that the quantum mechanical uncertainty principle is a special case of an inequality from J-holomorphic map theory, that is, J-holomorphic curves minimize the difference between a symplectic area and the quantum covariance matrix determinant corresponding to the measurement of two observables.

51 *Publishing math texts directly to the web–some fantastic free tools.*
Albert Schueller, Whitman College †

Historically, publishing mathematics on the web has been difficult. Most authors simply converted their documents to pdf and post the pdf files. In recent years, several nice tools have emerged that make publishing open-source texts directly in html not only possible, but desirable. An argument will be presented that through the use of MathJax, embedded Sage, and JSXGraph, on-line texts become vastly more capable than simple pdf files. These free tools have the added benefit that they are platform independent in the sense that they will function on any computing device that has a Javascript-enabled browser (e.g. windows, mac, iPad etc). Finally, the ease of use of some of these tools will be demonstrated.

52 *Cores and Prime Numbers: A Connection*
Michael Severino, University of Montana*†

A core is a graph in which every homomorphism from the graph to itself is a bijection. A natural analog of a core in the directed case has been defined in terms of acyclic homomorphisms in a few recently published papers. An *acyclic homomophism* from a digraph D to a digraph H is a function $f : V(D) \to V(H)$ such that if uv is an arc in D the $f(u)f(v)$ is an arc in H or $f(u) = f(v)$ and for all $x \in V(H)$ the subdigraph of D induced by $f^{-1}(x)$ is acyclic. I prove that if D is a vertex transitive digraph with a prime number of vertices then D is a core.

53 *Broken Ray Transform and Inversion*
Brian Sherson, Oregon State Univeristy*

In this talk, we introduce the Broken Ray Transform, a problem in optical tomography with a single scattering event. We also will introduce an inversion formula and discuss methods of computing an inversion.

54 *Social Dynamics of Gang Involvement: A Mathematical Approach*
Emily Smith, Linfield College **†**, Joshua Austin, University of Maryland, Baltimore County, Sowmya Srinivasan, Bryn Mawr College, Fabio Sánchez, Arizona State University**

Gangs have played a significant role in the social and political history of the United States, and continue to impact the country today, as gang violence and incidence rates continue to grow. In this paper, we explore the dynamics of gang involvement between at-risk individuals, gang members, and reformed gang members using an SIR-type model. We investigate the effect that social influence of reformed gang members has on the "at-risk" population using a general function, which takes into account the cost of gang membership and a threat factor. We establish that the influence of the reformed population is highly sensitive to initial gang member population size and recidivism.

55 *The three point ellipse*
Everett Sullivan, Seattle University†**, Dylan Helliwell, Seattle University**

We are very familiar with both the circle and the ellipse since they are both conic sections and thus have many nice properties that we can use to our advantage to study them. However we wonder what happens if generalize to more than two focal points. In the following presentation we explore the consequences of creating shapes of this from and the interesting properties that they have.

56 *The United States vs Australia: A Comparison of High School Math Curricula*
Kellie Takamori, Pacific University †

Because Australia arranges math topics in an integrated fashion as opposed to the United States' separation of math topics by subject content, we have opted to assess the content of Australia's national numeracy test and correlate the content to U.S. math subjects such as Algebra I, Geometry, Algebra II, etc. We will create my own scale of 'proficiency' levels for Australian students by subject and compare the data to the proficiency levels in the U.S. We have chosen to compare the results of grade 9 of Australia's National Assessment Program Literacy and Numeracy (NAPLAN) Test (formerly known as the Basic Skills Test) and America's Oregon Assessment of Knowledge and Skills (OAKS) Test. By narrowing the focus of my project, were enabling the results of the project to be more accurate. In particular, we have chosen to analyze year 9 in public high schools of the state of Oregon to represent the United States and the state of South Australia to represent Australia. We have chosen the states Oregon and South Australia as representation for their countries with the notion that these are average-performing states.

