Summary

Welcome

Welcome to Ubatuba!

This booklet contains the titles and abstracts of the plenary talks, as well as the schedule of the parallel sessions of the *Workshop on Combinatorics, Algorithms, and Applications*, Ubatuba, 1–5 September 2003.

This workshop has been organized by the Brazilian combinatorics community collaborating under the ProNEx Project *Complexity of Discrete Structures* (Proc. CNPq 664107/1997-4). This workshop is also part of the activities of IM-AGIMB, the Mathematics Millennium Institute *Avanço Global e Integrado da Matemática Brasileira*.

Complexity of Discrete Structures is a project sponsored by the Ministry of Science and Technology (MCT) through the National Council for Scientific and Technological Development (CNPq), under the ProNEx Programme, a program for supporting "Core Groups of Excellence" in the country. In the past five years, this project has been fundamental for the research in combinatorics in Brazil by, among others, nurturing the collaboration of the research groups of the participating institutions: University of São Paulo, State University of Campinas, Federal University of Rio de Janeiro, Federal University of Pernambuco, and Federal University of Mato Grosso do Sul.

This workshop has been designed to play a dual rôle for our community. Besides being the final major event organized under this project, which will be formally over within a few months, we hope it will be the seed for our next major project (or projects!) in the area in the country.

A quick look at the list of invited speakers, their talk titles and their abstracts suffices to show that this meeting will do its double job magnificently. We are most grateful to our invited speakers for agreeing to come. We are also grateful to the session organizers, for securing a fine set of speakers in their sessions.

Despite the busy programme, we do hope that you will have some time to see the environs and enjoy the beautiful local beaches.

We wish you all a pleasant and very productive workshop!

August 2003

Carlos Eduardo Ferreira

Yoshiharu Kohayakawa

Sponsors and Support

This meeting is being organized by the combinatorics community of Brazil, around the ProNEx Project "Complexity of Discrete Structures," (`http://www.ime.usp.br/~yoshi/pronex/`), supported by CNPq/MCT, and is also part of the activities of the Mathematics Millennium Institute of IMPA (IM-AGIMB; `http://milenio.impa.br/`). This event is also partially supported by FAPESP.

Overview of Program

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8:15 - 8:30	Opening remarks				
8:30 - 9:30	Cornuéjols	Duffus	Raghavan	Reed	
9:30 - 10:30	Kauffman	Spinrad	Szwarcfiter	Viola	GraphTh II ProbComb
10:30 - 11:00	Coffee break	Coffee break	Coffee break	Coffee break	
11:00 - 12:30 Sessions	Alg CombOpt	CompBio DiscMath	CompBio DiscMath	GraphTh II ProbComb	Coffee break Ukkonen
12:30 - 14:00	Lunch	Lunch	Lunch	Lunch	Closing ceremony Farewell lunch
14:00 - 16:00 Sessions	DiscMath GraphTh I	Alg GraphTh II	Conference excursion	CombOpt ProbComb	
16:00 - 16:30	Coffee break	Coffee break		Coffee break	
16:30 - 18:00 Sessions	CompBio ProbComb	CombOpt GraphTh I		CompBio/Alg GraphTh I	
18:00 - 19:00	Lucchesi	Frieze		Richmond	

Parallel sessions (organizer)

- Alg: Algorithms (P. Feofiloff).
- CompBio: Computational Biology (M.-F. Sagot and Y. Wakabayashi).
- CombOpt: Combinatorial Optimization (C.G. Fernandes and Y. Wakabayashi).
- DiscMath: Discrete Mathematics (M. Lemos and S. Lins).
- ProbComb: Probabilistic Combinatorics (Y. Kohayakawa).
- GraphTh I: Graph Theory I (C.M.H. de Figueiredo).
- GraphTh II: Graph Theory II (C. Lucchesi).

All plenary talks will take place at room *Spazio Sole e Vita*. The parallel sessions will be either at room *Spazio Sole e Vita* or at room *Ituverava/Olímpia*.

Cocktail party

There will be a cocktail party on Monday, at 19:00h. After that, there will be a business meeting of the ProNEx Project "Complexity of Discrete Structures".

Workshop dinner

The event dinner will be on Tuesday, at 19:30h.

Plenary talks

Monday, 8:30 - 9:30

A Polynomial Algorithm for Recognizing Perfect Graphs
Gérard Cornuéjols
Carnegie Mellon University, USA and *Université de Marseille, France.*

Chair: Celina M.H. de Figueiredo

We present a polynomial algorithm for recognizing whether a graph is perfect, thus settling a long standing open question. This result was obtained jointly by Maria Chudnovsky, Paul Seymour, Kristina Vuskovic, Xinming Liu and Gérard Cornuéjols. There are three parts to this work. A first phase, called "cleaning", was developed jointly by the five authors. A second phase, to recognize whether a "clean" graph is perfect, was performed independently by two subgroups. Cornuéjols, Liu and Vuskovic devised an algorithm based on a decomposition theorem of Conforti, Cornuéjols and Vuskovic. Another polynomial algorithm for recognizing perfect graphs, which does not use decomposition, was obtained simultaneously by Chudnovsky and Seymour.

Monday, 9:30 - 10:30

Virtual Knot Theory
Louis H. Kauffman
University of Illinois at Chicago

Chair: Celina M.H. de Figueiredo

Virtual knot theory is a generalization of classical knot theory to the study of abstract oriented Gauss codes modulo Reidemeister moves. A diagrammatic representation of virtual knots is obtained by extending classical knot diagrams to include virtual crossings that are neither undercrossings nor overcrosssings. The theory can be characterized by a set of moves on these extended diagrams. Virtual knot theory is equivalent to the study of knots and links in thickened oriented surfaces stabilized by the addition and subtraction of empty handles. Many classical invariants generalize to invariants of virtual knots and links, with interesting variations. The talk will discuss virtual knots with unit Jones polynomial, detecting classicality of virtual knots, quantum invariants of virtual knots, quandles and biquandles, Vassiliev invariants and the structure of virtual three-manifolds.

Monday, 18:00 - 19:00

Ear Decompositions and Pfaffian Orientations
Cláudio L. Lucchesi
Universidade Estadual de Campinas

Chair: U.S.R. Murty

Ear decomposition of matching covered graphs. Bases for the matching lattice. Number of non-similar Pfaffian orientations of Pfaffian graphs.

Tuesday, 8:30 - 9:30

An Order Theoretic Approach to Union Closed Set Systems

Dwight Duffus
Emory University

Chair: Sulamita Klein

The union-closed set system conjecture, which appears to have been formulated by Peter Frankl in the 1970's, is that any nontrivial such system has an element in at least half the sets. There is an easy translation, made independently by several researchers, into statements about lattices. Attempts to solve the conjecture in this order theoretic context have led, not surprisingly, to partial results for special classes of lattices. The lattice theory viewpoint also suggests several approaches to the problem and some interesting variants on the original conjecture. In this talk, partial results and related conjectures, obtained with Bill Sands [University of Calgary], are presented, as well as an experimental results, done with Bob Roth [Emory University].

