Booklet of abstracts and academical program

XII Latin-American Algorithms, Graphs and Optimization Symposium

Huatulco, Mexico, September 18-22, 2023

Contents

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Plenary speakers

Federico Ardila

San Francisco State University, USA

Federico Ardila Mantilla is a Colombian mathematician and musician, interested in the intersection between Combinatorics, Geometry, and Algebra. Federico received his Ph.D. from the Massachusetts Institute of Technology, and he is currently a professor at the San Francisco State University, and La Universidad de Los Andes. He was an Invited Speaker at the International Congress of Mathematicians 2022, he is a Fellow of the American Mathematical Society (AMS), winner of the CAREER Award of the National Science Foundation, the National Haimo Award for Teaching of the Mathematical Association of America, and the Mathematics Programs that Make a Difference Award, of the AMS. He has been advisor of more than 50 graduate students, and he is co-director of MSRI-UP, a research program for students from racial and ethnic minorities in the United States. In all aspects of his work, Federico seeks to contribute to the construction of an increasingly inclusive and equitable mathematical community.

Maria Axenovich

Karlsruhe Institute of Technology, Germany

Maria Axenovich was born in Novosibirsk, Russia, where she did her undergraduate studies. After completing her PhD at the University of Illinois at Urbana-Champaign, USA, in 1999, under the guidance of Zoltan Füredi, and having a couple of long-term research visits, she was a professor at Iowa State University, Ames, IA, USA. Since 2012 she has been employed as a chair of the Discrete Mathematics group at the Karlsruhe Institute of Technology, Germany. She serves as an associate editor of the journal Order and as an editor in chief of the Electronic Journal of Combinatorics. Maria works on extremal problems in graphs and set systems.

Ruy Fabila

CINVESTAV, Instituto Politécnico Nacional, Mexico

Ruy Fabila-Monroy obtained his B.Sc. in Computer Science from the Universidad Nacional Autónoma de México (UNAM), as well as his M.Sc. and Ph.D. in Mathematics. After receiving his Ph.D., he was awarded an Australia's Endeavour Fellowship at the University of Melbourne. Ruy currently is a 3C researcher in the Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV). He is a Level III National Researcher at the prestigious Sistema Nacional de Investigadores (SNI) of the Consejo Nacional de Ciencia y Tecnología. His interests stand in the intersection of Combinatorial Geometry, Graph Theory and Computational Geometry; his main line of research has been Erdős-Szekeres type problems, order types on point sets, rectilinear crossing numbers and token graphs.

Celina Figueiredo

Universidade Federal do Rio de Janeiro, Brazil

Celina Miraglia Herrera de Figueiredo received a B.Sc. and an M.Sc. in Mathematics from PUC-Rio, an M.Sc. in Mathematics from UMIST-UK, and a D.Sc. in Computer Science from COPPE-UFRJ. Celina joined the Federal University of Rio de Janeiro (UFRJ) as assistant professor in the Computer Science Department of the Mathematics Institute, and she is now a full professor at the Systems Engineering and Computer Science Program of COPPE, also at UFRJ. She is a CNPq research fellow in Computer Science and a FAPERJ "Cientista do Nosso Estado" fellow. She received the Giulio Massarani COPPE Award for Academic Merit and the COPPE Fifty Years Award. She is a member of the editorial board of RAIRO Theoretical Informatics and Applications and of RAIRO Operations Research. She has recently been elected a member of the Brazilian Academy of Sciences.

Pavol Hell

Simon Fraser University, Burnaby, Canada

Pavol Hell is a Professor Emeritus of Computing Science at Simon Fraser University in Burnaby. After his mathematical studies at Charles University in Prague, he obtained his MSc at McMaster University in Hamilton, and his PhD at the Université de Montréal. Prior to joining SFU, Pavol was an associate professor at Rutgers University in New Brunswick; he has also held visiting positions at a number of universities in Brazil, France, Italy, and the Czech Republic. He was a long term managing editor of the Journal of Graph Theory, and sits on the editorial boards of several other journals. He was named a SIAM Fellow, class of 2012. His area of interest is "computational combinatorics", including algorithmic graph theory and complexity of graph problems. His current focus is on nicely structured graph and digraph classes, and on the complexity of various versions of graph and digraph homomorphism problems.

Deborah Oliveros

Universidad Nacional Autónoma de México, Mexico

Deborah Oliveros Braniff received her B.A., M.A., and Ph.D. in Mathematics from the Universidad Nacional Autónoma de México (UNAM). She was a postdoctoral fellow at the University of Calgary, in Canada, where she held an academic position for 7 years. In 2005, she joined the Instituto de Matemáticas at UNAM, where she is now a "Titular B" researcher. Deborah is a fellow of the Academia Mexicana de Ciencias, a Level III national researcher at the prestigious Sistema Nacional de Investigadores (SNI), and she is founding member and current director of the Unidad Juriquilla del Instituto de Matemáticas, in Querétaro, Mexico. Her research interests center in Discrete and Computational Geometry, as well as in Convexity. Her main contributions follow paths on Helly-type Problems, Transversal Theory, Convex and Abstract Polytopes and Construction of Bodies of Constant Width.

Gelasio Salazar

Universidad Autónoma de San Luis Potosí, Mexico

After obtaining B.Sc. and M.Sc. degrees in Physics, Gelasio Salazar received his Ph.D. in Mathematics in Ottawa. He held a postdoctoral position at Georgia Tech, and was visiting professor at the Ohio State University and at the University of Waterloo. He has been a professor at the Institute of Physics at the Universidad Autónoma de San Luis Potosí for over 20 years. Gelasio started working in Topological Graph Theory in the boom of the early 1990s, after the Robertson and Seymour proof of Wagner's Conjecture. Later on he also got interested in Geometric Graph Theory, and in the application of Probabilistic and Extremal Graph Theory techniques in both Geometric and Topological Graph Theory. As part of a midlife crisis he has stubbornly (and sometimes successfully) tried to shed some light on some classical Knot Theory problems using elementary combinatorial techniques.

Maya Stein

Universidad de Chile, Chile

Maya Stein is a full professor at the University of Chile. Her research interests include Extremal Combinatorics, Structural Graph Theory, Combinatorial Algorithms and Complexity, and Infinite Graphs and Groups. She has published over 50 research papers in internationally peer-reviewed journals, and has served on the program committees for various conferences in Discrete Mathematics and Theoretical Computer Science. She currently serves as an editor for the Electronic Journal of Combinatorics, the SIAM Journal on Discrete Mathematics, Orbita Mathematicae and the soon-to-be-launched Innovations in Graph Theory. She was recently elected vice chair of the SIAM Activity group in Discrete Mathematics, and has served on the scientific committees of the Math- and SticAmSud Program of the Chilean Mathematical Society. She has led and participated in a number of nationally or internationally funded projects, and is the deputy director as well as the academic director of the Center for Mathematical Modeling (Chile).

Jayme Luiz Szwarcfiter

Universidade Federal do Rio de Janeiro, Brazil

Jayme Szwarcfiter received his PhD from the University of Newcastle upon Tyne, England, and held postdoctoral positions at the University of California, Berkeley, USA, and the University of Cambridge, England. Jayme is an Emeritus Professor at the Federal University of Rio de Janeiro, Brazil, and, at the moment, he is also Visiting Professor at the State University of Rio de Janeiro. He is a member of the Brazilian Academy of Sciences. Some of his former students are distinguished scholars of renowned institutions around the world. His main interests are Graph Theory and Algorithms, besides Computational Complexity.

General schedule

Time	Monday		Tuesday		Wednesday	Thursday		Friday
8:00–8:35	Registration							
8:35–8:55	Inauguration							
9:00-9:55	Gelasio Salazar		Deborah Oliveros		Pavol Hell	Maya Stein		Maria Axenovich
10:00–10:25	**Coffee Break**					**Coffee Break**		
Room	**Maguey**	**Coyote**	**Maguey**	**Coyote**		**Maguey**	**Coyote**	**Maguey**
10:25–10:45	Bernard Lidický	Lucas de Oliveira	Magda Dettlaff	Lucía Busolini	Coffee & Posters	Caroline de Paula Silva	Samuel N. Araújo	Flor Aguilar
10:50–11:10	Martín Matamala	Lívia Medeiros	Dipayan Chakraborty	Niklas Troost	Pablo Romero	André Guedes	Dipayan Chakraborty	Héctor Maravillo
11:15–11:35	Gerardo L. Maldonado	Romaric Duvignau	Denae Ventura	J. Carlos García-Altamirano	Mathias Schacht	Hanna Furmańczyk	Mauro R. Costa da Silva	Oliver Bachtler
11:40–12:00	**Coffee Break**				José Alvarado	**Coffee Break**		
12:00–12:20	Diego S. Nicodemos	Annegret K. Wagler	Amanda Montejano	Yaqiao Li		Pastora Revuelta	Weidong Luo	Ruy Fabila
12:25–12:45	Esteban Contreras	Stephen Arndt	Alonso Ali	César Hernández-Cruz		João P. de Souza	Paulo Medeiros	12:00–12:55
12:50–15:00	**Lunch**					**Lunch**		
15:00-15:55	Celina Figueiredo		Federico Ardila			Jayme Luiz Szwarcfiter		
16:00–16:20	**Coffee Break**					**Coffee Break**		
16:20–16:40	Florian Horn	Isac Costa	Úrsula Hébert-Johnson	Mariana Escalante		Annegret K. Wagler	Martín Matamala	
16:45–17:05	Octavio Zapata	Tatiana Pantoja	Marina Groshaus	José Alvarado		Gabriele Di Stefano	Ileana González-Escalante	
17:10–17:30	Mayank Goswami	Mateus de Paula Ferreira	Julio Araujo	Diana Sasaki		Matheus Simões	René González-Martínez	

Monday morning

Time	Monday Morning	
	Room Maguey	**Room Coyote**
9:00-9:55	**Gelasio Salazar** From two dimensions to three dimensions: applications of graph theory to knot theory	
10:00–10:25	**Coffee Break**	
10:25–10:45	**Bernard Lidický** Crossing numbers of complete bipartite graphs	**Lucas de Oliveira** Freeze–Tag is NP-hard in 3D with L_1 distance
10:50–11:10	**Martín Matamala** Counting lines in semi-complete digraphs	**Lívia Medeiros** Mixed integer programming and quadratic programming formulations
11:15–11:35	**Gerardo L. Maldonado** On prescribing total orders for bipartite sets of distances in the Euclidean plane	**Romaric Duvignau** Greediness is not always a vice efficient discovery algorithms for assignment problems
11:40–12:00	**Coffee Break**	
12:00–12:20	**Diego S. Nicodemos** Spherical fullerene graphs that do not satisfy Andova and Skrekovski's conjecture	**Annegret K. Wagler** A polyhedral study of a relaxation of the routing and spectrum allocation problem
12:25–12:45	**Esteban Contreras** Polarity on H-split graphs	**Stephen Arndt** Resource augmentation analysis of the greedy algorithm for the Online Transportation Problem

Room Maguey

9:00 – 9:55

PLENARY TALK:
From two dimensions to three dimensions: applications of graph theory to knot theory

Gelasio Salazar
Universidad Autónoma de San Luis Potosí, Mexico

If we project a knot to a plane we obtain a 2-dimensional curve, a *shadow* of the knot. We are interested in the following general question: which properties of a knot can be obtained from its shadow? In this talk we will illustrate how standard techniques from topological and extremal graph theory can be used to investigate this problem. No previous knot theory knowledge is expected from the audience (and very little knot theory knowledge should be expected from the speaker).

