Archived Colloquia
2012/13

August 24, 2012: Bogdan Suceava (CSU Fullerton)

Title: ***Geometries Induced by Logarithmic Oscillations and their Natural Extensions*** (Flyer)

Abstract: Introduced originally in 1934, Barbilian's metrization procedure induced a distance on a planar domain by a metric formula given by the so-called logarithmic oscillation. In 1959, Barbilian generalized this process to domains of a more general form, withstanding not necessarily on planar sets, but in a more abstract setting. We will show that there exists more general classes of distances than the ones produced by logarithmic oscillation. As a consequence, we will present the most general form of Barbilian's metrization procedure. Additionally, in a recent work written with W. G. Boskoff, we are introducing a new distance on a subset of the n-dimensional real space. We will prove it generates an example of Gromov hyperbolic distance on the punctured open unit ball and then study its geometric properties and its relations with other remarkable metrics.

August 31, 2012: Oscar Vega (CSU Fresno)

Title: ***The Mathematics of M.C. Escher*** (Flyer) (Slides)

Abstract: There are only a handful of artists that are admired by the vast majority of math people. There is only one that has been 'stolen' from the art world and considered property of the mathematical community: M.C. Escher. The art of Escher plays with our minds by bending the standard rules of space, by showing us objects while hiding others, and by presenting strange worlds, where things do not quite work the same way our 'real' world works. In this talk you will learn bibliographical facts about Escher, and see some of the artwork that made him so admired by people like H.S.M. Coxeter and Roger Penrose (mutual admiration, really). We will also discuss some of the underlying math structure in his works.

September 7, 2012: Heather Russell (University of Southern California)

Title: ***Knots, Webs and Tableaux*** (Flyer)

Abstract: A knot is a circle embedded in three-dimensional space. There are infinitely many different knots, and distinguishing them is an important topic in mathematical research. We will discuss certain polynomial invariants of knots which have a simple diagrammatic construction via planar graphs called webs. Webs have a rich combinatorial structure of their own including relationships with Young tableaux. We will explore some of these connections and finish with recent results about operations on webs and tableaux.

September 14, 2012: Valerie Peterson (University of Portland)

Title: ***Geometry, Topology, Group Theory, and Killer Robots*** (Flyer) (Slides)

Abstract: Suppose you have robotic agents in your manufacturing plant that help with assembly. The robots move between different work stations to carry out their tasks, but must travel along a shared track in the floor while doing so (more sophisticated robots are quite expensive). How do you coordinate them so that they complete their assembly tasks without colliding? If you're a mathematician, you might build a configuration space that records all allowable positions of the robots and then examine that space for answers. In this talk, we'll build some configuration spaces and see lots of examples of settings where they are useful (robotics, biology, and chemistry, to name a few). We will also discuss some surprising ways in which geometry, topology, and group theory make appearances. Definitions (and "robots") will be provided.

September 21, 2012: Tamas Forgacs (CSUF)

Title: ***Linear Operators on*** $\boldsymbol{R}[x]$ (Flyer) (Slides)

Abstract: The vector space $\mathrm{R}[x]$ appears in every introductory linear algebra class. This talk will give an introduction to linear operators on this space. Subsequently, I will discuss a research area of complex analysis (namely the theory of multiplier sequences), which obtains a significant amount of its results using special properties of various bases for $\mathrm{R}[x]$. The talk will conclude with the exposition of some of the research questions accessible to undergraduate students.

September 28, 2012: Matt Horak (University of Wisconsin-Stout)

Title: ***Geometric Group Theory: Where Geometry Meets Algebra*** (Flyer) (Slides)

Abstract: We are physical creatures with an excellent geometric intuition about the shapes in the world around us. Most of us, however have less intuition about abstract algebraic relationships. Geometric group theory is one of the disciplines that attempts to gain algebraic insights through geometric reasoning. This talk will start with an introduction to discrete geometry and graph theory. We will then move into "large scale" questions, which allow us to ignore small differences between objects and focus on their larger properties. We'll answer questions like, "How is an infinitely large screen door like the Euclidean plane?" In the end, the beautiful symmetries of geometric group theory will help uncover some subtleties of large scale geometry that could serve as starting points for many kinds of research projects.

October 5, 2012: Ke Wu (CSUF)

Title: ***Two-Sample Scale Problem under Different Censoring Models of Survival Data*** (Flyer)

Abstract: Survival analysis has been used to investigate things like how long a cancer patient lives, how long it takes before a lightbulb breaks, Geometric Group Theory Graphichow long people stay unemployed, etc. One is often interested in studying the difference

of the effects of two treatments in a clinical trial, leading to the two-sample problem. In the two-sample scale model a specific treatment extends the life of the subject, in the sense that the lifetime is multiplied by a scale parameter. During this talk we will discuss the nature of survival data, the non-parametric Kaplan-Meier estimates of the survival curves, and minimum distance estimators of the scale parameter when the data are under different censoring models including the general right censoring model, Koziol-Green model, and partial Koziol-Green model. We will present the large-sample properties of the estimators and study the efficiencies of the estimators under these different censoring models.

October 12, 2012: Larry Cusick (CSUF)

Title: ***Knot Quandles and Quandle Knots*** (Flyer) (Slides)

Abstract: A quandle is a simple algebraic structure that comes from a knot diagram. Despite their simplicity, there are still many unanswered questions about their theory and their relationship with knots and links. I will provide a gentle introduction to quandles with an eye towards the true interplay between the algebra and the combinatorial topology of knots.