Tuesday, 9:30 - 10:30

Certificates and Graph Algorithms

Jeremy Spinrad
Vanderbilt University

Chair: Sulamita Klein

The notion of a certificate for a property, which is due to Edmonds, arises frequently in complexity theory. A certificate is a proof that a property holds, and the length of a certificate may be much shorter than the time needed to find such a certificate. This talk will discuss three different areas of graph algorithms, in which certificates have played crucial roles. The first is the notion of a robust algorithm. A robust algorithm to solve a problem on a class of inputs must solve the problem correctly if the input is in the class, and if the input is not in the class may either solve the problem correctly or answer that the input is not valid. The second type of problem related to certificates involves using matrix multiplication to improve asymptotic running times of algorithms. Matrix multiplication is used to improve time bounds for such problems as finding minimal fill, two-pairs, asteroidal triples, and a variety of other problems on graphs. A third area where certificates arise is a certifying algorithm, which is required to produce output such that the answer is "easy" to verify.

Tuesday, 18:00 - 19:00

On packing Hamilton cycles in ϵ-regular graphsRandom Walks on Random Graphs

Alan Frieze
Carnegie Mellon University

Chair: Bruce Reed

A graph $G = (V, E)$ on n vertices is (α, ϵ)-regular if its minimal degree is at least αn, and for every pair of disjoint subsets $S, T \subset V$ of cardinalities at least ϵn, the number of edges $e(S, T)$ between S and T satisfies:

$$\left| \frac{e(S,T)}{|S||T|} - \alpha \right| \leq \epsilon.$$

We prove that if $\alpha \gg \epsilon > 0$ are constants, then every (α, ϵ)-regular graph on n vertices contains a family of $(\alpha/2 - O(\epsilon))n$ edge-disjoint Hamilton cycles. As a consequence we derive that for every constant $0 < p < 1$, with high probability in the random graph $G(n, p)$, almost all edges can be packed into edge-disjoint Hamilton cycles. A similar result is proven for the directed case.

Wednesday, 8:30 - 9:30

Social Networks: Algorithms and Applications

Prabhakar Raghavan
Verity and *Stanford University*

Chair: Yoshiko Wakabayashi

Beginning with Milgram's classic "six degrees of separation" experiments in the 1960's, social network theory has evolved to study how individuals interact and disseminate information. More recently, the study has come to encompass the broader network involving people as well as the documents and information they interact with—examples include recommendation systems and the use of link analysis in web search engines. This talk will provide an overview of this evolving area and the many research problems that arise, including issues in privacy protection.

Wednesday, 9:30 - 10:30

On Two Generalizations of Split Graphs

Jayme L. Szwarcfiter
Universidade Federal do Rio de Janeiro

Chair: Yoshiko Wakabayashi

A graph G is a *split graph* when $V(G)$ can be partitioned into a clique and an independent set. They form a very well known class of graphs, introduced about 35 years ago. In this talk we consider two generalizations of split graphs, namely *starlike graphs* and *generalized split graphs*. The former corresponds to the intersection graphs of substars of a star, while the latter class can be defined as follows. Say that a graph G is *clique-split* when $V(G)$ can be partitioned into cliques $C, C_1, \ldots, C_k$, such that no two vertices belonging to distinct cliques C_i, C_j are adjacent. Say that G is a *generalized split graph* when G or its complement is clique-split. Starlike graphs were introduced in the context of the pathwidth problem, while generalized split graphs were defined in the probabilistic study of perfect graphs. We describe different characterizations for starlike graphs, including one by forbidden subgraphs. For generalized split graphs, we formulate a characterization and a polynomial time recognition algorithm. Starlike graphs form a simple generalization of split graphs, and generalized split graphs extend starlike graphs, in a natural way. The work on starlike graphs has been done jointly with Márcia Cerioli, while on generalized split graphs, with Frédéric Maffray.

Thursday, 8:30 - 9:30

Brambles and Excluded Minors

Bruce Reed
McGill University

Chair: Cristina G. Fernandes

After defining and motivating the concept of *brambles*, we shall discuss recent work on the tree-width of graphs without large prisms and of graphs without small grids.

Thursday, 9:30 - 10:30

Adaptive Sampling for Quickselect

Alfredo Viola
Universidad de la República

Chair: Cristina G. Fernandes

The median-of-3 variant of quickselect has been largely studied. However, the following natural adaptive variant had not been analyzed: "choose as pivot the smallest of the sample if the rank of the sought element is small, the largest if the rank is large, and the median if the rank is medium". We first analyze proportional-of-2 and proportional-of-3 in which we use equal-size intervals. We propose ν-find, a generalization of median-of-3 and proportional-of-3 with interval breakpoints ν and $1-\nu$. We give the optimal ν and values for which ν-find outperforms median-of-3. The talk will be concentrated in the algorithmic aspects of the problem, as well as how its analysis contributes to the understanding of the most delicate parts of them. This is joint work with Conrado Martínez and Daniel Panario.

Thursday, 18:00 - 19:00

Components and Primes

Bruce Richmond
University of Waterloo

Chair: Daniel Panario

There is an analogy between the prime factors of the first n integers and the components of combinatorial objects of size n. The objects may be permutations which may be factored into cycles. The objects may be polynomials over a finite field which can be factored into into irreducible polynomials. The unique factorization gives an analogy between generating functions but more is true. The probability that the first n integers have largest prime factor $\leq m$ is asymptotic to the Dickman function evaluated at $\log n/\log m$ for m sufficiently small compared to n. The probability that the smallest prime factor of the first n integers is $\geq m$ is asymptotic to the Buchstab function evaluated at $\log n/\log m$ divided by $\log m$. We can obtain the corresponding probabilities for combinatorial objects by replacing $\log n$ and $\log m$ by n and m. This was pointed out by Billingsley (1972) and Knuth and Trabb-Pardo (1976). Gourdon established this analogy for the largest component using the Flajolet-Odlyzko singularity analysis for general classes of combinatorial objects. Panario and Richmond followed with the analogy for the smallest component. Recently the Buchstab and Dickman original recursive arguments have been adapted to combinatorial objects by Bender, Mashatan, Panario and Richmond. When the objects are 2-regular graphs new Buchstab and Dickman functions arise. These results will be surveyed.

Friday, 11:30 - 12:30

String Matching for Music

Esko Ukkonen
University of Helsinki

Chair: Marie-France Sagot

Computer-aided retrieval and analysis of music offers fascinating novel challenges for pattern matching research. The standard writing of music uses notes, giving the pitch and duration of each tone. As the pitch levels and durations are limited to a relatively small set of discrete values, we in fact have a sequence of discrete symbols - a natural domain for combinatorial pattern matching. The talk considers transposition invariance in string matching, motivated by music retrieval. Transposition invariance can be achieved both in the exact and in the approximate string matching with relatively small extra effort. We also consider the related problem of geometric point pattern matching under translations and discuss how the periodicity of the pattern can be utilized.

This is joint work with K. Lemstrom, V. Makinen and G. Navarro.