10:25 – 10:45

Crossing numbers of complete bipartite graphs

Bernard Lidický
Iowa State University
Coauthors: József Balogh, Sergey Norin, Florian Pfender, Gelasio Salazar, Sam Spiro

The long standing Zarankiewicz's conjecture states that the crossing number $\mathrm{cr}(K_{m,n})$ of the complete bipartite graph is $Z(m,n) := \left\lfloor \frac{m}{2} \right\rfloor \left\lfloor \frac{m-1}{2} \right\rfloor \left\lfloor \frac{n}{2} \right\rfloor \left\lfloor \frac{n-1}{2} \right\rfloor$. Using flag algebras we show that $\mathrm{cr}(K_{n,n}) \geq 0.9118 \cdot Z(n,n) + o(n^4)$. We also show that the rectilinear crossing number $\overline{cr}(K_{n,n})$ of $K_{n,n}$ is at least $0.987 \cdot Z(n,n) + o(n^4)$. Finally, we show that if a drawing of $K_{n,n}$ has no $K_{3,4}$ that has exactly two crossings, and these crossings share exactly one vertex, then it has at least $Z(n,n) + o(n^4)$ crossings. This is a local restriction inspired by Turán type problems that gives an asymptotically tight result.

10:50 – 11:10

Counting lines in semi-complete digraphs

Martín Matamala
DIM-CMM Universidad de Chile
Coauthors: G. Araujo-Pardo, J. Zamora

It is a classic result that a set of n non-collinear points in the Euclidean plane defines at least n different lines. Chen and Chvátal conjectured in 2008 that the same results is true in metric spaces for an adequate definition of line. More recently, this conjecture was studied in the context of quasi-metric spaces.

One way to study lines in an space is though its betweenness. Given a quasi-metric space (V,ρ), its induced quasi-metric betweenness is the set of triples $(x,y,z) \in V^3$ such that $\rho(x,z) = \rho(x,y) + \rho(y,z)$. In this work, we prove the existence of a quasi-metric space on four points a, b, c and d whose quasi-metric betweenness is $\mathcal{B} = \{(c,a,b),(a,b,c),(d,b,a),(b,a,d)\}$. This space has only three lines, none of which has four points. Moreover, we show that the betweenness of any quasi-metric space on four points with this property is isomorphic to $\mathcal{B}$. Since $\mathcal{B}$ is not metric, we conclude that Chen and Chvátal's conjecture is valid for any metric space on four points.

11:15 – 11:35

On prescribing total orders for bipartite sets of distances in the Euclidean plane

Gerardo Maldonado
Universidad Nacional Autónoma de México
Coauthors: Miguel Raggi, Edgardo Roldán-Pensado

In this note we give a negative answer to a question proposed by Almendra-Hernández and Martínez-Sandoval. Let $n \leq m$ be positive integers and let X and Y be sets of sizes n and m in $\mathbb{R}^{n-1}$ such that $X \cup Y$ is in generic position. There is a natural order on $X \times Y$ induced by the distances between the corresponding points. The question is if all possible orders on $X \times Y$ can be obtained in this way. We show that the answer is negative when $n < m$. The case $n = m$ remains open.

12:00 – 12:20

Spherical fullerene graphs that do not satisfy Andova and Skrekovski's conjecture

Diego Nicodemos
UERJ / CPII
Coauthors: Thiago M.D. Silva, Simone Dantas

A fullerene graph is a planar, cubic, 3-connected graph with only pentagonal and hexagonal faces. In 2012, Andova and Škrekovski conjectured that the diameter of every fullerene graph with n vertices is at least $\left\lfloor \sqrt{\frac{5n}{3}} \right\rfloor - 1$. They computed this lower bound by studying a particular class of fullerene graphs named spherical with icosahedral symmetry. We denote these graphs by $G_{i,j}$, by setting two parameters $i, j \in \mathbb{N}^*$, such that $i \leq j$. In their study, Andova and Škrekovski offered numerous properties of hexagonal lattices and calculated the diameter of two remarkable spherical fullerene graphs: $G_{0,j}$ and $G_{j,j}$. Although the conjecture is valid for these two distinct classes, it remains open deciding whether the premise is proper for all spherical fullerene graphs $G_{i,j}$.

In this work, we present the first class of fullerene graphs with icosahedral symmetry that do not satisfy Andova and Skrekovski's conjecture, which refutes that this conjecture is valid for all spherical graphs. We also focus on showing properties of spherical fullerene graphs and the hexagonal lattice itself. We prove that all graphs $G_{i,j}$ have a reduction of the form $G_{i-k,j-k}$, where $k \leq i$, such that their triangular faces are entirely contained in the triangular faces of $G_{i,j}$. In addition, by setting $k = i$, this property states a particular link among $G_{i,j}, G_{i-1,j-1}, \cdots, G_{0,j-i}$, creating a chain of reductions of $G_{i,j}$, which implies that $diam\left(G_{i,j}\right) \geq diam\left(G_{0,j-i}\right)$.

12:25 – 12:45

Polarity on H-split graphs

Esteban Contreras
Universidad Nacional Autónoma de México
Coauthors: César Hernández-Cruz

Given nonnegative integers, s and k, an (s, k)-polar partition of a graph G is a partition (A, B) of V_G such that $G[A]$ and $\overline{G[B]}$ are complete multipartite graphs with at most s and k parts, respectively. If s or k is replaced by ∞, it means that there is no restriction on the number of parts of $G[A]$ or $\overline{G[B]}$, respectively. A split graph is a graph admitting a $(1, 1)$-polar partition. A graph is said to be unipolar or monopolar if its vertex set admits an (∞, ∞)-polar partition (A, B) such that A is a clique or an independent set, respectively.

Naturally, most problems related to polar partitions are trivial on split graphs, even when some of them are very hard in general. In this work, we present some results related to polar partitions on two graph classes generalizing split graphs. Our main results include efficient algorithms to decide whether a graph on these classes admits such partitions, as well as upper bounds for the order of minimal (s, k)-polar obstructions on such graph families for any s and k (even if s or k is ∞).

Room Coyote

10:25 – 10:45

Freeze-Tag is NP-hard in 3D with L_1 distance

Lucas de Oliveira Silva
Unicamp
Coauthors: Lehilton Lelis Chaves Pedrosa

The Freeze-Tag Problem (FTP) is the task of scheduling the activation of a robot swarm. The input consists of the initial locations of a set of mobile robots in some metric space. A single robot is initially "active" while the others are initially "frozen". Active robots can move at unit speed, and upon reaching the location of a frozen robot, the latter is activated. The goal is to activate all the robots within the minimum time, minimizing the so-called *makespan* of the schedule. The complexity of this problem in Euclidean spaces was open until 2017, when Abel et al. [1] proved that FTP is NP-hard in the Euclidean plane with L_2 distance. During that same year, Demaine and Rudoy [2] showed that it is also NP-hard in 3D Euclidean space with L_p distance for any $p > 1$, but left open the case with $p = 1$. This paper closes this gap and shows that FTP is indeed NP-hard in 3D Euclidean space with L_1 distance. Furthermore, the hardness result holds in the strong sense, such that every coordinate is a rational bounded by a polynomial in the instance size.

10:50 – 11:10

Mixed integer programming and quadratic programming formulations for the interval count problem

Lívia Medeiros
Universidade do Estado do Rio de Janeiro
Coauthors: Fabiano Oliveira, Abilio Lucena, Jayme Szwacfiter

A graph is an interval graph if its vertex set corresponds to a family of intervals on the real line, called a model, such that two distinct vertices are adjacent in the graph if and only if their corresponding intervals intersect each other. The minimum number of interval lengths that suffices to represent a model of a given interval graph is its interval count. The use of mathematical optimization techniques for solving interval count problems was first explored by Joos et al. [1]. In more detail, given a bipartition of vertices into classes of lengths, the authors propose an efficient linear programming based algorithm for solving the interval count two problem. However, so far, no mathematical formulation exists in the literature for general interval count. As a contribution in that direction, we introduce a mixed integer programming formulation for the exact value of interval count, parameterized by the largest interval length. Additionally, we also propose a quadratic formulation for a valid upper bound on interval count. Solution algorithms for these formulations were tested on interval count instances found in the literature. As an outcome of these experiments, the algorithm for the upper bound formulation was shown to run much faster than its exact solution counterpart. Furthermore, the upper bounds thus obtained were frequently certified as optimal by the exact algorithm.

11:15 – 11:35

Greediness is not always a vice: Efficient Discovery Algorithms for Assignment Problems

Romaric Duvignau
Chalmers University of Technology
Coauthors: Ralf Klasing

Finding a maximum-weight matching is a classical and well-studied problem in computer science, solvable in cubic time in general graphs. We introduce and consider in this work the "discovery" variant of the bipartite matching problem (or assignment problem) where edge weights are not provided as input but must be *queried*, requiring additional and costly computations. Hence, discovery algorithms are developed aiming to minimize the number of queried weights while providing guarantees on the computed solution. We show in this work the hardness of the underlying problem in general while providing several efficient algorithms that can make use of natural assumptions about the order in which the nodes are processed by the greedy algorithms. Our motivations for exploring this problem stem from finding practical solutions to maximum-weight matching in hypergraphs, a problem recently emerging in the formation of peer-to-peer energy sharing communities.

12:00 – 12:20

A polyhedral study of a relaxation of the routing and spectrum allocation problem

Annegret Wagler
University Clermont Auvergne
Coauthors: Federico Bertero, Herve Kerivin, Javier Marenco

The *routing and spectrum allocation (RSA) problem* arises in the context of flexible grid optical networks, and consists in routing a set of demands through a network while simultaneously assigning a bandwidth to each demand, subject to non-overlapping constraints. One of the most effective integer programming formulations for RSA is the DR-AOV formulation, presented in a previous work. In this work we explore a relaxation of this formulation with a subset of variables from the original formulation, in order to identify valid inequalities that could be useful within a cutting-plane environment for tackling RSA. We present basic properties of this relaxed formulation, we identify several families of facet-inducing inequalities, and we show that they can be separated in polynomial time.

