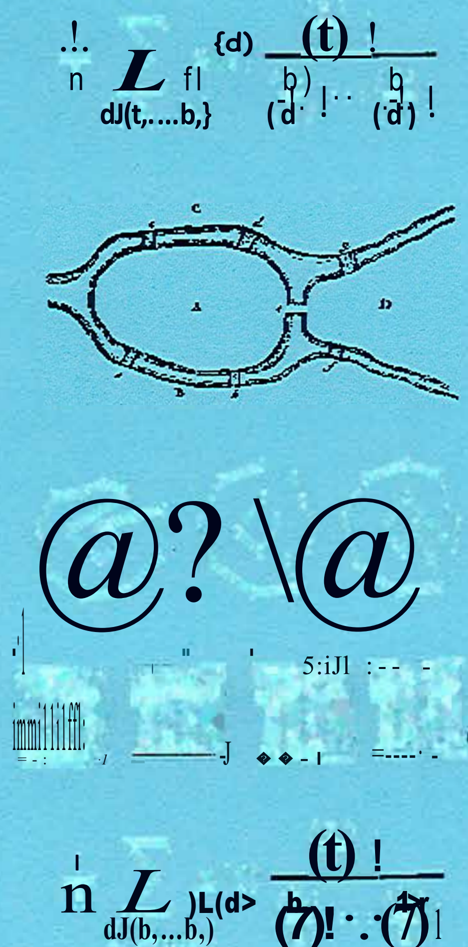

Thirty-Eighth Southeastern International Conference on

Combinatorics, Graph Theory & Computing

Florida Atlantic University

March 5-9, 2007

Program and Abstracts

Invited Talks

Monday, March 5, 2007
Aviezri Fraenkel
Sequences, Games and Complexity (9:30 AM)
The Rat Game and the Mouse Game (2:00 PM)

Tuesday, March 6, 2007
Brigitte Servatius
Graphs, frameworks, molecules and mechanisms Part I (9:30 AM)
Graphs, frameworks, molecules and mechanisms Part II (2:00 PM)

Wednesday, March 7, 2007
Ralph Faudree
Linear Forests, k-Ordered, and Pancyclic Graphs (10:30 AM)
Connectivity and Cycles in Graphs (2:00 PM)

Thursday, March 8, 2007
Jonathan Jedwab
Written on a Torus or on a Cylinder? An Elementary Proof of the Barker Array Conjecture (9:30 AM)
Simplification through Generalisation: Constructing and Enumerating Golay Sequences via Golay Arrays (2:00 PM)

Friday, March 9, 2007
Mike Burmester
Secure Group Key Exchange, Revisited Part I (9:30 AM)
Secure Group Key Exchange, Revisited Part II (2:00 PM)

Monday, March 5, 2007 (9:30 AM)

Sequences, Games and Complexity

Aviezri Fraenkel
Weizmann Institute of Science, Rehovot, Israel
aviezri.fraenkel@weizmann.ac.il

For a position $(x_1, \ldots, x_n) \in \mathbb{Z}^n_{\geq 0}$ in a combinatorial impartial game on n piles of tokens, the question whether it belongs to the set of second player winning positions can sometimes be decided efficiently (in polynomial space and polynomial time). More often the answer to this question is unknown, and the best known algorithms are exponential, hence the winning strategy is intractable. Our main purpose is to introduce the notion of a probabilistic winning algorithm for some such games. No prior knowledge in games and complexity is assumed.

Monday, March 5, 2007 (2:00 PM)

The Rat Game and the Mouse Game

Aviezri Fraenkel
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aviezri.fraenkel@weizmann.ac.il

A position in the 2-player Rat game on 3 piles of tokens is a triple $(x, y, z) \in \mathbb{Z}^3_{\geq 0}$, $0 \leq x \leq y \leq z$. There are 3 types of moves: (i) Take any positive number of tokens from up to 2 piles. (ii) Take $h > 0$ from x, $k > 0$ from y, any positive number from z, such that $|k - h| < a$, where $a = 1$ if $y - x \not\equiv 0 \pmod 7$, $a = 2$ if $y - x \equiv 0 \pmod 7$. (iii) Take $h > 0$ from x, $k > 0$ from z, any positive number from y, such that $|k - h| < b$, where $b = 3$ if $w = u$; otherwise, $b = 5$ if $w - u \not\equiv 4 \pmod 7$, $b = 6$ if $w - u \equiv 4 \pmod 7$. The Mouse game is simpler, played on 2 piles. Three winning strategies, of different complexities, are given for each of the games. What's the motivation for inventing and analyzing this game? Why are the rule moves complicated? What's the relation to rats and mice? And what about the Fat Rat game?

Tuesday, March 6, 2007
Part I (9:30 AM)
Part 11(2:00 PM)

Graphs, frameworks, molecules and mechanisms
Brigitte Servatius, WPI

A framework is a collection of labeled points in m-space with bars between some of the pairs of the points. The bars are considered as a collection of constraints on the space of all possible configurations of points. The framework is said to be rigid if these bar constraints determine the configuration up to rigid congruence in a neighborhood of the given initial configuration. The question as to whether a framework is rigid or not depends on both the underlying graph G, determined by the bars, as well as on the geometric configuration itself. For a given graph G, if the set of configurations in m-space with rigid corresponding framework is open (or equivalently dense) in the space of all possible configurations, then G is said to be generically rigid in m-space. The main subject of combinatorial rigidity is to study and to determine, if possible, combinatorial conditions under which a graph is generically rigid in m-space, especially form = 1, 2, and 3. We will introduce some of the basic concepts informally and provide a short history of the study of rigid frameworks. As a basic tool we will introduce infinitesimal rigidity, which in turn motivates the use of matroid theory and leads to the definition of an abstract rigidity matroid. Generic rigidity in the line and in the plane are well understood. While the search for a combinatorial characterization of generic rigidity in dimension 3 is one of the foremost open problems in the field, there are some recent developements in planar rigidity with surprising new applications. We will explain the connections of planar rigidity with pseudo-triangulations used in computational geometry and Assur groups used by mechanical engineers. Finally we will survey the progress on the molecular conjecture in dimensions 2 and 3.

Wednesday, March 7, 2007 (10:30 AM)

Linear Forests, k-Ordered, and Pancyclic Graphs
Ralph J. Faudree
University of Memphis

Given integers k, s, t with Os s :st and k � 0, a (k, t, s)-linear forest F is a graph that is the vertex disjoint union oft paths with a total of k edges and with s of the paths being single vertices. Given integers m and n with k+t s m s n, a graph G of order n is (k, t, s,m)-pancyclic if for any (k, t, s)-linear forest F and for each integer r with m s r s n, there is a cycle of length r containing the linear forest F. If the paths of the forest Fare required to appear on the cycle in a specified order, then the graph is said to be (k, t, s,m)-pancyclic ordered. If, in addition, each path in the system is oriented and must be traversed in the order of the orientation, then the graph is said to be strongly (k, t, s,m)-pancyclic ordered. Minimum degree conditions and minimum sum of degree conditions of nonadjacent vertices that imply a graph is (k, t, s,m)-pancylic, as well as degree conditions that imply a graph is (strongly) (k, t, s,m)-pancylic ordered will be given. Examples showing the sharpness of the conditions **will** be described. Problems and open questions related to these conditions will be presented.

Wednesday, March 7, 2007 (2:00 PM)

Connectivity and Cycles in Graphs
Ralph J. Faudree
University of Memphis

Appropriate connectivity in a graph implies the existence of (Hamiltonian) cycles and cycle structures such as 2-factors in graphs. Classical results on cycles implied by connectivity conditions will be presented. Results for special classes of graphs, such as planar, regular, bipartite, and clawfree graphs that involve cycles and connectivity **will** also be discussed. An emphasis will be placed on open conjectures, present status of these conjectures, and progress that has been made on these conjectures. Recent results and techniques will also be highlighted.

Thursday, March 8, 2007 (9:30 AM)

Written on a Torus or on a Cylinder? An Elementary Proof of the Barker Array Conjecture
Jonathan Jedwab
Simon Fraser University

The existence pattern for Barker sequences arose as a problem in digital sequence design in the 1950s. Although deceptively easy to state, the problem continues to resist solution. It has stimulated the development of a large body of theory, including the merit factor problem in communications engineering and the algebraic study of difference sets in discrete mathematics.

In 1989 Alquaddoomi and Scholtz proposed a generalisation of Barker sequences to two dimensions, conjecturing that no non-trivial examples exist except of size 2×2 . I shall present a recent proof of this conjecture. The proof uses only elementary methods. A key conceptual point in the proof is whether to regard the array as being written on a torus or on a cylinder.

The talk will not assume any prior knowledge.

(Joint work with Jim Davis and Ken Smith)

Thursday, March 8, 2007 (2:00 PM)

Simplification through Generalisation: Constructing and Enumerating Golay Sequences via Golay Arrays

Jonathan Jedwab
Simon Fraser University

Golay complementary sequences have been used since the 1950s in many digital sequence applications for which Barker sequences are not available. In 1999 Jim Davis and I demonstrated a connection with the classical Reed-Muller codes, which accounted for all known Golay sequences of length 2^m over binary, quaternary, and higher-order alphabets.

But in 2005 Li and Chu unexpectedly discovered an additional 1024 length 16 Golay quaternary sequences. I shall explain how these additional sequences arise, and describe a new approach to the construction and enumeration of Golay sequences. This elementary approach accounts, in particular, for all quaternary Golay sequences spawned by Li and Chu's examples. A significant simplification is obtained by first generalising the definition of Golay sequences to multi-dimensional Golay arrays, and then viewing a Golay sequence as the projection of a Golay array.

The talk will not assume any prior knowledge.

(Joint work with Frank Fiedler and Matthew Parker)

Friday, March 9, 2007
Part I (9:30 AM)
Part II (2:00 PM)

Secure Group Key Exchange, Revisited

Mike Burmester
Florida State University

Group Key Exchange (GKE) protocols are a generalization of two-party KE protocols, such as the Diffie-Hellman KE, to groups of $n>2$ users. Recently Katz and Yung described a compiler that transforms a GKE protocol into an authenticated GKE (AKE) protocol. In particular, they showed how the cycle-based version of the Burmester-Desmedt GKE (BD-1) can be used to get an AKE with constant rounds (3) and O(n) communication and computation complexity (per user). The problem with this solution is that it is not scalable: the complexity per user can be very large. In this talk we shall look at the issues involved in KE and GKE, from both a security point of view and a complexity point of view. We will review the two Burmester-Desmedt GKE protocols: the cycle-based protocol (BD-1) and a tree-based protocol (BD-11). Then we shall briefly overview other authenticated GKE proposed in the literature. Finally we shall show how to design a scalable compiler for tree-based GKE protocols and use it to get an authenticated version of BD-11 that requires only 3 rounds and has O(log n) complexity.

Monday, March 5, 2007

8:00am	Registration in Grand Palm Room			
9:00am	Welcome by President Frank Brogan, Provost John Pritchett, Dean Gary Perry			
9:30am	**Aviezri Fraenkel**			
10:30am	COFFEE			
	Sessions for Contributed papers in Live Oak Pavilion			
	A	B	C	D
11:00am	1 Okamoto	2 Caliskan	3 Beavers	4 Cummings
11:20am	5 Boothe	6 Ngwane	7 Goddard	8 Houghten
11:40am	9 Billington	10 Carnes	11 Emert, Owens	12 Tapia-Recillas
12:00pm	LUNCH (on your own)			
2:00pm	**Aviezri Fraenkel**			
3:00pm	COFFEE			
3:20pm	13 Khodkar	14 Voigt	15 Siewert	16 Jajcay
3:40pm	17 Enciso	18 Zhang	19 Froncek	20 Boats
4:00pm	21 A. Jamieson	22 Voloshin	23 K. Factor	24 Kikas
4:20pm	25 Gera	26 West	27 B. Sullivan	28 Bajnok
4:40pm	29 L. H. Jamieson	30 Schiermeyer	31 Berman	32 Narayan
5:00pm	33 Pinciu	34	35	36
5:30pm	**Reception at Baldwin House**			

Tuesday, March 6, 2007

8:00am	Registration in Grand Palm Room			
	Sessions for Contributed papers in Live Oak Pavilion			
	A	B	C	D
8:20am	37 Yuceturk	38 Eroh	39Abreu	40Grimaldi
8:40am	41 Sarvate	42 Heinz. Majumdar	43 Balof	44 Ruskey
9:00am	45 Huang	46T. Wang	47 Menashe	48 Haas
9:30am	**Brigitte Servatius**			
10:30am	COFFEE			
10:50am	49 Rosa	SOY. Wang	51 Angeleska	52 Daniel
11:10am	53 Srinivasan	54 Rasmussen	55 Escuadro	56 Johnson
11:30am	57 Beam	58 Ng	59Vandell	60 Tanny
11:50am	61 D. Hoffman	62 Shiu	63 Bode	64Yi
12:10pm	65 Pettis	66 Ung	67 Shawash	68 Nanda
12:30pm	LUNCH (on your own)			
2:00pm	**Brigitte Servatius**			
3:00pm	COFFEE			
3:20pm	69 Bobga	70 Kwong	71 Matheis	72 Balakrishnan
3:40pm	73 Roberts	745-M Lee	75S. Gao	76H. Wong
4:00pm	nTonchev	78 P-T Chung	79 Liu	80 Szwarcfiter
4:20pm	81 Kuhl	82 Barrientos	83 Fallon	84Stewart
4:40pm	85 Gronau	86 Bagga	87 S. Sullivan	88 Kobayashi
5:00pm	89 Laue	90Adachi	91 Niederhausen	92Abbott
5:20pm	93	94	95	96
6:00pm	Reception at the Visual Arts Patio			

Wednesday, March 7, 2007

8:00am	Registration in Grand Palm Room			
	Sessions for Contributed papers in Live Oak Pavilion			
	A	B	C	D
8:20am	97 Leach	98 Ozkan	99 Kirk	100 A. C. lee
8:40am	101 Allagan	102 Isaak	103 DeDeo	104 Dufour
9:00am	105 Sinko	106 McCauley	107 Bezrukov	108 Bohme
9:20am	109 Slater	11 o Dinavahi	111 Amavut	112 Stevens
9:40am	113 Redl	114 Chinn	115 lefmann	116 Krause
10:00am	COFFEE			
10:30am	**Ralph Faudree**			
11:30am	Commemoration of Peter Hammer			
12:05pm	**Conference Photo**			
12:15pm	LUNCH (on your own)			
2:00pm	**Ralph Faudree**			
3:00pm	**TICA Meeting**			
3:40pm	COFFEE			
4:00pm	117 Bailey	118 M.J. Lipman	119 Jia	120 Kanno
4:20pm	121 Del-Vecchio	122 D. J. Lipman	123 league	124 Heubach
4:40pm	125 Meyerowitz	126 Patra	127 Unger	128 Brown
5:00pm	129 Merz	130 Winters	131 Matsui	132 Golumbic
5:20pm	133	134	135	136
6:30pm	**Conference Banquet at the Pavilion on Yamato Road and Dixie Highway**			

Thursday, March 8, 2007

8:00am	Registration in Grand Palm Room			
	Sessions for Contributed papers in Live Oak Pavilion			
	A	B	C	D
8:20am	137 Kemnitz	138 Fowler	139 Schneider	140
8:40am	141 McKeon	142 Grolmusz	143 Gargano	144
9:00am	145 S. Holliday	146 Lurie	147 Radziszowski	148
9:30am	**Jonathan Jedwab**			
10:30am	COFFEE			
10:50am	149 Hamburger	150 Daugherty	151 Morris	152
11:10am	153Gimbel	154 Saccoman	155 Beasley	156
11:30am	157 Gross	158 Wierman	159 Soifer	160 Shapiro
11:50am	161 Suffel	162 Finizio	1632. Tong	164 Salaam
12:10pm	165 Qiu	166 Chopra	167 Myrvold	168 Faria
12:30pm	LUNCH (on your own)			
2:00pm	**Jonathan Jedwab**			
3:00pm	COFFEE			
3:20pm	169 Lucas	170 Rudolph	171 Yoshimoto	172 Chan
3:40pm	173 Vaughn	174 Harborth	175 Levi!	176 Boucher
4:00pm	1TT Moriya	178Wei	179 Hilton	180Augeri
4:20pm	181 Tener	182 Maity	183 Salehi	184 Bartha
4:40pm	185 Quistorff	186 Singh	187 Bullington	188 Oda
5:00pm	189 Bhattacharjya	190	191 Gagliardi	192 Roblee
5:20pm	193	194	195	196
5:45pm	**Informal Party at Coyote Jack's**			

Friday, March 9, 2007

8:00am	Registration in Grand Palm Room			
	Sessions for Contributed papers in Live Oak Pavilion			
	A	B	C	D
8:20am	197 Jacob	198	199 Suzuki	200 van der Merwe
8:40am	201 Lyle	202	203 Nakamoto	204 Delavina
9:00am	205 Molina	206	207 Negami	208 Rubalcaba
9:30am	**Mike Burmester**			
10:30am	COFFEE			
10:50am	209 Arroyo	210 Dios	211 Klerlein	212 Roden
11:10am	213 Canfield	214	215 Curran	216 Sewell
11:30am	217 Gottlieb	218 Bennett	219 Ota	220 Walsh
11:50am	221 Wagner	222 Fujita	223 Ozeki	224 Ellis-Monaghan
12:10pm	225	226 Low	227 Moghadam	228 Loizeaux
12:30pm	LUNCH (on your own)			
2:00pm	**Mike Burmester**			

Coffee and refreshments will be served in the registration area of the Grand Palm Room.

Monday, March 5, 2007, 11:00 AM

1) Vertex-Distinguishing Colorings of Graphs - A Survey
Henry Escuadro*, Juniata College
Futaba Okamoto, Ping Zhang, Western Michigan University

A research problem in graph theory concerns distinguishing the vertices of a graph by means of graph colorings. We survey various methods, results, and open questions from this area of research.

Key Words: color codes, graph coloring

2) The proper subplanes of VW_{121}
Cater Caliskan*, Spyros S. Magliveras
Florida Atlantic University

We determine orbit representatives of all proper subplanes of the Veblen-Wedderburn(VW) plane of order 11^2 under its full collineation group. In particular there are 13 orbits of Baer subplanes all of which are desarguesian and approximately 3000 orbits of Fano subplanes. This work was motivated by the well known question: "Does there exist a non-desarguesian projective plane of prime order p?". The question remains unsettled.

3) All Pairs Optimum Path Algorithms for an Average Path Value
Gordon Beavers*, Wing-Ning Li
University of Arkansas

Let G(V,E) be a simple graph. Given u,v in V, let Max(u,v) denote the maximum "path value" over all simple paths from u to v. The "path value" of a path P is defined as the weight of the minimum edge in P divided by the number of edges in P. This notion of path value is a type of average that finds use in the analysis of social networks. This talk presents efficient algorithms for determining paths that produce Max(u,v) for all pairs u,v in V.

Keywords: maximum average path weight, weighted simple graph, optimum path, graph algorithms

4) On Unbordered Words in the n-Cube
Larry Cummings, University of Waterloo

We consider finite words over the binary alphabet, {O, 1}. Then-cube is the graph whose vertices are all binary words of length n and whose edges join only vertices that differ in exactly one entry. If a word w has a non-empty prefix which is also a suffix then w is said to be bordered. Otherwise, w is unbordered. Unbordered words have been studied extensively and have applications in synchronizable coding and pattern matching. Every Lyndon word is unbordered but the converse is not true. We give a counterexample to the conjecture that the Lyndon words dominate the unbordered words in the n-cube for all n > 1. We construct an unbordered word which is not a Lyndon word in the 13-cube but whose neighbors in the subgraph of unbordered words are at Hamming distance at least 2 from any Lyndon word. Further results study the structure of the subgraph of unbordered words in the n-cube for general n.

Keywords: n-cube, unbordered words, Lyndon words

5) Graph Covering by Shortest Paths

Peter Boothe•, Zdenek Dvorak, Arthur M. Farley, Andrzej Proskurowski
University of Oregon and Charles University, Prague

We consider a problem motivated by computer network monitoring and sampling. A network can be modeled as a connected, undirected graph G. Let I(u,v) be the intersection of edge sets on all shortest paths between vertices u and v in G. Let U(u,v) be the union of such edge sets. Let I(u) be the union of edges in I(u,v), over all vertices v in G. Let U(u) be the union of U(u,v) over all vertices v. We define two new shortest path covering problems, SPCI(G) and SPCU(G). The problems accept a graph G as an input and ask for minimum size vertex sets that include all edges of G in the union of I(u) and U(u), respectively, over all vertices u in the sets. We prove that the decision versions of both problems are NP-Complete. We also present efficient solutions for both problems on several restricted classes of graphs.

Keywords: graph theory, graph cover, shortest path, NP complete

6) A lower bound for the minimum weight of the dual 7-ary code of a projective plane of order 49

J.D. Key, F. F. Ngwane*, Auburn University

Existing bounds on the minimum weight d of the dual 7-ary code of a projective plane of order 49 show that this must be in the range of $75 < d < 99$. We use combinatorial arguments to improve this range to $87 < d < 99$, noting that the upper bound can be taken to be 91 if the plane has a Baer subplane, as in the desarguesian case. A brief survey of known results for the minimum weight of the dual codes of finite projective planes is also included.

7) Automated Bounds on Recursive Structures

Wayne Goddard, Clemson University

Tables are the basis for many dynamic programming algorithms on recursive structures such as trees and grids. These tables record the rules for combining structures. We show how such a table can be used to determine the maximum or minimum value of the associated parameter, and implement software that automatically determines the general form of the extremal function from the table, and outputs a proof thereof. We use the software to solve some old and new problems; for example, we obtain the values of domination parameters for some small grids.

Keywords: bounds, computer, algorithm, trees

8) Optimal Variable-Length Codes of Different Types

S.Baker, R.Flack, S.Houghten*, Brock University, Canada

The insertion-deletion distance between two vectors is the minimal number of insertions and/or deletions required to transform one vector into another. Edit distance, also known as Levenshtein distance, encompasses both Hamming distance and insertion-deletion distance, allowing for a combination of insertions, deletions and substitutions. While codes defined using edit distance or insertion-deletion distance are analogous to similar codes defined using Hamming distance, the theory is significantly different, in particular because the spheres about codewords do not all have the same size. A variable-length $(n,M, d)_q$ insertion-delection correcting (respectively, edit) code is a q-ary code with minimum insertion-deletion (respectively, edit) distance d and in which the longest codeword has length n. An optimal code is a code of maximal size for a given maximum length and minimum distance. We explore the theory underlying these codes and discuss computational issues relating to searches for optimal codes. We provide tables of bounds on code sizes for both insertion-deletion correcting and edit codes for short lengths and small alphabets.

