Inria International program
Associate Team proposal 2016-2018
Submission form

Online submission on https://drisi.inria.fr/eaEquipeAssociee/new
Inria submission deadline: September 30, 2015

Title: Algorithms for large and Dynamic Networks

Associate Team acronym: AlDyNet

Principal investigator (Inria): Nicolas NISSE

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1 Partnership

1.1 Detailed list of participants

List the participants of the Associate Team, giving for each: name, affiliation, status (senior researcher/professor, junior researcher/professor, postdoc, PhD / master student), type of contract (fixed/long term or permanent contract, start and end dates) and a link to their web page (if they have one). Add any other relevant information to understand the dynamics of the project (e.g. specific expertise). Expected length: one page.

INRIA Participants list.

David COUDERT: *CR INRIA*, HdR, head of EPC COATI.
`http://www-sop.inria.fr/members/David.Coudert/`

Frédéric GIROIRE *CR CNRS*, EPC COATI.
`http://www-sop.inria.fr/members/Frederic.Giroire`

Nicolas NISSE: *CR INRIA*, EPC COATI.
`http://www-sop.inria.fr/members/Nicolas.Nisse`

Stéphane PÉRENNES: *DR CNRS*, EPC COATI.
`http://www-sop.inria.fr/members/Stephane.Perennes/`

Guillaume DUCOFFE: *Ph.D. Student*, EPC COATI.
`http://www-sop.inria.fr/members/Guillaume.Ducoffe/`

List of the participants from the partner institution.

Eduardo MORENO: *Associate Professor*, Universidad Adolfo Ibáñez.
`http://emoreno.uai.cl/`

Esteban ROMAN: *Ph.D. Student*, Universidad Adolfo Ibáñez.

Karol SUCHAN: *Associate Professor*, Universidad Adolfo Ibáñez.
`http://www.uai.cl/docentes/karol-suchan`

John TREIMUN: *GIS Expert*, Territorial Intelligence Research Center, Universidad Adolfo Ibáñez. `http://www.uai.cl/facultades-y-carreras/escuela-de-diseno/centros-de-investigac centro-de-inteligencia-territorial/quienes-somos/john`

Ricardo TRUFFELLO: *Assistant Professor*, Territorial Intelligence Research Center, Universidad Adolfo Ibáñez. `http://www.uai.cl/docentes/ricardo-truffello`

Wilfredo YUSHIMITO: *Assistant Professor*, Universidad Adolfo Ibáñez.
`http://www.uai.cl/docentes/wilfredo-yushimito`

List of the participants from other institutions.

Marcos KIWI: *Full Professor*, Universidad de Chile, Santiago, Chile.
`http://www.dim.uchile.cl/~mkiwi/`

Dieter MITSCHE: *Assistant Professor* at Lab. Dieudonné, Université Nice-Sophia Antipolis.
`http://math.unice.fr/~dmitsche/`

1.2 Nature and history of the collaboration

Describe the nature and complementarity of the collaboration and the past/existing activities between the participants. Expected length: half a page.

This associated team would be the **natural continuation of the fruitful EA AlDyNet** (2013-2015, `https://team.inria.fr/coati/projects/aldynet/`)

The EA AlDyNet (2013-2015) gave rise to about 15 publications in international journals and conferences (including 6 co-publications and 2 on-going work between the partners) and many research visits. In particular, 3 Ph.D. students of EPC COATI spent 1 month in Santiago (Bi Li and Fatima Moataz in 2013, Guillaume Ducoffe in 2014), Esteban Catafau (Ph.D. student of Univ. Adolfo Ibañez) spent a total of 5 months at Inria and Klaus Jaschan (M.Sc. student of Univ. Adolfo Ibañez) spent 2 months at Inria.

The EA AlDyNet (2013-2015) has focused on the study of the structure of networks (modeled by graphs) to design both efficient distributed algorithms and reliable network topologies suitable to applications. It has followed a long collaboration between the two main investigators. Namely, Nicolas Nisse and Karol Suchan were postdocs at Departamento de Ingeniería Matemática (DIM) of Universidad de Chile, project CONICYT ACT-08 Anillo en Redes (2007-2008), working on graph decompositions and pursuit-evasion games. Since then, they have continued their collaboration: between 2010 and 2015, N. Nisse spent about two weeks a year in Santiago, and K. Suchan spent 3 weeks at Inria in 2010, 3 months (as invited professor) in 2011, and 2 weeks per year in 2013 and 2014. They have mainly worked on distributed routing algorithms in graph classes with specific structural properties and on distributed computational models.

These collaborations, formalized and reinforced by the EA AlDyNet (2013-2015), led to many joint publications (see Section 6.1). On the research and development side, they were the basis for introducing a line of research of Project Team Decision Support Systems for Industrial Problems (of UAI), at CIRIC - Inria Chile.

2 Scientific program

2.1 Context

Outline the general scientific context of this collaboration: area, general problems, motivations... It is recommended to document this context with references (to be listed in Section 6). Expected length: half a page.

As already said, this associated team would be the continuation of the EA AlDyNet (2013-2015, `https://team.inria.fr/coati/projects/aldynet/`). The EA AlDyNet (2013-2015) has focused on the study of the structure of networks (modeled by graphs) to design both efficient distributed algorithms and reliable network topologies suitable to applications such as routing. We want to continue our algorithmic study of graph properties (see below) and to apply our expertise to improve models of transportation of Santiago agglomeration.

