

Associate Team proposal 2023-2025

Submission form

*Please name this file “acronymeoftheassociateteam_Proposal_2023.pdf”
Online submission on <https://drisi.inria.fr/eaEquipeAssociee/new>
Inria submission deadline: October 17th, 2022*

Title: Combinatorial Algorithms for Networking prOblEms

Associate Team acronym: CANOE

Principal investigator (Inria): Nicolas NISSE

CRCN Inria in EPI COATI (Combinatorics, Optimization, and Algorithms for Telecommunications, common team with I3S (CNRS, University Côte d’Azur (UCA))), Inria Sophia Antipolis, France.

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Other participants: *if the project involves other partners on either side name them here (Inria project-team, university, research center...)*

Key Words: **Add key words with regard to:** *Please refer to the online Scientific Cartography Portal: <https://cartographie.inria.fr/SIKeywords/accueilKW>*

A- Research themes on digital science: *(at most 5 keywords)* A8.1. Mathématiques discrètes, combinatoire A8.7. Théorie des graphes A8.2. Optimisation A7.1. Algorithmique A7.1.3. Algorithmique des graphes

B- Other research themes and application areas: *(at most 5 keywords)* B6.3.3. Gestion des réseaux B6.3.4. Réseaux sociaux

1 Partnership

1.1 Detailed list of participants

Expected length: one page.

Inria Participants list.

Thomas DISSAUX: *PhD student* (since Oct. 2020, supervised by N. Nisse, on “Metric properties of tree-decompositions in planar graphs”), EPI COATI, graph algorithms, graph decompositions. <http://www-sop.inria.fr/members/Thomas.Dissaux>

Frédéric GIROIRE: *DR2 CNRS*, EPI COATI, graph algorithms, random graphs, large scale networks. <http://www-sop.inria.fr/members/Frederic.Giroire>

Frédéric HAVET: *DR1 CNRS*, EPI COATI, graph theory, directed graph theory.
<http://www-sop.inria.fr/members/Frederic.Havet>

Nicolas NISSE: *CRCN Inria*, HdR, EPI COATI, graph algorithms, graph decompositions, combinatorial games. <http://www-sop.inria.fr/members/Nicolas.Nisse>

Lucas PICASARRI-ARRIETA: *PhD student* (since Oct. 2021, co-supervision F. Havet and S. Bessy (Pr., Univ. Montpellier), on “Di-coloring of directed and oriented graphs”), EPI COATI, graph theory, directed graph theory. <https://lucaspicasarri.github.io/>

List of the participants from the main partner institution (ParGO team, UFC).

Júlio ARAÚJO: *Associate professor* at Dept. de Matemática, ParGO, UFC, graph algorithms, complexity. <http://matematica.ufc.br/pt/julio/>

Fabricio BENEVIDES: *Associate professor* at Dept. de Matemática, ParGO, UFC, graph theory, probability. <http://lattes.cnpq.br/4695081445531168>

Victor CAMPOS: *Associate professor* at Dept. de Computação, ParGO, UFC, graph theory, graph decompositions. <https://pargo.ufc.br/pt/victor-campos/>

Claudio CARVALHO: *PhD student in Computer Science* (since 2020), supervised by C. Linhares Sales and A-K. Maia, on “On cuts and flows on edge colored graphs”, UFC.

Jonas COSTA: *PhD student in Computer Science* (since 2019), supervised by A-K. Maia, on “Arc-disjoint branching flows”, UFC.

Leonardo DE ABREU: *Master student in Computer Science* (since 2022), supervised by M. Campêlo, UFC.

Claudia LINHARES SALES: *Professor* at Dept. de Computação, ParGO, UFC, graph theory. <http://lattes.cnpq.br/6115379961132154>

Ana Karolinna MAIA: *Associate professor* at Dept. de Computação, ParGO, UFC, graph theory. <http://lattes.cnpq.br/3309825374177429>

1.2 Nature and history of the collaboration

The longstanding history between the EPI COATI and the ParGO team at UFC started in the 1990s, when R. Corrêa (one of the founders of ParGO) was mentored by A. Ferreira. They are no longer members of these groups, but the collaboration has been maintained since then. Between 2002 and 2008, Mascotte (ancestor of EPI COATI) members visited the UFC regularly (on average 3 two-week visits per year), while Brazilian researchers' visits to France were less regular, but over a longer period. Ricardo Correa stayed at Mascotte for 2 months in 2003 and for 3 months in 2006; Claudia Linhares-Sales (ParGO) spent her sabbatical year 2006/2007 at Mascotte. Between 2008 and 2014, the collaboration was strengthened by the EA AWIN¹ (2009-2011) and by student exchanges between the groups. There have been long visits of French PhD students to ParGO (I. Sau-Valls and F. Huc, 1 month each in 2008, D. Mazauric for 6 weeks in 2008). On the Brazilian side, several students did their master internship and their Ph.D. thesis in the COATI team: N. Nepomuceno (supervisor: J-C. Bermond, defended in 2010), J. Araújo (supervisor: J-C. Bermond, defended in 2012), L. S. Rocha (supervisor: F. Havet, defended in 2012), R. P. Soares (supervisor: N. Nisse, defended in 2013), A.K. Maia (supervisor: F. Havet, defended in 2015).

Since then, all these students got a position at UFC (or at some other universities in Fortaleza), and several of them are part of this proposal. This collaboration has been sustained by the associate CNRS/FUNCAP team GAIATO (Graphs and AlgorIthms Applied to TelecomuncatiOns) 2014-16 with, in particular, the organization of the first two Workshops Franco-brésilien de Graphes et Optimisation Combinatoire (GCO) (April 2012² and March 2016³). Moreover, several master/Ph.D. students did internships/visits in the EPI COATI: P. Moura (March-July 2013), N. Martins (May-July 2015), R. Lopez (Sept-Nov 2016, July 2019), R. Dantas (Nov 2013-Feb 2014) and C. Carvalho (Nov 2013-Feb 2014), and members of the ParGO team regularly visit our team: J. Araújo and A.K. Maia (September 2016), V. Campos (Dec-2010, Nov-Dec 2011, Oct 2015), C.L. Sales (February 2017), A. Silva (January 2017), R. Sampaio (November 2013). More recently, the collaboration went through thanks to the STIC Am-Sud project GALOP⁴ (Graphs ALgorithms for Optimization Problems, 2019-21, PI: N. Nisse): visit of J. Bensmail and N. Nisse at UFC (May 2019), visit of R. Lopez at Inria (July 2019), visits of J. Araújo, A.K. Maia and C.L. Sales at COATI (Dec. 2019), invited professor position of F. Benevides at COATI (Sept. 2019-July 2020) and “sandwich thesis” of J. Costa (Dec. 2019-Nov. 2020) at COATI. Thanks to a CAPES grant, N. Nisse will be an invited professor at UFC during Nov. 2022.