Keywords: Optimal Codes, Variable-Length Codes, Insertion-Deletion Distance, Levenshtein Distance

9) Path decompositions in complete multipartite graphs

Elizabeth J. Billington*, The University of Queensland, Australia
O.G. Hoffman, Auburn University

Necessary and sufficient conditions are given for the existence of an edge-disjoint decomposition of any arbitrary complete multipartite graph into paths of certain short lengths. Further necessary conditions are given for longer length paths.

10) Necessary Conditions for 1, M, N-Antiautomorphisms of Directed Triple Systems

Neil P. Carnes, McNeese State University

A transitive triple, (a, b, c), is defined to be the set {(a, b), (b, c), (a, c)} of ordered pairs. A directed triple system of order v, DTS(v), is a pair (D,β), where D is a set of v points and β is a collection of transitive triples of pairwise distinct points of D such that any ordered pair of distinct points of D is contained in precisely one transitive triple of β. An antiautomorphism of a directed triple system, (D,β), is a permutation of D which maps β to β^{-1}, where $\beta^{-1}=\{(c, b, a) \mid (a, b, c) \in \beta\}$. We give necessary conditions for the existence of a directed triple system of order v admitting an antiautomorphism consisting of two cycles of lengths M, and N, and one fixed point.

Keywords: antiautomorphism, bicyclic, directed triple system

11) Multiple Towers of Hanoi with a Path Transition Graph

John W. Emert*, Roger 8. Nelson, Frank W. Owens*
Ball State University

The multiple towers of Hanoi puzzle with a path transition graph is a variation of the classic towers of Hanoi puzzle with three posts to a puzzle with p posts, where p > 2. The posts are the nodes of a path graph P_p called the transition graph of the puzzle. Number the posts so that 0, 1, 2, . . . , p - 1 is a path connecting the endpoints of the transition graph. Designate one post to be the source post S and another post to be the destination post D. The remaining posts are called temporary posts. As usual, there are n disks no two of which have the same diameter. Number the disks 1, . . . , n in order of increasing diameter. Each disk has a hole in the center so that it will fit over a post. At no time may a disk be placed on top of a disk having a smaller diameter. Thus, there are p^n legal configuration states of the n disks on the p posts. Initially, all n disks are on the source post S. A disk may be moved from the top of one post to the top of another post if and only if the move will not result in the disk being placed on top of a disk having a smaller diameter and the two posts are adjacent in the transition graph. The problem is to determine the minimum number of moves required to transfer all the disks to the destination post 0.

Key Words: multiple, towers, Hanoi, transition graph

12) The Simplex Code over Galois rings

H. Tapia-Recillas, Universidad Aut6noma Metropolitana-I MEXICO

In this note the linear simplex code over a Galois ring is introduced and its homogeneous weight distribution is determined. It is shown with an example that in general its image under the Gray map is not a linear code. Examples of these rings include the ring $Z/$ of integers modulo p^s (p prime and s a positive integer). Therefore results previously reported for p = 2 can be recovered from those presented here.

Keywords: Linear codes, Simplex code, Galois rings

Monday, March 5, 2007, 3:20 PM

13) Trees whose double domination number is twice their domination number

H. Karami, Sharif University of Technology Tehran
I.R. Iran, Abdallah Khodkar•, University of West Georgia, Carrollton
S.M. Sheikholeslami, Azarbaijan University ofTarbiat Moallem, Tabriz, Iran

In a graph G, a vertex dominates itself and its neighbors. A subset S of v i s a dominating set of G if S dominates every vertex of G at least once. A subset S of V is an independent dominating set of G if S is a dominating set and the induced subgraph G[S] has no edges. The domination number γ (G) is the minimum cardinality of a dominating set of G. Similarly, the independent domination number i(G) is the minimum cardinality of an independent dominating set of G. A subset S ♦ V (G) is a double dominating set of G if S dominates every vertex of G at least twice. The double domination number dd(G) is the minimum cardinality of a double dominating set of G. In this talk we first show that for a tree T of order at least two, dd(T) = 2γ (T) if and only if γ (T) = i(T) and every dd(T)-set of T is the union of two disjoint i(T)-sets. Then, we present a constructive characterization of all trees with dd(T) = 2γ (T).

Keywords: domination number, independent domination number, double domination number

14) Some remarks on list critical graphs

M. Stiebitz, Zs. Tuza, M.Voigt•

Some basic properties of k-list critical graphs are discussed in the talk. A graph G is k-list critical if there exists a list assignment L for G with IL(v)I = k - 1 for all vertices v of G such that every proper subgraph of G is L-colorable, but G itself is not L-colorable. This generalizes the usual definition of a k-dlromatic critical graph, where L(v) = {1, ... , k -1} for all vertices v of G. Several unexpected phenomena occur, for instance a k-list critical graph may contain another one as a proper induced subgraph, with the same value of k. It is shown that, for all 2 s p s k, there is a minimal k-list critical graph with chromatic number p. Furthermore, we discuss the question, for which value of k and n is the complete graph Kn k-list critical. While this is the case for all 5 s k s n, Kn is not 4-list critical if n is large.

Key words: list colorings, critical graphs

15) Existence of Strict Inequalities Between the Various Matrix Ranks of Tournament Matrices

Daluss J. Siewert, Black Hills State University

The biclique cover and partition numbers of bipartite graphs and digraphs are related to several matrix ranks. These matrix ranks include the Boolean rank, nonnegative integer rank, term rank, and real rank. It has been shown that the real rank of an n-tournament matrix is n or n-1. This result, together with other known basic relationships between the various matrix ranks, greatly restricts the possible values of the ranks of adjacency matrices corresponding to tournaments. These restrictions lead naturally to the problem of finding specific examples or classes of n-tournament matrices that satisfy the various inequality relationships between the ranks. In this talk, I will discuss the possible rank relationships for n-tournament matrices and I will give some known results concerning the existence of tournaments or classes of tournaments whose corresponding adjacency matrices have ranks that satisfy various inequalities. In addition, I will pose several open problems related to the existence of n-tournament matrices or classes of n-tournament matrices with ranks satisfying certain inequalities.

Key Words: Tournament, Upset Tournament, Biclique Cover, Biclique Partition, Boolean Rank, Nonnegative Integer Rank, Real Rank, and Term Rank

16) Regular Cayley maps from finite abelian groups

Robert Jajcay, Indiana State University

Almost all the known orientable regular maps (2-<:ell embeddings of graphs in orientable surfaces whose orientation preserving automorphism groups act regularly on their sets of darts) are Cayley maps. For example, four of the five Platonic solids are Cayley maps. Therefore, the study of regular Cayley maps is guaranteed to provide substantial insights into the general theory of regular maps as well. Recently, a lot of progr॰ss toward understanding the regular Cayley maps has been made, in part due to the use of the concept of a skew-morphism introduced by Jajcay and \v Sir\' a\v n (2002). A classification of all finite abelian groups supporting at least one regular Caytey map has been completed by Muzychuk in 2004, and several classification results of all regular Cayley maps for special subclasses offinite abelian groups have been completed as well. In our presentation, we present some of our most recent results concerning Cayley maps from abelian groups based on the skew-morphism idea.

Keywords: regular orientable map, Cayley map, skew-morphism, abelian group, orientation preserving automorphism group

17) Lower Bounds for Global Alliances on Planar Graphs
Rosa I. Enciso*, Ronald D. Dutton
University of Central Florida

In a graph G = (V, E), a set S where $S \neq \Phi$ and is a subset of V is a defensive alliance of G if an element x of S means $|N(x) \cap S| \geq |N[x] - S|$. The set S is an offensive alliance if for every $x \in \partial S$, $|N(x) \cap S| \geq |N(x) \cap (V - S)|$. The set S is a dual alliance if it is both defensive and offensive. If the inequalities are strict, the alliances are said to be strong. This paper focuses on bounds on the defensive and dual alliance number in planar graphs.

Keywords: global alliances, dual alliances, powerful alliances, defensive alliances, planar graphs

18) From Edge Coloring to Vertex Coloring
Henry Escuadro, Juniata College
Futaba Okamoto, Ping Zhang*, Western Michigan University

Given a (not necessarily proper) edge coloring c of a graph G, a proper vertex coloring of G is defined in terms of c and a corresponding "chromatic number" is defined. We present some results and an open question.

Key Words: edge coloring, vertex coloring

19) Fair Incomplete Tournaments With Odd Number of Teams
Dalibor Froncek
University of Minnesota Duluth

Suppose n teams are ranked from 1 to n with the strength of the i-th ranked team defined by $s(i) = n + 1 - i$. The total strength of opponents that team i plays in a complete round robin tournament is $S_{n,n-1}(i) = n(n+1)/2 - s(i) = (n+1)(n-2)/2 + i$. *A fair incomplete tournament* of n teams with k rounds, FIT(n, k), is a tournament in which every team plays exactly k other teams and the total strength of the opponents that team i plays is $S_{n,k}(i) = n(n+1)/2 - s(i) - m$ for some fixed constant m. It follows that the total strength of the opponents that each team misses is the same. An *equalized incomplete tournament* of n teams with r rounds, EIT(n, r), is a tournament in which every team plays exactly r other teams and the total strength of the opponents that each team plays, $T_{n,r}(i)$, is the same. Obviously, a FIT(n, k) exists if and only if an EIT(n, n - k - 1) exists. The existence of an EIT(n, r) is equivalent to the existence of an r-regular graph on n vertices with a *1-vertex-magic vertex labeling* with the magic constant m. It was proved by DF, Tereza Kovarova and Petr Kovar *[Bull. ICA* 48 (2006), 31-33) that for n even an EIT(n, r) exists if and only if r is even and either $n \equiv 0$ (mod 4) or $r \equiv 0$ (mod 4). We will present some methods and results for n odd.

Keywords: magic type labeling, round robin tournament, tournament scheduling

20) The Nova Graph: An Improvement to the Alternating Group Graph
Jeffrey Boats*, Lazaros Kikas, John Oleksik
University of Detroit Mercy

Suppose we have k pairs of vertices $(s_1, t_1), (s_2, t_2), \ldots, (s_k, t_k)$ and we wish to find k disjoint paths; each path connecting exactly one pair. If in a graph G we can do this for any k pairs of vertices then we say that G has the k-disjoint path property. In this talk we present a new structure called A_n^*, or the Nova graph which is an enhancement of the alternating group graph. By including the permutation *J=(12)(34)*, the number of possible disjoint paths increases with a minimal addition of edges. We discuss the properties of this Cayley graph and outline a proof that A_n^* has the 3-*Disjoint Path Property*

Key words: Disjoint paths, graphs, permuations

21) An Edge-based Variant of the Wimer Method for Computing the EV-domination Numbers of Trees

Alan Jamieson, Clemson University

In this paper, we will discuss a little-studied domination parameter called Edge-Vertex Domination (EV-domination), first discussed by Laskar and Peters in 1985. An EV-dominating set of a tree T = 0/, E) is a set S ◆ E, where each v e V is either covered by a member of S. or adjacent to a vertex that is covered by S. We will provide linear algorithms for determining the minimum cardinality of an EV-dominating set and the maximum cardinality of a minimal EV-dominating set We will also provide edge weighted versions of these algorithms. We will use a newly developed, edge-based variant of the Wimer method for constructing linear algorithms on trees.

22) Problems and Results on Colorings of Mixed Hypergraphs

Zs. Tuza, Hungarian Academy of Sciences, Budapest, Hungary
V. Voloshin•, Troy University, Troy, Alabama

We survey results and open problems on 'mixed hypergraphs' that are hypergraphs with two types of edges. see the Mixed Hypergraph Coloring Web Site at http://spectrum.troy.edu/-voloshin/mh.htm. In a proper vertex coloring the edges of the first type must not be monochromatic, while the edges of the second type must not be completely multicolored. Though the first condition just means 'classical' hypergraph coloring, its combination with the second one causes rather unusual behavior. For instance, hypergraphs occur that are uncolorable, or that admit colorings with certain numbers k' and k" of colors but no colorings with exactly k colors for any k'<k<k".

Key words: hypergraph coloring, mixed hypergraph, colorability, upper chromatic number, chromatic spectrum.

23) Local Out-Tournaments with Upset Tournament Strong Components: Equal Matrix Ranks of less than n

Kim A. S. Factor•, Rebecca M. Kohler. Franco Rupcich
Marquette University

A local out-tournament is a digraph where the outset of every vertex is a tournament. Here. local out-tournaments with strong components that are upset tournaments are examined. Specifically, we use upset tournaments whose adjacency matrices have less than full rank. The ranks of their associated out-tournaments are discussed. Boolean. nonnegative integer, term and real ranks of the adjacency matrices of these digraphs vary widely depending upon the construction, and we provide examples where rank equality of less than *n* occurs. The biclique cover and partition numbers of the tournaments are included.

Keywords: local out-tournament, upset tournament, {0, 1}-matrix ranks, biclique cover and partition numbers

24) An Algebraic Approach for Finding Disjoint Paths in the Alternating Group Graph and Other Cayley Graphs

Jeffery Boats, Lazares Kikas•, Mithra Koyyalamudi , John Oleksik
University of Detroit Mercy

For the purpose of large scale computing, we are interested in linking computers into large interconnection networks. In order for these networks to be useful, the underlying graph must possess desirable properties such as a large number of vertices, high connectivity, and small diameter. Suppose we have k pairs of vertices $(s_1, t_1), (s_2, t_2), \cdots, (s_k, t_k)$ and wish to find k disjoint paths; each path connecting exactly one pair. If in a graph G we can do this for any k pairs of vertices then we say that G has the k-disjoint path property. In 2005, Cheng, Kikas. and Kruk presented an existence proof that the Alternating Group Graph A_n has the *(n-2)*-disjoint path property. In 2006, Boats, Kikas and Oleksik, presented an algorithm that actually constructs the disjoint paths from scratch. In this paper we further refine our algorithm so that it can be generalized to other Cayley graphs. We also present a graphical interface for finding the disjoint paths in the alternating group graph. We close with a discussion of possible research stemming from this work.

Key words: Disjoint paths. graph, permutations

Monday, March 5, 2007, 4:20 PM

25) On Dominator Colorings in Graphs

Ralucca Gera*, Craig Rasmussen, Naval Postgraduate School
Steve Horton, United States Military Academy West Point

A dominator coloring in a graph is a proper coloring with the additional property that each vertex in the graph dominates an entire color class. The dominator chromatic number $\chi_d(G)$ is the minimum number of color classes in a dominator coloring of a graph G. We present several bounds, realization results, and its relationship to the domination and chromatic numbers.

Keywords: coloring, domination

26) Parity and Strong Parity Edge-Colorings of Graphs

David P. Bunde, Knox College
Kevin Milans, Douglas 8. West*, Hehui Wu, University of Illinois

A parity walk in an edge-coloring of a graph is a walk along which each color is used an even number of times. Let p(G) be the fewest colors in an edge-coloring of G having no parity path (a
parity edge-coloring). Let p'(G) be the least number of colors in an edge-coloring of G having no open parity walk (a strong parity edge- coloring). Always p'(G) 2 p(G) 2 J'(G). The study of these parameters was motivated by the characterization of subgraphs of hypercubes. This talk will emphasize examples, relations to other parameters, and open problems. We give examples where p(G) and p'(G) are equal and examples where they differ; equality is conjectured to hold for all bipartite graphs and for complete graphs. The main resul.t is that $p'(K_n)$ = i 'gnl - 1 for all n (using vector spaces); this strengthens a special case of Yuzvinsky's Theorem.

Keywords: edge-coloring, parity, bipartite, complete graph, closed walk

27) Directed cycles in dense digraphs

Blair D. Sullivan
Princeton University

Given a directed tournament, the condition of being triangle-free (having no directed cycles of length at most three) forces the digraph to be acyclic. What can one say then about triangle-free digraphs which are almost tournaments (i.e. the number of non-edges is bounded)? In joint work with Maria Chudnovsky and Paul Seymour, we showed that all triangle-free digraphs with k non-edges can be made acyclic by deleting at most k edges. We conjecture that in fact, every such digraph can be made acyclic by deleting at most k/2 edges, and prove this stronger result for two classes of digraphs - circular interval digraphs, and those where the vertex set is the union of two cliques. We discuss these recent results and proof methods, as well as present several open problems relating to the conjecture.

28) The spanning number and the independence number of a subset of an abelian group

Bela Bajnok, Gettysburg College

Let A = {a_1, a2, . . . , am} be a subset of a finite abelian group G. We call A t-independent in
G, if whenever
$A_1 a$, + A2a_2 + · · · + Ama_m = 0
for some integers A1, >2, . . . , Am with |$>_1$|+|>2|+ · · +|Am| $ t, we have $>_1$ = A_2 = · · · = A_m = 0. We say that A is s-spanning in G, if every element g of G can be written as
g = A1a1 + >2a2 + · · · + Ama_m
for some integers A_1, >2• . . . , Am with |>1|+|$>_2$|+ · · +|Am| S s. In this talk we give an upper bound for the size of a t-independent set and a lower bound for the size of an s-spanning set in G, and determine some cases when this extremal size occurs. We also discuss an interesting connection to spherical combinatorics.

29) Weighted Alliances in Graphs

Lindsay H. Jamieson•, Brian C. Dean
Clemson University

let G =0/, E) be a graph and let W:V N be a non-negative integer weighting of the vertices in V. A nonempty set of vertices S ♦ V is called a weighted defensive alliance if

V v E S, L w(u) ♦ L w(x)- A non-empty set S ♦ V is a weighted
ueN(vy,S ieN(v)-S

offensivealliance if v'vE JS, L w(u) ♦ Lw(x). A weighted alliance
ueN(vy,S xeN(v)-S

which is both defensive and offensive is called a weighted powerful alliance, (a...(G) denotes the weighted powerful alliance number of a graph G) while a weighted alliance S for which oS = V - S is called a weighted global alliance. This paper shows that the algorithmic complexity of finding the weighted alliance number for all types of alliances is NP-complete even when restricted to stars, while algorithms are presented for finding weighted defensive and weighted offensive alliances on paths.

Keywords: alliances, weighted alliances, complexity, algorithms

30) New upper bounds for the chromatic number of a graph

Ingo Schiermeyer
Technische Universitat Bergakademie Freiberg

For a connected graph G of order n, the clique number w(G), the chromatic number X (G) and the independence number a (G) satisfy w(G) s X (G) s n - a (G) + 1. We will show that the arithmetic mean of the previous lower and upper bound provides a new upper bound for the chromatic number of a graph. Theorem: let G be a graph of order n with clique number *w(G)* and independence number a (G). Then

z(G) ♦ $\frac{n+m+l-a}{2}$. Moreover, $z(G)=\frac{n+a>+l-a}{2}$, if either $a>+a = n+1$ (then G is a split graph) or a +(J) = n + 1

and G contains a K ,,,..3 - C_5. Theorem (Nordhaus and Gaddum, extended): Let G be a graph of order n with clique number QJ (G) and independence number a (G). Then X(G) + $x(G)$ ♦ $n+1$. Moreover, $x(G)+x(G)=n+1$. if either

m(G)+a(G) =a(G)+m(G) =*n*+ 1 (then G and G are split graphs) or

a>(G) + a(G) = a(G) + m(G) = n - l and (K,,<G>+J - C_5) c G.

(K.,<J,., -Cs) c G.

31) Brother Avoiding Round Robin Doubles Tournaments

David R. Berman•. Douglas D. Smith
University of North Carolina at Wilmington

A *spouse avoiding mixed doubles round robin tournament, SAMDRR(N),* for N couples is a schedule of games for N male-female couples. In each game two players of opposite sex compete against two other players of opposite sex, and

- each pair of players of the same sex are opponents exactly once
- each pair of players of the opposite sex, except spouses, are opponents exactly once and partners exactly once.

A *brother avoiding round robin doubles tournament, BARRDT(N),* for N pairs of brothers consists of games for teams of two players such that

- each player has exactly one brother
- brothers never play in the same game as partners nor as opponents
- each pair of players who are not brothers are opponents exactly once and partners at most once.

Every SAMORR(N) is a BARRDT(N) in which spouses in the SAMDRR(N) are identified as "brothers· in the BARRDT(N). We use a variety of construction methods to show that there is a BARRDT(N) that is not a SAMDRR(N) for all N > 4 except possibly N = 14, 15, 18, 22, 27, 30, 33, and 34.

Keywords: SAMDRR(N), BARRDT(N)

32) Applications of Graph Theory to 3-D Surface Reconstruction, Telecommunication Networks, and WWW Cybercommunities

Darren A. Narayan·
Rochester Institute of Technology

We will give an overview of the STEM Real World Applications Modules Project (NSF-DUE #0536364). The goal is to enhance student learning by motivating mathematical concepts with cutting-edge real-world applications. Technological innovations which will be discussed in this talk include: 3-0 surface reconstruction (Microsoft Research); analysis of airline flight networks (JetBlue Airways); fiber-optic telecommunications networks (Level 3 Communications); and identification of WWW cybercommunities (Google).

Keywords: Minimum-weight perfect matching, Menger's Theorem, Max-Flow/ Min Cut Theorem

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33) Unfolding Polyhedra into Nets

Val Pinciu, Southern Connecticut State University

Given a polyhedron, what is the fewest number of nets, each of which unfolds into a simple polygon, into which it may be cut by slices along edges? Shephard's conjecture states that the number is 1 for convex polyhedra, but it's still open. For non-convex polyhedra that number is more than 1. We provide the best upper bounds known for simplicial, simple and general polyhedra, then we use graph domination to improve some of these bounds.