In summary, we would like to compare the numeracy levels of public high schools in Australia and the United States by analyzing nationally implemented tests. Our goal is to model the results and, in addition, to investigate the differences in math curriculum and assessment. We would like to arrive to conclusions about factors such as the benefits to different assessments and curricula in order to relate the results to high school graduation, first year college enrollment, and proficiency statistics.

57 *Chebyshev's Inequality and Types of Convergence*
Kathy Temple, Central Washington University †

Ever wonder why probabilists talk about "almost sure" convergence and mean that as a technical term? What do we mean when we talk about probability distributions converging in the Central Limit Theorem? We'll start with Chebyshev's Inequality, which is really a real analysis result, and use that as a jumping-off point to talk about 3 different types of convergence and how each is used in probability. A little familiarity with probability terminology (random variables and expected values) would be helpful but not required.

58 *The Lebesgue Integration Made Easy Through Henstock-Kurzweil*
Elena Toneva, Eastern Washington University†

The integral introduced by Henstock and Kurzweil is one of the recent advancements of the theory of integration. Also in 20th century an unified theory of limits was developed.

An alternative approach to the Lebesgue integral will be introduced based on these tools.

59 *Application of a Proportional-Odds Cumulative Logit Model in Efficacious Introductory Mathematics Placement*
Terri Torres, Oregon Institute of Technology †**, Joseph Reid, Oregon Institute of Technology** †**, David Waite, Oregon Institute of Technology**

A statistical model was built to place students into Oregon Institute of Technologys mathematics curriculum in order to attempt to reduce costs and hopefully improve accuracy for student placement. For the model, a latent variable of mathematical preparedness is assumed, and an ordinal logistic, proportional-odds model of first time freshmen placement is presented (based on 450 observations from students who passed introductory courses in previous cohorts) where students are placed into one of four introductory mathematics courses according to cut scores

derived from the model. Variables employed to measure the latent variable include student major, high school GPA, and SAT math score (or ACT equivalent). This new model is then applied to a validating set of 204 first time freshmen from the most resent cohort. Resulting proportions of student over and under placement were comparable between the existing placement test model and the logistic model with the logistic model being more conservative. The traditional placement test model achieved 79.41% (162/204) success in students passing their first course; whereas, of the students who took the course the logistic model would have placed them into, 78.57% (88/112) achieved a passing grade. The model only achieves 54.9% (112/204) agreement with the current placement test; however, techniques are presented that could allow for a change in cut scores in order to affect this agreement proportion if so desired.

60 *Dellanoy Numbers: Counting Certain Restricted Paths in an Integer Lattice*
Vivan Qianru Wang, Pacific University †

Dellanoy numbers count the number of paths in an integer lattice from one point to another where legal moves are to move one step up, one step right, or one step diagonally up and right. In this talk, we discuss the generating function for Dellanoy numbers, present a combinatorial proof of a formula for central Dellanoy numbers, and introduce a new problem in which we add an additional legal move.

61 *Investigating Infinite Exponentials*
Gabriel Wechter, University of Alaska Southeast †**

In this talk we explore the properties of what we call infinite exponentials by introducing a recursive sequence as follows, $s_1 = x$ and $s_{n+1} = x^{s_n}$. We found that the behavior of this sequence can be drastically different depending on the value of x. We will give some examples of convergent and divergent cases for both real and complex values of x, as well as provide a general result for the positive real numbers.

62 *Juggling Mathematics: Counting Juggling Sequences*
Travis White, Pacific University†**

Juggling is a repetitive act that can easily be described using sequences. In this talk, we learn how to categorize juggling sequences by their landing schedules, we then see that generating functions can be used to represent how many b ball juggling sequences exist with a fixed landing schedule.