All these “face-to-face” collaborations led to **more than 30 international joint publications** (see the References section) **which proves the importance of physical meetings to obtain substantial results. The goal of this proposal is to sustain this fruitful collaboration within a structuring international partnership.**

¹<http://www-sop.inria.fr/teams/mascotte/equipeassociee/ewin/ewin09.html>

²<http://www-sop.inria.fr/mascotte/Events/GC02012>

³<http://www.lia.ufc.br/GC02016>

⁴<https://team.inria.fr/coati/projects/sticamsud-galop/>

2 Scientific program

2.1 Context **Expected length: half a page.**

A graph is a mathematical structure that allows modeling networks in many contexts, from route networks, telecommunication networks, biological networks, neural networks to social networks. There are graph problems arising in each of these domains that are classified as computationally difficult, where the objective is to obtain an efficient algorithm for any graph presented as input. However, studying algorithms for a problem restricted to special graphs can shed light on the problem. This approach consists in assuming that the graph has some special structural property and exploiting this property in the algorithm. Such a structural property defines a class of graphs, for example, trees or planar graphs. The aim is to build an efficient algorithm for a class of graphs, and then explore the ideas used to solve larger and larger classes of graphs or with fewer structural constraints. While a lot of work has been dedicated to the study of structural properties of graphs [CM93,RSST97,RS04,CFK+15,FDHT16], very few results are known concerning directed graphs [Neu82,GHK+16] or hypergraphs [ALNP19] which better model real life networks. For instance, road networks are intrinsically directed and so are many social networks (e.g., Twitter), co-authorship networks correspond to hypergraphs (where each publication corresponds to an hyperedge gathering the co-authors), etc. **This project aims at tackling challenging theoretical open problems in digraphs and/or hypergraphs.** The purpose of this project is also to pursue and extend our fruitful collaboration with the ParGO team from Universidade Federal do Ceara (Fortaleza) which is one of the partner universities of LNCC (Laboratório Nacional de Computação Científica).

2.2 Objectives (for the three years) **Expected length: half a page.**

The main goal of this Associate Team is to obtain further progresses in the understanding of structural properties of directed graphs and hypergraphs, in order to use them in the design of efficient algorithms for applications in various networks (e.g., routing, frequency assignment, tasks scheduling in telecommunication networks) and also to better predict their evolution (large scale social networks). We will mainly investigate three complementary research directions.

- A classical way to design efficient graph algorithms is to use the divide-and-conquer paradigm by decomposing the graphs into smaller instances [CM93,Bod98]. However, no good decompositions are known for directed graphs [GHK+16]. One first direction of this project is to investigate possible definitions of such **directed graph decompositions** and their computations.
- **Graph coloring** is a classical graph problem that consists in partitioning the vertex set into few stable sets. The numerous applications (frequency assignment, tasks scheduling and planification, etc.) of this problem lead to many variants depending on additional constraints. Many challenging questions remain open in directed graphs (for instance, the analogous of the famous four colors theorem in planar graphs is not known [Neu82]). We will investigate this family of problems in directed graphs.
- Social networks have mainly been modeled by graphs [ER59,WS98,AB02] while relationships between individuals are often not only binary (edges), but multiple (hyperedges). We are interested in **real large social networks** such as co-publication network (freely available, e.g., on dblp) and their **evolution over time**. We aim at designing random models to generate (via simulations) evolving hypergraphs and compare them (and the evolution of their structural properties) with real social networks.

The originality of the proposal is to focus on structures (directed graphs, (dynamic) hypergraphs) that have been much less studied than (static) graphs. One challenge here is that we will face very difficult questions (e.g., longstanding open questions) that will require to introduce new or adapt existing theoretical tools (decompositions, temporal graphs, etc.).

2.3 Work-program (for the first year) **Expected length: one page.**

During the last decades, amazing progresses have been done both in the understanding of structural properties of graphs and in the algorithmic impact that such structures bring (e.g., the famous Graph Minor Theory [RS04], the parameterized complexity framework [CFK+15]). A cornerstone of these fundamental results is the notion of tree-decomposition of graphs [CM93,Bod98]. Roughly, a *tree-decomposition* of a graph G is a recursive decomposition, in a tree-like structure, of G along its separators. The classical measure of a tree-decomposition is the size of the separators (a.k.a. the *treewidth* of a graph). Many NP-hard problems can be solved efficiently when restricted to graphs of bounded treewidth [CM93,FDHT16]. However, computing good tree-decompositions remains a challenging question and few is known about directed graphs.

- The *directed treewidth* has been proposed as a generalization of treewidth to directed graphs [JRST01, KK15, GHK+16]. Such decompositions are computationally hard to obtain. We want to use integer programming, branch and bound and separation algorithms for computing tree-decompositions [FHL08]. An alternative approach will be to consider other decompositions' measures (e.g., the diameter of the separators [DG07, DN22]).

Participants: V. Campos, J. Costa, T. Dissaux, F. Havet, A-K. Maia, N. Nisse.

Among graph problems, the one that has received the most attention is without doubt the *Graph Colouring Problem* that asks whether the vertex-set of a graph G can be partitioned in at most k stable sets. For instance, the famous 4-colour Theorem states that any planar graph can be partitioned into four stable sets [RSS97]. However, the case of directed graphs have received much less attention. During the first year, we will focus on the following questions.

- Orientation of graphs are closely related to digraph colouring. One question is, given a graph, to compute an orientation and a weight of its edges such that any two adjacent vertices have distinct weighted in-degrees (their colours). Trees have been investigating [AGG+20] and we aim at considering larger graph classes [AHL+]. A more general question is to understand, for a given graph G , what are the properties of its possible orientations depending on the structural properties of G .
- A way to generalize graph proper colouring to digraphs is to say that a k -proper dicolouring of a graph G is a partition of its vertex-set to k acyclic parts [Neu82]. One longstanding open problem is to (dis)prove that any planar digraph can be partitioned into 2 acyclic digraphs. We want to address such a question by studying all proper dicolourings of a digraph through its dicolouring reconfiguration graph [CHJ09, BB18, BHN+].

Participants: J. Araújo, J. Costa, F. Havet, A-K. Maia, N. Nisse, L. Picasarri-Arrieta, C. Linhares Sales.

The structural properties of social networks impact their behaviour, e.g., the way information (or virus) spreads across them or how communities emerge. We are mainly concerned by two kinds of questions that both rely on the evolution of such networks: the evolution of the communities in the co-authorship networks (we will focus on this question during the first year) and the impact of different lockdown policies on the spread of viruses in large scale social network. We aim at studying them using the recent advances in temporal graphs [MS22] and compare our results with real life networks (either using real data, or via simulations).

- We will study the evolution of communities in the scientific co-publication network(s). Note that there is a strong relationship between communities and graph colouring (a community is a stable set in the complementary graph) and graph decompositions (small separators may be used to identify communities). One question behind this study is to better understand the impact of pluri-diciplinary grants on the scientific collaborations. As an example, we will investigate various preferential attachment models [AB02, GNTS22+] and study the evolution of communities and of degrees (number of publications/collaborations) of the nodes (researchers).

Participants: J. Araújo, F. Benevides, F. Giroire, N. Nisse, L. Picasarri-Arrieta.

As the breadth of the objectives described suggests, the methodology for this project will require a holistic approach, integrating interdependent activities. In addition to the usual activities of the project teams (bibliography, design and analysis of algorithms, computer simulations, organization of seminars, participation to national and international conferences, etc.), we will organize an annual workshop for a better integration of researchers and students from both participating institutions and organize semi-annual activities with high school students for the popularization of science (consolidating the strong involvement of the COATI team in the TERRA NUMERICA⁵ project. In particular, we plan to develop new activities to explain the problematics behind the social networks to a large public.)

