



Center for Mathematics and Applications

CMA/FCT/UNL

2017 Report

FCT Fundação
para a Ciência
e a Tecnologia

Funded by Project UID/MAT/00297/2013

NOVA
id**FCT**
Associação para a Inovação
e Desenvolvimento da FCT

Scientific Coordinator

Fabio Augusto da Costa Carvalho Chalub

Executive Commission

Fabio Augusto da Costa Carvalho Chalub

João Nuno G. F. Martins (until August; then) Ana Cristina Malheiro Casimiro

Maria Isabel Azevedo Rodrigues Gomes

Marta Cristina Vieira Faias Mateus

Research Group Coordinators

Algebra and Logic: António José Mesquita da Cunha Machado Malheiro

Analysis: Oleksiy Karlovych

Operations Research: Ana Luísa da Graça Batista Custódio

Statistics and Risk Management: Manuel Leote Tavares Inglês Esquível

Thematic Lines Coordinators

Mathematical modeling for the independent living of elderly, disabled, and chronic patients: Maria Isabel Azevedo Rodrigues Gomes

Mathematical modeling in ecology, evolution and genetics: Jorge Orestes Lasbarreres Cerdeira

External Advisory Commission

Barry Arnold, University of California, USA

Charles R. Johnson, College of William & Mary, USA

Immanuel Bomze, University of Vienna, Austria

Rafael Ortega, University of Granada, Spain

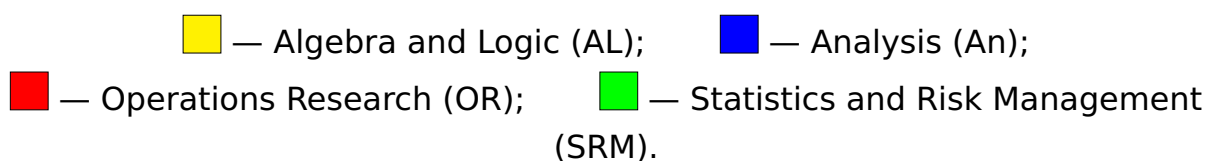
Roman Zmyślony, University of Zielona Góra, Poland

Report structure

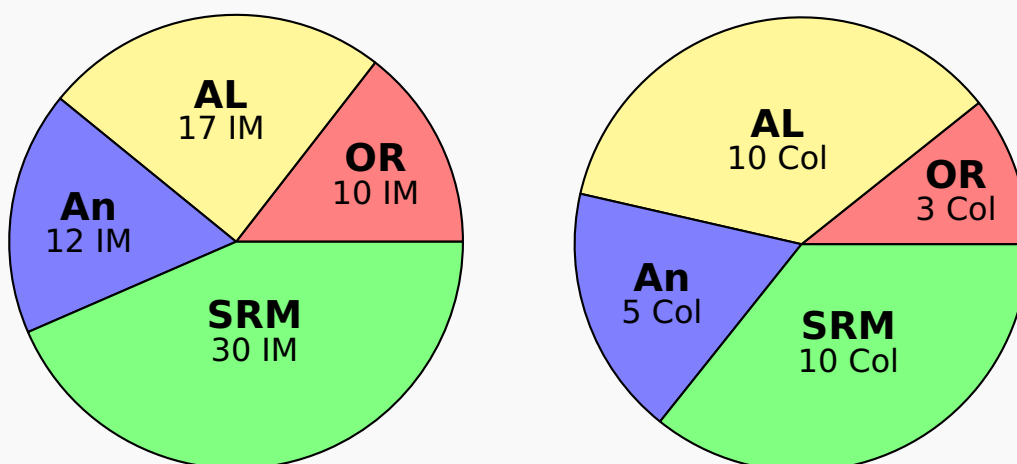
I Pictorial Report	7
II Activities at CMA	15
III Activities in the research groups	31
1 Algebra and Logic	33
2 Analysis	53
3 Operations Research	71
4 Statistics and Risk Management	85

Part I

Pictorial Report

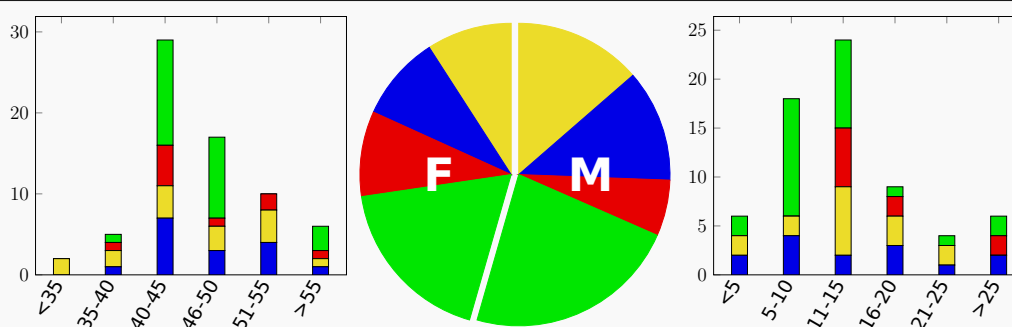


Composition 2017

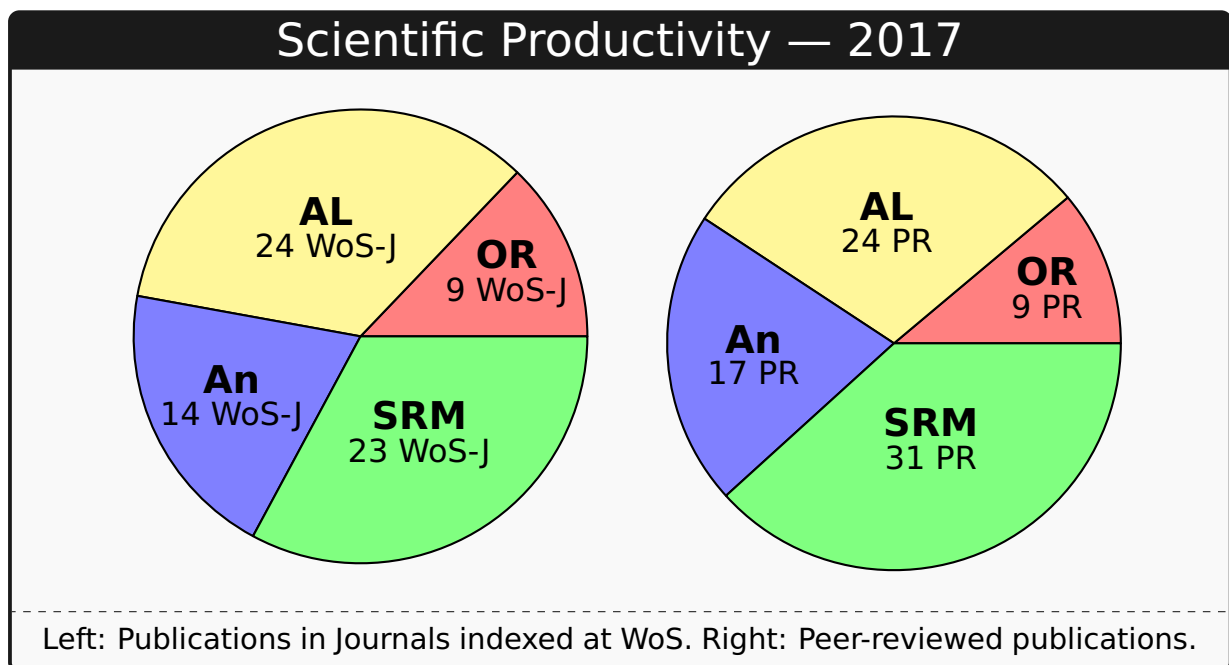
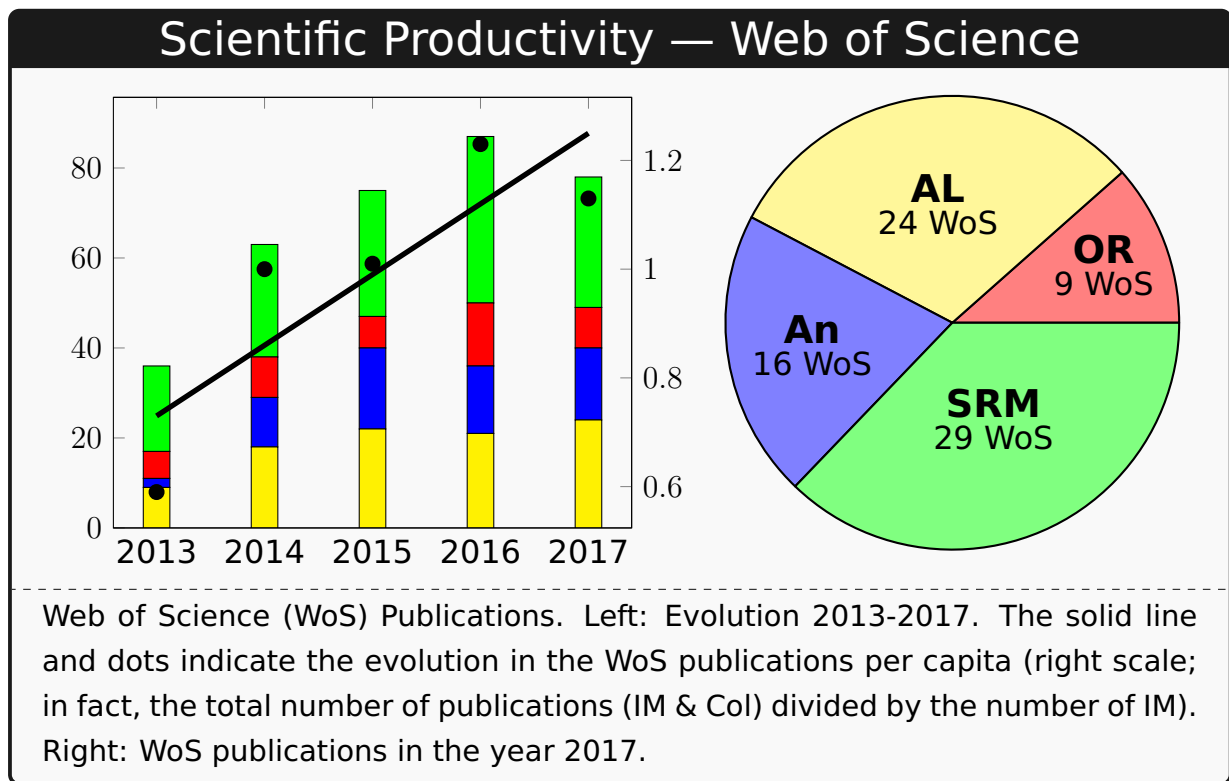