Overview of Parallel Sessions

Monday

Parallel Sessions: **Monday, 11:00 - 12:30**		
Algorithms *Chair: Paulo Feofiloff*		*Room: Spazio Sole e Vita*
Alfredo Viola, On worst case Robin-Hood hashing		Carlos Alberto Martinhon, An improved derandomized approximation algorithm for the max-controlled set problem
Combinatorial optimization *Chair: Yoshiko Wakabayashi*		*Room: Ituverava/Olímpia*
Cid Carvalho de Souza, The datapath merging problem in the design of reconfigurable systems	Marcus Poggi de Aragão, Integer program reformulation for robust branch-and-cut-and-price	Cristina G. Fernandes, A randomized approximation for the Quality of Service Steiner Tree Problem

Parallel Sessions: **Monday, 14:00 - 16:00**			
Discrete mathematics *Chair: Sóstenes Lins*			*Room: Ituverava/Olímpia*
Nicolau Corção Saldanha, Two results on tilings of quadriculated annuli	Pedro Lopes, Telling knots apart: counting colorings and algorithms for implementing it	Daniel Panario, Permutation binomials over finite fields	
Graph theory I *Chair: Celina M.H. de Figueiredo*			*Room: Spazio Sole e Vita*
Ricardo Dahab, Some developments on Tutte's 3-flow conjecture	Christiane Campos, On the total colouring conjecture in powers of cycles	Jeremy Spinrad, Problem session	

Parallel Sessions: **Monday, 16:30 - 18:00**		
Computational biology *Chair: Yoshiko Wakabayashi*		*Room: Spazio Sole e Vita*
	Marie-France Sagot, Bases of repeated motifs with don't cares	
Probabilistic combinatorics *Chair: Yoshiharu Kohayakawa*		*Room: Ituverava/Olímpia*
Bruce Reed, List-coloring when χ is near n	Martín Matamala, On the connected domination number	

Tuesday

Parallel Sessions: **Tuesday, 11:00 - 12:30**		
Computational biology		
Chair: Marie-France Sagot and Yoshiko Wakabayashi		*Room: Spazio Sole e Vita*
Katia S. Guimarães, Efficient secondary structure prediction	Alair Pereira do Lago, A sparse dynamic programming algorithm for alignment with inversions	
Discrete mathematics		
Chair: Sóstenes Lins		*Room: Ituverava/Olímpia*
Sóstenes Lins, Recouplings in gems and PL-manifold	Arnaldo Mandel, Deciding whether some word antichains are finite	Carlos Gustavo T. de A. Moreira, Measures of pseudo-randomness for finite sequences: minimum and typical values

Parallel Sessions: **Tuesday, 14:00 - 16:00**		
Algorithms		
Chair: Paulo Feofiloff		*Room: Ituverava/Olímpia*
Bruce Richmond, The largest and smallest components of combinatorial objects		
Graph theory II		
Chair: Cláudio Lucchesi		*Room: Spazio Sole e Vita*
Fábio Protti, On (p, q, s)-Helly hypergraphs	Minchih Lin, On balanced graphs and some subclasses	Jayme Szwarcfiter, Problem session

Parallel Sessions: **Tuesday, 16:30 - 18:00**		
Combinatorial optimization		
Chair: Cristina G. Fernandes		*Room: Spazio Sole e Vita*
	Gérard Cornuéjols, Recent advances in cutting plane theory	
Graph theory I		
Chair: Celina M.H. de Figueiredo		*Room: Ituverava/Olímpia*
U.S.R. Murty, Perfect matching polytope and solid bricks	Orlando Lee, Independent spanning trees in 4-connected graphs	Aurora Morgana, The k-behaviour of iterated cliques graphs

Wednesday

Parallel Sessions: **Wednesday, 11:00 - 12:30**		
Computational biology		
Chair: Marie-France Sagot and Yoshiko Wakabayashi		*Room: Spazio Sole e Vita*
Esko Ukkonen, Haplotype analysis: finding blocks and founders	Esko Ukkonen, Discussion	
Discrete mathematics		
Chair: Sóstenes Lins		*Room: Ituverava/Olímpia*
Louis H. Kauffman, Quantum entanglement and topological entanglement	Dwight Duffus, Set systems as lattices	Pedro Lopes, Counting Colorings and Knotted Surfaces

Thursday

Parallel Sessions: **Thursday, 11:00 - 12:30**		
Graph theory II *Chair: Cláudio Lucchesi*		*Room: Ituverava/Olímpia*
U.S.R. Murty, Ear decompositions and conformal minors of matching covered graphs	Elaine Eschen, List Partition Problem for graphs	Vinicius Gusmão, A new upper bound for the Homogeneous Set Sandwich Problem
Probabilistic combinatorics *Chair: Yoshiharu Kohayakawa*		*Room: Spazio Sole e Vita*
Prabhakar Raghavan, A theory of computing symposia	Marcos Kiwi, Expected length of the longest common subsequence for words over large alphabets	

Parallel Sessions: **Thursday, 14:00 - 16:00**	
Combinatorial optimization *Chair: Yoshiko Wakabayashi*	*Room: Spazio Sole e Vita*
Gérard Cornuéjols, Problem session	
Probabilistic combinatorics *Chair: Yoshiharu Kohayakawa*	*Room: Spazio Sole e Vita*
	Alan Frieze, Random walks on random graphs

Parallel Sessions: **Thursday, 16:30 - 18:00**		
Computational biology *Chair: Marie-France Sagot and Yoshiko Wakabayashi*		*Room: Ituverava/Olímpia*
Estela M. Rodrigues, Approximation algorithms for measuring distances between phylogenetic trees		
Algorithms *Chair: Paulo Feofiloff*		*Room: Ituverava/Olímpia*
	Daniel Panario, What do random polynomials over finite fields look like?	
Graph theory I *Chair: Celina M.H. de Figueiredo*		*Room: Spazio Sole e Vita*
Cláudia Linhares, On Clique-inverse graphs of K_p-free graphs	Silvia Tondato, Some properties of maximal generating trees for the clique weighted graphs of chordal graphs	Loana Tito Nogueira, Chordal graph extensions

Friday

Parallel Sessions: **Friday, 9:30 - 11:00**		
Graph theory II *Chair: Cláudia Linhares*		*Room: Spazio Sole e Vita*
Jeremy Spinrad, Improving a minimal fill algorithm		
Combinatorial optimization *Chair: Cláudia Linhares*		*Room: Spazio Sole e Vita*
	Flávio K. Miyazawa, Approximation algorithms for packing problems with orthogonal rotations	
Probabilistic combinatorics *Chair: Yoshiharu Kohayakawa*		*Room: Ituverava/Olímpia*
	Luiz Renato Fontes, Convergence times and decay of the return probability for random walks with random rates in $\mathbb{Z}^d$	Fábio Prates Machado, $p_c(\mathcal{G})$ for the frog model is not a monotonic function of $\mathcal{G}$

Parallel Sessions

The lectures being short and the arrangements somewhat informal, we only very recently requested the abstracts from the speakers, and many did not yet have a chance to reply.

Algorithms

Time: Monday, 11:00 - 12:30
Organizer: Paulo Feofiloff

On worst case Robin-Hood hashing (11:00 - 12:00)
Alfredo Viola
Universidad de la República

We consider open addressing hashing, and implement it by using the Robin Hood strategy, that is, in case of collision, the element that has traveled the furthest can stay in the slot. We hash $\sim \alpha n$ elements into a table of size n where each probe is independent and uniformly distributed over the table, and $\alpha < 1$ is a constant. Let M_n be the maximum search time for any of the elements in the table. We show that with probability tending to one, $M_n \in [\log_2 \log n + \sigma, \log_2 \log n + \tau]$ for some constants σ, τ depending upon α only. This is an exponential improvement over the maximum search time in case of the standard FCFS (first come first served) collision strategy, and virtually matches the performance of multiple choice hash methods. This is joint work with Luc Devroye and Pat Morin.

