LAGOS 2017

IX Latin and American Algorithms, Graphs, and Optimization Symposium

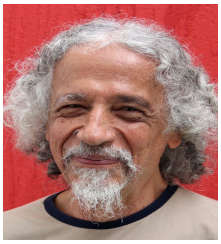
September 11-15, 2017

CIRM, Marseille, France

lagos2017-org@lipn.univ-paris13.fr

Celebrating the 150th anniversary of two
of the most influential researches, colleagues and friends,

Jayme Szwarcfiter



Thomas Liebling

Sponsored by

LAGOS 2017 – IX Latin and American Algorithms, Graphs, and Optimization Symposium

Centre International de Rencontres Mathématiques (CIRM), Luminy, Marseilles, France
September 11th – September 15th, 2017

It is a pleasure to extend our warmest welcome to the IX Latin and American Algorithms, Graphs, and Optimization Symposium (LAGOS 2017). This Symposium is taking place at CIRM in Marseille, France from September 11th to September 15th, 2017, gathering participants from all over the world. By now, this Latin and American conference is a well-established major event for the graphs and optimization community, as demonstrated by the ever increasing interest in it by high ranking researchers from the Americas and Europe.

This edition of LAGOS gives us the opportunity to celebrate the 150th anniversary of two of the most influential researches, colleagues and friends, Jayme Luiz Szwarcfiter (UFRJ, Brazil) and Thomas Liebling (EPFL, Switzerland). For this special edition, LAGOS Symposium is hosted by France, a Latin Country which has always collaborated with the development of the science in the Latin American countries. We also are able to welcome 11 prominent researchers from our field taking part of LAGOS 2017 as invited speakers.

We have received a total of 124 contributed submissions, and 54 of them have been accepted for presentation during the conference. We gratefully acknowledge the Program Committee members and the reviewers for the thorough and detailed refereeing of the contributed submissions. The refereeing process turned out to be a hard task, as we have received a huge number of excellent submissions. We would also like to thank the authors of the contributed papers, and apologize to the authors of the rejected papers due to the lack of enough conference time and space.

We are indebted to Olivia Barbarroux and the people from the CIRM for the local support.

We hope that you enjoy LAGOS 2017 and your stay at the CIRM!

September, 2017
F. Bassino, F. Bonomo, L. Pournin, M. Valencia-Pabon, J. C. Vera

Program Committee

Liliana Alcón (UNLP, Argentina)
Frédérique Bassino (Paris 13, France)*
Flavia Bonomo (UBA, Argentina)*
Henning Bruhn-Fujimoto (Ulm, Germany)
Cid Carvalho de Souza (UNICAMP, Brazil)
Victor Chepoi (LIF Marseille, France)
Mitre Dourado (UFRJ, Brazil)
Cristina G. Fernandes (USP, Brazil)
Luciano Grippo (UNGS, Argentina)
Frédéric Havet (Nice, France)
Frédéric Maffray (G-Scop, France)
Javier Marenco (UNGS, Argentina)
Martín Matamala (U Chile, Chile)
Eduardo Moreno (U Adolfo-Ibáñez, Chile)
Graciela Nasini (UNR, Argentina)
Miguel Pizaña (UAM, Mexico)
Lionel Pournin (Paris 13, France)*
Bernard Ries (Fribourg, Switzerland)
Gelasio Salazar (UASLP, Mexico)
Rudini Sampaio (UFC, Brazil)
Oliver Schaudt (Cologne, Germany)
Gautier Stauffer (G-Scop, France)
Maya Stein (U Chile, Chile)
Nicolás Stier (Facebook, USA)
Mario Valencia-Pabon (Paris 13, France)*
Juan C. Vera (Tilburg, Netherlands)*
Annegret Wagler (Clermont, France)
Luis Fernando Zuluaga (Lehigh, USA)

*co-chairs

Steering Committee

Guillermo Durán (UBA, Argentina & U Chile)
Celina M. H. de Figueiredo (UFRJ, Brazil)

Organizing Committee

Frédérique Bassino (Paris 13, France)
Flavia Bonomo (UBA, Argentina)
Lionel Pournin (Paris 13, France)
Mario Valencia-Pabon (Paris 13, France)
Juan C. Vera (Tilburg, Netherlands)

Local Support at CIRM

Olivia Barbarroux

Reviewers of contributed abstracts

Aida Abiad
Eduardo Álvarez-Miranda
Joergen Bang-Jensen
Laurent Beaudou
Fabricio S. Benevides
Julien Bensmail
Katherine Benson
Silvia Bianchi
Guillaume Blin
Marthe Bonamy
Flavia Bonomo
Andrei Braga
Fábio Botler
Henning Bruhn-Fujimoto
Sergio Cabello
Rafaek G. Cano
Rodrigo Carrasco
Moisés Carvalho
Steven Chaplick
Jeremie Chalopin
Edgar Chavez
Victor Chepoi
Rayan Chikhi
François Clautiaux
Julien Clément
Denis Cornaz
Christophe Crespelle
Alexandre Cunha
Konrad Kazimierz Dabrowski
Guillaume Damiand
Andreas Darmann
Pablo De Caria
Rosiane De Freitas
Paloma De Lima
Fabien De Montgolfier
Marc Demange
Vinícius F. Dos Santos
Eric Duchene
Philippe Duchon
Mariana Escalante
Daniel Espinoza
Cristina G. Fernandes
Florencia Fernández Slezak
Alexandre Freire
Yuri Frota
Elke Fuchs
Fabio Furini
André L. P. Guedes
Laura Guellert
Marisa Gutierrez
Pierre-Cyrille Heam
Hiep Han
Tatiana Romina Hartinger
Frédéric Havet
Matthias Heinlein
Irene Heinrich
Petr Hlineny
Edna Hoshino
Andrea Jimenez
Frantisek Kardos
Ringi Kim
Kolja Knauer
Tim Kos
Sven Krumke
Mathieu Lacroix
Valeria Leoni
Benjamin Leveque
Mateusz Lewandowski
Carlos Vinicius Lima
Bernardo Llano
Eugen Mandrescu
Javier Marenco
Martín Matamala
María Pía Mazzoleni
Marni Mishna
Thierry Monteil
Juan Montellano
Mercè Mora
Eduardo Moreno
Andrea Munaro
Graciela Nasini
Nicolas Nisse
Fabiano Oliveira
Rodolfo Oliveira
Mika Olsen
Bernardo Pagnoncelli
Daniel Paulusma
Boram Park
Aline Parreau
Lehilton L. C. Pedrosa
Ignacio M. Pelayo
Iztok Peterin
Christophe Picouleau
Miguel Pizaña
Daniel Posner
Lionel Pournin
Miguel Raggi
Dieter Rautenbach
Vlady Ravelomanana
Bruce Reed
Bernard Ries
Ismael Ariel Robles
Martín Safe
Gelasio Salazar
Rudini Sampaio
Oliver Schaudt
Jean-Sebastien Sereni
Daniel Severin
Luidi Simonetti
Lingsheng Shi
Francisco Soulignac
Uéverton Souza
Gautier Stauffer
Maya Stein
Nicolás Stier
Pablo Torres
Vilmar Trevisan
Sebastián Urrutia
Mario Valencia-Pabon
Petru Valicov
Yann Vaxes
Juan C. Vera
José Verschae
Laurent Viennot
Alfredo Viola
Annegret Wagler
Don Wagner
Eduardo Xavier
Liana Yepremyan
José Zamora
Luis Fernando Zuluaga

Invited Speakers

Maria Chudnovsky *(Princeton University, USA)*
Coloring graphs with forbidden induced subgraphs

Chistoph Dürr *(CNRS, Univesité Pierre et Marie Curie, France)*
An adversarial model for optimization and testing

Marcos Kiwi *(Universidad de Chile, Chile)*
The Random Hyperbolic Graph Model

Monique Laurent *(Tilburg University and CWI Amsterdam, Netherlands)*
Combinatorial and algorithmic properties of Robinsonian matrices

Claudia Linhares Sales *(Universidade Federal do Ceará, Brazil)*
***b*-colorings: an structural overview**

Martin Milanič *(IAM and FAMNIT, University of Primorska, Koper, Slovenia)*
Reconstructing perfect phylogenies via binary matrices, branchings in DAGs, and a generalization of Dilworth's theorem

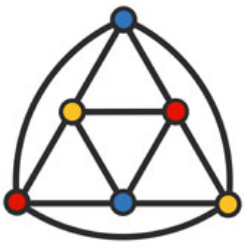
Fabio Protti *(Universidade Federal Fluminense, Brazil)*
A general framework for path convexities

Dieter Rautenbach *(Universität Ulm, Germany)*
Restricted Types of Matchings

Martín Safe *(Universidad Nacional del Sur, Argentina)*
Forbidden subgraphs of some graphs representable by arcs on a circle

Alexander Schrijver *(University of Amsterdam and CWI Amsterdam, Netherlands)*
The Partially Disjoint Paths Problem

András Sebő *(CNRS, Université Grenoble Alpes, France)*
Matchings, Matroids and Polyhedra for Approximating the Traveling Salesman Problem



LAGOS 2017

IX Latin and American Algorithms, Graphs, and Optimization Symposium

September 11-15, 2017
CIRM, Marseille, France
lagos2017-org@lipn.univ-paris13.fr

LAGOS 2017 – Detailed Program

Sunday, September 10th

14:00 - Arrival at CIRM

19:30 Cold dinner

Monday, September 11th

07:30 - 08:45 Breakfast

09:00 Opening ceremony (Amphi)

10:00 Plenary Session (Amphi). Chair: Antoine Deza
Chistoph Dürr: An adversarial model for optimization and testing 10

11:00 Coffee break

11:30 Amphi. Chair: Annegret K. Wagler
Recovery of disrupted airline operations using k-Maximum Matching in graphs
by *Julien Bensmail, Valentin Garnero, Nicolas Nisse⋆, Alexandre Salch and Valentin Weber* 11
Minimum density of identifying codes of king grids
by *Rennan Dantas, Frédéric Havet⋆ and Rudini Sampaio* 12

