Inria International program
Associate Team proposal 2013-2015

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Deadline:September 30, 2012

Associate Team acronym: AlDyNet

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

[1]In January 2013, the EPI MASCOTTE will be replaced by EPI COATI (head: D. Coudert). All members of this Associated Team Proposal that are currently in EPI MASCOTTE will be part of the EPI COATI.

1 Partnership

1.1 Detailed list of participants

List the participants to the associate team, giving for each: name, affiliation, status (senior researcher/professor, junior researcher/professor, postdoc, PhD / master student) 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). Maximum 1 page.

INRIA Participants list.

David COUDERT: *CR INRIA*, HdR, head of EPI MASCOTTE.

`http://www-sop.inria.fr/members/David.Coudert/`

Bi LI: *Ph.D. student* (since Oct. 2011), EPI MASCOTTE.

`http://www-sop.inria.fr/members/Bi.Li/`

Nicolas NISSE: *CR INRIA* (since 2009), EPI MASCOTTE.

`http://www-sop.inria.fr/members/Nicolas.Nisse`

Stéphane PÉRENNES: *DR CNRS*, EPI MASCOTTE.

`http://www-sop.inria.fr/members/Stephane.Perennes/`

Ronan P. SOARES: *Ph.D. student* (since Nov. 2010), EPI MASCOTTE.

`http://www-sop.inria.fr/members/Ronan.Pardo_Soares/`

List of the participants from the partner institution.

Marcos GOYCOOLEA: *Associate professor* at Universidad Adolfo Ibáñez.

`http://mgoycool.uai.cl/`

José MERINO: *Master student* (to start in 2013) at Universidad Adolfo Ibáñez.

Eduardo MORENO: *Associate professor* at Universidad Adolfo Ibáñez.

`http://emoreno.uai.cl/`

Esteban ROMÁN: *PhD student* (since Mar. 2012) at Universidad Adolfo Ibáñez.

Karol SUCHAN: *Assistant professor* at Universidad Adolfo Ibáñez.

`http://www.suchan.info/`

1.2 Nature and history of the collaboration

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

Nicolas Nisse and and Karol Suchan were postdocs at Departamento de Ingeniería Matemática (DIM) Universidad de Chile, project CONICYT ACT-08 Anillo en Redes (2007-2008). They worked on graph decompositions and related capture games [NisseS08,FGK+10]. Since then, they have continued their collaboration. In 2009, while Nicolas Nisse was postdoc in EPI MASCOTTE and Karol Suchan was assistant professor et UAI, they worked on distributed routing algorithms in graph classes with specific structural properties [NRS09, NRS12].

After Nicolas Nisse became permanent INRIA researcher, Karol Suchan went several times to visit EPI MASCOTTE (one week in February 2010, two weeks in July/August 2010, three months from October to December 2011). Nicolas Nisse also went several times to visit Adolfo Ibáñez University (two weeks in January 2011, two weeks in August 2012). In particular, Nicolas Nisse has been invited to give a talk in the IMSA Workshop on Algorithms and Randomness (January 2011) co-organized by Karol Suchan. During this period, they continued their work on distributed computational models initiated in 2008 [BMN+11,BKN+12].

These crossed visits also allowed them to continue their collaboration on distributed routing algorithms using graph decompositions. Bi Li (Ph.D. student under the supervision of N. Nisse) has collaborated with Karol Suchan during these visits [KLNS12].

These collaborations led to many joint publications (see Section 6.1).

2 Scientific program

2.1 Context

Current evolution of telecommunication networks leads to new algorithmic challenges. Indeed, both the size of networks [FaceBook,CAIDA] as well as the amount of traffic in such networks [CISCO] grow drastically. In this context, numerous problems become challenging to solve even if there exist algorithms that are suitable for smaller networks (algorithms of running time $O(n^4)$ are not scalable to networks of size $n = 10^4$; at $n = 10^5$ even $O(n^3)$ is impractical). Therefore, solutions proposed so far do not scale up and new alternatives must be provided. On the one hand, recent results have proposed to design algorithms that take advantage of special structural properties often found in large-scale networks to achieve better performances. Indeed, it is well known that many telecommunication, social, and biological networks share structural properties such as logarithmic diameter, power-law degree distribution and high clustering coefficient [Erdos59,Barabasi99,Kle00,Albert02,Bu02]. These properties can be exploited for algorithmic purposes (e.g., for routing [FG97,TZ05,AGM06,AG06,CSTW09,KPBV09,AGMW10 ,KLNS12]). On the other hand, centralized solutions proposed so far do not allow to efficiently face the dynamicity of these networks (variations of both topology and state of connections). Moreover, another important aspect of some of the new networks is that they are not defined in a global way (but, e.g., social networks are defined through local interactions). Hence, it is interesting to propose distributed or even localized solutions, i.e., algorithms based on information that can be retrieved locally and in a distributed way[2]. Many recent works study the tradeoffs between the power of communication and the kind of structural properties that can be computed [KMW04,BMN+11,FKP11,AF12,BKN+12,FHW12].