It is well known that many networks (e.g., social networks) share structural properties such as logarithmic diameter, power-law degree distribution and high clustering coefficient [Erdos59,Barabasi99,Kle00,Albert02,Bu02]. Moreover, several routing algorithms take advantage of these properties [Boguna07,Krioukov07]. On the other hand, many graph parameters (such as hyperbolicity [Gromov87], treelength [Dourisboure05,DourisboureG07] and centrality [Sabidussi66]) are very important since they provide accurate information about the structure of the distances and of the shortest paths in a graph. Therefore, these parameters must have an impact on the behaviour of diffusion processes. In particular, in urban networks, they impact the way people are traveling (which way to take to go to work avoiding congestion...) and even the formation of communities (the choice of a school greatly depends on its location). Unfortunately, despite the amount of work dedicated to the computation of graph properties, very few practical algorithms exist for handling graphs with more than thousand nodes [Borassi+15,CoudertMN14,CohenCL15]. Indeed, not only some of these properties are NP-hard to compute in general (e.g., treelength), but even properties that can be computed in polynomial-time are difficult to handle in practice. For example, the best known exact algorithms for hyperbolicity are of time complexity $\Omega(n^{3,69})$, which is not scalable for $n = 10^5$ (approximate number of nodes in the road network of Santiago agglomeration).

A current important direction of research aims at designing algorithms that may actually compute or approximate such properties in real large networks [AkibaYY15, BorassiCH+15, CoudertDN14].

2.2 Objectives (for the three years)

State the main scientific goals of this collaboration: research directions, anticipated challenges, intended approaches / methodologies / techniques... Expected length: half a page.

The main goal of this Associate Team is to design and implement practical algorithms for computing graph structural properties. We will then use these algorithms on a concrete case of study which concerns the transportation network of the Santiago agglomeration. We are both interested in theoretical results concerning the feasibility of computing graph properties, and by their practical implementation (using SageMath [Sage]) for our application and their diffusion in the scientific community. There are three main objectives:

- Design efficient algorithms to compute important graph properties (hyperbolicity, treelength, centrality, treewidth...) in real networks. We are not interested by the worst-case time-complexity of these algorithms but by their performance in practice.

- Implement and document our algorithms using the open-source framework SageMath. One advantage of using SageMath is that it has interfaces with other graph libraries (igraph, Boost...) and with Linear Programming solver (GLPK, Cplex...). Moreover, the

success of SageMath (which has accumulated thousands of users over the last 10 years) will participate to the diffusion of our algorithms.

- Apply our algorithms on the Santiago transportation network that have been collected by our Chilean partner during the last year of AlDyNet (2013-2015). Based on the results, propose tools for decision support in designing bus routes, timetables, etc.

  Note that the number of nodes in the road network of Santiago agglomeration is between 10^5 and 10^6. At this scale, already $\Omega(n^3)$ time complexity is unacceptable for many practical applications. On the other hand, even $\Omega(n^2)$ space complexity often brings to instances that cannot be solved in the main memory (RAM) of data analyst's workstation. Due to differences in random access speed between RAM and hard disk [Jacobs09], algorithms that rely heavily on random access to the memory, which is the case in many interesting graph algorithms, can experience as much as 100.000 fold slow-down when RAM space is not enough and virtual memory (hard disk swap space) has to be used to store data. This motivates research in algorithms of $o(n^3)$ time and $o(n^2)$ space complexity.

  Our main contribution will be to bring our expertise on graph structural and metric properties to design algorithms with better complexity, smaller memory requirement, and acceptable response time for enabling interactive data analysis (hours of computations per query is not suitable in this context).

There are two main challenges. On the theoretical side, we aim at designing algorithms for solving difficult problems on large (but very specific) networks. On the application side, developing tools for network analysis of Santiago agglomeration would be a very important way to help improve the quality of life of citizens, by for instance improving the transportation system, education and healthcare accessibility, etc.

2.3 Work-program (for the first year)

Describe the planned activity for 2016 if the Associate team is accepted. List the problems that will be tackled, the approaches/methodologies/techniques considered, the participants involved and the exchanges planned (please specify the number of visits planned from France to partner country and from partner country to France). Expected length: one page.

During the Associated Team AlDyNet (2013-2015), we have progressed in our understanding of graph structural properties (graph decompositions) and we have started investigating the metric properties of graphs (hyperbolicity). We aim at pursuing this direction since many problems are still open. An important challenge remains in the computation of "good" decompositions of graphs:

- Tree-decompositions of graphs have been one of the main algorithmic tools of the last 30 years [CourcelleM91,DemaineH08,RobertsonS86,KLNS15]. Unfortunately, computing decompositions with small width remains a challenge (e.g., the computational complexity of treewidth in planar graphs has been open for 20 years [SeymourT94]). Our on-going work [CoudertDN14] opens promising perspectives for the design of approximation algorithms for this purpose. It differs from previous work in the fact that our algorithms are based on simple Breadth First Search. This means that we expect efficient performances in practice. We will progress in this direction of theoretical research.

- Following our experimental work on path-decompositions [CoudertDN14], we aim at implementing our algorithms on tree-decompositions [LKNS15,CoudertDN14,LMNK15] and to conduct simulation campaigns in order to validate the performances of our algorithms in practice. In particular, the algorithm in [LKNS15] may be used as a heurisitic in general graphs and we expect new results about it from simulations. This part is not restricted to graph decompositions but also to other graph parameters such as chordality, hyperbolicity, etc. [CoudertD14,CKM]

Participants: D. Coudert, G. Ducoffe, M. Kiwi, D. Mitsche, N. Nisse, S Pérennes, K. Suchan.