Tuesday, September 12th

17:30 **Room A.** Chair: Rosiane de Freitas
Fleet management for autonomous vehicles using flows in time-expanded networks
by *Sahar Bsaybes, Alain Quilliot and Annegret K. Wagler*⋆ 35
The minimum chromatic violation problem: a polyhedral study
by *Mónica Braga, Diego Delle Donne, Mariana Escalante*⋆*, Javier Marenco, María Elisa Ugarte and María del Carmen Varaldo* 36
A linear-time algorithm for the identifying code problem on block graphs
by *Gabriela R. Argiroffo, Silvia M. Bianchi*⋆*, Yanina Lucarini and Annegret K. Wagler* 37

19:30 **Dinner**

Wednesday, September 13th

07:30 - 08:45 **Breakfast**

09:00 **Plenary Session (Amphi).** Chair: Martín Matamala
Marcos Kiwi: The Random Hyperbolic Graph Model 38

10:05 **Amphi.** Chair: Celina M. H. Figueiredo
On Efficient Domination for Some Classes of H-Free Chordal Graphs
by *Andreas Brandstädt*⋆ *and Raffaele Mosca* 39
k-quasi-transitive digraphs of large diameter
by *César Hernández-Cruz*⋆ *and Jesús Alva-Samos* 40

10:05 **Room A.** Chair: Arman Boyacı
Möbius Stanchion Systems
by *Lucas Isenmann*⋆ *and Timothée Pecatte* 41
An Approximation Algorithm for the p-Hub Median Problem
by *Camile Frazão Bordini*⋆ *and André Luís Vignatti* 42

11:00 **Coffe break**

11:25 **Amphi.** Chair: Irena Penev
On the recognition of neighborhood inclusion posets
by *Pablo De Caria*⋆ 43
Detecting an induced subdivision of K_4
by *Ngoc Khang Le*⋆ 44

11:25 **Room A.** Chair: Uéverton S. Souza
On Type 2 Snarks and Dot Products
by *Luana Cordeiro*⋆*, Simone Dantas and Diana Sasaki* 45
AVD-edge coloring on powers of paths
by *Mayara M. Omai*⋆*, Sheila M. de Almeida and Diana Sasaki* 46

12:30 **Lunch**

14:00 **Excursion in boat**

19:30 Dinner

Thursday, September 14th

07:30 - 08:45 Breakfast

09:00 **Plenary Session (Amphi).** Chair: Luciano Grippo
Martin Milanič: Reconstructing perfect phylogenies via binary matrices, branchings in DAGs, and a generalization of Dilworth's theorem 47

10:05 **Amphi.** Chair: Lionel Pournin
Facets of the polytope of legal sequences
by *Manoel Campêlo and Daniel Severín** 49

10:05 **Room A.** Chair: Mario Valencia-Pabon
Hyper-Hamiltonicity in graphs: some sufficient conditions
by *Renata R. Del-Vecchio*, Cybele T. M. Vinagre and Guilherme B. Pereira* 50

10:30 Coffe break

10:55 **Amphi.** Chair: Lionel Pournin
Scaffolding skeletons using spherical Voronoi diagrams
by *Alvaro Javier Fuentes Suárez* and Evelyne Hubert* 51

10:55 **Room A.** Chair: Mario Valencia-Pabon
On graphs with a single large Laplacian eigenvalue
by *Luiz Emilio Allem, Antonio Cafure, Ezequiel Dratman, Luciano N. Grippo*, Martín Safe and Vilmar Trevisan* 52

11:25 **Plenary Session (Amphi).** Chair: Andreas Brandstädt
Dieter Rautenbach: Restricted Types of Matchings 53

12:30 Lunch

14:30 **Plenary Session (Amphi).** Chair: Pavol Hell
Fabio Protti: A general framework for path convexities 54

15:35 **Amphi.** Chair: Luis Pedro Montejano
Graphs admitting antimagic labeling for arbitrary sets of positive integers
by *Martín Matamala* and José Zamora* 55
The Geodetic Hull Number is Hard for Chordal Graphs
by *Stéphane Bessy, Mitre C. Dourado, Lucia D. Penso* and Dieter Rautenbach* . . 56
Ruling out FPT algorithms for Weighted Coloring on forests
by *Júlio Araújo, Julien Baste and Ignasi Sau** 57

15:35 **Room A.** Chair: Fábio Botler

17:00 **Coffee break**

17:30 **Amphi.** Chair: Ignasi Sau

17:30 **Room A.** Chair: Frédérique Bassino

19:30 **Special Dinner !**

Friday, September 15th

07:30 - 08:45 **Breakfast**

09:00 **Plenary Session (Amphi).** Chair: Frédéric Havet

10:05 **Amphi.** Chair: Maycon Sambinelli

10:05 **Room A.** Chair: Christophe Picouleau

11:00 **Coffe break**

11:25 **Amphi.** Chair: Pablo De Caria

11:25 **Room A.** Chair: Mario Valencia-Pabon

12:30 **Lunch**

15:00 **Departure from CIRM**

Invited Plenary Lecture

An adversarial model for optimization and testing

Chistoph Dürr

CNRS, Univesité Pierre et Marie Curie, France

Abstract

One practical difficulty in computing a solution to some combinatorial optimization problem is that the data might be known only within some interval of uncertainty. In some cases it might be possible to tests specific variables of the input and obtain their exact value. A natural task in this model is to minimize the number of tests until it is possible to produce an optimal solution. This problem has been addressed in the context of computing a minimum spanning tree for a graph where edge weights are given within some uncertainty intervals, but also for the knapsack problem and a single-machine scheduling problem. In the later the processing time of a job can potentially be reduced (by an a priori unknown amount) by testing the job. Testing a job j takes one unit of time and may reduce its processing time from the given upper limit $\bar{p}_j$ (which is the time taken to execute the job if it is not tested) to any value between 0 and $\bar{p}_j$. This setting is motivated e.g. by applications where a code optimizer can be run on a job before executing it.

This talk with be a gentle introduction into this new model, reveal key algorithmic ideas and present more in detail the later scheduling problem.

Recovery of disrupted airline operations using k-Maximum Matching in graphs

Julien Bensmail[1], Valentin Garnero[1], Nicolas Nisse[1], Alexandre Salch[2] and Valentin Weber[2]

[1] *Université Côte d'Azur, CNRS, Inria, I3S, France*
[2] *Innovation & Research, Amadeus IT*

Abstract

By Berge's theorem, finding a *maximum matching* in a graph relies on *the use* of *augmenting paths*. When no further constraint is added, Edmonds' algorithm allows to compute a maximum matching in polynomial time by sequentially augmenting such paths. Motivated by applications in the scheduling of airline operations, we consider a similar problem where only paths of bounded length can be augmented. Precisely, let $k \geq 1$ be an odd integer, a graph G and a matching M of G. What is the maximum size of a matching that can be obtained from M by *using* only augmenting paths of length *at most* k?

We first prove that this problem can be solved in polynomial time for $k \leq 3$ in any graph and that it is NP-complete for any fixed $k \geq 5$ in the class of planar bipartite graphs of degree at most 3 and arbitrarily large girth. We then prove that this problem is in P, for any k, in several subclasses of trees such as caterpillars or trees with all vertices of degree at least 3 "far appart". Moreover, this problem can be solved in time $O(n)$ in the class of n-node trees when k and the maximum degree are fixed parameters. Finally, we consider a more constrained problem where only paths of length *exactly* k can be augmented. We prove that this latter problem becomes NP-complete for any fixed $k \geq 3$ and in trees when k is part of the input.

Keywords: Graph; Matching; Augmenting paths; Complexity; Trees.

Minimum density of identifying codes of king grids

Rennan Dantas, Rudini M. Sampaio

Universidade Federal do Ceará, Fortaleza, Brazil

Frédéric Havet

Université Côte d'Azur, CNRS, I3S, INRIA, France

Abstract

A set $C \subseteq V(G)$ is an *identifying code* in a graph G if for all $v \in V(G)$, $C[v] \neq \emptyset$, and for all distinct $u, v \in V(G)$, $C[u] \neq C[v]$, where $C[v] = N[v] \cap C$ and $N[v]$ denotes the closed neighbourhood of v in G. The minimum density of an identifying code in G is denoted by $d^*(G)$. In this paper, we study the density of king grids which are strong product of two paths. We show that for every king grid G, $d^*(G) \geq 2/9$. In addition, we show this bound is attained only for king grids which are strong products of two infinite paths. Given $k \geq 3$, we denote by $\mathcal{K}_k$ the (infinite) king strip with k rows. We prove that $d^*(\mathcal{K}_3) = 1/3$, $d^*(\mathcal{K}_4) = 5/16$, $d^*(\mathcal{K}_5) = 4/15$ and $d^*(\mathcal{K}_6) = 5/18$. We also prove that $\frac{2}{9} + \frac{8}{81k} \leq d^*(\mathcal{K}_k) \leq \frac{2}{9} + \frac{4}{9k}$ for every $k \geq 7$.

Keywords: Identifying code, King grid, Discharging Method.

Biclique graph of bipartite permutation graphs

M. Groshaus [a] A. L. P. Guedes [b] J. P. Puppo [c]

[a] *CONICET, Buenos Aires, Argentina*

[b] *Universidade Federal do Paraná, Curitiba, Brazil*

[c] *Universidad Tecnológica Nacional, Santa Fé, Argentina*

Abstract

The biclique graph $KB(G)$ is the intersection graph of bicliques of a graph G. The aim of our work is to recognize graphs that are biclique graphs of bipartite permutation graphs. In this paper we prove that the biclique graph of a bipartite permutation graph is a $K_{1,4}$-free interval graph, we present a characterization of such graphs and a characterization of a subclass that lead to a polynomial time recognition algorithm.

Keywords: Bicliques; Biclique graphs; Bipartite permutation graphs.