63 *A Mathematical Model of Stress-Induced Insomnia*
Sarah Whittemore, Whitworth University **†

Although stress-induced insomnia is one of the most common sleep disturbances, the biological processes that underlie it are still relatively unexplored. Working with the mathematical representations of the flip-flop and two-process models, we introduced a stressor variable in the form of a differential equation into the system to emulate the timing and characteristics of a stress-induced night of insomnia. A stressor that mimics the growth of the homeostat forces the system into a half-sleep state in which both the wake-active and sleep-active systems are simultaneously firing. In accordance with human data and results from experiments conducted upon rats, our model exhibits increased sleep latency, fragmentation, and reduced total sleep time. We then added in the effects of a generic nonbenzodiazepine in order to test the effects a common sleping pill would have upon our model. The inclusion of the nonbenzodiazepine

served to shift the circadian rhythm forward and weaken the GABA-regulated inhibitory connections within our model. Our efforts illuminate the detailed interactions between the sleep homeostat, circadian rhythm, and an external stressor responsible for the stress-induced insomnia phenotype. Analysis of our model and its results yield a deeper understanding of sleep, insomnia, their treatments, and the potential mechanisms regulating each.

64 *Quilting in Geometry Class*
Nick Willis, George Fox University †

Add a bit of creativity to a College Geometry class by adding a geometrical art project.

65 *Zero Divisor Graphs of Inverse Systems of Abelian Groups*
Cynthia Wu, Gonzaga University **†

Let S be a commutative semigroup with zero ($0x = 0$ for all $x \in S$). F.R. DeMeyer, T. McKenzie and K. Schneider (2002) associated a graph to S in *The zero-divisor graph of a commutative semigroup*. The vertices are the nonzero elements of S, with two vertices a, b joined by an edge in case $ab = 0$. We associate a commutative semigroup with zero to any inverse system of abelian groups over a poset with least element. Then, we use the associated graph to construct a number of classical graphs.

66 *Fourier Transforms*
Kelli Zehr, Western Oregon University **†

We'll offer a brief glimpse into the world of Fourier Transforms by first considering the wave equation and the trigonometric series solution to this partial differential equation. We will also use Parsevals Identity as a way to find the sums of certain infinite series. We will derive the formula for the Discrete Fourier Transform (DFT) from the trapezoid rule. Time permitting, we will move to the DFT matrix to show the eigenvalues of any $n \times n$ DFT matrix are ± 1 and $\pm i$. Much less is known about the eigenvectors of the DFT, and this is the subject of my ongoing research project.

Abstracts of Student Posters

(in alphabetical order, by presenter)

67 *Polyomino Dissections The Damaged Patchwork Quilt*
Megan Arnoldy, George Fox University **†

Martin Gardner was a rather famous mathematician who published a number of mathematical games in the magazine Scientific American. One of the very last columns he published included the puzzle, the damaged patchwork quilt. The patchwork quilt was originally made up of 108 squares, rectangular in shape, before the 8 center squares became warn and thus were removed. The puzzle asked to cut the quilt along the lines into just two parts that could be sewn back together to form a 10x10 quilt.

68 *The St. Petersburg Paradox*
Daniel Carlson, George Fox University **†

On probability, and the paradox that arises from the 'expected value' of gambling.

69 *Triangular Numbers, Gaussian Integers and KenKen*
Sarah Colón, George Fox University **†

Latin squares form the basis for the recreational puzzles sudoku and KenKen. In this article we show how useful several ideas from number theory are in solving a KenKen puzzle. For example, the simple notion of triangular number is surprisingly effective. We also introduce a variation of KenKen that uses the Gaussian integers in order to illustrate the concept of unique factorization.

70 *Folding Polyominoes from One Level to Two*
Jakob Daum, George Fox University **†

The various ways and methods of transforming Polyominoes of one level into a similar shape of two levels.

71 *The Secrets of the KenKen*
Ana Goldys, George Fox University **†

KenKen is an arithmetical puzzle game invented by a Japanese mathematics teacher by the name of Tetsuya Miyamoto. KenKen, loosely translated from Japanese, means wisdom squared. Shortly after its creation in 2004, it became a popular standard feature in many newspapers around the world.

As in Sudoku, the goal in KenKen is to fill an n x n grid with the numbers 1 through n so as not to repeat a number in any row or column. Solving a KenKen puzzle depends heavily upon several important ideas about numbers; these ideas are introduced with the consideration of triangular numbers and Gaussian integers.