Exchanges Program.

From INRIA to UFC: T. Dissaux, F. Havet, N. Nisse (2 weeks each), L. Picasarri-Arrieta (1.5 months).

From UFC to INRIA: J. Araújo, V. Campos (2 weeks each), J. Costa, L. de Abreu (1 month each).

⁵<http://terra-numerica.org/>

3 Data Management Plan

This section can be filled out with the help of a CPPI from your research centre. Explain your data management strategy/plan. For each data set used or produced, it should include information on: - Design - Collection of the data set

- Data set ownership / Content of the data set / Data set format / Data format*
- Storage – Use - Processing*
- Data set storage / Backup of the dataset / Access control during the project / Sharing during the project / Traceability of data processing operations*
- Preservation - Archiving of the dataset*
- Documentation and metadata / Shelf life / Archiving*
- Dissemination - Publication - Sharing of the dataset*
- Open archive or data warehouse / Licence / No diffusion*

The project is mainly theoretical and our results will be published in national and international conferences and reviews (and on HAL and our personal websites).

The data we will use (mainly for our study of scientific collaboration networks) are openly available (in dblp⁶).

⁶<https://dblp.org/db/about/copyright.html>

4 Budget

4.1 Budget (for the first year)

Summarize the budget for 2023: planned expenses, funding requested from Inria, co-funding (from outside Inria). For co-funding, indicate clearly whether it has been secured or just applied for. Please provide a spreadsheet with the following columns: Researcher full name (when known), Status (student, PhD, junior/senior researcher, Institution, Origin, Destination, Planned date, Duration (in days), Estimated cost (trip+per diem), Funding institution (Inria or cofunding), Mission objective) *Expected length: half a page.*

Estimated budget for mission INRIA to UFC	People	Time	Estimated cost
researchers	2	2 weeks each	5k euros
Ph.D. student	2	1.5 months + 2 weeks	7.5k euros
Estimated total cost			12.5k euros

From INRIA to UFC: T. Dissaux (Ph.D. student), F. Havet (DR1 CNRS), N. Nisse (CRCN Inria) (2 weeks each), L. Picasarri-Arrieta (Ph.D. student, 1.5 months).

Estimated budget for mission UFC to INRIA	People	Time	Estimated cost
researcher	2	2 weeks each	5k euros
Ph.D. student	1	1 month	4k euros
Master student	1	1 month	4k euros
Estimated total cost			13k euros

From UFC to INRIA: J. Araújo, V. Campos (Associate Prof., 2 weeks each), J. Costa, another student (Ph.D. students, 1 month each).

The objectives of these exchanges have been detailed in Section 2.3.

Other sources of funding.

- ANR DIGRAPHS (EPI COATI, until end 2023)
- FUNCAP PS1-0186-00155.01.00/21 (ParGO, PI: R. Sampaio): 10.5k euros (2022-23)
- CNPq 437841/2018-9 (ParGO, PI: F. Benevides): 7.8k euros (2019-23)
- Funcap PNE-0112-00061.01.00/16 (ParGO, PI: V. Campos): 55k euros (2017-23)
- Funcap MLC-0191-00056.01.00/22 (ParGO, PI: Ana S. Silva): 16.8k euros (2022-24)
- Project CAPES/COFECUB N^o 32/2022, *Graphs, Optimization, Combinatorics and Algorithms*, between UFC, EPI COATI and Avignon University, applied August 2022.
- Project STIC-AmSud, to be applied in 2023.

Global cost of the collaboration project	25.5k euros
External resources (other than Associated Team program)	13k euros
Funding from the Associate Team program	12.5k euros

4.2 Tentative Budget for second and third year

Give an estimate of the budget for year 2 and year 3 of the project (global amounts requested to Inria for each year) The detailed budget for year 2 and 3 will be submitted by the associate team PI in the annual report at the end of each year. Please note that the associate team budget is allocated each year by DRI according to the funds available for the programme.

Year 2 estimated budget for Inria:

Estimated budget for mission INRIA to UFC	People	Time	Estimated cost
researchers	2	2 weeks each	5k euros
Ph.D. student	2	1.5 months + 2 weeks	7.5k euros
Estimated total cost			12.5k euros

Estimated budget for mission UFC to INRIA	People	Time	Estimated cost
researcher	2	2 weeks each	5k euros
Ph.D. student	1	1 month	4k euros
Master student	1	1 month	4k euros
Estimated total cost			13k euros

Global cost of the collaboration project	25.5k euros
External resources (other than Associated Team program)	13k euros
Funding from the Associate Team program	12.5k euros

Year 3 estimated budget for Inria:

Estimated budget for mission INRIA to UFC	People	Time	Estimated cost
researchers	2	2 weeks each	5k euros
Ph.D. student	2	2 weeks each	5k euros
Estimated total cost			10k euros

Estimated budget for mission UFC to INRIA	People	Time	Estimated cost
researcher	2	2 weeks each	5k euros
Ph.D. student	1	1 month	4k euros
Master student	1	1 month	4k euros
Estimated total cost			13k euros

Global cost of the collaboration project	23k euros
External resources (other than Associated Team program)	13k euros
Funding from the Associate Team program	10k euros

4.3 Strategy to get additional funding

Mention complementary grants, H2020, other countries'/funding agencies programmes and fellowships you are planning to apply for. Briefly describe, your strategy to obtain other funding and how the Associate Team will have a leverage action to participate to other funding programmes. (*For Associate Teams with European partners: It is expected that an Associate Team in Europe plans to participate in the Horizon 2020 framework programme, to get additional funding that will increase its impact. In this case, the proposal has to explain the strategy to take benefit from the Horizon 2020 framework programme). **Expected length: half a page.***

We have submitted (August 2022), to CAPES/COFECUB, a larger project “Graphs, Optimization, Combinatorics and Algorithms”. In addition to the partners of the CANOE proposal, the CAPES/COFECUB project includes members from the Avignon University (LMA, LIA) and from Montpellier University (LIRMM). Several topics presented here are common to both proposals, and the participants to the CAPES/COFECUB project (who are not included in this project) will also bring their own expertise (in particular on Operational Research).

We plan to apply for a STIC-AmSud project (next call in Spring 2023) on similar topics. This will allow us to include in our consortium other specialists on graph theory from South America (other universities in Brazil and/or in Argentina).

The ANR DIGRAPHS should end in December 2023. We plan to apply for an ANR project (in 2023) together with french partners who will bring their own expertise in graph theory, algorithm and temporal graphs (e.g., LIRMM, LIP, LaBRI).

5 Added value

*In which way will this Associate team benefit the research of the partners? Explain added value and strengths of each associate team partner. **Expected length: half a page.***

Both teams have a common background on graph theory and graph algorithms, but also bring their own specificities which allows an important complementarity that has proved to be a clear success in co-working. More precisely, the ParGO team has a strong expertise in parameterized complexity (J. Araújo), directed graph decompositions (V. Campos), probability and percolation problems (F. Benevides), graph colouring (A-K. Maia, C. Linhares Sales), temporal graphs (A. Silva), operational research (M. Campêlo), etc. On the other hand, the COATI team will bring its expertise in graph decompositions (N. Nisse, T. Dissaux), directed graph colouring (F. Havet, L. Picasarri-Arrieta), random graphs (F. Giroire) and real data analysis (F. Giroire and N. Nisse).

