

# Archived Seminars

## 2009/10

September 25, 2009: Michael Dorff (Brigham Young University)

**Title:** *Topics in Harmonic Analysis*

**Abstract:** Not Available

October 9, 2009: Sam Nelson (Claremont McKenna College)

**Title:** *Quandle Homology and Knot Invariants*

**Abstract:** The knot quandle is a complete invariant of knots up to ambient homeomorphism. Quandle cocycle invariants give us a practical way to extract information about a knot from its knot quandle. In this talk we will see link invariants defined from quandle homology and various invariants.

October 27, 2009: Lance Burger (CSUF)

**Title:** *Meta Representational Knowledge, Transfer, and Multiple Embodiments in Linear Algebra*

**Abstract:** A common theme in educational research on linear algebra concerns cognitive inflexibility associated with the appropriation of different linear algebra problem settings to similar matrix representations and methods, a consequence of the multiple embodiments of linear algebra concepts (Harel, 1989; Hillel & Mueller, 2006; DeVries & Arnon, 2004; Hillel & Sierpiska, 1994; Dias & Artique, 1995; Dorier, 2000). The study of multiple embodiments in linear algebra is important since students require an ability to establish meaningful links between representational forms in order to "understand the necessity for representing these situations by a general concept," a competence known as representational fluency (Harel, 1987, p.30-31). Informed by methods from experimental psychology, this mixed-methods study reconceived cognitive inflexibility and the role of meta-mathematical information in terms of the transfer of knowledge from familiar to unfamiliar problems settings sharing common abstract problem solving schemas.

Previous research in experimental psychology suggests spontaneous transfer between non-isomorphic problem settings to be rare in the absence of hints concerning the relationships between those settings (Holyoak & Koh, 1987). Two factorial experiments reinforce previous findings that transfer does not significantly occur between dissimilar settings, even when problems share abstract problem solving schemas and representations. A third experiment supports the *Indirect Representational Transfer Hypothesis*: meta-representational reflection on the meaning of a common abstract representation in relation to diverse mathematical settings induces schema transfer. Over the past several decades, a debate has ensued concerning the theoretical foundations of transfer theory. Rather than judging transfer according to normative, i.e., expert functionalist views, according to Lobato (2003), "actor-oriented transfer is defined as the personal construction of relations of similarity between the activities." In conclusion of this mixed-methods study, qualitative interviews uncover evidence of the role

of meta-representational thought as part of a larger developmental process of actor-oriented transfer.

**November 5, 2009: Stefaan Delcroix (CSUF)**

**Title:** *Error-Correcting Codes: Part One*

**Abstract:** Not Available

**November 19, 2009: Stefaan Delcroix (CSUF)**

**Title:** *Error-Correcting Codes: Part Two*

**Abstract:** Not Available

**December 1, 2009: Ana-Cristina Jimenez (CSUF)**

**Title:** *Three Strands, Three Crossings, One P-Colorability*

**Abstract:** This project explores the  $p$ -colorability of a particular family of braids, containing three strands and three crossings, up to their  $n$ th repetitions. This was accomplished by creating a matrix representation of the braid, found by relabeling the strands according to crossings. Once the matrix was established, it was solved for powers of  $n$ . The matrices, and therefore braids, were found to have one of three solutions. Each braid was  $p$ -colorable according to one of the following:

- $P$ -colorable if and only if  $4|n$ .
- $P$ -colorable if and only if  $p|n$ .
- $P$ -colorable if and only if  $p$  divides  $d_n$ , where  $d_n$  is the greatest common divisor of two sequences derived from the matrix, and always for  $p = 3$  if  $n$  was even.

This research was completed during the summer of 2009, under the supervision of Dr. Larry Cusick at CSU Fresno.

**December 3, 2009: Isaac Birnbaum (CSUF)**

**Title:** *On the Well-Covered Dimensions of Various Individual Graphs and Graph Families*

**Abstract:** For any graph  $G$  and field  $\mathbf{F}$ , the well-covered dimension  $wcdim(G, \mathbf{F})$  is the dimension of the vector space over  $\mathbf{F}$  formed by the set of all well-covered weightings  $f$  of  $G$ . In this session, we shall compute the well-covered dimensions of various individual graphs and graph families. We shall also show that for certain individual graphs and graph families, such as the crown graphs, the well-covered dimension can change with respect to the characteristic of the field chosen.

This research was completed over the summer and fall semesters of 2009 under the supervision of Dr. Oscar Vega at California State University, Fresno.

December 8, 2009: Comlan de Souza (CSUF)

**Title:** *On the Supports of Periodic Eigenfunctions of the Fourier Transform Operator*

**Abstract:** The  $p$ -periodic generalized function

$$f(x) = \sum_{m=-\infty}^{\infty} \sum_{n=0}^{N-1} \gamma[n] \delta \left( x - \frac{n}{p} - mp \right) \quad (1)$$

where  $\gamma$  is an eigenvector of the discrete Fourier transform operator  $\mathcal{F}_N$  with

$$(\mathcal{F}_N \gamma)[k] = \frac{1}{N} \sum_{n=0}^{N-1} \gamma[n] e^{-2\pi i kn/N} = \frac{\lambda}{\sqrt{N}} \gamma[k], \quad k = 0, 1, \dots, N-1,$$

and where  $\lambda \in \{-1, 1, -i, i\}$  and  $p = \sqrt{N}$  is an eigenfunction of the Fourier transform operator, i.e.,