12:25 – 12:45

Resource augmentation analysis of the greedy algorithm for the Online Transportation Problem

Stephen Arndt
University of Pittsburgh
Coauthors: Josh Ascher, Kirk Pruhs

We consider the online transportation problem set in a metric space containing parking garages of various capacities. Cars arrive over time, and must be assigned to an unfull parking garage upon their arrival. The objective is to minimize the aggregate distance that cars have to travel to their assigned parking garage. We show that the natural greedy algorithm, augmented with garages of $k \geq 3$ times the capacity, is $\left(1 + \frac{2}{k-2}\right)$-competitive.

Monday afternoon

Time	Monday Afternoon	
	Room Maguey	**Room Coyote**
15:00-15:55	**Celina Figueiredo** A Perfect Path from Computational Biology to Quantum Computing	
16:00–16:20	**Coffee Break**	
16:20–16:40	**Florian Horn** The problem of Discovery in Version Control Systems	**Isac Costa** The Conversion Set Problem on Graphs
16:45–17:05	**Octavio Zapata** Descriptive complexity of controllable graphs	**Tatiana Pantoja** Biclique coloring game
17:10–17:30	**Mayank Goswami** Fair subgraph selection for contagion containment	**Mateus de Paula Ferreira** On the absolute and relative oriented clique problems' time complexity

Room Maguey

15:00 – 15:55

PLENARY TALK:
A Perfect Path from Computational Biology to Quantum Computing

Celina Figueiredo
Universidade Federal do Rio de Janeiro, Brazil

I will revisit my contributions to the P versus NP millennium problem and the computational complexity of combinatorial problems, especially those arising in Computational Biology and Quantum Computing, through 20 PhD theses, mine and of my students. I will explain how the dichotomy NP-complete versus polynomial-time of long-standing problems together with their multivariate analysis is settled. Yet, intriguing questions remain.

16:20 – 16:40

The problem of discovery in version control systems

Florian Horn
IRIF-CNRS, Université Paris Cité
Coauthors: Laurent Bulteau, Pierre-Yves David

Version Control Systems, used by developers to keep track of the evolution of their code, model repositories as Merkle graphs of revisions. In order to synchronize efficiently between different instances of a repository, they need to determine the common knowledge that they share. This process is called *discovery*.

In this paper, we provide theoretical definitions for the problem of discovery, establish some universal upper and lower bounds on the amount of data that needs to be exchanged, as well as NP-hardness for a restricted variant (with only 2 round-trips). We also present and analyze some algorithms that are used in extant VCSs, such as Mercurial and Git, and propose an algorithm based on chain-decomposition.

16:45 – 17:05

Descriptive complexity of controllable graphs

Octavio Zapata
Universidad Nacional Autónoma de México
Coauthors: Aida Abiad, Anuj Dawar

Let G be a graph on n vertices with adjacency matrix A, and let $\mathbf{1}$ be the all-ones vector. We call G *controllable* if the set of vectors $\mathbf{1}, A\mathbf{1}, \ldots, A^{n-1}\mathbf{1}$ spans the whole space $\mathbb{R}^n$. We characterize the isomorphism problem of controllable graphs in terms of other combinatorial, geometric and logical problems. We also describe a polynomial time algorithm for graph isomorphism that works for almost all graphs.

17:10 – 17:30

Fair subgraph selection for contagion containment

Mayank Goswami
City University New York
Coauthors: Esther M. Arkin, Rezaul A. Chowdhury, Jason Huang, Joseph S. B. Mitchell, Valentin Polishchuk, Rakesh Ravindran

We present a new class of problems where the goal is to select a "fair" subgraph H of a given graph $G = (V, E)$, such that H decomposes into many small components. A subgraph $H \subset G$ is (P, d) fair if every vertex $v \in P$ has the same degree d in H, where $P \subset V$ and $d > 0$ are input parameters.

These problems arise when the goal is to allow individuals to equally participate in activities in such a way that the connected components within an interaction graph, which models potential interactions among people, are of the smallest possible size, so that the spread of the contagion, and the difficulty of contact tracing in case of infection, is minimized. Within a preference graph that models the set of preferred choices for each individual when selecting among available options of where to conduct any particular type of activity (e.g., which gym to attend), we seek to compute the fair subgraph of assignments of individuals to these options, so that the number of people in each connected component ("interaction community") of the resulting subgraph is minimized, and everyone is given the same number of options for every activity.

We show that the fair subgraph selection problem is NP-hard, even for very restricted versions. We then formulate the problem as an integer program, and give a polynomial time computable lower bound on the optimal solution.

Room Coyote

16:20 – 16:40

The Conversion Set Problem on Graphs

Isac Costa
Universidade Federal do Cariri
Coauthors: Carlos V.G.C. Lima, Thiago Marcilon

Given a graph $G = (V, E)$ and a threshold function $f : V(G) \to \mathbb{N}$, an f-reversible process on G is a dynamical system such that, given an initial vertex labelling $c_0 : V(G) \to \{0, 1\}$, every vertex v changes its label if and only if it has at least $f(v)$ neighbors with the opposite label, synchronously in discrete-time steps. An f-conversion set of G is a subset of vertices of G with initial label equal to 1 such that, in an f-reversible process on G, eventually, all vertices reach label 1 and it does not get changed anymore. The conversion set number $r_f(G)$ is the minimum cardinality of an f-conversion set of G. The Conversion Set Problem asks whether $r_f(G) \leq k$, which is known to be NP-complete. We prove that it is W[1]-hard when parameterized by the treewidth of G and k together by showing an fpt-reduction from Target Set Selection with the same parameters. We also show a polynomial-time algorithm to determine $r_f(P)$ for any path P, which has been left open by Dourado et al. [1]. We also consider a quite similar version on an orientation $D = (V, \overrightarrow{E})$ of a graph $G = (V, E)$, that is, the oriented graph obtained from G by choosing one orientation for each edge of G. In this version, a vertex v changes its label if and only if it has at least $f(v)$ incoming neighbors with opposite label. We prove the W[2]-hardness of the Conversion Set Problem for this version parameterized by k, even for an orientation with only one directed cycle and all thresholds equal to 1, and a linear-time algorithm for acyclic orientations.

16:45 – 17:05

Biclique coloring game

Tatiana Pantoja
Unniversidade Federal Fluminenese
Coauthors: Simone Dantas, Daniel F.D. Posner

A *biclique q-coloring* is an assignment of q-colors to the vertices of a graph G, so that no biclique (maximal set of vertices that induces a complete bipartite subgraph of G with at least one edge) is monochromatic. Inspired by the coloring game, we introduce the *biclique q-coloring game* played on a graph G defined as follows. Two players, Alice and Bob, alternately color the vertices of a graph G using q colors. Alice's goal is to color the vertices of G so that no biclique is monochromatic, and Bob tries to prevent this. Both players play optimally and respect the following rule: if a biclique is fully colored, then there exist at least two vertices in the biclique with different colors. In this paper, we prove that the biclique q-coloring game is PSPACE-complete and study the game in powers of paths P_n^k.

17:10 – 17:30

On the absolute and relative oriented clique problems' time complexity

Mateus de Paula Ferreira
Universidade Federal de Goiás
Coauthors: E.M.M. Coelho, H. Coelho, L. Faria, S. Klein

Let $\overrightarrow{G} = (V, A)$ be an oriented graph. An *oriented k-coloring* of $\overrightarrow{G}$ is a partition of V into k color classes, such that there is no pair of adjacent vertices belonging to the same class and all the arcs between a pair of color classes have the same orientation. The smallest k such that $\overrightarrow{G}$ admits an oriented k-coloring is the *oriented chromatic number* $\chi_o(\overrightarrow{G}) = k$ of $\overrightarrow{G}$. In an oriented coloring of $\overrightarrow{G}$ every pair of vertices with oriented distance at most 2 in $\overrightarrow{G}$ have different colors. In 2004, Klostermeyer and MacGillivray defined the concept of an "analogue of clique" for oriented coloring in which a subgraph $\overrightarrow{H}$ of $\overrightarrow{G}$ is an oriented clique if every pair of vertices of $\overrightarrow{H}$ is in an oriented distance of at most 2 in $\overrightarrow{H}$. The authors defined the absolute oriented clique number of $\overrightarrow{G}$ as the number of vertices $|V(H)| = \omega_{ao}(\overrightarrow{G})$ of the largest oriented clique $\overrightarrow{H}$ of $\overrightarrow{G}$ and satisfies that $\omega_{ao}(\overrightarrow{G}) \leq \chi_o(\overrightarrow{G})$. Ever since, for almost 20 years, the time complexity status of this parameter remained unknown. The *relative oriented clique number* $\omega_{ro}(\overrightarrow{G})$ of an oriented graph $\overrightarrow{G}$ is the size of the largest set of vertices R, such that every pair of vertices of R is at a maximum oriented distance of 2 in R. For every oriented graph $\overrightarrow{G}$, $\omega_{ao}(\overrightarrow{G}) \leq \omega_{ro}(\overrightarrow{G}) \leq \chi_o(\overrightarrow{G})$. In this paper we classify Absolute Oriented Clique – the Klostermeyer and MacGillivray's decision problem – proving that given an oriented graph $\overrightarrow{G}$ and a positive integer k it is NP-complete to decide whether $\omega_{ao}(\overrightarrow{G}) \geq k$. We prove that for all $\varepsilon > 0$, there is no polynomial-time approximation for Relative Oriented Clique and for Absolute Oriented Clique within a factor of $n^{1-\varepsilon}$, unless $P = NP$. Finally, we prove that Relative Oriented Clique is $W[1]$-complete and that Absolute Oriented Clique belongs to $W[2]$ and is $W[1]$-hard.

Tuesday morning

Time	Tuesday Morning	
	Room Maguey	**Room Coyote**
9:00-9:55	**Deborah Oliveros** Tverberg type Theorems: The study of partitions of points as simplicial complexes	
10:00–10:25	**Coffee Break**	
10:25–10:45	**Magda Dettlaff** Common edge independence number of a graph	**Lucía Busolini** Characterization of balanced graphs within claw-free graphs
10:50–11:10	**Dipayan Chakraborty** Identifying codes in bipartite graphs of given maximum degree	**Niklas Troost** A general approximation for multistage subgraph problems
11:15–11:35	**Denae Ventura** Unavoidable patterns in 2-colorings of the complete bipartite graph	**J. Carlos García-Altamirano** Computacional complexity of Hajós constructions of symmetric odd cycles
11:40–12:00	**Coffee Break**	
12:00–12:20	**Amanda Montejano** Sidon sets and Sidon-partitions in cyclic groups through almost different sets	**Yaqiao Li** Online vector bin packing and hypergraph coloring illuminated: simpler proofs and new connections
12:25–12:45	**Alonso Ali** Five edge-independent spanning trees	**César Hernández-Cruz** Simple certifying algorithms for variants of the $(2, 1)$-colouring problem

Room Maguey

9:00 – 9:55

PLENARY TALK:
Tverberg type Theorems: The study of partitions of points as simplicial complexes

Déborah Oliveros
Universidad Nacional Autónoma de México

Tverberg Theorem is one of the most beautiful theorems in discrete geometry. This theorem could be interpreted as a Ramsey type result, as follows: If you have sufficiently many points in the Euclidean space, there exists always a way of partitioning them in such a way that the intersection pattern is a complete graph. We will discuss possible ways of generalizing this theorem as well as some interesting applications.