An important added value of the project is, for both teams, to bring new collaborations to the other. For instance, recently, our common STIC-AmSud GALOP allowed us to meet Malgorzata Sulkowska⁷ (who was collaborating with F. Benevides). She then spent two years (as postdoc) in the COATI team (sept. 2020-sept. 2022) which resulted in a very fruitful collaboration. On the other side, for instance, Ignasi Sau Walls (now CR CNRS at LIRMM and Ph.D. student in MASCOTTE (former COATI) until 2009) now collaborates regularly with members of the ParGO team. In particular, the exchange of students between both teams is an important added value of such a common project.

In addition, the collaboration of both teams will certainly improve the partnership between Inria and LNCC (Laboratório Nacional de Computação Científica) whose UFC is one of partner universities, providing Inria with new insights on Brazilian scientific research. Indeed, our research project fits in the domains of Big Data and “calcul scientifique” (in particular with our will to better understand the evolution of large complex networks) which are part of the research line of the LNCC.

⁷<https://www.researchgate.net/profile/Malgorzata-Sulkowska-3>

6 Previous Associate Teams

Nicolas Nisse has been the PI of the Inria associate team **AIDyNet** (2013-2018), <https://team.inria.fr/coati/projects/alldynet/>, with K. Suchan, Universidad Adolfo Ibañez, Santiago, Chile. Note that the main Brazilian investigator of this proposal has also been involved in this collaboration (common visit of J. Araujo and N. Nisse in Santiago, Chile, in Nov. 2015, which led to the publication [7]).

7 Impact

Identify the industrial prospects of this collaboration and how they will be taken in account (patent filing, etc.). List any expected results that could be transferred to industry or that could be used in industry and any relevant links with relevant French or foreign companies. List potential application domains for the topics addressed in the framework of the proposed associate team.

We will work on problems at the intersection of the themes: Graphs, Optimisation, Combinatorics and Algorithms, with the main objective of training human resources and publishing scientific articles in high-level international journals and conferences.

While our results on graph theory are mainly theoretical, graphs are a mathematical abstraction of many concrete networks and problems (routing, network design, task scheduling, community detection...). Therefore, our results on structural properties of graphs and their use in algorithm design will find natural applications in many problems addressed by companies. As examples, the COATI team has used its expertise in graph algorithms in the context of recent industrial collaborations: with the company Instant System⁸ in the context of routing in directed multimodal networks⁹, and with the company Millionroads¹⁰ in the context of using properties of a large complex network representing Curriculum Vitae of millions of users.

8 Intellectual Property Right Management

This section can be filled out with the help of a CPPI from your research centre. The goal of this section is to describe the measures to protect the background knowledge and joint results obtained in the framework of the collaboration.

8.1 Background

Identify here any knowledge, information, data, methods, process, tools, know-how and software, and any intellectual property rights, for example patents, and copyrights, relating thereto, owned by or licensed to one Party prior to this associate team and needed for the execution of this collaboration.

The background relies on theoretical expertise and our previous publications in scientific revues and conferences. Software used are freely available (e.g., using open libraries as SageMath¹¹). The same holds for the results we will obtain (they will be published on HAL) and the softwares we could implement.

8.2 Protective measures

Elaborate which measures will be applied to protect previous knowledge and joint results. Highlight how the risks in respect of the PPST have been identified and the protective measures to mitigate them.

As seen with the Inria STIP ref. there will not be any embedded software on both side. Our main contributions will only be on the high level co-publications.

⁸<https://instant-system.com/>

⁹<https://project.inria.fr/multimod/>

¹⁰<https://www.millionroads.com/>

¹¹<https://www.sagemath.org/fr/>

9 Ethical Issues

This section can be filled out with the help of one of the two Coerle contact points available in your Inria research centre (see <https://intranet.inria.fr/Inria/Instances/Instances-nationales/COERLE>, bottom of the page). Identify any potential ethical issue by taking in account the highest standards of research integrity, as set out, for instance, in the National Charter for Ethics in Research Activities and the European Code of Conduct for Research Integrity

NA.

10 Others

Any other element you would like to add. [Expected length: half a page.](#)

11 References

11.1 Joint publications of the partners

List all joint publications of the partners (if any). In blue are the members of the partners' institutions.

1. J. Araujo, F. Havet, C. Linhares Sales, N. Nisse, and K. Suchan. Semi-proper orientations of chordal graphs. In progress.
2. J. Bensmail, V. Campos, M. Correia, A. K. Maia, N. Nisse, A. Silva. Characterizing butterfly minors of cylindrical grids. In progress.
3. J. Bang-Jensen, J. Costa Ferreira da Silva, F. Havet. On the inversion number of oriented graphs. CoRR abs/2105.04137 (2021), submitted.
4. J. Araújo, J. Bensmail, V. Campos, F. Havet, A. K. Maia, N. Nisse, A. Silva. On finding the best and worst orientations for the metric dimension. Submitted.
5. C. Carvalho, J. Costa, R. Lopes, A. K. Maia, N. Nisse, C. Linhares Sales, Characterizing Networks Admitting k Arc-disjoint Branching Flows. Accepted under minor revision to DMTCS.
6. F. Benevides, J-C. Bermond, H. Lesfari, and N. Nisse. A journey through virality. Accepted in European Journal of Combinatorics.
7. J. Araújo, F. Havet, Mathieu Schmitt: Steinberg-like theorems for backbone colouring. *Discrete Applied Mathematics* 245: 155-167 (2018)
8. R. Dantas, F. Havet, R. M. Sampaio: Minimum density of identifying codes of king grids. *Discrete Mathematics* 341(10): 2708-2719 (2018)
9. F. Havet, A. K. Maia, B. Mohar: Finding a subdivision of a prescribed digraph of order 4. *Journal of Graph Theory* 87(4): 536-560 (2018)
10. J. Araújo, G. Ducoffe, N. Nisse, K. Suchan: On interval number in cycle convexity. *Discrete Mathematics & Theoretical Computer Science* 20(1) (2018)
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12. R. Dantas, F. Havet, R. M. Sampaio: Identifying codes for infinite triangular grids with a finite number of rows. *Discrete Mathematics* 340(7): 1584-1597 (2017)
13. R. Dantas, R. M. Sampaio, F. Havet: Minimum density of identifying codes of king grids. *Electronic Notes in Discrete Mathematics* 62: 51-56 (2017)
14. J. Araújo, F. Giroire, J. Moulrierac, Liu, Y.; Modrzejewski, R. Energy Efficient Content Distribution. *Computer Journal* 59, 192-207 (2016)
15. J. Araújo, F. Havet, C. Linhares Sales, A. Silva: Proper orientation of cacti. *Theor. Comput. Sci.* 639: 14-25 (2016)
16. N. Nisse, R. Soares: On the monotonicity of process number. *Discrete Applied Mathematics* 210: 103-111 (2016)