72 *Hexaflexagons*
Sally Gordon, George Fox University **†

For the mathematician, after a long day of calculating the best way to relax is to enjoy a contemplative activity. From Martin Gardners series of Mathematical Games, the Hexaflexagon appears to simply be folded paper but proposes a phenomenon. The Hexaflexagon presents entertainment to a wide audience.

73 *Who does the Housework?*
Moriah Kimmer, George Fox University **†

Angela Vierling-Claassen uses game theory to study the dynamics of housework between two roommates. The main concept is to see if or how a task is completed and whose goals are accomplished by the completion or incompletion of that task. The information is then further used to study the gender division of housework.

74 *Math Tricks*
Mitch Main, George Fox University **†

Martin Gardner loved magic tricks based around mathematical ideas. Most of these tricks he based on an important idea called a state diagram, a helpful tool in most combinatorial problems. The article written by Ian Stewart, explores the mathematical concepts, which Martin Gardner developed around these tricks and provides other applications of the concepts.

75 *Computation of Determinants Using Condensation*
Kenton Miller, George Fox University **†

Using a method Lewis Carroll (Rev. Charles Lutwidge Dodgson) described known as condensation, determinants of large-full matrices can be computed in a fairly efficient and intriguing way. Although this method does not allow for certain interiors of the matrix to have a zero value, there are some work around methods that swap those values of zero for others in the matrix. However, in spite of this flaw this method of condensation is extremely helpful in computing determinants for larger determinants where using expansion of minors or reducing to an upper or lower triangle can be vastly tedious and subject to many mistakes. The following describes the practice of the condensation method and gives examples in which the method is successful and will also show how it fails while briefly describing the work around.

76 *Squares, Cubes and Cube Roots*
Isaac Paulus, George Fox University **†

Formulas and patterns can be used to solve squares, cubes, and cube roots that are not obvious. This work is intended to prevent the necessity of a calculator.

77 *Cups and Downs*
Brianna Phelps, George Fox University **†

Taking the article about a coin-flipping trick by Martin Gardner, this article by Ian Smart compares a similar trick using three cups flipped in pairs. Through analysis by various methods, this article then explores a broader problem using n cups flipped m at a time.

78 *The Center of Package Transportation in the United States. Where is it?*
Sam Rohde, George Fox University **†

There is a quickest and shortest route from each persons package pick up, to the delivery destination. This project explores if the quickest delivery time is the same as the shortest pick up to destination point. FedEx has chosen Memphis at it's central hub, did they make the right choice?

79 *A Midsummer Knot's Dream*
Christina Rubesh, George Fox University **†

This article focuses on games that can be played with the shadows of knots and centers around two games in particular: Much Ado About Knotting and To Knot or Not To Knot. The games are explained in detail, winning strategies are discussed, and variations of these two games are also explored. Probability, design, and proofs are supplied to prove that winning strategies are possible.

80 *CORDIC: How Hand Calculators Calculate*
Erika Stutts, George Fox University **†

It is a common misconception that many calculators use Taylor Polynomials to compute trigonometric values. There actually exists an alternate method, the COordinate Rotation DIgital Computer, that is often used in calculators today. This method, commonly referred to as CORDIC, can calculate trigonometric functions (and other quantities) using only the operations that are simple and fast for a computer to perform. This project will illustrate the CORDIC method for calculating sine and cosine values in binary form.

81 *The Rascal Triangle*
Dmitrey Timofeyev, George Fox University **†

A number triangle similar to Pascals triangle is compared to the Pascals triangle and proven to contain only positive integers.

82 *Cycles in Fibonacci Numbers*
Michael Vandeberg, George Fox University **†

Does the series formed by an nth Fibonacci number mod n (fib(n) % n) form a cycle for Fibonacci series starting with initial values fib(1) = a, fib(2) = b? Modeling this behavior using computers can be used to find these cycles.

Campus Information

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Select the ‘MAA-Guest’ WiFi network. You will be prompted to provide a password. Enter the following:

PacNW2012

PC/Mac access is available in the computer lab in Franz Hall 111; ask the attendant at the central desk for login information.

