Contributed Talks
CombinaTexas, Saturday, April 19, 2008

Contributed Talks I			
	10:55–11:15	11:20–11:40	11:45–12:05
Session A	David Haws	Pavel Tumarkin	Michael Reid
Session B	Miklos Bona	Vladik Kreinovich	Susan Margulies
Contributed Talks II			
	2:45–3:05	3:10–3:30	3:35–3:55
Session A	Brian K. Miceli	Ji Li	Emil Daniel Schwab
Session B	James M. Salvador	Jeremy Martin	Sarah Crown
Contributed Talks III			
	4:25–4:45	4:50–5:10	5:15–5:35
Session A	Catherine Yan	Mihai Popa	Svetlana Poznanovik
Session B	Jian Shen	Daniela Ferrero	Landon Jennings

I. Saturday, 10:55–12:05, Session A

10:55–11:15 **David Haws**, University of California, Davis

Ehrhart polynomials, h^*-vectors, and triangulations of matroid polytopes

First, I will cover new developments and conjectures on useful invariants of matroid polytopes. Specifically we conjecture that the h^*-vector is unimodal and the coefficients of the Ehrhart polynomial are positive. Theoretical and computational evidence will be shown in support of these conjectures. I briefly explain our result that the Ehrhart polynomial of matroid polytopes can be computed efficiently when the rank is fixed. In the second half I will discuss the problem of unimodular triangulations and coverings of matroid polytopes. The White conjecture implies that every matroid polytope has a regular unimodular triangulation and computational evidence will be shown in support of this. I will also discuss interesting combinatorial and geometric properties of simplices of matroid polytopes sufficient to prove they are unimodular.

11:20–11:40 **Pavel Tumarkin**, Michigan State University

Simplicial affine groups and root systems matroids

I will discuss graphs of special type which initially were used to describe the answer to the following problem: which Euclidean simplices generate discrete reflection groups? The description in terms of these graphs occurs to be useful for investigation of automorphism groups of root systems matroids of classical types. The same graphs (in simply-laced case) appear also in cluster algebras.

11:45–12:05 **Michael Reid**, University of Central Florida

Combinatorics of Box Packing

Let T be a protoset of d-dimensional polyominoes. Which boxes can be perfectly packed by T? In general, this can be a difficult question. An easier question is: which "sufficiently large" boxes can be perfectly packed by T? In this talk, we describe several fundamental theorems about box-packing, show how they relate to the two questions above, and discuss some of the techniques involved in analyzing these questions.

I. Saturday, 10:55–12:05, Session B

10:55–11:15 **Miklos Bona**, University of Florida

Generalized Descents are Asymptotically Normal

In a permutation, a d-descent is an inversion in which the geographical descent between the two entries is not more than a given integer d. We prove that for every d, the distribution of d-descents converges to a normal distribution. This stays true even if d is allowed to grow with the length of the permutation.

11:20–11:40 **Vladik Kreinovich**, University of Texas at El Paso
Towards a General Computation-Oriented Description of Physical Quantities: From Intervals to Graphs to Simplicial Complexes and Their Projective Limits

In scientific and engineering computing, most computations process the values of relevant physical quantities – either to predict the future values of these and other properties (in science) or to describe the best design or control which appropriately changes the values of some properties (in engineering problems). In order to meaningfully discuss the existence and efficiency of the corresponding data processing algorithms, it is important to know what information we have about the values of the input quantities.

Some physical quantities are simple, they can be described by real numbers. In practical applications, the values come from measurements, and measurements provide only an approximate value of a quantity. So, after the measurement, we get, in effect, an (rational-valued) interval that contains the actual (unknown) value of the quantity. A lot of research has been done on the algorithms for processing such intervals.

Often, however, often, we need to describe more complex quantities: e.g., a physical field is a function which maps a spatial location into the value of a field at that location, a quantum observable is an operator in Hilbert space, etc. In this talk, we show that for a single measuring instrument, possible results of measuring such a complex quantity can be naturally represented by a graph or, more generally, by a simplicial complex. The quantity itself can then be naturally represented as a projective limit of the graphs (complexes) corresponding to more and more accurate measurements. We show how this representation helps in designing algorithms for processing such quantities.