10:25 – 10:45

Common edge independence number of a graph

Magda Dettlaff
University of Gdansk
Coauthors: Magdalena Lemańska, Jerzy Topp

The cardinality of a largest matching of G, denoted by $\alpha'(G)$, is called the upper matching number of G. The lower matching number $i'(G)$ of a graph G is the cardinality of a smallest maximal matching of G. We introduce the concept of the *common edge independence number* of a graph G, denoted by $\alpha'_c(G)$, is the largest integer k such that every edge of G belongs to a matching that has at least k edges. For any graph G, the relations between above parameters are given by the chain of inequalities $i'(G) \leq \alpha'_c(G) \leq \alpha'(G)$. We study relations between this three parameters, in particular we show that the difference between $\alpha'_c(G)$ and $i'(G)$ can be arbitrarily large while $\alpha'(G)$ and $\alpha'_c(G)$ may differ by at most one. We also characterize the trees T for which $i'(T) = \alpha'_c(T)$, and the trees T for which $\alpha'_c(T) = \alpha'(T)$.

10:50 – 11:10

Identifying codes in bipartite graphs of given maximum degree

Dipayan Chakraborty
Université Clermont Auvergne
Coauthors: Florent Foucaud, Tuomo Lehtilä

An *identifying code* of a closed-twin-free graph G is a set S of vertices of G such that any two vertices in G have a distinct intersection between their closed neighborhoods and S. It was conjectured in [F. Foucaud, R. Klasing, A. Kosowski, A. Raspaud. On the size of identifying codes in triangle-free graphs. Discrete Applied Mathematics, 2012] that there exists an absolute constant c such that for every connected graph G of order n and maximum degree Δ, G admits an identifying code of size at most $\frac{\Delta-1}{\Delta}n + c$. We provide significant support for this conjecture by proving it for the class of all bipartite graphs that do not contain any pairs of open-twins of degree at least 2. In particular, this class of bipartite graphs contains all trees and more generally, all bipartite graphs without 4-cycles. Moreover, our proof allows us to precisely determine the constant c for the considered class, and the list of graphs needing $c > 0$. For $\Delta = 2$ (the graph is a path or a cycle), it is long known that $c = 3/2$ suffices. For connected graphs in the considered graph class, for each $\Delta \geq 3$, we show that $c = 1/\Delta \leq 1/3$ suffices and that c is required to be positive only for a finite number of trees. In particular, for $\Delta = 3$, there are 12 trees with diameter at most 6 with a positive constant c and, for each $\Delta \geq 4$, the only tree with positive constant c is the Δ-star. Our proof is based on induction and utilizes recent results from [F. Foucaud, T. Lehtilä. Revisiting and improving upper bounds for identifying codes. SIAM Journal on Discrete Mathematics, 2022].

11:15 – 11:35

Unavoidable patterns in 2-colorings of the complete bipartite graph

Denae Ventura
UC Davis
Coauthors: Adriana Hansberg

We determine the colored patterns that appear in any 2-edge coloring of $K_{n,n}$, with n large enough and with sufficient edges in each color. We prove the existence of a positive integer z_2 such that any 2-edge coloring of $K_{n,n}$ with at least z_2 edges in each color contains at least one of these patterns. We give a general upper bound for z_2 and prove its tightness for some cases. We define the concepts of bipartite r-tonality and bipartite omnitonality using the complete bipartite graph as a base graph. We provide a characterization for bipartite r-tonal graphs and prove that every tree is bipartite omnitonal. Finally, we define the bipartite balancing number and provide the exact bipartite balancing number for paths and stars.

12:00 – 12:20

Sidon sets and Sidon-partitions in cyclic groups through almost different sets

Amanda Montejano
Universidad Nacional Autónoma de México
Coauthors: Luis-Miguel Delgado, Hamilton Ruiz, Carlos Trujillo

We investigate the Sidon set problem in the modular case and its corresponding version in Ramsey theory. Specifically, we study the function $\overline{F(n)}$ that maximizes the size of a Sidon set in $\mathbb{Z}_n$, as well as the minimum n such that $\mathbb{Z}_n$ admits no Sidon r-partition (a partition whose parts are all Sidon sets), denoted by $\overline{SR(r)}$, for a fixed positive integer r. We use known results and the pigeonhole principle to establish an upper bound of $\overline{SR(r)}$, which allows us to find the exact values of $\overline{SR(r)}$ for $r \in \{2, 3, 4, 7\}$. We also present a criterion for determining the non-existence of almost difference sets (ADS) in $\mathbb{Z}_n$. By exploiting such criterion and the connection between ADS sets and the existence of Sidon sets in $\mathbb{Z}_n$, we derive nontrivial upper bounds of $\overline{F(n)}$ for infinitely many values of n, and we refine the upper bound on $\overline{SR(r)}$ in multiple cases, determining also the exact value for $r \in \{5, 6\}$. Our findings shed new light on the behavior of Sidon sets in cyclic groups. In particular, we find infinitely many values for which $\overline{F(n)} > \overline{F(n+1)}$.

12:25 – 12:45

Five edge-independent spanning trees

Alonso Ali
UNICAMP
Coauthors: Orlando Lee

Let G be a graph and let r be a fixed vertex of G. Two spanning trees T_1 and T_2 of G rooted at r are *edge-independent* if for every vertex $v \in V(G)$, the paths from v to r in T_1 and from v to r in T_2 are edge-disjoint. Itai and Zehavi conjectured that for every k-edge-connected graph and any vertex $r \in V(G)$ there are k edge-independent spanning trees rooted at r (Edge-Independent Spanning Trees Conjecture). Itai and Rodeh proved the case $k = 2$, Schlipf and Schmidt proved the case $k = 3$, and Hoyer and Thomas proved the case $k = 4$ of the conjecture. In this paper, we prove the case $k = 5$.

Room Coyote

10:25 – 10:45

Characterization of balanced graphs within claw-free graphs

Lucía Busolini
Universidad de Buenos Aires
Coauthors: Guillermo Durán, Martín D. Safe

A graph is balanced when its clique matrix is balanced. Bonomo, Durán, Lin and Szwarcfiter (2006) proved that a graph is balanced if and only if it contains no induced subgraphs known as extended odd suns. However, a characterization of balanced graphs by minimal forbidden induced subgraphs is not known. In this work, we find such a characterization when restricted to the class of claw-free graphs. As a consequence, we prove that there is an $O(m^2 + n)$−time algorithm that, given any graph, either decides that it is balanced or gives a certificate of the fact that it is not claw-free balanced.

10:50 – 11:10

A general approximation for multistage subgraph problems

Niklas Troost
Osnabrück University
Coauthors: Markus Chimani, Tilo Wiedera

Subgraph Problems are optimization problems on graphs where a solution is a subgraph that satisfies some property and optimizes some measure. Examples include shortest path, minimum cut, maximum matching, or vertex cover. In reality, however, one often deals with time-dependent data, i.e., the input graph may change over time and we need to adapt our solution accordingly. We are interested in guaranteeing optimal solutions after each graph change while retaining as much of the previous solution as possible. Even if the subgraph problem itself is polynomial-time computable, this *multistage* variant turns out to be NP-hard in most cases.

We present an algorithmic framework that—for any subgraph problem of a certain type—guarantees an optimal solution for each point in time and provides an approximation guarantee for the similarity between subsequent solutions.

We show that the class of applicable multistage subgraph problems is very rich and that proving membership to this class is mostly straightforward. As examples, we explicitly state these proofs and obtain corresponding approximation algorithms for the natural multistage versions of Shortest s-t-Path, Perfect Matching, Minimum s-t-Cut—and further classical problems on bipartite or planar graphs, namely Maximum Cut, Vertex Cover, and Independent Set. We also report that all these problems are already NP-hard on only two stages.

11:15 – 11:35

Computacional complexity of Hajós constructions of symmetric odd cycles

Juan Carlos García-Altamirano
Universidad Nacional Autónoma de México
Coauthors: Jorge Cervantes-Ojeda, Mika Olsen

The dichromatic number of a digraph D is the minimum number of colors of a vertex coloring of D such that D has no monochromatic cycles, the dichromatic number is an extension of the chromatic number to the class of digraphs. The Hajós join is a tool to obtain r-chromatic graphs, using the dichromatic number, J. Bang-Jensen et. al. extended the Hajós join to digraphs, and thus obtained a tool to obtain r-dichromatic digraphs. J. Bang-Jensen et. al. posed in 2020 the problem of how to obtain the symmetric cycle of length 5 from symmetric cycles of length 3. We recently solved this problem by applying a genetic algorithm. In this article, we generalize the construction of the symmetric cycle of length 5 and determine the computational complexity as $\Theta(n \ln(n))$.

12:00 – 12:20

Online vector bin packing and hypergraph coloring Illuminated: simpler proofs and new connections

Yaqiao Li
Concordia University
Coauthors: Denis Pankratov

This paper studies the online vector bin packing (OVBP) problem and the related problem of online hypergraph coloring (OHC). Firstly, we use a double counting argument to prove an upper bound on the competitive ratio of $FirstFit$ for OVBP. Our proof is conceptually simple, and strengthens the result in [1] by removing the dependency on the bin size parameter. Secondly, we introduce a notion of an online incidence matrix that is defined for every instance of OHC. Using this notion, we provide a reduction from OHC to OVBP, which allows us to carry known lower bounds on the competitive ratio of algorithms from OHC to OVBP. Our approach significantly simplifies the previous argument from [1] that relied on using intricate graph structures. In addition, we slightly improve their lower bounds. Lastly, we establish a tight bound on the competitive ratio of algorithms for OHC, where input is restricted to be a hypertree, thus resolving a conjecture in [2]. The crux of this proof lies in solving a certain combinatorial partition problem about multi-family of subsets, which might be of independent interest.

12:25 – 12:45

Simple certifying algorithms for variants of the (2, 1)-colouring problem

César Hernández-Cruz
Universidad Nacional Autónoma de México
Coauthors: Fernando Esteban Contreras-Mendoza

A $(2,1)$-colouring of a graph is a partition of its vertex set into two independent sets and a clique (any of which may be empty). We present forbidden induced subgraph characterizations for some hereditary graph classes obtained from $(2,1)$-colouring by adding restrictions between its parts (e.g., there are no edges between the clique and one of the independent sets). The obtained characterizations yield certifying algorithms to recognize these graph classes, which run in time $O(|V| + |E|)$. All the algorithms presented are straightforward to implement using basic data structures.

