

CEOC

Centro de Estudos em Optimização e Controlo
(Centre for Research in Optimization and Control)

Optimization, Graph Theory and Combinatorics

Scientific Reports 2003-2005

Universidade de Aveiro
Departamento de Matemática

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Scientific report 2003

1. Optimization, graph theory and combinatorics

1.1 Activities during 2003

During 2003, part of a Portuguese book on discrete mathematics organized in four parts: I - General concepts and general results; II - Combinatorics; III - Algebraic combinatorics; IV - Graph theory and algorithms, was written by Domingos M. Cardoso, Jerzy Szymanski (from Adam Mickiewicz University, Poznan, Poland) and Mohammad Rostami (from Universidade da Beira Interior). Also a MSc course was prepared in cooperation with Adam Mickiewicz University (namely, Michal Karonski and Jerzy Szymanski) and Universitat Politcnica de Catalunya (namely, Marc Noy and Oriol Serra). Several results about Laplacian and adjacency eigenvalues and eigenvectors and their relations with (k, τ) -regular sets were obtained, namely in the framework of strongly regular graphs (this research was done in cooperation with Charles Delorme from University of Paris-Sud, Orsay, and the results were submitted for publication). Agostinho Agra (supervised by Miguel Constantino from Universidade de Lisboa), Cristina Requejo (supervised by Luís Gouveia from Universidade de Lisboa) and Paula Carvalho (supervised by António Guedes de Oliveira from Universidade do Porto) finishing their PhD dissertations. Some results relating the convex quadratic upper bound for the stability number with the Lovasz theta number were obtained and submitted for publication. Some relations between the optimal parameter of a self-concordant barrier over a symmetric cone, the Carathéodory number of the cone and the rank of every underlying Euclidean Jordan algebra were also obtained and submitted for publication (this research was done in cooperation with Luís A. Vieira from Universidade do Porto which are finishing his PhD dissertation under the supervision of Domingos M. Cardoso). A multi-attribute ranking solution procedure was developed and applied to confirm the results obtained by a multi-attribute ranking decision methodology on a tender for the supply of buses to the Porto Public Transport Operator (STCP) (this research was done in cooperation with Jorge F. Sousa from Universidade do Porto and submitted for publication). An algorithm of dynamic

step size adaptation was constructed that allows to increase the step size when the algorithm is relatively far from the solution, in the 'deterministic' phase, and to decrease it in the 'stochastic' phase, when the algorithm is near the solution. The algorithm allows to increase efficiency significantly on the 'transient' stage. Convergence almost surely of the algorithm is proved. We have demonstrated the second order sufficient optimality conditions for nonlinear programming problems with mixed constraints that in the case of abnormal extrema guarantee isolatedness of extremal point in the admissible set.

Essentially foundational studies were made with attempts at approximate minimization via embeddings in hyperfinite-dimensional normed spaces as well as from hyperfinite families of curves hereby including versions of min-max theorems for finite dimensional spaces, in collaboration with Maria João Borges of the IST, in Lisbon. Preparatory studies about generalized manifolds were made by the beginning PhD student Ricardo Almeida and were presented at the weekly task seminar.

1.2 Output indicators

Number of Publications	2003
Books	1
Papers in international journals	4
Papers in national journals	1
Number of Communications	
in International Meetings	10
in National Meetings	2
Reports	10
Organization of seminar and conferences	10
Advanced training	
number of PhD theses	0
number of Master theses	4

1.3 List of publications

- **Books**

1. A. Batel Anjo, Ricardo Fernandes e A. Simões Carvalho, "Curso de MatLab", Principia - Publicações Universitárias e Científicas, 2003.

- **Articles in International Journals (including book chapters)**

1. Domingos M. Cardoso, "On graphs with stability number equal to the optimal value of a convex quadratic program", *Matemática Contemporânea*, 25 (2003): 9-25.
2. Domingos M. Cardoso and Jorge F. Sousa, "Numerical tools for multiattribute ranking problems", *Networks*, 41, 4 (2003): 229-234.

3. Jürg Hüster, Pedro Cruz, Andreia Hall, Carlos M. Fonseca, "On optimization and extreme value theory. Methodology and computing in applied probability, 5 (2003): 183-195.
4. Rosa A. Martins and João F. Queiró, "2-widths of Hölder unit balls", *Linear Algebra and its Applications*, 361 (2003): 245-255.