17. J. Araújo, F. Havet, M. Schmitt: Steinberg-like theorems for backbone colouring. *Electronic Notes in Discrete Mathematics* 50: 223-229 (2015)
18. F. Havet, A. K. Maia, Min-Li Yu: Complexity of greedy edge-colouring. *J. Braz. Comp. Soc.* 21(1): 18:1-18:7 (2015)
19. J. Araújo, N. Cohen, S. F. de Rezende, F. Havet, P. F. S. Moura: On the proper orientation number of bipartite graphs. *Theor. Comput. Sci.* 566: 59-75 (2015)
20. F. Giroire, I. Lamprou, D. Mazauric, N. Nisse, S. Pérennes, R. Soares: Connected surveillance game. *Theor. Comput. Sci.* 584: 131-143 (2015)
21. J. Araújo, N. Nisse, S. Pérennes: Weighted Coloring in Trees. *SIAM J. Discrete Math.* 28(4): 2029-2041 (2014)
22. J. Araújo, N. Nisse, S. Pérennes: Weighted Coloring in Trees. *STACS 2014*: 75-86
23. V. A. Campos, F. Havet, R. M. Sampaio, A. Silva: Backbone colouring: Tree backbones with small diameter in planar graphs. *Theor. Comput. Sci.* 487: 50-64 (2013)
24. N. Nisse, R. Pardo Soares: On the Monotonicity of Process Number. *Electronic Notes in Discrete Mathematics* 44: 141-147 (2013)
25. J. Araújo, V. A. Campos, F. Giroire, N. Nisse, L. Sampaio, R. Soares: On the hull number of some graph classes. *Theor. Comput. Sci.* 475: 1-12 (2013)
26. F. Giroire, D. Mazauric, N. Nisse, S. Pérennes, R. Soares: Connected Surveillance Game. *SIROCCO 2013*: 68-79
27. J. Araújo, N. Cohen, F. Giroire, F. Havet: Good edge-labelling of graphs. *Discrete Applied Mathematics* 160(18): 2502-2513 (2012)
28. F. Havet, C. Linhares Sales, L. Sampaio: b-coloring of tight graphs. *Discrete Applied Mathematics* 160(18): 2709-2715 (2012)
29. J. Araújo, J-C. Bermond, F. Giroire, F. Havet, D. Mazauric, R. Modrzejewski: Weighted improper colouring. *J. Discrete Algorithms* 16: 53-66 (2012)
30. V. A. Campos, A. Gyárfás, F. Havet, C. Linhares Sales, F. Maffray: New Bounds on the Grundy Number of Products of Graphs. *Journal of Graph Theory* 71(1): 78-88 (2012)
31. J. Araújo, J-C. Bermond, F. Giroire, F. Havet, D. Mazauric, R. Modrzejewski: Weighted Improper Colouring. *IWOCA 2011*: 1-18
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11.2 Main publications of the participants relevant to the project

List the main publications of the participants that are relevant for the project. List *at most 5* publications for each partner.

Inria Participants:

- **Thomas Dissaux** is Ph.D. student in EPI COATI since Oct. 2020, on “Metric properties of decompositions in planar graphs”, under the supervision of N. Nisse. He undergraduated (master 2 thesis) from University Côte d’Azur in 2020. His research interests include graph algorithms, graph decompositions and games in graphs.

Selected Publications:

- a. T. Dissaux, F. Fioravantes, H. Galhawat, N. Nisse. Further results on Hunter and Rabbit game in graphs. In progress.
 - b. T. Dissaux, N. Nisse: Pathlength of Outerplanar graphs. To appear in 15th Latin American Theoretical Informatics Symp. (LATIN), Springer, LNCS, 2022.
 - c. T. Dissaux, G. Ducoffe, N. Nisse, S. Nivelle: Treelength of Series-parallel Graphs. In 11th Latin-American Algorithms, Graphs and Optimization Symp. (LAGOS), Elsevier, Volume 195, pages 30-38, 2021.
- **Frédéric Giroire** is a senior researcher (Directeur de recherche) at CNRS. His research interest are in network optimisation, large scale networks, graph algorithms and applications. He has a strong expertise in graph theory, linear optimisation and large scale data base analysis. He has authored more than 30 articles in high level peer-review international journals and more than 50 papers in international conferences. He (co-)supervised the PhD of seven students (one of which is Júlio Araújo) and is currently (co-)supervising 3 Ph.D. students. Since 2021, he is the head of the research team COMRED of Laboratory I3S.

Selected Publications:

- a. F. Giroire, N. Nisse, T. Trollet, M. Sulkowska: Preferential attachment hypergraph with high modularity. accepted to Network Science (2022+)
 - b. F. Giroire, N. Nisse, K. Ohulchanskyi, M. Sulkowska, T. Trollet: Preferential attachment hypergraph with vertex deactivation. CoRR abs/2205.00071 (2022)
 - c. T. Trollet, N. Cohen, F. Giroire, L. Hogue, S. Pérennes: Interest clustering coefficient: a new metric for directed networks like Twitter. J. Complex Networks 10(1) (2021)
 - d. F. Giroire, S. Pérennes, T. Trollet: A Random Growth Model with Any Real or Theoretical Degree Distribution. COMPLEX NETWORKS (2) 2020: 437-449
 - e. J. Araújo, V. A. Campos, F. Giroire, N. Nisse, L. Sampaio Rocha, R. Soares: On the hull number of some graph classes. Theor. Comput. Sci. 475: 1-12 (2013)
- **Frédéric Havet** is a senior researcher (Directeur de recherche) at CNRS. His research interest are in graph theory, graph algorithms and applications. He has a strong expertise in graph colouring and directed graph theory. He has authored more than 70 articles in high level peer-review international journals and more than 25 papers in international conferences. He supervised the PhD of six students, two of which are now assistant professors in Brasil. He is currently co-supervising a seventh one. Since 2011 he is the vice-head of the research group COATI and from 2013 to 2021 he is the head of the research

team COMRED of Laboratory I3S. He often acts as an expert for research agencies of various countries and is an editor for DMTCS since 2011.

Selected Publications:

- a. J. Bensmail, T. Blanc, N. Cohen, F. Havet, and L. Rocha. Backbone colouring and algorithms for TDMA scheduling. *Discrete Mathematics and Theoretical Computer Science*, 21 (3), 2019.
 - b. F. Havet, A. K. Maia, and B. Mohar. Finding a subdivision of a prescribed digraph of order 4. *Journal of Graph Theory*, 87(4): 536–560, 2018.
 - c. N. Cohen, F. Havet, W. Lochet, and R. Lopes. Bispindles in strongly connected digraphs with large chromatic number. *Electronic Journal of Combinatorics*, 25(2) P2.39, 2018.
 - d. F. Giroire, F. Havet, and J. Moulierac. On the complexity of compressing two-dimensional routing tables with order. *Algorithmica*, 80(1): 209–233, 2018.
 - e. R. Dantas, F. Havet, and R. Sampaio. Identifying codes for infinite triangular grids with a finite number of rows. *Discrete Mathematics* 340(7): 1584–1597, 2017.
- **Nicolas Nisse** (CR Inria) is a full-time researcher at Inria Sophia Antipolis since 2009, in the EPI COATI. He received his engineer diploma from Supélec, in 2004, and received his Master (2004) and Ph.D. (2007) degrees from Laboratoire de Recherche en Informatique (LRI). He did a postdoct at Departamento de Ingenieria Matematica (DIM), Universidad de Chile (2007-2008) and then a postdoc in the MASCOTTE team project (2008-2009).