Tuesday afternoon

Time	Tuesday Afternoon	
	Room Maguey	**Room Coyote**
15:00-15:55	**Federico Ardila** The geometry of geometries: matroid theory, old and new	
16:00–16:20	**Coffee Break**	
16:20–16:40	**Úrsula Hébert-Johnson** Min-max coverage problems on tree-like metrics	**Mariana Escalante** Characterization of graphs with perfect closed neighbourhood matrices
16:45–17:05	**Marina Groshaus** Biclique transversal and biclique independent set	**José Alvarado** Resilience for loose Hamilton cycles
17:10–17:30	**Julio Araujo** Semi-proper orientations of dense graphs	**Diana Sasaki** Kochol superposition of Goldberg with Semi-blowup snarks is Type 1

Room Maguey

15:00 – 15:55

PLENARY TALK:
The geometry of geometries: matroid theory, old and new

Federico Ardila
San Francisco State University, USAn

The theory of matroids or combinatorial geometries originated in linear algebra and graph theory, and has deep connections with many other areas, including field theory, matching theory, submodular optimization, Lie combinatorics, and total positivity. Matroids capture the combinatorial essence that these different settings share.

In recent years, the (classical, polyhedral, algebraic, and tropical) geometric roots of the field have grown much deeper, bearing new fruits. My talk will survey, in an accessible manner, some recent successes. I will discuss joint work with Carly Klivans, Graham Denham, and June Huh.

16:20 – 16:40

Min-max coverage problems on tree-like metrics

nombre académico
UC Santa Barbara
Coauthors: Eric Aaron, Danny Krizanc, Daniel Lokshtanov

We consider a number of min-max coverage problems. In each problem, the input is an unweighted graph G and an integer k, and possibly some additional information, such as a root vertex r. In the Min-Max Path Cover problem, the task is to cover all vertices of the graph by k walks, minimizing the length of the longest walk. The variant of Min-Max Path Cover in which all walks start and end at the same prescribed root vertex r is called the k-Traveling Salesmen Problem. In the Min-Max Tree Cover problem, the task is to cover all vertices of the graph by k trees, minimizing the size (number of edges) of the largest tree. In the rooted version, Min-Max k-Rooted Tree Cover, the input also contains k roots $r_1, \dots, r_k$, and the ith tree must contain the root r_i. These four problems are all known to be APX-hard and to admit a constant-factor approximation. In this paper, we initiate the systematic study of these problems on trees and, more generally, on graphs of constant treewidth. As opposed to most graph problems, all four of the above coverage problems remain NP-hard even when G is a tree. We obtain an $n^{O(k)}$-time exact algorithm for all four problems on graphs of bounded treewidth. Our main contribution is a quasi-polynomial-time approximation scheme (QPTAS) for the k-Traveling Salesmen Problem, Min-Max Path Cover, and Min-Max Tree Cover on graphs of bounded treewidth.

16:45 – 17:05

Biclique transversal and biclique independent set

Marina Groshaus
Universidade Tecnológica Federal do Paraná
Coauthors: Juan Carlos Terragno

A *biclique* of a graph G is a maximal complete bipartite induced subgraph of G with at least one edge. We define and study the time complexity of the problems of finding the *minimum biclique transversal* and *maximum biclique independent set* of a graph G, denoted by $\alpha_b(G)$ and $\tau_b(G)$ respectively. We prove that the Biclique-Transversal and Biclique-Independent-Set problems are NP-Complete for the classes of split graphs, planar graphs C_4-*free* with $\Delta = 4$, and bipartite C_4-*free* graphs with $\Delta = 4$. In addition, we provide polinomial time algorithms for block graphs and split *gem-free* graphs. Finally, we introduce the concept of biclique-perfectness.

17:10 – 17:30

Semi-proper orientations of dense graphs

Júlio Araújo
Universidade Federal do Ceará
Coauthors: F. Havet, C. Linhares Sales, N. Nisse, K. Suchan

An *orientation* D of a graph G is a digraph obtained from G by replacing each edge by exactly one of the two possible arcs with the same ends. An orientation D of a graph G is a *k-orientation* if the in-degree of each vertex in D is at most k. An orientation D of G is *proper* if any two adjacent vertices have different in-degrees in D. The *proper orientation number* of a graph G, denoted by $\overrightarrow{\chi}(G)$, is the minimum k such that G has a proper k-orientation.

A *weighted orientation* of a graph G is a pair (D, w), where D is an orientation of G and w is an arc-weighting $A(D) \to \mathbb{N} \setminus \{0\}$. A *semi-proper orientation* of G is a weighted orientation (D, w) of G such that for every two adjacent vertices u and v in G, we have that $S_{(D,w)}(v) \neq S_{(D,w)}(u)$, where $S_{(D,w)}(v)$ is the sum of the weights of the arcs in (D, w) with head v. For a positive integer k, a *semi-proper k-orientation* (D, w) of a graph G is a semi-proper orientation of G such that $\max_{v \in V(G)} S_{(D,w)}(v) \leq k$. The *semi-proper orientation number* of a graph G, denoted by $\overrightarrow{\chi}_s(G)$, is the least k such that G has a semi-proper k-orientation.

In this work, we first prove that $\overrightarrow{\chi}_s(G) \in \{\omega(G) - 1, \omega(G)\}$ for every split graph G, and that, given a split graph G, deciding whether $\overrightarrow{\chi}_s(G) = \omega(G) - 1$ is an NP-complete problem. We also show that, for every k, there exists a (chordal) graph G and a split subgraph H of G such that $\overrightarrow{\chi}(G) \leq k$ and $\overrightarrow{\chi}(H) = 2k - 2$. In the sequel, we show that, for every $n \geq p(p + 1)$, $\overrightarrow{\chi}_s(P_n^p) = \left\lceil \frac{3}{2}p \right\rceil$, where P_n^p is the p^{th} power of the path on n vertices. We investigate further unit interval graphs with no big clique: we show that $\overrightarrow{\chi}(G) \leq 3$ for any unit interval graph G with $\omega(G) = 3$, and present a complete characterization of unit interval graphs with $\overrightarrow{\chi}(G) = \omega(G) = 3$. Then, we show that deciding whether $\overrightarrow{\chi}_s(G) = \omega(G)$ can be solved in polynomial time in the class of co-bipartite graphs. Finally, we prove that computing $\overrightarrow{\chi}_s(G)$ is FPT when parameterized by the minimum size of a vertex cover in G or by the treewidth of G. We also prove that not only computing $\overrightarrow{\chi}_s(G)$, but also $\overrightarrow{\chi}(G)$, admits a polynomial kernel when parameterized by the neighbourhood diversity plus the value of the solution. These results imply kernels of size $4^{O(k^2)}$ and $O(2^k k^2)$, in chordal graphs and split graphs, respectively, for the problem of deciding whether $\overrightarrow{\chi}_s(G) \leq k$ parameterized by k. We also present exponential kernels for computing both $\overrightarrow{\chi}(G)$ and $\overrightarrow{\chi}_s(G)$ parameterized by the value of the solution when G is a cograph. On the other hand, we show that computing $\overrightarrow{\chi}_s(G)$ does not admit a polynomial kernel parameterized by the value of the solution when G is a chordal graph, unless $\mathsf{NP} \subseteq \mathsf{coNP/poly}$.

Room Coyote

16:20 – 16:40

Characterization of graphs with perfect closed neighbourhood matrices

Mariana Escalante
Universidad Nacional de Rosario - CONICET
Coauthors: E. Hinrichsen

The main purpose of this work is to characterize the graphs whose closed neighbourhood matrices are perfect since this property implies the resolution of some packing problems in polynomial time. Given a 0-1 matrix M, $Q(M)$ denotes the graph whose cliques have their incidence vectors as the rows of M. A 0-1 matrix M is perfect if it is the clique-node matrix of $Q(M)$ and $Q(M)$ is a perfect graph.

First, we define a set T of seven graphs and prove that $N[G]$ is a clique-node matrix if and only if every node induced subgraph of G in the set T, has a common neighbour in G. Second, we define two families of graphs, called H-graphs and A-graphs, and prove that $Q(N[G])$ does not have an induced odd hole if and only if G has no H-subgraph for some additional conditions on G. Finally, we show that $Q(N[G])$ does not have an induced odd antihole if and only if G has neither an A-subgraph nor a web graph W^t_{4t+3} in suitable sets of nodes of $V(G)$, thus completing a characterization of graphs with perfect closed neighbourhood matrix.

16:45 – 17:05

Resilience for loose Hamilton cycles

José D. Alvarado
Universidade de São Paulo
Coauthors: Yoshiharu Kohayakawa,Richard Lang, Guilherme Oliveira Mota, Henrique Stagni

We study the emergence of loose Hamilton cycles in subgraphs of random hypergraphs. Our main result states that the minimum d-degree threshold for loose Hamiltonicity relative to the random k-uniform hypergraph $\mathrm{H}_k(n, p)$ coincides with its dense analogue whenever $p \geq n^{-(k-1)/2+o(1)}$. The value of p is approximately tight for $d > (k+1)/2$. This is particularly interesting because the dense threshold itself is not known beyond the cases when $d \geq k-2$.

17:10 – 17:30

Kochol superposition of Goldberg with Semi-blowup snarks is Type 1

Diana Sasaki
Universidade do Estado do Rio de Janeiro
Coauthors: Miguel A.D.R. Palma, Simone Dantas

A *q-total coloring* of G is an assignment of q colors to the vertices or edges of G, so that adjacent or incident elements have different colors. The Total Coloring Conjecture (TCC) asserts that a total coloring of a graph G has at least $\Delta + 1$ and at most $\Delta + 2$ colors. Rosenfeld has shown that the total chromatic number of a cubic graph is either 4 (Type 1) or 5 (Type 2). We present Type 1 new infinite families of snarks (cubic bridgeless graphs of chromatic index 4) obtained by the Kochol superposition of Goldberg with t-Semiblowup snarks. These results provide evidence of a negative answer for the question proposed by Cavicchioli et al. (2003) about the smallest order of a Type 2 snark of girth at least 5.

Wednesday morning

Time	Wednesday
	Room Maguey
9:00-9:55	**Pavol Hell** Graph homomorphism dichotomies
10:00–10:45	**Coffee & Posters**
10:50–11:10	**Pablo Romero** Least corank for the nonexistence of uniformly most reliable graphs
11:15–11:35	**Mathias Schacht** Canonical colourings in random graphs *Best paper award*
11:40–12:00	**José Alvarado** A canonical Ramsey theorem with list constraints in random graphs *Best paper award*

Room Maguey

9:00 – 9:55

PLENARY TALK:
Graph homomorphism dichotomies

Pavol Hell
Simon Fraser University, Burnaby, Canada

I will offer personal reminiscences on the graph theoretic origins of the 1993 Feder-Vardi Dichotomy Conjecture, proved in 2017 by Bulatov and by Zhuk. Then I will describe some recent work and open problems on other versions of graph homomorphism dichotomy.