- **Articles in National Journals (including book chapters)**

1. Carlos J. Luz, "The graph bisection minimization problem", *Investigação Operacional*, 23 (2003): 85-101.

1.4 List of talks

- **Talks at International Conferences**

1. Agostinho Agra and Miguel Constantino, "MIP cuts based on knapsaks with 2 integer variables", 18th International Symposium on Mathematical Programming, August 18-22, 2003, Copenhagen, Denmark.
2. Domingos M. Cardoso, "Graphs with convex- QP stability number", 18th International Symposium on Mathematical Programming, August 18-22, 2003, Copenhagen, Denmark.
3. Domingos M. Cardoso, Charles Delorme and Paula Rama, "On Laplacian eigenvectors and eigenvalues an almost equitable partitions", *Combinatorics in Oporto*, September 12-17, 2003, Porto, Portugal.
4. Domingos M. Cardoso e Maria H. Silva, "Abordagens analíticas de um problema combinatório de descodificação de imagens", *Congresso Galego de Estatística e Investigación de Operacións*, November 5-7, 2003, Vigo, Spain.
5. Luís Gouveia, Thomas Magnanti and Cristina Requejo, "An intersecting tree model for odd-diameter-constrained minimum spanning and steiner trees", *INOC 2003*, October 27-29, Evry/Paris, France.
6. Luís Gouveia, Thomas Magnanti and Cristina Requejo, "MA 2-paths approach for odd-diameter-constrained minimum spanning and steiner trees", 18th International Symposium on Mathematical Programming, August 18-22, 2003, Copenhagen, Denmark.
7. Natália Martins and Vítor Neves, "Nonstandard Discrete Derivatives and Existence Theorems for ODES", *Second European Junior Meeting on Control Theory and Stabilization*, December 2003, University of Torino, Italy.
8. Rommel Barbosa and Domingos M. Cardoso, "On a subclass of well-covered graphs". *Thirty-fourth Southeastern Conference on Combinatorics, Graph Theory, and Computing*, March 3-7, 2003, Boca Raton, Florida, USA.

9. Líliliana Sousa, Helena Galante, A. Batel Anjo, Pedro Hespanha, 'Observing cities' social inequalities: a cartographic case study of Aveiro, Portugal", Vol XX, n. 1, pp: 123–131, The International Journal of Urban Ploicy and Planning, Pergamon, Elsevier, 2003.
10. Vítor Neves, "Nonstandard Calculus of Variations", Variational Analysis and Applications, (June/July 2003), Erice, Sicily.
11. Vítor Neves, "Nonstandard Calculus of Variations", 12th St.Petersburg Summer Meeting in Mathematical Analysis, August 2003.

- **Talks at National Conferences**

1. Domingos M. Cardoso, "Uma abordagem algébrica de grafos fortemente regulares", Sessão de Homenagem ao Professor Mário da Silva Rosa, October 15, 2003, Coimbra, Portugal.
2. Carlos J. Luz e M. Odete Pereira "Análise da Interferência da Variáveis Demográfica e Organizacionais nas Atitudes face à Melhoria da Qualidade", I Jornadas de Gestão e Empreendedorismo, Janeiro 23, Universidade Internacional da Figueira da Foz.

1.5 List of reports (including proceedings)

- 1. Agostinho Agra and Miguel Constantino, "Description of 2-integer continuous knapsack polyhedra", Centro de Investigação Operacional, Working Paper n. 3 (2003): 12 p.
 2. Agostinho Agra and Miguel Constantino, "Lifting 2-integer knapsack inequalities", Optimization Online, Integer programming submissions, August (2003): 33 p.
 3. Alexander Plakhov and Pedro Cruz, "A stochastic approximation algorithm with step size adaptation", Cadernos de Matemática, Universidade de Aveiro, CM03/I-04, 2003.
 4. Carlos J. Luz, "Relating the Lovász theta number with some convex quadratic bounds on the stability number of a graph", Cadernos de Matemática, Universidade de Aveiro, CM03/I-22, 2003).
 5. Domingos M. Cardoso e Luís A. Vieira, "Conceitos e resultados sobre álgebras de Jordan", Cadernos de Matemática, Universidade de Aveiro, CM03/I-20 (2003): 44 p.
 6. Domingos M. Cardoso e Luís A. Vieira, "Representação quadrática de uma álgebra de Jordan", Cadernos de Matemática, Universidade de Aveiro, CM03/I-23 (2003): 31 p.
 7. Domingos M. Cardoso e Luís A. Vieira, "On the optimal parameter of a self concordant barrier over a symmetric cone", Cadernos de Matemática, Universidade de Aveiro, CM03/I-32 (2003): 13 p.

8. Luís Gouveia, Thomas Magnanti and Cristina Requejo, "A 2-path approach for odd-diameter-constrained minimum spanned trees", Centro de Investigação Operacional, Working Paper n. 2 (2003): 25 p.
9. Luís Gouveia, Thomas Magnanti and Cristina Requejo, "An intersecting tree model for odd-diameter-constrained minimum spanning and steiner trees", Proceedings of the International network optimization conference - INOC 2003, pag. 254-260.
10. R. Orlando Isidro, Ricardo Fernandes, Alexandra Bernardo, A. Batel Anjo, J. David Vieira, J. Sousa Pinto, EquaMat2003: descrição da Infra-Estrutura do Sistema de Informação, Cadernos de Matemática, CM03/D-04, Setembro, 2003.

1.6 List of organized seminars and conferences

• Organized seminars

1. Natália Martins, "Uma demonstração não standard do teorema de existência de Caratheodory", Seminários do CEOC, November 28, 2003, Universidade de Aveiro.
2. Paula Rama, "Valores e vectores próprios de laplacianos e partições quase equilibradas de grafos", Seminários do CEOC, October 10, 2003, Universidade de Aveiro.
3. Jayme L. Swarcfiter, "On self-clique graphs", Seminários do CEOC, September 18, 2003, Universidade de Aveiro.
4. Miguel Constantino, "Planeamento integrado da produção e sequenciamento de lotes na indústria de tintas: programação inteira mista, decomposição e programação por restrições", Seminários do CEOC, June 20, 2003, Universidade de Aveiro.
5. Tim Hultberg, "Formulation of linear optimization problems in C++", Seminários do CEOC, June 13, 2003, Universidade de Aveiro.
6. Jerzy Szymanski, "Propriedades de "dags" aleatórios", Seminários do CEOC, May 16, 2003, Universidade de Aveiro.
7. A. Leal Duarte, "Valores próprios múltiplos de matrizes cujo grafo é uma árvore", Seminários do CEOC, April 4, 2003, Universidade de Aveiro.
8. Filipa D. Carvalho, "Contribuições da optimização combinatória na protecção de dados estatísticos", Seminários do CEOC, March 28, 2003, Universidade de Aveiro.
9. Vitor Noeves, "O cálculo de variações estocástico não standard - II", Seminários do CEOC, March 21, 2003, Universidade de Aveiro.
10. Carlos J. Luz, "Relating the Lovász varthteta number with some convex quadratic bounds on the stability number of a graph", Seminários do CEOC, March 7, 2003, Universidade de Aveiro.

