

CURRICULUM VITAE

Lastname : Fortz

Firstname : Bernard

Place of Birth : Namur (Belgium)

Date of Birth : May 31, 1971

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Education

1989-1993 : Facultés Universitaires Notre-Dame de la Paix, Namur
Licence en Sciences Mathématiques (B. Sc. Math.)

1993-1998 : Université Libre de Bruxelles
Doctorat en Recherche Opérationnelle (Ph. D. in Operations Research)
Director : Prof. Martine Labbé.
Title : “**Design of survivable networks with bounded rings**”

Professional activities

October 2014 - now: Professor (professeur).
Université Libre de Bruxelles, Belgium.

October 2006 - September 2014: Associate professor (chargé de cours).
Université Libre de Bruxelles, Belgium.

October 2006 - September 2008: Invited professor.
Université Catholique de Louvain, Belgium.

September 2000 - September 2006: Associate professor (chargé de cours).
Université Catholique de Louvain, Belgium.

January 2000 - August 2000: Post-doctoral researcher.
Maastricht University, The Netherlands.

February 1999 - April 1999: Consultant researcher.
AT&T Labs Research, Florham Park, NJ, USA.

October 1993 - August 2000: Researcher and teaching assistant.
Université Libre de Bruxelles, Belgium.

Publications

- [1] Q. Botton, B. Fortz, and L. Gouveia. **On the hop-constrained survivable network design problem with reliable edges.** *Computers & Operations Research*, 64(0):159 – 167, 2015.
- [2] B. Fortz. **Location Problems in Telecommunications.** In G. Laporte, S. Nickel, and F. Saldanha da Gama, editors, *Location Science*, pages 537–554. Springer International Publishing, 2015.
- [3] B. Fortz and D. Papadimitriou. **Branch-and-cut strategies for a multi-period network design and routing problem.** In *Control, Decision and Information Technologies (CoDIT), 2014 International Conference on*, pages 128–133, Nov 2014.

- [4] D. Papadimitriou and B. Fortz. **Reliability-dependent combined network design and routing optimization.** In *Reliable Networks Design and Modeling (RNDM), 2014 6th International Workshop on*, pages 31–38, Nov 2014.
- [5] B. Fortz, L. Gouveia, and M. Moniz. **Mathematical Programming Models for Traffic Engineering in Ethernet Networks Implementing the Multiple Spanning Tree Protocol.** In *Combinatorial Optimization - Third International Symposium, ISCO 2014, Lisbon, Portugal, March 5-7, 2014, Revised Selected Papers*, pages 242–254, 2014.
- [6] D. Papadimitriou and B. Fortz. **Methods for time-dependent combined network design and routing optimization.** In *IEEE Global Communications Conference, GLOBECOM 2014, Austin, TX, USA, December 8-12, 2014*, pages 1303–1309, 2014.
- [7] D. Papadimitriou and B. Fortz. **Time-dependent combined network design and routing optimization.** In *IEEE International Conference on Communications, ICC 2014, Sydney, Australia, June 10-14, 2014*, pages 1124–1130, 2014.
- [8] A. Altin, B. Fortz, M. Thorup, and H. Ümit. **Intra-domain traffic engineering with shortest path routing protocols.** *Annals of Operations Research*, 204:65–95, 2013.
- [9] Q. Botton, B. Fortz, L. Gouveia, and M. Poss. **Benders Decomposition for the Hop-Constrained Survivable Network Design Problem.** *INFORMS Journal on Computing*, 25(1):13–26, 2013.
- [10] P. Carroll, B. Fortz, M. Labbé, and S. McGarraghy. **A branch-and-cut algorithm for the ring spur assignment problem.** *Networks*, 61(2):89–103, 2013.
- [11] B. Fortz, M. Labbé, F. Louveaux, and M. Poss. **Stochastic binary problems with simple penalties for capacity constraints violations.** *Mathematical Programming*, 138:199–221, 2013.
- [12] B. Fortz, M. Labbé, and A. Violin. **Dantzig-Wolfe Reformulation for the Network Pricing Problem with Connected Toll Arcs.** *Electronic Notes in Discrete Mathematics*, 41(0):117 – 124, 2013.
- [13] A. Altin, B. Fortz, and H. Ümit. **Oblivious OSPF routing with weight optimization under polyhedral demand uncertainty.** *Networks*, 60(2):132–139, 2012.
- [14] E. Amaldi, M. Bruglieri, and B. Fortz. **On the Hazmat Transport Network Design Problem.** In Julia Pahl, Torsten Reiners, and Stefan Voß, editors, *Network Optimization*, volume 6701 of *Lecture Notes in Computer Science*, pages 327–338. Springer Berlin Heidelberg, 2011.
- [15] P. Carroll, B. Fortz, M. Labbé, and S. McGarraghy. **Improved Formulations for the Ring Spur Assignment Problem.** In Julia Pahl, Torsten Reiners, and Stefan Voß, editors, *Network Optimization*, volume 6701 of *Lecture Notes in Computer Science*, pages 24–36. Springer Berlin Heidelberg, 2011.