Number of members per group. Left: Integrated Members (IM), i.e., members who satisfy the productivity criterion; Right: Collaborators with Ph.D. (Col). Group budget is proportional to the number of IM.

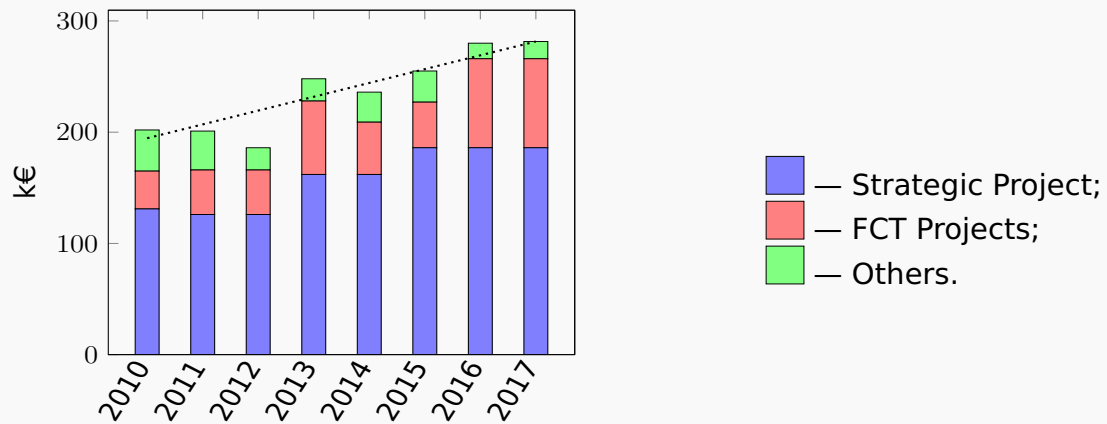
Who are the IM?



Left: Age distribution. Center: Gender distribution. Right: Post-doctoral experience (years). All data as of 1st January 2018.

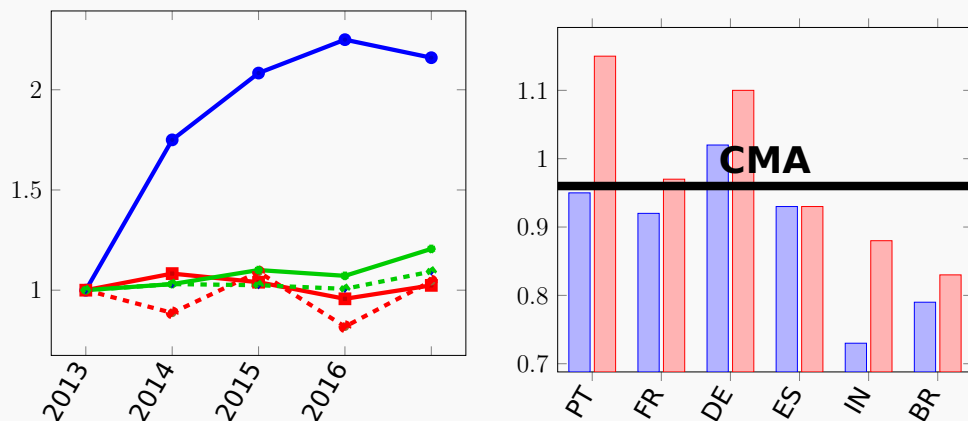


Budget Evolution — 2010-17



Funding from different sources from 2010 to 2017.

CMA in Portugal & Beyond



Left: Evolution in the number of publications, normalized to the year 2013: CMA (solid blue line) vs “Mathematics” (continuous line) vs “Mathematics, Applied” (dashed), in accordance to the WoS categories, in Portugal (red) and in the World (green). Right: Citations in 2017 of the papers published in 2016, per paper (immediate impact): CMA, Portugal and selected countries (France, Germany, Spain, India, and Brazil) in “Mathematics” (blue) and “Mathematics, Applied” (red). These numbers of publications and citations are not directly comparable, as many publications of CMA are not classified in these WoS categories, but provide an indication of the quantity and quality of the CMA research nationally and internationally.

Conferences

Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences | DSABNS Jan. 31 - Feb. 3, 2017
Colégio do Espírito Santo, Universidade de Évora, Portugal

Higher Structures Lisbon (deformation theory, operads, higher categories developments & applications)

Instituto Superior Técnico, Lisbon, 24-27 July 2017



6. A. Hurw
7. C. Carathéodory
8. D. Hilbert (Göttingen):
A. Speiser (Zürich):
(Erlaubung):
Axiomatisches D
Ueber den Klassenkörper.
Une preuve directe que les systèmes
sont les seuls systèmes de triples de Steiner
Sur un point de la théorie des nombres hyp
geometrisches Gesetz der Kollin
formation einer Kollin
halschen 7

Axiomatic Thinking

OCTOBER 11 - 14, 2017

Outreach

MatNova 2017
Escola de Verão de Matemática
Departamento de Matemática
Faculdade de Ciências e Tecnologia
Universidade Nova de Lisboa
5-9 SET

mathINGENΦUS
faculdade de ciências e tecnologia | universidade nova de lisboa
5 a 7 de Julho de 2017