A column generation approach for the strong network orientation problem

Alexandre Xavier Martins [a,c], Christophe Duhamel [b]
Andréa Cynthia Santos [c],

[a] *Universidade Federal de Ouro Preto, João Monlevade, Brazil*

[b] *Universite Clermont Auvergne, CNRS, LIMOS, Clermont-Ferrand, France*

[c] *ICD-LOSI, Université de Technologie de Troyes, Troyes, France.*

Abstract

In this study, an aggregated flow formulation and a column generation strategy are proposed for the Strong Network Orientation Problem (SNOP) that consists in setting an orientation for each edge in a given graph, such that the resulting digraph is strongly connected and the total travel distance between all pairs of vertices is minimized. SNOP is NP-hard and finds application in urban networks.

Keywords: Network design, road networks, strong connectivity, column generation.

Invited Plenary Lecture

Matchings, Matroids and Polyhedra for Approximating the Traveling Salesman Problem

András Sebő

CNRS, Université Grenoble Alpes, France

Abstract

During the last five years, a series of improvements have been made concerning approximation algorithms for the Traveling Salesman Problem: for the special case of distance metrics of graphs (graph-TSP), for the generalization where the salesman starts from and arrives at different fixed vertices (general s-t-path TSP), and for proving some weaker versions of the forty years old "general, four-third-approximation-and-gap conjecture" (uniform covers by tours).

While Matching Theory is a usual tool for the TSP, in the most recent improvements two other pillars of combinatorial optimization appeared: matroids (intersection and union), and polyhedra, in a new way, providing links between the TSP and classical, exact combinatorial optimization.

In this talk I wish to tell some successful ideas, report about our most recent improvements and mention some old and new conjectures.

Ramsey for complete graphs with a dropped edge or a triangle

Luis Pedro Montejano

Centro de Investigación en Matemáticas, CIMAT
Guanajuato, México

Jonathan Chappelon and Jorge Luis Ramírez Alfonsín

Institut Montpelliérain Alexander Grothendieck
Université de Montpellier
Montpellier, France

Abstract

Let $K_{[k,t]}$ be the complete graph on k vertices from which a set of edges, induced by a clique of order t, has been dropped (note that $K_{[k,1]}$ is just K_k). In this paper we study $R(K_{[k_1,t_1]}, \ldots, K_{[k_r,t_r]})$ (the smallest integer n such that for any r-edge coloring of K_n there always occurs a monochromatic $K_{[k_i,t_i]}$ for some i).

We first present a general upper bound (containing the well-known Graham-Rödl upper bound for complete graphs in the particular case when $t_i = 1$ for all i). We then focus our attention when $r = 2$ and dropped cliques of order 2 and 3 (edges and triangles). We give the exact value for $R(K_{[n,2]}, K_{[4,3]})$ and $R(K_{[n,3]}, K_{[4,3]})$ for all $n \geq 2$.

Keywords: Ramsey number, recursive formula.

Computational determination of the largest lattice polytope diameter

Nathan Chadder

Department of Computing and Software
McMaster University
Hamilton, Canada

Antoine Deza

Department of Computing and Software
McMaster University
Hamilton, Canada

Abstract

A lattice (d, k)-polytope is the convex hull of a set of points in dimension d whose coordinates are integers between 0 and k. Let $\delta(d, k)$ be the largest diameter over all lattice (d, k)-polytopes. We develop a computational framework to determine $\delta(d, k)$ for small instances. We show that $\delta(3, 4) = 7$ and $\delta(3, 5) = 9$; that is, we verify for $(d, k) = (3, 4)$ and $(3, 5)$ the conjecture whereby $\delta(d, k)$ is at most $\lfloor (k + 1)d/2 \rfloor$ and is achieved, up to translation, by a Minkowski sum of lattice vectors.

Keywords: Lattice polytopes, edge-graph diameter, enumeration algorithm

Intersection Graphs of Orthodox Paths in Trees

Claudson Ferreira Bornstein

DCC-IM
Federal University of Rio de Janeiro
Rio de Janeiro, Brazil

José Wilson Coura Pinto

PESC-COPPE
Federal University of Rio de Janeiro
Rio de Janeiro, Brazil

Dieter Rautenbach

Institute of Optimization and Operations Research
Ulm University
Ulm, Germany

Abstract

We study the graph classes ORTH$[h, s, t]$ introduced by Jamison and Mulder, and focus on the case $s = 2$, which is closely related to the well-known VPT and EPT graphs. We collect general properties of the graphs in ORTH$[h, 2, t]$, and provide a characterization in terms of tree layouts. Answering a question posed by Golumbic, Lipshteyn, and Stern, we show that ORTH$[h + 1, 2, t] \setminus$ ORTH$[h, 2, t]$ is non-empty for every $h \geq 3$ and $t \geq 3$. We derive decomposition properties, which lead to efficient recognition algorithms for the graphs in ORTH$[h, 2, 2]$ for every $h \geq 3$. Finally, we show that the graphs in ORTH$[3, 2, 3]$ are line graphs of planar graphs.

Keywords: Intersection graph, (h, s, t)-representation, orthodox (h, s, t)-representation, line graph, chordal graph

Maximum Cuts in Edge-colored Graphs

Rubens Sucupira [a], Luerbio Faria [a], Sulamita Klein [b]
Ignasi Sau [c,d], and Uéverton S. Souza [e]

[a] *IME, Universidade Estadual do Rio de Janeiro, Rio de Janeiro, Brasil*

[b] *IM, COPPE, Universidade Federal do Rio de janeiro, Rio de Janeiro, Brasil*

[c] *CNRS, LIRMM, Université de Montpellier, Montpellier, France*

[d] *Departamento de Matemática, Universidade Federal do Ceará, Fortaleza, Brasil*

[e] *IC, Universidade Federal Fluminense, Niterói, Brasil*

Abstract

The input of the Maximum Colored Cut problem consists of a graph $G = (V, E)$ with an edge-coloring $c : E \to \{1, 2, 3, \ldots, p\}$ and a positive integer $k > 0$, and the question is whether G has a nontrivial edge cut using at least k colors. The Colorful Cut problem has the same input but asks for a nontrivial edge cut using *all* colors. Unlike what happens for the classical Maximum Cut problem, we prove that both problems are NP-complete even on complete, planar, or bounded treewidth graphs. Furthermore, we prove that Colorful Cut is NP-complete even when each color class induces a clique of size at most 3, but is trivially solvable when each color induces a K_2. On the positive side, we prove that Maximum Colored Cut is fixed-parameter tractable when parameterized by either k or p, and that it admits a cubic kernel in both cases.

Keywords: colored cuts, edge cuts, max cut, planar graph, polynomial kernel.

Invited Plenary Lecture

Forbidden subgraphs of some graphs representable by arcs on a circle

Martín Safe

Universidad Nacional del Sur, Argentina

Abstract

Given a family of arcs on a circle, its *intersection graph* has one vertex for each set of the family, and two of its vertices are adjacent if and only if the corresponding arcs have nonempty intersection. A family of arcs on a circle is *Helly* if every nonempty subfamily of mutually intersecting arcs has nonempty intersection. A family of arcs on a circle is *normal* if no two arcs of the family cover the whole circle.

A graph is a *circular-arc graph* if it is the intersection graph of a family of arcs on a circle. If the family of arcs can be chosen to be Helly, the graph is called a *Helly circular-arc graph*. If the family can be chosen to be Helly and normal simultaneously, the graph is known as a *normal Helly circular-arc graph*.

A graph is *concave-round* (sometimes also a *Tucker circular-arc graph*) if there is an arrangement of its vertices on a circle in such a way that the closed neighborhood of each vertex (i.e., the set consisting of the vertex and its neighbors) forms an arc in the circular arrangement.

In this talk, we will present some results on Helly circular-arc graphs, normal Helly circular-arc graphs, and concave-round graphs. We will discuss minimal forbidden induced subgraph characterizations as well as linear-time algorithms for finding one of the corresponding forbidden subgraphs.

Results on normal Helly circular-arc graphs are joint work with Yixin Cao and Luciano Grippo.

Invited Plenary Lecture

Combinatorial and algorithmic properties of Robinsonian matrices

Monique Laurent

Tilburg University and CWI Amsterdam, Netherlands

Abstract

Robinsonian matrices are structured matrices that have been introduced in the 1950's by the archeologist W.S. Robinson for chronological dating of Egyptian graves.
A symmetric matrix is said to be Robinsonian if its rows and columns can be simultaneously reordered in such a way that the entries are monotone nondecreasing in the rows and columns when moving toward the main diagonal. Robinsonian matrices can be seen as a matrix analog of unit interval graphs, which are precisely the graphs having a Robinsonian adjacency matrix. We will discuss several aspects of Robinsonian matrices: links to unit interval graphs; new efficient combinatorial recognition algorithm based on Similarity-First Search, a natural extension to weighted graphs of Lex-BFS; structural characterization by minimal forbidden substructures; and application to tractable instances of the Quadratic Assignment Problem.

Correspondence Homomorphisms to Reflexive Graphs

Tomás Feder

268 Waverley St., Palo Alto, CA 94301, USA

Pavol Hell

School of Computing Science
Simon Fraser University
Burnaby, B.C., Canada V5A 1S6

Abstract

Correspondence homomorphisms are a common generalization of homomorphisms and of correspondence colourings. For a fixed reflexive target graph H, the problem is to decide whether an input graph G, with each edge labeled by a pair of permutations of $V(H)$, admits a homomorphism to H 'corresponding' to the labels. We classify the complexity of this problem as a function of H. It turns out that there is dichotomy – each of the problems is polynomial or NP-complete. While most graphs H yield NP-complete problems, there is an interesting polynomial case when the problem can be solved by Gaussian elimination. We also classify the complexity of the analogous correspondence list homomorphism problems.

Keywords: Homomorphism, dichotomy, NP-completeness

Minimum Linear Arrangements

Rafael Andrade [a,b], Tibérius Bonates [a,b], Manoel Campêlo [a,b], and Mardson Ferreira [a,c]

[a] *Universidade Federal do Ceará*
Campus do Pici, BL 910, CEP 60.455-760 - Fortaleza, Ceará, Brasil.