- [16] B. Fortz. **Applications of meta-heuristics to traffic engineering in IP networks.** *International transactions in Operational Research*, 18(2):131–147, 2011.
- [17] B. Fortz and L. Brotcorne. **Editorial: Preface to the Special Issue.** *Networks*, 58(2):81–82, 2011.
- [18] B. Fortz and H. Ümit. **Efficient techniques and tools for intra-domain traffic engineering.** *International Transactions in Operational Research*, 18(3):359–376, 2011.
- [19] E. Amaldi, B. Fortz, and C. Iuliano. **On Finding a Minimum Weight Cycle Basis with Cycles of Bounded Length.** In *CTW'2010*, pages 5–8, 2010. Cologne, Germany.
- [20] A. Bley, B. Fortz, E. Gourdin, K. Holmberg, O. Klopfenstein, M. Pióro, A. Tomaszewski, and H. Ümit. **Optimization of OSPF Routing in IP Networks.** In A. M. C. A. Koster and X. Muñoz, editors, *Graphs and Algorithms in Communication Networks: Studies in Broadband, Optical, Wireless and Ad Hoc Networks*, chapter 8, pages 199–240. Springer, 2010.
- [21] B. Fortz and L. Gouveia. **Editorial.** *Networks*, 55:169–170, 2010.
- [22] B. Fortz, M. Labbé, and M. Poss. **A branch-and-cut-and-price framework for convex MINLP applied to a stochastic network design problem.** In *European Workshop on Mixed Integer Nonlinear Programming*, 2010. Marseille, France.
- [23] B. Fortz and M. Poss. **Easy distributions for combinatorial optimization problems with probabilistic constraints.** *Oper. Res. Lett.*, 38(6):545–549, 2010.
- [24] G. Strack, B. Fortz, and F. Riane. **Comparison of Heuristics Procedures for An Integrated Model for Production and Distribution Planning in an Environment of Shared Resources.** In *Proc. 8ème Congrès International de Génie Industriel*, June 2009.
- [25] G. Strack, B. Fortz, and F. Riane. **Heuristic Approaches for Integrated Production and Distribution Planning.** In *Proc. Industrial Engineering and Systems Management (IESM) 2009*, May 2009.
- [26] A. Altin, B. Fortz, and H. Ümit. **Oblivious OSPF routing with weight optimization under polyhedral demand uncertainty.** In *Proc. INOC 2009*, April 2009.
- [27] A. Altin, B. Fortz, M. Thorup, and H. Ümit. **Intra-domain traffic engineering with shortest path routing protocols.** *4OR*, 7(4):301–335, 2009.
- [28] B. Fortz and M. Poss. **An improved Benders decomposition applied to a multi-layer network design problem.** *Oper. Res. Lett.*, 37(5):359–364, 2009.
- [29] Q. Botton and B. Fortz. **Extended Node-Arc Formulation for the K-Edge-Disjoint Hop-Constrained Network Design Problem.** In *Proc. INOC 2007*, April 2007.