Key words: dual graph, domination set, polyhedron, unfolding

34)

35)

36)

37) Maximum packing for perfect four-triple configurations

Selda Ku;;uk;;if;;i, Guven Yuceturk·, Auburn University

The graph consisting of the four :x:ycles (triples) (x,, x2, Xe), (x2, x,, x.), (x.. Xs x;), and (x., x,, Xe), where X;'s are distinct, is called a 4-cyde-triple block and the ♦cle (x2, x., x., Xe) of the ♦de-triple block is called the interior (inside) 4-cycle. The graph consisting of the four 3-cycles (x,, x2, x;), (x2, x3, x.), (x., Xs, x.). and (x., x7, Xe), where X;'s are distinct. is called a kite-triple block and the kite (x2, x., x.)-Xe (formed by a :x:yde with a pendant edge) is called the interior kite. A decomposition of 3kK., into ♦de-triple blocks (or into kite triple blocks) is said to be perfect if the interior ♦des (or kites} form a k-fold ♦de system (or kite system). A packing of 3kK., with ♦de-triples (or kite-triples) is a triple (X,B,L}, where X is the vertex set of K,,, B is a collection of ♦cle-triples (or kite-triples}. and L is a collection of 3-cycles, such that B U L partitions the edge set of 3kKn. If lll is as small as possible. or equivalently lBl is as large as possible, then the packing (X,B,L) is called maximum. If the maximum packing (X.B,l) with 4-cyde-triples (or kite-triples) has the additional property that the interior ♦des (or kites) plus a specified subgraph of the leave L form a maximum packing of kK., with 4-cycles (or kites), it is said to be perfect. This paper gives a complete solution to the problem of constructing perfect maximum packings of 3kK., with ♦de-triples and kite-triples, whenever n is the order of a 3k-fold triple system.

Keywords: 4-cycle triple block, kite-triple block, maximum packing, perfect triple configuration

38) Values of y-labelings of complete bipartite graphs

Grady Bullington, Linda Eroh•, John Koker, Hosien Moghadam, Steven J. Winters
University of Wisconsin Oshkosh

A y-labeling of a graph G of order n and size m is any labeling of the vertices with integers from the set {0, 1, 2, . . . ,m}. so that no label is used more than once. If f(u) is the label assigned to vertex u, the edge uv has the induced label lf(u) - f(v)l- The value of a y-labeling is the sum of the induced labels of its edges. For a graph G, $val_{max}(G)$ is the maximum value over all possible y-labelings of G and $val_{...n}(G)$ is the minimum value over all possible y-labelings of G. These definitions were introduced by Chartrand, Erwin, V.anderJagt, and Zhang. In this talk, we present some results about val_{m};nand val,,, .. for complete bipartite graphs and for products of cycles and some partial results about the spectrum of all possible values of y-labelings of complete bipartite graphs.

keywords: y-labeling, graceful labeling

39) Free poset on permutations by scalar products

Maria Cristina Rangel. Federal University of Espirito Santo
Nair Maria Maia de Abreu•. Federal University of Rio de Janeiro

We introduce an ordering on the permutation set based on the scalar products of nonnegative vectors in R"•. In this way, we obtain the free poset that contains the well known inversion posel Pairs of free-comparable permutations are defined by the scalar products of vectors relative to these permutations. A polynomial algorithm to decide if a pair of these permutations is free-comparable is presented. A chain of comparability graphs corresponding to a chain of posets is built in order to prove the foUowing result: Let p and a- be two free-comparable permutations and for v nonincreasing and w nondecreasing vectors in R".; let <v, p (w}> and <v. a- (w)> be the scalar products relative to them. If the inversion number of p is less than the inversion number of O' . we prove that <v, p (w)> is no greater than <v, O' (w)>.

Key words: Poset. Permutations. Scalar products

40) Compositions and the Alternate Fibonacci Numbers

Ralph Grimaldi, Rose-Hulman Institute of Technology

For a positive integer n, we count the number of compositions of n, where we have two kinds of ones, denoted by 1 and 1'. These compositions are counted by the odd-subscripted Fibonacci numbers, starting with 2. Among the properties of these compositions, that we investigate, are the number of times a given summand occurs, the total number of summands for all the compositions of a given integer n, as well as, the number of summands that are even and those that are odd.

41) Using Resolvable BIBDs To Construct GDDs With Two Groups and Block Size k+2

Spencer Hurd, The Citadel
Dinesh G. Sarvate*, College of Charleston

We construct GDDs with two groups and block size k + 2 using resolutio n classes of a BIBD{v, k, l) when the number of classes satisfies a certai n necessary condition . We apply the theorem to give a construction of a GDD(16, 2, 6; 28, 30) and for GDD(9, 2, 5; 11, 12) for all possible indices (11, 12).

Keywords: GOD, BIBO, PBIBD, group divisible design, resolvable

42) On Graceful Labelings of Cycles

Jay Bagga, Adrian Heinz*, Mahbubul Majumder*
Ball State University

Suppose that G is a connected graph with n vertices and m edges. A vertex labeling f : V (G) {O, 1, 2, ... ,m} such that distinct vertices have distinct labels induces an edge labeling where an edge xy gets the label lf(x) - f(y)j. If the edges are labeled 1, 2, ... ,m then the labeling is called graceful. In 1967, Rosa proved that all cycles C_n (where n $\equiv$ 0 or 3 (mod 4)) are graceful. In this presentation, we discuss a recursive algorithm for finding all possible graceful labelings for a given cycle C_n.

Keywords: Graceful labeling, Cycle, Algorithm

43) Vertices and Extreme Rays of the Semiorder Polyhedron

Barry Balof
Whitman College

A representation of a semiorder (X, P) assigns each element x of the order a numerical value f(x), as well as an 'element differentiation value', r, to the order. (For those familiar with the idea of a unit interval representation, the values f(x) can be thought of as the left endpoint of the interval corresponding to x, and the value r can be thought of as the length of the intervals). Two elements of the order are incomparable if and only if their function values are within r of each other. Additionally, we can define a threshhold, & , with two elements comparable if and only if their function values are at least r + & apart. We can view the set of all representations of a semiorder on n elements as a polyhedron in n-dimensional space. In this talk, we examine this polyhedron, specifically, its vertices and extreme rays, and connect them to certain directed graphs that one can associate to the semiorder. This is joint work with Jean-Paul Doignon and Samuel Fiomi of the Universite Libre de Bruxelles.

Keywords: Semiorders, Polyhedra, Vertices, Rays, Linear Programming

44) Combinatorial realizations of generalized meta-Fibonacci sequences

Chris Deugau, Frank Ruskey", University of Victoria, Brad Jackson
San Jose State University

We show that a family of generalized meta-Fibonacci sequences arise when counting the number of leaves at the largest level in certain infinite sequences of k-ary trees, when counting some restricted compositions of an integer, and when listing certain "self-referential" integer sequences. For this family of generalized meta-Fibonacci sequences and two families of related sequences we derive ordinary generating functions and recurrence relations.

Keywords: Meta-Fibonacci sequence, k-ary tree, ruler function, composition, generating function

45) A decomposition of $(A$ K v t with extended triangles

Wen-Chung Huang•, Soochow University, Taiwan
C. A. Rodger, Auburn University

By an extended triangle, we mean a loop, a loop with an edge attached (known as a lollipop), or a copy of Ki (known as a triangle). In this paper, we completely solve the problem of decomposing the graph $(A$ K v t into extended triangles for all possible number of loops.

Keywords: Decomposition, Extended triple system, Latin Square

46) On The Balanced Windmill Graphs

Sin-Min Lee, Brian Chan, Thomas Wang•
San Jose State University

Let G be a graph with vertex set V (G) and edge set E(G), and let A = {O, 1}. A labeling f : V (G) A induces an edge partial labeling f* : E(G) A defined by f*(xy) = f(x), if and only if f(x) = f(y) for each edge xy E E(G). For i E A, let v, (i) = card{v E V (G) : f(v) = i} and er (i) = card{e E E(G) : f*(e) = i}. A labeling f of a graph G is said to be friendly if lvt(O)-v, (1)l s 1. If, le, (0)-e, (1)l s 1 then G is said to be balanced. We also show that here several families of balanced graphs for regular windmill and general windmill graphs.

Keywords: Vertex labeling, friendly labeling, cordiality, balanced, NPcomplete

47) Semiorders and Riordan Numbers

Barry Balof, Jacob Menashe•
Whitman College

Semiorders, or unit interval orders, get their genesis in mathematical psychology but are more formally studied in ordered set theory. It is a classic combinatorial result that the number of semiorders on an n element set is the nth Catalan number, Cn. In our talk we are looking at a special class of these semiorders, those for which no two elements share the same predecessor and successor sets and each element is incomparable with its predecessor in the underlying linear order. We call semiorders with these properties 'interesting semiorders'. We also examine the set of Motzkin Paths, which are generalizations of Catalan Paths (these are Catalan Paths which allow horizontal as well as up- and down- steps). In our talk, we exhibit both an enumerative proof as well as a bijection between interesting semiorders and those Motzkin Paths which have no horizontal steps on the x-axis. Both of these sets are counted by the Riordan Numbers, which are a cousin to the Catalan Numbers.

Keywords: Semiorders, Catalan Paths, Motzkin Paths, Riordan Numbers

48) The combinatorics of a poset of involution

Ruth Haas·, Smith College
Aloysius G. Helminck, North Carolina State University

Weyl groups generalize permutation groups and are useful in many branches of mathematics. The set of involutions is the set of elements of order 2. For a given Weyl group, all involutions can be generated starting from the identity giving a poset. This poset is similar to the weak order poset for the whole Weyl group, whose combinatorics is important in representation theory and has been studied extensively by many mathematicians. This talk will focus on the combinatorics of this poset.

49) Cyclic Kirkman triple systems

Mariusz Meszka, University of Science and Technology, Krakow, Poland
Alexander Rosa•, McMaster University

A parallel class in a Steiner triple system (STS) (V,B) is a set of pairwise disjoint triples which partition the v-set of elements V. An STS (V,B) is resolvable if one can partition the set of triples B into parallel classes; any such partition R is a resolution. A Kirkman triple system (KTS) (V,B,R) is an STS (V,B) together with a particular resolution R. It is cyclic if there exists a permutation of V consisting of a single cycle of length v which preserves both, the set of blocks B, and the resolution R. We survey the known and new results on the existence and nonexistence of cyclic KTSs, and on the construction and enumeration of cyclic KTSs of small orders. We also propose an existence conjecture for cyclic KTSs.

50) On r-paths labeled with a condition at distance two

John P. Georges, David Mauro, Yan Wang•
Trinity College, Hartford

For r 2 1 and n 2 r + 1, the r-path on n vertices, denoted Pn(r), is the graph of smallest size on n vertices whose vertex set is $\{x_1, x_2, \cdots, x_n\}$ and whose induced subgraph on $\{x_p, x_{p+1}, \cdots, x_{p+r}\}$ is complete for all 1 s p s n - r. For positive integers j 2 k, an L(j, k)-labeling of a given graph G assigns nonnegative integers to its vertices so that the labels of adjacent vertices differ by at least j and the labels of vertices distance two apart differ by at least k. The L(j, k)-number of G, denoted by J(G), is the minimum span of all L(j, k)-labelings of G. In this paper we derive formulas for J(Pn (r)) for all values of j and k, where $\frac{j}{k}$ 2 2.

Key words: L(j, k)-labeling, r-path, J(G)

51) Realizable Words for DNA of Ciliates and Assembly Graph Diagrams

Angela Angeleska•, Natasa Jonoska, Masahico Saito
University of South Florida

Motivated by problems in gene recombination observed in ciliates, we define assembly graphs as a finite graphs with rigid vertices of degree four and even number of vertices of degree one. We investigate certain properties and applications of assembly graphs, such as: the assembly number, smoothing, hamiltonian and polygonal paths. Also some results for words associated with assembly graphs are presented.

Key words: ciliates, hamiltonian path, smoothing, 4-valent graphs

52) Using Signed Permutations to Represent Weyl Group Elements of a Symmetric Space

Jennifer R. Daniel, Lamar University

A Weyl group, W(<I>(t)), is a reflection group of a root system <I>(t). Weyl group elements are usually given in terms of generators and relations. This representation is not unique and therefore leads to computational problems. In 2005, Haas and Helminck introduced the unique representation of a Weyl group element as a signed permutations. In 2004, Daniel and Helminck gave a complete set of algorithms for computing the fine structure of local symmetric spaces over algebraically closed fields and used this to compute bases for the spaces. Implicit in these algorithms are the Weyl group of the root system of a Lie algebra, <I>(t), and the Weyl group associated with the local symmetric space, <I>(a). In this paper, the author investigates the use of signed permutations in computations related to symmetric spaces.

keywords: symmetric spaces, Lie algebras of linear algebraic groups, Weyl groups, computing

53) Disjoint Intersection Problem for Steiner Triple Systems

Dr Chris Rodger, Sangeetha Srinivasan*
Auburn University

Let (S, T_1) and (S, T_2) be two *Steiner Triple systems* on the set S of symbols with the set of triples T_1 and T_2 respectively. They are said to *intersectin m blocks* if $|T_1 \cap T_2| = m$. If the blocks in $T_1 \cap T_2$ are pair-wise disjoint then (S, T_1) and (S, T_2) are said to *intersect in m pair-wise disjoint blocks.* The *Disjoint Intersection Problem* for Steiner Triple Systems is to completely determine $Int_d(v) = \{m \mid \exists$ two Steiner triple systems of order v intersecting in m pair-wise disjoint blocks}. $Int_d(v)$ was determined by Chee. Here we describe a different proof of his result using a modification of the *Bose* and *Skolem Constructions.*

Keywords: Steiner Triple System, Disjoint, Intersection

54) On Computation of Minimum Sum Vertex Covers

Craig Rasmussen, Naval Postgraduate School

The minimum sum vertex cover (msvc) number of a nonempty undirected graph G = (V,E} is defined as follows: The function $f: V \to \{1, 2, \ldots, |V|\}$ is an ordering of V, and the weight function $w: E \to Z+$ is defined by $w(uv) = \min\{f(u), f(v)\}$. The msvc number is $\mu_s(G) = \min_f \sum_{e \in E} w(e)$, where the minimum is taken over all orderings f. We show that $\mu_s(G)$ can be found in polynomial time for several classes of graphs.

Keywords: vertex labeling, vertex cover, split graph, elimination ordering

55) Vertex-Distinguishing Colorings of Graphs - A Survey

Henry Escuadro*, Juniata College
Futaba Okamoto, Ping Zhang, Western Michigan University

A research problem in graph theory concerns distinguishing the vertices of a graph by means of graph colorings. We survey various methods, results, and open questions from this area of research.

Key Words: color codes, graph coloring

56) Self-Referential Derivation

Okechukwu Chidume, LaShundra Griswold, Peter Johnson*
Auburn University

A sequence b(1),...,b(n) is a self-referential derivative of a sequence a(1),...,a(n) iff for each j=1,...,n, b(j) is the number of times a(j) appears in the sequence b(1),...,b(n). For example, 1,2,2 is a self- referential derivative of itself, but it has four other self-referential derivatives: (i) 1,0,0; (ii) 0,2,2; (iii) 0,0,0; and (iv) 2,1,1. Of these, only 2,1,1 has a self-referential derivative, 0,0,0. Self-referential derivation was invented as a recreational curiosity (although not by name) by Clifford Pickover; it may descend from a problem posed by Martin Gardner. Here we find all possible self-referential derivatives of all sequences of distinct non-negative integers.

57) A New Type of Block Design

Oinesh G. Sarvate, William Beam*
College of Charleston

The definition and examples of new type of designs, called strict and non-strict adesigns will be given with block sizes 3 and 4. Though the obvious necessary conditions for block size two are sufficient for the existence of strict (or non-strict) adesigns, the necessary conditions obtained for block size three and four are far from sufficient. The progress on the construction of these designs for block size three and four will be reported.

58) On Balancedness of Some Families of Trees

Yong-Song Ho, Nan Chiao High School, Singapore
Sin-Min Lee, Ho Kuen Ng*, San Jose State University

Yihui Wen, Suzhou Science and Technology College, Suzhou, Jiangsu 215009, China

The balancedness of trees is studied. We exhibit some families of balanced and unbalanced trees. We show that all binary trees are balanced and every tree is an induced subtree of a balanced tree.

Keywords: trees, graph labeling, balanced

59) Decycling Revisited

Chip Vandell
Indiana University Purdue University Fort Wayne

In this talk we will revisit the parameter v'(G), the *decycling number* of a graph and look at how it is affected when additional constraints are put on the decycling set. In particular we will look at independence and connectedness. Do decycling sets with these additional constraints exist? If so, what is their relationship to the original parameter?

Key words: decycling, independent, connected

60) On the behaviour of V(n)

B. Balamohan, A. Kuznetsov, Stephen Tanny*
University Of Toronto

We solve the meta-Fibonacci recursion
$V(n) = V(n- V(n-1)) + V(n- V(n-4))$, a variant of Hofstadter's meta-Fibonacci Q-sequence. For the initial conditions
$V(1)= V(2)= V(3)= V(4) = 1$ we prove that the sequence V(n) is monotone, with successive terms increasing by 0 or 1, so the sequence hits every positive integer. We demonstrate certain special structural properties and fascinating periodicities of the associated frequency sequence (the number of times V(n) hits each positive integer) that make possible an iterative computation of V(n) for any value of n. Further, we derive a natural partition of the V-sequence into blocks of consecutive terms ("generations") with the property that terms in one block determine the terms in the next. We conclude by examining all the other sets of four initial conditions for which this meta-Fibonacci recursion has a solution; we prove that in each case the resulting sequence is essentially the same as the one with initial conditions all ones.

Key Words: Meta-Fibonacci recursion; Hofstadter sequence.

61) Super Sudoku Squares

D. G. Hoffman, Auburn U.

We define "super sudoku square of order n", reveal a surprising connection to a classic design problem, and thus determine those n for which such squares exist. (Note: this is NOT a talk on how to solve sudoku puzzles!)

62) Edge-magic Labeling Matrices of the Composition of Paths with Null Graphs

Wai Chee Shiu
Hong Kong Baptist University

Given two graphs G and *H*. The composition of G with H is the graph with vertex set $V(G) \times V(H)$ in which (u_1, v_1) is adjacent to (u_2, v_2) if and only if $u_1u_2 \in E(G)$ or $u_1 = u_2$ and $v_1v_2 \in E(H)$. In this talk, we shall construct some matrices with some special row sums, column sums or diagonal sums. By using these matrices we obtain an edge-magic labeling of the composition of P_n with N_n. Also we obtain an edge-magic labeling of the composition of P_m with N_{mk} for odd *mk* with m 3 and k 1.

63) Distance graph Ramsey Sets

Jens-P. Bode, Technische Universitat Braunschweig, Germany

The distance graph Dn;d has the vertex set {1,2, ... ,n} and two vertices are adjacent if their difference is at most d. For given graphs G and H the distance graph D_n,d has the arrow property D_n,d (G,H) if in every two-coloring of the edges of D_n,d there is a subgraph G of the first color or a subgraph H of the second color. The Ramsey set r_0(G,H) contains the smallest pairs (n, d) for which D_n,d (G,H). Distance graph Ramsey sets for some small graphs and classes of graphs are presented. Common work with Heiko Harborth.

64) Repetitions in coding sequences and Euler's formula for graphs on surfaces

Siemion Fajtlowicz, Univ. of Houston
Eunjeong Yi*, Texas A & M-Galveston

A coding sequence of an Eulerian graph G is a sequence of vertices in the order in which they are traversed in an Eulerian tour of G. Let r be the number of repetitions of symbols in a coding sequence of G, let c be the cyclotomic rank of G, and let f be the number of faces of a planar graph G. In "Toward Fully Automated Fragments of Graph Theory" the first author notes that Graffiti's conjecture r = c suggests a new, probably the simplest, proof of Euler characteristic formula; indeed, the idea works for arbitrary planar graphs. The coding sequences of arbitrary graphs are defined by including a new additional symbol* to indicate "lifting of the pencil", whenever it is necessary for drawing these graphs without traversing any of their edges twice. The number of proper repetitions of these more general coding sequences S is defined now as R = r - z, where r, as before, denotes the number of repetitions of vertices of G in S, and z is the number of occurrences of• in S - i.e., R is the number of repetitions, discarding the first repetition after each occurrence of*. With this new definition of the number of repetitions R, the number of faces in a 2-cell embedding of a graph into any orientable surface of genus g is R + 1 - 2g, and, for any non-orientable surface, it is R + 1 - g. The formula can be deduced from the Euler characteristic formula for graphs on surfaces, but we will also give direct and simpler proofs in some cases.

65) The 6· Intersection Problem for Hexagon Triple Systems
Cart S. Pettis, Auburn University

A hexagon triple is the graph

0

and a hexagon triple system is an edge disjoint decomposition of 3k,, into hexagon triples. Note that a hexagon triple is the union of 3 triangles (= triples). The intersection problem for 3-fold triple systems has been solved for some time now. The purpose of this paper is to give a complete solution of the intersection problem for 3-fold triple systems each of which can be organized into hexagon triple systems.

66) Full Friendly Index Set of C_m X C.
W.C. Shiu, M.L.Tang, M.H.Ling•
Hong Kong Baptist University

Let G = *(V.E)* be a connected simple *(p,* q)-graph. A labeling f: V Z_2 induces an edge labeling *r* :E Z 2 defined by r(xy) = f(x)+f(y) for each xy E E. For *i* E Z 2, let v,(,) = 1r[1] (i)1 and e,(1) = *r*·[1](,) I. A labeling tis called friendly if lv,(1) • v,(0)1 S 1. For a friendly labeling *f* of a graph G, we define the friendly index of Gunder *fby* ;, (G) = e, (1) - e,(0). The set {i, (G) | f is a friendly labeling of *GJ* is called the full friendly index set of G, denoted by FFI(G). In this talk, we will present some results on the full friendly index sets of cartesian product of two cycles.

67) New Decomposition Method for Generalized Star Graphs A.k and $S_{n,k}$
Eddie Cheng, Nart Shawash•, Oakland University, Rochester, MI

Star graphs S_n have been proposed as an attractive alternative for hypercubes. However they suffer from having -too many- n! vertices. As a remedy for that problem two generalizations of star graphs have been suggested, namely Arrangement graphs A.,., and (n, k)-star graphs o r s•.•, both having $\frac{n!}{(n-k)!}$ vertices. One popular recursive decomposition have been used in the literature, namely decomposing A_n.• or S_n.• into n vertex disjoint copies of A,,. 1,- 1 or s ... ,.•. 1. In this paper, we introduce another recursive decomposition of these graphs into k edge disjoint copies of A..-1.•-1 hooked into a copy of A..-, •• in case of An•, and (k - 1) edge disjoint copies of S.,. , .•. 1 and a *copy* of S,,.1: connected to a stable set on $\frac{(n-1)!}{(n-k)!}$ vertices. Moreover. this decomposition reflects transposition tree structure that generates these graphs. As a corollary, we have star graphs as a subgraphs of alternating group graphs. And a quotient/litling -reduction/extension- relation between two classes A_n.• and S••.