Jornada da Matemática
WE π
7.ª Jornada da Matemática

CIÊNCIA VIVA
inscreve-te
NO LABORATÓRIO
2017
8
21.ª edição

12 relevant outcomes

1. M. F. Anjos and **M. V. C. Vieira**. Mathematical optimization approaches for facility layout problems: The state-of-the-art and future research directions. *Eur. J. Oper. Res.*, 261(1):1–16, AUG 16 2017.
2. J. Araujo, M. Kinyon, J. Konieczny, and **A. Malheiro**. Four notions of conjugacy for abstract semigroups. *Proc. R. Soc. Edinb. Sect. A-Math.*, 147(6):1169–1214, DEC 2017.
3. F. Bernal, **G. Dos Reis**, and G. Smith. Hybrid PDE solver for data-driven problems and modern branching. *Eur. J. Appl. Math.*, 28(6):949–972, DEC 2017.
4. A. Bullivant, M. Calcada, Z. Kadar, P. Martin, and **J. F. Martins**. Topological phases from higher gauge symmetry in 3+1 dimensions. *Phys. Rev. B*, 95(15), APR 13 2017.
5. N. Chemetov and **F. Cipriano**. Well-posedness of stochastic second grade fluids. *J. Math. Anal. Appl.*, 454(2):585–616, OCT 15 2017.
6. J.-P. Dias and **F. Oliveira**. On a quasilinear nonlocal Benney system. *J. Hyperbolic Differ. Equ.*, 14(1):135–156, MAR 2017.
7. **M. L. Esquivel**, **G. R. Guerreiro**, and J. M. Fernandes. Open Markov chain scheme models fed by second order stationary and non stationary processes. *REVSTAT-Stat. J.*, 15(2):277–297, APR 2017.
8. **M. Faias** and J. Pablo Torres-Martinez. Credit market segmentation, essentiality of commodities, and supermodularity. *J. Math. Econ.*, 70:115–122, MAY 2017.
9. J. Goncalves, **M. I. Gomes**, **M. Fonseca**, T. Teodoro, P. P. Barros, and M.-A. Botelho. Selfie Aging Index: An Index for the Self-assessment of Healthy and Active Aging. *Front. Med.*, 4, DEC 22 2017.
10. S. D. Karamintziou, **A. L. Custodio**, B. Piallat, M. Polosan, S. Chabardes, P. G. Stathis, G. A. Tagaris, D. E. Sakas, G. E. Polychronaki, G. L. Tsirogiannis, O. David, and K. S. Nikita. Algorithmic design of a noise-resistant and efficient closed-loop deep brain stimulation system: A computational approach. *PLoS One*, 12(2), FEB 21 2017.
11. **A. Y. Karlovich**, Y. I. Karlovich, and A. B. Lebre. The index of weighted singular integral operators with shifts and slowly oscillating data. *J. Math. Anal. Appl.*, 450(1):606–630, JUN 1 2017.
12. **G. Tabuada**. A(1-)homotopy invariance of algebraic K-theory with coefficients and du Val singularities. *Ann. K-Theory*, 2(1):1–25, 2017.

Part II

Activities at CMA

General Information

Highlights

1. CMA directly funded 3 conferences in 2017.
2. The post-doc program is expanding: in 2017 2 post-docs directly funded by CMA plus 3 by FCT.
3. CMA members published 70 papers in journals indexed by Web of Science: 1 per integrated member.
4. Project “Hilbert’s 24th problem”, funded with 200 k€ and led by R. Kahle, continued in 2017.
5. One CMA member is vice president of the European Society of Mathematical and Theoretical Biology and one is member of the Applied Mathematics Committee of the European Mathematical Society. Two members are on the board of national scientific societies.
6. Participation in two COST projects, one binational with Germany, one funded by Switzerland and another by South Africa.

.....

1. Objectives and Achievements

...

1.1. Unit Description

The Center for Mathematics and Applications (“Centro de Matemática e Aplicações”, CMA/FCT/UNL, or simply CMA) is located at the “Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa” (FCT/UNL) at the Caparica Campus and occupies two large rooms on the second floor of building VII. The Department of Mathematics (DM) is also located in this building.

FCT/UNL is the largest academic unit of the “Universidade Nova de Lisboa”, founded in 1977 and dedicated to research and higher education in Science, Technology, and Engineering. It has about 7500 students, of whom about 2500 are postgraduates. Its mission is the development of high-quality, international-level, research, which is being implemented as part of a fundamental policy of strengthening FCT/UNL as a research-oriented school. This is the essential basis for excellence in teaching, especially of postgraduates. As such, the Research Centers are fundamental components of FCT/UNL’s strategy, which is fully committed to their success.

The CMA has 69 active Ph.D. researchers and 28 internal collaborators. In the 2013 Evaluation of R&D Units by the Portuguese Science and Technology Foundation, CMA was ranked “very good”. Since then, the number of publications indexed by the Web of Science database has steadily increased, from 36 in the year 2013, to 63 in 2014, 75 in 2015 and 82 in 2016. Currently 16 Ph.D. students are members of CMA, and are supervised or co-supervised by CMA members.

The center is organized into four research groups: Algebra and Logic (AL), Analysis (An), Operations Research (OR), and Statistics and Risk Management (SRM) and along two thematic lines: “Mathematical Modelling for the Independent Living of Elderly, Disabled, and Chronic Patients” and “mathematical Modelling In Ecology, Evolution, and Genetics”.

An External Permanent Advising Scientific Committee including five internationally recognized high-level researchers assesses the scientific activities of the center.

General administrative support is provided by a BGCT (*Bolsa de Gestão de*

Ciência e Tecnologia, or, Science and Technology Management Fellowship), with the help of the secretariat of the Department of Mathematics. CMA bylaws and membership requirement regulations are available in a written document, reviewed every year in order to assess the classification of the researchers according to productivity indicators. Funding is allocated to each team, proportionally to the corresponding number of active Ph.D. researchers. For more information please visit the CMA/FCT/UNL web site:

<http://www.cma.fct.unl.pt>

• • •

1.2. Productivity Criterion

Starting from 1 January, 2015, the criterion used to define integrated members (hereinafter, IM) is

During the year X a researcher is considered to be an integrated member if he or she satisfies at least one of the following four items, during the period from 1 January of year X-5 until 31 December of year X-1,

A) One publication in one of the 10% WoS top journals in the following WoS^a scientific areas: Computer Science, Theory and Methods; Logic; Mathematical and Computational Biology; Mathematics; Mathematics, Applied; Mathematics, Interdisciplinary Applications; Operations Research & Management Science; Statistics & Probability; Physics, Mathematical.

B) Ph.D. dissertation defended after 1 January of year X-3 and one publication in a peer reviewed journal.

C) Four scientific indicators, according to the FCT definition^b (see Registration Guide^c p. 25), two of them classified in WoS.

D) Three scientific indicators, according to the FCT definition (see Registration Guide p. 25), all of them classified in WoS.

^aWeb of Science

^bInternational publication with referees, books, book chapters, patents.

^cThe Registration Guide, used by *Fundação para a Ciência e Tecnologia* – Science and Technology Foundation (FCT) is available in Portuguese at http://www.fct.pt/apoios/unidades/avaliacoes/2013/docs/GuiaoRegisto_AvaliacaoUnidades2013.pdf.

Members who do not satisfy the criterion are invited to present a 3-year work plan, in the scope of the group project. The plan should present a credible strategy to recover scientific productivity (as measured by the Unit productivity criterion). If the plan is approved, they will be considered as “internal

collaborators". Internal collaborators are funded in the same way as integrated members. Integrated members and internal collaborators contribute together to the progress of the scientific program of the center. The designation "internal collaborators" also applies to Ph.D. candidates supervised by members of the Unit. As soon as an internal collaborator fulfills the criterion, he or she will be considered an integrated member.

In all internal decisions, only integrated members have the right to vote.

It is important to note that the CMA team for the year 2015 included all members in the FCT proposal, drafted in 2013 (i.e., all members who satisfied the criterion in 2012 or 2013) plus all members who satisfied the criterion in 2014. No one was excluded as integrated member before the start of the project. This explains the increase in the number of IM in 2015. This will not be repeated in 2016, and therefore we expected a slight decrease in the number of IM in the year 2016.

.....

2. Indicators

...