[b] *Departamento de Estatística e Matemática Aplicada*

[c] *Programa de Mestrado e Doutorado em Ciência da Computação*

Abstract

Let $G = (V, E)$ be a simple undirected graph. Given distinct labels in $\{1, \cdots, |V|\}$ to the vertices of G, we define the weight of an edge $uv \in E$ as the absolute difference between the labels assigned to u and v. The minimum linear arrangement problem (MinLA) consists in finding a labeling of the vertices of G such that the sum of the weights of its edges is minimized. It is an NP-Hard problem whose corresponding polyhedron has a factorial number of extreme points. We propose a quadratic model for MinLA and use it to obtain a novel compact mixed integer linear programming (MILP) formulation for the problem, featuring $\mathcal{O}(|V|^2)$ variables and $\mathcal{O}(|V|^2)$ constraints. We show the correctness of the new model and discuss valid inequalities for the problem. Our findings open new insights on the study of effective exact approaches to the problem. Computational experiments show that the new quadratic and mixed linear models performed better than existing ones in the literature for new and benchmark instances of this problem.

Keywords: minimum linear arrangement, quadratic programming, mixed integer programming, compact model.

On the local density problem for graphs of given odd-girth

Wiebke Bedenknecht

Fachbereich Mathematik, Universität Hamburg
20146 Hamburg, Germany

Guilherme Oliveira Mota

Instituto de Mathemática e Estatística
Universidade de São Paulo, Rua do Matão 1010
05508-090, São Paul, Brazil

Christian Reiher and Mathias Schacht

Fachbereich Mathematik, Universität Hamburg
20146 Hamburg, Germany

Abstract

Erdős conjectured that every n-vertex triangle-free graph contains a subset of $\lfloor n/2 \rfloor$ vertices that spans at most $n^2/50$ edges. Extending a recent result of Norin and Yepremyan, we confirm this for graphs homomorphic to so-called Andrásfai graphs. As a consequence, Erdős' conjecture holds for every triangle-free graph G with minimum degree $\delta(G) > 10n/29$ and if $\chi(G) \leq 3$ the degree condition can be relaxed to $\delta(G) > n/3$. In fact, we obtain a more general result for graphs of higher odd-girth.

Keywords: Andrásfai graphs, Erdős $(1/2, 1/50)$ - conjecture, sparse halves

The Solitaire Clobber game and correducibility

S. Dantas[a], R. Marinho[a,b], S. Tanushevski[a]

[a] *IME, Universidade Federal Fluminense, Brazil*

[b] *Dept. of Mathematics, Pontifical Catholic University of Rio de Janeiro, Brazil*

Abstract

The Solitaire Clobber game is a one-player combinatorial game played on a graph. A stone, black or white, is placed on each vertex of the graph. A move in the game consists in picking up a stone and clobbering another one of different color located on an adjacent vertex; the clobbered stone is removed and replaced by the stone that has been moved. The game has been extensively investigated in relation to the problem of minimizing the number of stones remaining on the graph when no further move in the game is possible. We study a different question: For a given graph G, what is the largest positive integer k such that for every non-monochromatic configuration of stones on G and every subset S of $V(G)$, there is a Solitaire Clobber game that empties S? We call this number the correducibility of G. For $i = 1, 2$, we show that a graph is i-correducible if and only if it is i-connected. Furthermore, for each $k \geq 1$, we prove that k-connected graphs are k-correducible. However, connectivity is a stronger condition on a graph than correducibility. Indeed, we give examples of graphs with small connectivity and arbitrary large correducibility.

Keywords: Graph theory, combinatorial games, connectivity, solitaire clobber.

Invited Plenary Lecture

The Partially Disjoint Paths Problem

Alexander Schrijver

University of Amsterdam and CWI Amsterdam, Netherlands

Abstract

The partially disjoint paths problem asks for paths $P_1, \ldots, P_k$ between given pairs of terminals, while certain pairs of paths P_i,P_j are required to be disjoint. With the help of combinatorial group theory, we show that, for fixed k, this problem can be solved in polynomial time for planar directed graphs. We also discuss related problems.
No specific foreknowledge is required.

Invited Plenary Lecture

Coloring graphs with forbidden induced subgraphs

Maria Chudnovsky

Princeton University, USA

Abstract

The problem of testing if a graph can be colored with a given number k of colors is NP-complete for every $k > 2$. But what if we have more information about the input graph, namely that some fixed graph H is not present in it as an induced subgraph? It is known that the problem remains NP-complete even for $k = 3$, unless H is the disjoint union of paths.

We consider the following two questions:

(i) For which graphs H is there a polynomial time algorithm to 3-color (or in general k-color) an H-free graph?

(ii) For which graphs H are there finitely many 4-critical H-free graphs?

This talk will survey recent progress on these questions, and in particular give a complete answer to the second one.

Clique cutsets beyond chordal graphs

Valerio Boncompagni Irena Penev Kristina Vušković

School of Computing, University of Leeds, Leeds LS2 9JT, UK.

Abstract

Truemper configurations (thetas, pyramids, prisms, and wheels) have played an important role in the study of complex hereditary graph classes (e.g. the class of perfect graphs and the class of even-hole-free graphs), appearing both as excluded configurations, and as configurations around which graphs can be decomposed. In this paper, we study the structure of graphs that contain (as induced subgraphs) no Truemper configurations other than (possibly) universal wheels and twin wheels. We also study several subclasses of this class. We use our structural results to analyze the complexity of the recognition, maximum weight clique, maximum weight stable set, and optimal vertex coloring problems for these classes. We also obtain polynomial χ-bounding functions for these classes.

Keywords: clique, stable set, vertex coloring, structure, algorithms.

Weighted upper domination number

Arman Boyacı

Bogazici University,Turkey

Jérôme Monnot

Université Paris-Dauphine, PSL Research University, CNRS, LAMSADE, 75016 Paris, France

Abstract

The cardinality of a maximum minimal dominating set of a graph is called its upper domination number. The problem of computing this number is generally **NP**-hard but can be solved in polynomial time in some restricted graph classes. In this work, we consider the complexity and approximability of the weighted version of the problem in two special graph classes: planar bipartite, split. We also provide an inapproximability result for unweighted version of this problem in regular graphs.

Keywords: Maximum weighted minimal dominating set (WUDS); **NP**-hard; inapproximability; planar bipartite; split graphs; UDS in regular graphs.

Facet-inducing inequalities and a cut-and-branch for the bandwidth coloring polytope based on the orientation mode

Bruno Dias [a] Rosiane de Freitas [a] Nelson Maculan [b]
Javier Marenco [c]

[a] *Instituto de Computação, Universidade Federal do Amazonas, Brasil.*

[b] *PESC/COPPE - Universidade Federal do Rio de Janeiro, Brasil.*

[c] *Instituto de Ciencias, Universidad Nacional de General Sarmiento, Argentina.*

Abstract

The *bandwidth coloring problem* (BCP) is a generalization of the well-known vertex coloring problem (VCP), asking colors to be assigned to vertices of a graph such that the absolute difference between the colors assigned to adjacent vertices is greater than or equal to a weight associated to the edge connecting them. In this work we present an integer programming formulation for BCP based on the orientation model for VCP. We present two families of valid inequalities for this formulation, show that they induce facets of the associated polytope, and report computational experience suggesting that these families are useful in practice.

Keywords: bandwidth coloring, integer programming, polyhedral combinatorics.

On Generalizations of the Parking Permit Problem and Network Leasing Problems

M. S. de Lima [a] M. C. San Felice [b] O. Lee [a]

[a] *Institute of Computing, Unicamp, Campinas - SP, Brazil*

[b] *Institute of Mathematics and Statistics, USP, São Paulo - SP, Brazil*

Abstract

We propose a variant of the parking permit problem, called multi parking permit problem, in which an arbitrary demand is given at each instant and one may buy multiple permits to serve it. We show how to reduce this problem to the parking permit problem, while losing a constant cost factor. We obtain a 4-approximation algorithm and, for the online setting, a deterministic $O(K)$-competitive algorithm and a randomized $O(\lg K)$-competitive algorithm, where K is the number of permit types. For a leasing variant of the Steiner network problem, these results imply $O(\lg n)$-approximation and online $O(\lg K \lg |V|)$-competitive algorithms, where n is the number of requests and $|V|$ is the size of the input metric. Also, our technique turns into polynomial-time the pseudo-polynomial algorithms by Hu, Ludwig, Richa and Schmid for the 2D parking permit problem. For a leasing variant of the buy-at-bulk network design problem, these results imply: (i) an algorithm which improves the best previous approximation, and (ii) the first competitive online algorithm.

Keywords: leasing optimization, Steiner network, buy-at-bulk network design, approximation algorithms, competitive online algorithms.

Bispindle in strongly connected digraphs with large chromatic number.

Nathann Cohen

CNRS, LRI, Univ. Paris Sud, Orsay, France

Frédéric Havet

Univ. Côte d'Azur, CNRS, I3S, INRIA, France

William Lochet

Univ. Côte d'Azur, CNRS, I3S, INRIA, and LIP, ENS Lyon, France

Raul Lopes

Departamento de Computaçao, Universidade Federal do Ceará, Fortaleza, Brazil

Abstract

A $(k_1 + k_2)$-*bispindle* is the union of k_1 (x, y)-dipaths and k_2 (y, x)-dipaths, all these dipaths being pairwise internally disjoint. Recently, Cohen et al. showed that for every $(2 + 0)$- bispindle B, there exists an integer k such that every strongly connected digraph with chromatic number greater than k contains a subdivision of B. We investigate generalisations of this result by first showing constructions of strongly connected digraphs with large chromatic number without any $(3 + 0)$-bispindle or $(2+2)$-bispindle. Then we show that for any k, there exists γ_k such that every strongly connected digraph with chromatic number greater than γ_k contains a $(2 + 1)$-bispindle with the (y, x)-dipath and one of the (x, y)-dipaths of length at least k.

Keywords: Digraph, chromatic number, subdivision.

Locally self-avoiding Eulerian tours

Tien-Nam Le

Laboratoire d'Informatique du Parallélisme
École Normale Supérieure de Lyon
Lyon, France

Abstract

It was independently conjectured by Häggkvist in 1989 and Kriesell in 2011 that given a positive integer ℓ, every simple Eulerian graph with high minimum degree (depending on ℓ) admits an Eulerian tour such that every segment of length at most ℓ of the tour is a path. Bensmail, Harutyunyan, Le and Thomassé recently verified the conjecture for 4-edge-connected Eulerian graphs. Building on that proof, we prove here the full statement of the conjecture. This implies a variant of the path case of Barát-Thomassen conjecture that any simple Eulerian graph with high minimum degree can be decomposed into paths of fixed length and possibly an additional path of shorter length.