Keywords: Interconnection networks, arrangement graphs, alternating group graphs, star graphs, Cayley graphs, S_n.• graphs

68) Efficient Techniques for Network Attack Identification and Path Prediction
Sanjeeb Nanda•, Narsingh Deo
University of Central Florida

The ubiquity of the Internet has instigated an explosion in the number of networked applications developed for the consumption of users. Unfortunately, many are maliciously designed to harm network infrastructure and systems. Considerable effort has been focused on detecting attacks by such applications that are known as malware, and predicting the breaches in security rendered by them. However, large networks pose a formidable challenge to representing and analyzing such attacks using scalable models. Furthermore, the availability of only partial information on the vulnerabilities admitted by a large fraction of the networked systems makes the task of forecasting those that are likely to be exploited by such applications in the future equally hard. In this paper, we present innovative methods to identify attacks on large networks and forecast their propagation over time, and compare their relative advantages with respect to existing techniques.

Keywords: Networks, exploits, attacks, defense, forecasting

69) Completing Partial Latin Squares: Cropper's Problem
B.B.Bobga*, P.D.Johnson Jr.
Auburn University

The problem of completing a partial nxn latin square is a list coloring problem in which the graph is the Cartesian product of two n-cliques and the lists are determined in an obvious way by the filled-in cells. Hall's condition is a fairly well known necessary condition on a graph with a list assignment for the existence of a proper coloring. Matt Cropper some years ago asked whether Hall's condition is sufficient for the completion of a partial latin square. We show that the answer is "yes" when the filled-in cells form a subrectangle, or a subrectangle minus one cell. In the former case, Hall's condition implies Ryser's condition.

Key words and phrases: partial latin square, Hall's condition, Ryser's condition, list coloring

70) On Balance Index Sets of Chain Sum and Amalgamation of Generalized Theta Graphs
Harris Kwong*, State University of New York at Fredonia
Sin-Min Lee, San Jose State University

Let G be a graph with vertex set V and edge set E. A vertex labeling $f: V \to \{0, 1\}$ induces a partial edge labeling $f^*: E \to \{0, 1\}$ defined by $f^*(xy) = f(x)$ if and only if $f(x) = f(y)$. For $i = 0, 1$, let $v_f(i) = |\{v \in V: f(v) = i\}|$ and $e_f(i) = |\{e \in E: f^*(e) = i\}|$. We call f a friendly labeling if $|v_f(0) - v_f(1)| \leq 1$. The balance index set of G is defined as $BI(G) = \{|e_f(0) - e_f(1)| : f \text{ is friendly}\}$. In particular, G is said to be balanced if $BI(G) \subseteq \{0, 1\}$. In this paper, we study the balance index sets of generalized theta graphs, their chain sums and one-point unions.

Keywords: balance index set, generalized theta graphs, chain sum, amalgamation

71) Enumeration Of Nonnegative Integer Matrices
Kenneth Matheis*, Shanzhen Gao, Florida Atlantic University
Zhonghua Tan, Guangdong University of Technology

Let t(m, n, s, t) be the number of nonnegative integer matrices of size mxn with each row sum equal to s and each column sum equal to t (sm = nt). We present some rather involved closed formulas for t(m, n, s, t) and an algorithm.

72) Centrality based community discovery
Hemani Balakrishnan*. Narsingh Deo
University of Central Florida

It has been observed that real-world random networks like the WWW, Internet, social networks, citation networks, etc., organize themselves into closely-knit groups that are *locally dense* and *globally sparse*. These closely-knit groups are termed *communities*. Mining these communities facilitates better understanding of their evolution and topology, and is of great theoretical and commercial significance. Centrality of a node is a value that portrays how central a node is to a given graph. The centrality of a graph is defined as the mean of the centrality measures of all its nodes. In this paper we propose a method of utilizing existing centrality metrics to compute the importance of the edges in a given graph, which in turn is used to discover communities. We also compare several centrality metrics and their effectiveness in discovering communities.

Keywords: Community Discovery, Centrality, Graph Clustering

Tuesday, March 6, 2007, 3:40 PM

73) Projective Planes and Complete Sets of Orthogonal, Self-orthogonal Latin Squares

George P. Graham, Charles E. Roberts*
Indiana State University

We show how to produce algebraically a complete orthogonal set of Latin squares from a left quasifield and how to generate algebraically a maximal set of self-orthogonal Latin squares from a left nearfield. For a left Veblen-Wedderburn system, we establish the algebraic relationships between the standard projective plane construction of a complete set of Latin squares, our projective plane construction, and our algebraic nearfield generation. Via a projective plane construction, we establish the equivalence of a complete set of self-orthogonal Latin squares and a restricted ((0).I�)-Desarguesian plane.

Key words: Projective Planes, Self-orthogonal Latin Squares

74) On The Q(a)-Balance Edge-magic Graphs

Sin-Min Lee*, Thomas Wang
San Jose State University

For a � 1, we denote

$$Q(a) = \begin{cases} \{\pm a, \dots, \pm(a-1+q/2)\}, & \text{if } q \text{ is even,} \\ \{0, \pm a, \dots, \pm(a-1+(q-1)/2)\}, & \text{if } q \text{ is odd.} \end{cases}$$

A (p, q)-graph G in which the edges are labeled by Q(a) so that the vertex sums mod p is a constant, is called Q(a) balance edge-magic. In this paper, we investigate some Q(a) balance edge-magic graphs. Several conjectures are proposed in this paper.

Keywords: multigraph, edge-magic, Q(a)-super edge-magic

75) Some (0,1)-Matrices Enumerative Problems

Shanzhen Gao*, Florida Atlantic University
Zhonghua Tan, Guangdong University of Technology, China

Let f(m, n, s, t) be the number of (0, 1) - matrices of size mxn such that each row has exactly s ones and each column has exactly t ones (sm = nt). The determination of f(m, n, s, t) is an unsolved problem, except for very smalls, t. Let f.(n) be the number of (0, 1) - matrices of size nxn such that each row has exactly s 1's and each column has exactly s **1**'s and with the restriction that no **1** stands on the main diagonal. We present some formulas for f(m, n, s, t) and f.(n).

76) Efficaciously Dismantling Terrorist Networks Subject To Budget Constraints Using Evolutionary Methods

Michael L. Gargano, Henry Wong*
Pace University

How can we efficaciously apportion a counter terrorist budget designed to effectively dismantle a terrorist network? Given a budget, it can be apportioned so that a certain amount is spent on trying to eliminate (or make ineffective) each node in the cell. By "taking out" apposite nodes (i.e., terrorists) in a terrorist cell, the cell can become effectively useless. One such method for example is if enough nodes are eliminated so that the maximal nodes (leaders) are disconnected from minimal nodes (operators). The desired effect may then be produced. This research proposes using evolutionary techniques (e.g., genetic algorithms, swarm intelligence, and similar hybrids) to apportion such a counter terrorist budget efficiently.

Tuesday, March 6, 2007, 4:00 PM

77) Steinert-wise balanced designs for two-stage disjunctive testing

Vladimir D. Tonchev, Michigan Technological University

The subject of this talk are some constructions of Steinert-wise balanced designs with blocks of two different sizes. The study of such designs is motivated by a combinatorial lower bound on the minimum number of individual tests at the second stage of a 2-stage disjunctive testing algorithm.

78) On the Super Edge-graceful Spiders of even orders

Ping-Tsai Chung·, Long Island University
Sin-Min Lee, San Jose State University

A (p,q)-graph G is said to be edge graceful if the edges can be labeled by 1,2, ... , q so that the vertex sums are distinct, mod p. It is shown that if a tree T is edge-graceful then its order must be odd. Lee conjectured that all trees of odd orders are edge-graceful. J. Mitchem and A. Simoson introduced the concept of super edge-graceful graphs which is a stronger concept than edge-graceful for some classes of graphs. A graph G=(V,E) of order p and size q is said to be super edge-graceful if there exists a bijection

f: E-+{O, +1,-1,+2,-2, ... ,(q-1)/2, -(q-1)/2} ifq is odd

f: E-+{ +1,-1,+2,-2, ... ,q/2, -q/2} ifq is even

such that the induced vertex labeling f" , defined by f"(u)= rf(u,v), where (u,v) E E, has the property:

f": V-+{0,+1,-1, ... ,+(p-1)/2,-(p-1)/2} ifp is odd

f": V-+{+1,-1, ... ,+p/2,-p/2} if pis even

is a bijection. The conjecture is still unsettled. In this paper we exhibit spiders of even orders which are super edge-graceful.

Key words: edge-graceful, super edge-gracful, tree, spider, tree reduction, irreducible

79) The Combinatorics of M' = 3M3T

Chunmei Liu*, Louis Shapiro, Howard University

The central binomial coefficients have the generating function (GF) B = L(n}" = (1-4z)·¹¹2 and it is easily shown that B'= 28³· The ternary analog is the GF M = I(!n and the situation is more interesting. The analogous identity is M'= 2M³T where T = I $\frac{1}{2n+\mathrm{I}}$ (³n}" We give a combinatorial proof by interpreting M,T, and M' in terms of even trees which are ordered trees where the outdegree of every vertex is even.

Keywords: Even tree, Ternary number, Catalan number

80) The Convex Partition Number of a Graph

Danilo Artigas, Mitre C. Dourado, Fabio Protti, Jayme L. Szwarcfiter*
Universidade Federal do Rio de Janeiro

Let G be an undirected graph and S a subset of its vertices. Say that S is convex if the set of all vertices lying in any shortest path between any two vertices of S coincides with S. The graph G is called k-convex when its vertex set can be partitioned into k 2 2 non-empty convex subsets. The convex partition number of G is the least k 2 2 for which G is k-convex. In this paper, we present some properties of k-convex graphs and describe a characterization for a cograph to have convex partition number k. In addition, we survey some of the complexity results related to convexity of graphs. Among these, we mention determining the geodetic number, hull number and convexity number of a graph, both for the general case and special classes of graphs.

Key Words: cographs, convex number, convex partitions. convexity, geodetic number, hull number

81) A generalization of the Evans Conjecture

Jaromy Kuhl, University of West Florida

The Evans conjecture states that an n x n partial Latin square with at most n-1 entries is completable. We show that the condition of at most n-1 entries appearing is sufficient for completing nxn partial r-multi Latin squares. An n x n r-multi Latin square is an n x n array of nr symbols so that each cell contains r symbols and each symbol appears exactly once in each row and column. In addition, we prove a case of a conjecture of Haggkvist on completing nr x nr partial Latin squares with at most n - 1 distinct r x r squares filled.

82) Graceful Path-Like Trees

Christian Barrientos, Clayton State University

A graph G of order m and size n is called graceful if it is possible to label the vertices of G with distinct non-negative integers in such a way that the induced edge labeling, which prescribes the integer |i-j| to the edge joining the vertices labeled i and j, assigns the labels 1, 2, ... ,n to the n edges of G. After 40 years of research in this area, many graph families are known to be graceful; however, the open question still exists as to whether all trees are graceful. We construct a new family of graceful trees, namely, path-like trees using the graceful labeling of the path P_n. Path-like trees are obtained from a set of elementary transformations on an embedding of a path in the 2-dimensional grid. We prove that all path-like trees are graceful and study which types of trees are not path-like trees.

Key Words: Graceful graph, path-like tree

83) A Finite Operator Approach to the Tennis Ball Problem

Joshua Fallon•. Shanzhen Gao
Florida Atlantic University

For integers n, r, s, with 0 < s < r, the tennis ball problem can be stated as follows: From a set of nr balls, each labeled distinctly 1, 2, . . . , m, place balls 1, 2, . . . , r into a bin, then remove s of the balls from the bin. Then add the next r balls in sequence and remove s balls. This process is repeated n times. We desire the number of distinct sets of labels on the balls that have been removed after n iterations. This problem can be represented as a lattice path with north and east steps from (0,0) to (n (r - s),ns), bounded below by the walk $(E'\text{-}sN^5)''$. We present solutions for the case (r, s) = (4, 2) and (r, s) = (6, 3) using the Finite Operator Calculus, and offer a conjecture on the appearance of certain Cataan numbers in these paths.

Keywords: Tennis Ball, Catalan, Lattice Path, Finite Operator Calculus

84) New Graphs From Star Graphs

Joshua Abbott, Phyllis Z. Chinn, Tyler Evans, A. J. Stewart•
Humboldt State University

Given a Star Graph one can derive a new graph by applying a single rule from a particular set of 2-d Cellular Automaton rules on the adjacency matrix of the Star Graph. An example of one of these rules is the 9-term binary addition rule. This talk will present the features of this rule as well as some preliminary results regarding the properties of the derived graphs and the periodicity of the process when it is iterated.

Key Words: Cellular Automata, Star Graph

85) On m-simple designs
H.-D.O.F. Gronau, University, Inst. of Math., 18051 Restock, Germany

A $2-(v, k, \lambda)$-design is called m-simple ($2 \le m \le k$), if any two blocks have at most m elements in common. Obviously, every design is k-simple and every simple design is (k-1)-simple. The other extreme are 2-simple designs, known as super-simple designs, which were studied in recent years. New m-simple designs appear for m with $3 \le m \le k-2$. Necessary conditions for the existence are the usual arithmetic conditions for $2-(v, k, \lambda)$-design. The existence of such designs requires that the v is large enough. It is known by S.Hartmann that the necessary conditions are sufficient for the existence of super-simple designs for sufficiently large v. But there is a range of v's, where simple designs do exist, whereas super-simple designs do not. Here appears the question, if there are m-simple designs for some m with $3 \le m \le k-2$. First results will be presented in the talk.

Key words: designs, simple designs, super-simple designs

86) Properties of Graceful Labelings of Cycles
Jay Bagga*, Adrian Heinz, Mahbubul Majumder
Ball State University

In 1967, Rosa showed that a cycle C_n has a graceful labeling if and only if $n \equiv 0 \pmod 4$ or $n \equiv 3 \pmod 4$. A graceful labeling of C_n has n distinct labels from the set $I_n = \{0, 1, 2, \ldots, n\}$, so exactly one element of I_n is missing from the labeling. In this paper we investigate several properties of graceful labelings of such cycles. In particular, we obtain results about the distribution of the elements of I_n as labels on the cycle, and show that the missing element must lie between $\lceil \frac{n}{4} \rceil$ and $\lceil \frac{3n}{4} \rceil$.

Keywords: Graceful labeling, Cycle

87) Euler coefficients and Dyck paths with a limited sequence of down steps
Heinrich Niederhausen, Shaun Sullivan*
Florida Atlantic University

In 1778, Euler considered the coefficients of the polynomial

$(1 + x + x^2 + \cdots + x^{r})^n$. We define $\binom{n}{i}_r$ as the coefficient of x^i in

$(1 + x + x^2 + \cdots + x^{r-1})^n$. We explore the properties of these Euler coefficients, their computation, and how they can be used to enumerate Dyck paths avoiding a consecutive sequence of r or more down steps.

Keywords: Euler coefficients, Dyck paths, pattern avoidance

88) An Extension of the Disjoint Paths Problem
Yusuke Kobayashi

Given a graph G and a collection of vertex pairs $\{(s_1, t_1), \ldots, (s_k, t_k)\}$, the disjoint paths problem is to find k vertex-disjoint paths from s_i to t_i. This problem is one of the classic problems in algorithmic graph theory and has many applications, for example in VLSI-design. As an extension of the disjoint paths problem, we introduce a new problem which we call the stable paths problem. In this problem we are given a graph G and a collection of vertex pairs $\{(s_1, t_1), \ldots, (s_k, t_k)\}$. The objective is to find k paths $P_1, \ldots, P_k$ such that P_i is a path from s_i to t_i and P_i and P_j have neither common vertices nor adjacent vertices for any distinct i, j. The stable paths problem has several variants, for example, k is a fixed constant or a part of the input, the graph is directed or undirected, and the graph is planar or not. We investigate the computational complexity of several variants of the stable paths problem. We show that the stable paths problem (i) is solvable in polynomial time when k is fixed and G is a directed (or undirected) planar graph, (ii) is NP-hard when k = 2 and G is a directed (or undirected) general graph, (iii) is NP-hard when k = 2 and G is an acyclic directed graph.

89) t-Wise Balanced Steiner Systems
Reinhard Laue, University of Bayreuth

Steiner 3-wise balanced designs are constructed for parameters
$3\text{-}(3^n - 1, \{4, 8\}, 1)$, $3\text{-}(q^{nm} - q^m, \{q - 1, q, q + 1\}, 1)$,
$3\text{-}(q^{nm} - 2q^m - 1, \{q^m - 3, q^m - 2, q^m - 1, q^m, q^m + 1\}, 1)$,
$3\text{-}(q^{nm} - 2q^m, \{q^m - 3, q^m - 2, q^m - 1, q^m, q^m + 1\}, 1)$,
$3\text{-}(q^{nm} - 2q^m + 1, \{q^m - 3, q^m - 2, q^m - 1, q^m, q^m + 1\}, 1)$,
where q is a prime power and $n \geq 2$, $m \geq 1$ are integers. Further designs are obtained from these.

Keywords: t-wise balanced designs, Steiner systems, automorphism groups
MR Subject Classification: 05805, 20825, 05E20

90) Labellings for the complete bipartite graph and Disk Array
Tomoko Adachi, Toho University, Japan

The desire to speed up secondary storage systems has lead to the development of redundant arrays of independent disks (RAID) which incorporate redundacy utilizing erasure code. To minimaze the access cost in RAID, Cohen, Colboum and Froncek (2001) introduced (d, f)-cluttered orderings of various set system for positive integers d, f. In case of a graph this amounts to an ordering of the edge set such that the number of points contained in any d consecutive edges is bounded by the number f. For the complete graph, Cohen et al. gave some cyclic constructions of cluttered orderings based on wrapped p-labellings. MOiier, Adachi and Jimbo (2005) investigated cluttered orderings for the complete bipartite graph. RAID utilizing two-dimentional parity code can be modeled by the complete bipartite graph. MOiier et al. adapted the concept of wrapped t.-labellings to the bipartite case instead of wrapped p-labellings, and gave the explicite construction of several infinite families of wrapped t.-labellings. Here, we investigate more general cases of the complete bipartite graph. In this talk, we will give some constructions of wrapped t.-labellings for such cases.

91) Euler coefficients and Dyck paths with a limited sequence of down steps
Heinrich Niederhausen, Shaun Sullivan*
Florida Atlantic University

In 1778, Euler considered the coefficients of the polynomial

$(1 + x + x^2 + \cdots + [illegible])^n$. We define (; I as the coefficient of x^k in

$(1 + x + x^2 + \cdots + x^{r-1})^n$. We explore the properties of these Euler coefficients, their computation, and how they can be used to enumerate Dyck paths avoiding a consecutive sequence of r or more down steps.

Keywords: Euler coefficients, Dyck paths, pattern avoidance

92) Variations on Conway's ***Game of Ufe***
Josh Abbott*, Phyllis Chinn, Tyler Evans, Allen Stewart
Humboldt State University

We define a cellular automaton (CA) as a discrete dynamical system consisting of a lattice of cells, where each cell assumes values from some finite alphabet, and a local update rule that determines the value of each cell at the next time step. A simple graph's adjacency matrix can be viewed as a lattice of cells with an alphabet of {0, 1}. We will show that certain CA update rules acting on this adjacency matrix yield other simple graphs. Conway's *Game of Life* is one example of a CA that preserves a graph structure but does not maintain graph isomorphism. We create a general class of "life-like" update rules that do retain graph isomorphism and demonstrate the evolution of graphs within this class of rules.

Key words: cellular automata, Game of Life, isomorphism

97) The chromatic number of $K_2(9, 4)$

David Leach*, Abdallah Khodkar
University of West Georgia

In 2004, Kim and Nakprasit showed that the chromatic number of K2(9, 4) is at least 11. In this talk we outline a computational method for coloring $K_2(9, 4)$ and go on to present an 11-coloring, proving that the chromatic number of $K_2(9, 4)$ is 11.

key words: Kneser graph, chromatic number, square, computer search

98) Hamilton decompositions **with** primitive complements

Sibel Ozkan•, Chris A. Rodger, Auburn University, AL

Hamilton cycle in a graph G is a cycle that passes through all the vertices of G. Also, a Hamilton decomposition of a graph G is a partition of its edges into edge-disjoint Hamilton cycles. And a d-regular graph is called primitive if it does not contain any proper factors with degree d', for $d' < d$. Hamilton decompositions of graphs into Hamilton cycles with no Hamilton cycles in the complement, and into 2-factors with no 2-factors in the complement have been done in previous studies by D.G. Hoffman, C.A. Rodger, and A. Rosa. In this study, by using amalgamation technique, we find necessary and sufficient conditions for the existence of Hamilton decompositions of graphs where the complement is primitive. We also give necessary conditions for the existence of Hamilton decompositions of graphs with primitive complements in complete multipartite graphs.

Keywords: Hamilton cycles, graph decompositions, amalgamation, edge-coloring, vertex-coloring, maximal sets

99) The hyper-Wiener index of trees with a given maximum degree

Russell Kirk*, Hua Wang
University of Florida

The Wiener Index ('W") and hyper-Wiener ('WW") index are two graph theoretical indices used in biochemistry. Both the mathematical and scientific community has analyzed the correlation between W and WW. It is well known that W is maximized by the path and minimized by the star among general trees of the same number of vertices. The problem of minimizing W for trees with a given maximum degree was previously studied and solved. We study and characterize the extremal trees of WW for general trees and trees with a given maximum degree.

