Report on the East Coast Combinatorial Conference 2007

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There is a vibrant combinatorial community in Atlantic Canada. This regional conference provides an opportunity for researchers and students to meet to exchange ideas and to discuss topics of mutual interest. The participants all appreciated the opportunity to network and to see what others in the region are doing and it would not be surprising if there are some new collaborations as a result of this meeting. Recent East Coast Combinatorial Conferences have been hosted by UNB Fredericton in 2005 and by UPEI in 2006. This year the conference was held April 18 and 19 at Mount Allison University in Sackville, NB.

This year's conference was funded by the AARMS NB-PEI Regional Committe and by the Dean of Science and the Department of Mathematics and Computer Science of Mount Allison University. Neil Calkin's talk was sponsored by the Distinguished Lecturer Program of AARMS. An application for funding to MITACS was unsuccessful. As happened last year, the Steering Committee decided to charge a registration fee of $60 for faculty with grants; fees were waived for students and faculty without grants. Complete financial information is attached.

A conference had a total of 30 participants: 19 faculty members, 1 post-doctoral fellow, 7 graduate students and 3 undergraduate students. Participants came from both mathematics and computer science departments from 9 Atlantic universities: Memorial, Dalhousie, St. Mary's, Cape Breton, St. Francis Xavier, UPEI, UNB, UNBSJ and Mount Allison.

The plenary speaker was Michael Plummer of Vanderbilt University. The other invited speakers were Neil Calkin, Clemson University (thanks to the AARMS Distinguished Lecturer Program), Pat Morin, Carleton University and David Pike, Memorial University. Their talks covered a wide spectrum of combinatorial topics. In addition, there were 12 contributed talks, 4 by graduate students. A copy of the schedule and the abstracts for the talks is attached.

This year a lunch for the participants was held at the University Club, Mount Allison on April 18. This provided a venue for more relaxed discussion away from the more structured part of the conference.

The Steering Committee would like to thank the AARMS NB-PEI Regional Committee for both its financial and moral support.

Financial Report, ECCC 2007

	expense	income
Invited speakers travel		
Plummer	769.71	
Morin	812.03	
Pike	214.79	
Student/Post-doc travel		
3 MUN students	1654.56	
4 Dal students, 1 Dal post-doc	366.46	
Coffee breaks	412.24	
Lunch, 18 April	299.00	
supplies/copying	9.32	
AARMS NB-PEI Regional Com.		3000.00
Dean of Science, Mt A		500.00
Registration fees		600.00
surplus from 2006		75.24
Math/CS Dept, Mt A		362.87
Total	4538.11	4538.11

East Coast Combinatorial Conference 2007
Schedule and Abstracts

Wednesday April 18		Thursday April 19	
		9:00-9:30	J. Preen
9:30-10:30	Registration and coffee	*9:30-10:00*	S. Fitzpatrick
		10:00-10:30	N. Clarke
10:30-11:30	M. Plummer: *Recent Advances in Several Areas of Domination in Graphs*	*10:30-11:00*	coffee
		11:00-12:00	N. Calkin: *Counting Kings, Collecting Coupons, and Other Applications of Linear Algebra to Combinatorics*
11:30-12:00	T. Alderson		
12:00-1:30	lunch		
1:30-2:30	P. Morin: *Algorithms for Zonoids*	*1:30-2:30*	D. Pike: *Existential Closure and BIBD Block-Intersection Graphs*
2:30-3:00	A. Hill	*2:30-3:00*	H. Thomas
3:00-3:15	coffee	*3:00-3:15*	coffee
3:15-3:45	M.-E. Messinger	*3:15-3:45*	A. Farrag
3:45-4:15	O. Yasur	*3:45-4:15*	S. Finbow
4:15-4:45	P. Pralat		
4:45-5:15	A. Ababnah		

Contributed Talks

Ahmad Ababneh (Memorial), *Disjoint Starters Sequences*

Tim Alderson (UNBSJ), *Coprimitive Sets and Maximal Linear Codes*

Nancy Clarke (Acadia University), *A Step Toward the Characterization of Copnumber 2 Graphs*

A. Farrag (Dalhousie), *Reconfiguration of the Hypercube*

Stephen Finbow (St. Francis Xavier), OO-Irredundance in Trees

Shannon Fitzpatrick (UPEI), *Speed vs Cost in the Game of Cops and Robber*

Alan Hill (DRDC CORA AST, Government of Canada), *Ant Colony Optimization and the Deployment Problem*

Margaret-Ellen Messinger (Dalhousie), *Cleaning a Network with Brushes*

Pawel Pralat (Dalhousie), *Threshold for k-regular Subgraphs of Random Graphs*

James Preen (Cape Breton), *Largest 6-regular Toroidal Graphs of a Given Diameter*

Hugh Thomas (UNB), *A Graph-theoretic Approach to (some) Cluster Algebras*

Oznur Yasar (Memorial), *Monotonicity of Weighted Edge Searching*

Abstracts

Invited Talks

Counting Kings, Collecting Coupons, And Other Applications Of Linear Algebra To Combinatorics

Neil Calkin, Clemson University

We discuss various applications of linear algebra to combinatorial problems, highlighting some pretty results and some annoying open problems.