2.2 Objectives (for the three years)

The main goal of this Associate Team is to study the structure of networks (modeled by graphs) to design both efficient distributed algorithms and reliable network topologies suitable to applications. We are interested both in large-scale (Facebook, Internet, etc.) and in smaller networks (e.g., WDM) that handle heavy traffic. More precisely, we aim at designing new techniques of distributed and localized computing to test structural properties of networks and to compute structures (e.g., decompositions) to be used in applications. Concerning the applications, we will first focus on routing and subgraph packing problems. There are two main objectives:

- Find **efficient localized algorithms to test certain graph properties** or to prove that no such algorithms exist. We will formalize several distributed computing models and analyze which properties can and which cannot be tested in them.
- Define **graph properties** - computable or approximable in distributed systems - such as structures/decompositions/representations. The driving idea is to combine several well studied graph properties in order to obtain more specific structures that we hope to be computable more easily.

To verify the practical efficiency of our results, the designed algorithms will be implemented and compared to existing ones. For this purpose, a particular effort will be put to design and implement algorithms to generate graphs that satisfy properties of interest, in order to use them to test the algorithms.

The originality of the proposal is to combine powerful tools of graphs theory (e.g., FPT complexity) and of combinatorial optimization (Mixed Integer Programming) with distributed computing. One challenge here is to balance between the degree of locality of desired algorithms and the relevance of properties that may be computed.

[2]The difference between distributed and localized is mainly related to the restrictions imposed on message exchanges between nodes.

2.3 Work-program (for the first year)

Last decade have shown promising advances in exploiting the structure of the underlying graph to solve hard problems efficiently. We propose to study structural properties of graphs with two main guidelines: to focus on specific graph classes and to keep in mind the algorithmic applications of the considered properties. We expect to find structures that could be computed easily (by greedy or localized algorithms) and that would allow to design efficient algorithms for important problems like routing or graph packing. For this purpose, we want to first extend the classical centralized approaches to have a better understanding of graph structures:

- To continue the study of graphs decompositions: in particular, it is important to design simple algorithms to compute (or approximate) decompositions in particular graphs classes [BK11]: for instance, graphs with small treewidth (generic algorithms of Bodlaender and Kloks being inefficient even in such graphs classes), subclasses of planar graphs (the complexity of computing treewidth of planar graphs is still open).
  An approach that we will follow during the first year is the computation of such decompositions via integer programming, branch and bound and separation algorithms. Very few works have considered this direction [FHL08,BFK+12].
- To generalize this study to directed graphs: currently several groups of researchers (e.g., [Ganian et al. 2010]) aim at designing "good" decompositions for directed graphs, i.e., having the same algorithmic performances as tree-decompositions in the undirected case.

Participants: D. Coudert, M. Goycoolea, J. Merino, N. Nisse, R. P. Soares, K. Suchan.

Most of the graph characteristics used to improve the performances of algorithms are centralized and global structures. We aim at deriving simpler structures and graph characterizations that could be locally computable. In particular, we want to focus on information localized at vertices (or close neighborhoods) that suffices to compute structural properties that support efficient algorithms for applications, therefore:

- To focus on characterizations that may be efficiently computed and used in a distributed setting. For instance, in the case of tree-decompositions, the size of the "pieces" of the decomposition is important to obtain efficient generic algorithms using dynamic programming. However, when we are interested in specific problems, it would be more relevant to consider the structure of the pieces instead of their size. For instance, preliminary results show that graphs with bounded chordality admit tree-decompositions where each bag has a short dominating path. Moreover, such a decomposition can be computed by a greedy algorithm and has interesting applications for compact routing [KLNS12].
- To propose new characterizations for graphs satisfying a combination of classical properties. It will be crucial to design algorithms to check whether a graph satisfies these combinations, and to generate families of graphs satisfying them. A particular attention will be paid to properties and structures of real-world networks.