2.1. Scientific Productivity

CMA has experienced a steady increase in the ratio of publications (total number of publications in peer reviewed journals per integrated member). Since 2014 we also count the total and the per capita number of publications indexed by Web of Science (WoS), and since 2016 we divide the WoS count in "journals" and "others" (proceedings indexed at WoS).

Note that only WoS publications are considered in the definition of integrated members (IM).

Annual data for the total number of publications:

	2009	10	11	12	13	14	15	16	17
Publications in international peer reviewed journals	46	41	39	57	38	76	105	88	81
Publications in international peer reviewed journals per IM	0.96	0.84	0.80	1.03	0.62	1.25	1.42	1.29	1.17
WoS publications					36	63	75	86	78
WoS per IM					0.59	1.00	1.01	1.21	1.13
WoS journals							66	63	70
WoS journals per IM							0.89	0.93	1.01

Publication by each group in 2017:

Group	WoS Total	per IM	WoS Journals	per IM	Peer reviewed	per IM
AL	24	1.41	24	1.41	24	1.41
An	16	1.33	14	1.67	17	1.42
OR	9	0.90	9	0.90	9	0.90
SRM	29	0.97	23	0.77	31	1.03

A detailed list of publications (including proceedings, book chapters, didactic, and popular science publications) is available in Part III of this report.

...

2.2. Funding

The table below presents CMA funding, on an annual basis, considering different sources.

	2012	2013	2014	2015	2016	2017
LA FCT	0	0	0	0	0	0
Units FCT	126348	162438	162504	185787	185787	185787
Projects FCT	39743	65858	46625	41187	79604	79284
Other (National)	0	0	0	5740	13999	8827
Other (International)	19965	19965	27268	27993	0	6665
National Industry	0	0	0	0	0	0
International Industry	0	0	0	0	0	0
Total	186056	248261	236397	260707	279390	280563

...

2.3. Team

In the table below we present the evolution, from 2007 to 2016, of the number of Integrated Members. Note that a productivity criterion was implemented in 2010, and modified in 2015 (implemented in 2016). In the second line we present the number of full time researchers in the CMA team with salary paid directly by the Ministry of Science, Technology and Higher Education (up to 2011 and after 2015) and the Ministry of Education and Science (from 2011 to 2015) — programs “Ciência”, “Investigador FCT,” and post-docs paid directly from CMA’s budget or long term post-docs (1 year or more) paid by projects hosted by CMA. Short term post-docs (less than 1 year) paid by projects are not included in this table.

	2007	08	09	10	11	12	13	14	15	16	17
Integrated Members	42	49	48	49	49	55	61	63	74	68	69
Full time researchers	0	2	2	0	0	0	1	2	4	5	5
Ph.D. dissertations completed	12	9	7	1	1	5	4	3	2	3	1

...

2.4. Full-time equivalent researchers

All researchers at CMA (including collaborators, post-docs and students) are required to declare the percentage of time dedicated to research. The table below summarizes all declarations:

Percentage	# of IM
0-10	1
11 - 20	7
21 - 30	2
31 - 40	3
41 - 50	1
51 - 60	94
61 - 70	1
71 - 80	1
81 - 90	0
91 - 100	10

This amounts to 56 full-time equivalent (FTE) researchers at CMA.

...

2.5. Impact of 2016 research

In the table below we show the immediate impact (II) of CMA research per research group.

$$II = \frac{\# \text{ citations in 2017 of papers published by CMA researchers in 2016}}{\# \text{ papers published by CMA researchers in 2016}}$$

	# papers in 2016	# citations in 2017 of these papers	II
AL	21	14	0.67
An	15	14	0.93
OR	13	36	2.78
SRM	37	18	0.49
CMA	85	82	0.96

Note that there are minor differences in the number of papers presented here and in the 2016 Report. This reflects inclusions in the WoS database after the production of report and correction of errors in the previous report.

...

2.6. Teaching load

According to Portuguese law, Professors at public universities are expected to teach between 6 and 9 hours per week, while at Polytechnic Institutes, this number varies between 6 and 12 hours. However, except during sabbatical leaves, most of the IM are requested to teach the maximum legally possible.

In the table below we provide information only for the 42 IM with contracts as professors at the Universidade Nova de Lisboa. For the year 2017, it was not possible to have the precise teaching load of the other researchers.

In the left table we present the number of different disciplines taught during civil year 2017 (1st semester plus 2nd semester), while in the right table we add the average number of effective hours in class per week for the 1st semester and 2nd semester during 2017. (0 hours and/or 0 disciplines indicate a "sabbatical leave".)

Disciplines	# of IM at UNL	Hours	# of IM at UNL
0	2	0	2
1	5	1-7	5
2	11	8-10	3
3	6	11-13	4
4	13	14-16	6
5	2	17-19	9
6	2	20-22	11
7	1	23-	2

...

2.7. Other relevant information

Technical Personnel: Vanda Sofia dos Santos Martins, since 1 April 2011.

.....

3. Visitors

In 2015, CMA launched a program to attract researchers for stays of *circa* 1 month. Every 6 months CMA asks all members to invite a researcher for stays between 20 and 40 days, and pays all expenses, including travel and an allowance of 2650 euros per month before taxes. Visitors are expected to interact with the CMA members and present a short course. In 2017, we had three visitors under this program:

1. Jörg Koppitz, Institute of Mathematics, Potsdam University, Germany: 15/1/2017 to 13/2/2017.
<https://www.math.uni-potsdam.de/professuren/graphentheorie/team/pd-dr-joerg-kopp>
2. Albert Shiryaev, Russian Academy of Sciences: 11/9/2017 to 23/9/2017
https://en.wikipedia.org/wiki/Albert_Shiryaev
3. Wilfried Sieg, Department of Philosophy, Carnegie Mellon University: 9/10/2017 to 25/10/2017.
<https://www.cmu.edu/dietrich/philosophy/people/faculty/sieg.html>

.....

4. Post-doctoral program

In 2015, for the first time, CMA opened a call for post-docs. Out of 20 applicants, **Benjamín Alarcón Heredia** and **Miguel Fonseca** were selected and started working in September 2015, in the groups of Algebra and Logic, and Statistics and Risk Management, respectively.

After the term of CMA's fellowship, **Miguel Fonseca** started a 6 year fellowship directly funded by FCT, with CMA as host institution.

The contract of **Benjamín Alarcón Heredia** ended in September 2017, and now he works as Software Engineer Intern in Switzerland.

In the project led by Reinhard Kahle, **Gabriele Pulcini** was hired as a post-doc in 2016 and continues at CMA.

In October 2016 CMA opened a call for one post-doctoral fellowship, in all areas of Mathematics. Out of 17 applicants, **Maíra Aguiar** was selected to work in the group of Analysis, and started at 1st January 2017. Her contract was renewed for more one year by the end of 2017.

During the year 2017, **Tara Brough** joined CMA, as post-doc in the group of Algebra and Logic, following the results of the FCT 2016 call.

.....

5. Activities

...

5.1. Organization of events

In 2015, for the first time, CMA launched a call to support conferences organized or co-organized by CMA members. Until then, support had been negotiated on a case by case basis. During the year 2017, CMA directly supported three conferences:

1. **Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences**, Colégio do Espírito Santo of Évora University in Portugal, from January 31st to February 3rd, 2017.

<http://dsabns2017.rd.ciencias.ulisboa.pt/>

2. **HSL 2017 — The Higher Structures Lisbon (deformation theory, operads, higher categories developments & applications)**, Instituto Superior Técnico, University of Lisbon, Portugal, from July 24th to July 27th, 2017.

<http://hsl2017.campus.ciencias.ulisboa.pt/>

3. **Axiomatic Thinking**, Faculty of Science and Technology of the New University of Lisbon, Portugal, from October 11th to October 14th, 2017.

<https://eventos.fct.unl.pt/aips17/home>

Further details on these and other conferences supported directly by the group's budget, can be found in detail in the second part of the report.