Thanks to the surge in use of geographical information systems, there is more and more information on people activities in their territory. In our collaboration with Chilean government, we have collected data on education, transportation, urban infrastructure, etc. For example, we have information on the transportation networks of Santiago (pedestrian, private, and public transport), the use of public transport (data of smart cards for automatic fare collection -BIP-, bus routes and bus schedules, etc.), urban infrastructure information, schools' addresses, and approximate locations where students live. We have been working on this data to develop decision support tools, for example, for improving quality education accessibility.

So far, the Territorial Intelligence Center of Universidad Adolfo Ibáñez uses a Geographical Information System software called ArcGIS [arcgis] to deal with this data. In a metropolitan area like that of Santiago de Chile, the model has to include information on some 40.000 blocks in a network with some 150.000 junctions. In this setting, even a state of the art software like ArcGIS takes hours to compute a complete origin-destination matrix for all blocks, a fundamental input to all further analysis.

- The first phase is to develop a simple toolkit that will allow to import and export transportation system information from ArcGIS to SageMath (this choice comes from the fact that SageMath provides many interfaces with other graph libraries). An interesting auxiliary task that emerges here is that of correcting errors in the maps created by human users of ArcGIS and merging maps coming from different sources. An exercise that is not trivial, given de scale of networks to be corrected and the nature of problems ranging from erroneous coordinates and duplicate or missing nodes and edges to wrong street orientation. We have already initiated this phase and aim at going on.

- Then, we will be able to use our algorithms in order to extract meaningful information about topological and metric structures of Santiago agglomeration. In a first step, computing "simple" properties as standard all-pairs shortest paths, education offer vs. demand rates (based on floating catchment areas [Wan12]), origin-destination matrices, transportation and traffic patterns, is expected. Then we will move on to harder properties like flows, betweeness and other centrality measures, hyperbolicity, and improvements (especially with respect to space complexity) to shortest paths queries based on pre-computed indexes [Sommer2014]. Finally, we want to tackle:

  - NP-hard problems, like shortest paths with forbidden turns [Kante15], graph decompositions, facility location [Benati2002, Haase2009, Haase2012, Haase2014], and reliable design problems.
  - Develop tools to assess the effects of transportation in metropolitan areas such as effects of transportation facilities in employment and other social analysis [Chen2015]; transit accessibility [Tasic 2014, Cheng2015, Wang2015]; agglomeration effects on time for transit facilities and routes [Zhang2014]; O-D estimation and traffic patterns, catchment areas for intermodal transportation facilities (i.e, Park & Rides [ArosVera13], bike sharing stations, transit transfer facilites); accident analysis [Yamada2004, Anderson2009].

Participants: D. Coudert, G. Ducoffe, E. Moreno, N. Nisse, K. Suchan, J. Treimun, R. Truffello.

Exchanges Program.
From INRIA to Chile: D. Coudert (2 weeks), G. Ducoffe (1 month), N. Nisse (2 weeks), D. Mitsche (2 weeks).
From Chile to INRIA: M. Kiwi (2 weeks), E. Moreno (2 weeks), E. Roman (1 month), K. Suchan (2 weeks).

3 Budget

3.1 Budget (for the first year)

Summarize the budget for 2016: planned expenses, funding requested, co-funding (if any). For co-funding, indicate clearly whether it has been secured or just applied for. Expected length: half a page.

Estimated budget for mission INRIA to partner	People	Time	Estimated cost
researchers	3	2 weeks each	7k euros
Ph.D. student	1	1 months	3k euros
Estimated total cost			10k euros

Estimated budget for mission partner to INRIA	People	Time	Estimated cost
researchers	3	2 weeks each	7k euros
Ph.D. student	1	1 months	3k euros
Estimated total cost			10k euros

3.2 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. (*Mandatory for Associate Teams with European partners: It is expected that an Associate Team in Europe has to take benefit from 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.*

- ANR STINT (COATI, until end 2017)
- ANR BESAGE (COATI to be applied)
- ANR TASTE (COATI to be applied)
- project SticAmSud PUDDING (2 partners + Univ. Fortaleza, Brazil, applied in May 2015)
- FONDEF CA13i10023, Prototype of a an analytic and interactive system to support design, development and evaluation of public policies in education, 2014 – 2016.
- FONDEF (applied in September 2015), The geography of education: a territorial intelligence platform to support the implementation and management of new public policies in education
- FONDECYT (to apply in 2016), Algorithms for Large Scale Geographical Information Systems
- Proyecto Basal: Centro de Modelamiento Matemático de la Universidad de Chile (2013 - 2018)

- Project Team Decision Support Systems for Industrial Problems (of UAI), part of the second stage of CIRIC (Inria Chile)

It is important to note that funds of CONICYT do not allow to fund missions for students.

Global cost of the collaboration project	20k euros
External resources (other than Associated Team program)	10k euros
Funding from the Associate Team program	10k euros

4 Added value

In which way will this Associate team benefit the research of the partners? Expected length: half a page.

The two partners of this Associate Team have a strong expertise in graph theory, graph algorithms and combinatorial optimization. The team EPC COATI has a deep expertise in modeling and solving routing problems in telecommunication networks. In particular, members of EPC COATIare specialists in the field of determining the graph structures that make a problem difficult. Partners from Universidad Adolfo Ibáñez, in addition of the experts in graph theory, include researchers from Territorial Intelligence Research Center, Universidad Adolfo Ibáñez, who are specialist in geographical information systems. Locally, this Associated Team is expected to reinforce the relationship between Inria and Dieudonné Laboratory (Dieter Mitsche) in Nice, and Univ. Adolfo Ibáñez and Univ. de Chile in Santiago (Marcos Kiwi). Moreover, the expertise of D. Mitsche and M. Kiwi in random graphs and randomized algorithms will be a plus for the project.