His research interests include graph theory and algorithms. His work mainly focuses on information spreading problems in telecommunication networks (e.g. routing, and virus spreading). His expertise concerns the design of algorithms using structural properties (e.g., graph decompositions) of networks. He has authored more than 50 articles in high level peer-review international journals and more than 40 papers in international conferences. He supervised the PhD of 7 students, one of which is now assistant professor in the ParGO team. He is currently co-supervising one PhD student (T. Dissaux).

He participated to several national and international projects (COST 295 DYNAMO, Anillo en Redes, EULER project with Alcatel-Lucent-Bell on dynamic compact routing algorithmic, ANR MultiMod (2018-21), ANR Digraphs (2020-23)...). He was the PI of the associate team ALDyNet (with Univ. Adolfo Ibañez, Santiago, Chile, 2013-2018), the ECOS-Sud project (Algorithmes distribués pour le calcul de la structure des réseaux, with UAI, Chile, 2013-15) and was the PI of the STIC Am-Sud project GALOP (with UFC and UDP, 2019-21). He has also collaborations with Brazil, Canada, Chile, China, Greece, Norway and Japan. He is also strongly involved in scientific popularization.

Selected Publications:

- a. J. Bensmail, F. Fioravantes, F. Mc Inerney, N. Nisse: The Largest Connected Subgraph Game. *Algorithmica* 84(9): 2533-2555 (2022)
- b. N. Nisse: Network Decontamination. *Distributed Computing by Mobile Entities* 2019: 516-548
- c. D. Coudert, G. Ducoffe, N. Nisse: To Approximate Treewidth, Use Treelength! *SIAM J. Discrete Math.* 30(3): 1424-1436 (2016)
- d. A. Kosowski, B. Li, N. Nisse, K. Suchan: k-Chordal Graphs: From Cops and Robber to Compact Routing via Treewidth. *Algorithmica* 72(3): 758-777 (2015)

e. J. Araújo, N. Nisse, S. Pérennes: Weighted Coloring in Trees. *SIAM J. Discrete Math.* 28(4): 2029-2041 (2014)

- **Lucas Picasarri-Arrieta** is Ph.D. student in EPI COATI since Oct. 2021, on “Dicoloring of directed and oriented graphs”, under the co-supervision of F. Havet and S. Bessy (Univ. Montpellier). He undergraduated (master 2 thesis) from University of Montpellier in 2021. His research interests include (directed) graph theory and (di)graph coloration.

Selected Publications:

- a. J. Bang-Jensen, S. Bessy, D. Gonçalves, L. Picasarri-Arrieta. Complexity of some arc-partition problems for digraphs. *Theoretical Computer Science*, 2022.
- b. S. Bessy, J. Pardey, L. Picasarri-Arrieta, D. Rautenbach. Factorially Many Maximum Matchings Close to the Erdős-Gallai Bound. *Electronic J. of Combinatorics*, 2022.
- c. S. Bessy, J. Pardey, L. Picasarri-Arrieta, D. Rautenbach. Unbalanced spanning subgraphs in edge labeled complete graphs. Accepted in *Electronic J. of Combinatorics*.
- d. N. Bousquet, F. Havet, N. Nisse, L. Picasarri-Arrieta, A. Reinald. Digraph redicolouring. In preparation.

UFC Participants:

- **Júlio Araújo** is an associate professor at Universidade Federal do Ceará (UFC) since 2014. He has received bachelor and master’s degrees in Computer Science from UFC (2003-2009). From 2009 to 2012 he did his PhD in Computer Science in a co-agreement between UFC and Université de Nice-Sophia Antipolis. In this period, he joined MASCOTTE (former COATI) and he had his PhD in Computer Science supervised by Jean-Claude Bermond and Frédéric Giroire, alongside Cláudia Linhares Sales from UFC. Afterwards, he had a postdoc in COATI funded by CNPq-Brazil in 2013 and he was visiting professor in the AlgCo Team (LIRMM-Montpellier) from 2020-2021. He was the coordinator of the Licentiate Course in Mathematics (2015-2016) and vice-coordinator of the Graduation Program in Mathematics of UFC (2019-2021).

His main research interests are related to Graph Theory, Algorithms and Computational Complexity. Since 2014, he has supervised 4 master’s dissertations and he is now supervising two PhD and two master students. He has coordinated a CNPq-Universal project and he was the Brazilian side coordinator of the STIC-AmSud project called “Graphs ALgorithms for Optimization Problems (GALOP)”. He is and was also a member of several other funded research projects such as CNPq-Universal, CNPq/Funcap Pronem and DAAD Probral with Germany. Since 2012, he has published 20 articles in international peer-reviewed journals and has other 4 papers accepted for publications, while teaching around 160 hours per semester. It is important to emphasize that he has co-authored papers with most members of COATI.

Selected Publications:

- a. Araujo, J.; Baste, J.; Sau, I. Ruling out FPT algorithms for Weighted Coloring on forests. *Theoretical Computer Science*, p. 11-19, 2018.
- b. Araujo, J.; Ducoffee, G.; Nisse, N.; Suchan, K. On interval number in cycle convexity. *Discrete Mathematics and Theoretical Computer Science*, v. 20, p. 1, 2018.
- c. Araujo, J.; Giroire, F.; Moulhierac, J.; Liu, Y.; Modrzejewski, R. Energy Efficient Content Distribution. *Computer Journal*, v. 59, p. 192-207, 2016.

- d. Araujo, J.; Cohen, N.; De Rezende, S. F.; Havet, F.; Moura, P.F.S. On the proper orientation number of bipartite graphs. *Theoretical Computer Science*, v. 566, p. 59-75, 2014.
 - e. Araujo, J.; Bermond, J-C.; Giroire, F.; Havet, F.; Mazauric, D.; Modrzejewski, R. Weighted improper colouring. *Journal of Discrete Algorithms*, v. 16, p. 53-66, 2012.
- **Fabricio Siqueira Benevides** is a professor at the Mathematics Department of Universidade Federal do Ceará (UFC) since October 2011. Was in sabbatical at INRIA, Sophia Antipolis, from August 2019 to June 2020. Is a researcher of CNPq (Brazilian funding agency), rank PQ2, since 2016, with main interest in graph theory and extremal combinatorics but also in some random discrete structures. Have participated in several projects (most recently in the STIC Am-Sud with France and Chile, DAAD Probral with Germany), coordinating some of them (two CNPQ Universal projects). The graduate program he works has the highest possible rank in Brazil (according to CAPES). He is also scientific coordinator of this program and coordinator of the Bachelor's degree course at UFC. Was an affiliated member of the Brazilian Academy of Science from 2014 to 2018 (to which 30 young researchers are selected every among all subject areas), was regional coordinator of the Brazilian Math Olympiad from 2012 to 2016, and a member of its scientific committee since then. Recently, other than doing research in Combinatorics, has been engaged in a project to bring science to concrete political policies, in particular in training high-school teachers and producing materials that have been used by hundreds of schools. When he was an undergraduate student he competed in the World Final of the "ACM international collegiate programming contest" and in High-School, and got a Bronze medal at the International Mathematics Olympiad.