An improved derandomized approximation algorithm for the max-controlled set problem (12:00 - 12:30)
Carlos Alberto Martinhon
Universidade Federal Fluminense

A vertex v of a graph $G = (V, E)$ is said to be *controlled* by $M \subseteq V$ if the majority of the elements of the neighborhood of v (including itself) belong to M. The set M is a *monopoly* in G if every vertex $v \in V$ is controlled by M. Given a set $M \subseteq V$ and two graphs $G_1 = (V, E_1)$ and $G_2 = (V, E_2)$ where $E_1 \subseteq E_2$, the MONOPOLY VERIFICATION PROBLEM (MVP) consists of deciding whether there exists a sandwich graph $G = (V, E)$ (i.e., a graph where $E_1 \subseteq E \subseteq E_2$) such that M is a monopoly in $G = (V, E)$. If the answer to the MVP is No, we then consider the MAX-CONTROLLED SET PROBLEM (MCSP), whose objective is to find a sandwich graph $G = (V, E)$ such that the number of vertices of G controlled by M is maximized. The MVP can be solved in polynomial time; the MCSP, however, is NP-hard. In this work, we present a deterministic polynomial time approximation algorithm for the MCSP with ratio $\frac{1}{2} + \frac{2+\sqrt{2n}}{2n-4}$ (where $n = |V| > 8$). The algorithm is obtained through the use of randomized rounding and derandomization techniques, namely the method of conditional expectations. Additionally, we show how to improve this ratio if good estimates of expectation are obtained in advance.

Algorithms

Time: Tuesday, 14:00 - 15:00
Organizer: Paulo Feofiloff

The largest and smallest components of combinatorial objects (14:00 - 15:00)
Bruce Richmond
University of Waterloo

It is elementary that the integer n can be factored into its prime factors which we presently call components. A polynomial over a finite field can be factored into its irreducible factors which we refer to as components. A permutation can be factored into its cycles which we call also call components. The polynomials are an example of an *additive number system* as introduced by J. Knopfmacher. The integers and cycles are examples of *multiplicative number systems* again introduced by J. Knopfmacher. The book by S. Burris contains a more recent discussion of these topics than Knopfmacher's. There is a natural size associated with each of these objects. We can talk of the smallest component therefore. Let $b_n(c_n)$ denote the number of objects (components) of size n. Let $b_{n,m}$ denote the number of objects of size n having smallest component of size $\geq m$. Our Theorem 1 gives conditions under which the quantity $b_{n,m}/b_n$ is asymptotically equivalent to the probability that the integer $n \leq N$ has smallest prime factor $\geq m$ as $N \to \infty$. The Buchstab function $\omega(.)$ is defined as the solution to the differential-difference equation

$$\begin{aligned} u\omega(u) &= 1 + \int_2^u \omega(u-1)\, du, \quad u \geq 2 \\ u\omega(u) &= 1 \text{ if } 1 \leq u < 2. \end{aligned}$$

Our first result is

Theorem 1 *Suppose*

$$\frac{c_n}{n!} \sim \frac{1}{n\rho^n}, \quad \frac{b_n}{n!} \sim \frac{1}{\rho^n}$$

for labeled objects and

$$c_n \sim \frac{\rho^{-n}}{n}, \quad b_n \sim \rho^{-n}$$

for unlabeled objects. Then uniformly for $2 \leq m \leq n$

$$b_{n,m} \sim \frac{b_n(\omega(n/m) + O(\frac{1}{m^2}))}{m}.$$

Remark 1 : Frequently the hypothesis of Theorem 1 is established using the singularity analysis of Flajolet and Odlyzko. See Flajolet and Soria for many examples.

Remark 2 : Panario and Richmond derive Theorem 1 using singularity analysis. The present proof produces the result in a simpler and much more direct way. In particular the Buchstab function is not derived in the form of the inverse of its Laplace transform. Our present derivation is a close analogue of the proof of the result for integers free of small factors presented by Tenenbaum. We give all the details because the proof is not too long and we wish to highlight the similarities between the combinatorics and the number theory.

Algorithms

Time: Thursday, 17:00 - 18:00
Organizer: Paulo Feofiloff

What do random polynomials over finite fields look like? (17:00 - 18:00)
Daniel Panario
Carleton University

In this talk we survey old and new results about random univariate polynomials over finite fields. We are interested in three aspects:

1. the decomposition of a random polynomial in terms of its irreducible factors,
2. the use of random polynomials in algorithms, and
3. the average-case analysis of algorithms that use polynomials over finite fields.

We show a methodology that can be systematically employed to study the most important features of these problems. This framework has two basic components: generating functions to express the properties of interest, and asymptotic analysis when exact estimations are not possible. This generic methodology naturally relates finite fields and their applications to combinatorics and analytic number theory.

Computational biology

Time: Monday, 17:00 - 18:00
Organizer: Marie-France Sagot and Yoshiko Wakabayashi

Bases of repeated motifs with don't cares (17:00 - 18:00)
Marie-France Sagot
INRIA, Rhône-Alpes

The notion of a basis of repeated motifs with don't cares in an input string of n symbols drawn over an alphabet A was initially introduced in 2000 by L. Parida and co-workers. The don't care is a special symbol matching any symbol of A. The notion of a basis of motifs corresponds to the algebraic one of a set of generators for all motifs with don't cares appearing at least q times in the string, for a given integer q greater than one. Besides its elegance, the notion could be of great practical usefulness if the basis is of small size as in general there can be an exponential number of repeated motifs with don't cares.

We investigate the problem of determining the basis of repeated motifs with don't cares in an input string. New upper and lower bounds on the problem are given. A notion of basis that is provably smaller than (and contained in) previously defined ones is introduced. Such basis can be computed in less time and space, and is still able to generate the same set of motifs. Unfortunately, it is possible to prove that the number of motifs in all the bases that have been defined so far grows exponentially with q, a point that went unnoticed in earlier work. A polynomial-time algorithm can therefore also exist only for fixed q.

This is joint work with Maxime Crochemore, Roberto Grossi and Nadia Pisanti.

Computational biology

Time: Tuesday, 11:00 - 12:00
Organizer: Marie-France Sagot and Yoshiko Wakabayashi

Efficient secondary structure prediction (11:00 - 11:30)
Katia S. Guimarães
Universidade Federal de Pernambuco

We will present a simple and efficient neural network model for protein secondary structure prediction.

Combining only three neural networks, an average Q3 accuracy prediction by residues of 75,93% is achieved. This value is better than the best results reported on the same test and training database, CB396, using the same validation method. For a second database, RS126, an average Q3 accuracy of 74,13% is attained, which is better than each individual method, being defeated only by CONSENSUS, a rather intricate engine, which is a combination of several methods.

We will also discuss the use of Principal Components Analysis (PCA) to try to avoid the "curse of dimensionality", which led to results almost as good as the previously mentioned, and still beating all predictors different from CONSENSUS.

This is joint work with Jeane C.B. de Melo and George D.C. Cavalcanti.

A sparse dynamic programming algorithm for alignment with inversions (11:30 - 12:00)
Alair Pereira do Lago
Universidade de São Paulo

Alignment of sequences is widely used for sequence comparisons and, in its model, only biological events like mutations, insertions and deletions are considered. It admits a dynamic programming algorithm and has become a fundamental tool for DNA and protein evolutive studies.

Other biological events like inversions are not automatically detected by the usual alignment algorithms and some alternative approaches have been tried in order to include inversions or other kind of rearrangements.

We will discuss some of these approaches that include inversions to the comparison studies and we will show a dynamic programming algorithm for one of them.