The collaboration of both teams will certainly improve the action of the CIRIC in Chile, providing INRIA with new insights on Chilean scientific research. In particular, Karol Suchan is involved in the project-team of CIRIC at UAI, working on tools for analysis and visualisation of large volumes of georeferenced data (Big Geo-Data).

5 Other remarks

Any other element you would like to add. Maximum length: half a page.

6 References

6.1 Joint publications of the partners

List all joint publications of the partners (if any).

During AlDyNet 2013-2015

[**ADNS**] J. Araujo, G. Ducoffe, N. Nisse, and K. Suchan. Instantaneous cycle convexity. In preparation.

[**CKM**] D. Coudert, M. Kiwi, D. Mitsche. On the hyperbolicity of random hyperbolic graphs. In preparation.

[**ASN+15**] G. DAngelo, G. Di Stefano, A. Navarra, N. Nisse, and K. Suchan. A unified approach for different tasks on rings in robot-based computing systems. In 15th Workshop on Advances in Parallel and Distributed Computational Models (**APDCM**). IEEE, 2013.

[**LMNK14**] B. Li, F. Moataz, N. Nisse, and K. Suchan. Minimum size tree-decompositions. In 9th International colloquium on graph theory and combinatorics (**ICGT**), 2014. communication without proceedings.

[**BKM+15**] F. Becker, A. Kosowski, M. Matamala, N. Nisse, I. Rapaport, K. Suchan, and I. Todinca. Allowing each node to communicate only once in a distributed system : shared whiteboard models. **Distributed Computing**, 28(3) : pp. 189– 200, 2015.

[**LMNK15**] B. Li, F. Moataz, N. Nisse, and K. Suchan. Minimum size tree-decompositions. In 8th Latin-American Algorithms, Graphs and Optimization Symposium (**LAGOS**). Elsevier, 2015. to appear in Electronic Note Discrete Maths.

[**ASN+15**] G. DAngelo, G. Di Stefano, A. Navarra, N. Nisse, and K. Suchan. Computing on rings by oblivious robots : A unified approach for different tasks. **Algorithmica**, 72(4) : pp. 1055–1096, 2015.

[**KLNS15**] A. Kosowski, B. Li, N. Nisse, and K. Suchan. k-chordal graphs : From cops and robber to compact routing via treewidth. **Algorithmica**, 72(3) : pp. 758–777, 2015.

Before AlDyNet 2013-2015

[**NRS12**] N. Nisse, I. Rapaport and K. Suchan, Distributed computing of efficient routing schemes in generalized chordal graphs. **Theoretical Computer Science**, Volume 444(27), pp. 17-27, 2012.

[**KLNS12**] A. Kosowski, B. Li, N. Nisse and K. Suchan. k-Chordal Graphs: from Cops and Robber to Compact Routing via Treewidth. In Proceedings of 39th Int. Colloquium on Automata, Languages and Programming (**ICALP**), Springer LNCS 7392, pp. 610-622, 2012.

[**KLNS12b**] A. Kosowski, B. Li, N. Nisse and K. Suchan. k-Chordal Graphs: from Cops and Robber to Compact Routing via Treewidth. In 14es Rencontres Francophones sur les aspects Algorithmiques des Télécommunications (**AlgoTel**), pp. 83-86, 2012.

[**BKN+12**] F. Becker, A. Kosowski, N. Nisse, I. Rapaport and K. Suchan. Allowing each node to communicate only once in a distributed system: shared whiteboard models. In Proc. of 24th ACM Symp. on Parallelism in Alg. and Architectures (**SPAA**), pp. 11-17, 2012.

[**BMN+11**] F. Becker, M. Matamala, N. Nisse, I. Rapaport, K. Suchan, and I. Todinca. Adding a referee to an interconnection network: What can(not) be computed in one round. In Proc. of the 25th IEEE Int. Parallel & Dist. Processing Symp. (**IPDPS**), IEEE, pp. 508-514, 2011.

[**BMN+11b**] F. Becker, M. Matamala, N. Nisse, I. Rapaport, K. Suchan, and I. Todinca. Reconstruire un graphe en une ronde. In 13es Rencontres Francophones sur les aspects Algorithmiques des Télécommunications (**AlgoTel**), pp. 31-34, 2011.

[**FGK+10**] F. V. Fomin, P. Golovach, J. Kratochvil, N. Nisse and K. Suchan, Pursuing a fast robber on a graph. **Theoretical Computer Science**, Volume 411(7-9), pp. 1167-1181, 2010.

[**NRS09**] N. Nisse, I. Rapaport and K. Suchan, Distributed computing of efficient routing schemes in generalized chordal graphs. In Proc. of the 16th Colloquium on Structural Information and Communication Complexity (**SIROCCO**), Springer LNCS 5869, pp. 252-265, 2009.

[**NisseS08**] N. Nisse and K. Suchan, Fast Robber in Planar Graphs. In Proceedings of the 34th International Workshop on Graph-Theoretic Concepts in Computer Science (**WG**), Springer LNCS 5344, pp. 312-323, 2008.

6.2 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:

- **David COUDERT** (CR1 INRIA, HdR) is a senior research scientist at INRIA Sophia Antipolis, since 2002, and the head of the COATI project-team. He graduated from the Ecole Normale Supérieure de Lyon (1997), received the Ph.D. degree in computer science from University of Nice Sophia (2001) and the habilitation (HdR) in 2010, and did a post-doc at Universitat Polytècnica de Catalunya (2002).