Keywords: hyper-Wiener index, trees, Wiener index, maximal degree

100) Revisiting the mastermind game

Andrew C. Lee, U. of Louisiana at Lafayette

Informally, the mastermind game is a secret guessing game between two players A and B. Player A selects n colored pegs (n=4 or 5 in practice) as the secret code. Player B attempts to solve the secret by posting as few guesses as possible. For each guess, B will receive feedbacks from A on how many colors are correct and how many colors are also in the correct position. Using these information adaptively, B can eventually determine A's secret code. The same game can be played by exchanging the roles of A and B. The winner is the player who solve his opponent's secrets with fewer guesses. The strategies for playing mastermind resemble a basic paradigm in machine learning, namely, to learn a target concept via queries. In this talk we will consider variants of the mastermind game. The connections between the game strategies and the strategies used in query learning will be discussed.

Keywords: Theory of Computing, Leaming, Queries, Computer Game Design

101) Chromatic Polynomial of linear r-uniform unicyclic hypergraph

Julian A. Allagan*, Chris Rodger
Auburn University

In this talk, we extend the notion of chromatic polynomials to hypergraphs. In particular, the chromatic polynomial of unicyclic, linear, connected hypergraphs **will be** discussed.

Key words: hypergraph, chromatic polynomial, unicyclic hypergraph

102) A measure of Hamiltonicity

Garth Isaak, Lehigh University

A Hamiltonian path can be viewed as a labeling of the vertices of a graph with distinct consecutive integers so that labels of nonadjacent vertices differ by at least 2. Ifwe drop 'distinct' from this to allow repeated labels (and still require consecutive integers {1, 2, ... ,t} with every value used by some vertex) the smallest such t can be thought of as a measure of Hamiltonicity. Since vertices in an independent set all receive labels differing by at least 2 the value *oft* is at least 2a -1 where a is the maximum size of an independent set. (The chromatic number of the compliment can replace a for a better bound.) The minimum value is $2a$ for P_4 and C_4, the path and cycle on 4 vertices. We give a simple inductive proof that the bound 2a - 1 is tight for graphs which are P_4 and C_4 free (arborescent comparability graphs). We will also discuss this parameter more generally.

103) Heisenberg Graphs of Order 6 or more over the Ring of Integers

Michelle DeDeo
Univerisity of North Florida

The aim of this talk is to study graphs in an effort to find models that represent optimal communication networks. The most direct method in doing so is to find Ramanujan graphs. Ramanujan graphs provide the best family of explicitly known expander graphs. These graphs are regular graphs with a small number of edges where every subset of vertices has many distinct neighbors. As it is often difficult to determine which mathematical group is involved with an application, we choose a group and attempt to determine, using different conditions, whether the families of graphs defined by those conditions satisfy the requirements for Ramanujancy. Even if the graphs tum out not to be Ramanujan under those certain conditions, there are other mathematical attributes such as the distribution of the spectra of the graph which are of great interest. Here we choose the finite Heisenberg group over the ring of integers modulo a prime. The Heisenberg group is ideal in that it is considered the simplest non-abelian group. The finite analogue of the group over the real numbers relates to the uncertainty principal in quantum mechanics. This finite case has applications in probability and random number generation stated by Zack. Although, Heisenberg graphs of order four have been studied extensively by Terras et al. and DeDeo, this research expands this research to graphs of order six or more. We also examine the spectra of these graphs and investigate whether the spectrum of the Heisenberg graphs approaches the Wigner Sato-Tate distribution as the graphs increasingly expands.

Keywords: Heisenberg graph, Ramanujan graph, spectra

104) Subtraction games {a,b,c}

Matthieu Dufour*, Universite du Quebec a Montreal
Jean Turgeon, Universite de Montreal

We consider games defined by subtraction sets of the form {a, b, c}, i.e., a game where two players have a stack of chips in common and take in turn either a, b, or c chips, where a < b < c. The winner is the one who takes the last chip. The case for a general set {a, b, c} is still open, but we have solutions for some specific values of a. We will see that even for a simple subtraction set such as {1,b,c}, the description of the kernel (set of loosing positions) of the game can become quite complex. We will give a technique to obtain a rigourous proof without going crazy trying to verify the hundreds of sub cases the very complex patterns of losing positions generate.

105) An Introduction to general R- chromatic Problems

Anne Sinko•, Peter J. Slater
University of Alabama in Huntsville

Various coloring parameters for a graph G involve a collection $R = \{R_1, R_2, \ldots, R_t\}$ of subsets of the vertex set $V(G)$ such as $R = E(G)$. This paper introduces colored problems involving a chromatic parameter. We let R be any a subset of the power set of the vertex set of a graph G, $R = \{R_1, R_2, \ldots, R_t\}$. where each R_i is considered to be a region. For example, R can be the collection of edges. Then the R - chromatic number $\chi_R(G)$ is defined to be the minimum number k of sets $C_1, C_2, \ldots, C_k$ that partition $V(G)$ such that, for each R_i, no C_j contains R_i. In particular. we consider the case where R is the collection of all open neighborhoods and consider $\chi_{(2)}(G)$. where $\chi_{(2)}(G)$ is defined to be the minimum number k of sets $C_1, C_2, \ldots, C_k$ that partition $V(G)$ such that no C_i contains any open neighborhood $N(v)$.

Keywords: open neighborhood. open enclaveless, chromatic number

106) Hamilton Decompositions of Multi-Partite Graphs with Specified Leaves

L. McCauley•. C. Rodger, Auburn University

Given two 2-factorizations, G and H, and a multi-partite graph, K(m,p), we will decompose K(m,p) into Hamiltonian cycles and two two-factors isomorphic to G and H. Some cases (mainly graphs of odd order) were presented at last year's conference, the remaining cases will be discussed.

Keywords: hamitlon cycles, 2-factorizations, decompositions, multi-partite

107) Restoration of information in a distributed database

Sergei L. Bezrukov•, Victor P. Piotrowski
Uwe Leck University of Wisconsin - Superior

Consider a database consisting of several storage centers located in the vertices of an n-dimensional $k \times \cdots \times k$ grid. We assume some duplication of information in the database so that every line of the grid is a codeword of some n-dimensional iterative code, which is capable to correct up to t errors. The health state of the database is represented by a configuration of its faulty nodes. If there is a request for an information located in a faulty node, we should attempt to restore it by applying a decoding via some appropriate lines of the grid. This way the nodes of that line will be removed from the set of faulty nodes. The problem is to find a scheme of decoding steps for restoring a given faulty node by using a minimum number of 1-dim decodings. We consider the complexity aspects of the problem and construct configurations of faulty nodes that require maximum number of decoding steps among all restorable configurations of a given size. **We** also consider a version of this problem consisting of restoring all faulty nodes. Our lower and upper bounds for the complexity match in the most practical cases n = 2 and n = 3.

Keywords: n-dimensional grid, iterative code, fault-tolerance

108) Leaming in Games

Thomas Behme•, Jens Schreyer
Technische Universitat Ilmenau, Germany

We consider games played by a finite number of players. For each player there is a finite set of strategies and a payoff function with values 1 (win) and O (loss). We suppose that no player has any information on the other players (not even that there are other players). A subset Q of players is called potentially successful if there is a collection $T = \{s_q \mid q \in Q\}$ of strategies (one for each player in Q) such that each player in Q will win every game whenever all players in Q apply their strategies from T. Consider a sequence of plays and assume that there is a potentially successful subset. It is proved that there are randomized leaming algorithms with the property that if all players apply such an algorithm, then almost surely the players in some potentially successful subset will leam to win. The presented results are partial joint work with Francois Laviolette (Universite Laval (Quebec), Canada) and Frank Goring (TU Chemnitz, Germany).

Keywords: game theory. Markovian chains, reinforcement learning

109) On coupled and proper-coupled-domination

Suk Jai Seo, Middle Tennessee State University
Peter J. Slater*, University of Alabama in Huntsville

Given a partition S = {S_1, S_2, . . . , S_l} of the vertex set V(G) of a graph G, S is called a coloring of G and set S_i is the color class *i*. An S-dominating set D is a dominating set with the property that either D∩ S_i = q or D∩ S_i = S_i for each i with 1 :; i:,; *t*. The S-domination number y(G;S) is the minimum cardinality of an S-dominating set. We let $Y_{PRT(k)}$(G) be the maximum value of y(G;S) over all colorings S with each ISA :; *k*. Coloring S is called N-proper if each S_i is enclaveless, and $y^*_{PRT(k)}$(G) is the maximum value of y(G;S) over all N-proper colorings with each IS,i:,; ***k***. In this paper we consider the coupled and proper-coupled-domination numbers rc,,I,_G) = $Y_{PRT(2)}$(G) and y*,,pi(G) = $y^*_{PRT(2)}$(G).

Keywords: Domination, N-proper coloring, Enclaveless, Coupled domination, Proper-coupled-domination

110) Decomposition of a complete graph into paths with no subsystems

Chandra Dinavahi*, Chris Rodger
Auburn University

For any two graphs G and H, a G-decomposition of H is an ordered pair T= (V, D) where V=V (H) and D is a partition of E (H), each element of which induces a copy of G. A subsystem of G is an ordered pair S= (V', D') where V' is a subset of V and D' is subset of D and (V', D') is a G-decomposition of Kv. There are several results in the literature that consider the problem of finding a G-decomposition of H that contains no subsystem. In this paper we solve the problem when G= P_m(a simple path with m edges) and H=K_v. In this talk I am going to give a flavor of the proof when the path is of odd length.

111) Block Minimization Problem

Ziya Arnavut, SUNY Fredonia

Lossless compression of images is one of the most challenging tasks in the field of data compression. Joint Photographic Experts Group (JPEG) has developed several standards compression techniques for images. Most recently, JPEG LS has been introduced for lossess compression techniques. In this work, we treat the images as two dimensional arrays and explore row and column (r,c) permutations such that if r and c are applied to an image P, the resulting image P' has the minimum JPEG complexity. Experimental results show that there may be some improvements in compression of lossless images.

Keywords: Image compression, Lossless, Applications of Permutations.

112) A Bishop's Tale: A combinatorial Proof of $F^2_n = 2(F^2_{n-1} + F^2_{n-2}) - F^2_{n-3}$

Gary E. Stevens, Hartwick College, Oneonta, NY

Counting the number of **ways** that non-attacking bishops can be placed on a 2 x n chessboard can be done an easy way and a hard **way.** Doing both provides a combinatorial proof of the identity $F^2_n = 2(F^2_{n-1} + F^2_{n-2}) - F^2_{n-3}$, for n 3. where F_n is the n^{th} Fibonacci number.

Keywords: Fibonacci numbers, king, bishop, chessboard

113) University Timetabling via Graph Coloring: An Alternative Approach

Timothy A. Redl, University of Houston-Downtown

The problem of timetabling courses (or final exams) at a university can be modeled and solved using graph coloring techniques. Traditional timetabling via graph coloring models involve graphs in which a vertex represents a course (or final exam) to be scheduled, an edge represents a pair of courses (or final exams) that conflict (i.e., cannot be scheduled for the same time period), and the color of a vertex represents the time period to which that course (or final exam) is to be scheduled. We present an alternative graph coloring method for university timetabling that also incorporates room assignment. This method involves construction of a alternative type of course (or final exam) conflict graph. We discuss the construction of this alternative conflict graph and methods for coloring it, along with the means by which one can use such a coloring to produce a satisfactory course (or final exam) timetable.

Key Words: university timetabling, graph coloring

114) Tiling Paths with Primal Graphs

Phyllis Chinn*, Allen J. Stewart
Humboldt State University

In 1969 A. K. Dewdney introduced the notion of Primal Graphs, namely the unique collection of graphs such that every graph is primal or can be edge-decomposed into primal graphs using no more than one copy of any primal graph. While the collection of primal graphs is unique, the primal decompositions are not necessarily unique. In this talk we will present some preliminary results regarding the number of distinct ways to decompose paths of length n into primal graphs.

Key words: primal graphs, decompositions, tilings, paths

115) Good Distributions of Points with Large Convex Hulls of Point Sets

Hanno Lefmann
Fakultat fur Informatik, Chemnitz University of Technology

Heilbronn's triangle problem asks for a distribution of n points in the unit square [0, 1] such that the minimum area 6_J{n) of a triangle is as large as possible. The currently best known lower and upper bounds on 6_2(n) are due to Komlos, Pintz and Szemeredi and are of the order n (log n/n^2) and 0 (n-sn+c) for any fixed c > 0. Here we consider a generalization of this problem to point sets of small (or large) size, i.e., for fixed (or nonfixed) integers k 3 we investigate the largest value of the minimum area determined by the convex hull of any k points among n points in the unit square [0, 1]^2. Moreover, for fixed d we consider extensions of this problem in the d-dimensional unit cube [0, 1t The corresponding existence results can be made constructive, namely, in polynomial time one can construct such 'good' distributions of sets of n points.

116) Measuring Time Using Connected Hourglasses

Stefan Krause, TU Graz, Austria

We discuss how to measure time using a set of hourglasses mounted in a single frame. The glasses have running times $t_0, \ldots, t_n$ and can only be flipped simultaneously. We model the relevant states ofthe glasses as vertices of a digraph and by this means we get a characterization of the durations that can be measured. Additionally, we consider the time needed in advance to prepare the measuring, that is, to reach the state of the hourglasses where measuring begins. Especially we ask for the maximum preparation time. This is joint work with Jens-P. Bode and Alexander Kroller.

Wednesday, March 7, 2007, 4:00 PM

117) Outerplanar Edge Bipartitions of Planar Graphs

Brad Bailey*, John Holliday, Dianna Spence
North Georgia College & State University

We find an algorithm for partitioning a simple connected planar graph into two outerplanar subgraphs. This leads to the proof that any planar graph has an outerplanar edge bipartition. We also modify the algorithm to find another outerplanar edge bipartition more succintly.

keywords: planar, outerplanar, edge partitions, edge bipartition

118) Induced Trees in the Influence Digraph of a Time-Stamped Graph

Marc J. Lipman
Indiana University - Purdue University Fort Wayne

A time-stamped graph is an extension of the concept of a collaboration graph which accounts for the relative timing of collaborations. Edges, corresponding to specific acts of collaboration, are labeled with time-stamps. In a time-stamped graph H, vertex Q influences vertex R iff there is a non-decreasing path from Q to R in H. Given a time-stamped graph H, the associated influence digraph of H is the digraph on the vertex set of H with an arc from Q to R iff Q influences R in H. One question that can be asked: Given a graph G, what is the smallest time-stamped graph H so that G is an induced subgraph of the associated influence digraph of H? In this paper we verify the conjecture of Cheng, Grossman, and Lipman that for trees with n vertices H requires an additional n-2 vertices.

keywords: time-stamped graph, influence digraph, induced subgraph, tree

119) On a Network Traffic Sensing Problem

Xingde Jia, Texas State University

In order to maintain a dynamic and efficient flow of information in a network, one needs to monitor the traffic situation of the network. live traffic flow information can be obtained by deploying a set of sensors onto the network. The sensor locations in the network will affect greatly the efficiency and effectiveness of the sensing network. A major question is to determine the optimal sensor locations for a traffic network. We shall discuss the case where sensors are placed on the networks links, and also the case where the sensors are placed on the nodes in the network. A traffic network can be represented by a digraph, while the network links with sensors form an edge {or vertex) control set of the digraph. Several results have been proved on minimal edge (or vertex) control sets of digraphs. These results can be used to help the placement of sensor in a sensing network. I will also discuss some open problems at the end of the talk.

120) A Generating Theorem for 5-Regular Simple Planar Graphs I

Guoli Ding, Jinko Kanno*, Matthias Kriesell
Louisiana State University, Louisiana Tech University, University of Hamburg

Let 6_5 be the class of all 5-regular simple planar graphs. We will provide a partial solution to generate all graphs in 6_5. We shall discuss reducing graphs instead of constructing. We separate 6_5 into two subclasses, $6_5(T)$ and $\&_5(N)$, which are complement each other. A graph $G \in C_5$ belongs to $6_5(T)$ if and only if G contains an edge that is a part of three distinct triangles of G. Our main result is that every graph in $6_5(T)$ can be reduced to a smaller graph H in $6_5(N)$ by repeatedly applying one of Toida's operations, called Doperation, together with some K-transformations. Applying a D-operation to G is to delete two adjacent vertices {x, y} in G and to add new edges between vertices of degree less than five in G - {x, y} so that the new graph is still in 6_5. The K-transformations change only edges and will be applied if the new graph is still in 6_5. An alternating universal cycle in G is a universal circuit C that alternately contains edges from G and its complementary graph $\overline{G}$. To flip C means to delete its edges in G from G and to add its edges from $\overline{G}$ to G. Applying a K-transformation to G is to select an alternating universal cycle in G and to flip it. We use our general result that if a connected graph G' in C_5 is not 3-connected, then G' can be reduced to a smaller graph in 6_5 by a combination of 0-operations and K-transformations.

Key words: generating graphs, graph operations, 5-regular, planar graphs, simple graphs, universal circuit, alternating universal cycle

121) A note on the Laplacian index of graphs

Renata R. Del-Vecchio•, Cybele T. M. Vinagre, Universidade Federal Fluminense
Maria A. A. de Freitas, Universidade Federal do Rio de Janeiro

It is known that the greatest Laplacian eigenvalue of a graph, which is called here the Laplacian index of the graph, is bounded by the number of its vertices. In this paper we characterize Hamiltonian graphs for which the maximum of the laplacian index is attained. Necessary and sufficient conditions for this characterization are related with the maximum degree of the graph. We exhibit non-isomorphic Hamiltonian graphs with the same Laplacian index. We obtain some Laplacian integral graphs (graphs for which all the eigenvalues with respect to the Laplacian matrix are integers numbers) in this class and discuss when they are integrally completable- laplacian integral graphs G with the property that there is a sequence of Laplacian integral graphs $G_0, G_1, \ldots, G_t$ such that $G_0 = G$, $G_t = K$. and for each $i = 1, \ldots, t$, G_i is formed from G_{i-1} by adding an edge between a pair of non-adjacent vertices of G_{i-1}. Finally, we investigate the class of maximal outerplanar graphs, a special case of Hamiltonian graphs, and prove that, in this subclass, the Laplacian index attains its maximum value if and only if the maximum degree is equal to n-1. We establish also upper bounds to the Laplacian index when the maximum degree is at most n-2.

Key words: Laplacian index; Laplacian eigenvalue; Hamiltonian graph; maximal outerplanar graph

122) Complete Bipartite Graphs as Induced Subgraphs of a Influence Digraph of a Time-Stamped Graph

Drew J. Lipman• Oakland University
Marc J. Lipman, Indiana University- Purdue University

A Time-Stamped Graph is a graph with multiple edges but no loops, where each edge is labeled with a timestamp. A timestamp is used to represent the time of a collaboration between vertices joined by the edge. Given a time-stamped graph H, the associated influence digraph of H is the digraph of the vertex set of H with an arc from Q to R iff there is a path from Q to R in H with non-decreasing timestamps. We say that Q influences R. One question that can be asked is: Given a graph G, what is the smallest time-stamped graph H so that G is an induced subgraph of the associated influence digraph of H? In this paper we show that if H is such a graph for a $K_{m,m}$ $m \geq 2$, H has 4m vertices.

Kewords: collaboration graph, time-stamped graph, complete bipartite graph

123) On the Construction of Convergent Transfer Subgraphs in General Labeled Directed Graphs

Mohammed Ghriga, Christopher League•
Long Island University

Let L and L' be finite input and output alphabet sets, respectively. In a graph whose edges are labeled with input/output symbols, the transfer decision problem (Ghriga and Kabore, 1999) is to determine whether there are sequences over L x L' that guarantee transfer from a known vertex v to a destination vertex w. Convergent transfer subgraphs (CTS) are graphical representations of such sequences. This is an abstraction of the transfer of a communication protocol to a specific state for testing purposes. Li, Ghriga, and Kabore (2000) presented a polynomial time algorithm to solve the CTS problem for labeled directed acyclic graphs. This was reduced to a linear-time algorithm by Li (2003). However, there are no efficient algorithms for general directed graphs. In this paper, we present an algebraic framework for the incremental construction of convergent transfer subgraphs. We shall prove composition theorems that form the basis for the practical construction of convergent transfer subgraphs over general directed graphs.

Keywords: convergent transfer subgraphs, transfer sequences, labeled graphs, conformance testing

124) Partially Ordered Patterns And Compositions

Silvia Heubach•. California State University Los Angeles
Sergey Kitaev, Reykjavik University, Reykjavik, Iceland
Toufik Mansour, Haifa University, Haifa, Israel

A partially ordered (generalized) pattern (POP) is a generalized pattern some of whose letters are incomparable. In this paper, we study avoidance of POPs in compositions and generalize results for avoidance of POPs in permutations and words. Specifically, we obtain results for the generating functions for the number of compositions that avoid shuffle patterns and multi-patterns. In addition, we give the generating function for the distribution of the maximum number of non-overlapping occurrences of a segmented POP , among the compositions of n, provided we know the generating function for the number of compositions of n that avoid T .

Keywords: Compositions, partially ordered (generalized) patterns, non-overlapping occurrences, generating functions

125) Tutte Polynomials for Grids
Aaron Meyerowitz, Florida Atlantic University

We discuss computation of the Tutte polynomial T (X, Y) for the grid graphs $G_{m \times n}$, For fixed m there are various ways to specify a finite matrix M so that the Tutte polynomial of $G_{m \cdot n}$ is easily derived from M". This is not a new observation. For small m one can show how to cobble together linked recursions. In principle this can be done for any m and even for any recursively defined family with bounded tree width. What does seem new is that we give, for arbitrary m, a precisely described matrix M. The dimension is a Catalan number and M = AB where A and B are triangular matrices, one depending only on X and the other only on Y. The matrices are indexed by certain partitions and the i, j entry can be easily described. A and Bare very sparse and the nonzero entries factor nicely.

126) Center, Centroid and Characteristic Set of a Tree
K L Patra, IIT Kanpur, India

Let G be a simple connected graph and let L(G) be the Laplacian matrix of G. Let μ(G) be the second smallest eigenvalue of L(G). An eigenvector of L(G) corresponding to eigenvalue μ(G) is called a Fiedler vector of G. Let Y be a Fiedler vector of G. A characteristic vertex is a vertex u of G such that Y (u) = 0 and there is a vertex w adjacent to u satisfying Y (w) ≠ 0. A characteristic edge is an edge (u, v) such that Y (u)Y (v) < 0. The characteristic set C(G, Y) is the collection of all characteristic vertices and characteristic edges of G with respect to Y. The characteristic set of a tree consists of a single element which is either a vertex or an edge and it is the same for any Fiedler vector. Consider a tree $P_{n-g,g}$, n 2, 1 s g s n - 1 on n vertices which is obtained from a path on [1, 2, ... ,n-] vertices by adding g pendant vertices to the pendant vertex n - g. We prove that over all trees on n 5 vertices, the distance between center and characteristic set, centroid and characteristic set and center and centroid is maximized by trees of the form $P_{n-g,g}$, 2 s g s n - 3. For n 5, we also supply the precise location of the characteristic set of the tree $P_{n-g,g}$, 2 s g s n - 3.