We will also present a sparse dynamic programming implementation of this algorithm that compacts the tables involved.

Computational biology

Time: Wednesday, 11:00 - 12:00
Organizer: Marie-France Sagot and Yoshiko Wakabayashi

Haplotype analysis: finding blocks and founders (11:00 - 11:30)
Esko Ukkonen
University of Helsinki

The talk discusses algorithms for finding so-called haplotype blocks as well as the problem of constructing founder sequences and recombination points for a given set of haplotypes.

Discussion (11:30 - 12:00)
Esko Ukkonen
University of Helsinki

Computational biology

Time: Thursday, 16:30 - 17:00
Organizer: Marie-France Sagot and Yoshiko Wakabayashi

Approximation algorithms for measuring distances between phylogenetic trees (16:30 - 17:00)
Estela M. Rodrigues
Universidade de São Paulo

There are various techniques for reconstructing phylogenetic trees from data, and in this context the problem of determining how distant two such trees are from each other arises naturally. Various metrics for measuring the distance between two phylogenies have been defined. Another way of comparing two trees $\mathcal{T}$ and $\mathcal{U}$ is to compute the so called *maximum agreement forest* of these trees. Informally, the number of components of an agreement forest tells how many edges from each of $\mathcal{T}$ and $\mathcal{U}$ need to be cut so that the resulting forests agree, after performing all forced edge contractions. This problem is NP-hard even when the input trees have maximum degree 2. Hein, Jiang, Wang and Zhang presented in 1996 an approximation algorithm for it, claimed to have performance ratio 3. We show that the performance ratio of Hein's algorithm is 4, and we also present two new 3-approximation algorithms for this problem. We mention how one of these 3-approximation algorithms can be generalized to a $(d+1)$-approximation algorithm for trees with bounded degree $d \geq 2$. Finally, we report on some computational experiments comparing the performance of the algorithms presented in this paper.

This is joint work with M.-F. Sagot and Y. Wakabayashi

Combinatorial optimization

Time: Monday, 11:00 - 12:30
Organizer: Cristina G. Fernandes and Yoshiko Wakabayashi

The datapath merging problem in the design of reconfigurable systems (11:00 - 11:30)
Cid Carvalho de Souza
Universidade Estadual de Campinas

In this talk we discuss the problem of merging circuit datapaths in the design of reconfigurable systems. We show that this problem can be formulated in terms of a graph optimization problem and belongs to NP-hard.

The focus of our work is on the development of an Integer Programming model capable to provide good dual bounds for the problem and, hopefully, to prove optimality of some solutions for real-world instances. To this end, we propose an Integer Programming model and present some valid inequalities that can be added to tighten the linear relaxation and used as cutting planes in a branch-and-cut type algorithm.

Preliminary computational results on real instances arising from multimedia applications are reported. These results give an indication that, under certain circumstances, it might be reasonable to try to solve the problem exactly via Integer Programming techniques.

This is joint work with André Lima, Nahri Moreano and Guido Araújo.

Integer program reformulation for robust branch-and-cut-and-price (11:30 - 12:00)
Marcus Poggi de Aragão
Pontifícia Universidade Católica do Rio de Janeiro

Since cut and column generation were established as two of the most important techniques in integer programming, researchers have looked for ways of combining them into a robust branch-and-cut-and-price algorithm. Here, "robust" means that neither branching nor the addition of cuts should change the structure of the pricing subproblems. In the last few years, several researchers independently noted that cuts expressed in terms of variables from a suitable original formulation could be added to the master problem without disturbing the pricing. This fact is still little known outside the "column generation community" and its consequences on integer programming are just beginning to be explored. This work intends to be a detailed analysis of how to reformulate an integer program in order to build an efficient robust branch-and-cut-and-price. In particular, we propose an alternative master problem that can be quite advantageous in some situations. Another key issue addressed is how to avoid the pitfalls that arise from variable symmetries in the original formulations of many problems. We present extensive computational experiments on the capacitated minimum spanning tree, capacitated vehicle routing, and generalized assignment problems. Remarkable results on benchmark instances from the literature clearly attest the power of combining cut and column generation.

This is joint work with Eduardo Uchoa.

A randomized approximation for the Quality of Service Steiner Tree Problem (12:00 - 12:30)
Cristina G. Fernandes
Universidade de São Paulo

The QoS Steiner Tree Problem asks for the most cost-efficient way to multicast multimedia to a heterogeneous collection of users with different consumption rates. We assume that the cost of using a link is not constant but rather depends on the maximum bandwidth routed through the link. Formally, given a graph with costs on the edges, a source vertex, a set of terminal vertices, each one with a bandwidth requirement, the goal is to find a Steiner tree containing the source, and the cheapest assignment of bandwidth to each of its edges so that each source-to-terminal path has bandwidth at least as large as the bandwidth required by the terminal. We present a randomized primal-dual approximation algorithm that achieves a ratio of 4.311 for the problem.

This is joint work with Gruia Călinescu.

Combinatorial optimization

Time: Tuesday, 17:00 - 18:00
Organizer: Cristina G. Fernandes and Yoshiko Wakabayashi

Recent advances in cutting plane theory (17:00 - 18:00)
Gérard Cornuéjols
Carnegie Mellon University, USA and *Université de Marseille, France.*

In this talk, we survey several classical cutting planes for mixed integer programs. In particular, we discuss the relation between split cuts, Gomory mixed integer cuts and intersection cuts. These connections are then used to generate better cutting planes

This is joint work with Kent Andersen and Yanjun Li.

Combinatorial optimization

Time: Thursday, 14:00 - 15:00
Organizer: Cristina G. Fernandes and Yoshiko Wakabayashi

Problem session (14:00 - 15:00)
Gérard Cornuéjols
Carnegie Mellon University, USA and *Université de Marseille, France.*

Combinatorial optimization

Time: Friday, 10:00 - 10:30
Organizer: Cristina G. Fernandes and Yoshiko Wakabayashi

Approximation algorithms for packing problems with orthogonal rotations (10:00 - 10:30)
Flávio K. Miyazawa
Universidade Estadual de Campinas

We consider packing problems in which orthogonal rotations are allowed. No significant approximation results have appeared in the literature in which orthogonal rotations are considered. We show a technique that leads to approximation algorithms with improved bounds. We consider the *strip packing*, the *two-dimensional bin packing*, the *three-dimensional strip packing*, and the *three-dimensional bin packing* problems. For these problems we give algorithms with asymptotic performance bounds 1.613, 2.64, 2.76 and 4.89, respectively. To our knowledge, these bounds are the best known for these problems.

This is joint work with Yoshiko Wakabayashi.

Discrete mathematics

Time: Monday, 14:00 - 15:30
Organizer: Manoel Lemos and Sóstenes Lins

Two results on tilings of quadriculated annuli (14:00 - 14:30)
Nicolau Corção Saldanha
Pontifícia Universidade Católica do Rio de Janeiro

Tilings of a quadriculated annulus A are counted according to *volume* (in the formal variable q) and *flux* (in p). The generating function $\Phi_A(p, q)$ is such that, for $q = -1$, the non-zero roots in p are roots of unity and for $q > 0$, real negative.