  His research interests include algorithmic graph theory and combinatorial optimization with applications in network design and management, transportation systems and bio-informatics.

  He participates to several national and European projects: FP5 CRESCCO (2002-2005), COST 293 GRAAL (2004-2008), FP6 AEOLUS (2005-2010), and FP7 EULER (2010-2014). He has several collaborations with Alcatel-Lucent Bell labs, Amadeus, SMEs 3Roam and Instant-System. He is member of the editorial board of Discrete Applied Mathemathics (DAM) and Networks.

  Selected Publications:

  1. Jean-Claude Bermond, David Coudert, Gianlorenzo D'Angelo, and Fatima Zahra Moataz. Finding disjoint paths in networks with star shared risk link groups. Theoretical Computer Science, 579:74–87, 2015.
  2. Michele Borassi, David Coudert, Pierluigi Crescenzi and Andrea Marino. On Computing the Hyperbolicity of Real-World Graphs. European Symposium on Algorithms (ESA), 2015.
  3. Nathann Cohen, David Coudert, and Aurlien Lancin. On computing the Gromov hyperbolicity. ACM Journal of Experimental Algorithmics, 20(1.6), 2015.
  4. David Coudert, Dorian Mazauric, and Nicolas Nisse. Experimental Evaluation of a Branch and Bound Algorithm for computing Pathwidth. In Symposium on Experimental Algorithms (SEA), volume 8504 of LNCS, pages 46-58, June 2014.
  5. David Coudert, Florian Huc, Dorian Mazauric, A Distributed Algorithm for Computing the Node Search Number in Trees. Algorithmica 63(1-2): 158-190 (2012)

- **Guillaume DUCOFFE** (PHD student, University Nice-Sophia Antipolis) has been a PHD candidate in the COATI project-team, INRIA Sophia Antipolis, since September 2014. He graduated from the École Normale Supérieure de Cachan (2014) and the École Polytechnique Universitaire Nice-Sophia Antipolis (2013).

  His research interests include algorithmic graph theory and combinatorics. In particular, his thesis is about the metric properties of graphs, efficient computation of these parameters in large networks, and their applications to some information-sharing problems in social networks.

  Selected Publications:

  1. Guillaume Ducoffe, Mathias Lécuyer, Augustin Chaintreau, Roxana Geambasu. Web Transparency for Complex Targeting: Algorithms, Limits, and

Tradeoffs. SIGMETRICS '15 Proceedings of the 2015 ACM SIGMETRICS International Conference on Measurement and Modeling of Computer Systems, Jun. 2015, Portland, Oregon, United States.

2. Mathias Lécuyer, Guillaume Ducoffe, Francis Lan, Andrei Papancea, Theofilos Petsios, Riley Spahn, Augustin Chaintreau, Roxana Geambasu. XRay: Enhancing the Web's Transparency with Differential Correlation. USENIX Security Symposium, Aug 2014, San Diego, United States.
3. David Coudert, Guillaume Ducoffe. On the Recognition of C_4-free and $\frac{1}{2}$-hyperbolic graphs. Siam Journal on Discrete Mathematics, Society for Industrial and Applied Mathematics, 2014, 28 (4), pp.2029 - 2041.
4. Julio Araujo, Jean-Claude Bermond, Guillaume Ducoffe. Eulerian and Hamiltonian dicycles in directed hypergraphs. Discrete Mathematics, Algorithms and Applications, World Scientific Publishing, 2014, 06, pp.1450012.
5. David Coudert, Guillaume Ducoffe, Nicolas Nisse. Diameter of Minimal Separators in Graphs. Research Report, INRIA-RR-8639, HAL, Sophia Antipolis, France, Nov. 2014.

- **Frédéric GIROIRE** (CR1 CNRS) is a research scientist at CNRS since 2008 inside the joint team Coati between I3S (CNRS, University of Nice-Sophia Antipolis) laboratory and Inria. His research interests include algorithmic graph theory and combinatorial optimization for network design and management issues. He has knowledge of both practical thematics, as proposed by industrials like Sprint (2 patents), Intel (one patent), France Telecom and Alcatel Space, and of theoretical methods developed during his researcher life (optimization, graph theory, analysis of probabilistic algorithms). He has experience in project management: he was main investigator of the ANR-JCJC Dimagreen on the Design and Management of Green networks with low power consumption 2009-2012, and on PEPS project Systemic on the control of systemic risks in graphs of financial networks (2015). He is the author of 14 papers in international journals (in combinatorial optimization and networking), 32 papers in international peer-reviewed conferences (in analysis of algorithms, networking, combinatorial optimization) and 3 patents.

  Selected Publications:

  1. F. Giroire, A. Nucci, N. Taft, and C. Diot. Increasing the robustness of ip backbones in the absence of optical level protection. In Proceedings of the Twenty-Second Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM), 2003.
  2. O. Dalle, F. Giroire, J. Monteiro, and S. Prennes. Analysis of failure correlation impact on peer-to-peer storage systems. In Proceedings of the 9th IEEE International Conference on Peer-to-Peer Computing (P2P), pages 184193, sep 2009.
  3. F. Giroire, J. Chandrashekar, N. Taft, E. Schooler, and K. Papagiannaki. Exploiting temporal persistence to detect covert botnet channels. In Springer, editor, 12th International Symposium on Recent Advances in Intrusion Detection (RAID09), volume 5758 of Lecture Notes in Computer Science, pages 326345, Saint Malo, France, September 2009.
  4. F. Giroire. Order statistics and estimating cardinalities of massive data sets. Discrete Applied Mathematics, 157(2):406427, 2009.
  5. F. Giroire, J. Moulierac, T. K. Phan, and F. Roudaut. Minimization of network power consumption with redundancy elimination. Computer Communications, 59, 98-105, 2015.