10:50 – 11:10

Least corank for the nonexistence of uniformly most reliable graphs

Pablo Romero
Universidad de Buenos Aires
Coauthors: Martín D. Safe

If G is a simple graph and $\rho \in [0,1]$, the reliability $R_G(\rho)$ is the probability of G being connected after each of its edges is removed independently with probability ρ. A simple graph G is a *uniformly most reliable graph* (UMRG) if $R_G(\rho) \geq R_H(\rho)$ for every $\rho \in [0,1]$ and every simple graph H on the same number of vertices and edges as G. Boesch [J. Graph Theory 10 (1986), 339–352] conjectured that, if n and m are such that there exists a connected simple graph on n vertices and m edges, then there also exists a UMRG on the same number of vertices and edges. Some counterexamples to Boesch's conjecture were given by Kelmans, Myrvold et al., and Brown and Cox. It is known that Boesch's conjecture holds whenever the corank, defined as $c = m - n + 1$, is at most 4 (and the corresponding UMRGs are fully characterized). Ath and Sobel conjectured that Boesch's conjecture holds whenever the corank c is between 5 and 8, provided the number of vertices is at least $2c - 2$. In this work, we give an infinite family of counterexamples to Boesch's conjecture of corank 5. These are the first reported counterexamples that attain the minimum possible corank. As a byproduct, the conjecture by Ath and Sobel is disproved.

11:15 – 11:35

A canonical Ramsey theorem with list constraints in random graphs
Best paper award

José D. Alvarado
Universidade de São Paulo
Coauthors: Yoshiharu Kohayakawa, Patrick Morris, Guilherme Oliveira Mota

The celebrated canonical Ramsey theorem of Erdős and Rado implies that for a given graph H, if n is sufficiently large then any colouring of the edges of K_n gives rise to copies of H that exhibit certain colour patterns, namely monochromatic, rainbow or lexicographic. We are interested in sparse random versions of this result and the threshold at which the random graph $\mathbf{G}(n,p)$ inherits the canonical Ramsey properties of K_n. Our main result here pins down this threshold when we focus on colourings that are constrained by some prefixed lists. This result is applied in an accompanying work of the authors on the threshold for the canonical Ramsey property (with no list constraints) in the case that H is an even cycle.

11:40 – 12:00

Canonical colourings in random graphs
Best paper award

Mathias Schacht
Universität Hamburg
Coauthors: Nina Kamčev

Rödl and Ruciński [*Threshold functions for Ramsey properties*, J. Amer. Math. Soc. **8** (1995)] established Ramsey's theorem for random graphs. In particular, for fixed integers r and $\ell \geqslant 2$ they showed that $\hat{p}_{K_\ell,r}(n) = n^{-\frac{2}{\ell+1}}$ is a threshold for the Ramsey property that every r-colouring of the edges of the binomial random graph $G(n,p)$ yields a monochromatic copy of K_ℓ. We investigate how this result extends to arbitrary colourings of $G(n,p)$ with an unbounded number of colours. In this situation, Erdős and Rado [*A combinatorial theorem*, J. London Math. Soc. **25** (1950)] showed that *canonically coloured* copies of K_ℓ can be ensured in the deterministic setting. We transfer the Erdős–Rado theorem to the random environment and show that both thresholds coincide when $\ell \geqslant 4$. As a consequence, the proof yields $K_{\ell+1}$-free graphs G for which every edge colouring contains a canonically coloured K_ℓ.

The 0-statement of the threshold is a direct consequence of the corresponding statement of the Rödl–Ruciński theorem and the main contribution is the 1-statement. The proof of the 1-statement employs the transference principle of Conlon and Gowers [*Combinatorial theorems in sparse random sets*, Ann. of Math. (2) **184** (2016)].

Poster session

10:00 – 10:45

Sidon-Ramsey and B_h-Ramsey numbers

Manuel-García Espinosa
UNAM-UMSNH
Coauthors: Amanda Montejano, Edgardo Roldán-Pensado, J. David Suárez / Daniel Pellicer

Given a positive integer k, the Sidon-Ramsey number $SR(k)$ is defined as the least integer n such that in any partition of $[1, n]$ in k parts there is a part that is not a Sidon set, i.e., there is a part that contains two distinct pairs of integers with the same sum. We introduce asymptotic estimates of Sidon-Ramsey numbers and some generalizations, such as:
- The equivalent parameter for higher dimensions. We consider Sidon partitions in the box $[1, n_1] \times [1, n_2] \times ... \times [1, n_d]$,
- Asymptotic estimates of B_h-Ramsey numbers. This case considers sets such that the sum of each h-tuple is distinct.
The estimate for Sidon-Ramsey numbers in intervals is tight. In the other cases we have tight estimates up to a constant factor. Also we introduce new values for specific Sidon-Ramsey numbers.

On the Treewidth of Token Graphs

Sergio Gómez Galicia
CINVESTAV
Coauthors: Ruy Fabila-Monroy, César Hernández-Cruz, Ana Laura Trujillo-Negrete

Let G be a graph on n vertices, and let $1 \leq k \leq n-1$ be an integer. The k-token graph of G is the graph $F_k(G)$ with vertex set all k-subsets of $V(G)$, being two of them adjacent whenever their symmetric difference is a pair of adjacent vertices in G. Informally, the treewidth, $\text{trw}(G)$, of G is a measure of how close is G from being a tree. In this work we study the treewidth of the $k-$token graph $F_k(G)$ when G is the star, the path, and the complete graph. We show that for constant k, for the first two cases, the treewidth is of order $\Theta(n^{k-1})$, in contrast with the treewidth of the complete graph on n vertices, which we show that is of order $\Theta(n^k)$.

Cycles of length 3 and 4 in edge-colored complete graphs with restrictions in the color transitions

Felipe Hernández-Lorenzana
Universidad Nacional Autónoma de México
Coauthors: Hortensia Galeana-Sánchez, Rocío Sánchez-López

A walk in an edge-colored graph is said to be a properly colored walk iff every two consecutive edges have different color, this includes the first and last edges when the walk is closed. Properly colored walks have shown to be an effective way to model certain real applications in different fields. In view of this, it is natural to ask about the existence of properly colored walks with restrictions in the transitions of colors allowed in the edges of a graph.
Consider the following edge-coloring of a graph G: Let H be a graph possibly with loops. We say that G is an H-colored graph whenever there exists a function $c : E(G) \longrightarrow V(H)$. A walk $(u_1, \ldots, u_k)$ in an H-colored graph G is an H-walk iff $(c(v_1v_2), c(v_2v_3), \ldots, c(v_{k-1}v_k))$ is a walk in H, and a cycle $(v_1, ..., v_n, v_1)$ is an H-cycle iff $(c(v_1v_2), c(v_2v_3), \ldots, c(v_{n-1}v_n), c(v_nv_1), c(v_1v_2))$ is a walk in H. Hence, H decides which color transitions are allowed in a cycle in order to be an H-cycle, in particular, when H is a complete graph without loops, every H-cycle is a properly colored cycle.
Let G be an H-colored complete graph. In this work, we show conditions implying that each vertex of G is contained in an H-cycle of length 3 (respectively 4).

Borsuk and Vázsonyi problem through Reuleaux Polyhedra

Gyivan López-Campos
Universidad Nacional Autónoma de México
Coauthors: Déborah Óliveros, Jorge Luis Ramírez Alfonsín

The Borsuk conjecture and the Vázsonyi problem are two attractive and famous questions in discrete and combinatorial geometry, both based on the notion of diameter of bounded sets. In this poster, we present an equivalence between the critical sets with Borsuk number 4 in $\mathbb{R}^3$ and the minimal structures for the Vázsonyi problem by using the well-known Reuleaux polyhedra. The latter lead to a full characterization of all finite sets in $\mathbb{R}^3$ with Borsuk number 4.

The proof of such equivalence needs various ingredients, in particular, we proved a conjecture dealing with strongly critical configuration for the Vázsonyi problem and showed that the diameter graph arising from involutive polyhedra is vertex (and edge) 4-critical.

Thursday morning

Time	Thursday Morning	
	Room Maguey	**Room Coyote**
9:00-9:55	**Maya Stein** Oriented trees in digraphs	
10:00–10:25	**Coffee Break**	
10:25–10:45	**Caroline de Paula Silva** Obstructions for χ-diperfectness	**Samuel N. Araújo** Complexity and winning strategies of graph convexity games
10:50–11:10	**André Guedes** Edge and non-edge differentiated biclique graphs	**Dipayan Chakraborty** Cops and robber on variants of retracts and subdivisions of oriented graphs
11:15–11:35	**Hanna Furmańczyk** Adjacent vertex distinguishing total coloring of corona products	**Mauro R. Costa da Silva** Positional Knapsack Problem: NP-hardness and approximation scheme
11:40–12:00	**Coffee Break**	
12:00–12:20	**Pastora Revuelta** Lower bounds and exact values of the 2-color off-diagonal generalized weak	**Weidong Luo** Processing complexity for some graph problems parameterized by structural parameters
12:25–12:45	**João P. de Souza** On nonrepetitive colorings of cycles	**Paulo Medeiros** On the hull and interval numbers of oriented graphs

Room Maguey

9:00 – 9:55

PLENARY TALK:
Oriented trees in digraphs

Maya Stein
Universidad de Chile, Chile

This talk will survey conditions that can guarantee the existence of a given oriented tree in a digraph D. In particular, we will be interested in conditions on the minimum semidegree or on the minimum number of edges of D.

10:25 – 10:45

Obstructions for χ-diperfectness

Caroline Ap. de Paula Silva
University of Campinas
Coauthors: Cândida Nunes da Silva, Orlando Lee

In 1982, Berge defined the class of χ-diperfect digraphs. A digraph D is χ-diperfect if for every minimum coloring $\mathcal{S}$ of D there is a path P containing exactly one vertex of each color class of $\mathcal{S}$ and this property holds for every induced subdigraph of D. The ultimate goal in this research area is to obtain a characterization of χ-diperfect digraphs in terms of forbidden induced subdigraphs, but this may be a very difficult problem and not likely to be solved in a near future. Berge showed the first examples of obstructions for χ-diperfect digraphs (i.e. minimal non-χ-diperfect digraphs) by presenting orientations of odd cycles and complements of odd cycles that are not χ-diperfect. In 2022, de Paula Silva, Nunes da Silva and Lee showed characterizations of non-χ-diperfect super-orientations of odd cycles and their complements. Moreover, they showed that these structures are not the only obstructions for χ-diperfect digraphs, by presenting new obstructions with stability number two and three. In this paper, we present new obstructions for χ-diperfect digraphs with arbitrary stability number and arbitrary chromatic number.