1.7 List of PhD and MSc dissertations

- **MSc dissertations**

1. Ana Helena Tavares, "Aspectos Matemáticos da Entropia", Universidade de Aveiro, 2003 (supervisor: António Batel Anjo).
2. António M. V. Rodrigues, "As não conformidades e a inovação", Universidade Aberta, 2003 (supervisor: Carlos J. Luz).
3. Maria H. Silva, "Abordagens analíticas de um problema combinatório de descodificação de imagens", Universidade de Aveiro, 2003 (supervisor: Domingos M. Cardoso).
4. Sandra Pinho, "Optimização Matemática e Entropia", 2003 (supervisor: António Batel Anjo).

Scientific report 2004

2. Optimization, graph theory and combinatorics

2.1 Activities during 2004

- During 2004 the first three parts of a Portuguese book on discrete mathematics was completed in cooperation with Jerzy Szymanski (from Adam Mickiewicz University, Poznan, Poland) and Mohammad Rostami (from Universidade da Beira Interior). Some algorithmic strategies were implemented, in order to get a conclusion about the existence of the fourth graph of Moore (that is, the strongly regular graph with parameters $(3250, 57; 0, 1)$). New relations between the existence of certain regularity conditions of the graph (like the existence of (k, τ) -regular sets and equitable partitions), and its combinatorial structure or adjacency spectrum, are deduced. In addition, new conclusions about the Laplacian eigenvectors and eigenvalues are taken from the existence of almost equitable partitions (which are generalizations of equitable partitions). Application of continuous optimization techniques to the study of combinatorial properties of graphs. Research efforts with some promising results have been made in order to recognize in polynomial time the graphs with convex quadratic stability number. On the other hand, the theoretical relation between convex quadratic bounds and the Lovász theta number was definitively stated. Some generalizations of this relation have been considered. The polyhedral description of several special cases of the integer single node flow set were obtained and these results were submitted for publication. The Diameter-Constrained Steiner Tree Problem is being studied, a communication and the publication on the proceedings book (with referee) was accepted for the *INOC* 2005. Within the framework of the PhD project on Stochastic Approximation of João Pedro /under supervision of Alexander Plakhov), new algorithms with stochastic step size adaptation aiming at the convergence acceleration were studied and submitted for publication. Beyond having organized and participated in two international meetings, some Nonstandard Palais-Smale type conditions were obtained and ap-

plied to various versions of Ambrosetti-Rabinowitz Mountain Pass theorem and established some properties of internal functions that have to do with different kinds of smoothness, both in euclidian spaces and in locally convex spaces. There are also results (new and reformulated) on existence and location of critical points of functionals. Work on manifolds has essentially been collection, organization and adaptation of bibliography and results therein, treated in an informal almost weekly seminar.

During 2004 the following researcher, with joint work with members of CEOC, visited our Mathematics Department.

1. Prof. Jerzy Szymański, Adam Mickiewicz University, Poznan, Poland.
2. Professor Marian Dondajewski, Poznań University of Technology, Piotrowo 3a 60-965 Poznań Poland.

2.2 Output indicators

Number of Publications	2004
Books	0
Papers in international journals	11
Papers in national journals	0
Number of Communications	
in International Meetings	14
in National Meetings	2
Reports	9
Organization of seminar and conferences	14
Advanced training	
number of PhD theses	4
number of Master theses	0

2.3 List of publications

• Articles in International Journals (including book chapters)

1. Alexander Plakhov, Pedro Cruz, A stochastic approximation algorithm with step size adaptation, Journal of Mathematical Sciences (Series of Contemporary Mathematics and Its Applications, Special volume "Aveiro Seminar on Control, Optimization, and Graph Theory"), N.Y. (USA), 120, N.1, (2004): 964-973.
2. Carlos J. Luz, Improving an upper bound on the stability number of a graph, approved for publication in Journal of Global Optimization, on April 2004.
3. Domingos M. Cardoso and Paula Rama, "Equitable bipartitions of graphs and related results", Journal of Mathematical Sciences (Series of Contemporary Mathematics and Its Applications, Special volume "Aveiro Seminar on Control, Optimization, and Graph Theory"), N.Y. (USA), 120, N.1, (2004): 869-880.