$$\mathcal{F} f(x) = \lambda f(x)$$

The support of  $f$  is the lattice

$$\mathcal{L} = \{mp : m \in \mathbb{Z}\} \cup \left\{ \frac{1}{p} + mp : m \in \mathbb{Z} \right\} \cup \left\{ \frac{2}{p} + mp : m \in \mathbb{Z} \right\} \cup \dots \cup \left\{ \frac{p^2-1}{p} + mp : m \in \mathbb{Z} \right\}$$

and at a lattice point  $x_0 = \frac{n}{p} + m_0 p$ ,  $0 \leq n \leq p^2 - 1$ ,  $m_0 \in \mathbb{Z}$ , the weight of the Dirac  $\delta$ -spike is  $\gamma[n]$ .

We will prove that in  $\mathbb{R}$ , the only eigenfunctions with the representation (1) such that  $\gamma[n]$  is constant for  $0 \leq n \leq p^2 - 1$  have for support the set of integers  $\mathbb{Z}$ . We will generalize this result on  $\mathbb{R}^2$  and  $\mathbb{R}^3$ .

March 10, 2010: Oscar Vega (CSUF)

**Title:** *The Well-Covered Dimension of a Graph*

**Abstract:** Graph theory uses techniques that are not necessarily those commonly associated with discrete structures. Among those other areas linked to graphs is linear algebra. In this talk we will see how a vector space of functions can be constructed from any given graph, and from there we will attach the graph with the dimension of that vector space. This number is called the well-covered dimension of the graph, and this presentation will be a summary of everything that is known about this topic by now.

Quite a few results to be mentioned in this talk were obtained by one of our undergraduate students (Isaac Birnbaum) as part of his Senior Project. We encourage student's attendance to this talk.

**March 24, 2010: Ke Wu (CSUF)**

**Title:** *Survival Analysis*

**Abstract:** Survival analysis has been used to investigate things like how long people stay unemployed, how long a cancer patient lives, how long it takes before a lightbulb breaks, etc. What these examples have in common is that they all investigate how long it takes before a certain event (finding a job, dying, breaking of a lightbulb) happens. In this talk we will discuss the nature of survival data, the basic quantities and models for survival data, and the commonly used techniques in analyzing survival data including the non-parametric Kaplan-Meier estimates of the survival curves and the log rank test to compare two survival curves.

**April 7, 2010: Agnes Tuska (CSUF)**

**Title:** *Area and Volume Formulas - How to Communicate the Big Ideas of Their Developers?*

**Abstract:** How to lead students to comprehend the thinking that went on during the historical development of formulas related to the area of the circle, and the surface area and volume of the sphere? The emphasis will be on demonstrating the engagement of the audience as individuals in the study of works of Archimedes.

**April 9, 2010: John Baez (UC Riverside)**

**Title:** *Refer to colloquium talk on this day.*

**Abstract:** (See Colloquim Talk - same date)

**April 29, 2010: Tamas Forgacs (CSUF)**

**Title:** *Rigor in the Chicken Game - Some Proofs and Ideas*

**Abstract:** In the generalized chicken game  $n$  players all want to receive a reward which is only given out if at least  $k$  players invest their endowment. Despite wanting the reward, no one wants to be an investor if they can help it. We will prove some results about Nash equilibria in this game and discuss issues that arise while attempting to select one of the many. The talk should be accessible to undergraduate students, and as usual, all are welcome to attend.

**May 5, 2010: Ana-Cristina Jimenez (CSUF)**

**Title:** *A Representation of the Braid Groups Inside the Temperley-Lieb Algebra*

**Abstract:** In this talk we will describe the oriented version of the Jones polynomial of a link and define the Temperley-Lieb algebra in terms of generators and relations. We will also define a representation of the braid groups into the Temperley-Lieb algebra and show that it can be used to recover the Jones polynomial.

This research was conducted over the spring semester of 2010 under the supervision of Dr. Carmen Caprau and was partially supported by the Provost Undergraduate Research Award.

**May 12, 2010: Peter Tannenbaum (CSUF)**

**Title:** *What is a Hadamard Matrix (and Why Should You Care)?*

**Abstract:** In 1893 Hadamard asked the following: If  $H$  is an  $n$  by  $n$  real matrix whose entries  $h_{ij}$  have absolute value 1, what is the maximum absolute value of the determinant of  $H$ ? Hadamard proved that  $|\det H| \leq n^{n/2}$  with equality iff (a)  $h_{ij} = \pm 1$ , and (b) any two distinct rows (columns) of  $H$  are mutually orthogonal. A matrix  $H$  satisfying conditions (a) and (b) is called a Hadamard matrix. [The preceding is a linear algebraic definition, but Hadamard matrices also have a beautiful combinatorial interpretation: if you take any two distinct rows (columns) and you place one on top of the other, there are an equal number of "matches" and "mismatches."]

It is not hard to prove that the only possible orders for a Hadamard matrix are  $n = 2$  or  $n = 4k$ . The converse of this fact is the mother of all Hadamard matrix questions: Are there Hadamard matrices of order  $n$  for all  $n = 4k$ ? It is generally believed that the answer is Yes, but progress in proving this 100+ year old conjecture has been very slow. In this talk I will give a general overview on what is known (and mostly not known) about the existence of Hadamard matrices.