10:50 – 11:10

Edge and non-edge differentiated biclique graphs

André Guedes
Universidade Federal do Paraná
Coauthors: Edmilson P. Cruz, Marina Groshaus

A biclique is a maximal set of vertices in a graph that induces a complete bipartite graph. The biclique graph $KB(G)$ of a graph G is the intersection graph of all bicliques in G. In this work, we introduce the concept of differentiating edges and non-edges between pairs of intersecting bicliques in a graph and the corresponding variants of the biclique graph: the edge differentiated (KB_{edif}) and the non-edge differentiated (KB_{ndif}) biclique graphs. Two bicliques are mutually included if they can be partitioned respectively into (X_1, Y_1) and (X_2, Y_2) such that $X_1 \subset X_2$ and $Y_2 \subset Y_1$. We show that all pairs of mutually included bicliques are non-edge differentiated, but they are not edge differentiated. We show that every pair of intersecting bicliques are differentiated by either edge or non-edge. Finally, we prove that graphs are free of edge differentiated bicliques if and only if they are (K_3, C_5)–free and that graphs are free of non-edge differentiated bicliques if and only if they are (P_4, paw)–free.

11:15 – 11:35

Adjacent vertex distinguishing total coloring of corona products

Hanna Furmańczyk
University of Gdansk, Poland
Coauthors: Rita Zuazua

An adjacent vertex distinguishing total k-coloring f of a graph G is a proper total k-coloring of G such that no pair of adjacent vertices has the same color sets. In 2005 Zhang et al. posted the conjecture (AVDTCC) that every simple graph G has adjacent vertex distinguishing total $(\Delta(G) + 3)$-coloring. In this paper we confirm the conjecture for many coronas, in particular for generalized, simple and l-coronas of graphs, not relating the results to particular graph classes.

12:00 – 12:20

Lower bounds and exact values of the 2-color off-diagonal generalized weak Schur numbers $WS(2; k_1, k_2)$

Pastora Revuelta
Universidad de Sevilla
Coauthors: T. Ahmed, L. Boza, M.I. Sanz

In this study, we focus on the concept of the 2-color off-diagonal generalized weak Schur numbers, denoted as $WS(2; k_1, k_2)$. These numbers are defined for integers $k_i \geqslant 2$, where $i = 1, 2$, as the smallest integer M, such that any 2-coloring of the integer interval $[1, M]$ must contain a 2-colored solution to the equation $E_{k_j} : x_1 + x_2 + \ldots + x_{k_j} = x_{k_j+1}$ for $j = 1, 2$, with the condition that $x_i \neq x_j$ when $i \neq j$. Our objective is to determine lower bounds for these 2-color off-diagonal generalized weak Schur numbers and demonstrate that in several cases, these lower bounds match the exact values.

12:25 – 12:45

On nonrepetitive colorings of cycles

João Pedro de Souza
Universidade Federal do Rio de Janeiro
Coauthors: Fábio Botler, Wanderson Lomenha

We say that a sequence $a_1 \cdots a_{2t}$ of integers is *repetitive* if $a_i = a_{i+t}$ for every $i \in \{1, \ldots, t\}$. A *walk* in a graph G is a sequence $v_1 \cdots v_r$ of vertices of G in which $v_i v_{i+1} \in E(G)$ for every $i \in \{1, \ldots, r-1\}$. Given a k-coloring $c \colon V(G) \to \{1, \ldots, k\}$ of $V(G)$, we say that c is *walk-nonrepetitive* if for every $t \in \mathbb{N}$, for every walk $v_1 \cdots v_{2t}$ in G the sequence $c(v_1) \cdots c(v_{2t})$ is not repetitive unless $v_i = v_{i+t}$ for every $i \in \{1, \ldots, t\}$, and the *walk-nonrepetitive chromatic number* $\sigma(G)$ of G is the minimum k for which G has a walk-nonrepetitive k-coloring. Let C_n denote the cycle with n vertices. In this paper we show that $\sigma(C_n) = 4$ whenever $n \geq 4$ and $n \notin \{5, 7\}$, which answers a question posed by Barát and Wood in 2008.

Room Coyote

10:25 – 10:45

Complexity and winning strategies of graph convexity games

Samuel N. Araújo
Federal University of Ceará
Coauthors: Raquel Folz, Rosiane de Freitas, Rudini Sampaio

Accordingly to Duchet (1987), the first paper of convexity on general graphs, in english, is the 1981 paper "Convexity in graphs". One of its authors, Frank Harary, introduced in 1984 the first graph convexity games, focused on the geodesic convexity, which were investigated in a sequence of five papers that ended in 2003. In this paper, we continue this research line, extend these games to other graph convexities, and obtain winning strategies and complexity results. Among them, we obtain winning strategies for general convex geometries in graphs. We also obtain the first PSPACE-hardness results on convexity games, by proving that the normal play and the misère play of the hull game on the geodesic and the monophonic convexities are PSPACE-complete.

10:50 – 11:10

Cops and robber on variants of retracts and subdivisions of oriented graphs

Dipayan Chakraborty (on behalf of the authors)
Université Clermont Auvergne
Authors: Harmender Gahlawat, Zin Mar Myint, Sagnik Sen

Cops and Robber is one of the most studied two-player pursuit-evasion games played on graphs, where multiple *cops*, controlled by one player, pursue a single *robber*. The *cop number* of a graph is the minimum number of cops that can ensure the *capture* of the robber. In directed graphs, two kinds of moves are defined for players: *strong move*, where a player can move both along and against the orientation of an arc to an adjacent vertex; and *weak move*, where a player can only move along the orientation of an arc to an *out-neighbor*. We study three variants of Cops and Robber on oriented graphs: *strong cop model*, where the cops can make strong moves while the robber can only make weak moves; *normal cop model*, where both cops and the robber can only make weak moves; and *weak cop model*, where the cops can make weak moves while the robber can make strong moves. We study the cop number of these models with respect to several variants of retracts on oriented graphs and establish that the strong and normal cop number of an oriented graph remains invariant in their strong and distributed retracts, respectively. Next, we go on to study all three variants with respect to the subdivisions of graphs and oriented graphs. Finally, we establish that all these variants remain computationally difficult even when restricted to the class of 2-degenerate bipartite graphs.

11:15 – 11:35

Positional Knapsack Problem: NP-hardness and approximation scheme

Mauro Costa da Silva
Universidade Estadual de Campinas
Coauthors: Lehilton L. C. Pedrosa, Rafael C.S. Schouery

We present the Positional Knapsack Problem (PKP), show that it is NP-hard and admits a Fully Polynomial-Time Approximation Scheme (FPTAS). This problem is a variant of the classical Binary Knapsack Problem (KP) in which the contribution of an item to the objective function varies according to the position in which it is added. The change in the valuation adds new properties to the problem that do not hold for KP as PKP is not a generalization of KP. Our FPTAS is based on a dynamic programming algorithm and uses a recursive rounding approach, which is necessary since the objective function depends on each item's value and position.

12:00 – 12:20

Preprocessing complexity for some graph problems parameterized by structural parameters

Weidong Luo
University of Sherbrooke
Coauthors: Manuel Lafond

Structural graph parameters play an important role in parameterized complexity, including in kernelization. Notably, vertex cover, neighborhood diversity, twin-cover, and modular-width have been studied extensively in the last few years. However, there are many fundamental problems whose preprocessing complexity is not fully understood under these parameters. Indeed, the existence of polynomial kernels or polynomial Turing kernels for famous problems such as Clique, Chromatic Number, and Steiner Tree has only been established for a subset of structural parameters. In this work, we use several techniques to obtain a complete preprocessing complexity landscape for over a dozen of fundamental algorithmic problems.

12:25 – 12:45

On the hull and interval numbers of oriented graphs

Pedro Medeiros
Universidade Federal do Ceara
Coauthors: J. Araújo, A. K. Maia, L. Penso

In this work, for a given oriented graph D, we study its interval and hull numbers, denoted by $\acute{\mathrm{in}}(D)$ and $\acute{\mathrm{hn}}(D)$, respectively, in the oriented geodetic, $\overrightarrow{P_3}$ and $\overrightarrow{P_3^*}$ convexities. This last one, we believe to be formally defined and first studied in this paper, although its undirected version is well-known in the literature.

Concerning bounds, for a strongly oriented graph D and the oriented geodetic convexity, we prove that $\overrightarrow{\mathrm{hn}}_{\mathrm{g}}(D) \leq m(D) - n(D) + 2$ and that there is at least one such that $\overrightarrow{\mathrm{hn}}_{\mathrm{g}}(D) = m(D) - n(D)$. We also determine exact values for the hull numbers in these three convexities for tournaments, which imply polynomial-time algorithms to compute them. These results allow us to deduce polynomial-time algorithms to compute $\overrightarrow{\mathrm{hn}}_{\mathrm{P}_3}(D)$ when the underlying graph of D is split or cobipartite.

Moreover, we provide a meta-theorem by proving that if deciding whether $\overrightarrow{\mathrm{in}}_{\mathrm{g}}(D) \leq k$ or $\overrightarrow{\mathrm{hn}}_{\mathrm{g}}(D) \leq k$ is NP-hard or W[i]-hard parameterized by k, for some $i \in \mathbb{Z}_+^*$, then the same holds even if the underlying graph of D is bipartite. Next, we prove that deciding whether $\overrightarrow{\mathrm{hn}}_{\mathrm{P}_3}(D) \leq k$ or $\overrightarrow{\mathrm{hn}}_{\mathrm{P}_3^*}(D) \leq k$ is W[2]-hard parameterized by k, even if the underlying graph of D is bipartite; that deciding whether $\overrightarrow{\mathrm{in}}_{\mathrm{P}_3}(D) \leq k$ or whether $\overrightarrow{\mathrm{in}}_{\mathrm{P}_3^*}(D) \leq k$ is NP-complete, and the same for $\overrightarrow{\mathrm{hn}}_{\mathrm{P}_3^*}(D) \leq k$ even if D has no directed cycles and the underlying graph of D is a chordal bipartite graph; and that deciding whether $\overrightarrow{\mathrm{in}}_{\mathrm{P}_3}(D) \leq k$ or whether $\overrightarrow{\mathrm{in}}_{\mathrm{P}_3^*}(D) \leq k$ is W[2]-hard parameterized by k, even if the underlying graph of D is split.

Finally, we also argue that the interval and hull numbers in the $\overrightarrow{P_3}$ and $\overrightarrow{P_3^*}$ convexities can be computed in polynomial time for directed graphs with underlying graph of bounded tree-width by using Courcelle's theorem.