- [30] H. Ümit and B. Fortz. **Fast Heuristic Techniques for Intra-Domain Routing Metric optimization.** In *Proc. INOC 2007*, April 2007.
- [31] B. Fortz and M. Thorup. **A primal-dual approach for the IGP weight setting problem.** In *Proc. 8th INFORMS Telecommunication Conference*, March 2006.
- [32] S. Cerav-Erbas, O. Delcourt, B. Fortz, and B. Quoitin. **The interaction of IGP weight optimization with BGP.** In *The international Conference on Internet Surveillance and Protection (ICISP)*, Cap Estérel, France, 29-31 Aug. 2006. IEEE Computer Society.
- [33] B. Fortz and M. Labbé. **Design of survivable networks.** In M.G.C. Resende and P.M. Pardalos, editors, *Handbook Of Optimization In Telecommunications*, chapter 15, pages 367–389. Springer, 2006.
- [34] B. Fortz, A.R. Mahjoub, S.T. Mc Cormick, and P. Pesneau. **Two-edge connected subgraphs with bounded rings: Polyhedral results and Branch-and-Cut.** *Mathematical Programming*, 105:85–111, 2006.
- [35] L. De Giovanni, B. Fortz, and M. Labbé. **A Lower Bound for the Internet Protocol Network Design Problem.** In L. Gouveia, editor, *Proc. INOC 2005*, pages 401–407, March 2005.
- [36] B. Fortz and M. Labbé. **Two-connected networks with rings of bounded cardinality.** *Computational Optimization and Applications*, 27(2):123–148, 2004.
- [37] B. Fortz and M. Thorup. **Increasing Internet Capacity Using Local Search.** *Computational Optimization and Applications*, 29(1):13–48, 2004.
- [38] B. Fortz and M. Thorup. **Robust optimization of OSPF/IS-IS weights.** In W. Ben-Ameur and A. Petrowski, editors, *Proc. INOC 2003*, pages 225–230, October 2003.
- [39] B. Fortz, P. Soriano, and C. Wynants. **A Tabu Search Algorithm for Self-Healing Ring Network Design.** *European Journal of Operational Research*, 151(2):280–295, 2003.
- [40] B. Fortz. **On the evaluation of the reliability of OSPF routing in IP networks.** In *Proc. SSGRR 2002w International Conference - Advances in Infrastructure for e-Business, e-Education, e-Science, and e-Medicine on the Internet*, January 2002.
- [41] C. Allal, B. Colson, and B. Fortz. **A Park & Ride integrated system.** In M. Patriksson and M. Labbé, editors, *Transportation Planning, State of the Art*, chapter 13, pages 213–228. Kluwer Academic Publishers, 2002.
- [42] B. Fortz and M. Labbé. **Polyhedral results for two-connected networks with bounded rings.** *Mathematical Programming*, 93(1):27–54, 2002.
- [43] B. Fortz, J. Rexford, and M. Thorup. **Traffic Engineering with Traditional IP Routing Protocols.** *IEEE Communications Magazine*, 40(10):118–124, 2002.

- [44] B. Fortz and M. Thorup. **Optimizing OSPF/IS-IS Weights in a Changing World.** *IEEE Journal on Selected Areas in Communications*, 20(4):756–767, 2002.
- [45] B. Fortz. *Design of Survivable Networks with Bounded Rings*, volume 2 of *Network Theory and Applications*. Kluwer Academic Publishers, 2000.
- [46] B. Fortz, M. Labbé, and F. Maffioli. **Solving the two-connected network with bounded meshes problem.** *Operations Research*, 48(6):866–877, 2000.
- [47] B. Fortz and M. Thorup. **Internet Traffic Engineering by Optimizing OSPF Weights.** In *Proc. 19th IEEE Conf. on Computer Communications (INFOCOM)*, pages 519–528, 2000.
- [48] P. Soriano, C. Wynants, R. Séguin, M. Labbé, M. Gendreau, and B. Fortz. **Design and dimensioning of survivable SDH networks.** In P. Soriano and B. Sansò, editors, *Telecommunications network planning*, chapter 9, pages 147–168. Kluwer Academic Publishers, 1999.
- [49] B. Fortz, M. Labbé, and F. Maffioli. **Methods for designing reliable networks with bounded meshes.** In V. Ramaswami and P.E. Wirth, editors, *Teletraffic Contributions for the Information Age*, volume 2a of *Teletraffic Science and Engineering*, pages 341–350. Elsevier, 1997.

Participation to conferences as plenary speaker

2010: EWGLA 2010, Naples, Italy.

2009: EUMEeting 2009, Porto, Portugal.

2004: ALGOTEL'04, Batz-sur-Mer, France.