4. Domingos M. Cardoso and L. A. Vieira. *Euclidean Jordan algebras with strongly regular graphs*. Journal of Mathematical Sciences (Series of Contemporary Mathematics and Its Applications, Special volume "Aveiro Seminar on Control, Optimization, and Graph Theory"), N.Y. (USA), Vol. 120, N. 1, (2004): 881-894.
5. Domingos M. Cardoso and Jorge F. Sousa. *A Multi-attribute Ranking Solutions Confirmation Procedure*, approved for publication in Annals of OR, on July 2004.
6. L. Gouveia, T. Magnanti and C. Requejo, *A 2-path approach for odd-diameter-constrained minimum spanning and Steiner trees*. Networks, Hoboken (NJ, USA), **44**(4) (2004): 254-265.
7. Natália Martins and Vítor Neves, *Nonstandard discrete derivatives and existence theorems for ODEs*. approved for publication in Rediconti del Seminario Matematico dell'Università e del Politecnico di Torino, Special Issue "Control Theory and Stabilization", on July 2004.
8. Paula Carvalho , A. Guedes de Oliveira, *Intersection and Linking Numbers in Oriented Matroids*, Discrete and Computational Geometry, N.Y. (USA), **31**, n^o2 (2004): 305-321.
9. Rommel Barbosa and Domingos M. Cardoso. *On regular-stable graphs*, Ars Combinatoria, Winnipeg (canada), 70 (2004): 149-159.
10. Tchemisova, T.V. *On the Constructive Solution of Convex Programming Problems in Separable Form*. Journal of Mathematical Sciences (Series of Contemporary Mathematics and Its Applications, Special volume "Aveiro Seminar on Control, Optimization, and Graph Theory"), N.Y. (USA), Vol. 120, N. 1, (2004): 183-202.
11. Vítor Neves, *Nonstandard Calculus of Variations - a survey*, Journal of Mathematical Sciences (Series of Contemporary Mathematics and Its Applications, Special volume "Aveiro Seminar on Control, Optimization, and Graph Theory"), N.Y. (USA), Vol. 120, N. 1, (2004): 940-954.

2.4 List of talks

- **Talks at International Conferences**

1. Agostinho Agra and Miguel Constantino, "Lifting 2-integer knapsack inequalities", AUSSOIS 2004 - International Workshop in Combinatorial Optimization , January 5-9, 2004, Aussois, France.
2. Agostinho Agra and Miguel Constantino, "On the multiple integer knapsack polyhedra", OPTIMIZATION 2004, July 26-28, 2004, Lisbon, Portugal.

3. Carlos Luz, Lovász Theta Number: A New Alternative Definition, SIAM Conference on Discrete Mathematics, June 13-16, 2004, Nashville, EUA.
4. Carlos Luz, Luís Cavique Santos and Sérgio Fernandes, Approximating the Lovász theta number by convex quadratic programming (I), Optimization 2004 July, 25-28, Lisbon.
5. —Approximating the Lovász theta number by convex quadratic programming (II), Optimization 2004 July, 25-28, Lisbon.
6. Cristina Requejo, Luís Gouveia and Thomas Magnanti, *A Disjunctive programming approach for Odd-Diameter-Constrained Minimum Spanning and Steiner Trees*, OPTIMIZATION 2004 - 5th International Conference on Optimization, Lisboa, July 25-28, 2004.
7. Domingos M. Cardoso (2004). *Continuous optimization techniques on graphs*, Workshop on Challenges of Continuous Optimization in Theory and Applications, July 2-3, Rhodes, Greece.
8. Domingos M. Cardoso, C. Delorme and P. Rama (2004). *Eigenvectors and eigenvalues of graphs with regularity constraints*, Conference on Graph Theory in memory of Claude Berge, July 5-9, Paris, France.
9. João N. Clímaco, Domingos M. Cardoso e Jorge F. Sousa (2004). *Reflexões sobre o Ensino da Pesquisa Operacional*, Painel de Educação, organizado por João Carlos C. B. de Mello da Universidade Federal Fluminense, XXXVI - SBPO, Simpósio Brasileiro de Pesquisa Operacional, 23-26 de Novembro, São João del-Rei, MG, Brasil.
10. Natália Martins (presenter) & Vítor Neves, Nonstandard Palais-Smale conditions, First CTS Workshop, Inst. of Systems and Robotics, Univ. of Coimbra Portugal, July 1 to 3, 2004.
11. Natália Martins (presenter) & Vítor Neves, Nonstandard Palais-Smale conditions, Nonstandard Mathematics 2004, Dep. of Math., Univ. of Aveiro Portugal, July 5 to 10, 2004.
12. Natália Martins, Nonstandard proofs of some Critical Point Theorems, Third Junior European Meeting on Control, Optimization and Computation, Dep. of de Math. University of Aveiro, September 6 to 8, 2004.
13. Tatiana Tchemisova, "Abnormal Extrema in Non Linear Programming Problems: Optimality Conditions and Rigidity", Workshop on Challenges of Continuous Optimization in Theory and Applications, July 2-3, Rhodes, Greece.
14. Vítor Neves, The Power of Gâteaux Differentiability, Nonstandard Mathematics 2004, Dep. of Math., Univ. of Aveiro Portugal, July 5 to 10, 2004.

- **Talks at National Conferences**

1. Tatiana Tchemisova, *Uma Abordagem Heurística de um Problema de Optimização de Rotas e Veículos*, April 4-7, 11th APDIO Congress, Porto.
2. D. M. Cardoso e M. H. Silva. *Um modelo combinatorio para codificação de imagens*, 11o Congresso da APDIO, 4-7 de Abril, Porto.