• • •

5.2. Seminars

During the year 2017, 70 seminars and short courses (from 54 in 2016) were organized by CMA. We do not count student seminars or seminars that were part of larger events (e.g., conferences, Jornadas da Matemática, Mat-Nova etc). 40 seminars (from 40 in 2016 and 32 in 2015) were given by specialists outside CMA, including 24 from visitors from abroad (from 18 in 2016 and 15 in 2015).

In the second part of this report we present a full list of seminars.

• • •

5.3. Outreach

CMA continues to be involved in outreach activities. Many members write to general audiences, or are invited to participate in outreach events in schools, public libraries, etc.

During 2017, CMA directly partially funded three summer schools for high-school students:

1. **MatNova 2017**: <http://eventos.fct.unl.pt/matnova2017/>
2. **MathInGenious 2017**: <https://eventos.fct.unl.pt/mathingenious2017/pages/inicio>
3. **Ciência Viva no Laboratório**: <http://www.cienciaviva.pt/estagios/jovens/ocjf2017/> and <https://www.fct.unl.pt/noticias/2017/07/matematica-experimental-ciencia-viva-no-departamento-d>

Furthermore, we also support the one-day event, locally organized, *Jornadas da Matemática*, normally around π -day (i.e, 14 March - 3/14).

Part III

Activities in the research groups

Research Group

Algebra and Logic

Highlights

1. Project “Hilbert’s 24th problem” is funded with €199.902.
2. One new pos-doc has joined the group.
3. Participation in one project with Switzerland.

.....

1.1. Team

...

1.1.1. Integrated Members

1. **Alan James Cain** - a.cain@fct.unl.pt
2. **Ana Cristina Malheiro Casimiro** - amc@fct.unl.pt
3. **António José Mesquita da Cunha Machado Malheiro** - ajm@fct.unl.pt
4. **Benjamín Alarcón Heredia** - baheredia@ugr.es
5. **Carlos Manuel Saiago** - cls@fct.unl.pt
6. **Gabriele Pulcini** - gab.pulcini@gmail.com
7. **Gonçalo Jorge Trigo Nery Tabuada** - tabuada@fct.unl.pt
8. **Isabel Maria Oitavem Fonseca da Rocha Kahle** - ifr@fct.unl.pt
9. **Joaquim Eurico Anes Duarte Nogueira** - jen@fct.unl.pt
10. **Manuel Almeida Silva** - mnas@fct.unl.pt
11. **Maria do Rosário Silva Franco Fernandes** - mrff@fct.unl.pt
12. **Maria Helena Coutinho Gomes de Almeida Santos** - mhas@fct.unl.pt
13. **Reinhard Josef Klaus Kahle** - kahle@fct.unl.pt
14. **Tara Rose Brough** - tarabrough@gmail.com
15. **Teresa Maria de Araújo Melo Quinteiro** - tmeloquinteiro@gmail.com
16. **Teresa Maria Jerónimo Sousa** - tmjs@fct.unl.pt
17. **Vítor Hugo Bento Dias Fernandes** - vhf@fct.unl.pt

...

1.1.2. Other Researchers/Collaborators

1. **Herberto de Jesus da Silva** - hdjs@fct.unl.pt
2. **Jaime da Gama Gaspar** - mail@jaimegaspar.com
3. **Joana Mendonça Fonseca Marques de Matos** - jmf.matos@fct.unl.pt
4. **João Nuno Gonçalves Faria Martins** - jn.martins@fct.unl.pt
5. **João Pedro Bizarro Cabral** - jpbc@fct.unl.pt

6. **Jorge Manuel Leocádio André** – `jmla@fct.unl.pt`
7. **Júlia Maria Nunes Loureiro Vaz de Carvalho** – `jvc@fct.unl.pt`
8. **Manuel Messias Rocha de Jesus** – `mrj@fct.unl.pt`
9. **Maria Cecília Perdigão Dias da Silva** – `mcds@fct.unl.pt`
10. **Maria de Fátima Vale de Gato Santos Rodrigues** – `mfsr@fct.unl.pt`

...

1.1.3. Ph.D. Students

1. **Duarte Chambel Ribeiro** – `dc.ribeiro@campus.fct.unl.pt`
2. **Mirko Engler** – `mir.engler@gmail.com`
3. **João Rodrigo Pimenta Simões** – `jrs12140@campus.fct.unl.pt`
4. **Ricardo Jorge Pratas Guilherme** – `rj.guilherme@campus.fct.unl.pt`
5. **Serena Delli** – `sere.rex@gmail.com`

.....

1.2. Funding

...

1.2.1. Projects led by CMA members

1. Hilbert's 24th Problem PTDC/MHC-FIL/2583/2014, (2016-2019)
 PI: **Reinhard Kahle**
 CMA members: **R. Kahle, A. J. Cain, A. Malheiro, I. Oitavem, M. Silva, G. Pulcini, S. Delli.**
 Funded by: FCT
 Total funding: €199.902.
2. IF/01622/2013/CP1161/CT0001, Investigador FCT Exploratory Project, led by **Alan Cain** (2014-2019).
 Total funding (CMA only) €50 000.00.
3. A correspondência de Hugo Baptista Ribeiro (2015-2017)
 PI: **Reinhard Kahle**
 CMA members: **R. Kahle, I. Oitavem**
 Funded by Gulbenkian Foundation.
 Total funding: €11.480.

4. Jaime Gaspar continues to be funded by a Research Postgraduate Scholarship from the UK Engineering and Physical Sciences Research Council (EPSRC) / School of Computing, University of Kent.
5. Tara Brough is funded by the FCT pos-doc grant SFRH/BPD/121469/2016
6. Reinhar Kahle received the *Paul Bernays' Philosophy of Mathematics Swiss National Science Foundation*, Grant: 175054. CHF 3,300.

<https://grants.uberresearch.com/501100001711/175054/Paul-Bernays-Philosophy-of-Mathematics>

.....

1.3. Publications

...

1.3.1. Publications in the Web of Science database

- [1] J. Araujo, M. Kinyon, J. Konieczny, and **A. Malheiro**. Four notions of conjugacy for abstract semigroups. *Proc. R. Soc. Edinb. Sect. A-Math.*, 147(6):1169–1214, DEC 2017.
- [2] A. Bernardino, R. Pacheco, and **M. Silva**. Coloring factors of substitutive infinite words. *Discret. Math.*, 340(3):443–451, MAR 2017.
- [3] T. S. Blyth and **M. H. Almeida Santos**. Special subgroups of regular semigroups. *Commun. Algebr.*, 45(10):4246–4256, 2017.
- [4] T. S. Blyth and **H. J. Silva**. Congruence kernels in Ockham algebras. *Algebr. Universalis*, 78(1):55–65, SEP 2017.
- [5] M. Bondarko and **G. Tabuada**. Picard groups, weight structures, and (noncommutative) mixed motives. *Doc. Math.*, 22:45–66, 2017.
- [6] T. Brough and **A. J. Cain**. Automaton semigroups: New constructions results and examples of non-automaton semigroups. *Theor. Comput. Sci.*, 674:1–15, APR 25 2017.
- [7] A. Bullivant, M. Calcada, Z. Kadar, P. Martin, and **J. F. Martins**. Topological phases from higher gauge symmetry in 3+1 dimensions. *Phys. Rev. B*, 95(15), APR 13 2017.
- [8] **A. J. Cain**, R. D. Gray, and **A. Malheiro**. On finite complete rewriting systems, finite derivation type, and automaticity for homogeneous monoids. *Inf. Comput.*, 255(1):68–93, AUG 2017.