Invitation as speaker for seminars

- Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany, March 2015.
- University of Liège
Liège, Belgium, March 2015.
- University College Dublin
Dublin, Ireland, March 2015.
- Politecnico di Milano
Milan, Italy, February 2015.
- COMEX Workshop, CIRRELT
Montreal, Canada, November 2014.
- Operations Research Department, University of Maastricht
Maastricht, Netherlands, June 2013.

- University of Linköping
Linköping, Sweden, November 2012.
- University of Aveiro
Aveiro, Portugal, May 2011.
- LIPN, Université de Paris Nord
Paris, France, February 2011.
- CORE, Université Catholique de Louvain
Louvain-la-Neuve, Belgium, December 2009.
- Institut d'Informatique et du Groupe Informatique et Gestions de l'Université de Mons
Mons, Belgium, June 2009.
- LAAS-CNRS
Toulouse, France, July 2008.
- Operations Research Department, University of Maastricht
Maastricht, Netherlands, November 2003.
- CORE, Université Catholique de Louvain
Louvain-la-Neuve, Belgium, October 2001.
- Université Blaise Pascal - Clermont-Ferrand
Clermont-Ferrand, France, April 2001.
- I.A.G., Université Catholique de Louvain
Louvain-la-Neuve, Belgium, March 2001.
- CERTI, Université Catholique de Louvain
Louvain-la-Neuve, Belgium, February 2001.
- Université Blaise Pascal - Clermont-Ferrand
Clermont-Ferrand, France, June 2000.
- Philips Research
Eindhoven, Netherlands, November 1999.
- C.R.T.
Montréal, Canada, March 1999.
- Operations Research Department, University of Maastricht
Maastricht, Netherlands, September 1997.
- Politecnico di Milano
Milan, Italy, February 1995.
- C.R.T.
Montréal, Canada, December 1994.

Supervision of PhD theses

Completed:

- Maria Govorun, “Pension and health insurance phase-type modeling” (ULB, 2013)
- Co-promotor: G. Latouche
- Géraldine Strack, “An integrated decision making process: An application on warehouse, inventory, production and distribution decisions” - 2012 - Co-promotor: F. Riane
- Michael Poss: “Stochastic optimization and network design” - 2011 - Co-promotors: M. Labbé and F. Louveaux.
- Quentin Botton, “Decomposition Methods for the Optimization of Survivable Telecommunications Networks” - 2010 (UCL) - Co-promotor: Ph. Chevalier
- Hakan Ümit, “Techniques and Tools for Intra-domain Traffic Engineering” - 2009 (UCL) - Co-promotor: Ph. Chevalier

In progress:

- Luciano Porretta, “Models and methods for the study of genetic associations”
- Martim Moniz, “Traffic engineering in Ethernet networks”
- Fabio Sciamannini, “Exact algorithms for variants of the coloring”

Supervision of Postdoctoral researchers

- Markus Leitner (ULB, 2015-now)
- Enrico Gorgone (ULB, 2013-now)
- Fauto Pascali (ULB, 2009-2010)
- Aysegül Altin (ULB, 2008)
- Selin Cerav (UCL, 2004-2005)
- Pierre Pesneau (UCL, 2003-2004)

Jurys of PhD theses

- “Bi-Objective Network Design”, Markus Sinnl, University of Vienna, 2015. Promotors: Ivana Ljubić, Immanuel Bonze.
- “Optimisation dynamique des réseaux IP/MPLS”, Josselin Vallet, LAAS-CNRS, Université de Toulouse, 2015. Promotors: Olivier Brun, Balakrishna J. Prabu.
- “Mathematical programming approaches to pricing problems”, Alessia Violin, ULB, 2014. Promotors: Martine Labbé, Lorenzo Castelli.