Keywords: Eulerian graphs, path-decomposition, Barát–Thomassen conjecture.

Gallai's Conjecture for graphs with treewidth 3

Fábio Botler [a] and Maycon Sambinelli [b]

[a] *CIMFAV, Facultad de Ingeniería, Universidad de Valparaíso, Chile*

[b] *Institute of Computing, University of Campinas, Brazil*

Abstract

Gallai conjectured (1966) that the edge-set of a simple graph G with n vertices can be covered by at most $(n+1)/2$ edge-disjoint paths. Lovász (1968) verified this conjecture for graphs with at most one vertex of even degree, and Pyber (1996) verified it for graphs in which every cycle contains a vertex of odd degree. Recently, Bonamy and Perrett verified this Conjecture for graphs with maximum degree at most 5. In this paper, we verify this Conjecture for graphs with treewidth at most 3.

Keywords: Gallai's Conjecture, path decomposition, treewidth, reducing subgraph

Fleet management for autonomous vehicles using flows in time-expanded networks

Sahar Bsaybes, Alain Quilliot, Annegret K. Wagler

LIMOS, University Clermont Auvergne, Clermont-Ferrand, France

Abstract

The VIPAFLEET project aims at developing a framework to manage a fleet of Individual Public Autonomous Vehicles (VIPA). We consider a fleet of such cars distributed at specified stations in an industrial area to supply internal transportation, where the cars can be used in different modes of circulation (tram mode, elevator mode, taxi mode). We treat in this paper the pickup and delivery problem related to the taxi mode by means of flows in time-expanded networks. We compute optimal offline solutions, propose a replan strategy for the online situation, and evaluate its performance in comparison with the optimal offline solution.

Keywords: fleet management, offline and online pickup and delivery problem

The minimum chromatic violation problem: a polyhedral study

M. Braga[a] D. Delle Donne[a] M. Escalante[b,c] J. Marenco[a]
M. E. Ugarte[b] M. C. Varaldo[b]

[a] *ICI, Universidad Nacional de General Sarmiento, Buenos Aires, Argentina.*
[b] *FCEIA, Universidad Nacional de Rosario, Rosario, Argentina.*
[c] *CONICET, Argentina.*

Abstract

We propose a generalization of the k-coloring problem, namely the *minimum chromatic violation problem* (MCVP). Given a graph $G = (V, E)$, a set of *weak edges* $F \subset E$ and a set of colors $\mathcal{C}$, the MCVP asks for a $|\mathcal{C}|$-coloring of the graph $G' = (V, E \setminus F)$ minimizing the number of weak edges with both endpoints receiving the same color. We present an integer programming formulation for this problem and provide an initial polyhedral study of the polytopes arising from this formulation. We give partial characterizations of facet-inducing inequalities and we show how facets from weaker and stronger instances of MCVP (i.e., more/less weak edges) are related. We then introduce a general lifting procedure which generates (sometimes facet-inducing) valid inequalities from generic valid inequalities and we present several facet-inducing families arising from this procedure. Finally, we present another family of facet-inducing inequalities which is not obtained from the prior lifting procedure.

Keywords: Vertex coloring, Integer programming, Chromatic violation.

A linear-time algorithm for the identifying code problem on block graphs

Gabriela R. Argiroffo[1], Silvia M. Bianchi[1], Yanina Lucarini*

1 Universidad Nacional de Rosario (Dept. de Matemática), Rosario, Argentina

∗ CONICET, Argentina

Annegret K. Wagler

2 University Clermont Auvergne (LIMOS, UMR 6158 CNRS), Clermont-Ferrand, France

Abstract

The identifying code problem is a special search problem, challenging both from a theoretical and a computational point of view, even for several graphs where other in general hard problems are easy to solve, like bipartite graphs or chordal graphs. Hence, a typical line of attack for this problem is to determine minimum identifying codes of special graphs. In this work we study the problem of determining the cardinality of a minimum identifying code in block graphs (that are diamond-free chordal graphs). We present a linear-time algorithm for this problem, as a generalization of a linear-time algorithm proposed by Auger in 2010 for the case of trees. Thereby, we provide a subclass of chordal graphs for which the identifying code problem can be solved in linear time.

Keywords: identifying codes, block graphs, computational complexity

Invited Plenary Lecture

The Random Hyperbolic Graph Model

Marcos Kiwi

Universidad de Chile, Chile

Abstract

Random hyperbolic graphs (RHG) were proposed rather recently (2010) as a model of real-world networks. Informally speaking, they are like random geometric graphs where the underlying metric space has negative curvature (i.e., is hyperbolic). In contrast to other models of complex networks, RHG simultaneously and naturally exhibit characteristics such as sparseness, small diameter, non-negligible clustering coefficient and power law degree distribution.

We will give a slow pace introduction to RHG, explain why they have attracted a fair amount of attention and then survey most of what is known about this promising infant model of real-world networks.

On Efficient Domination for Some Classes of H-Free Chordal Graphs

Andreas Brandstädt

Institut für Informatik, Universität Rostock, D-18051 Rostock, Germany

Raffaele Mosca

Dipartimento di Economia, Universitá degli Studi "G. D'Annunzio", Pescara 65121, Italy

Abstract

A vertex set D in a finite undirected graph G is an *efficient dominating set* (*e.d.s.* for short) of G if every vertex of G is dominated by exactly one vertex of D. The *Efficient Domination* (*ED*) problem asks for the existence of an e.d.s. in G, and the *Weighted Efficient Domination* (*WED*) problem asks for such an e.d.s. of minimum weight. While, based on CoRR arXiv:1407.4593, 2014 and CoRR arXiv:1304.6255, 2013, for the complexity of WED on H-free graphs, a dichotomy was reached - see *SIAM J. Discrete Math.* 30, 4 (2016) pp. 2288-2303 and Proc. ACM SODA 2016, pp. 1784–1803 - it is still an open problem for many classes of H-free chordal graphs; a standard reduction from the NP-complete Exact Cover problem shows that WED is NP-complete for a very special subclass of chordal graphs (slightly generalizing split graphs - see the forbidden induced subgraphs such as $2P_3$ and seven other examples in the figure). The main results in this paper are polynomial-time solutions of WED for H-free chordal graphs, when H is co-P, net, $S_{1,2,2}$, and $S_{1,2,3}$.

k-quasi-transitive digraphs of large diameter

César Hernández-Cruz

Instituto de Matemáticas
Universidad Nacional Autónoma de México
Ciudad de México, México

Jesús Alva-Samos

Instituto de Matemáticas
Universidad Nacional Autónoma de México
Ciudad de México, México

Abstract

Let k be an integer, $k \geq 2$. A digraph $D = (V, A)$ is k-quasi-transitive if for every pair of vertices $u, v \in V$, the existence of a directed path of length k from u to v implies the existence of the arc (u, v) or (v, u) in $A(D)$. Under this definition, quasi-transitive digraphs are 2-quasi-transitive digraphs.

A recursive characterization (the so-called Canonical Decomposition) is known for quasi-transitive digraphs, but no characterization is known for k-quasi-transitive digraphs in the general case. Recently, Wang and Zhang proved that if k is an even integer, then a k-quasi-transitive digraph of diameter at least $k + 2$ admits a partition of its vertex set into two parts, each of them inducing a semicomplete digraph. In this work, we will present an analogous result for the case when k is an odd integer and discuss some of its consequences and future lines of research.

Keywords: quasi-transitive digraph, k-quasi-transitive digraph, traceability, hamiltonicity

Möbius Stanchion Systems

Lucas Isenmann

LIRMM, Montpellier, France

Timothée Pecatte

LIP, ENS de Lyon, France

Abstract

Consider a group of stanchions linked together in a waiting line. In order to paint both sides of every stanchion you will need to lift your paintbrush as many times as the number of faces of the corresponding plane graph. As a lazy graph theorist you want to twist the strips between stanchions in a Möbius fashion such that you do not need to lift up your paintbrush. We call such a twist a MSS and we investigate the space of all MSSs of a planar graph. Our main results are that all the MSSs are connected by a series of two elementary operations, and that the space of MSSs does not depend on the planar embedding of the graph.

Keywords: Planar graphs, combinatorial embeddings, spanning trees.

An Approximation Algorithm for the p-Hub Median Problem

Camile Frazão Bordini, André Luís Vignatti

DINF - Federal University of Paraná (UFPR)
Curitiba-PR, Brasil

Abstract

In the *p-hub median problem* we are given a set of clients V, a set of demands $D \subseteq V \times V$, a cost function $\rho : V \times V \to \mathbb{R}^+$, and an integer $p > 0$. The objective is to select $T \subseteq V$ of terminals, where $|T| \leq p$, and assign each demand to a terminal, in order to minimize the total cost between demands and terminals. We present the first approximation bounds for the problem: an $1 + 2/e$ lower bound if **NP** $\subset$ **DTIME**$(n^{O(\log \log n)})$, and a (4α)-approximation algorithm if we are allowed to open at most $\left(\frac{2\alpha}{2\alpha-1}\right) p$ terminals, where $\alpha > 1$ is a trade off parameter.

Keywords: approximation algorithms, linear programming, hub location problems, p-hub median problem.

On the recognition of neighborhood inclusion posets

Pablo De Caria

CONICET
Departamento de Matemática, Universidad Nacional de La Plata
Argentina

Abstract

Let G be a simple graph. When we order the different closed neighborhoods of G by inclusion, the resulting poset is called the neighborhood inclusion poset. In this paper, we show that the problem of determining whether a poset is a neighborhood inclusion poset is NP-complete. We also apply this result to prove the NP-completeness of another problem about clique trees of chordal graphs and compatible trees of dually chordal graphs.