- [9] **A. J. Cain** and **A. Malheiro**. Crystallizing the hypoplactic monoid: from quasi-Kashiwara operators to the Robinson-Schensted-Knuth-type correspondence for quasi-ribbon tableaux. *J. Algebr. Comb.*, 45(2):475–524, MAR 2017.
- [10] **A. J. Cain** and V. Maltcev. Growths of endomorphisms of finitely generated semigroups. *J. Aust. Math. Soc.*, 102(2):163–184, APR 2017.
- [11] W. A. Carnielli and **G. Pulcini**. Cut-elimination and deductive polarization in complementary classical logic. *Log. J. IGPL*, 25(3):273–282, JUN 2017.
- [12] M. A. Duffner and **R. Fernandes**. Semilinear preservers of the immanants in the set of the doubly stochastic matrices. *Electron. J. Linear Algebra*, 32:76–97, 2017.
- [13] H. F. da Cruz, G. Dolinar, **R. Fernandes**, and B. Kuzma. Maximal doubly stochastic matrix centralizers. *Linear Alg. Appl.*, 532:387–396, NOV 1 2017.
- [14] H. F. da Cruz, **R. Fernandes**, and S. Furtado. Minimal matrices in the Bruhat order for symmetric $(0,1)$ -matrices. *Linear Alg. Appl.*, 530:160–184, OCT 1 2017.
- [15] J. A. Dias da Silva, **F. Rodrigues**, P. C. Silva, and M. M. Torres. A note on symmetry classes of tensors and Specht modules. *Linear Alg. Appl.*, 531:118–128, OCT 15 2017.
- [16] I. Dimitrova, **V. H. Fernandes**, and J. Koppitz. A note on generators of the endomorphism semigroup of an infinite countable chain. *J. Algebra. Appl.*, 16(2), FEB 2017.
- [17] P. A. Garcia-Sanchez, **B. A. Heredia**, H. I. Karaka, and J. C. Rosales. Parametrizing Arf numerical semigroups. *J. Algebra. Appl.*, 16(11), NOV 2017.
- [18] C. R. Johnson, A. L. Duarte, and **C. M. Saigo**. The number of distinct eigenvalues for which an index decreases multiplicity. *Linear Alg. Appl.*, 516:8–23, MAR 1 2017.
- [19] H. Liu and **T. Sousa**. Decompositions of Graphs into Fans and Single Edges. *J. Graph Theory*, 85(2):400–411, JUN 2017.
- [20] M. Marcolli and **G. Tabuada**. Bost-Connes systems, categorification, quantum statistical mechanics, and Weil numbers. *J. Noncommutative Geom.*, 11(1):1–49, 2017.

- [21] M. Piazza and **G. Pulcini**. Unifying logics via context-sensitiveness. *J. Logic Comput.*, 27(1):21–40, FEB 2017.
- [22] **G. Tabuada**. A(1-)homotopy invariance of algebraic K-theory with coefficients and du Val singularities. *Ann. K-Theory*, 2(1):1–25, 2017.
- [23] **G. Tabuada**. A(1)-homotopy invariants of corner skew Laurent polynomial algebras. *J. Noncommutative Geom.*, 11(4):1627–1643, 2017.
- [24] **G. Tabuada**. Kimura-finiteness of quadric fibrations over smooth curves. *C. R. Math.*, 355(6):628–632, JUN 2017.

• • •

1.3.2. Other (international) publications

- [1] **A. J. Cain** and **A. Malheiro**. Combinatorics of cyclic shifts in plactic, hypoplactic, Sylvester, and related monoids. In *Combinatorics on words*, volume 10432 of *Lecture Notes in Comput. Sci.*, pages 190–202. Springer, Cham, 2017.
- [2] **J. Nogueira**, **F. Rodrigues**, and L. Trabucho de Campos. Inheritance issues. In *Actas de Recreational Mathematics Colloquium V, 28-31 Jan, 2017*,.
- [3] **R. Kahle**. Mathematical Truth Revisited: Mathematics as a Toolbox. In E. Agazzi, editor, *Varieties of Scientific Realism*, pages 395–406. Springer, 2017.
- [4] **R. Kahle**. The Logical Cone. *IfCoLog Journal of Logics and their Applications*, 4(4):1087–1101, 2017. Special Issue Dedicated to the Memory of Grigori Mints. Dov Gabbay and Oleg Prosorov (Guest Editors).
- [5] **R. Kahle**. Von Dedekind zu Zermelo versus Peano zu Gödel. *Mathematische Semesterberichte*, 64(2):159–167, 2017. Also published in a volume In Memoriam Richard Dedekind (1831-1916).
- [6] **R. Kahle**. Von Dedekind zu Zermelo versus Peano zu Gödel. In K. Scheel, T. Sonar, and P. Ullrich, editors, *In Memoriam Richard Dedekind (1831-1916)*, volume 3 of *Schriften zur Geschichte der Mathematik und ihrer Didaktik*, pages 174–185. WTM, Verlag für wissenschaftliche Texte und Medien, Münster, 2017. Also published in the *Mathematische Semesterberichte*.

• • •

1.3.3. Other (national) publications

- [1] P. G. Santos and **R. Kahle**. Diagonalização, Paradoxos e o Teorema de Löb. *Revista Portuguesa de Filosofia*, 73(34):1169–1188, 2017.

- [2] **T. Sousa.** Maryam Mirzakhani, a “nobel da matemática” deixa-nos aos 40 anos de idade. *Gazeta de Matemática*, 183, 2017.

.....

1.4. Activities

...

1.4.1. Organization of conferences & sessions

1. Workshop on Computational Algebra, Monte de Caparica, Portugal, 2nd of December, 2017. Organizing Committee: J. Araújo (Open University), A. Malheiro (New University of Lisbon).
2. Axiomatic Thinking, Monte de Caparica, Portugal, 11-14 October, 2017. Scientific Committee: Fernando Ferreira (University Lisbon), Gerhard Heinzmann (Nancy University), Reinhard Kahle (New University of Lisbon). Organizing Committee: Mirko Engler, Isabel Oitavem (Chair), Cecília Perdigão, Gabriele Pulcini (New University of Lisbon) and others.
3. Workshop: Simplicity of Proofs in Automated Reasoning, Monte de Caparica, Portugal, 6th of July. Organizing Committee: A.J. Cain, M. Engler, A. Malheiro and G. Pulcini (New University of Lisbon).
4. Proof, Computation and Complexity 2017, Göttingen, Germany, 26-27 July, 2017. Program Committee: Reinhard Kahle (New University of Lisbon), Lars Kristiansen (University of Oslo), Ralph Matthes (University of Toulouse), Isabel Oitavem (New University of Lisbon).
5. Computability in Europe 2017, Turku, Finland, 12-16 June, 2017. Program Committee: Isabel Oitavem (New University of Lisbon) et al. (32 members). Logic and Computational Complexity 2017, Reykjavik, Iceland, on June 19. Steering Committee chairs: Anuj Dawar (Cambridge), Isabel Oitavem (New University of Lisbon).
6. Axiomatic Thinking, September 14-15, 2017, Zurich (Reinhard Kahle)
7. Hilbert-Bernays Summer School on Logic and Computation 2017, Göttingen 23. July - 29. July 2017 (Reinhard Kahle)

...

1.4.2. Seminars & Short-courses

Organized by Alan Cain and Isabel Oitavem

17 January: *Numerical semigroups, Feng-Rao distances, and Telescopic numerical semigroups*, Benjamin Alarcón Heredia , CMA, FCT-UNL.

24 January: *On some semigroups of partial fence-preserving injections on a finite set*, Ilinka Dimitrova , Faculty of Mathematics and Natural Science, South-West University 'Neofit Rilski', Bulgária.

31 January: *Maximal subsemigroups of some semigroups of order-preserving mappings on a countable set*, Tiwadee Musunthia , Silpakorn University, Tailândia.

7 February: *Semigroups of Transformations Preserving a Fence 1*, Jörg Koppitz , Institute of Mathematics, Potsdam University, Alemanha.

8 February: *Semigroups of Transformations Preserving a Fence 2*, Jörg Koppitz , Institute of Mathematics, Potsdam University, Alemanha.

14 February: *Limits of Tangents*, João Cabral , DM, FCT-UNL.

21 February: *Spectral Variation Under Congruence*, Charles Johnson , Department of Mathematics, College of William and Mary, Estados Unidos.

7 March: *Topological finiteness properties of monoids*, Robert Gray , School of Mathematics, University of East Anglia, Reino Unido.

21 March: *Constructing finite complete rewriting systems for Plactic monoids of arbitrary finite rank*, Duarte Ribeiro , Programa MMA, FCT-UNL.