- “Population-based Heuristic Algorithms for Continuous and Mixed Discrete-Continuous Optimization Problems”, Tianjun Liao, ULB, 2013. Promoters: Marco Dorigo et Thomas Stützle.
- “Multipath Selection for Resilient Network Routing” (external examiner), Nayyar Almas Kazmi, University of Warwick, 2013. Promoters: Jürgen Branke and Arie M.C.A. Koster
- “Shortest Path Routing — Modelling, Infeasibility and Polyhedra” (opponent), Mikael Call, Linköping University, 2012. Promoter: Kaj Holmberg.
- “Traffic engineering techniques for data center networks”, Trong Viet Ho, UCL, 2012. Promoters: Yves Deville, Olivier Bonaventure.
- “Optimisation de l’intégrale de Choquet pour le calcul de plus courts chemins multi-objectifs préférés”, Hugo Fouchal, Université de Nantes, 2011. Promoter: Xavier Gandibleux.
- “Incremental Social Learning in Swarm Intelligence Systems”, Marco A. Montes de Oca Roldán, ULB, 2011. Promoter: Marco Dorigo.
- “An Integer Programming Approach to Layer Planning in Communication Networks”, Aykut Özsoy, ULB, 2011. Promoter: Martine Labbé.
- “Supervisory control of infinite state systems under partial observation”, Gabriel Kalyon, ULB, 2010. Promoter: Thierry Massart.
- “Advances in robust combinatorial optimization and linear programming”, Martha Salazar Neumann, ULB, 2010. Promoter: Martine Labbé.
- “Estimation-based Metaheuristics for Stochastic Combinatorial Optimization: Case Studies in Stochastic Routing Problems”, Prasanna Balaprakash, ULB, 2010. Promoter: Marco Dorigo.
- “Sélection Séquentielle en Environnement Aléatoire Appliquée à l’Apprentissage Supervisé”, Olivier Caelen, ULB, 2009. Promoter: Gianluca Bontempi.
- “A Multi-Agent Framework for Developing Adaptable and Open Service Oriented Systems”, Youssef Achbany, UCL, 2009. Promoters: Manuel Kolp et Marco Saerens.
- “Contributions to Traffic Engineering and Resilience in Computer Networks”, Simon Balon, Université de Liège, 2008. Promoter: Guy Leduc.
- “Models and Methods in Molecular Phylogenetics”, Daniele Catanzaro, ULB, 2008. Promoter: Martine Labbé.
- “Network pricing problems: complexity, polyhedral study and solution approaches”, Géraldine Heilporn, ULB, 2008. Promoter: Martine Labbé.
- “Estimation du trafic, planification et optimisation des ressources pour l’ingénierie des réseaux IP/MPLS” (rapporteur), Cédric Fortuny, Université Toulouse III - Paul Sabatier, 2008. Promoter: Jean-Marie Garcia.

- “Interdomain traffic engineering with MPLS”, Cristel Pelsser, UCL, 2006. Promotor: Olivier Bonaventure.
- “BGP-based interdomain traffic engineering”, Bruno Quoitin, UCL, 2006. Promotor: Olivier Bonaventure.
- “Reverse Engineering of Declarative User Interfaces”, Laurent Bouillon, UCL, 2006. Promotor: Jean Vanderdonckt.
- “Design of survivable networks with bounded-length paths”, David Huygens, ULB, 2005. Promotor: Martine Labbé.
- “Optimization of multimedia flows over data networks : the core location problem and the peakedness characterization”, Jean-François Macq, UCL, 2005. Promotors: Benoît Macq et Laurence Wolsey.
- “Pricing in Networks”, Anton F. van der Kraaij, Universiteit Maastricht, 2004. Promotor: Stan Van Hoesel.
- “Implications of traffic characteristics on interdomain traffic engineering”, Steve Uhlig, UCL, 2004. Promotor: Olivier Bonaventure.
- “Exploring structure and reformulations in different integer programming algorithms”, Quentin Louveaux, UCL, 2004. Promotor: Laurence Wolsey.
- “Conception de réseaux 2-connexes avec contraintes de bornes” (rapporteur), Pierre Pesneau, Université Blaise Pascal - Clermont-Ferrand II, 2003. Promotor: Ali Ridha Mahjoub.
- “A Solution Approach of Production Planning Problems based on Compact Formulations for Single-Item Lot-Sizing Models”, Mathieu Van Vyve, UCL, 2003. Promotor: Yves Pochet et Laurence Wolsey.
- “Optimisation du routage dans les réseaux internet avec qualité de service” (rapporteur), Nawal Bourquia, Université Paris IX Dauphine, 2003. Promotors: Pierre Tolla et Eric Gourdin.
- “Optimisation des réseaux, routage et dimensionnement” (rapporteur), Matthieu Rombaut, Université de Versailles, 2003. Promotors: Gérard Hébuterne, Michel Priem.
- “Stronger Mixed 0-1 Models for Lot Sizing Problems”, Marko Loparic, UCL, 2001. Promotor: Laurence Wolsey.
- “Formulations and algorithms for fixed charge networks and lot-sizing problems”, Francisco Ortega, UCL, 2001. Promotor: Laurence Wolsey.