Keywords: Poset, neighborhood inclusion, chordal graph, clique tree, dually chordal graph, compatible tree

Detecting an induced subdivision of K_4

Ngoc Khang Le

LIP, ENS de Lyon
Lyon, France

Abstract

We propose a polynomial-time algorithm to test whether a given graph contains a subdivision of K_4 as an induced subgraph. This continues the study of detecting an induced subdivision of H for some fixed graph H, which is still far from being complete. Our result answers a question posed by Chudnovsky *et al.* and Lévêque *et al.*

Keywords: Detecting, ISK4, induced subgraph.

On Type 2 Snarks and Dot Products

L. Cordeiro[a], S. Dantas[a], D. Sasaki[b]

[a] *IME, Universidade Federal Fluminense, Brazil*

[b] *IME, Universidade do Estado do Rio de Janeiro, Brazil*

Abstract

In order to investigate the relationship between snarks and the total colouring, in this paper, we contribute to the work of Brinkmann et al. (2015) by constructing new Type 2 snarks with girth 4, that can be obtained from dot products of Type 1 snarks. Furthermore, we show that those snarks found by Brinkmann et al. cannot be decomposed in a dot product of two Type 1 snarks.

Keywords: Total Coloring; Snarks; Dot Product.

AVD-edge coloring on powers of paths

Mayara M. Omai [a], Sheila M. de Almeida [a], Diana Sasaki [b]

[a] *DAINF, Federal University of Technology - Paraná, Ponta Grossa, Brazil*

[b] *IME, Rio de Janeiro State University, Brazil*

Abstract

In a proper edge coloring of a graph, the set of colors of a vertex v is the set of colors of the edges incident to v, $C(v)$. If $C(u) \neq C(v)$ for every adjacent vertices u and v, this edge coloring is an AVD-edge coloring. The least number of colors for which G has an AVD-edge coloring is called AVD-chromatic index, $\chi'_a(G)$. We determine the a AVD-chromatic index for the powers of paths.

Keywords: AVD-edge coloring, AVD-chromatic index, powers of paths.

Invited Plenary Lecture

Reconstructing perfect phylogenies via binary matrices, branchings in DAGs, and a generalization of Dilworth's theorem

Martin Milanič

IAM and FAMNIT, University of Primorska, Koper, Slovenia

Abstract

A perfect phylogeny is a rooted tree representing the evolutionary history of a set of n objects. The objects bijectively label the leaves of the tree and there are m binary characters, each labeling exactly one edge of the tree. For each leaf, the set of characters that appear on the unique root-to-leaf path is the set of characters taking value 1 at the object labeling the leaf. While every perfect phylogeny naturally corresponds to an $n \times m$ binary matrix having objects as rows and characters as columns, the perfect phylogeny problem asks the opposite question: Does a given binary matrix correspond to a perfect phylogeny? The problem is well known to be polynomially solvable: the yes instances are characterized by the absence of pairs of conflicting columns, where two columns of a binary matrix are said to be in conflict if there exist three rows on which the two columns read 11, 10, and 01, respectively. The perfect phylogeny problem and various generalizations of it -many of which were proved intractable- have been extensively studied in computational biology.
We will discuss two generalizations of the perfect phylogeny problem, first considered by Hajirasouliha and Raphael in 2014 and motivated by applications in cancer genomics. Both problems are optimizations problems and can be defined as follows:

- The minimum conflict-free row split (MCRS) problem: split each row of a given binary matrix into a bitwise OR of a set of rows so that the resulting matrix has no pairs of conflicting columns (that is, it corresponds to a perfect phylogeny) and has the minimum number of rows among all matrices with this property.

- The minimum distinct conflict-free row split problem: the variant of the problem

in which the task is to minimize the number of distinct rows of the resulting matrix.

The talk will focus on various graph theoretic and computational aspects of the two problems, including:

- formulations of the two problems in terms of branchings in a derived directed acyclic graph,
- a related characterization of cocomparability graphs,
- inapproximability results and approximation algorithms for the two problems,
- two polynomial time heuristic algorithms for the MCRS problem: an algorithm based on coloring cocomparability graphs, and an improvement of it that finds an optimal solution in a reduced search space via a new min-max result in weighted acyclic digraphs generalizing Dilworth's theorem.

The results presented in the talk were obtained in collaborations with Ademir Hujdurović, Edin Husić, Urša Kačar, Bernard Ries, Romeo Rizzi, and Alexandru I. Tomescu.

Facets of the polytope of legal sequences

Manoel Campêlo

Dep. Estatística e Matemática Aplicada, Universidade Federal do Ceará, Brazil

Daniel Severín

Depto. de Matemática (FCEIA), Universidad Nacional de Rosario, Argentina
CONICET, Argentina

Abstract

A sequence of vertices in a graph is called a *(total) legal dominating sequence* if every vertex in the sequence (total) dominates at least one vertex not dominated by those ones that precede it, and at the end all vertices of the graph are (totally) dominated. The *Grundy (total) domination number* of a graph is the size of the largest (total) legal dominating sequence. In this work, we present integer programming formulations for obtaining the Grundy (total) domination number of a graph, we study some aspects of the polyhedral structure of one of them and we test the performance of some new valid inequalities as cuts.

Keywords: Grundy (total) domination number, Legal dominating sequence, Facet-defining inequality, Web graph.

Hyper-Hamiltonicity in graphs: some sufficient conditions

Renata R. Del-Vecchio [a], Cybele T. M. Vinagre [a] and Guilherme B. Pereira [a]

[a] *Instituto de Matemática e Estatística, Universidade Federal Fluminense, Niterói, Brazil*

Abstract

A Hamiltonian graph G is hyper-Hamiltonian if $G - v$ is Hamiltonian for any $v \in V(G)$. In this paper, we give some sufficient conditions for a graph to be hyper-Hamiltonian. We provide both, spectral and non-spectral conditions for hyper-Hamiltonicity.

Keywords: Hyper-Hamiltonian graph, spectral radius, adjacency matrix, singless laplacian matrix, distance matrix, laplacian matrix.

Scaffolding skeletons using spherical Voronoi diagrams

A.J. Fuentes Suárez E. Hubert

Inria Sophia Antipolis

Abstract

Given a skeleton made of line segments we describe how to obtain a coarse mesh (or scaffold) of a surface surrounding it. We emphasize in this abstract the key result that allows us to complete the approach in Bærentzen et al. (Comput. and Graphics, 36(5) 2012) that could not treat skeletons with cycles.

Keywords: mesh generation, skeletal models, 3D modeling, Voronoi diagrams

On graphs with a single large Laplacian eigenvalue

L. Emilio Allem [a] Antonio Cafure [b,c,d] Ezequiel Dratman [b,e]
Luciano N. Grippo [e] Martín D. Safe [f] Vilmar Trevisan [a]

[a] *Instituto de Matemática, Universidade Federal do Rio Grande do Sul, Brazil*

[b] *CONICET, Argentina*

[c] *Instituto del Desarrollo Humano, Universidad Nacional de General Sarmiento, Argentina*

[d] *Depto. de Matemática, CBC, Universidad de Buenos Aires, Argentina*

[e] *Instituto de Ciencias, Universidad Nacional de General Sarmiento, Argentina*

[f] *Departamento de Matemática, Universidad Nacional del Sur, Argentina*

Abstract

We address the problem of characterizing those graphs G having only one Laplacian eigenvalue greater than or equal to the average degree of G. Our conjecture is that these graphs are stars plus a (possible empty) set of isolated vertices.

Keywords: anticomponents, Laplacian eigenvalues, stars

Invited Plenary Lecture

Restricted Types of Matchings

Dieter Rautenbach

Universität Ulm, Germany

Abstract

We present new results concerning restricted types of matchings such as uniquely restricted matchings and acyclic matchings, and we also consider the corresponding edge coloring notions. Our focus lies on bounds, exact and approximative algorithms. Furthermore, we discuss some matching removal problems.

The talk is based on joined work with J. Baste, C. Lima, L. Penso, I. Sau, U. Souza, and J. Szwarcfiter.

Invited Plenary Lecture

A general framework for path convexities

Fabio Protti

Universidade Federal Fluminense, Brazil

Abstract

In the study of graph convexities, a special interest is devoted to the so-called "path convexities", defined over special collections of paths. For example, the collection of the shortest paths in a graph is associated with the well-known geodesic convexity, while the collection of the induced paths is associated with the monophonic convexity; and there are many other examples. In this work we propose a general path convexity framework, of which most existing path convexities can be viewed as particular cases. Some benefits of the proposed framework are the systematization of the algorithmic study of related problems and the possibility of defining new convexities not yet investigated.

This is joint work with J. V. C. Thompson, L. T. Nogueira, R. S. F. Bravo, M. C. Dourado, and U. S. Souza.

Graphs admitting antimagic labeling for arbitrary sets of positive integers

Martín Matamala

DIM-CMM (UMI 2807 CNRS)
Universidad de Chile
Santiago, Chile

José Zamora

Departamento de Matemáticas
Universidad Andres Bello
Santiago, Chile

Abstract

A connected graph $G = (V, E)$ with m edges is called *universal antimagic* if for each set B of m positive integers there is an bijective function $f : E \to B$ such that the function $\tilde{f} : V \to \mathbb{N}$ defined at each vertex v as the sum of all labels of edges incident to v is injective. In this work we prove that several classes of graphs are universal antimagic. Among others paths, cycles, split graphs, and any graph which contains the complete bipartite graph $K_{2,n}$ as a spanning subgraph.

Keywords: Antimagic graphs, split graphs, complete bipartite graphs

The Geodetic Hull Number is Hard for Chordal Graphs

Stéphane Bessy

Laboratoire d'Informatique, de Robotique et de Microélectronique de Montpellier
Université de Montpellier, Montpellier, France

Mitre C. Dourado

Departamento de Ciência da Computação, Instituto de Matemática
Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Lucia D. Penso

Institute of Optimization and Operations Research
Ulm University, Ulm, Germany

Dieter Rautenbach

Institute of Optimization and Operations Research
Ulm University, Ulm, Germany

Abstract

We show the hardness of the geodetic hull number for chordal graphs.