- **Seminars**

1. Ricardo Almeida, Fundamentos da análise não standard (Foundations of Nonstandard Analysis), Univ. Portucalense, Porto, Portugal, March 17, 2004.
2. Agostinho Agra, Descrição poliédrica de conjuntos envolvendo duas variáveis inteiras, CMUC, July 8, 2004, Univ. of Coimbra.
3. Agostinho Agra, "Levantamento de desigualdades válidas para modelos de programação inteira mista elementares", CMUC, October 7, 2004, Univ. of Coimbra.
4. Cristina Requejo (with Luís Gouveia e Thomas Magnanti), *O problema da árvore de suporte com restrições de diâmetro ímpar: modelos de fluxos e modelo de programação disjuntiva*, December 3, 2004, CISUC (Universidade de Coimbra).
5. Cristina Requejo (Luís Gouveia e Thomas Magnanti), *Modelos para o problema da árvore de suporte com restrições de diâmetro ímpar*, September 30, 2004, CMUC (Linha de Análise Numérica e Aplicações - Departamento de Matemática da Universidade de Coimbra).
6. Domingos M. Cardoso (2004). *The class of graphs with convex-QP stability number*, Seminar of Department of Discrete Mathematics, Adam Mickiewicz University, January 6, Poznań, Poland.
7. Domingos M. Cardoso (2004). *Moore graphs and (k, τ) -regular sets*, Seminar on Applied Mathematics, Institute of Mathematics, Poznań University of Technology, January 7, Poznań, Poland.

2.5 List of reports (including proceedings)

- 1. A. Batel Anjo, M. Paula Oliveira, J. Sousa Pinto, Teste Diagnóstico em Matemática - TDMat, Linhas 01, Revista Comemorativa dos 30 anos da Universidade de Aveiro, 2004.
 2. Carlos Luz, Carlos Pais, Vítor Pires, Rui Amaral, João Amaral, João Martins e O.P. Dias, A Strategy To Improve Engineering Teaching Process Based On An E-Learning Approach, Vítor Pires, Rui Amaral, João Amaral, João Martins e O.P. Dias, in Proc. of the ITHET2004 (International Conference on Information Technology Based Higher Education and Training), Istanbul/Turkey, May 31-June 2, 2004.

3. Carlos Luz, Carlos Pais, V. Fernão Pires, Rui Amaral, João Martins and O. P. Dias EDBI - An E-Learning Based Project to Improve Engineering Teaching, in Paul Borza, Luís Gomes and Georghie Scutaru (Eds.) - Proc. of the 1st International Workshop on e-learning and virtual and Remote Laboratories, VIRTUAL-LAB 2004 (in conjunction with ICINCO 2004 Setúbal/Portugal, August 2004).
4. D. Dias Rasteiro, A. Batel Anjo, The maximum expected value of an utility function over a probabilistic network, *Cadernos de Matemática*, CM 04/I – 18, Julho, 2004.
5. Domingos M. Cardoso, C. Delorme and P. Rama (2004). *Eigenvectors and eigenvalues of graphs with regularity constraints*, *Cadernos de Matemática do Departamento de Matemática da Universidade de Aveiro*, CM04/I-9.
6. Natália Martins & Vítor Neves, Nonstandard Discrete derivatives and Existence Theorems for ODEs, *Cadernos de Matemática CM04/I-03*, Dep. de Matemática, Univ. Aveiro Portugal.
7. Rui O. Isidro, A. Batel Anjo, J. Sousa Pinto, Sónia Pais, Computerized Diagnostic Test - The use of Evaluation System and Aided Computer Learning. In Nuno Guimarães e Pedro Isaias, editor, *Proceedings of the IADIS International Conference Applied Computing 2004*, volume I, Lisboa, Portugal, Mar. 2004.
8. T. Kudryk, W. Lyantse, Neves V., Nonstandard Universe based on Internal Set Theory, *North-Holland Math. Studies n. 197 2004*(Proc. of the Int. Conference on Functional Analysis and Applications dedicated to the 110th anniversary of Stefan Banach, May 2002).
9. Sarychev A.V., Tchemisova T.V. Rigidity of Abnormal Extrema in the Problem of Non Linear Programming with Mixed Constraints, *Cadernos de Matemática CM04/I-14*.

2.6 List of organized seminars and conferences

- **Organized seminars**

1. Leonor Moreira (Universidade do Porto), "Aspectos Combinatórios e Geométricos dos Matroides Lagrangeanos", February 6, 2004, Universidade de Aveiro.
2. Ricardo Almeida (Universidade Portucalense), "Variedades diferenciáveis: transformações infinitesimais e espaço tangente", February 13, 2004, Universidade de Aveiro.
3. Tatiana Tchemisova", "Rigidez dos Extremos Anormais em Problemas de Programação Não Linear com Restrições Mistas", CEOC, February 20, 2004, University of Aveiro.