Telling knots apart: counting colorings and algorithms for implementing it (14:30 - 15:00)
Pedro Lopes
Instituto de Matemática Pura e Aplicada

Knot diagrams are networks of arcs obtained by projecting knots onto planes and consistently breaking the lines that go under at crossings. If two knot diagrams are related by the so-called Reidemeister moves then the corresponding knots are deformable into each other (and vice versa). The knot quandle of a given knot is presented by regarding arcs as generators and reading specific relations at the crossings; it is a knot invariant since the defining axioms of quandles are modeled on the three Reidemeister moves. This presentation is not very useful on its own. In this way we count homomorphisms from the knot quandles to a fixed quandle in order to tell knots apart. These homomorphisms are the so-called colorings. In this talk we will develop these ideas and explain how to set up algorithms for counting colorings of knots.

Permutation binomials over finite fields (15:00 - 15:30)
Daniel Panario
Carleton University

A polynomial f over a finite field $\mathbb{F}_q$ is called a permutation polynomial if the mapping $f\colon \mathbb{F}_q \to \mathbb{F}_q$ permutes the elements of $\mathbb{F}_q$. Many results about permutation polynomials have appeared in the literature since Hermite.

In the last 20 years there has been a revival in the interest for permutation polynomials, in part due to their cryptographic applications. For example, the RC6 block cipher uses a permutation polynomial modulo 2^w, where w is the word size of the machine.

We give a characterization of permutation polynomials over finite fields $\mathbb{F}_q$ based on their coefficients. Using this characterization we provide the form and number of binomial permutations over $\mathbb{F}_q$ where $q = 2p+1$ and p is a prime (that is, Sophie Germain primes). This gives a partial answer to the well-known open problem asking the number of binomial permutations over any finite field $\mathbb{F}_q$. We comment on similar results for other finite fields.

This is joint work with Ariane Masuda and Steven Wang.

Discrete mathematics

Time: Tuesday, 11:00 - 12:30
Organizer: Manoel Lemos and Sóstenes Lins

Recouplings in gems and PL-manifold (11:00 - 11:30)
Sóstenes Lins
Universidade Federal de Pernambuco

A *recoupler* R is a special pair of edges with the same color in a bipartite n-gem G. The recoupling of R is the interchange of its two edges by a new pair having the same ends and the same color so as to preserve bipartiteness. A recoupling maintains the induced orientable PL-manifold. A *blob* in an n-gem is an n-dipole. A blob *creation* or *cancellation* is the creation/cancellation of the n-dipole and, therefore, maintains the induced PL-manifold. We prove the following result: if G and H are gems with the same number of vertices inducing the same n-manifold, then there is an integer $\alpha(G,H)$ such that G^α and H^α are linked by a finite number of recouplings, where G^α and H^α are respectively G and H with α blobs put in arbitrary places. In consequence, it is enough to establish a bound for $\alpha(G,H)$ in order to produce an algorithm to move from G and H by α blob creations, followed by a finite number of recouplings followed by α blob cancellations.

Deciding whether some word antichains are finite (11:30 - 12:00)

Arnaldo Mandel
Universidade de São Paulo

We consider antichains of words related to antichains of nonnegative integer vectors. Words are ordered by divisibility, and vectors by componentwise comparison. Fix an alphabet X on n letters, and associate to each word w its Parikh vector $\pi(w)$ in $\mathbb{N}^n$, describing the number of occurrences of each letter. Given an antichain $C \subseteq \mathbb{N}^n$, denote by $\pi^{\geq}(C)$ the set of words w such that $\pi(w) \geq v$ for some $v \in C$. The antichains we look at are

$$\begin{aligned} J &= \text{the minimal words of } \pi^{\geq}(C). \\ S &= \text{the minimal sorted words of } \pi^{\geq}(C). \end{aligned}$$

We try to find out whether each is finite, or if some reordering the letters renders S finite. These questions are decidable if C is given in any reasonable way. If C is given by a list of members, some of these questions afford good characterizations, and can be answered in polynomial time. One question includes the recognition of a slight generalization of comparability graphs, and is NP-complete. If C is given by a polyhedral type description, all our questions turn out to be NP-complete.

This is joint work with Ed Green and Cristina G. Fernandes.

Measures of pseudorandomness for finite sequences: minimum and typical values (12:00 - 12:30)

Carlos Gustavo T. de A. Moreira
Instituto de Matemática Pura e Aplicada

Mauduit and Sárközy introduced and studied certain numerical parameters associated to finite binary sequences $E_N \in \{-1,1\}^N$ in order to measure their "level of randomness". These parameters, the *normality measure* $\mathcal{N}(E_N)$, the *well-distribution measure* $W(E_N)$, and the *correlation measure* $C_k(E_N)$ *of order* k, focus on different combinatorial aspects of E_N. In their work, amongst others, Mauduit and Sárközy (i) investigated the relationship among these parameters and their minimal possible value, (ii) estimated $\mathcal{N}(E_N)$, $W(E_N)$, and $C_k(E_N)$ for certain explicitly constructed sequences E_N suggested to have a 'pseudorandom nature', and (iii) investigated the value of these parameters for genuinely random sequences E_N.

In this talk, we report on recent work in the direction of (iii) above. We shall discuss some results that show that, for typical $E_N \in \{-1,1\}^N$, both $W(E_N)$ and $\mathcal{N}(E_N)$ are of order $\sqrt{N}$, while $C_k(E_N)$ is of order $\sqrt{N \log \binom{N}{k}}$ for any given $2 \leq k \leq N/4$. We shall also prove a lower bound for the correlation measure $C_k(E_N)$ for arbitrary sequences E_N, which, in particular, gives that $\min_{E_N} C_k(E_N) \geq c_k \sqrt{N}$ for some $c_k > 0$ for any constant even k.

This is joint work with N. Alon, Y. Kohayakawa, C. Mauduit, and V. Rödl.

Discrete mathematics

Time: Wednesday, 11:00 - 12:30
Organizer: Manoel Lemos and Sóstenes Lins

Quantum entanglement and topological entanglement (11:00 - 11:30)
Louis H. Kauffman
University of Illinois at Chicago

This talk explores, via the structure of braiding operators, the relationship between entanglement of quantum states and topological measures of entanglement such as linking numbers and knot polynomials. We will discuss the relationship of this theme with issues in quantum computation.

Set systems as lattices (11:30 - 12:00)
Dwight Duffus
Emory University

We outline two constructions related to the union-closed set system conjecture and motivated by a lattice theory point of view. First, we consider the collection of all lattices with the same set of join irreducible elements, which itself forms a lattice in a natural way. Second, there is a construction that yields all atomic lattices from Boolean ones that leads to an interesting approach to the conjecture. The second part of this is joint work with Bill Sands.

Counting Colorings and Knotted Surfaces (12:00 - 12:30)
Pedro Lopes
Instituto de Matemática Pura e Aplicada

Graph theory I

Time: Monday, 14:00 - 16:00
Organizer: Celina M.H. de Figueiredo

Some developments on Tutte's 3-flow conjecture (14:00 - 14:30)
Ricardo Dahab
Universidade Estadual de Campinas

On the total colouring conjecture in powers of cycles (14:30 - 15:00)
Christiane Campos
Universidade Estadual de Campinas

Problem session (15:00 - 16:00)
Jeremy Spinrad
Vanderbilt University

Graph theory I

Time: Tuesday, 16:30 - 18:00
Organizer: Celina M.H. de Figueiredo

Perfect matching polytope and solid bricks (16:30 - 17:00)
U.S.R. Murty
University of Waterloo

The *perfect matching polytope* of a graph G is the convex hull of the set of incidence vectors of perfect matchings of G. Edmonds (1965) showed that a vector x in $\mathbb{Q}^E$ belongs to the perfect matching polytope of G if and only if it satisfies the inequalities: *(i)* $x \geq 0$ (*non-negativity*), *(ii)* $x(\nabla(v)) = 1$, for all v in V (*degree constraints*) and *(iii)* $x(\nabla(S)) \geq 1$, for all odd subsets S of V (*odd set constraints*). We are interested in the problem of characterizing graphs whose perfect matching polytopes are determined by non-negativity and the degree constraints. (It is well-known that bipartite graphs have this property.) The appropriate context for studying this problem is the theory of matching covered graphs.