Keywords: Geodesic convexity; shortest path; hull number; chordal graphs

Ruling out FPT algorithms for Weighted Coloring on forests

Júlio Araújo[†], Julien Baste[‡], and Ignasi Sau[†,‡]

[†] *Departamento de Matemática, Universidade Federal do Ceará, Fortaleza, Brazil*
[‡] *CNRS, LIRMM, Université de Montpellier, Montpellier, France*

Abstract

Given a graph G, a *proper k-coloring* of G is a partition $c = (S_i)_{i\in[1,k]}$ of $V(G)$ into k stable sets $S_1, \ldots, S_k$. Given a weight function $w : V(G) \to \mathbb{R}^+$, the *weight of a color* S_i is defined as $w(i) = \max_{v\in S_i} w(v)$ and the *weight of a coloring* c as $w(c) = \sum_{i=1}^{k} w(i)$. Guan and Zhu [Inf. Process. Lett., 1997] defined the *weighted chromatic number* of a pair (G, w), denoted by $\sigma(G, w)$, as the minimum weight of a proper coloring of G. For a positive integer r, they also defined $\sigma(G, w; r)$ as the minimum of $w(c)$ among all proper r-colorings c of G.

The complexity of determining $\sigma(G, w)$ when G is a tree was open for almost 20 years, until Araújo *et al.* [SIAM J. Discrete Math., 2014] recently proved that the problem cannot be solved in time $n^{o(\log n)}$ on n-vertex trees unless the Exponential Time Hypothesis (ETH) fails.

The objective of this article is to provide hardness results for computing $\sigma(G, w)$ and $\sigma(G, w; r)$ when G is a tree or a forest, relying on complexity assumptions weaker than the ETH. Namely, we study the problem from the viewpoint of parameterized complexity, and we assume the weaker hypothesis $\mathsf{FPT} \neq \mathsf{W}[1]$. Building on the techniques of Araújo *et al.*, we prove that when G is a forest, computing $\sigma(G, w)$ is $\mathsf{W}[1]$-hard parameterized by the size of a largest connected component of G, and that computing $\sigma(G, w; r)$ is $\mathsf{W}[2]$-hard parameterized by r. Our results rule out the existence of FPT algorithms for computing these invariants on trees or forests for many natural choices of the parameter.

Keywords: weighted coloring; max-coloring; forests; parameterized complexity; $\mathsf{W}[1]$-hard.

Structure and Interpretation of Dual-Feasible Functions

Matthias Köppe

Dept. of Mathematics
University of California, Davis
USA

Jiawei Wang

Dept. of Mathematics
University of California, Davis
USA

Abstract

We study two techniques to obtain new families of classical and general Dual-Feasible Functions: A conversion from minimal Gomory–Johnson functions; and computer-based search using polyhedral computation and an automatic maximality and extremality test.

Keywords: integer programming, cutting planes, cut-generating functions, Dual-Feasible Functions, 2-slope theorem, computer-based search

Inapproximability Ratios for Crossing Number

Rafael Veiga Pocai

Instituto de Matemática e Estatística
Universidade de São Paulo
São Paulo, Brazil

Abstract

Assuming $P \neq NP$, we show that if there is a constant-factor polynomial c-approximation algorithm for Crossing Number, then $c \geq 2 - \frac{16}{17} \approx 1.058824$. Adding the Unique Games Conjecture to the hypotheses, then $c \geq 2 - \alpha \approx 1.121433$, where α is the approximation ratio of the algorithm for Maximum Cut by Goemans and Williamson.

Keywords: crossing number, computational complexity, approximation, inapproximability

Advances in Aharoni-Hartman-Hoffman's Conjecture for Split digraphs

Maycon Sambinelli [a], Cândida Nunes da Silva [b], Orlando Lee [a]

[a] *Institute of Computing, University of Campinas, Brazil*

[b] *Department of Computing, Federal University of São Carlos, Brazil*

Abstract

Let k be a positive integer and let D be a digraph. A *(path) k-pack* $\mathcal{P}^k$ of D is a collection of at most k vertex-disjoint paths in D. The *weight* of a k-pack $\mathcal{P}^k$ is the number of vertices covered by it and we say $\mathcal{P}^k$ is *optimal* if its weight is maximum. A vertex-coloring $\mathcal{C}$ is *orthogonal* to a k-pack $\mathcal{P}^k$ if each color class $C \in \mathcal{C}$ meets $\min\{|C|, k\}$ paths of $\mathcal{P}^k$. In 1985, Aharoni, Hartman and Hoffman conjectured that for any optimal k-pack of D there exists a coloring orthogonal to it. In this paper we give a partial answer to this question by presenting two special types of k-packs in split digraphs for which we can always find an orthogonal coloring.

Keywords: path k-pack, vertex-coloring, Aharoni-Hartman-Hoffman's Conjecture

Reducing the Chromatic Number by Vertex or Edge Deletions

Christophe Picouleau [a] Daniël Paulusma [b] Bernard Ries [c]

[a] *Laboratoire CEDRIC*
CNAM
Paris, France

[b] *School of Engineering and Computing Sciences*
Durham University
Durham, United Kingdom

[c] *Department of Informatics*
University of Fribourg
Fribourg, Switzerland

Abstract

A vertex or edge in a graph is critical if its deletion reduces the chromatic number of the graph by 1. We consider the problems of testing whether a graph has a critical vertex or edge, respectively. We give a complete classification of the complexity of both problems for H-free graphs, that is, graphs with no induced subgraph isomorphic to H. Moreover, we show that an edge is critical if and only if its contraction reduces the chromatic number by 1. Hence, we obtain the same classification for the problem of testing if a graph has an edge whose contraction reduces the chromatic number by 1. As a consequence of our results, we are also able to complete the complexity classification of the more general vertex deletion and edge contraction blocker problems for H-free graphs when the graph parameter is the chromatic number.

Keywords: edge contraction, vertex deletion, chromatic number.

Approximating the cone of copositive kernels to estimate the stability number of infinite graphs.

Olga Kuryatnikova

Department of Econometrics and Operations Research
Tilburg University
Tilburg, The Netherlands

Juan Carlos Vera Lizcano

Department of Econometrics and Operations Research
Tilburg University
Tilburg, The Netherlands

Abstract

It has been shown that the stable set problem in an infinite compact graph, and particularly the kissing number problem, reduces to an optimization problem over the cone of copositive kernels. We propose two converging hierarchies approximating this cone. Both are extensions of existing inner hierarchies for the finite dimensional copositive cone. We implement the first two levels of the new hierarchies for the kissing number problem.

Keywords: copositive programming, semidefinite approximations, lifting, kissing number

Strong intractability of generalized convex recoloring problems

Phablo F. S. Moura and Yoshiko Wakabayashi

Instituto de Matemática e Estatística
Universidade de São Paulo, Brazil

Abstract

A coloring of the vertices of a connected graph is r-convex if each color class induces a subgraph with at most r components. We address the r-convex recoloring problem defined as follows. Given a graph G and a coloring of its vertices, recolor a minimum number of vertices of G so that the resulting coloring is r-convex. This problem, known to be $\mathcal{NP}$-hard even on paths, was firstly investigated on trees and for $r = 1$, motivated by applications on perfect phylogenies. The more general concept of r-convexity, for $r \geq 2$, was proposed later, and it is also of interest in the study of protein-protein interaction networks and phylogenetic networks. In this work, we show that, for each $r \in \mathbb{N}$, the r-convex recoloring problem on n-vertex bipartite graphs cannot be approximated within a factor of $n^{1-\varepsilon}$ for any $\varepsilon > 0$, unless $\mathcal{P} = \mathcal{NP}$. We also provide strong hardness results for weighted and parametrized versions of the problem.

Keywords: convex recoloring, hardness, inapproximability, parameterized intractability

On the (di)graphs with (directed) proper connection number two

Guillaume Ducoffe [a,b] Ruxandra Marinescu-Ghemeci [c,d]
Alexandru Popa [b,c]

[a] *Université Côte d'Azur, Inria, CNRS, I3S, France*

[b] *National Institute for Research and Development in Informatics, Romania*

[c] *University of Bucharest, Faculty of Mathematics and Computer Science*

[d] *The Research Institute of the University of Bucharest ICUB, Romania*

Abstract

A coloring of a graph G is *properly connected* if every two vertices of G are the ends of a properly colored path. We study the *complexity* of computing the *proper connection number* (minimum number of colors in a properly connected coloring) for edge and vertex colorings, in undirected and directed graphs, respectively. First we disprove some conjectures of Magnant et al. (2016) on characterizing the strong digraphs with *proper arc connection number* at most two. Then, we prove that deciding whether a given digraph has proper arc connection number at most two is NP-complete. We initiate the study of proper vertex connectivity in digraphs and we prove similar results as for the arc version. Finally, we present polynomial-time recognition algorithms for *bounded-treewidth* graphs and *bipartite* graphs with *proper edge connection number* at most two.

Keywords: proper connection; digraphs; bipartite; even dicycles; NP-complete.

On cliques and bicliques

M.A. Pizaña I.A. Robles

Universidad Autónoma Metropolitana - Iztapalapa
Mexico City, 09340, Mexico

Abstract

Basic definitions are given in the next paragraph. We studied second clique graphs of suspensions of graphs, $K^2(S(G))$, and characterize them, in terms of an auxiliary biclique operator B which transforms a graph G into its biclique graph $B(G)$. The characterization is then: $K^2(S(G)) \cong B(K(G))$. We found a characterization of the graphs, G, that maximize $|B(G)|$ for any given order $n = |G|$. This particular version of biclique operator is new in the literature. The main motivation to study $B(G)$ is an attempt to characterize the graphs G that maximize $|K^2(G)|$, thus mimicking a result of Moon and Moser (Israel J. Math. **3** (1965) 23–28) that characterizes the graphs maximizing $|K(G)|$.