4. Tatiana Tchemisova, "Extremos Anormais em Problemas de Optimização: Rigidez e Condições de Optimalidade de 2a ordem", February 27, 2004, Universidade de Aveiro.
5. Jerzy Szymanski (Adam Mickiewicz University, Poland), "Conjuntos sem soma", March 12, 2004, Universidade de Aveiro.
6. Ricardo Almeida, "Transformações Infinitesimais e Espaço Tangente (II)", March 19, 2004, CEOC, Universidade de Aveiro.
7. Tatiana Tchemisova, "Uma Abordagem Heurística de um Problema de Optimização de Rotas e Veículos", March, 2004, CEOC, Universidade de Aveiro.
8. Rui Isidro (Projecto PmatE), "Do Modelo à Aplicação Final", March 26, 2004, Universidade de Aveiro.
9. Vera Oliveira e Joana Santos, "Uma Abordagem Heurística de um Problema de Optimização de Rotas e Veículos", April 2, 2004, CEOC Universidade de Aveiro.
10. Orestes Cerdeira (Universidade Técnica de Lisboa), "Questões Matemáticas no Traçado de Reservas para a Protecção da Biodiversidade", May 7, 2004, Universidade de Aveiro.
11. Andreas Hamel (Martin-Luther University, Germany), "Setvalued Optimization", October 29, 2004, Universidade de Aveiro.
12. Cristina Requejo (Luís Gouveia e Thomas Magnanti), *A disjunctive programming approach for odd-diameter-constrained minimum spanning trees* November 5, 2004, CEOC (Departamento de Matemática da Universidade de Aveiro).
13. Marian Dondajewski (Poznan University of Technology, Poland), "Plane embedded trees", December 3, 2004, Universidade de Aveiro.

- **Organized conferences**

1. Nonstandard Mathematics 2004, Dep. of Math., Aveiro Portugal, July 5 to 10, 2004.

2.7 List of PhD dissertations

- **PhD dissertations**

1. Agostinho Agra, "Estudo poliédrico de modelos básicos de programação inteira mista e extensões", University of Lisbon, 2004 (supervised by Miguel Constantino).
2. Cristina Requejo, "Modelos para o Problema da Árvore de Suporte com Restrições de Diâmetro: caso do Diâmetro Ímpar", University of Lisbon, 2004 (supervised by Luís Gouveia).

3. Luís António Almeida Vieira, "Barreiras Autoconcordantes e Álgebras de Jordan em Problemas Combinatórios", University of Aveiro, 2004 (supervised by Domingos Moreira Cardoso).
4. Maria Paula Carvalho, "Intersecções e Enlaces em Matróides Orientados", University of Oporto, 2004 (supervised by António Guedes de Oliveira).

Scientific report 2005

3. Optimization, graph theory and combinatorics

3.1 Activities during 2005

- During 2005 the chapters 12-17 of part four of a Portuguese book on discrete mathematics was written, in cooperation with Jerzy Szymanski (from Adam Mickiewicz University, Poznan, Poland) and Mohammad Rostami (from Universidade da Beira Interior). Now, we are finishing the book (writing the last three chapters, about Euler circuits and Hamilton cycles, Colorations in graphs, and planar graphs and generalizations). Furthermore, we develop several results in the following topics: Alternative characterizations of graphs with (k, τ) -regular sets, using the adjacency and Laplacian matrices (namely, for strongly regular graphs). Existence of equitable and almost equitable partitions in graphs. Extensions of the results obtained for graphs with convex- QP stability number to the determination of convex quadratic upper bounds on the size of k -regular induced subgraphs and necessary and sufficient conditions for this upper bound be attained (this study was done in cooperation with Vadim Lozin and Marcin Kamiński from Rutgers University, USA) and also to the study of graphs with least eigenvalue -2 , which are line graphs, generalized line graphs and exceptional graphs (this study was done in cooperation with Dragos Cvetkovic from University of Belgrade, Serbia and Montenegro). Convex quadratic characterization of the Schrijver and McEliece-Rodemich-Rumsey bound on the stability number of a graph. Polyhedral structure of several mixed integer sets such as the single node flow set with constant bounds. Variants of the diameter-constrained Steiner tree problem. Convex semi-infinite programming (SIP) problems, where a new implicit optimality criterion, without the regularity condition requirement (such as, for example, the Slater condition) was proved – given a convex SIP problem, we use the information about its immobile points to construct a nonlinear programming (NLP) problem in the special form and it is proved that an optimal solution of the original (infinite) SIP problem

should be optimal in the correspondent, (finite) NLP problem; additionally, the algorithm of determination of immobile points and the correspondent immobility orders (DIO algorithm) is developed (work in cooperation with Olga Kostyukova, from Institute of Mathematics of Belorussian Academy of Sciences, Belarus). A characterization of Uniform Differentiability of nonstandard hulls of internal maps between Locally Convex spaces was obtained; differentiability with some irregularity was studied and used towards characterization of continuous differentiability of internal maps; some new generalizations of Critical Point theorems for Functionals on Banach spaces as well as nonstandard proofs of min-max Theorems for finite dimensional spaces were achieved and included in Natália Martins' doctorate thesis (submitted in July 2005); work on nonstandard characterization of connectivity was also developed for compact connected sets. Stochastic Approximation, in which a multiplicative step adaptation algorithm was developed. Finally, some neural network empirical experiments with numerical results were done and several computer simulations for parameter estimating, in the field of Extreme Value Theory, were implemented in collaboration with members from UIMA (group of probability and statistics).

In the beginning of 2005 we start the two years project, supported by Programa PESSOA 2005/GRICES, entitled "Algebraic Methods in Graph Theory", in cooperation with several researchers from Paris-Sud University (C. Delorme, P. Bertholomé, D. Forge, and M. Kouider) and from Technical University of Lisbon (J. Cerdeira and R. Cordovil). On the other hand, in 2005 we develop an applied project, in cooperation with Yazaki Saltano de Portugal, C.E.A. Lda, entitled "Optimization of Diversity and Distribution of Cable Configuration for Automobile Industry"(the main goal of the project was the implementation of combinatorial optimization techniques to minimize the diversity of option connection configurations, from an universe determined according to the statistic data about customer preferences and selling expectations, fulfilling global cost requirements, and also to optimize the minimum cost supply of produced configurations, fulfilling the market requirements and a limit number of configurations). This problem was formalized as the minimum arc cost sum spanning star forest of the inclusion relation configuration digraph, with no more than k stars.