Keywords: Tree, Laplacian matrix, Center, Centroid, Chracteristic Set

127) Random walks and self-organization in communication networks
Herwig Unger, FemUniversitat in Hagen Germany

We discuss algorithms based on random walks in graphs. It will be shown that such algorithms can be used to build robust tree-like structures on top of communication networks, e.g. the Internet. These structures can for example serve as decentralized content directories in distributed file sharing systems.

Keywords: random walks, communication networks, peer-to-peer computing

128) Interval k-graphs
David E. Brown, Utah State University

We will present results about interval k-graphs that lead to a conjecture about a concise forbidden induced subgraph characterization for interval k-orders. An interval k-graph is a graph whose vertices can be represented with intervals partitioned into color classes such that vertices are adjacent if and only if their corresponding intervals intersect and correspond to distinct interval classes. We characterize the interval k-graphs that are cocomparability graphs via a restriction placed on the intervals that represent the vertices, and exhibit a forbidden induced subgraph characterization for those graphs that are 3-chromatic interval k-graphs. Relationships between probe interval graphs, and tolerance graphs will be discussed, as will alternate representations for interval graphs that yield alternate representations for the aforementioned.

Keywords: Interval graph, Probe interval graph, tolerance graph, cocomparability graph

129) The Distinguishing Number of a Digraph

Michael Babcock, Larry J. Langley, Sarah K Merz*
The University of the Pacific

The distinguishing number of a graph is the fewest number of colors needed to color the vertices (not necessarily property) of the graph so that the only color preserving automorphism is the trivial one. In other words, it is the minimum number of colors needed to uniquely identify each vertex in the graph, assuming the vertices are unlabeled. Analogously, we can define the distinguishing number of a digraph. Albertson and Collins established the distinguishing number of graphs in several classes (e.g., cycles, paths, trees). We consider the distinguishing number of digraphs in several classes.

keywords: distinguishing number, coloring, digraph

130) Edge-Deleted Eccentricities of Graphs

Linda Eroh, John Koker, Hosien Moghadam, Steven J. Winters*
University of Wisconsin Oshkosh

A graph G is *2-edge-connected* if the removal of any edge of G never results in a disconnected graph. For a vertex v in a 2-edge-connected graph G, we define the *edge-deleted eccentricity* $g(v)$ of v as the maximum eccentricity of v in $G - e$ over all edges e of G. We will show that the edge-deleted eccentricity set for graphs may not be a set of consecutive integers and we will classify graphs that have large "gaps" in their edge-deleted eccentricity set.

131) An algorithm for generating all perfect sequences of a chordal graph

Yasuko Matsui, Tokai University, Japan

An undirected graph is chordal if it contains no chordless cycles of length greater than 3. A clique of a graph G is a subset of vertices that are completely connected. A clique tree for a graph $G = (V,E)$ is a tree $T = (V_T, E_T)$ where V_T is a set of cliques of G that contains all maximal cliques of G. In general, a chordal graph has many clique trees. Denote the maximal cliques in G by C_k, $k = 1, \dots, K$. Define $I = \{1, \dots, K\}$. For the permutation $\pi : I \to I$, define $H_{\pi(k)}$, $k = 1, \dots, K$, and $S_{\pi(k)}$, $k = 2, \dots, K$, by $H_{\pi(k)} = C_{\pi(1)} \cup \cdots \cup C_{\pi(k)}$, $S_{\pi(k)} = H_{\pi(k-1)} \cap C_{\pi(k)}$, respectively. The sequence of the maximal cliques $C_{\pi(1)}, C_{\pi(2)}, \dots, C_{\pi(K)}$ is a perfect sequence of the maximal cliques if every $S_{\pi(k)}$ is a clique and there exists $k' < k$ such that $S_{\pi(k)} \subset C_{\pi(k')}$ for all $k \geq 2$. There exists a perfect sequence of maximal cliques if and only if G is chordal, and we can construct all perfect sequences of the clique tree of a given chordal graph G. In this talk, we will show an algorithm for generating without repetitions all perfect sequences of all clique trees of a given chordal graph. Our algorithm based on the reverse search method is proposed by Avis and Fukuda.

Keywords: chordal graph, clique tree, perfect sequence, enumeration

132) Edge intersection graphs of single bend paths on a grid

Martin Charles Golumbic, Marina Lipshteyn[1], Michal Stem[1].
[1]Caesarea Rothschild Institute, University of Haifa
[2]The Academic College of Tel-Aviv - Yaffo

We combine the known notion of the edge intersection graphs of paths in a tree with a VLSI grid layout model to introduce the edge intersection graphs of paths on a grid. Let P be a collection of nontrivial simple paths on a grid G. We define the edge intersection graph $EPG(P)$ of P to have vertices which correspond to the members of P, such that two vertices are adjacent in $EPG(P)$ if the corresponding paths in P share an edge in G. An undirected graph G is called an edge intersection graph of paths on a grid (EPG) if $G = EPG(P)$ for some P and G, and $< P,G >$ is an EPG representation of G. We prove that any graph is an EPG graph. A turn of a path at a grid point is called a bend. We consider here only EPG representations in which every path has at most a single bend, called B_1-EPG representations and the corresponding graphs are called B_1-EPG graphs. We prove that any tree is a B_1-EPG graph. Moreover, we give a structural property that enables to generate non B_1-EPG graphs. Consequently, some of well-known graphs appear to be non B_1-EPG graphs. Furthermore, we characterize the representation of cliques and chordless 4-cycles in B_1-EPG graphs.

137) [r, s, t)-Chromatic Numbers of Graphs

Arnfried Kemnitz, Techn. Univ. Braunschweig, Germany

Given non-negative integers r, s, and t, an [r, s, t]-coloring of a graph G with vertex set V (G) and edge set E(G) is a mapping c from V (G) u E(G) to the color set {O, 1, . . . , k-1} such that jc(v;) - c(vi)| r for every two adjacent vertices v;, vi, lc(e;) - c(ei)l s for every two adjacent edges e;, ei. and lc(v;) - c(ei)| t for all pairs of incident vertices and edges, respectively. The [r, s, t]-chromatic number X,,u (G) of G is defined to be the minimum k such that G admits an [r, s, t]-coloring. This is an obvious generalization of all classical graph colorings since c is a vertex coloring if r = 1, s = t = 0, an edge coloring if s = 1, r = t = 0, and a total coloring if r = s = t = 1, respectively. We present general bounds for X,.s., (G) as well as exact values for certain parameters. Moreover, we completely determine the [r, s, t]-chromatic numbers for stars.

Keywords: Chromatic number, chromatic index, total chromatic number MSC: 05C15

138) Conflicting definitions of the energy of a molecular graph

Patrick Fowler*, James Brackett
University of Sheffield

Mathematicians and chemists use two different expressions for the total energy of the mobile electrons of an unsaturated molecule. The mathematical 'energy of a graph' is the sum of the absolute values of the adjacency matrix eigenvalues; the chemical energy of an n- electron TTsystem (n even) is twice the sum of the n/2 largest adjacency eigenvalues. The former has advantages in that it can be expressed in terms of an integral of the logarithmic derivative of the characteristic polynomial, leading to numerous theorems on the relationship between energy and graph structure. but it is the second definition that approximates the physical reality. Here we make a preliminary survey of some chemically significant graphs in the light of two questions: When do the two definitions of energy yield the same result? How large can the discrepancy between the two energies be?

Key Words: (chemical} graph, eigenvalues, graph energy, characteristic polynomial

139) Neighborhood Sums in Graphs

Andrew Schneider", Peter J. Slater
University Of Alabama in Huntsville

Arranging the numbers 1, 2, ... , 10 in a circle, using the pigeonhole principle one can show that some three consecutive numbers sum toa total of at least 17. We think of this as labeling the vertices of cycle C10. We consider the following general problem: given graph G of order n = IV(G)I • label the vertices in V(G) using 1, 2, ... , n so as to minimize the maximum sum of the values in any closed neighborhood.

Keywords: graph labeling; neighborhood sum

140)

141) Rainbow Connection in Graphs

Gary Chartrand, Ping Zhang, Western Michigan University
Garry L. Johns, Saginaw Valley State University
Kathleen A. McKeon*, Connecticut College

Let G be a nontrivial connected graph on which is defined a coloring $c : E(G) \quad \{1,2,\ldots,k\}$, $k \in N$ of the edges of G, where adjacent edges may be colored the same. A path *P* in G is a rainbow path if no two edges of *P* are colored the same. The graph G is rainbow-connected if G contains a rainbow *u-v* path for every two vertices *u* and *v* of G. The minimum *k* for which there exists such a *k-edge* coloring is the rainbow connection number rc{G) of G. If, for every pair *u*, *v* of distinct vertices, G contains a rainbow *u-v* geodesic, then G is strongly rainbow-connected. The minimum *k* for which there exists a *k-edge* coloring of G that results in a strongly rainbow-connected graph is the strong rainbow connection number src(G) of G. Both rc(G) and src(G) are determined for all complete multipartite graphs G as well as other classes of graphs. For every pair a, b of integers with $a \quad 3$ and $b \quad (5a - 6)/3$, it is shown that there exists a connected graph G such that rc(G) = *a* and src(G) = *b*.

Key words: edge coloring, rainbow coloring, strong rainbow coloring

142) Hyperdense Coding with Probabilistic Memory Cells

Vince Grolmusz, Eotvos University, Budapest

We define Probabilistic Memory Cells (PMC's), and show how to encode n bits into n PMC's, transform n PMC's to $n^{o(1)}$ PMC's (we call this form Hyperdense Coding), and we show how one can transform back these $n^{o(1)}$ PMC's to n PMC's, and from these we can get back the original bits, while from the hyperdense form we could have got back only $n^{o(1)}$ bits. We also show that nxn matrices can be converted to $n^{o(1)} x n^{o(1)}$ matrices and from these tiny matrices we can retrieve original ones, also with linear transformations, using PMC's.

Keywords: Computation modulo composite numbers, hyperdense coding, computational
models

143) Bipartite-Assembly

Edward J. Farrell, The University of the West Indies, St. Augustine, Trinidad
Michael L. Gargano*, Louis V. Quintas, Pace University

Let A and B be nonempty sets of positive integers. We study the problem of finding bipartite graphs G with bipartition sets X and Y such that every element in A is the degree of at least one vertex in X and every element of B is the degree of at least one vertex in Y. In addition to the question of existence the problem of determining the minimum order and size of graphs that are realizable for a given A and B is considered.

144)

145) Efficient and Robust Phone Trees

E. S. Elliott, S. H. Holliday*, B. C. Wagner
University of Tennessee at Martin

Various institutions use phone trees to pass on information. For example, school groups use phone trees to warn about impending snow days, and military units use phone trees to pass along orders. It is desired that a phone tree be constructed so that information can be passed accurately, completely and efficiently from the source to each of the recipients. We shall examine four families of graphs having tree-like structures. We consider some parameters to measure the integrity or robustness of each and the efficiency of each graph type.

146) An evolutionary approach to the min-sum vertex cover problem

Michael L. Gargano, Lorraine Lurie*
Pace University

Let G be a graph with the vertex set V (G), edge set E(G). A vertex labeling is a bijection f : V (G) - > {1, 2, . . . , lV (G)l}. The weight of e = uv in E(G) is given by g(e) = min{f(u), f(v)}. The min-sum vertex cover (msvc) is a vertex labeling that minimizes the vertex cover number i.e. the sum of the edge weights. The minimum such sum is called the msvc cost. In this paper, we propose an evolutionary approach to solving this problem.

147) The nonexistence of certain small Folkman graphs

Stanistaw P. Radziszowski*, Rochester Institute of Technology
Xu Xiaodong, Guangxi Academy of Sciences, China

We discuss a branch of Ramsey theory concerning edge Folkman numbers. $F_e(3, 3; 4)$ involves the smallest parameters for which the problem is open, posing the question "What is the smallest order **N** of a Ki-free graph, for which any 2-coloring of its edges must contain at least one monochromatic triangle?" This is equivalent to finding the order N of the smallest Ki-free graph which is not a union of two triangle-free graphs. It is known that 16 s **N** (an easy bound), and it is known through a probabilistic proof by Spencer that **N** s 3 x 10^9• In this work we prove that 19 s N.

Keywords: Folkman numbers, graph coloring

148)

165) On a Combinatorial Problem on the Star Graph

Ke Qiu, Brock University, Canada

We describe a combinatorial problem on the star graph, the problem of computing the number of vertices at distance i from the identity node in a star graph. A brief survey and comparison of current results are provided.

166) Contributions to Orthogonal Arrays of Strength Six

D.V. Chopra•, Wichita State University
R.M. Low, San Jose State University
R. Dios, New Jersey Institute of Technology

An orthogonal array (0-array) T with m rows (constraints), N columns (runs), two symbols (say, 0 and 1), and of strength t = 6 is an (m × N) matrix T with elements O and 1 such that in every (6 × N) submatrix T" of T (clearly, there

are (;)such matrices), every (6 × 1) vector of weight I (0 :Si S 6; the

weight of a vector is the number of 1s in it) appears with the same frequency μ. T is called a balanced array (B-array) if every vector of weight i appears μ times. Thus, a 8-array is a structure with less severe combinatorial constraints. In this paper, we discuss, using balanced arrays along with other combinatorial results, the existence of O-arrays with t = 6. This leads to an improvement in the results already available in the literature.

Key words: orthogonal arrays, balanced arrays, runs, strength of an array, constraints of an array

167) Ally and Adversary Reconstruction Numbers

K. J. Asciak, M. A. Francalanza, J. Lauri, University of Malta
Wendy MyrvoW, University of Victoria

The deck of a graph G is its multiset of vertex-deleted subgraphs G-v for all vertices v. A graph G is reconstructible from a subset S of its deck if every graph H whose deck contains S is isomorphic to G. One of the major unsolved problems in graph theory is to prove the Reconstruction Conjecture which states that all graphs on at least three vertices are reconstructible from the complete deck. The ally-reconstruction number of a graph is the cardinality of a smallest subset of the deck from which a graph is reconstructible. The adversary-reconstruction number is the cardinality of a maximum subset S of the deck from which a graph G is reconstructible with the additional property that G is not reconstructible from any subset of S. Harary and Plantholt initiated the study of reconstruction numbers of a graph. This talk surveys work which has been done on reconstruction numbers focussing on the questions which this work leaves open.

Keywords: Graph reconstruction, vertex-deleted subgraphs, isomorphism

168) On the Max3Sat Expected Optimum Value

A.R. de Lyra, C.A.J. Martinhon, L. Faria*
UFF, Niter6i, FFP-UERJ, Sao Gom;alo*, RJ Brasil

An optimization Maximum 3-Satisfiability (Max3Sat) instance I=(U,C), with IUI=n and ICI=m, consists of a satisfiability instance such that every clause c in C has exactly 3 literals. A known result establishes that a randomized value for the variables of U, satisfies an expected number of (7/8)m clauses. In this work we are concerned on finding the formula f(n,m)=E[Op $_{a}$x3Sat(I)) to the expected optimum value of I=(U,C), a randomized instance of Max3Sat on n variables and m clauses. WE call I_n=(U, C_n) the complete instance into n variables if C_n is maximum with respect to U, having the maximum number *B C * of clauses. We define the graph G,=(V,E) associated to the Max3Sat instance I=(U,C), if V=C, and there is an edge xycE if and only if there is no variable u such that literal ucx, and literal Gey. In this paper is shown that given a Max3Sat instance I=(U,C), holds that O p ¾x3Sat(I)=m+w(Gr) - C \ such that w(Gr) is the size of the maximum clique of the graph Gr and I'=(U, C_n \ C). Hence m - C \ S Op $_{ax3Sat}$(I) :Sm.

149) On Directed Triangles in Digraphs

Peter Hamburger*, Western Kentucky University
Penny Haxell, University of Waterloo
Alexandr Kostochka, University of Illinois, Urbana

Caccetta and Haggkvist conjectured that each n-vertex digraph with minimum outdegree at least d contains a directed cycle of length at mostrn *Id* l- The following important case of the conjecture is still open: Each n-vertex digraph with minimum outdegree at least n/3 contains a directed triangle. Using a recent result of Chudnovsky, Seymour, and Sullivan, we slightly improve two bounds related to the previous spacial case of the Caccetta-Haggkvist Conjecture.

Key words: Caccetta-Haggkvist conjecture, digraph, outdegree, directed cycle and triangle

150) The Inertia of Unicyclic Graphs

Sean Daugherty, University of Victoria, Canada

The inertia of a graph is an integer triple specifying the number of positive, negative, and zero eigenvalues of the adjacency matrix of the graph. A unicyclic graph is a simple connected graph with an equal number of vertices and edges. This paper characterizes the inertia of a unicyclic graph in terms of the size of a maximum matching. Chemists are interested in whether an unsaturated hydrocarbon's molecular graph is closed shell, having exactly half of its eigenvalues positive, because this designates a closed-shell electron configuration. The inertia can be used to determine if a graph is closed shell, which provides a simple linear-time algorithm in the case of unicyclic graphs.

Keywords: unicyclic graphs, inertia, eigenvalues, spectrum, nullity, maximum matchings, closed
shell

151) Some results on Balanced Graphs

Joy Morris*, Pablo Spiga, Kerri Webb
University of Lethbridge

A balanced graph is a bipartite graph in which no induced cycle has length 2 (mod 4). These graphs arise in certain linear programming applications. This talk will discuss several recent results on balanced graphs, focusing on the result that there is no planar cubic balanced graph. A number of conjectures about balanced graphs will also be presented.

Key words: balanced graphs, planar graphs, bipartite graphs, cubic graphs

152)

Thursday, March 8, 2007, 11:10 AM

153) Covering Graphs with Cliques and Independent Sets

Tinaz Ekim, Ecole Polytechnique Federale de Lausanne
John Gimbel*, University of Alaska

An (a,b)-coloring of a graph G is a decomposition of V(G) with a+b parts where a parts induce empty graphs and b parts induce cliques. Let c(a,b) be the largest integer n with the property that every graph of order n has an (a,b)-coloring. We show c(3,3)=15. Further, asymptotic bounds on c(n,n) are discussed as well as c(k,n) where k is fixed and n is unbounded.

Key Words: Covering, coloring, extremal, Ramsey

154) A formula for the number of spanning trees for certain non-threshold split graphs

J. Michewicz, J.T. Saccoman*
Seton Hall University, South Orange, NJ

A graph G is a split graph if its node set can be partitioned into a clique and an independent set. Threshold graphs are split graphs with the added property that for all pairs of nodes u and v in G, $N(u) - \{v\}$ $N(v) - \{u\}$ whenever $deg(u) \leq deg(v)$. While there is a formula for the number of spanning trees of threshold graphs, none exist for non-threshold split graphs. We present a formula for the eigenvalues of a certain type of split graph which we call Ideal Proper Split (IPS) graphs. IPS graphs have c nodes of equal degree in the independent set and a clique on n-c nodes in which each node is adjacent to exactly one member of the independent set. After finding the eigenvalues for the Laplacian matrix for such graphs, a corollary to Kirchhoff's well-known Matrix-Tree Theorem leads to the number of spanning trees for these graphs. The eigenvalue formula for IPS graphs is shown to yield a formula for the number of spanning trees for a related split graph as well.

Keywords: split graphs, threshold graphs, spanning trees, Laplacian matrix

155) Perimeter of undirected graphs and their preservers.

LeRoy B. Beasley, Utah State University

A clique on n vertices is a graph whose non isolated vertices form a complete graph. A clique covering of a graph, G, is a union of cliques that equals G. The clique covering number of a graph is the fewest number of cliques whose union is the graph. The perimeter of a clique is the degree of any non isolated vertex. The perimeter of a clique covering of G is the sum of the perimeters of its constituent cliques. The perimeter of a graph is the minimum of the perimeters of the possible clique coverings of G. In this article we investigate the bounds on the perimeter of graphs with fixed number of edges and the structure of "linear" maps that preserve the perimeter.

Key words and phrases : Linear operator, perimeter, (P'. P)-operator

156)

157 Bounds for Component Order Edge Connectivity

Daniel Gross*, Seton Hall University
Frank Boesch, L William Kazmierczak, Charles Suffel, Antonius Suhartomo, Stevens Institute Of Technology

The component order edge connectivity parameter, A. k) , is defined as the minimum number of edges that must be deleted from a graph so that all components of the resulting subgraph have order less than k, where k is a predetermined threshold value. Formulas for J*> have been derived for paths, cycles, stars, and complete graphs; but no formula has been found for an arbitrary graph G. In this work we look at several bounds that can be applied to find the range of possible values for any graph. We then derive from these bounds formulas for {*> of the fan and the wheel.

158) Percolation Threshold Approximations Based on the Second Moment of the Degree Distribution

John C. Wierman*, Jonathan Smalletz, Cindy Lui
Johns Hopkins University

Percolation models are infinite random graph models for phase transitions and critical phenomena. In a bond percolation model, edges of the underlying graph are present or absent at random, while in a site percolation model, the vertices are present or absent at random. The percolation threshold is a critical probability value that corresponds to the critical temperature or phase transition point. Since the exact percolation threshold is known for only a few infinite periodic graphs, there is considerable interest in approximation formulas based on a small number of features of the graph, such as dimension and average degree. Introducing approximation formulas incorporating the second moment of the degree distribution for the first time, we produce substantially more accurate formulas for both site and bond percolation thresholds. Our use of the second moment is motivated by a relationship between the bond percolation threshold of a graph and the site percolation threshold of its line graph.