UP Public Safety and Security Information:

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Campus Safety Emergency: (503) 943-4444

Campus Safety (Non-emergency): (503) 943-7161

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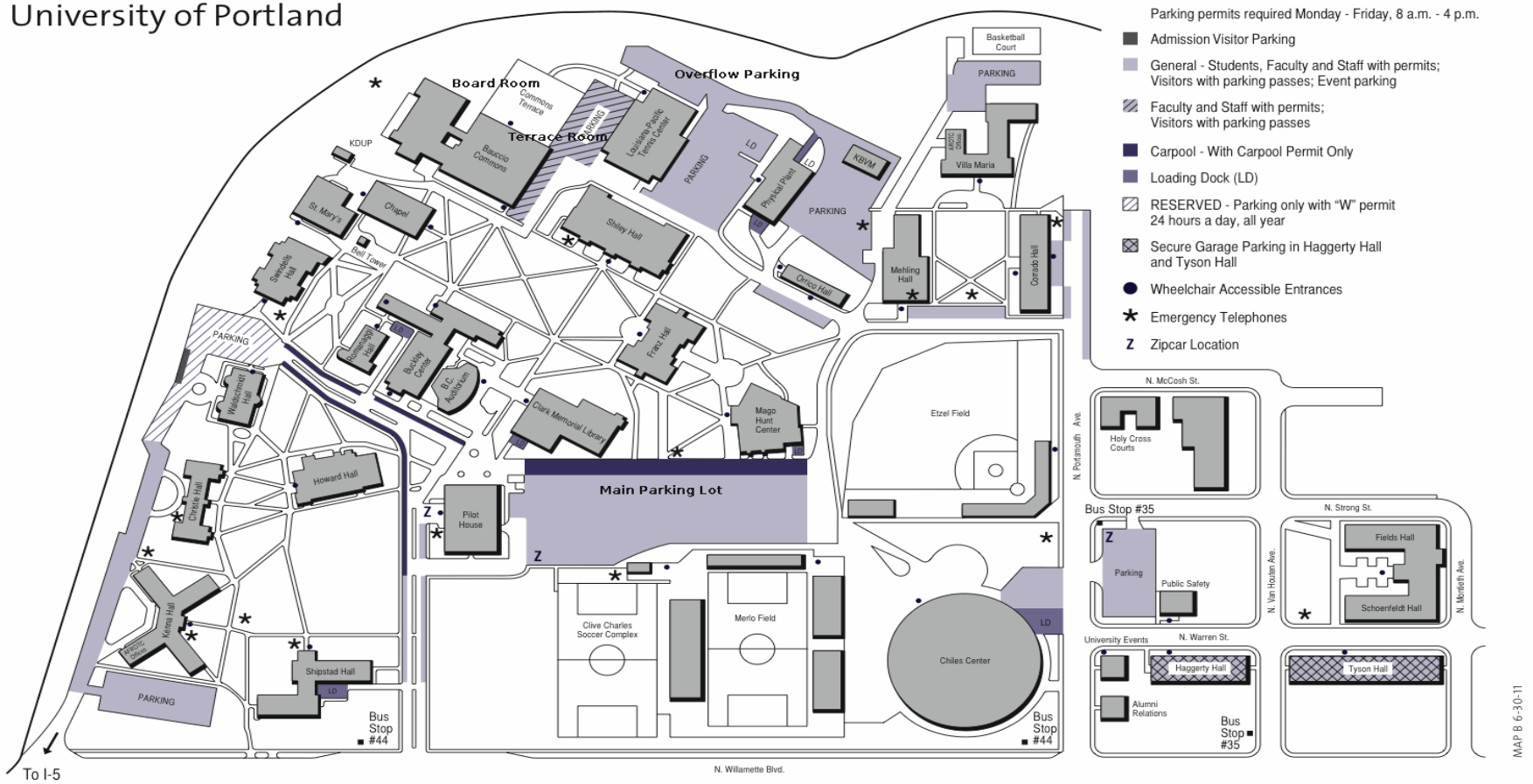