Distinctions and awards

- Winner of the AT&T Research Prize 1997.
- “Concours Bourses de Voyage” - Communauté Française de Belgique, 1993.

Patents

- US Patent 7185104 (February 2, 2007): Methods and systems for optimizing network traffic
Inventors: Thorup; Mikkel (Florence, MA); Fortz; Bernard (Cortil-Wodon, BE)
Assignee: AT&T Corp. (New York, NY)
- US Patent 6829220 (December 7, 2004): Methods And Systems For Fast Optimization Of Network Traffic
Inventors: Thorup; Mikkel (Florence, MA); Fortz; Bernard (Cortil-Wodon, BE)
Assignee: AT&T Corp. (New York, NY)

Editorial activities

- Guest editor of two special issues of “EURO Journal on Computational Optimization (EJCO)” (2013 and 2015).
- Guest editor of two special issues of *Networks* (INOC 2007, GOM 2008).
- Associate editor of *INFORMS Journal on Computing* since 2007.

Conferences organization

- Member of the program committee of the International Network Optimization Conference (INOC 2015), Warsaw, Poland.
- Member of the program committee of ICORES 2015, Lisbon, Portugal, January 2015.
- Member of the program committee of IFORS 2014, Barcelona, Spain, July 2014.
- Member of the program committee of ISCO 2014, Lisbon, Portugal, March 2014.
- Member of the program committee of INFORMS Telecommunications conference, Lisbon, Portugal, March 2014.
- Member of the program committee of ICORES 2014, Angers, France, March 2014.
- Member of the program committee of the International Network Optimization Conference (INOC 2013), Tenerife, Spain, May 2013.
- Member of the program committee of ICORES 2013, Barcelona, Spain, February 2013.
- Member of the program committee of ICORES 2012, Vilamoura, Portugal, February 2012.

- Organizer of ORBEL 26, Brussels, February 2012.
- Member of the program committee of the Triennial conference of the International Federation of Operations Research Societies (IFORS 2011), Melbourne, July 2011.
- Member of the program committee of the International Network Optimization Conference (INOC 2011), Hamburg, June 2011.
- Member of the program committee of the International Network Optimization Conference (INOC 2009), Pisa, April 2009.
- Organizer of the Graphs and Optimization Meeting 2008 (GOM 2008), Saint-Maximim La Sainte Baume, August 2008.
- Member of the program committee of the Triennial conference of the International Federation of Operations Research Societies (IFORS 2008), Sandton, July 2008.
- Member of the program committee of the 6th International Workshop on Design and Reliable Communication Networks (DRCN 2007), La Rochelle, October 2007.
- Organizer and program chair of the International Network Optimization Conference (INOC 2007), Spa, April 2007.
- Member of the program committee of the Triennial conference of the International Federation of Operations Research Societies (IFORS 2005), Hawaii, July 2005.
- Member of the program committee of the International Network Optimization Conference (INOC 2005), Lisbon, March 2005.
- Member of the scientific committee of Orbel from 1999 to 2010.
- Organizer of ORBEL 19, Louvain-la-Neuve, January 2005.
- Member of the organizing committee of Combinatorial Optimization 98, Brussels, April 1998.

Miscellaneous activities

1995- : Member of the board of administration of ORBEL (Belgian OR Society).

2003- : SOGESCI representative for EURO and IFORS.

2005- : Coordinator of EURO Working Group: “European Network Optimization Group (ENOG)”.

2006- : Treasurer of ORBEL.

2008-2012: INFORMS Telecom Section: Member of Council.

2008: Expert (hired by Belpex) in the evaluation panel of algorithms for the electricity markets, in view of the merge of the French, German, Dutch and Belgian markets.

2009 and 2014: Vice-president of the Computer Science Department, Faculty of Science, ULB.

2010-2013 : President of the Computer Science Department, Faculty of Science, ULB.

2015- Co-director of INRIA team “INtegrated Optimization with Complex Structure” (INOCS).

Research interests

- Decomposition methods for combinatorial optimization problems
- Bi-level programming
- Meta-heuristics
- Design of telecommunications networks
- Traffic engineering in IP networks