Participants: B. Li, J. Merino, E. Moreno, N. Nisse, S. Pérennes, E. Román, K. Suchan

Exchanges Program.
From INRIA to Chili: D. Coudert (2 weeks), B. Li (1.5 months), N. Nisse (2 weeks), S. Pérennes (2 weeks), R.P. Soares (2 weeks).
From Chili to INRIA: M. Goycoolea (2 weeks), J. Merino (1 month), E. Moreno (2 weeks), E. Roman (1 month), K. Suchan (2 weeks).

3 Budget

Summarize the budget for 2013: 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. Maximum half a page.

Estimated budget for mission INRIA to partner	People	Time	Estimated cost
researchers	3	2 weeks each	7.5k euros
Ph.D. student	2	1.5 months + 2 weeks	7.5k euros
Estimated total cost			15k euros

Estimated budget for mission partner to INRIA	People	Time	Estimated cost
researcher	3	2 weeks each	7.5k euros
Ph.D. student	1	1 month	4k euros
Master student	1	1 month	4k euros
Estimated total cost			15.5k euros

Other sources of funding.

- FP7 (FIRE) european project EULER (MASCOTTE, until end of 2013)
- ANR AGAPE (MASCOTTE, until end 2013)
- ANR DALTONS (MASCOTTE to be applied)
- ECOS Sud-Chili (2 partners, applied in June 2012)
- Proyecto Basal: Centro de Modelamiento Matemático de la Universidad de Chile (2008 - 2013, extendable for another 5 years)
- CONICYT ACT-88 (IMSA, 2010-2013)
- FONDECYT 1110674 (2011-2014)

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

Global cost of the collaboration project	35.5k euros
External resources (other than Associated Team program)	15k euros
Funding from the Associate Team program	15.5k euros

4 Added value

In which way will this associate team benefit to the research of the partners? Maximum half a page.

The two leaders of this Associate Team have a strong expertise in graph theory and distributed computing. The team MASCOTTE has a deep expertise in modeling and solving routing problems in telecommunication networks. In particular, members of MASCOTTE are specialists in the field of determining the graph structures that make a problem difficult. Partners from Universidad Adolfo Ibáñez have a strong experience of Mathematical Programming and Operations Research including mixed integer programming methodologies and separation algorithms. Moreover, they have a long experience of joint work with industry on networks coming from applications. The collaboration of both teams will certainly improve the action of the CIRIC in Chile, providing INRIA with new insights on Chilean scientific research. Indeed, our research project fits in the "Internet and Telecommunication" research line of the CIRIC dealing with Optimization models and algorithm for Telecommunication Network Management (Network Design).

5 Other remarks

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

6 References

6.1 Joint publications of the partners

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

[**ASN+12**] G. D'Angelo, G. Di Stefano, A. Navarra, N. Nisse and K. Suchan. A unified approach for different tasks on rings in robot-based computing systems. INRIA-RR8013, submitted.

[**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.

[**NisseS08b**] N. Nisse and K. Suchan, Voleur véloce dans un réseau planaire. In 10es Rencontres Francophones sur les aspects Algorithmiques des Télécommunications (**AlgoTel**), pp. 29-32, 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, in the project-team MASCOTTE. 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 did a post-doc at Universitat Polytècnica de Catalunya (2002). He was also vice team leader of MASCOTTE (2006-2010) and is the head of MASCOTTE since 2011.

  His research interests include algorithmic graph theory and combinatorial optimization for network design and management issues. He focuses mainly on routing and wavelength assignment, traffic grooming, protection mechanisms against single and multiple failures, routing reconfiguration for optical backbone networks, multilayer networks, and wireless backhaul networks.

  He participates to several national and European projects: FP5 CRESCCO (2002-2005), COST 293 GRAAL (2004-2008), FP6 AEOLUS (2005-2010), and FP7 EULER (2010-2013). He has several collaborations with Alcatel-Lucent Bell labs, SMEs 3Roam et AVISTO. He is member of the editorial board of Discrete Applied Mathemathics (DAM) and Networks.