Keywords: percolation, threshold, line graph

159) Ramsey Theory Before Ramsey

Alexander Soifer
Princeton University, DIMACS, Rutgers University, & University of Colorado at Colorado Springs

Before its birth, a new mathematical theory usually grows unnoticed within old and well established branches of mathematics. Ramsey Theory was no exception. Its roots go back decades before the 1930 pioneering paper of Frank Plumpton Ramsey saw the light of day after his untimely passing at the age of 26. I will look at the prehistory and emergence of what I named *Ramsey Theory before Ramsey* in works of David Hilbert (Existence of monochromatic n-dimensional affine cube, 1892), Issai Schur (Existence of monochromatic solutions of $x+y=z$ in finitely-colored positive integers, 1916), Pierre Joseph Henry Baudet, and Bartel L van der Waerden (Existence of arbitrarily long monochromatic arithmetic progressions in finitely-colored positive integers, 1927). Who coined the term *Ramsey Theory?* Which other term deservedly competed to the end for the name of this flourishing new branch of mathematics? I will disclose, for the first time, my answers to these questions.

160) The Three Fundamental Equations for Ordered Trees

Louis Shapiro, Howard University

The three fundamental equations are T = (1 - C)"1 • V = LT, and (zT)' =V. The kinds of ordered trees involved are binary trees, all ordered trees, Motzkin and Schroder trees, composition trees, Fibonacci trees, as well as various classes of ternary trees. This also leads to a combinatorial approach to the log of some well known sequences.

161) On Component Order Edge Connectivity

Frank Boesch, L William Kazmierczak, Charles Suffel*, Antonius Suhartomo, Stevens Institue of Technology
Daniel Gross, Seton Hall University

The component order connectivity parameter, J ⊲⊳ is defined to be the minimum number of edges that must be deleted from a graph so that all components of the resulting subgraph have order less than some predetermined threshold value k . The analogous parameter *K?>* is defined when nodes rather than edges are removed. In this work, we present some results that relate J ⊲⊳ to other parameters, an anomalous result regarding the relationship between $A_c(t)$ and K!kl for trees, and realizability results for the triple{ n , k , l , (t l) .

162) Z-cyclic DTWh(p) and OTWh(p)

Norman J. Finizio
University of Rhode Island

Let p denote a prime such that $p \equiv 2^k + 1 \bmod 2^{k\bullet 1}$, k 2. For k = 2, 3, 4 it is known that Z-cyclic directed triplewhist designs and Z- cyclic ordered triplewhist designs exist for all such primes except for the impossible cases p = 5, 13, 17. Here the cases k = 5, 6, 7 are investigated. Due to the nature of the constructions employed, the analytical asymptotic bounds obtained via applications of Weil's Theorem are so large that an attempt to establish complete existence for these cases is impractical. It is shown that for k = 5, 6, 7 and for all primes $p \equiv 2^k + 1 \bmod 2^{k\bullet 1} \bullet p < 3{,}200{,}000$, Z-cyclic directed triplewhist designs exist except, possibly, for p = 97, 193, 449, 641, 1153, 1409 and Z-cyclic ordered triplewhist designs exist except, possibly, for p = 97,193,449,577,641, 1409. Furthermore, for each k = 5, 6, 7, an empirical asymptotic bound, N_k, is introduced and it is conjectured that Z-cyclic directed triplewhist designs and Z-cyclic ordered triplewhist designs exist for all corresponding primes greater than N_k. The conjectures are that N_s = 72,673, N_s = 321,000 and N_1 = 1,345,000.

163) Connectedness of a Lattice Fuzzy Graph

Zengxiang Tong
Otterbein College

This paper is the extention of the research, titled *Connectedness in a Fuzzy Graph,* which was published on the Congressus Numerrantium. In this paper, I introduce the concepts of a lattice fuzzy graph and its connectedness. Applying the relationship between the connectedness of a lattice fuzzy graph and the transitive closure of a lattice fuzzy matrix, this paper establishes an algorithm to determine the connectedness.

164) Least Common Ancestors and Decomposition Methods in Phylogenetic Trees

Lifoma Salaam*, Louis Shapiro
Howard University

Phylogenetic trees are used to model evolutionary relationships between sets of species. The leaves of the tree are associated with extant species data (genetic, molecular or physical) while the internal nodes represent hypothetical ancestral species. The species (the vertices) are grouped or colored according to similarities between the data. Convexity is a requirement that guarantees that all vertices of a given color induce a sub-tree. We use vertex and leaf generating functions and an interesting tree decomposition method to determine useful combinatorial statistics on convex tree partitions in Phylogenetic trees. This method is also used with the least common ancestor to count anti-chains of arbitrary size in Binary Trees, Incomplete Binary Trees, Motzkin Trees, and Ordered Trees.

Key words: Phylogenetic Tree, Least Common Ancestor, Binary Tree, Incomplete Binary Tree, Motzkin Tree, Ordered Tree, Generating Function, Convex Tree Partition, Anti-chain

169) On Dynamic Optimality in Binary Search Tree Algorithms

Joan M. Lucas
State University of New York, College at Brockport

The binary search tree is the most well studied data structure in computer science. Sleator and Tarjan introduced the splay tree in 1985, and showed that its amortized worst-case performance matches that of any of the other known binary search tree algorithms. Sleator and Tarjan made an even stronger claim concerning splay trees. They conjecture that splay trees are dynamically optimal; i.e., that the cost of performing any sequence of searches using splaying is at most a constant multiple of the cost of performing those same searches using any other binary search tree algorithm. This conjecture remains an open problem. We examine the properties of dynamically optimal binary search tree algorithms. We show that, without loss of generality, all binary search tree algorithms can be shown to conform to a limited range of behavior while maintaining their efficiency. The subsequent narrowing of the possible behaviors of dynamically optimal algorithms should prove useful in demonstrating the optimality of specific algorithms. For example, splay trees comply with the forms we present.

Keywords: Binary search tree, splay tree, dynamic optimality

170) Algorithms for Exploring Generalized PBIBD(2) Combinatorial Designs

George Rudolph, The Citadel

Mathematicians are typically interested in one or more of three things when investigating combinatorial designs: proving or disproving the existence of designs with particular parameters, generating one or more designs with particular parameters, or enumerating all designs of a type with particular parameters. While working on a constraint logic-based approach to solving a certain class of PBIBD(2)'s, we developed a simple spreadsheet tool to help automate the process of exploring and visualizing designs with specific parameters. The spreadsheet is easy to set up, and requires only a basic knowledge of spreadsheet functions, with a minimum of programming. In this paper, we show the setup of the spreadsheet, give some results, and show how the tool can be useful for exploration, including ideas for algorithms to further automate this process and potentially others.

Keywords: association scheme, cyclic PBIBD(2). constraint language programming

171) On the number of components in 2-factors of claw-free graphs III

Kiyoshi Yoshimoto, Nihon Univeristy

Let G be a claw-free graph, where a claw is the $K_{1,3}$. It is a well known conjecture by Matthews and Sumner that if G is 4- connected, then G is hamiltonian. This conjecture is still open. On the other hand, it holds that if the minimum degree of G is at least four, then G has a 2-factor, which is a 2-regular spanning subgraph of G. In this talk, we discuss the upper bound of the number of components in 2-factors of claw-free graphs. Some of results given in this talk are almost best possible.

key words: claw-free graph, 2-factor

172) Bandwidth of Three Dimensional Meshes

Wai Hong Chan, Hong Kong Baptist University

In 1995, the bandwidth of triangulated triangles T_m were found by Hockberg *et al.* Based on the proof of Hockberg, Lam et al obtained the bandwidth of convex triangulated meshes $T_{l,m,n}$ in 1997. In this paper, we shall consider a three dimensional analogue of T_m. Let TT_m be a simple graph whose vertices are the triples (x, y, z) of nonnegative integers such that $x, y, z \leq m - 1$, with edges joining any two triples if they agree in one or two coordinates and differ by 1 in the remaining coordinate(s). We shall obtain an upper bound for the bandwidth of TT_m and show that this upper bound of the bandwidth is irreducible on the "level-by-level" numbering.

173) Improving a Greedy DNA Motif Search Using a Multiple Genomic Self-Adapting Genetic Algorithm

Michael L. Gargano, Louis V. Quintas, Pace University
Gregory A. Vaughn*, St. Francis College

The problem of combining a greedy motif search algorithm with a self-adapting genetic algorithm using multiple genomic representations is considered in order to find high scoring string patterns of size k in a set of t DNA sequences of size n. This **will** improve the results of the stand-alone greedy motif search. A method employing multiple genomic (i.e., redundant) representations of permutations in a self-adapting genetic algorithm (GA) employing various codes with different locality properties is proposed.

174)_Latin Triangle and Hexagon Boards

Heiko Harborth, TU Braunschweig, Germany

There are three classes of parallel lines of cells in hexagonal triangle and hexagon gameboards. At most 2n-1 or n cells are in the lines for triangle or hexagon boards, respectively. Arrangements of the numbers 1,2, ... ,2n-1 or 1,2, ... ,n in the cells of triangle or hexagon boards, respectively, are called d-Latin boards if in each line with l cells pairwise different integers from 1,2, ... ,l+d occur. Here we ask for the existence of d-Latin boards with the special interest in the minimum of d. Common work with Stefan Krause.

175) Some Structural Properties of Very Well-Covered Graphs

Vadim E. Levit*, Eugen Mandrescu
Holon Institute of Technology, Israel

A graph without isolated vertices is very well-covered provided all its maximal stable sets are of the same size equal to half of its order. A set is local maximum stable in a graph if it is a maximum stable set of the subgraph induced by its closed neighborhood. If the sum of the stability and matching numbers of a graph equals its order, then it is called a Koenig-Egervary graph. In this paper we demonstrate that if the girth of a graph is at least five, then it is very well-covered if and only if it has a perfect matching consisting of pendant edges. We also show that for a very well-covered graph, the closed neighborhood of a local maximum stable set is a Koenig-Egervary graph.

Keywords: very well-covered graph, perfect matching, local maximum stable set, Koenig-Egervary graph

176) Graph Isomorphism Completeness for Perfect Graphs and Subclasses of Perfect Graphs

Christina Boucher*, Maja Omanovic, Dave Loker
University of Waterloo, Waterloo, Ontario, Canada

The Graph Isomorphism (GI) problem consists of deciding whether there exists a bijective mapping from the vertices of one graph to the vertices of the second graph such that the edge adjacencies are respected. GI is of great interest since it is one of the few problems contained in NP that is neither known to be computable in polynomial time nor to be NP-complete. A problem is said to be GI-complete if it is provably as hard as graph isomorphism, implying that there is a polynomial time Turing reduction from the graph isomorphism problem. It is known that the GI problem is GI-complete for some special graph classes including regular graphs, bipartite graphs, chordal graphs and split graphs. We prove that deciding isomorphism of double split graphs, the class of graphs exhibiting a 2-join, and the class of graphs exhibiting a balanced skew partition are GI-complete. Further, we show that the GI problem for the larger class including these graph classes that is, the class of perfect graphs-is also GI-complete.

177) Some additional results on the subgraph connecting problem

Daisuke Kawasaki, Etsuro Moriya•
Waseda University, Tokyo, Japan

The subgraph connecting problem is the problem to determine, given a graph G and its subgraphs G1, • • • ,G_m, whether or not there exist a connected subgraph G' of G such that it intersects each G_i, 1 S i :Sm? This problem is NP♦mplete. A variety of variants of this problem were introduced by the second author at CGTC35 such that they are complete for a number of important complexity classes. Also counting and optimization variants were introduced by the authors at CGTC36 to show that they are #P-complete, NPO-complete, and APX♦mplete. In this talk, we give a new variant which belongs to PTAS as well as FPTAS.

Keywords: complexity class, counting problem, optimization problem, NPcomplete, #P-complete, NPO-complete, APX-cornplete, PTAS, FPTAS

178) On the Ancestral Compatibility of Evolutionary Trees

Spyros Magliveras, Wandi Wei*, Florida Atlantic University

An evolutionary tree is a tree in which the leaves represent species, and the internal nodes correspond to speciation events. Two of the important issues in phylogenetics are to determine whether or not two given evolutionary trees are ancestrally compatible, and, when they are, to construct a supertree that is ancestrally compatible with both of them and have some specific properties as well. Some polynomial-time algorithms have been designed for these issues. We present here another polynomial-time algorithm of a different type.

179) Degree bounded factorizations of pseudographs

A.J.W. Hilton
Reading University and Queen Mary University of London

Ford 2 1, s 2 0 a (d, d + s)-graph is a graph whose degrees all lie in the interval {d, d+1, ... , d+s}. For r 2 1, a 2 0 an (r, r +a)-factor of a graph G is a spanning (r, r + a)-subgraph of G. An (r, r + a)-factorization of a graph G is a decomposition of G into edge-disjoint (r, r + a)-factors. We prove a number of results about (r, r + a)-factorizations of (d, d + s)-pseudographs (multigraphs with loops permitted). For example, fort 2 1 let 1r(r, s, a, t) be the least integer such that, if d 2 1r(r, s, a, t) then every (d, d + s)-pseudograph G has an (r, r + a)-factorization into x (r, r + a)-factors for at least t different values of x. Then we show that, if r and a are even, then $;r(r,s,a,t) = r\frac{rrr+s-11}{a}+(t-l)r$.
We use this to give bounds for 1r(r, s, a, t) when r and a are not both even. Finally we consider the corresponding functions for multigraphs without loops, and for simple graphs.

Keywords: [a, b]-factorizations, semi regular factorizations, pseudographs

180) An Algorithm for Determining Isomorphism

Chris Augeri·, Barry Mullins, Dursun Bulutoglu, Rusty Baldwin, Air Force Institute of Technology (AFIT), OH, Leemon Baird, United States Air Force Academy (USAFA), CO

We present an algorithm for finding a canonical isomorph of a graph; subsequent comparison of two similarly obtained canonical isomorphs determines isomorphism. Our work is based on the PageRank algorithm, which transforms an adjacency matrix to a positive stochastic matrix, computes the leading eigenvector of the transformed matrix, and sorts vertices (web pages) on this eigenvector. By the Perron-Frobenius theorem, this eigenvector exists and is unique; however, it will not typically find a canonical isomorph. Our first extension lexicographically sorts on all eigenvectors and applies the induced permutation to the adjacency matrix. We iterate this step by the base-2 logarithm of the number of vertices. The next extension considers other information matrices, such as the inverse, to sort on. We use two isomorphism-preserving transforms to ensure an inverse exists: the first is a seemingly trivial way to improve performance; the second leverages the Gershgorin Circle theorem to yield a diagonally dominant matrix. Finally, we sort lexicographically on the inverse's individual sorted rows and then its native form. Our numerical implementation uses parallel linear algebra libraries and Cholesky decomposition; using symbolic libraries, we have implemented it with arbitrary precision. This simple, deterministic algorithm executes in polynomial time. We discuss rare cases where it gives incorrect answers, and show that it is correct for all graphs having eight or fewer vertices, and for almost all regular and random graphs that we have tested.

Keywords: Graph Isomorphism, Canonical Isomorph, Inverse, PageRank

181) Attacks on difficult instances of graph isomorphism

Greg Tener*, Narsingh Deo
University of Central Florida

The Graph Isomorphism (GI) problem asks if two graphs are isomorphic. This problem is of interest because of its unknown classification within *P* or NP-Complete. Algorithms to determine graph isomorphism are used in SAT solver engines, isomorph-free generation, combinatorial exploration, and other applications. One of the most popular algorithms is the software package *Nauty*. The algorithm used by *Nauty* canonically labels a graph and outputs generators for the automorphism groups of the graph. We make modifications to the *Nauty* algorithm to improve its performance on graphs that are known to pose difficulty. We focus on projective planes as hard examples. The algorithm searches a tree of partitions of the vertices. We extend the algorithm to handle digraphs better by using both in and out degree as invariants. This significantly speeds up performance on digraphs. A new indicator function is used for added pruning of the search tree. This modification has theoretical interest but usually degrades average performance. Finally we employ a speculative target cell chooser, which helps keep the search tree small and provides good speedup in many cases.

Keywords: isomorphism. automorphism, canonical label

182) Permutation Polynomials Modulo p"

Soumen **Maity*,** Rajesh Pratap Singh
Indian Institute of Technology

A polynomial f over a finite ring *R* is called a *permutation polynomial* if the mapping *R* *R* defined by *f* is one-to-one. In this paper we consider the problem of characterizing permutation polynomials; that is, we seek conditions on the coefficients of a polynomial which are necessary and sufficient for it to represent a permutation. We also present a new class of permutation binomials over finite field of prime order.

Keywords: Permutation Polynomials. Finite Rings, Combinatorial Problem. Cryptography

183) On Zero-Sum **Magic** Graphs and Their Null Sets

Ebrahim Salehi, University of Nevada Las Vegas

For any hE N, a graph G = (V,E) is said to be h-magic if there exists a labeling l : E(G) Zt, - {O} such that the induced vertex set labeling l' : V (G) zh defined by

$$t^{+}(v) = \sum_{U\backslash EE(G)} l(UV)$$

is a constant map. When this constant is O we call G a zero-sum h-magic graph. The null set of G is the set of all natural numbers hE N for which G admits a zero-sum h-magic labeling. In this paper several classes of zero sum magic graphs will be determined and their null sets will be identified.

184) Graph reduction in linear time

Miklos Bartha, Memorial University of Newfoundland

A redex in a graph G is a triple r = (u, c, v) of distinct vertices determining a 2- star in G. Contracting r means deleting the center c and merging u with v into one sink vertex. The reduction of G entails contracting all of its redexes in a recursive fashion, and, at the same time, deleting all loops that arise during this process. It is easy to see that in this way G reduces to a redex-free graph r(G) that is unique up to isomorphism. Reduction is matching invariant, so it can be applied as a preamble in matching algorithms to speed them up. It is shown that reduction can be carried out in linear time, so that the gain might be quite substantial for certain sparse graphs. Reduction is also relevant in the study of some molecular switching devices called soliton or matching automata. The difficulty of constructing r(G) lies in the recursive nature of reduction. It is very easy to come up with a $O(n^2)$ time complexity algorithm, but finding a linear one is much harder. The key idea is to use the depth-first strategy to impose a structure on the set of redexes.

Key words: graph matchings, depth-first search trees, redex groves, reduction algorithm, complexity

185) New Results on Integer Programming for Codes

W. Lang, Berlin School of Economics
J. Quistorff", E. Schneider (FHTW Berlin-University of Applied Sciences)

Consider the n–dimensional q-ary Hamming space a''. A code Cs;; a'' is called R–covering if the union of ball of radius R around the codewords exhausts the whole space. It is called e-error correcting if the balls of radius e around the codewords are disjoint, e.e. if the minimum distance between distinct codewords is at least 2e+1. Let Kq(n,R) denote the minimal cardinality of an R-covering code and let Aq(n,2e+1) denote the maximal cardinality of an e-error correcting code in Q". Additionally, let $K_{2,3}(n_2,n3,R)$ denote the minimal cardinality of an R–covering code in the mixed Hamming space $\{0, 1\}^{n2}$ X {0, 1,2}"3. Sphere bounds on the above cardinalities can be improved by decompositions of the underlying spaces, leading to integer programming problems. Applying this method, we derive a large number of new records for lower bounds on Kq(n,R) and Ki.J(n_2,n3,R) as well as a few records for upper bounds on Aqn,3).

186) A Variant of Arazi's Key Agreement Protocol

Rajesh Pratap Singh*, Soumen Maity
Indian Institute of Technology

In 1993, Arazi presented a key agreement protocol that integrates the Diffie-Hellman key agreement protocol and the digital signature algorithm (DSA). The security of this protocol depends on the intractability of Diffie-Hellman problem. This protocol is not small subgroup attack resistant, i.e. it is easy for malicious second party to know static private key of the first party. This protocol is also lacking in some important key agreement attributes like known-key security, forward secrecy and key-compromise impersonation. In this paper, we present a variation of Arazi's key agreement protocol that can withstand small subgroup attack. We also prove that the modified Arazi Key Agreement Protocol meets the desirable security attributes under the assumption that the discrete logarithm problem is intractable.

Keywords: Cryptography, Key Agreement, Small Subgroup Attack, Discrete Logarithm Problem

187) The Connell Sum Sequence

G. Bullington, University of Wisconsin Oshkosh

The Connell sum sequence refers to the partial sums of the Connell sequence 1,2,4,5,7,9, 10, 12, 14, 16, 17, ... (Online Encyclopedia of Integer Sequences, A001614). The Connell sequence, Connell sum sequence and generalizations from Iannucci and Mills-Taylor are interpreted as sums of elements of triangles, relating them to polygonal number-stuttered arithmetic progressions. The n-th element of the Connell sum sequence is established as a sharp upper bound for the value of a gamma-labeling of a graph of size n. The limiting behavior and a direct formula for the Connell (m,r)-sum sequence are also given.

Keywords: integer sequence, Connell sequence, gamma labeling

188) Special cases of the Vehicle Routing Problem

Yoshiaki Oda
Keio University, Japan

The Traveling Salesman Problem (TSP) is one of the most famous NP-hard problems. So, much works have been done to study polynomially solvable cases, that is, to find good conditions for distance matrices such that an optimal tour can be found in polynomial time. These good conditions give some restriction on the optimal tour, for example, Monge property, Demindeko conditions and so on. Moreover, it is significant to find algorithms which compute the shortest tour with the restriction. A pyramidal tour appears frequently in those concepts. For a given weighted graph G, a vertex v of G, and an integer k, the Vehicle Routing Problem (VRP) is to find a minimum weight connected subgraph F of G such that F is a union of at most k cycles sharing only one vertex x. In this talk, we apply good conditions for the TSP to the VRP. At first, we define a new concept which is an extension of a pyramidal tour and we show that a minimum weight connected subgraph among them can be computed in polynomial time. Next, we show that if a given weighted graph satisfies several conditions for the TSP, an optimal solution for the VRP can also be computed in polynomial time.

Keywords: the Traveling Salesman Problem, the Vehicle Routing Problem, Monge Property and pyramidal tours

189) On the Existence of Constrained Labeling of Locally Finite Graphs

B. Bhattacharjya*, A. K. Lal
IIT Kanpur, India

A labeling of a graph G =01, E) over an abelian group G, is a mapping of the edge set of the graph into G. A sequence r =(r(v))ve v where r(v) E G, for all v E V is called a constrained sequence of G over G. A labeling f of G is called a constrained labeling corresponding to the constrained sequence r, if the sum of the labels of the edges incident to v is r(v), for all v E V . For finite graphs, the existence of a constrained labeling corresponding to a given constrained sequence was extensively studied by various authors. These results depend on whether the graph considered is bipartite or not, as well as on some specific conditions on the constrained sequence. In this paper, we discuss the existence of constrained labelings for locally finite graphs. We have proved that given any constrained sequence for a locally finite graph, a constrained labeling always exists. We have provided two proof of this fact. The first proof is constructive in nature and uses the famous Konig's Infinity Lemma and a lemma of our own which we feel is interesting in it's own right. The second one uses the method of countable induction. These study open the door of generalizing the concept of magicness of finite graphs to infinite graphs.