11:45–12:05 **Susan Margulies**, University of California, Davis
P, NP and the Nullstellensatz: Independent Set and Graph-3-Coloring Infeasibility Certificates

Systems of polynomial equations over an algebraically-closed field K can be concisely used to model many combinatorial problems. In this way, a combinatorial problem is feasible (e.g., a graph is 3-colorable or has an independent set of size k) if and only if a related system of polynomial equations has a solution over K. If the combinatorial problem is infeasible, Hilbert's Nullstellensatz and a large-scale linear algebra computation yields a certificate of infeasibility. Thus, unless P = NP, there must exist an infinite sequence of infeasible instances (for each hard combinatorial problem) where the minimum-degree of a Hilbert Nullstellensatz infeasibility certificate grows.

We show that the minimum-degree of a Nullstellensatz certificate for the non-existence of an independent set of size greater than the stability number of the graph is the stability number of the graph. Moreover, such a certificate contains at least one term per independent set in G. By contrast, for graph-3-colorability, the Nullstellensatz-Linear Algebra (NulLA) algorithm proves the infeasibility of instances having thousands of nodes and tens of thousands of edges.

II. Saturday, 2:45–3:55, Session A

2:45–3:05 **Brian K. Miceli**, Trinity University
Some Combinatorial Properties of Poly-Stirling Numbers

This talk will highlight some of the combinatorial aspects of a new generalized type of Stirling number called a Poly-Stirling number. A Poly-Stirling number of the second kind is a number $S(n,k,p)$ which satisfies the initial conditions $S(0,0,p) = 1$ and $S(n,k,p) = 0$ for $n < k$ and the recursion

$$S(n+1,k,p) = S(n,k-1,p) + p(k)S(n,k,p),$$

where $p(x)$ is a polynomial with natural number coefficients. Similar definitions exist for Poly-Stirling numbers of the first kind as well as unsigned Poly-Stirling numbers of the first kind.

3:10–3:30 **Ji Li**, University of Arizona
Enumerating with Species Theory

The theory of combinatorial species is useful in combinatorial enumeration, for the reason that this theory not only provides a new way to understand combinatorial structures, but also applies a language of formality that combines the generating functions for both labeled and unlabeled combinatorial structures. In this short talk, I will go over a few basic definitions of species and some applications of enumerating graphs with certain properties using species theory.

3:35–3:55 **Emil Daniel Schwab**, University of Texas at El Paso
Coordinates Pairs Of Fibonacci And Thue-Morse Words

We study some combinatorial properties of Fibonacci and Thue-Morse words. Based on that, we will construct the posets and the triangular categories (in the sense of Leroux) of coordinates pairs and the connection of corresponding Möbius functions.

II. Saturday, 2:45–3:55, Session B

2:45–3:05 **James M. Salvador**, University of Texas at El Paso
Chemical Applications of the Matching Polynomial

The Matching Polynomial (MP) is a substructure of the Characteristic Polynomial or Secular Determinant of an Adjacency Matrix. MP can be calculated by matching walks on an adjacency matrix, by a retrosynthesis of a graph or by using partial-differential edge operators on a product of vertex variables. MP has been proposed as a Reference or Acyclic Polynomial for calculating a topological resonance energy for cyclic Pi systems including fullerenes. MP has been used to correlate structure to physical properties, and to sort and identify chemical structures. The mathematics of MP has been used for ring perception.

3:10–3:30 **Jeremy Martin**, University of Kansas
On distinguishing trees by their chromatic symmetric functions

The chromatic symmetric function of a graph, introduced by Stanley in 1995, is a refinement of the usual chromatic polynomial. While the chromatic polynomial of a tree depends only on its number of vertices, it is unknown whether two nonisomorphic trees can share the same chromatic symmetric function. Matthew Morin, Jennifer Wagner and I have made (we hope) partial progress on this problem by identifying a family of invariants that can be recovered from the chromatic symmetric function of a tree.

3:35–3:55 **Sarah Crown**, Denison University
The Homology of the Cyclic Coloring Complex

In this talk, we will define the cyclic coloring complex, a complex which can be associated to a simple graph. We will illustrate how the dimensions of the homology groups of the cyclic coloring complex associated to a graph G are related to the coefficient of the smallest degree term of the chromatic polynomial of G.