  Selected Publications:

  1. Jean-Claude Bermond, David Coudert, Joanna Moulierac, Stéphane Prennes, Ignasi Sau Valls, and Fernando Solano Donado, GMPLS Label Space Minimization through Hypergraph Layouts. Theoretical Computer Science (TCS), 444:3-16, 2012.
  2. David Coudert, Florian Huc, Dorian Mazauric, A Distributed Algorithm for Computing the Node Search Number in Trees. Algorithmica 63(1-2): 158-190 (2012)
  3. Grit Classen, David Coudert, Arie M. C. A. Koster, and N Napoleão Nepomuceno, Bandwidth assignment for reliable fixed broadband wireless networks. In 12th IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM), Lucca, Italy, pages 1-6, IEEE, 2011.
  4. Nathann Cohen, David Coudert, Dorian Mazauric, Napoleão Nepomuceno, Nicolas Nisse, Tradeoffs in process strategy games with application in the WDM reconfiguration problem. Theor. Comput. Sci. 412(35): 4675-4687 (2011)
  5. David Coudert, Napoleão Nepomuceno, Hervé Rivano, Power-efficient radio configuration in fixed broadband wireless networks. Computer Communications 33(8): 898-906 (2010)
  6. Jean-Claude Bermond, David Coudert, Benjamin Lévêque, Approximations for All-to-All Uniform Traffic Grooming on Unidirectional Rings. Journal of Interconnection Networks 9(4): 471-486 (2008)

- **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 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 participated to several national and international projects (COST 295 DYNAMO, Anillo en Redes, etc.) and is currently involved in a project with Alcatel-Lucent-Bell on dynamic compact routing algorithmic. He has also collaborations with Canada, Greece, Norway and Chile.

Selected Publications:

1. Lali Barrière, Paola Flocchini, Fedor V. Fomin, Pierre Fraigniaud, Nicolas Nisse, Nicola Santoro, Dimitrios M. Thilikos, Connected graph searching. Inf. Comput. 219: 1-16 (2012)
2. Adrian Kosowski, Bi Li, Nicolas Nisse and Karol Suchan, k-Chordal Graphs: from Cops and Robber to Compact Routing via Treewidth. In Proc. of 39th Int. Col. on Automata, Languages and Prog. (ICALP), Springer LNCS 7392, pp. 610-622, 2012.
3. Fedor V. Fomin, Petr Golovach, Jan Kratochvil, Nicolas Nisse and Karol Suchan, Pursuing a fast robber on a graph. Theoretical Computer Science, Volume 411(7-9), pages 1167-1181, 2010.
4. Omid Amini, Frdric Mazoit, Nicolas Nisse, Stéphan Thomassé, Submodular partition functions. Discrete Mathematics 309(20): 6000-6008 (2009)
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.

3. Omid Amini, Florian Huc, Stéphane Pérennes, On the Path-Width of Planar Graphs. SIAM J. Discrete Math. 23(3): 1311-1316, 2009.
4. Michele Flammini, Ralf Klasing, Alfredo Navarra, Stéphane Pérennes, Improved Approximation Results for the Minimum Energy Broadcasting Problem. Algorithmica 49(4): 318-336, 2007.
5. Cyril Gavoille, David Peleg, Stéphane Pérennes, Ran Raz, Distance labeling in graphs. J. Algorithms 53(1): 85-112, 2004.

Chilean partners Participants:

- **Marcos GOYCOOLEA** is an associate professor at the School of Business of Universidad Adolfo Ibáñez (UAI). He completed his PhD studies at the School of Industrial and Systems Engineering (ISYE) of Georgia Tech, and defended his thesis on November 9th, 2006. He received an undergraduate degree in Mathematical Engineering from the School of Engineering of Universidad de Chile.

  He teaches courses related to Operations Management and conduct research, both theoretical and applied, on Mathematical Programming and Operations Research. His research interests include: scheduling operations for forestry and mining, the traveling salesman problem, and mixed integer programming methodologies.

  Selected Publications:

  1. Ricardo Fukasawa, Marcos Goycoolea, On the exact separation of mixed integer knapsack cuts. Math. Program. 128(1-2): 19-41, 2011.
  2. Sanjeeb Dash, Marcos Goycoolea, Oktay Gnlk, Two-Step MIR Inequalities for Mixed Integer Programs. INFORMS Journal on Computing 22(2): 236-249, 2010.
  3. William J. Cook, Daniel G. Espinoza, Marcos Goycoolea, Generalized Domino-Parity Inequalities for the Symmetric Traveling Salesman Problem. Math. Oper. Res. 35(2): 479-493, 2010.
  4. David Applegate, Robert E. Bixby, Vasek Chvtal, William J. Cook, Daniel G. Espinoza, Marcos Goycoolea, Keld Helsgaun, Certification of an optimal TSP tour through 85, 900 cities. Oper. Res. Lett. 37(1): 11-15, 2009.
  5. William J. Cook, Daniel G. Espinoza, Marcos Goycoolea, Computing with Domino-Parity Inequalities for the Traveling Salesman Problem (TSP). INFORMS Journal on Computing 19(3): 356-365, 2007.