28 March: *Reductive algebraic monoids*, Ana Cristina Casimiro , DM & CMA, FCT-UNL.

5 April: *Stochastic variational principles on Lie groups*, Ana Bela Cruzeiro, Grupo de Física Matemática, Instituto Superior Técnico, Universidade de Lisboa.

2 May: *Algebra and Topology: 2-Dimensional Topological Quantum Field Theories*, Björn Gohla, Grupo de Física Matemática, Instituto Superior Técnico, Universidade de Lisboa.

9 May: *Geometric legitimacy*, Andrew Arana, University of Paris 1 Panthéon-Sorbonne and IHPST, França.

23 May: *Some rare numerical semigroups*, Manuel Delgado, CMUP, Universidade do Porto.

5 June: *Symmetry classes of tensors and Specht modules*, Maria Manuel Torres, Faculdade de Ciências, Universidade de Lisboa.

20 June: *Bounded domains of negative multipliers*, Gonçalo Morais, CMA.

13 September: *An Introduction to Littelmann's paths through crystal bases theory*, Ricardo Guilherme, Programa do Doutoramento em Matemática, FCT-UNL.

16 October: *Mechanical procedures - What is the concept of computation?*, Wilfried Sieg, Carnegie Mellon University, Estados Unidos.

17 October: *Natural deduction in bi-directional ways*, Wilfried Sieg, Carnegie Mellon University, Estados Unidos .

20 October: *Natural formalization - The Cantor-Bernstein Theorem derived in ZF*, Wilfried Sieg, Carnegie Mellon University, Estados Unidos.

23 October: *Automated search for Gödel's Theorems*, Wilfried Sieg, Carnegie Mellon University, Estados Unidos.

30 October: *Polinómios superprimitivos*, Eurico Nogueira, DM & CMA, FCT-UNL.

6 November: *The McKay Correspondence*, José Reis, CMA.

13 November: *Monotonicity in Logic and Complexity*, Anupam Das, University of Copenhagen, Dinamarca.

20 November: *Inverse monoids and immersions of cell complexes*, Nóra Szakács, CMUP, Universidade do Porto.

27 November: *Right-angled Artin groups: commensurability classification and subgroup intersection problem*, Alexander Zakharov, CMUP, Universidade do Porto.

• • •

1.4.3. Supervision of Ph.D. students

1. V. H. Fernandes: supervises João Simões, co-supervision with C. Fernandes, New University of Lisbon. Starting.
2. R. Fernandes: supervises D. Salomão, University of Beira Interior, co-supervision with H. F. da Cruz. Topic: Bruhat orders. Ongoing.
3. R. Kahle: supervises René Gazarri, University of Tübingen, co-supervision

with Peter Schroeder-Heister. Topic: The Calculus of Natural Calculations. Ongoing.

4. R. Kahle and G. Pulcini: supervise Serena Delli, New University of Lisbon, within the project “Hilbert’s 24th Problem”. Ongoing.
5. R. Kahle: supervises Mirko Engler, Humboldt-University, Berlin, co-supervision with Karl-Georg Niebergall, within the project “Hilbert’s 24th Problem”. Topic: Combinatorial proofs and Hilbert’s 24th problem. Ongoing.
6. R. Kahle: supervises Fernando Ferreira, Open University. Starting.
7. A. Malheiro: supervises F. Silva, University of Lisbon, co-supervision with G. Gomes. Topic: Computations and combinatorics on Hopf algebras and monoids. Ongoing.
8. A.J. Cain and A. Malheiro: supervise R. Guilherme, New University of Lisbon. Topic: Littelmann paths for hypoplactic, sylvester, and related monoids, and connections to computation, combinatorics, and crystals. Ongoing.
9. A.J. Cain and A. Malheiro: supervise D. Ribeiro, New University of Lisbon. Topic: Identities and bases in plactic, hypoplactic, sylvester, and related monoids. Starting.
10. A. Malheiro: supervises T. Ribeiro, Open University, co-supervision with J. Araújo. Topic: Exporting techniques from loops to semigroups. Ongoing.

• • •

1.4.4. Invited talks in international and national conferences

1. A.J.Cain. Identities in plactic, hypoplactic, sylvester, Baxter, and related monoids, 7th Combinatorics Day, May 26, Évora, Portugal.
2. T. Brough. The power of symbol-tuples for automaton semigroup constructions, Clôture du projet MealyM, July 12, Université Paris Diderot, France. T. Brough. Word problems of free inverse semigroups, 25th North British Semigroups and Applications Network (NBSAN) Meeting, January 18, York, United Kingdom.
3. R. Kahle, Hilberts umfassendes Programm, Logik zwischen Mathematik und Philosophie, Göttingen, Germany, 28.4.2017

4. R. Kahle, Hilberts umfassendes Programm, Universität des Saarlandes, Germany, 19.7.2017
5. R. Kahle, Hilbert's Larger Programme, Summer School for Proof Theory in First-Order Logic, Funchal, Madeira, 22–23.8.2017
6. R. Kahle, Zur Verantwortung des theoretischen Wissenschaftlers, Universität Tübingen, Germany, 2.11.2017
7. A. Malheiro. Crystals for Plactic-like monoids, All Kinds of Mathematics Remind me of You, Conference to celebrate the 70th Anniversary of Peter J. Cameron, July 26, Lisbon, Portugal.
8. I. Oitavem. Recursion and Complexity (course), Hilbert Bernays Summer School on Logic and Computation, July, Göttingen, Germany.
9. Manuel Silva. Ramsey Theory for infinite words. The music of numbers, Conference in honor of Javier Cilleruelo, 20th-22nd September 2017, IC-MAT (Madrid)
10. G. Tabuada. Grothendieck's standard conjectures via noncommutative geometry, Colloquium, December 2017, University of California at San Diego, USA.
11. G. Tabuada. Noncommutative motives (course of four lectures), Conference Vector bundles and algebraic curves, September 2017, Essen, Germany.
12. G. Tabuada. Grothendieck's standard conjectures via noncommutative geometry, Mathematische Arbeitstagung 2017 (in honor of Yuri I. Manin), June 2017, Max-Planck-Institut für Mathematik, Bonn, Germany.
13. G. Tabuada, Additive invariants of orbifolds, Workshop K-theory in algebraic geometry and number theory, May 2017, Hausdorff Research Institute for Mathematics, Bonn, Germany.
14. G. Tabuada, Additive invariants of orbifolds, Conference Algebro-Geometric and Homotopical Methods, March 2017, Institut Mittag-Leffler, Sweden.
15. G. Tabuada, An introduction to Noncommutative Motives, Colloquium, February 2017, University of Southern California, USA.
16. G. Tabuada, An introduction to Noncommutative Motives, Colloquium, January 2017, Institut de Mathématiques de Jussieu, Paris, France.

17. G. Tabuada, Additive invariants of orbifolds, Algebraic Topology seminar, January 2017, Universite Paris 13, France.
18. T. Brough. Word problems in one dimension. Pure Mathematics Colloquium, University of St Andrews, October 19.
19. T. Brough. Word problems of free inverse monoids. Seminário do CEAPEL, Universidade de Lisboa, May 5.
20. T. Brough. Word problems of free inverse semigroups as languages. Seminar on Semigroups, Automata and Languages, Centro de Matemática da Universidade do Porto, February 2.
21. A. Casimiro. Reductive algebraic monoids. Algebra and Logic Seminar, march 14, FCT-UNL.
22. R. Kahle, Applicative Theories for probabilistic classes of computational complexity, Seminar Logic and Theoretical Computer Science, Bern, Switzerland, 18.5.2017
23. R. Kahle, Von Cantor zu Hilbert, Seminar Die Grundlagen der Analysis aus philosophischer und historischer Sicht, ETH Zürich, Switzerland, 31.5.2017
24. A. Malheiro. Conjugation in semigroups. Algebra Seminar, Faculty of Mathematics, Informatics and Mechanics, Warsaw University.

...