Selected Publications:

- a. F. S. Benevides, C. Hoppen, H. Lefmann, K. Odermann. Heilbronn triangle-type problems in the unit square $[0,1]^2$. *Random Structures and Algorithms*, 2022.
 - b. F. S. Benevides, M. Sulkowska. Maximizing the expected number of components in an online search of a graph. *Discrete Maths.*, v.345, p.112-668, 2022.
 - c. J. Bastos, F. S. Benevides, J. Han. The number of Gallai k -colorings of complete graphs. *J. of Combinatorial Theory Serie B.*, 2019.
 - d. F. S. Benevides, C. Hoppen, R. M. Sampaio. Edge-colorings of graphs avoiding complete graphs with a prescribed coloring. *Discrete Maths.*, v.340, p.2143-2160, 2017.
 - e. F. S. Benevides, M. Przykucki. Maximum Percolation Time in Two-Dimensional Bootstrap Percolation. *SIAM Journal on Discrete Mathematics*, v.29, p.224-251, 2015.
- **Victor Campos** is an associate professor at Universidade Federal do Ceará (UFC) since 2010. He has received a PhD degree in Computer Science from UFC in 2011. His main research interests are related to Graph Theory, Algorithms and Computational Complexity. Since 2010, he has supervised 4 masters dissertations and 1 phd thesis. He is now supervising one PhD and one masters students. He has coordinated a CNPq-Universal project with total funding of R\$ 30,000.00 and is currently coordinating a FUNCAP-PRONEM project with total funding of R\$ 282,607.90. Since 2008, he has published 21 articles in international peer-reviewed journals while teaching around 130 hours per semester.

Selected Publications:

- a. J. Araújo, M. Bougeret, V. Campos, and I. Sau. Introducing lop-kernels: A framework for kernelization lower bounds. *Algorithmica*, 2022.
 - b. J. Araújo, V. Campos, A. K. Maia, I. Sau, and A. Silva. On the complexity of finding internally vertexdisjoint long directed paths. *Algorithmica*, 2020.
 - c. V. Campos, G. Gomes, A. Ibiapina, R. Lopes, I. Sau, and A. Silva. Coloring problems on bipartite graphs of small diameter. *Electronic Journal of Combinatorics*, 2021.
 - d. V. Campos and R. Lopes. A proof for a conjecture of gorgol. *Discrete Applied Mathematics*, 2018.
 - e. V. Campos, R. Lopes, A. K. Maia, and I. Sau. Adapting the directed grid theorem into an fpt algorithm. In *X Latin and American Algorithms, Graphs and Optimization Symposium (LAGOS 2019)*, 2019.
- **Cláudio Carvalho** is a Ph.D. student at UFC (Universidade Federal do Ceará, Fortaleza, Brazil), since 2019. He graduated in Computer Science in 1998 at UECE (Universidade Estadual do Ceará), and received his Master degree in Computer Science in 2014 at UFC. He worked as Substitute Professor at UVA (Universidade Estadual Vale do Acaraú) from 2000 to 2004, and he has worked as Assistant Professor at UVA since 2005. His research interests include graph theory, algorithms, and combinatorics. Currently, his work mainly focuses on arc-disjoint flows in digraphs and flow decompositions on edge-colored digraphs.

Selected Publications:

- a. C. Carvalho, J. Costa, R. Lopes, A. K. Maia, N. Nisse, C. Linhares Sales. From branching to flows: a study of an Edmond's like property to arc-disjoint branching flows.
 - b. C. Carvalho, J. Costa, R. Lopes, A. K. Maia, N. Nisse, C. Linhares Sales. Arc-disjoint Branching Flows: A Study of Necessary and Sufficient Conditions. 9th Latin American Works on Cliques in Graphs (LAWCG), 2020.
 - c. C. Carvalho, J. Costa, R. Lopes, A. K. Maia, N. Nisse, C. Linhares Sales. Characterizing Networks Admitting k Arc-disjoint Branching Flows. XL Congresso da Sociedade Brasileira de Computação (CSBC), Cuiabá - MT, In: *Anais do CSBC 2020 - V Encontro de Teoria da Computação (ETC)*, 2020.
- **Jonas Costa** is a Ph.D. student at UFC (Universidade Federal do Ceará, Fortaleza, Brazil), since 2019. He graduated in Computer Science in 2017 at UFC and received his Master degree in 2019, also in Computer Science (UFC). He was member of the project STIC Am-Sud GALOP (with EPI COATI). His research interests include graph theory, algorithms, and combinatorics. Currently, his work mainly focuses on arc-disjoint flows problems in digraphs.

Selected Publication:

- a. J. Bang-Jensen, J. Costa Ferreira da Silva, F. Havet. On the inversion number of oriented graphs. CoRR abs/2105.04137 (2021), submitted.
- b. C. Carvalho, J. Costa, R. Lopes, A. K. Maia, N. Nisse, C. Linhares Sales, Characterizing Networks Admitting k Arc-disjoint Branching Flows. Accepted under minor revision to DMTCS.
- c. A. K. Maia, J. Costa, R. Lopes. Fluxos Ramificados Arco-disjuntos em Redes de Capacidade Restrita. In: XXXVIII Congresso da Sociedade Brasileira de Computação, 2018, Natal-RN. *Anais do CSBC 2018 - III Encontro de Teoria da Computação*, 2018.

- **Leonardo Cavalcante de Abreu** is a master's student in Computer Science at Universidade Federal do Ceará (UFC), Fortaleza, Brazil, since 2022. He has Bachelor's degree in Applied Mathematics (Matemática Industrial) by UFC, Fortaleza, Brazil. His research interests include algorithms, graph theory, polyhedral combinatorics and optimization. Past works focused on acyclic subgraph problems in directed graphs with disjunctive constraints.

Selected Publication:

- a. L. C. de Abreu, M. Campêlo, A. K. Maia. Conjunto de arcos de realimentação sob restrições de forçamento é FPT. In: Encontro de Teoria da Computação, 2021, Brasil. Anais do VI Encontro de Teoria da Computação (ETC 2021). Porto Alegre, RS: Sociedade Brasileira de Computação - SBC, 2020. p. 30-33.
- b. L. C. de Abreu, M. Campêlo, A. K. Maia. Maximum acyclic subgraph under conflict constraints on bounded degree graphs. In: LATIN - 14th Latin American Theoretical Informatics Symposium, 2021, São Paulo. Poster Session, 2021.

- **Cláudia Linhares Sales** is a Full Professor at Universidade Federal do Ceará (UFC) since 1998. She obtained her Ph.D. in Applied Mathematics at Université Joseph Fourier (Advisors: Claude Benzaken and Frédéric Maffray) in 1996. Her main research interests are related to Graph Theory, Algorithms and Computational Complexity.