Algorithms for Zonoids

Pat Morin, Carleton University

Zonoid depth (Dyckerhoff et al 2002) is a form of interpolation between the convex hull and the mean of a point set. Zonoid depth appears under different names in several branches of computer science and mathematics, including exploratory data analysis, multivariate statistics, clustering, outlier removal, and machine learning. This talk will present recent results on the combinatorial structure of zonoids and efficient algorithms that result by exploiting this structure.

Existential Closure and BIBD Block-Intersection Graphs

David Pike, Memorial University of Newfoundland

A graph G with vertex set V is said to be *n-existentially closed* (or n-e.c. for short) if, for every proper subset S of V with $\mid S \mid = n$ and every subset T of S, there exists a vertex x in $V \setminus S$ such that x is adjacent to each vertex of T but is adjacent to no vertex of $S \setminus T$.

A balanced incomplete block design (BIBD) with parameters (v, k, λ) consists of a set of blocks, each of which is a k-subset of a set V of cardinality v, such that each 2-subset of V occurs in precisely λ of the blocks of the design.

Given a combinatorial design D with block set B, its block-intersection graph is the graph having B as its vertex set, such that two vertices b_1 and b_2 are adjacent if and only if b_1 and b_2 have non-empty intersection.

In this talk we will present some recent results concerning balanced incomplete block designs (BIBDs) and when their block-intersection graphs are$n$-existentially closed. These results represent joint research with Neil A. McKay.

Recent Advances in Several Areas of Domination Graphs

Michael Plummer, Vanderbilt University

A subset of vertices D of a graph G is a *dominating set* for G if every vertex of G not in D is adjacent to one in D. The cardinality of any smallest dominating set in G is denoted by $\gamma(G)$ and called the *domination number* of G.

In this talk, we report on some recent results obtained with N. Ananchuen, with K. Kawarabayashi and A. Saito and with X. Zha involving four different areas of domination in graphs.

Graph G is said to be γ-*edge-critical* if $\gamma(G+e) < \gamma(G)$ for each edge $e \notin E(G)$ and is said to be γ-*vertex-critical* if $\gamma(G-v) < \gamma(G)$, for every vertex $v \in V(G)$. The structure of both γ-edge-critical graphs and γ-vertex-critical graphs is not well understood, even in the case when $\gamma(G) = 3$. We will present some new theorems involving matchings in both classes.

Reed conjectured in 1996 that if G is a cubic graph with n vertices, then $\gamma(G) \leq \lceil \mid V(G) \mid /3 \rceil$. We will present some new results pertaining to this conjecture.

Finally, in 1996, Tarjan and Matheson proved that any triangulation of the plane having n vertices can be dominated using no more than $\lfloor n/3 \rfloor$ vertices. We investigate extensions of this result to the projective plane, torus and Klein bottle.

Contributed Talks

Disjoint Starters Sequences
Ahmad Ababneh, Memorial University

A *starter sequence* of order n in an abelian group of order $2n+1$ is a sequence$S = (s_1, s_2, ..., s_{2n})$ of $2n$ integers satisfying the following conditions: (1) every integer $k = 1, 2, 3, \ldots, n$ or its inverse occurs in exactly two positions in S; (2) if $s_i = s_j = k$ or its inverse, $i < j$, then $j - i = k$ or its inverse. Two starter sequences $S = (s_1, s_2, ..., s_{2n})$ and $T = (t_1, t_2, ..., t_{2n})$ of order n are called *disjoint* if for some i there exists j such that $s_i = s_i + k = t_j = t_j + k = k$ or its inverse for all $k = 1, 2, \ldots, n$ then i does not equal j. In this representation we show the necessary conditions to the existence of disjoint starters, then we generalize the result by Baker and Shalaby on disjoint Skolem sequences to the case of disjoint starters sequences, also we introduce indirect construction of disjoint starters using a new method for starters product.

Coprimitive Sets and Maximal Linear Codes
Tim Alderson, UNBSJ

Complete (n, r)-arcs in $PG(k-1, q)$ and projective $(n, k, n-r)_q$-codes that admit no projective extensions are equivalent objects. We show that projective codes of reasonable length admit only projective extensions. Thus, we are able to prove the maximality of many known linear codes. At the same time our results sharply limit the possibilities for constructing long nonlinear codes. We also show that certain short linear codes are maximal. The methods here may be just as interesting as the results. They are based on the Bruen-Silverman model of linear codes as well as the theory of Rédei blocking sets.