Thursday afternoon

Time	Thursday Afternoon	
	Room Maguey	**Room Coyote**
15:00-15:55	**Jayme Luiz Szwarcfiter** On edge domination of graphs	
16:00–16:20	**Coffee Break**	
16:20–16:40	**Annegret K. Wagler** Managing Time Expanded Networks through Project and Lift: the Lift Ussue	**Martín Matamala** A de Brujin and Erdős property in quasi-metric spaces with four points
16:45–17:05	**Gabriele Di Stefano** Mutual-visibility in distance-hereditary graphs: a linear-time algorithm	**Ileana González-Escalante** Graphs with constant balancing number
17:10–17:30	**Matheus Simões** Hyper-heuristics with Path Relinking applied to the Generalised Time-Dependent ATSP in air travel	**René González-Martínez** On the detection of local and global amoebas: theoretical insights and practical algorithms

Room Maguey

15:00 – 15:55

PLENARY TALK:
On edge domination of graphs

Jayme Szwarcfiter
Universidade Federal do Rio de Janeiro, Brazil

Denote by G, an undirected simple graph, with vertex set V, and edge set E. An edge $e \in E$ *dominates* itself and every edge adjacent to e. A set $E' \subseteq E$ is an *(edge)* dominating set of G, if each edge of E is dominated by some edge of E' . The domination is called *efficient* if each edge is dominated exactly once, and is called *proper* if each edge of $E \setminus E'$ is dominated exactly once. In this talk, we survey and describe complexity results on these three types of edge domination. In special, we consider the a class of graphs, where each edge is contained in some triangle. We mention hardeness and polynonial time cases on subclasses of this class, for edge domination problems.

16:20 – 16:40

Managing time expanded networks through Project and Lift: the lift issue

Annegret Wagler
University Clermont Auvergne
Coauthors: José Luis Figueroa González, Alain Quilliot, Hélène Toussaint

Time Expanded Networks, built by considering the vertices of a base network over some time space, are powerful tools for the formulation of problems that simultaneously involve resource assignment and scheduling. Still, in most cases, deriving algorithms from those formulations is difficult, due to both the size of the resulting models and the propagation of time rounding errors. The purpose of this paper is to address this algorithmic issue. We propose a generic Project and Lift decomposition scheme, and focus, inside this decomposition scheme, on the Lift issue, which consists in turning a solution defined on the base network into a solution in the time expanded space.

16:45 – 17:05

Mutual-visibility in distance-hereditary graphs: a linear-time algorithm

Gabriele Di Stefano
University of L'Aquila
Coauthors: Serafino Cicerone

The concept of mutual-visibility in graphs has been recently introduced. If X is a subset of vertices of a graph G, then vertices u and v are X-visible if there exists a shortest u, v-path P such that $V(P) \cap X \subseteq \{u, v\}$. If every two vertices from X are X-visible, then X is a mutual-visibility set. The mutual-visibility number of G is the cardinality of a largest mutual-visibility set of G. It is known that computing the mutual-visibility number of a graph is NP-complete, whereas it has been shown that there are exact formulas for special graph classes like paths, cycles, blocks, cographs, and grids. In this paper, we study the mutual-visibility in distance-hereditary graphs and show that the mutual-visibility number can be computed in linear time for this class.

17:10 – 17:30

Hyper-heuristics with Path Relinking applied to the Generalised Time-Dependent ATSP in air travel

Matheus Simões
Universidade Federal do Rio de Janeiro
Coauthors: Laura Bahiense, Celina Figueiredo

In this work we propose the use of path relinking within a hyper-heuristic framework to solve the Generalised Time-Dependent Asymmetric Traveling Salesman problem applied to Air Travel. We implemented several heuristic selection methods, such as Simple Random, Random Descent, Random Permutation and Reinforcement Learning. We were able to achieve very good solutions for 13 of the 14 instances from a well-known benchmark set, evidencing that the adequate use of a hyper-heuristic framework with path relinking can be very efficient in improving the final results.

Room Coyote

16:20 – 16:40

A de Bruijn and Erdős property in quasi-metric spaces with four points

Martín Matamala
DIM-CMM Universidad de Chile
Coauthors: G. Araujo-Pardo, J. Zamora

It is a classic result that a set of n non-collinear points in the Euclidean plane defines at least n different lines. Chen and Chvátal conjectured in 2008 that the same results is true in metric spaces for an adequate definition of line. More recently, this conjecture was studied in the context of quasi-metric spaces.

One way to study lines in an space is though its betweenness. Given a quasi-metric space (V, ρ), its induced quasi-metric betweenness is the set of triples $(x, y, z) \in V^3$ such that $\rho(x, z) = \rho(x, y) + \rho(y, z)$. In this work, we prove the existence of a quasi-metric space on four points a, b, c and d whose quasi-metric betweenness is $\mathcal{B} = \{(c, a, b), (a, b, c), (d, b, a), (b, a, d)\}$. This space has only three lines, none of which has four points. Moreover, we show that the betweenness of any quasi-metric space on four points with this property is isomorphic to $\mathcal{B}$. Since $\mathcal{B}$ is not metric, we conclude that Chen and Chvátal's conjecture is valid for any metric space on four points.

16:45 – 17:05

Graphs with constant balancing number

Ileana González-Escalante
Universidad Nacional Autónoma de México
Coauthors: Yair Caro, Adriana Hansberg, Mariel Jácome, Tonatiuh Matos Wiederhold, Amanda Montejano

In this paper, we study the existence of unavoidable 2-edge-colored patterns in edge-colorings of the complete graph. We are interested in how these patterns change as the densities of the color classes change. A graph is called *balanceable* if it can be found, with half its edges in one color and half of them in the other, in any 2-edge-coloring of K_n with sufficiently many edges in each color class and n large enough. The balancing number $bal(n, G)$ of a balanceable graph G is the maximum number m of edges such that there is a coloring of K_n with m edges in one color class without having a balanced copy of G. Equivalently, any 2-edge-coloring of K_n with more than $bal(n, G)$ edges in each color contains a balanced copy of G. Graphs with constant (not depending on n) balancing number have been previously characterized. We give a new proof of such characterization that allows us not only to understand in a deeper way the structure of the graphs with constant balancing number but also to show that $bal(n, G)$ is quadratic on the number of edges of G, a bound that differs substantially from the previous known that was exponential.

17:10 – 17:30

On the detection of local and global amoebas: theoretical insights and practical algorithms

René González-Martínez
Universidad Autónoma de Zacatecas
Coauthors: Marcos E. González Laffitte, Amanda Montejano

Let G be a graph of order n, and let $e \in E(G)$ and $e' \in \binom{V(G)}{2} \setminus E(G)$. If the graph $G' = G - e + e'$ is isomorphic to G, we say that $e \to e'$ is a feasible edge-replacement. We call G a local amoeba if, for any two copies G_1 and G_2 of G on $V(G)$, G_2 can be reach from G_1 by performing a sequence of edge replacements. A graph G is a global amoeba if it can be made into a local amoeba by adding some isolated vertices. Our work includes a proof that almost every graph is not an amoeba, and the identification of a special type of edge-replacement called weird-edge-replacements. Additionally, we provide an infinite family of trees that are both weird local and global amoebas. Our contributions extend to the development and implementation of several algorithms for detecting local and global amoebas, which are made available in a public repository along with multiple examples.

Friday morning

Time	Friday
	Room Maguey
9:00-9:55	**Maria Axenovich** Forbidding subgraphs in the hypercube
10:00–10:25	**Coffee Break**
10:25–10:45	**Flor Aguilar** Voltage graphs as a technique to obtaining semi-cubic cages
10:50–11:10	**Héctor Maravillo** Recovering cyclic tilings through β-skeletons
11:15–11:35	**Oliver Bachtler** Reductions for the 3-Decomposition Conjecture
11:40–12:00	**Coffee Break**
12:00–12:55	**Ruy Fabila** Token Graphs, reconstruction and automorphisms

Room Maguey

12:00 – 12:55

PLENARY TALK:
Forbidding subgraphs in the hypercube

Maria Axenovich
Karlsruhe Institute of Technology, Germany

One of the central problems in graph theory is finding, for a given graph H, the extremal function $ex(n, H)$, that is the largest number of edges in an n-vertex graph that contains no isomorphic copy of H as a subgraph. While determining the asymptotic behaviour of $ex(n, H)$ remains a challenge in general, we know exactly what graphs have positive Turán density, i.e., for what graphs H is $ex(n, H)$ a positive proportion of the total number of edges on n vertices. An analogous function $ex(Q_n, H)$, the largest number of edges in a subgraph of the n-dimensional hypercube Q_n that contains no isomorphic copy of H, is much less understood. In particular, we even do not have any characterisation for graphs H that have a positive hypercube Turán density. In this talk I will report on some recent progress on $ex(Q_n, H)$ and show connections between this function and other problems in extremal combinatorics.

10:25 – 10:45

Voltage graphs as a technique

Flor Aguilar
Universidad Nacional Autónoma de Mexico
Coauthors: Gabriela Araujo-Pardo, Leah Berman

In this work, I use some specific voltage graphs to study a generalization of the *Cage Problem*. In particular, we construct families of semi-cubic graphs with fixed girth and few vertices. Some of them are the smallest that exist because they attain the previously lower bounds.

10:50 – 11:10

Recovering cyclic tilings through beta-skeletons

Héctor Maravillo
Universidad Nacional Autónoma de Mexico
Coauthors: Gilberto Calvillo Vives, Erick Treviño Aguilar

There is a class of proximity graphs parameterized by a real number β that are called β-skeletons and which are geometrical graphs whose vertex set V is a discrete set of points in the plane and two points p and q are adjacent if certain region $lune_\beta(p, q)$ defined by them does not contain any other vertex. Special cases of β-skeletons are the Gabriel Graph ($\beta = 1$) and the Relative Neighborhood Graph ($\beta = 2$). Cyclic tilings are tilings of the plane whose tiles are convex cyclic polygons that contain the center of the circle in which they are inscribed. Up to our knowledge, this class of tilings has not been studied before. They generalize regular, Archimedean, and k-uniform tilings. We give sufficient conditions for the graph of a cyclic tiling to be a β-skeleton of its vertices. The result is particularly nice for the case of the Gabriel graph. The study of the relationship between tilings arises while studying street networks. This relationship is illustrated briefly.

11:15 – 11:35

Reductions for the 3-Decomposition Conjecture

Oliver Bachtler
RPTU Kaiserslautern-Landau
Coauthors: Irene Heinrich

The 3-decomposition conjecture is wide open. It asserts that every finite connected cubic graph can be decomposed into a spanning tree, a disjoint union of cycles, and a matching. We prove that the following graphs are reducible configurations for the 3-decomposition conjecture: the triangle, the $K_{2,3}$, the claw-square, the twin-house, and the domino. As an application, we show that all 3-connected cubic graphs of path-width at most 4 satisfy the 3-decomposition conjecture.

12:00 – 12:55

PLENARY TALK:
Token Graphs, reconstruction and automorphisms

Ruy Fabila
CINVESTAV, Mexico

Let G be a graph on n vertices and 1 $lek \leq n-1$ an integer. The k-token graph of G is the graph whose vertices are all k-subsets of vertices of G. Where two of them are adjacent if and only if their symmetric difference is an edge of G. Suppose we are given a graph F. We are interested in both the theoretical and algorithmic problem of determining if there exists an isomorphism f from F to $F_k(G)$. This isomorphism is called a k-token reconstruction of F In this talk we explore recent results on this problem and explain a somewhat surprising relationship between the "uniqueness" of the k-token reconstructions of F, and the relationship between the automorphism group of $F_k(G)$ and that of G.

Index of speakers

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