The *clique graph* $K(G)$ of a a graph G is the intersection graph of the set of all (maximal) cliques of G (and $K^2(G) = K(K(G))$). The *suspension* $S(G)$ of a graph G is the graph obtained from G by adding two new vertices which are adjacent to all other vertices, but not to each other. Here, a *biclique* (X, Y) is an ordered pair of not necessarily disjoint subsets of vertices of G such that each $x \in X$ is adjacent or equal to every $y \in Y$ and such that (X, Y) is maximal under component-wise inclusion. Finally $B(G)$ is the graph whose vertices are the bicliques of G with adjacencies given by $(X, Y) \simeq (X', Y')$ if and only if $X \cap X' \neq \varnothing$ or $Y \cap Y' \neq \varnothing$.

Keywords: graph theory, graph dynamics, clique graphs, bicliques.

On the Existence of Critical Clique-Helly Graphs

Liliana Alcón [a] Miguel Pizaña [c] Gabriela Ravenna [a,b]

[a] *Dto. de Matemática, FCE-UNLP, La Plata, Argentina*

[b] *CONICET*

[c] *Universidad Autónoma Metropolitana - Iztapalapa, Mexico City, 09340, Mexico*

Abstract

A graph is *clique-Helly* if any family of mutually intersecting cliques has non-empty intersection. Dourado, Protti and Szwarcfiter conjectured that every clique-Helly graph contains a vertex whose removal maintains it as a clique-Helly graph. We will present a counterexample to this conjecture.

Keywords: Helly property, Clique-Helly graphs, clique graphs.

Invited Plenary Lecture

b-colorings: an structural overview

Claudia Linhares-Sales

Universidade Federal do Ceará, Brazil

Abstract

A b-coloring of a graph G is a proper coloring such that every color class has a vertex with neighbors in each other color class. The b-chromatic number of G is the maximum integer k such that G admits a b-coloring with k colors. This parameter was introduced by Irving and Manlove in 1999. In that work, they proved that the related decision problem is NP-complete while polynomial on trees. In this talk, we start by relating the b-chromatic number of G with its other chromatic numbers issued of other heuristics. Then, we recall some structural properties of graphs which directly impact their b-chromatic number and other related parameters, such as girth, maximum degree, m-degree and forbidden subgraphs. In particular, we are going to see how the good structural behavior of product of graphs impact some parameters related to b-colorings. We finish this talk by showing two recently defined b-colorings parameters, namely b-homomorphism and partial b-coloring and some of their open problems of general interest.

A 3-approximation algorithm for the maximum leaf k-forest problem

M. F. Reis [a] M. C. San Felice [b] O. Lee [a] F. L. Usberti [a]

[a] *Institute of Computing, Unicamp, Campinas - SP, Brazil*

[b] *Institute of Mathematics and Statistics, USP, São Paulo - SP, Brazil*

Abstract

In the maximum leaf spanning tree problem we want to find a tree which spans every vertex of a graph and has as many leaves as possible. The maximum leaf k-forest problem is a generalization of that problem, in which we want a spanning forest with maximum number of leaves and no more than k components. We give a 3-approximation algorithm for this problem.

Keywords: approximation algorithms, maximum leaf spanning tree, k-forest

Transversals of Longest Paths

Márcia R. Cerioli

COPPE Sistemas e Instituto de Matemática
Universidade Federal do Rio de Janeiro, Brazil

Cristina G. Fernandes Renzo Gómez Juan Gutiérrez

Departamento de Ciência da Computação
Universidade de São Paulo, Brazil

Paloma T. Lima

Institutt for Informatikk
Universitetet i Bergen, Norway

Abstract

Let $\mathrm{lpt}(G)$ be the minimum cardinality of a set of vertices that intersects all longest paths in a connected graph G. We show that, if G is a chordal graph, then $\mathrm{lpt}(G) \leq \max\{1, \omega(G) - 2\}$, where $\omega(G)$ is the size of a largest clique in G; that $\mathrm{lpt}(G) \leq \mathrm{tw}(G)$, where $\mathrm{tw}(G)$ is the treewidth of G; and that $\mathrm{lpt}(G) = 1$ if G is a bipartite permutation graph or a full substar graph.

Keywords: longest path, transversal, chordal, permutation, substars, treewidth.

Delta–Wye Transformations and the Efficient Reduction of Almost–Planar Graphs

Isidoro Gitler, Gustavo Sandoval–Angeles

Departamento de Matemáticas
Centro de Investigación y de Estudios Avanzados del IPN
Apartado Postal 14–740
07000 Ciudad de México

Abstract

A non–planar graph G is almost–planar if, for every edge e of G, either $G \setminus e$ or G/e is planar. We provide an algorithmic proof of a theorem by D. K. Wagner, according to which every almost–planar graph can be reduced to the graph $K_{3,3}$ by some sequence of series/parallel reductions and delta–wye exchanges such that the reduction sequence is formed by almost–planar graphs. We study 3-connected almost–planar graphs on the projective plane and establish duality relations between the resulting families. We show that one family reduces to $K_{3,3}$ (with an added parallel edge) while the dual family reduces to K_5. We also characterize 3-terminal delta–wye reducibility for almost–planar graphs.

Keywords: delta–wye reducibility, almost–planar graphs, projective–planar graphs

Bounds on Directed star arboricity in some digraph classes

Henri Perret du Cray
Mourad Baïou, Laurent Beaudou, Vincent Limouzy

LIMOS
Université Clermont Auvergne
Aubière, France

Abstract

A *galaxy* is a forest of directed stars. The notion of galaxy can be related to Facility Location problems as well as wavelength assignment problems in optical networks. Amini et al. (Comb., Prob. & Comp. 19(2) 2010, 161–182) and Gonçalves et al. (Discr. Appl. Math. 160(6) 2012, 744–754) gave bounds on the minimum number of galaxies needed to cover the arcs of a digraph D, called directed star arboricity ($dst(D)$). They conjectured that those bounds could be improved such that $dst(D) \leq \Delta(D)$, for $\Delta(D) \geq 3$ and $dst(D) \leq 2\Delta^+(D)$ for $\Delta^+(D) \geq 2$. In this work, we study the directed star arboricity in two non-trivial digraph classes: k-degenerate digraphs and tournaments.

Keywords: directed star arboricity, galaxy, digraph, tournament

Simple Undirected Two-Commodity Integral Flow with a Unitary Demand

Alexsander A. Melo, Celina M. H. Figueiredo

Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Uéverton S. Souza

Universidade Federal Fluminense, Niterói, Brazil

Abstract

Even, Itai and Shamir (1976) proved that the simple two-commodity integral flow problem is NP-complete both in the directed and undirected cases. They showed the NP-completeness of the directed case even if the demand of one commodity is unitary. However, the complexity of the undirected case when one commodity has a demand bounded by a constant remained unknown since then. In this paper, we show the NP-completeness of Simple undirected two-commodity integral flow when the demand of one commodity is unitary, closing a forty-year complexity gap. Furthermore, we also prove the NP-completeness of a related problem, called $k+1$ vertex-disjoint paths, which aims to determine whether an undirected graph admits $k+1$ vertex disjoint paths where k of those paths are between a given pair of vertices and one path is between another given pair of vertices.

Keywords: two-commodity flow, undirected flow, unitary demand, $k+1$ disjoint paths, vertex-disjoint paths, edge-disjoint paths.

The lexicographic product of some chordal graphs and of cographs preserves b-continuity

Cláudia Linhares Sales [b] Leonardo Sampaio [c] Ana Silva [a]

[a] *Departamento de Matemática, Universidade Federal do Ceará, Fortaleza, Brazil*

[b] *Departamento de Computação, Universidade Federal do Ceará, Fortaleza, Brazil*

[c] *Centro de Ciências, Universidade Estadual do Ceará, Brazil.*

Abstract

A b-coloring of the vertices of a graph is a proper coloring where each color class contains a vertex which is adjacent to each other color class. The b-chromatic number of G is the maximum integer $\chi_b(G)$ for which G has a b-coloring with $\chi_b(G)$ colors. A graph G is b-continuous if G has a b-coloring with k colors, for every integer k in the interval $[\chi(G), \chi_b(G)]$. It is known that not all graphs are b-continuous, and also that the cartesian product and the strong product do not preserve b-continuity. However, the same is not known to be true about the lexicographic product $G[H]$. Here, we prove that $G[H]$ is b-continuous whenever H is b-continuous and G is an interval graph, a block graph or a cograph.

Keywords: b-chromatic number, b-continuity, lexicographic product, chordal graphs, cographs

Tropical matchings in vertex-colored graphs

J. Cohen [1] ,Y.Manoussakis [1] , H.P. Phong [1]

LRI, Univ.Paris-Sud, CNRS, CentraleSupélec, Université Paris-Saclay
91405 Orsay Cedex, France

Zs. Tuza

Department of Computer Science and Systems Technology, University of Pannonia, Egyetem u.10,
H-8200 Veszprém , Hungary

Abstract

A subgraph of a vertex-colored graph is said to be tropical whenever it contains all colors of the original graph. In this work we study the problem of finding, if any, maximum tropical matchings in vertex-colored graphs. We show that this problem is polynomial with complexity $max[O(cm), O(M)]$, where c is the number of colors, n (resp. m) the number of vertices (resp. edges) of the graph and $O(M)$ is the best known complexity for finding a maximum matching in general graphs. We also provide a polynomial algorithm of time $O(nM)$ for finding, if any, a minimum tropical matching in vertex-colored graphs.

Keywords: vertex-colored graphs, maximum tropical matchings, minimum tropical matchings

On the maximum density of fixed strongly connected subtournaments

Leonardo N. Coregliano

Institute of Mathematics and Statistics
Universidade de São Paulo
São Paulo, Brazil

Roberto F. Parente

Departamento de Ciência da Computação
Universidade Federal da Bahia
Salvador, Brazil

Cristiane M. Sato

Center of Mathematics, Computing and Cognition
Universidade Federal do ABC, Brazil

Abstract

We study the density of fixed strongly connected subtournaments on 5 vertices in large tournaments using flag algebras. We determine the maximum density asymptotically for five (out of the six) strongly connected tournaments as well as unique extremal sequences for each tournament. As a byproduct we also characterize tournaments that are recursive blow-ups of a 3-cycle as tournaments that avoid three specific tournaments of size 5.

Keywords: tournament, flag algebra, extremal combinatorics

Index

José Zamora, 55