A Step Toward the Characterization of Copnumber 2 Graphs
Nancy Clarke, Acadia University

In this version of the Cops and Robber game, the cops move in tandems, or pairs, such that they are at distance at most one after every move. We present a recognition theorem for tandem-win graphs and a characterization of triangle-free tandem-win graphs. We also investigate the game on several graph products.

Reconfiguration of the Hypercube
A. Farrag, Dalhousie University

Several interconnection networks (such as rings, meshes and hypercubes) can be modeled as circulant graphs. As a result, methods previously developed for constructing fault-tolerant solutions of circulant graphs can also be applied to these networks. Among these methods, the one based on the idea of "offsets partitioning" is the most efficient (for circulant graphs). We review this method in this paper, and extend its applications to hypercubes. Moreover, we develop new algorithms to reconfigure circulant graphs and hypercubes. Our results show that the fault-tolerant solutions obtained, and the reconfiguration algorithms developed are efficient.

OO-Irredundance in Trees
Stephen Finbow, St. Francis Xavier

A vertex set X is called *OO-irredundant* if for every $x \in X$, $N(x) - N(X - x) \neq \emptyset$. The concept of OO-irredundance was first studied by Farley and Schacham (1983) as a geralisation of irredundance. Our discussion of the concept will focus on results towards a lower bound on the size of a maximal OO-irredundant set in trees in terms of order and maximum degree. Analogous best possible bounds are known for irredundance, CO-irredundance and OC-irredundance.

Speed vs Cost in the Game of Cops and Robber
Shannon Fitzpatrick, UPEI

In the game of Cops and Robber played on a graph, theusual problem is to determine the minimum number of cops required to guarantee the robber's capture. Perhaps, however, we also want take the length of time required to capture the robber into consideration. For example, in a copwin graph a single cop can always capture the robber, but may take a relatively long time in doing so. At the other extreme, we could place cops on a dominating set of vertices and the game would come to a quick conclusion.

To balance these two concerns, we could define a cost function and work to minimize the cost of catching the robber. In this talk, I will discuss options for defining this function and present some preliminary results.

Ant Colony Optimization and the Deployment Problem
Alan Hill, DRDC CORA AST, Government of Canada

Ant Colony Optimization (ACO) is a metaheuristic for finding good solutions to some NP problems, such as the Travelling Salesman Problem, by modelling the behaviour of ants in the wild. The Deployment Problem is the problem of efficiently relocating equipment and personnel in a particular timeframe given limited resources. In this talk, we present preliminary work done to adapt ACO to solving the Deployment Problem.

Cleaning a Network with Brushes
Margaret-Ellen Messinger, Dalhousie University

Following the decontamination metaphor for searching a graph, we introduce the cleaning process which is related to both the chip-firing game and edge searching. This is joint work with Pawel Pralat and Richard Nowakowski.

Threshold for k-regular subgraphs of random graphs
Pawel Pralat, Dalhousie University

The *k-core* of a graph is the largest subgraph of minimum degree at least k. We show that for k sufficiently large, the $(k+2)$-core of a random graph $G(n,p)$ asymptotically almost surely has a spanning k-regular subgraph. Thus the threshold for the appearance of a k-regular subgraph of a random graph is at most the threshold for the $(k+2)$-core. In particular, this pins down the point of appearance of a k-regular subgraph in $G(n,p)$ to a window for p of width roughly $2/n$ for large n and moderately large k. (joint work with Jacques Verstraete and Nick Wormald)

Largest 6-regular toroidal graphs of a given diameter
James Preen, Cape Breton University

It will be shown that any 6-regular graph of diameter k that can be embedded on the torus must have at most $3k^2+3k+1$ vertices and a graph of this order for each $k \geq 1$ will be exhibited. Some implications of this result towards largest planar regular graphs of a given diameter will also be considered.

A graph-theoretic approach to (some) cluster algebras
Hugh Thomas, UNB

Cluster algebras were introduced by Fomin and Zelevinsky in 2000. The theory of cluster algebras has connections to a variety of areas, including combinatorics; to provide an introduction, I will mainly focus on the algebra associated to the triangulations of a polygon. It turns out that some simple graph-theoretic notions allow us to write down explicit formulas for the cluster variables, making extremely explicit some of the general themes of cluster algebras. Time permitting, I will discuss the extension of these results to the setting of Fomin-Shapiro-Thurston cluster algebras associated to triangulations of arbitrary surfaces. This is joint work with Ralf Schiffler.

Monotonicity of Weighted Edge Searching
Oznur Yasar, Memorial University

The weighted edge searching problem is to minimize the number of searchers needed to clean a weighted graph. Cleaning is done using a sequence of allowed moves. In a monotonic search the searchers are following a strategy in which no edge, once cleaned, is allowed to be recontaminated. In this talk we show that for any weighted graph, the number of searchers needed for a monotonic search is equal to the number of searchers needed for a (possibly non-monotonic) search. This is a joint work with Dr. Dyer, Dr. Kondratieva and Dr. Pike.