- **Karol SUCHAN** is an assistant professor at the Facultad de Ingeniera y Ciencias at Universidad Adolfo Ibáñez (Santiago, Chili) since August 2008. He received his master degree in Applied Mathematics (2003) at the AGH University of Science and Technology (Krakow, Poland). He received his master 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. His expertise covers centralized and distributed control of telecommunication 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. He has collaborations with Australia, Brasil, USA, France, Norway and Poland.

Selected Publications:

1. Fedor V. Fomin, Serge Gaspers, Petr A. Golovach, Karol Suchan, Stefan Szeider, Erik Jan van Leeuwen, Martin Vatshelle, Yngve Villanger, k-Gap Interval Graphs. LATIN 2012: 350-361, 2012.
2. Serge Gaspers, Mathieu Liedloff, Maya Stein, Karol Suchan, Complexity of Splits Reconstruction for Low-Degree Trees. WG 2011: 167-178, 2011.
3. Ivan Rapaport, Karol Suchan, Ioan Todinca, Jacques Verstrate, On Dissemination Thresholds in Regular and Irregular Graph Classes. Algorithmica 59(1): 16-34, 2011.
4. Ivan Rapaport, Karol Suchan, Ioan Todinca, Minimal proper interval completions. Inf. Process. Lett. 106(5): 195-202, 2008.
5. Karol Suchan, Ioan Todinca, On powers of graphs of bounded NLC-width (clique-width). Discrete Applied Mathematics 155(14): 1885-1893, 2007.

- **Eduardo MORENO** is an associate professor (profesor asociado) at the Facultad de Ingeniera y Ciencias at Universidad Adolfo Ibáñez, since 2007. He is an engineer in applied mathematics (Universidad de Chile). He received his Ph.D. degree in computer science (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 Departamento de Ingeniería Matemática (DIM), Univ. de Chile (2005-06).

  His research focuses on graph theory, automata theory, combinatorial optimization and operational research. In particular, he works on the optimization of telecommunication and transport networks both for the design and the routing with applications in mining industries, transportation sciences and bioinformatics.

  He participated to several national and international projects : Anillo ACT-08, Anillo ACT-88, Basal-CMM, Fondecyt 1060825, Fondef D05I10211, Fondef D06I1031, Fondef D11I1002, Stic-Amsud 09STIC03. He has also collaborations with Argentina, Brazil, USA, France, Uruguay.

  Selected Publications:

  1. Alexandre S. Freire, Eduardo Moreno, Juan Pablo Vielma, An integer linear programming approach for bilinear integer programming. Oper. Res. Lett. 40(2): 74-77, 2012.
  2. Renaud Chicoisne, Daniel G. Espinoza, Marcos Goycoolea, Eduardo Moreno, Enrique Rubio, A New Algorithm for the Open-Pit Mine Production Scheduling Problem. Operations Research 60(3): 517-528, 2012.
  3. Guido Lagos, Daniel G. Espinoza, Eduardo Moreno, Jorge Amaya, Robust Planning for an Open-Pit Mining Problem under Ore-Grade Uncertainty. Electronic Notes in Discrete Mathematics 37: 15-20, 2011.
  4. Eduardo Moreno, Daniel G. Espinoza, Marcos Goycoolea, Large-scale multi-period precedence constrained knapsack problem: A mining application. Electronic Notes in Discrete Mathematics 36: 407-414, 2010.
  5. Martn Matamala, Eduardo Moreno, Minimum Eulerian circuits and minimum de Bruijn sequences. Discrete Mathematics 309(17): 5298-5304, 2009.

6.3 Other references

List the other references used in Section 2.

[**AG06**] I. Abraham and C. Gavoille Object Location Using Path Separators In 25th Annual ACM Symposium on Principles of Distributed Computing (PODC), ACM, pp. 188-197, 2006.

[**AGM06**] I. Abraham, C. Gavoille and D. Malkhi. On Space-Stretch Trade-Offs: Lower Bounds. In 18th ACM Symp. on Parallel Alg. and Architectures (SPAA), pp. 217-224, 2006.

[**AGMW10**] I. Abraham, C. Gavoille, D. Malkhi and U. Wieder. Strong-Diameter Decompositions of Minor Free Graphs. Theory of Comp. Syst., Vol. 47(4), pp. 837-855, 2010.

[**Albert02**] R. Albert and A.-L. Barabsi, Statistical mechanics of complex networks, Reviews of Modern Physics, vol.74, pp.47-97, 2002.

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