Alumni Relations
Bauccio Commons - student-faculty dining hall; Terrace Room; Bon Appétit; Teske Room, Board Room
Bell Tower
Buckley Center - Center for Entrepreneurship; College of Arts and Sciences; Garaventa Center; School of Nursing; Shepard Freshman Resource Center; information services; mail center; printing services; residence life; classrooms
Chapel of Christ the Teacher - campus ministry
Chiles Center - convocation and athletic center; athletic office
Christie Hall - men's residence; international student services
Clark Memorial Library
Clive Charles Soccer Complex - Merlo Field; practice fields
Corrado Hall - men's and women's residence
Etzel Field - baseball field; Andy Pienovi hitting facility
Fields Hall - women's residence
Franz Hall - Dr. Robert B. Pamplin, Jr. School of Business Administration; School of Education; classrooms; computer labs; Learning Resource Center
Haggerty Hall - men's and women's residence
Holy Cross Court - priests' residence
Howard Hall - recreation center; swimming pool
KBVM - Catholic radio station
KDUP - campus radio station
Kenna Hall - men's and women's residence; Air Force ROTC; campus ministry outreach, Saturday Academy
Louisiana-Pacific Tennis Center
Mago Hunt Center - theater and recital hall
Mehling Hall - women's residence
Orrico Hall - career services; health center
Physical Plant
Pilot House - bookstore; The Cove; campus ministry outreach; campus information center; student lounge
Public Safety
Romanaggi Hall - classrooms; laboratories
Schoenfeldt Hall - men's residence
Shiley Hall - Donald P. Shiley School of Engineering; classrooms
Shipstad Hall - men's and women's residence; archives; museum
St. Mary's Student Center - ASUP; The Beacon; The Log; student activities; Moreau Center for Service and Leadership
Swindells Hall - classrooms; laboratories
Tyson Hall - men's and women's residence
University Events
Villa Maria Hall - men's residence; Army ROTC
Waldschmidt Hall - admissions; cashier; controller; development; executive officers; financial aid; Graduate School; personnel; marketing; registrar; student accounts

Acknowledgments

In recent years, our spring meetings have really taken on a life of their own. We've now had nearly a decade of meetings for which roughly half of the contributed program is comprised of student work. I'm proud that our Pacific Northwest Section of the Mathematical Association of America has been so successful in highlighting and promoting our work as mathematicians and educators. I'm also thankful for all the help I've received in putting this meeting together. In particular, I would like thank:

My colleagues Aaron Wootton, who took on the task of organizing accommodations, and Meike Neiderhausen, who was responsible for creating the web-resources and interfacing with our new math club in organizing student activities.

The program committee members Josh Laison and Chad Giusti (Willamette University) who helped organize the invited and contributed programs.

Dominic Klyve (Central Washington University) who helped organized the student portion of the program and promoted opportunities for student involvement in this meeting.

Jenny McNulty (University of Montana), and my colleagues Valerie Peterson, and Hannah Callender, who arranged the Project NExT program and social events.

Carol Bruce (Mathematics and Communications Departments Office Manager) and our student workers; Carol helped process mail-in registrations and made many of the arrangements for campus spaces. She and our students did innumerable (hey, we're mathematicians, they were *enumerable*), essential tasks in preparing for the meeting.

Jenny Walsh and Ryan Benedetti (Info. Services) who helped set up web-registration and other technical needs, Linda Lechler and Jane Woodcock (CAS Dean's Office), as well as Brian Foster (Assistant Controller) who helped with the budget and other details, and my colleagues in the Department of Mathematics who all made contributions by volunteering time and expertise whenever needed.

Our first Math-Club president, Samantha Warren, and members Rory Blucher and Reilly Hourigan, who helped organize the Friday Evening Social and recruited student volunteers.

Finally, I'd like to that all our meeting participants; without your continued support and patronage, the section would not have these great meetings!

Thank you,

Hans Nordstrom

Local Arrangements Chair