- **Nicolas NISSE** (CR1 INRIA) is a full-time researcher at INRIA Sophia Antipolis since 2009, in the project-team MASCOTTE. 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 received his Habilitation à Diriger des Recherches (HDR) in 2014, from Univ. Nice Sophia Antipolis. 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) and metric properties of networks.

  He participated to several national and international projects (COST 295 DYNAMO, Anillo en Redes, etc.) and is currently the principal investigator of the Assoicated team Al-DyNet (2013-2015) and of the project C12E03 (ECOS-Sud Chili/CONYCIT,2013-2015). He has also collaborations with Canada, Greece, Norway and Chile.

  Selected Publications:

  1. Mamadou Moustapha Kanté, Fatima Zahra Moataz, Benjamin Momège and Nicolas Nisse. Finding Paths in Grids with Forbidden Transitions. 41st Int. Workshop on Graph-Theoretic Concepts in Computer Science (WG), LNCS, Springer, 2015.
  2. Adrian Kosowski, Bi Li, Nicolas Nisse and Karol Suchan, k-Chordal Graphs: from Cops and Robber to Compact Routing via Treewidth. Algorithmica, Volume 72(3), pages 758-777, 2015.
  3. Florent Becker, Adrian Kosowski, Martin Matamala, Nicolas Nisse, Ivan Rapaport, Karol Suchan, and Ioan Todinca. Allowing each node to communicate only once in a distributed system: shared whiteboard models. Distributed Computing, Volume 28(3), pages 189-200, 2015.
  4. David Coudert, Dorian Mazauric and Nicolas Nisse. Experimental Evaluation of a Branch and Bound Algorithm for computing Pathwidth. In Proceedings of the 13rd Symposium on Experimental Algorithms (SEA), Springer LNCS, pages 46-58, Copenhagen, Denmark, 2014.
  5. Fedor V. Fomin, Pierre Fraigniaud and Nicolas Nisse, Non-Deterministic Graph Searching: From Pathwidth to Treewidth. Algorithmica, Volume 53(3), pages 358-373, 2009.

- **Stéphane Pérennes** (DR CNRS) is a full-time researcher in the MASCOTTE team project at INRIA Sophia Antipolis. He received the M.Sc. in computer science from Ecole Normale Superieure (ENS) Lyon and University Claude Bernard Lyon (UCBL), in 1992, and the Ph.D. degree in computer science from the University of Nice, in 1996.

  His research interests are the design of algorithms and models for problems motivated by telecommunication networks. He uses tools coming from discrete mathematics (linear programming, discrete probabilities, performance evaluation, Monte Carlo and simulation, complexity, graph theory) to study problems mainly motivated by telecommunications issues, as (distributed) routing, evaluation and modelling of peer to peer networks, virtual topologies optimization, and more generally distributed computing and approximation algorithms. He has co-authored more than 100 papers among which 40 in international journals and 40 in international conferences with peer review.

Selected Publications:

1. Omid Amini, David Peleg, Stéphane Pérennes, Ignasi Sau, Saket Saurabh, On the approximability of some degree-constrained subgraph problems. Discrete Applied Mathematics 160(12): 1661-1679, 2012.
2. Ioannis Caragiannis, Afonso Ferreira, Christos Kaklamanis, Stéphane Pérennes, Hervé Rivano, Fractional Path Coloring in Bounded Degree Trees with Applications. Algorithmica 58(2): 516-540, 2010.
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5. Cyril Gavoille, David Peleg, Stéphane Pérennes, Ran Raz, Distance labeling in graphs. J. Algorithms 53(1): 85-112, 2004.

Chilean partners Participants:

- **Eduardo MORENO** is an Associate Professor (profesor asociado) at the Facultad de Ingeniería y Ciencias at Universidad Adolfo Ibáñez, since 2007. He is a Mathematical Engineer (Universidad de Chile). He received his Ph.D. degree in Informatics (Université Paris-Est Marne-la-Vallée, France) and Doctorado en Ciencias de la Ingeniería, Mención en Modelamiento Matemático (Universidad de Chile) in 2005. He did a postdoc at Center of Mathematical Modeling (CMM), Universidad de Chile (2005-06).

  His research focuses on combinatorial optimization, algorithms, graph theory and operational research, with applications to network design, telecommunications, transportation and open-pit mining.

  He participated to several national and international projects : Anillo ACT-88, Basal-CMM, Fondecyt 1060825, Fondef D06I1031, Fondef D11I1002, Stic-Amsud 09STIC03, Fondecyt 1130681, Fondequip AIC34, Misti MIT Seed fund. He has also collaborations with Argentina, Brazil, Canada, France, Italy, Uruguay and USA.

  Selected Publications:

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5. Cristian E. Cortes, Pedro Jara-Moroni, Eduardo Moreno, Cristobal Pineda, Stochastic Transit Equilibrium, Trans. Res. B 51:29-44, 2013.

- **Esteban ROMAN** received his Master of Financial Engineering (2010) in UAI. His first studies was Math Engineering at Universidad Técnica Federico Santa María (2005, Valparaiso, Chili). He is the coordinator of the Computational Mathematics Laboratory at Facultad de Ingeniería y Ciencias of Universidad Adolfo Ibáñez, UAI, (Santiago, Chili) since September 2007. Simultaneously, he is also a PhD student of Complex Systems Engineering at UAI, working on graph theory using algorithms for geographical information systems.