An edge of a graph is *admissible* if there is some perfect matching of the graph containing that edge. A graph is *matching covered* if it is connected, has at least two vertices and each of its edges is admissible. A cut C of a matching covered graph G is a tight cut if $|M \cap C| = 1$ for every perfect matching M of G, and is a *separating cut* of G if each of the two graphs obtained by shrinking a shore of G to a single vertex is also matching covered. Every tight cut is also a separating cut, but the converse is not true. A non-bipartite matching covered graph is a *brick* if it has no nontrivial tight cuts and is a *solid brick* if it has no nontrivial separating cuts. We shall show that the above-mentioned problem may be reduced to one of recognizing solid bricks. The complexity status of this problem is unknown.

This is joint work with Marcelo de Carvalho and Cláudio Lucchesi.

Independent spanning trees in 4-connected graphs (17:00 - 17:30)
Orlando Lee
Universidade Estadual de Campinas

The k-behaviour of iterated cliques graphs (17:30 - 18:00)
Aurora Morgana
Universita degli Studi di Roma "La Sapienza"

Graph theory I

Time: Thursday, 16:30 - 18:00
Organizer: Celina M.H. de Figueiredo

On Clique-inverse graphs of K_p-free graphs (16:30 - 17:00)
Cláudia Linhares
Universidade Federal do Ceará

Some properties of maximal generating trees for the clique weighted graphs of chordal graphs (17:00 - 17:30)
Silvia Tondato
Universidad Nacional de La Plata

Chordal graph extensions (17:30 - 18:00)
Loana Tito Nogueira
Universidade Federal do Rio de Janeiro

Graph theory II

Time: Tuesday, 14:00 - 16:00
Organizer: Cláudio Lucchesi

On (p, q, s)-Helly hypergraphs (14:00 - 14:30)
Fábio Protti
Universidade Federal do Rio de Janeiro

In this work, we investigate a generalization of the Helly property proposed by Voloshin. Let $p \geq 1$, $q \geq 0$ and $s \geq 0$. A hypergraph $\mathscr{H}$ is (p, q)-*intersecting* when every partial hypergraph $\mathscr{H}' \subseteq \mathscr{H}$ formed by p or less hyperedges has intersection of cardinality at least q. A hypergraph $\mathscr{H}$ is (p, q, s)-*Helly* when every partial (p, q)-intersecting hypergraph $\mathscr{H}' \subseteq \mathscr{H}$ has intersection of cardinality at least s. (According to this terminology, the usual Helly hypergraphs correspond to the case $p = 2, q = s = 1$.) It is clear that recognizing (p, q)-intersecting hypergraphs can be done in polynomial time for fixed p. When p is not fixed, we show that this problem becomes Co-NP-complete. We present a structural characterization for (p, q, s)-Helly hypergraphs. The case $q = s$ leads to a particular characterization in terms of a special bipartite graph. For fixed p, q, the above characterizations lead to a polynomial-time recognition algorithm. When p is not fixed, we show that deciding whether a hypergraph $\mathscr{H}$ is (p, q, q)-Helly is NP-hard. We conclude by extending the definition of *Helly number* in three possible ways. This is joint work with Mitre C. Dourado and Jayme L. Szwarcfiter.

On balanced graphs and some subclasses (14:30 - 15:00)
Minchih Lin
Universidad de Buenos Aires

Problem session (15:00 - 16:00)
Jayme Szwarcfiter
Universidade Federal do Rio de Janeiro

Graph theory II

Time: Thursday, 11:00 - 12:30
Organizer: Cláudio Lucchesi

Ear decompositions and conformal minors of matching covered graphs (11:00 - 11:30)
U.S.R. Murty
University of Waterloo

A *single ear* of a graph G is a path P of odd length whose internal vertices, if any, have degree two in G. A *double ear* is a pair of vertex-disjoint single ears. An *ear* is either a single or double ear. If R is an ear of a graph G, the graph obtained from G by deleting all edges and internal vertices of the constituent paths of R is denoted by $G-R$ and is said to be obtained by removing R from G. An ear R of a matching covered graph G is *removable* if $G-R$ is matching covered. An *ear decomposition* of a matching covered graph G is a sequence $G_1, G_2, \ldots, G_r$ of matching covered subgraphs of G such that *(i)* $G_1 = K_2$, *(ii)* $G_r = G$, and *(iii)* for $1 \leq i \leq r-1$, G_i is obtained from G_{i+1} by removing a removable ear from it. Lovász and Plummer have shown that every matching covered graph has an ear decomposition. (Every bipartite graph has an ear decomposition which involves the removal of single ears only. An ear decompositions of a non-bipartite matching covered graph requires the removal of at least one double ear.) For each graph G_i in an ear decomposition $G_1, G_2, \ldots, G_r$, the graph $G - V(G_i)$ has a perfect matching and, conversely, given any matching covered subgraph H of G such that $G - V(H)$ has a perfect matching, there is an ear decomposition $G_1, G_2, \ldots, G_r$ of G such that $H = G_i$ for some i. The notions of a conformal subgraph and conformal minor are motivated by this observation.

A subgraph H of a matching covered graph G is a *conformal subgraph* of G if *(i)* H is matching covered and *(ii)* $G - V(H)$ has a perfect matching. A matching covered graph H is a *conformal minor* of G if some even subdivision of H is isomorphic to a conformal subgraph of G. If H is a conformal minor of G, we shall say that G has an *H-minor* and if H is not a conformal minor of G, then G is H-free.

This talk is an introduction to the theory of conformal minors of matching covered graphs. We shall comment in particular on two problems.

Lovász showed that every non-bipartite matching covered graph has either K_4-minor or a $\bar{C}_6$-minor. Solid bricks are $\bar{C}_6$-free. We have shown that every nonsolid brick has, as a conformal minor, either $\bar{C}_6$, the Petersen graph or one of the two graphs we denote by R_8 and R_{10}. The problems of characterizing K_4-free and $\bar{C}_6$-free graphs are very much open.

An orientation $\vec{G}$ of a matching covered graph G is called a *Pfaffian orientation* of G if, for every conformal circuit C of G, the number of edges of C whose directions in $\vec{G}$ agree with any given sense of orientation of C is odd. (In this case, the determinant of the adjacency matrix of $\vec{G}$ is the square of the number of perfect matchings of G.) The complete bipartite graph $K_{3,3}$ has no Pfaffian orientation. Little showed that a bipartite matching covered graph G has a Pfaffian orientation if and only if G is $K_{3,3}$-free. One of the deepest results in this theory is the characterization of braces that are $K_{3,3}$-free (due to Robertson, Seymour and Thomas, and McCuaig).