Keywords: Labellings, Locally Finite Graphs, Constrained Labellings

190)

191) Neighborhood regular graphs

Daniel J. Gagliardi*, SUNY Canton
Michael L. Gargano, Pace Univ.
Louis V. Quintas, Pace Univ.

A regular graph G is called vertex transitive if the automorphism group of G contains a single orbit. In this paper we define and consider another class of regular graphs called neighborhood regular graphs abbreviated NR. In particular, let G be a graph and N[v] be the closed neighborhood of a vertex v of G. Denote by G(N(v]) the subgraph of G induced by N(v]. We call G NR if G(N[v]) G(N[v']) for each pair of vertices v and v' in V (G). A vertex transitive graph is necessarily NR. The converse, however, is in general not true as is shown by the union of the cycles C_4 U Cs. Here we provide a method for constructing an infinite class of connected NR graphs which are not vertex transitive. A NR graph G is called neighborhood regular relative to N if N[v] N for each v E V (G). Necessary conditions for N are given along with several theorems which address the problem of finding the smallest order (size) graph that is NR relative to a given N. A table of solutions to this problem is given for all graphs N up to order five.

Keywords: vertex transitive, regular, neighborhood regular

192) Generalized Family of Extremal Edge-Regular Graphs

K.J. Roblee*, Troy University
T.D. Smotzer, Youngstown State University

An edge-regular graph is a simple regular graph such that there is a nonnegative integer /4 such that every pair of adjacent vertices have exactly /4 common neighbors. For such a graph there is necessarily a nonnegative integer p such that every pair of adjacent vertices have exactly p common nonneighbors. It has been shown that, for edge-regular graphs with parameters /4 , p>O, the number n of vertices satisfies n 3 /4 +3p. This equality is sharp provided p/2 divides /4 ; furthermore for such restricted values, the extremal graphs for this inequality are unique if /4 is large enough relative to p. Here, we consider a generalized family of these extremal graphs, and examine some of their properties.

Keywords: Edge-Regular, extremal

197) Double Vertex Graphs and Complete Double Vertex Graphs
Jobby Jacob*, Wayne Goddard, Renu Laskar
Clemson University

Let G = (V,E) be a graph of order n 2. The double vertex graph, U2(G), is the graph whose vertex set consists of all (;) 2-subsets of V such that two vertices {x, y} and {u, v} are adjacent if and only if I {x, y } n {u, v} I= 1 and if x = u, then y and v are adjacent in G. A generalization of a double vertex graph is called a complete double vertex graph, denoted by $CU_2(G)$, and is similar to $U_2(G)$, except that the vertex set is all $\binom{n+1}{2}$ unordered pairs of elements of V. We will look at some properties of these two graph products and will discuss which classes of graphs can be reconstructed from them.

198)

199) N-Flips in Even Triangulations on Surfaces
Ken-ichi Kawarabayashi, National Institute of Informatics
Atsuhiro Nakamoto, Yokohama National University
Yusuke Suzuki, Tsuruoka National College of Technology

An even triangulation G of a closed surface F^2 is a simple graph embedded on F^2 so that each face is triangular and each vertex has even degree. We have defined two local defomations called "N-flip" and "Prflip", both of which transfonn an even triangulation into another even triangulation. In this talk, we show that any two even triangulations on the same closed surface which have the same homological invaliant called monodoromy can be trancefonned into each other by a sequence of above two deformations, up to homeomorphism, if they have the same and sufficiently large number of vertices.

200) 4-Critical Graphs with Diameter 3
Marc Loizeaux, Lucas van der Merwe*
University of Tennessee at Chattanooga

Let y1(G) denote the total domination number of the graph G. G is said to be total domination edge critical, or simply vi-critical, if y1(G + e) < y1(G) for each edge e E E($\overline{G}$). In this paper we study 4-critical graphs with diameter three.

201) Role Assignments of Trees

Wayne Goddard, Jeremy Lyle*
Clemson University

A role assignment is a graph homomorphism r : V (G) V (R), with the further restriction that for all u e V (G), r(N(u)) = N(r(u)). For any graph G, we let R(G) denote the set of role graphs R such that G is R-role assignable. Similarly, for a subclass G of graphs, we let R(G) denote the set of role graphs R, such that there exists some G e G which is R-role assignable. In this talk, we will consider the role assignments of trees, **R(T).**

Key Words: Role Assignment, Graph Homomorphism, Colordom ination

202)

203) �-Minors in triangulations on surfaces

Atsuhiro Nakamoto
Yokohama National University, Japan

We say that a graph H is a minor of a graph G if H can be obtained from G by a sequence of contractions and deletions of edges. An H-minor is a minor of H. Let K_n denote a complete graph with n vertices. A triangulation of a surface is a fixed embedding of a simple graph on the surface such that each face is bounded by a cycle of length exactly three. It is easy to see that every triangulation on any surface has a -minor, and that every triangulation on any non-spherical surface has a K_5-minor. However, for each non-spherical surface, there exist triangulations with no -minors. In this talk, we characterize triangulations on several surfaces with -minors. As a corollary, we conclude that every 5-connected triangulation on those surfaces has a -minor. This is a joint work with K. Kawarabayashi and R. Mukae.

Keywords: complete graph, minor, triangulation, surface

204) Graffiti.pc on the total domination of a connected graph

Ermelinda DeLaVina•, Bill Waller
University of Houston-Downtown

The total domination number of a graph G is the minimum cardinality of a subset of vertices *D* such that every vertex of the graph G is adjacent to some vertex in D. Graffiti.pc, a program that makes graph theoretical conjectures (utilizing two conjecture making strategies, one of which is similar to S. Fajtlowicz's Graffiti), was queried for conjectures on the the total domination number of connected graphs. We discuss some resolved conjectures (for instance one is that in a connected graph the total domination number is at least the radius), and we present some that as far as we know are open.

keywords: total domination, radius, degrees, Graffiti.pc

Friday, March 9, 2007, 9:00 AM

205) On the Convergence of the Maximum Roots of a Fibonacci Type Polynomial Sequence

Robert Molina*, Alma College
Aklilu Zeleke, Michigan State University

Consider the Fibonacci type polynomial sequence defined by initial conditions $G_0(x) = -1$, $G_1(x) =$
$x-1$ and the recurrence relation $G_n(x) = x^2G_{n-1}(x)+G_{n-2}(x)$, n 2. Let g" denote the maximum real root of $G_n(x)$ for n 1. We show that the sequence {g2n} converges monotonically to 2 from above, and the sequence {g<2n+1}} converge monotonically to 2 from below. Directions for further research related to these results are discussed.

Key Words: Fibonacci polynomial, roots, convergence

206)

207) The distinguishing number of triangulations on the projective plane

Seiya Negami, Yokohama National University

A label-assignment f : V (G) {1, ... d} of a graph G is called a d-distinguishing labeling of G if no automorphism of G other than the identity
map preserves the labels given by f. The distinguishing number of G is defined as the minimum number d such that G has a d-distinguishing labeling. The author has already developed a general theory on the distinguishing number of triangulations on closed surfaces, applying his theory on their re-embedding structures. In this talk, he will present the following result on this topic, focusing on an individual case; the distinguishing number of any triangulation on the projective plane is either 1, 2, 3 or 6. Only the complete graph Ks with six vertices, which triangulates the projective plane, attains "6" and the structure for "3" can be specified concretely.

208) Fractional Roman domination

Robert R. Rubalcaba*, United States Department of Defense
Matt Walsh, Indiana University Purdue University Fort Wayne

A function f : V (G) {O, 1, 2} is a Roman dominating function if for every vertex with f(v) = 0, there exists a vertex w E N(v) with f(w) = 2. In this talk we discuss two different types of fractional Roman dominating functions based on linear relaxations of two integer programming formulations of Roman domination. We prove that both types are fractional isomorphism invariants.

Keywords: Roman domination, integer programming, equitable partitions, fractional isomorphisms

209) A Class of General Combinatorial Algebraic Identities and its Applications
E. Arroyo• and F. Arroyo•, Francis Marion University, SC
J. N. Sun, Jilin University, Changchun, China

L.C. Hsu introduced a class of combinatorial algebraic identities generated by polynomials. More specifically, he showed that for any polynomial $F(x) = a_n x^n + \dots + a_0$ of degree n over a complex field, the following identity holds:

$$\sum_{\substack{\varepsilon_i = 0, 1 \\ 1 \le i \le n}} (-1)^{n+\varepsilon_1+\cdots+\varepsilon_n} F(\varepsilon_1 x_1 + \cdots + \varepsilon_n x_n + t) = (-1)^n x_1 \cdots x_n a_n n!$$

where $x_1, \cdots, x_n$ and t are arbitrary complex numbers. Some well-known identities can be shown to be special cases of his identity. Moreover, he has shown how to use his identity to prove some results from number theory. In this paper, we present a more general version of his identity where the degree of the polynomial $F(X)$ is independent of the number of parameters X_i. We will also give some applications of our identity.

Keywords: Euler identity, Stirling identity, Diophantine equations

210) On Super Edge-magic Deficiencies of Join of Graphs
Dharam Chopra, Wichita State University
Rose Dies•, New Jersey Institute of Technology
Sin-Min Lee, San Jose State University
Tong Siu-Ming, Northwestern Polytechnic University

A (p, q) graph G is total edge-magic, if there exits a bijection f: V U E {1, 2, . . . , p+q} such that for each e = (u, v) in E, we have f(u)+f(e)+f(v) is a constant. A total edge-magic graph is called a super edge-magic if f(V (G)) = {1, 2, . . . , p}. The super edge-magic deficiency of a graph is defined and super edge-magic deficiencies of some well-known graphs are calculated. Some new super edge-magic graphs are exhibited.

Keywords: Total edge-magic, edge-magic, super edge-magic, deficiency

211) Sufficient Conditions for Hamiltonian Cycles in $C_n \times C_m - S$ •
Edward C. Carr, North Carolina A & T State University
Joseph 8. Klerlein•, Western Carolina University

Let $C_n \times C_m$ be the Cartesian product of two directed cycles C_n and C_m, and let S. be the kth square number. To form the directed graph $C_n \times C_m - S$, one removes S, vertices in a square pattern from the upper right corner of directed graph $C_n \times C_m$ and then the cycles are reconnected. In this paper we continue to investigate the hamiltonicity in the directed graphs $C_n \times C_m - S$.

Keywords: Digraph, Hamilton cycle, Cartesian product

212) Liar's Domination
Miranda Roden•, Peter J.Slater, University of Alabama in Huntsville

Assume that each vertex of a graph G is the possible location for an "intruder" such as a thief, a saboteur, a fire or some possible fault. A device at a vertex v is assumed to be able to detect the intruder at any vertex in its closed neighborhood N[v] *and to identify at which vertex in N[v] the intruder is located.* One must then have *a* dominating set S ⊆ V(G), a set with $\bigcup_{v \in S} N[v] = V(G)$, to be able to identify any intruder's location. If any one device can fail to detect the intruder, then one needs a double-dominating set. In this paper we study the recently introduced "liar's dominating sets", sets that can identify an intruder's location even when any one device can lie, that is, any one device can misidentify any vertex in its closed neighborhood.

Keywords: domination, fault-tolerant, locating

213) Enumeration Of Integer Matrices w/ Given Row, Column Sums

E. Rodney Canfield*, Univ. of Ga.
Brendan McKay, Australia Nat'l Univ.

How many 4x6 nonnegative integer matrices are there with row sums equal to 15 and column sums equal to 10? We have a conjectured asymptotic formula for M(m, s; n, t), which is proven for a range of the parameters. The formula begs for an insightful, direct proof.

Keywords: contingency tables, stochastic matrices, asymptotic enumeration

214)

215) Hamiltonicity of the Cartesian Product of Directed Cycles Minus a Rectangular Grid

Stephen Curran*, Michael Ferencak, Christopher Morgan, John Thompson
University of Pittsburgh at Johnstown

We determine necessary and sufficient conditions for the Cartesian product of two directed cycles minus a rectangular grid to be hamiltonian. Let R_{ab} be an a by b rectangular grid of vertices in Z_m x Z_n, the Cartesian product of directed cycles of lengths m and n. Then $Z_m x Z_n \setminus R_{ab}$ is hamiltonian if and only if one of the following conditions holds:

1. There exist nonnegative integers p, q, r and s such that qr-ps = 1, m = aq+bs, n = ap + br, and gcd(ap, bs) = 1;
2. There exist nonnegative integers p, q, r and s, and a positive integer k < a such that qr-ps = 1, m = aq+(b+k)s, n = ap+(b+k)r, and gcd(ap+kr, bs) = 1;

or

3. There exist nonnegative integers p, q, r and s, and a positive integer l < b such that qr - ps = 1, m = (a+l)q +bs, n = (a+l)p+br, and gcd(ap, bs+lq) = 1.

Keywords: Directed cycle, hamilton cycle

216) Locating Mobile Intruders Using Dominating Sets

J. Louis Sewell*, Peter J. Slater
University of Alabama, Huntsville

Using networks to model facilities one can be interested in determining the location of an intruder such as a thief or a saboteur. We assume that detection devices are available each of which in any given time period can determine the presence of such an intruder in the closed neighborhood of the vertex at which it is placed, but which of two neighboring vertices contains the intruder can not be determined. In this paper we consider the problem of precisely determining the location of a mobile intruder. In particular, we consider a (minimum cardinality) dominating set S of vertex locations for such detection devices that will precisely determine the intruder's exact location either immediately or when the intruder moves to an adjacent vertex. Such sets are called 1-step locating-dominating sets.

Keywords: location, dominating set, mobile intruder

Friday, March 9, 2007, 11 :30 AM

217) Some elementary results about the walklength of permutations

Eric Gottlieb, Rhodes College

Suppose n people are randomly arranged in a line. You are to visit each of them in some specified order. You begin at the first person specified, then walk to the second person specified, then the third, and so on, ultimately concluding your walk at the nth person. If it takes one step to go from any person to an adjacent person, what is the expected number of steps required to visit all n people? What is the greatest number of steps required to visit all of the people? In this talk, I will answer these and other questions using elementary techniques from combinatorics and probability. I will describe some related questions and some partial results and conjectures.

218) On Distance Two Magicness of Graphs

Ebrahim Salehi, Patrick Bennett•
University of Nevada Las Vegas

Given an abelian group A, a graph G = (V,E) is said to have a distance two magic labeling in A if there exists a labeling / : E(G) A - { 0 } such that the induced vertex labeling / * : V (G) A defined by

$I^*(v) = \sum_{e \in E(v)} l(e)$ is a constant map, where

$E(v) = \{e \in E(G): d(v,e) < 2\}$. The set of all $h \in Z_+$ for which G has a distance two magic labeling in Z_h, is called the distance two magic spectrum of G and is denoted by DM(G). In this paper, the distance two magic spectra of certain classes of graphs will be determined.

219) Toughness and bipartite-minors in graphs

Katsuhiro Ota, Keio University, Japan

A graph G is called t-tough, if for every subset S c V (G), the number of components in G - S is at most max{1, ISI/t}. By Tutte's theorem, every 4-connected planar graph is hamiltonian, and hence is 1-tough. Although there are many nonhamiltonian 3-connected planar graphs, it is easy to see that every 3-connected planar graph is (1/2)-tough. On the other hand, planar graphs can be characterized by forbidden minors. In particular, a 3-connected graph of order at least six is planar if and only if it does not contain a $K_{3,3}$-minor. Thus, every 3-connected K:i,3-minor-free graph is (1/2)-tough. Generalizing this fact, we obtain the following theorem: If G is a 3-onnected K3,t-minor-free graph, then G is 1/(t - 1)-tough. Furthermore, we consider the toughness of a-connected K..rminor-free graphs. This is a joint work with G. Chen, Y. Egawa, K. Kawarabayashi and B. Mohar.

Keywords: toughness, bipartite-minor, planar graphs

220) Generalized prisms and fractional domination

Matt Walsh, Indiana-Purdue Fort Wayne

Let G be a simple graph on $v_1, \ldots, v_n$. Given a permutation π on 1, ... , n the generalized prism πG is constructed from two isomorphic copies G_0, G_1 of G together with edges between v_i in G_0 and $v_{\pi(i)}$ in G_1 for every i, $1 \leq i \leq n$. A function $f: V(G) \to [0, 1]$ is fractional dominating if, for every vertex $v \in V(G)$, $\sum_{u \in N[v]} \geq 1$ where N[v] denotes the closed neighbourhood of v. The fractional domination number $\gamma_f(G)$ denotes the minimum size of a fractional dominating function (computed as the sum of the values of f over all vertices). It can be quickly shown that for any graph G and any permutation π of its vertex set, $\gamma_f(G) \leq \gamma_f(\pi G) \leq 2\gamma_f(G)$. This talk will explore the cases when the inequalities are sharp. The main result is to determine which graphs G are universal fixers: for any permutation π, $\gamma_f(\pi G) = \gamma_f(G)$.

221) Ascending Subgraph Decompositions of Tournaments

Ron Gould, Emory University
Brian C. Wagner*, University of Tennessee at Martin

A digraph D with $\binom{n+1}{2}$ arcs has an ascending subgraph decomposition (ASD) if there exists a partition of the arc set of D into n sets of arcs such that the digraphs $D_1, D_2, \ldots, D_n$ induced by arc sets in the partition satisfy the properties that D_i is isomorphic to a subgraph of D_{i+1} for all $1 \leq i \leq n-1$ and $|E(D_i)| = i$ for all $i = 1, 2, \ldots n$. We show that several classes of tournaments have ASDs.

Key Words: Ascending Subgraph Decomposition, Tournaments

222) Recent results on non-separating subgraphs in k-connected graphs

Shinya Fujita, Gunma National College of Technology

Recent progress on non-separating subgraphs in highly connected graphs will be reviewed. As a classical result, Thomassen proved that every kconnected graph contains an induced cycle whose deletion results in (k -3)-connected. Later, Egawa extended this result and proved that if G is a kconnected graph, then G contains either a triangle or an induced cycle whose deletion results in (k - 2)-connected. Very recently, I and Kawarabayashi proved that every k-connected graph contains either a 3-connected subgraph of order at most 5 or an induced cycle whose deletion results in (k - 2)-connected. In this talk, I will mention about the above result and other latest results concerning this thesis. This is mainly joint work with K. Kawarabayashi.

Keywords: vertex-connectivity, non-separating subgraphs, induced cycle

223) A σ_4 condition for the cyclability

Kenta Ozeki, Keio University, Japan

Let G be a graph and $S \subseteq V(G)$. We denote by $\alpha(S)$ the maximum number of pairwise nonadjacent vertices in S. For $x, y \in V(G)$, the local connectivity $\kappa(x, y)$ is defined to be the maximum number of internally disjoint paths connecting x and y in G. We define $\kappa(S) = \min\{\kappa(x, y) : x, y \in S, x \neq y\}$. In this talk, we show that if $\kappa(S) \geq 3$ and

$$\sum_{i=1}^{4} d_G(x_i) \geq |V(G)| + \kappa(S) + \alpha(S) - 1$$

for every independent set $\{x_1, x_2, x_3, x_4\} \subseteq S$, then G contains a cycle passing through S. This degree condition is sharp. This gives a new degree sum condition for a 3-connected graph to be hamiltonian. This is a jointwork with T. Yamashtia (Asahi University, Japan).

Keywords: degree sum, connectivity, independence number, cyclable

224) A little statistical mechanics for the graph theorist

Joanna A. Ellis-Monaghan
Saint Michael's College, Vemiont

We give a brief overview of the q-state Potts model partition function of statistical mechanics, which plays an important role in the theory of phase transitions and critical phenomena in physics, and has applications as widely varied as muscle cells, foam behaviors, and social demographics. The Potts model is typically constructed on various lattices, and when these lattices are viewed as graphs, then, remarkably, the Potts model is also equivalent to one of the most renown graph invariants, the Tutte polynomial. The emphasis will be on how the Potts model and Tutte polynomial are related and how research into the one has infomied the theory of the other, and vice versa. The talk includes computational complexity results and a brief excursion into Monte Carlo simulations, and concludes with some recent advances.

225)

226) Ring-magic labelings of graphs.

Wai-Chee Shiu, Hong Kong Baptist University
Richard M. Low•, San Jose State University

In this paper, a generalization of a group-magic graph is introduced and studied. Let R be a commutative ring with unity 1. A graph G = (V,E) is called R-ring magic if there exists a labeling f : E(G) R - {O} such that the induced vertex labelings r :V (G) R, defined by T(v) = L f(u, v) where (u, v) E E(G), and f" : V (G) R, defined by f"(v) = IJ f(u, v) where (u, v) E E(G), are constant maps. General algebraic results for R-ring magic graphs are established. In addition, Z_n-ring magic graphs and, in particular, trees are examined.

227) Path and Cycle Decomposition Numbers

Bullington, Eroh, McDougal, Moghadam•, Winters
University of Wisconsin Oshkosh

For a fixed graph *H* without isolated vertices, the H-decomposition number dH(G) of a graph G is the minimum number of vertices that must be added to G to produce a graph that can be decomposed into copies of *H*. In this paper, we find formulas for dH(G) in the cases where H is a path or a cycle and G is a path or a cycle. We also show a general lower bound which is useful in these cases and conjecture a formula for $d_{P_n}(K_{1,m})$-

228) Diameter 3, 4-critical graphs with a diametrical vertex of degree n - 4

Marc Loizeaux•, Lucas van der Merwe
University of Tennessee at Chattanooga

The degree of any vertex in a connected graph which has total domination number k is at most n - k. Let *F* be the family of 4-critical graphs with diameter three such that, G is in F if G has a diametrical vertex *u* with degree n - 4. We characterize a subfamily of F in which every vertex in G is on a diametrical path starting from *u*.

Keywords: Diameter, edge-critical, total domination