- **Karol SUCHAN** is an Associate Professor at the Facultad de Ingeniería y Ciencias of Universidad Adolfo Ibáñez (Santiago, Chili) since August 2008. He is also the head of iUAI Tech, IT research and development center at Universidad Adolfo Ibez. He received his M.Sc. degree in Applied Mathematics (2003) at the AGH University of Science and Technology (Krakow, Poland). He received his M.Sc. and Ph.D. degrees in computer science at Laboratoire d'Informatique Fondamentale d'Orléans (LIFO), Université d'Orléans (France). He did a postdoc at Departamento de Ingeniería Matemática (DIM), Universidad de Chile (2006-2008).

  His research focuses on graph theory, from structural and algorithmic points of view, networking and distributed computing. In particular, he works on analysis of graph structures and design of efficient algorithms that exploit graph properties to efficiently solve problems that are NP-complete in general, or to improve the complexity of polynomial algorithms for very large instances. His expertise covers centralized and distributed computation for telecommunication systems, algorithms for geographical information systems, and analysis of diffusion and pattern formation in social networks.

  He participated in several Chilean projects: Anillo ACT-08, Anillo ACT-88, Basal-CMM, Fondecyt 11090390, Ecos-Conicyt C12E03, Fondef CA13i10023, Fonide F911435. He has collaborations with Australia, Brasil, France, Norway and Poland.

  Selected Publications:

  1. F. Becker, A. Kosowski, M. Matamala, N. Nisse, I. Rapaport, K. Suchan, I. Todinca, Allowing each node to communicate only once in a distributed system: shared whiteboard models, Distributed Computing 28(3):89-200, 2015.
  2. 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.
  3. L. Kowalik, M. Pilipczuk, K. Suchan, Towards optimal kernel for connected vertex cover in planar graphs, Discrete Applied Mathematics 161(7-8):1154-1161, 2013.
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- **John TREIMUN** is a research scientist at the Territorial Inteligence Center of Adolfo Ibaez University (Santiago, Chili) since 2011. He is specialist on geographic models, remote sensing and GIS. He is also part of the national scientific community that are currently investigating global spatial downscaling techniques for urban climate models.

  He has participated in several Chilean original researches projects, the most recent are: Zonificacin Climtico-Ambiental Urbana mediante la integracin de Tcnicas Geomticas y

Mtodos Geoestadsticos (2015); "Analysis of the temporal behavior of the surface and the surface temperature of the Northern Patagonian Ice Field, Aysen Region, Chile. Period 2001-2014 "; "- Diagnosis of water resources in context of drought and agricultural dependence" and "Variaciones espacio-temporales del clima urbano en ciudades desrticas: el caso de Calama y Antofagasta". Also, he has contributed trough the innovation and adaptation of techniques and spatial analysis methods in Chilean and International Institutions.

On the other hand, he has optimized critical process in private or institutionalized territorial analysis services. In particular, he is an author of mathematical formalization of Econometric Model of Territorial Intelligence (Medit) and automation to get the price floor of large cities. Urbana Valor. 2012. He also is an author of automatized tool for ArcGIS environments, for the Calculation of Ecological Representativeness in the National System of Protected Area of Chile. GEF SNAP Project. PNUD, 2014.

- **Ricardo TRUFFELLO** is an Associate Professor at the Faculty of Design at Universidad Adolfo Ibáñez UAI - (Santiago, Chile) since March 2010. He is also the Head of Research for the Territorial Intelligence Center UAI. His research topics include the process of metropolization and detection of sub-centers; socioeconomic segregation; crime and spatial analysis in relation with the process of socioeconomic segregation; school choice and educational segregation; and functional sufficiency of equipment index and multi-scale urban diagnosis.

  He participated in several Chilean projects: Associate Professional at Centre for Social Conflict and Cohesion Studies 2013 2015]; FONIDE F911435; Researcher in FONDEF, A prototype of an analytical and interactive system to support the design, development and evaluation of public policies in education, CA13I10023, Santiago 2013 2015; Member of the International Advisory Committee in EURE, Journal of Urban regional Latin-Americans studies. (2012-2015);

  Selected Publications:

  1. R.Truffello, R.Hidalgo. Polycentricity in the Metropolitan Area of Santiago de Chile: commercial restructuring, mobility and characterization of sub-centers, EURE Journal, Vol.41, N121, January, 2015, Santiago.
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  4. L.Valenzuela, D.Opazo, R.Truffello, Cartographies of Santiago Metropolis, chapter in the book Urban Projects (Margaret Greene, Jos Rosas, Luis Valenzuela), Santiago, 2011.

- **Wilfredo F. YUSHIMITO** is an Assistant Professor at the Facultad de Ingeniería y Ciencias of Universidad Adolfo Ibáñez (Viña del Mar) since January 2012. He is member of iUAI Tech, IT research and development center at Universidad Adolfo Ibez. He received a M.S. degree in Industrial Engineering (2006) at the University of Puerto Rico at Mayagüez (PR, US). He received a M.S. in Applied Mathematics and Ph.D. in Transportation Engineering at Rensselaer Polytechnic Institute (Troy, NY, US).

His research focuses on transportation engineering, transportation network modeling, intelligent transportation, and logistics. In particular, he works on dynamic traffic assignment both in theoretical and algorithmic aspects and its applications for testing different transportation policies; microscopic and mesoscopic traffic simulation (calibration, evaluation, modeling aspects); risk and security aspects of transportation facilities; data fusion techniques to estimate traffic parameters and demand estimation; and optimization models for locating intermodal facilities (i.e., Park-and-Rides).