This is joint work with Marcelo de Carvalho and Cláudio Lucchesi.

List Partition Problem for graphs (11:30 - 12:00)
Elaine Eschen
West Virginia University

The k-partition problem is: Given a graph G and a positive integer k, partition the vertices of G into at most k parts $A_1, A_2, \ldots, A_k$, where it may be specified that A_i induce a stable set, a clique, or an arbitrary subgraph, and pairs A_i, A_j (i not equal to j) be completely non-adjacent, completely adjacent, or arbitrarily adjacent. The list k-partition problem generalizes the k-partition problem by specifying for each vertex x a list $L(x)$ of parts in which it is allowed to be placed. Many well-known graph problems can be formulated as list k-partition problems: e.g. 3-colorability, clique cutset, stable cutset, homogeneous set, skew partition, and 2-clique cutset.

We classify, with the exception of two polynomially equivalent problems, each list 4-partition problem as either solvable in polynomial time or NP-complete. In doing so, we provide polynomial-time algorithms for many problems whose polynomial-time solvability was open, including the list 2-clique cutset problem. This also allows us to classify each list generalized 2-clique cutset problem and list generalized skew partition problem as solvable in polynomial time or NP-complete.

This is joint work with K. Cameron, C.T. Hoang, and R. Sritharan.

A new upper bound for the Homogeneous Set Sandwich Problem (12:00 - 12:30)
Vinicius Gusmão
Universidade Federal do Rio de Janeiro

A homogeneous set is a non-trivial module of a graph, i.e. a non-unitary, proper subset H of a graph's vertices such that all vertices in H have the same neighbors outside H. Given two graphs $G_1(V, E_1), G_2(V, E_2)$, the Homogeneous Set Sandwich Problem asks whether there exists a sandwich graph $G_S(V, E_S)$, $E_1 \subseteq E_S \subseteq E_2$, which has a homogeneous set. Two years ago, Tang *et al.* proposed an interesting $O(\triangle_1 \cdot n^2)$ algorithm for this problem, which has been considered its most efficient algorithm since. We show the incorrectness of their algorithm and present a new deterministic algorithm for the Homogeneous Set Sandwich Problem, whose $O(m_1\overline{m_2})$ time complexity becomes its current upper bound.

Graph theory II

Time: Friday, 9:30 - 10:00
Organizer: Cláudio Lucchesi

Improving a minimal fill algorithm (9:30 - 10:00)
Jeremy Spinrad
Vanderbilt University

This talk reduces the time bound for computing a minimal fill in a dense graph. We use matrix multiplication to reduce the running time whil computing the same ordering of vertices as Tarjan's Lex-M algorithm for solving the problem. As a consequence, we get faster algorithms for decomposing graphs using clique cutsets.

Probabilistic combinatorics

Time: Monday, 16:30 - 18:00
Organizer: Yoshiharu Kohayakawa

List-coloring when χ is near n (16:30 - 17:00)
Bruce Reed
McGill University

On the connected domination number (17:00 - 17:30)
Martín Matamala
Universidad de Chile

A set of vertices X of a graph G is a dominating set if each vertex not in X has a neighbor in X. The domination number of a graph G, denoted $\gamma(G)$, is the smallest integer m such that there exists a dominating set X of G of size m. A dominating set X such that the graph induced by X is connected is called a dominating connected set. The connected domination number, $\gamma_c(G)$, is defined similarly. In this note we use probabilistic methods to improve the upper bound given by Caro, West and Yuster (SIAM J. Disc. Methods 2000) for $\gamma_c(G)$ in terms of the size of G and its minimum degree.

Probabilistic combinatorics

Time: Thursday, 11:00 - 12:30
Organizer: Yoshiharu Kohayakawa

A theory of computing symposia (11:00 - 11:30)
Prabhakar Raghavan
Verity and *Stanford University*

We consider the problem of scheduling a conference to achieve the benefits in time-compression of parallel sessions, but without the associated high degree of conflict between talks. We describe a randomized construction meetings these goals that we analyze based on an expansion property of an associated graph. We also give algorithms for attendees scheduling their time within such a conference as well as algorithms for verifying a proposed conference schedule.

Expected length of the longest common subsequence for words over large alphabets (11:30 - 12:30)
Marcos Kiwi
Universidad de Chile

Consider the length L of the longest common subsequence (LCS) of two randomly uniformly and independently chosen n character words over a k–ary alphabet. Subadditivity arguments yield that $\mathbb{E}(L)/n$ converges to a constant γ_k. Under suitable assumptions on k we settle a conjecture of Sankoff and Mainville from the early 80's claiming that $\gamma_k\sqrt{k} \to 2$ when $n \to \infty$.

Our work elicits a speculated upon connection between several probabilistic models of sequence comparison and the behavior of the celebrated longest increasing sequence (LIS) problem (also referred too as Ulam's problem).

The talk will survey results on both the LCS and LIS problem, place them under a common framework, and focus on the exact asymptotic results that can be derived. Several natural questions that arise from stating such framework will be discussed.

This is joint work with Martin Loebl and Jiří Matoušek.

Probabilistic combinatorics

Time: Thursday, 15:00 - 16:00
Organizer: Yoshiharu Kohayakawa

Random walks on random graphs (15:00 - 16:00)
Alan Frieze
Carnegie Mellon University

We give tight estimates for the cover time of random graphs and random regular graphs. We also give estimates for the number of vertices visited in a random walk on a randomly growing "web-graph". This is joint work with Colin Cooper.

Probabilistic combinatorics

Time: Friday, 10:00 - 11:00
Organizer: Yoshiharu Kohayakawa

Convergence times and decay of the return probability for random walks with random rates in $\mathbb{Z}^d$ (10:00 - 10:30)
Luiz Renato Fontes
Universidade de São Paulo

We consider symmetric random walks in the d-dimensional torus whose rates come from a family of i.i.d. random variables with a polynomial tail at the origin, and derive estimates for times of convergence to equilibrium as a function of the volume which are sharp in log scale. We also consider the decay of the return probability in infinite volume and obtain sharp estimates in the annealed case. Spectral techniques are key to all the derivations. This is joint work with Pierre Mathieu.

$p_c(\mathcal{G})$ for the frog model is not a monotonic function of $\mathcal{G}$ (10:30 - 11:00)
Fábio Prates Machado
Universidade de São Paulo

We show that $p_c(\mathcal{G})$, the critical probability for the frog model on a graph $\mathcal{G}$, is not a monotonic function. This answers a question presented in Alves *et al.*. The non-monotonicity is an unexpected fact as the frog model is a percolation model.

The frog model is a discrete time particle system on graphs, known as frog model with death. In this model particles move as a discrete time independent simple symmetric random walks (SSRWs) on the vertices of a graph $\mathcal{G}$ dying, after a geometrically distributed random lifetime. Initially there is an independent random number of particles at each site of $\mathcal{G}$. A site of $\mathcal{G}$ is singled out and called its root. All particles are inactive at time zero, except for those that are placed at the root. At each instant of time, each active particle may die with probability $(1-p)$. Once an active particle survives, it jumps - along edges - on one of its nearest neighbors sites, chosen with uniform probability, performing a SSRW on the vertices of $\mathcal{G}$. Up to the time it dies, it activates all inactive particles it hits along its way. From the moment they are activated on, every such particle starts to walk, performing exactly the same dynamics, independent of everything else.

This is joint work with L.R. Fontes and A. Sarkar.