From 2008 to 2014, she was the Scientific Director of FUNCAP (State of Ceará Research Foundation). In 2014-2015, she was Vice-Rector Adjoint of Graduate Studies and Research of Universidade Federal do Ceará. From 2014 to 2019, she was the Coordinator of the Special Committee of Combinatorics, Algorithms and Optimization of the Brazilian Computer Society. From 2016 to 2019, she was the Secretary of the Brazilian Association for the Advance of Science in the State of Ceará. From 2019 to 2021, she was the national Secretary of the Brazilian Association for the Advance of Science (SBPC Board of Directors). She was a member of the CNPq Advisory Committee, in the area of Computer Science from 2019-2022. She was a member of the Human Rights Committee of UFC from 2018 to 2020.

She is now, since 2021, the General Secretary of SBPC (the Brazilian Association for the Advance of Science and Advisor to the UFC Seara Science Museum.

Selected Publications:

- a. L. Alcon, S. Gravier, C. Linhares Sales, F. Protti, G. Ravenna. On clique-inverse graphs of graphs with bounded clique number. *J. of Graph Theory*, 94(3), p. 1-10, 2020.
- b. P. Hell, C. Hernandez-Cruz, C. Linhares Sales. Minimal obstructions to 2-polar cographs. *Discrete Applied Maths.*, 261: 219-228, 2019.
- c. J. Araújo, C. Linhares Sales, I. Sau, A. Silva. Weighted proper orientations of trees and graphs of bounded treewidth. *Theoretical Computer Science*, vol. 771, p. 39-48, 2018.
- d. F. Knox, S. G. H. L. Maza, B. Mohar, C. Linhares Sales. Proper Orientations of Planar Bipartite Graphs. *Graphs and Combinatorics*, vol. 33, p. 1189-1194, 2017.
- e. C. Linhares Sales, L. Sampaio, A. Silva. On the b-Continuity of the Lexicographic Product of Graphs. *Graphs and Combinatorics*, vol. 33, p. 1165-1180, 2017.

- **Ana Karolinna Maia de Oliveira** is a permanent professor at Universidade Federal do Ceará since 2016. She received her Bachelor's diploma in 2008, Master degree in 2011, both in Computer Science at Universidade Federal do Ceará and Ph.D. degree in 2014 in Informatique at Université de Nice Sophia Antipolis. She did a postdoc in Computer Science at Universidade Federal do Ceará in 2015 and a sabbatical year at Laboratoire d'Informatique, Robotique et Microélectronique de Montpellier (LIRMM) in 2020. Her research interests include Graph Theory, Algorithms and Complexity. Some of the international projects she participated are Graphs ALgorithms for Optimization Problems - GALOP (CAPES/STIC-AmSud) and Graphs and AlgorIthms Applied to Telecommunica-tions - GAIATO (Funcap). She also participated in some national projects (UNIVERSAL - Problemas de Coloração e Infecção em Grafos and PRONEM - Problemas em grafos: complexidade e métodos).

Selected Publications:

- a. V. Campos, R. Lopes, A. K. Maia, I. Sau. Adapting The Directed Grid Theorem into an FPT Algorithm. *SIAM Journal on Discrete Mathematics*. v. 36, p. 1887-1917 , 2022.
- b. L. Keiler, C. V. Lima, A. K. Maia, R. Sampaio, I. Sau. Target set selection with maximum activation time. In: *Latin and American Algorithms, Graphs and Optimization Symposium, 2021, Online Conference*. *Procedia Computer Science*. v. 195, p. 86-96, 2021.
- c. J. Araújo, V. Campos, A. K. Maia, I. Sau, A. Silva. On the Complexity of Finding Internally Vertex-Disjoint Long Directed Paths. *ALGORITHMICA*, v. 82, p. 1616-1639, 2020.
- d. C. Carvalho, J. Costa, C. Linhares Sales, R. Lopes, A. K. Maia, N. Nisse. Characterizing Networks Admitting k Arc-disjoint Branching Flows. In: *ETC 2020 - V Encontro de Teoria da Computação, 2020, Cuiabá*. *Anais do V Encontro de Teoria da Computação*, 2020.
- e. A. K. Maia, B. Mohar, F. Havet. Finding a subdivision of a prescribed digraph of order 4. *Journal of Graph Theory*, v. 87, p. 536-560, 2017.

11.3 Other references

List the other references used in previous section.

- [AGG+20] Jiangdong Ai, Stefanie Gerke, Gregory Gutin, Yongtang Shi, and Zhenyu Taoqiu. Proper orientation number of triangle-free bridgeless outerplanar graphs. *Journal of Graph Theory*, 95(2):256–266, 2020.
- [AB02] Réka Albert et Albert-László Barabási, *Statistical mechanics of complex networks*, *Reviews of Modern Physics*, vol. 74 (1), 2002, p. 47–97
- [AHL+] Júlio Araújo, Frédéric Havet, Claudia Linhares Sales, Nicolas Nisse, and Karol Suchan. Semi-proper orientations of chordal graphs. In progress.
- [ALNP19] Chen Avin, Zvi Lotker, Yinon Nahum, David Peleg: Random preferential attachment hypergraph. *ASONAM 2019*: 398-405
- [BFGR17] Rémy Belmonte, Fedor V. Fomin, Petr A. Golovach, M. S. Ramanujan: Metric Dimension of Bounded Tree-length Graphs. *SIAM J. Discret. Math.* 31(2): 1217-1243 (2017)
- BB18 Marthe Bonamy, Nicolas Bousquet: Recoloring graphs via tree decompositions. *Eur. J. Comb.* 69: 200-213 (2018)
- [Bod98] Hans L. Bodlaender: A Partial k -Arboretum of Graphs with Bounded Treewidth. *Theor. Comput. Sci.* 209(1-2): 1-45 (1998)
- BHN+ Nicolas Bousquet, Frédéric Havet, Nicolas Nisse, Lucas Picasarri-Arrieta, Amadeus Reinald. Digraph redicolouring. In preparation.
- CHJ09 Luis Cereceda, Jan van den Heuvel, Matthew Johnson: Mixing 3-colourings in bipartite graphs. *Eur. J. Comb.* 30(7): 1593-1606 (2009)
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12 Letter of Intent

Please attach to this submission form the signed letter of intent by the partner institution.



Letter of Intent

Commitment of the corresponding partner institution

Associate Team acronym: CANOE

Principal investigator (Inria): Nicolas Nisse

COATI (Combinatorics, Optimization, and Algorithms for Telecommunications)

Principal investigator (Partner team): Júlio César Silva Araújo

Universidade Federal do Ceará (UFC), Brazil

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Departamento de Matemática

Pós-Graduação em Matemática (PGMAT)

Mestrado e Doutorado em Ciência da Computação (MDCC)

ParGO Research Group

The *Universidade Federal do Ceará*, which is the partner team's institution legal entity, confirms its intention to participate in the Associate Team entitled *Combinatorial Algorithms for Networking prObIEms (CANOE)* and has been informed that it will be requested to sign an Associated Team agreement with *Inria*, in case the Associate Team entitled *Combinatorial Algorithms for Networking prObIEms (CANOE)* should be retained.

Date:

October 10, 2022

Name and function:

Regina Célia Monteiro de Paula

Diretor of the Science Center of UFC

Signature:

Regina Célia M. Paula
Profa. Regina Célia Monteiro de Paula
Diretora do Centro de
Ciências/UFC

Stamp of the partner institution

Ínria