In Chile he has received the Fondecyt Iniciación 11121439. He has been consultant and/or developed projects for Autopista Central, Autopista Vespucio Norte, Sonda, CityMovil, the Latin American & Caribbean Association of Air Transport(ALTA). He has also participated in projects in the United Stated funded by the California Center for Innovative Transportation, NYSERDA (NY, US), UTRC Region II (NY, US),and the US Department of Transportation. He has collaborations with United States of America, India, Brazil, and Colombia.

Selected Publications:

1. S. Ukkusuri, K. Ozbay, W.F. Yushimito, S. Iyer, E. Morgul, J. Holgu—'in-Veras, Assessing the impact of urban off-hour delivery program using city scale simulation models. EURO Journal on Transportation and Logistics, 1-26. In Print, 2015.
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5. W.F. Yushimito, M. Jaller, S. Ukkusuri, A Voronoi-based heuristic algorithm for locating distribution centers in disasters, Networks and Spatial Economics, 12(1): 21-39, 2012.

Partners from other institutions:

- **Marcos Kiwi** received his Bachelor and Engineering degree from the Universidad de Chile in 1990 and 1991, respectively, and his Ph.D. in Mathematics from MIT in 1996. Afterward he moved to the School of Engineering of the University of Chile where he is now Full Professor at the Departamento de Ingeniera Matemática and Associate Researcher at the Centro de Modelamenento Matemtico (also a CNRS-UMI).

  His research interests include computational complexity theory, random structures and algorithms. Lately he has been interested in problems concerning large networks, evolving data sets, and information dissemination in networks.

  He has served on numerous program committees for conferences in theoretical computer science, and was the program committee chair of the Latin American Theoretical Informatics Symposium (2006), Associate Editor of SIAM J. on Discrete Mathematics (2009-2015) and Theoretical Computer Science A (2010-2015). He was also Chair of the Department of Mathematical Engineering of the University of Chile (Jul 2008 - Jun 2010).

He has been principal investigator of four FONDECYT grants, and led the group project Anillo en Redes (2006-2007), was alternate director of a Nucleo Milenio grant (2012-2014), and is one of the responsible researcher of the Basal project in Applied Mathematics (2013-2017).

His main international collaborations are with researchers from Brazil, Czech Republic, France, Spain, and USA. **Selected Publications:**

1. M Bellare, D Coppersmith, J Hstad, M Kiwi and M Sudan, Linearity testing in characteristic two, IEEE Transactions on Information Theory 42(6):1781-1795. Preliminary version appeared in 36th IEEE Symposium on Foundations of Computer Science, 432-441, 1995.
2. M. Kiwi, F. Magniez and M. Santha. Testing with Relative Error. Computer and System Sciences, 66(2):371-392, 2003. Preliminary version appeared in Proceedings of the 31st ACM Symposium on Theory of Computing, 5160, 1999
3. M. Kiwi, M. Loebl and J. Matousek. Expected Length of the Longest Common Subsequence for Large Alphabets. Advances in Mathematics, 197(2):480-498, 2005. Preliminary version in Proceedings of the 6th Latin American Symposium on Theoretical Informatics, Springer-Verlag, LNCS 2976, 302-311, 2004.
4. M. Kiwi, D. Mitsche, A bound for the diameter of random hyperbolic graphs, Proceedings of the 12-th Workshop on Analytic Algorithmics and Combinatorics (ANALCO), p. 26-39, 2015
5. J.R. Correa, M. Kiwi, N. Olver and A. Vera. Adaptive Rumor Spreading. To appear in Proceedings of the 11th Conference on Web and Internet Economics - WINE. Springer-Verlag, LNCS, 2015

- **Dieter Mitsche** is a full-time assistant professor at Univ. Nice since 2012, in the group of Probability and Statistics. He received his master degree in 2003 from Univ. Klagenfurt and his PhD 2007 from ETH Zurich. He was a lecturer at UPC Barcelona (2007-2009), did a postdoc at CRM Barcelona (2009-2010), again lecturer at UPC Barcelona (2010-2011), and then he did a postdoc at Univ. Ryerson from 2011-2012. He spent a sabbatical from August 2014 to January 2015 at Univ. Ryerson.

  His main research interests are in the field of probabilistic combinatorics, in particular random graphs. His work focusses on the analysis of probabilistic graph models together with its applications to massive networks. He participated in several national and international projects (european projects: COMBSTRU, FRONTS) and is currently the main investigator of Nice of the German-French collaboration project PROCOPE RanConGraph. He has many international collaborations, including Chile. He visited Marcos Kiwi (Univ. Chile) in June 2014 and is currently spending his sabbatical from August 2015 to January 2016 again at Univ. Chile/CMM, to continue collobration with M. Kiwi and start collaboration with other researchers in Chile.

  Selected Publications:

1. A. Frieze, D. Mitsche, X. Perez-Gimenez, P. Pralat, On-line coloring of random graphs, Electronic Journal of Combinatorics, 22 (2) (2015), P2.41.
2. M. Kiwi, D. Mitsche, A bound for the diameter of random hyperbolic graphs, Proceedings of the 12-th Workshop on Analytic Algorithmics and Combinatorics (ANALCO), p. 26-39, 2015

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4. J. Diaz, D. Mitsche, X. Perez-Gimenez, Large connectivity for dynamic random geometric graphs, IEEE Transactions on Mobile Computing 8 (6) (2009), 821-835.
5. J. Diaz, A. Marchetti-Spaccamela, D. Mitsche, P. Santi, J. Stefa, Social-aware forwarding improves routing performance in pocket switched networks, ESA 2011, 723-735.

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