III. Saturday, 4:25–5:35, Session A

4:25–4:45 **Catherine Yan**, Texas A&M University
Lattice and Schroder paths with periodic boundaries

We consider paths in the plane with $(1, 0)$, $(0, 1)$, and (a, b)-steps that start at the origin, end at height n, and stay strictly to the left of a given non-decreasing right boundary. We show that if the boundary is periodic and has slope at most b/a, then the ordinary generating function for the number of such paths ending at height n is algebraic. Our argument is in two parts. We use a simple combinatorial decomposition to obtain an Appell relation or "umbral" generating function, in which the power z^n is replaced by a power series of the form $z^n\phi_n(z)$, where $\phi_n(0) = 1$. Then we convert (in an explicit way) the umbral generating function to an ordinary generating function by solving a system of linear equations and a polynomial equation. This conversion implies that the ordinary generating function is algebraic.

4:50–5:10 **Mihai Popa**, Indiana University
A combinatorial approach of non-commutative probability with amalgamation

When states are replaced by positive conditional expectations, the role of power series (such as the moment generating power series or the Voiculescu's R-trasform) is played by multilinear function series. The development of analytic tools such as the Cauchy transform is cumbersome. A more convenient approach is given by some combinatorial results on the lattices of non-crossing and interval partitions.

5:15–5:35 **Svetlana Poznanovik**, Texas A&M University
Crossings and Nestings of Two Edges in Set Partitions

Let π and λ be two set partitions with the same number of blocks. Assume π is a partition of $[n]$. For any integer $l, m \geq 0$, let $\mathcal{T}(\pi, l)$ be the set of partitions of $[n+l]$ whose restrictions to the last n elements are isomorphic to π, and $\mathcal{T}(\pi, l, m)$ the subset of $\mathcal{T}(\pi, l)$ consisting of those partitions with exactly m blocks. Similarly define $\mathcal{T}(\lambda, l)$ and $\mathcal{T}(\lambda, l, m)$. We prove that if the statistic *cr* (*ne*), the number of crossings (nestings) of two edges, coincides on the sets $\mathcal{T}(\pi, l)$ and $\mathcal{T}(\lambda, l)$ for $l = 0, 1$, then it coincides on $\mathcal{T}(\pi, l, m)$ and $\mathcal{T}(\lambda, l, m)$ for all $l, m \geq 0$. These results extend the ones obtained by Klazar on the distribution of crossings and nestings for matchings. Joint work with Catherine Yan.

III. Saturday, 4:25-5:35, Session B

4:25–4:45 **Jian Shen**, Texas State University
A Generalization of the Friendship Theorem

The Friendship Theorem states that if any two people in a party have exactly one common friend, then there exists a politician who is a friend of everybody. In this talk, we generalize the Friendship Theorem. Let λ be any nonnegative integer and μ be any positive integer. Suppose each pair of friends have exactly λ common friends and each pair of strangers have exactly μ common friends in a party. The corresponding graph is a generalization of strongly regular graphs obtained by relaxing the regularity property on vertex degrees. We prove that either everyone has exactly the same number of friends or there exists a politician who is a friend of everybody. As an immediate consequence, this implies a recent conjecture by Limaye et. al.

4:50–5:10 **Daniela Ferrero**, Texas State University
Walk Graphs

For a given graph G and a positive integer k the k-walk graph of G, denoted as $W_k(G)$, has for vertices the set of walks of length k in G in which no two consecutive edges are equal. Two vertices of $W_k(G)$ are adjacent when one of the corresponding walks can be obtained from the other by deleting an edge in one end and adding an edge to the other end. We present results regarding structural properties of $W_k(G)$, such as connectivity, diameter and traversability.

5:15–5:35 **Landon Jennings**, Rice University
Sufficient Condition for Hamiltonian Paths

Graffiti.pc conjectured new sufficient conditions for Hamiltonian paths on connected simple graphs in early 2006. The one discussed here uses a relatively new graph invariant called annihilation number. This new condition is very easy to calculate and can detect Hamiltonian paths that Chvátal's condition cannot.