October 19, 2012: Adnan Sabuwala (CSUF)

Title: ***Derivatives, Finite Differences, and Optimal Grids*** (Flyer)

Abstract: The derivative of a function, $f'(x)$, is first introduced in calculus. In a differential equations class, these derivatives are used to model real-world phenomena. In this talk, we will look at a practical implementation of the derivative on a computer using finite difference methods. Traditional finite-difference techniques using uniform grids for numerical solution of PDE's are slow and compute the solution over the entire problem domain. However, for receiver-targeted applications such as geophysical exploration, one wishes to compute faster solutions to PDE's at specific receiver locations with high accuracy. Spectrally matched optimal grids have been shown to achieve super exponential convergence for such problems. We will give an introduction to the method of computing spectrally matched optimal grids. We will also look at an application of these optimal grids to aniostropic problems.

October 26, 2012: William Y. Velez (University of Arizona)

Title: ***Mathematics Changed My Life*** (Flyer)

Abstract: It almost killed me at first. In my first semester in college I was a chemical engineering major and enrolled in calculus. I could not understand my calculus class and dropped it, falling back to college algebra and trig. That first semester I earned nine units of Ds (It is hard to believe but I do have a Ph.D. in mathematics and hold the post of University Distinguished Professor). I made a momentous decision in my second semester in college. I dropped engineering but re-took calculus. I did OK. In my fourth semester I decided I was going to earn a PhD in mathematics or physics. I was hooked, I was fascinated. It changed my life. The fact that I made that decision to continue on in mathematics provided me with the tools to address a complex array of problems. Understanding mathematics has

been fun, applying it to solve problems dealing with military communication systems has been exciting, introducing students to world-shaking mathematical ideas continues to be exhilarating. This is the message that I try to convey to students.

November 2, 2012: Stefaan Delcroix (CSUF)

Title: ***Fractals and Graphs - a Beautiful Connection*** (Flyer)

Abstract: We start with some basic definitions in graph theory: incidence matrix, eigenvalues and cartesian product. Then we introduce the tensor product of vector spaces. As the main result, we use tensor products to prove a relation between the eigenvalues of the cartesian product of graphs and the eigenvalues of the original graphs. Next, we introduce the concept of the Hausdorff dimension of a fractal and the relation with the eigenvalues of a strongly connected, weighted, directed graph. Finally, we use the Perron-Frobenius Theorem to calculate the Haussdorf dimension of fractals and cartesian products of graphs. We give explicit formulas in terms of the eigenvalues of the graph and the similarity ratios used with each graph.

November 16, 2012: Steve Cox (Rice University)

Title: ***One Can Hear the Composition of a String: Experiments with an Inverse Eigenvalue Problem*** (Flyer)

Abstract: We consider a case study in Inquiry Based Learning. To what extent do the vibrations of a mechanical system reveal its composition? Despite innumerable applications and mathematical elegance, this question often slips through those cracks that separate undergraduate courses in mechanics, differential equations, and linear algebra. We address this omission by detailing a classical finite dimensional example: the use of frequencies of vibration to recover positions and masses of beads vibrating on a string. First we derive the equations of motion, then compare the eigenvalues of the model against vibration data measured from our laboratory's monochord. More challenging is the recovery of masses and positions of the beads from spectral data. After presenting a solution, based on orthogonal polynomials, in a manner suitable for advanced undergraduates, we confirm its efficacy through physical experiment and discuss our students' ability to synthesize analysis, numerics and experiment.

November 30, 2012: Carmen Caprau (CSUF)

Title: ***Rational Tangles and Continued Fractions*** (Flyer)

Abstract: A tangle is a portion of a knot or link, and a *rational tangle* is a type of tangle obtained by consecutive twists on neighboring endpoints of two trivial arcs. Rational tangles form a basis for the classification of knots, and are of fundamental importance in the study of DNA recombination. A rational tangle is associated with a unique, reduced rational number, or ∞, called the *fraction* of the tangle. We will explore the classification of rational tangles using continued fractions, and look into an extraordinary interplay between the elementary number theory of fractions and continued fractions, and the topology of rational tangles and

rational knots and links.

December 7, 2012: Herbert A. Medina (Loyola Marymount University)

Title: ***Computing π Via New Polynomial Approximations to Arctangent: a new contribution to (arguably) the oldest approximation problem*** (Flyer)

Abstract: Rational functions after integration can produce arctangent and therefore can be used to approximate π. Using rational functions of the form:

$$\left\{\frac{t^{km}(t-\beta)^{lm}}{1+t^2}\right\}_{m\in N}$$

for different values of k, l and β, we produce families of efficient polynomial approximations to arctangent, and hence, provide approximations to π via known arctangent values. Some of the polynomials produce rational approximations to π and others approximations that require only the computation of a single square root; moreover, they are orders of magnitude more accurate than Maclaurin polynomials. We analyze the efficiency of the approximations and provide algebraic and analytic properties of the sequences of polynomials. Finally, we turn the approximations of π into series including one that gives about 21 additional decimal digits of accuracy with each successive term. This talk should be accessible to undergraduates with a good knowledge of integral calculus. i.e., those with a good knowledge of calculus II should be able to follow it.

March 3, 2013: Megan Kuneli, Katie Urabe, Carmen Caprau (CSUF)

Title: ***Celebration of Women in Mathematics*** (Flyer)

Abstract: We will celebrate the International Day of Women (March 8th) by talking about the life, work and achievements of a few historic female mathematicians (during times when women were denied access to higher education), including Hypatia of Alexandria, Elena Cornaro Piscopia, Maria Agnesi, Sophie Germain, Mary Fairfax Sommerville, Ada Lovelace, Charlotte Angas Scott, Sofia Kovalevskaya, Alicia Boole Stott, Emmy Noether, and Marjorie Lee Browne.
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