During 2005, the following researchers, with joint work with members of OGT&C project, visited our Mathematics Department: Jerzy Szymanski, from Adam Mickiewicz University, Poznan, Poland (September 1-30, 2005); Olga I. Kostyukova, Institute of Matematics, National Academy of Science, Belarus (July 25-August 3, 2005); Charles Delorme, University of Paris-Sud, Orsay, France (July 6-13, 2005); Dragos Cvetkovic, University of Belgrade, Serbia and Montenegro (May 9-19, 2005).

Paula Rama (supervised by Domingos M. Cardoso) and João Pedro Cruz (supervised by Alexander Plakhov) finished their PhD graduations.

3.2 Output indicators

Number of Publications	2005
Books	0
Papers in international journals	12
Papers in national journals	1
Number of Communications	
in International Meetings	6
in National Meetings	3
Reports	10
Organization of seminar and conferences	11
Advanced training	
number of PhD theses	2
number of Master theses	0

3.3 List of publications

- **Articles in International Journals (including book chapters)**

1. A. Agra, M. Constantino, "Description of 2-integer continuous knapsack polyhedra", approved for publication in Discrete Optimization, October 2005.
2. A. Agra, M. Constantino, "Polyhedral description of a mixed integer problem with constant bounds", approved for publication in Mathematical Programming, April 2005.
3. A. Agra, M. Constantino, "On the multiple integer knapsack polyhedra", International Journal of Pure and Applied Mathematics, vol. 5 (2005): 567-585.
4. D. M. Cardoso, P. Rama, "Spectral results on regular graphs with (k, τ) -regular sets", approved for publication in Discrete Mathematics, November 2005.
5. D. M. Cardoso, L. A. Vieira, "On the optimal parameter of a self-concordant barrier over a symmetric cone", Approved for publication in European Journal of Operational Research - EJOR, March 2005.
6. D. M. Cardoso, C. Delorme, P. Rama, "Laplacian eigenvectors and eigenvalues and almost equitable partitions", approved for publication in European Journal of Combinatorics, March 2005.
7. D. M. Cardoso, J. F. Sousa, "A multi-attribute ranking solutions confirmation procedure", Annals of Operations Research, Volume 138, Number 1 (2005): 127-141.
8. G. Dahl, L. Gouveia, C. Requejo, "On formulations and methods for the hop-constrained minimum spanning tree problem", approved for publication in Handbook of Optimization in Telecommunications, edited by M.G.C. Resende and P.M. Pardalos, Springer Science + Business Media, 2005.

9. C. J. Luz, "Improving an upper bound on the stability number of a graph", *Journal of Global Optimization* 31/1 (2005): 61-84.
10. C. J. Luz, A. Schrijver, "A convex characterization of the Lovász theta number", *SIAM J. Discrete Mathematics*, 19/2 (2005): 382-387.
11. N. Martins, V. Neves, "Nonstandard discrete derivatives and existence theorems for ODEs", *Rediconti del Seminario Matematico dell'Università e del Politecnico di Torino*, Special issue "Control Theory and Stabilization I", vol. 63, 4 (2005): 383-395.
12. T. V. Tchemisova, "Rigidity of Abnormal Extrema in Nonlinear Programming Problems with Equality and Inequality Constraints", approved for publication in *European Journal of Operational Research - EJOR*, September 2005.

- **Articles in National Journals**

1. C. J. Luz, "Uma introdução à forma canónica de Jordan", *Boletim da Sociedade Portuguesa de Matemática*, 52 (2005): 27-52.

3.4 List of talks

- **Talks at International Conferences**

1. D. M. Cardoso, "On the maximum cardinality of k-regular induced subgraphs", *INFORMS Annual Meeting*, San Francisco, USA, November 13–16, 2005.
2. D. M. Cardoso, A. Agra, O. Cerdeira, E. Rocha, "Optimization of Diversity and Distribution of Cable Configuration for Automobile Industry", *17th EURO Mini Conference: Continuous Optimization in Industry*, Pécs, Hungary, June 29 - July 1, 2005.
3. D. M. Cardoso, A. Agra, O. Cerdeira, E. Rocha, "A spanning star forest model for the diversity problem in automobile industry", *ECCO XVIII*, Minsk, Belarus, May 26-28, 2005.
4. L. Gouveia, T. Magnanti, C. Requejo, "On a Diameter-Constrained Steiner Tree Problem", *INOC - International Network Optimization Conference*, Lisbon, March 21-23, 2005.
5. A. Agra, M. Constantino, "A special case of the integer single node flow set with upper bounds", *INOC - International Network Optimization Conference*, Lisbon, March 21-23, 2005.
6. Pedro Cruz, "Speeding up backpropagation with multiplicative batch update step", *International Conference on Adaptive and Natural Computing Algorithms in Coimbra – Portugal*, March, 2005.

- **Talks at National Conferences**

1. C. J. Luz, "Caracterização de uma generalização do majorante de Lovász para o número de estabilidade de um grafo baseado em técnicas de programação quadrática", CEOC/CIMA-UE joint meeting on Optimization and Optimal Control, Évora, Portugal, April 22-23, 2005.
2. D. M. Cardoso, L. A. Vieira, "Álgebras de Jordan em Optimização Cónica", CEOC/CIMA-UE joint meeting on Optimization and Optimal Control, Évora, Portugal, April 22-23, 2005.
3. D. M. Cardoso, "A matemática e os seus problemas", Semana da Ciência e Tecnologia, Universidade de Aveiro, 21-27 de Novembro, 2005.

3.5 List of reports (including proceedings)

- 1. Agostinho Agra, Miguel Constantino, "A special case of the integer single node flow set with upper bounds", Proceedings of INOC 2005, Book2, pp. 479-485.
- 2. Alexander Plakhov, Pedro Cruz, "A stochastic approximation algorithm with multiplicative step size adaptation", Cadernos de Matemática, CM 05/I-06, Universidade de Aveiro, 2005.
- 3. Andreia Hall, Pedro Cruz, "Tudo sobre o meu príncipe, o índice extremal: apresentação informal", Actas do XIII Congresso Anual da SPE, 28 Setembro a 1 Outubro de 2005, Ericeira - Portugal.
- 4. L. Gouveia, T. Magnanti, C. Requejo, "On a diameter-constrained Steiner tree problem", Proceedings of the INOC 2005, Book2, pp. 462-469.
- 5. Natália Martins, "Nonstandard proofs of some Critical Point Theorems", Preprints of the Third Junior European Meeting on Control, Optimization and Computation, Cadernos de Matemática CM05/I-04, Universidade de Aveiro, 2005.
- 6. Maria João Borges, Natália Martins, Vítor Neves, João Teixeira, Manfred Wolff, "Mountain Pass Theorems without the Deformation Lemma. I. Finite dimensional spaces", Cadernos de Matemática CM05/I-36, Universidade de Aveiro, 2005.
- 7. Paula Carvalho, "On groebner basis for the ideal of the uniform chi-rotope variety", Cadernos de Matemática, CM 05/I-10, Universidade de Aveiro, 2005.
- 8. Pedro Cruz, "Almost sure convergence and asymptotical normality of a generalization of Kesten's stochastic approximation algorithm for multidimensional case", Cadernos de Matemática, CM05/I-25 Universidade de Aveiro, 2005.
- 9. Pedro Cruz, "Speeding up backpropagation with multiplicative batch update step", International Conference on Adaptive and Natural

Computing Algorithms in Ribeiro, B.; Albrecht, R.F.; Dobnikar, A.; Pearson, D.W.; Steele, N.C. (Eds.), (2005): 22–24, Springer, New York, (ISBN: 3-211-24934-6).

10. Olga Kostyukova, Tatiana Tchemisova, Svetlana Yermalinskaya, "Convex Semi-Infinite Programming: Implicit Optimality criterion based on the concept of immobile points", *Cadernos de Matemática*, CM 05/I-38, Universidade de Aveiro, 2005.

3.6 List of organized seminars and conferences

- **Organized seminars**

1. Isabel Martins (Universidade Técnica de Lisboa), "Modelos de Programação Inteira em Gestão de Florestas com Restrições Espaciais", Seminário do CEOC, Universidade de Aveiro, October 28, 2005.
2. Ricardo Almeida, "Uma abordagem Não Standard ao Teorema do Valor Médio", Seminário do CEOC, Universidade de Aveiro, October 14, 2005.
3. Olga Kostyukova (Institute of Mathematics, National Academy of Sciences of Belarus), "Parametric Optimal Control Problems", Seminário do CEOC, Universidade de Aveiro, July 20, 2005.
4. Charles Delorme (Université de Paris-Sud, ORSAY, FRANCE), "Counting Dyck paths with constraints", Seminário do CEOC, Universidade de Aveiro, June 22, 2005.
5. K. O. Kortanek (University of Pittsburgh, USA), "Using Geometric Programming for Solving Nonstochastic Uncertainty Models in Finance", Seminário do CEOC, Universidade de Aveiro, May 20, 2005.
6. Dragos Cvetkovic (University of Belgrade, Serbia and Montenegro), "Optimization and highly informative graph invariants", Seminário do CEOC, Universidade de Aveiro, May 11, 2005.
7. Dragos Cvetkovic (University of Belgrade, Serbia and Montenegro), "An introduction to the theory of graph spectra", invariants", Seminário do CEOC, Universidade de Aveiro, April 29, 2005.
8. Paula Carvalho, "Bases de Gröbner e Matróides Orientados", Seminário do CEOC, Universidade de Aveiro, March 18, 2005.
9. D. Rasteiro, A. Anjo, "Trajectos Óptimos em Redes com Parâmetros Aleatórios", Univ. de Aveiro, February 18, 2005.
10. João P. Cruz, "Aproximação Estocástica", Seminário do CEOC, Universidade de Aveiro, February 11, 2005.
11. Jerzy Szymanski (Adam Mickiewicz University, Poznan, Poland), "Topologia Digital", Seminário do CEOC, Universidade de Aveiro, January 12, 2005.

3.7 List of PhD dissertations

- **PhD dissertations**

1. Paula Rama, "Propriedades combinatórias e espectrais de grafos com restrições de regularidade", PhD Thesis, University of Aveiro, Universidade de Aveiro, June 2005 (supervised by Domingos Moreira Cardoso).
2. Pedro Cruz, "Stochastic Approximation Algorithms with Adaptive Step Value", PhD Thesis, University of Aveiro, 2005 (supervised by Alexander Plakhov).