1.4.5. Contributed talks in international and national conferences

1. A.J. Cain. Notions of simplicity and automated reasoning, Simplicity of Proofs in Automated Reasoning, July 6, Lisbon, Portugal.
2. A.J. Cain. Combinatorics of cyclic shifts in the plactic, hypoplactic, sylvester, and related monoids, 11th International Conference on Words, 14th September 14, Montréal, Canada.
3. A. Casimiro. Variational Integrators for reduced field equations, The Cape Verde international days on Mathematics 2017, 7 -12 de may, Praia, Cabo Verde.
4. A. Casimiro. Numerical Integrators in reduced coordinates for Lagrangian gauge field theories, 3rd International Conference on Symmetries, Dif-

- ferential Equations and Applications, “Centenary of Noether’s Theorem” 14-17 August, Istanbul, Turkey.
5. R. Fernandes. Existence theorems for nonnegative integral matrices with given line sums, in the Workshop Symmetry in Finite and Infinite Structures held on the 28th of July 2017, at the Faculty of Sciences, University of Lisbon, Portugal.
 6. R. Fernandes. Existence theorems for nonnegative integral matrices with given line sums, in The Second Malta Conference in Graph Theory and Combinatorics, 26-30 June 2017, Qawra, Malta.
 7. R. Kahle, Hilbert’s 24th Problem: 4 Questions, Simplicity of Proofs in Automated Reasoning, Universidade Nova de Lisboa, 7.6.2017
 8. R. Kahle, Hilbert and Bernays, PCC, Universität Göttingen, Germany, 26.7.2017
 9. A. Malheiro. Identities in plactic and related monoids, 94th Workshop on General Algebra - AAA94, in conjunction with the 5th Novi Sad Algebraic Conference - NSAC 2017, June 15, Novi Sad, Serbia.
 10. R. Kahle and G. Pulcini. Purity, Impurity, and Hilbert’s 24th Problem. Logica 2017. June 19-23, Hejnice Monastery, CZ.
 11. G. Pulcini. Second incompleteness theorem and the intensional problem. Brazilian Logic Conference, May 9-13, Pirenópolis, BR.
 12. R. Kahle, Hilbert’s Larger Programme, Seminário de Lógica Matemática FCUL, 17.2.2017
 13. R. Kahle, Paul Bernays (1888–1977), 30º Encontro do Seminário Nacional de História Matemática Academia Militar, Amadora, 1.7.2017
 14. T. Sousa. The Four Colour Theorem. Recreational Mathematics Colloquium V, Museu Nacional de História Natural e da Ciência, Lisboa
 15. T. Sousa. 280 anos de Teoria de Grafos. 30º Seminário Nacional da História da Matemática , Academia Militar.

• • •

1.4.6. Outreach

1. A. Casimiro and F. Rodrigues (coordinator) organized activities at “Clube-Math”, a Club for basic and high school students, which aims to show a different side of Mathematics, through fun and recreational activities, in order to stimulate skills and interest in this science.
2. J. Cabral, A. Casimiro, M. Jesus (organizer), J. Nogueira, C. Perdigão (organizer), F. Rodrigues, C. Saiago (organizer) were involved in "Matnova 2017", a summer school for undergraduate students.
3. I. Oitavem, F. Rodrigues (organizer) were involved in “Matemática na FCT”, a seminar program for students.
4. A. Casimiro, R. Fernandes, A. Malheiro, E. Nogueira, and I. Oitavem were involved in "Mathingenious 2017" a summer school for distinguished students of the 12th grade.
5. J. André, M. Jesus, A. Malheiro, E. Nogueira, I. Oitavem, F. Rodrigues (coordinator), C. Saiago, were involved at the "ExpoFCT 2017", an annual open event to young students.
6. J. André, J. Gaspar, M. Jesus, A. Malheiro, I. Oitavem, F. Rodrigues (coordinator), integrated the “Ciência Viva no Laboratório - 2017” program (26-30 June and 10-14 July).
7. F. Rodrigues was a member of the subcomission ICMI.PT of the portuguese nacional comission integrated on IMU (International Mathematical Union).
8. F. Rodrigues gave the training actions "MiMa Mãos na Matemática" and "Aplicações da Teoria dos Grafos", and presented the panel "A Ciência e o Desenvolvimento - Experiências Curriculares em Ciência dentro e fora da sala de aula - Que ilações" in the "IV Encontro da Casa das Ciências" at the University of Lisbon.
9. F. Rodrigues participated and coordinated the participation of CMA and of the Math Department of FCTUNL in the "Noite dos Investigadores 2017", "Feira da Matemática 2017" and CMA's participation in the Science and Technology Week 2017.

10. F. Rodrigues gave a training action "Workshop Matemática e Arte" at the University of Évora.
11. Jaime Gaspar, presented "Making a fairer coin from an unfair coin", at the "Canterbury Postgraduate Research Café", at the "Postgraduate Festival 2017" and at the "U3A [University of the Third Age] Showcase Event", University of Kent, United Kingdom, March and May, 2017.
12. T. Quinteiro gave a training action in "Semana Aberta" at ISEL/IPL.

. . .

1.4.7. Master thesis completed, supervised by CMA members

1. Duarte Ribeiro, Coherent presentation for the hypoplactic monoid of rank n , FCT-UNL, Julho de 2017

.....

1.5. Strategic Plan: 2015-2020

This text was written during the second semester of 2013 as part of the CMA's strategic plan for 2015-2020 and includes all members.

The group of Algebra and Logic consists of 13 Integrated Members and 9 Collaborators. All of them are mathematicians and, except TM Quinteiro (professor of ISEL), professors at the Mathematics Department of FCT-UNL.

Eight of the 13 Integrated Members (A Malheiro, VH Fernandes, MM Jesus, TM Quinteiro; J Nogueira; R Kahle, I Oitavem; AC Casimiro) were members of other research centers during 2008-12. They will reinforce the already existing research fields, and will extend the Center's expertise to new areas. During 2008-12 these new members published 6 book-chapters and 32 papers in international peer-reviewed journals: J Algebra, Algebr Colloq, Ann Pure Appl Logic, Commun Algebra, Finite Fields Appl, Glasg Math J, Inf Comput, Int J Math, J Geom Phys, J Log Comput, Math Log Q, Publ Math-Debrecen, Rev Symb Log, Semigroup Forum, Theor Comput Sci, Bull Malays Math Sci Soc. They pursued research in Semigroup/Automata Theory (1), Finite Fields (2), Logic (3), Algebraic and Differential Geometry (4):

(1)A Malheiro obtained results for some classes of rewriting systems and its associated monoids; in particular he showed, answering a question of Fields medalist E Zelmanov, that Plactic monoids of finite rank are biautomorphic. Most of the work of VH Fernandes, and his former PhD students MM Jesus and TM Quinteiro, was devoted

to the study of transformation semigroups in the special case of monotone transformations; he also obtained results on aspects of special classes of semigroups, such as block-groups and quotient numerical semigroups.

(2) J Nogueira described several configurations which give rise to standard and non-standard f -subgroups for linear recurrences of order 2, and also a number of families of non-standard f -subgroups for recurrences of order greater than 2.

(3) The team consists of 2 Integrated Members, I Oitavem, working in computational complexity and R Kahle, also a computer scientist, coming from mathematical proof theory, and a Collaborator J Gaspar, with a recent PhD in mathematical proof theory, working now in cryptography.

(4) AC Casimiro proved the equivalence between the (poly)stability notion for points of a character variety with respect to the action of an algebraic group G , and the (complete reducibility) irreducibility notion of subgroups of G . She also obtained a discrete geometric formulation of variational calculus in several independent variables. The research carried out by the remaining Integrated Members focus in the areas of: Linear Algebra, where CM Saiago works in eigenvalue problems for Hermitian matrices with a given graph; Semigroup Theory, where MH Almeida Santos is addressing the influence of certain elements and subsemigroups in the structure of regular semigroups; Algebraic topology, K-theory, homological algebra, and non-abelian algebraic geometry, where G. Tabuada developed a theory of noncommutative motives, following a program of Fields Medalist M Kontsevich; Higher Categories and Topological Quantum Field theories, where J Martins works mainly on Higher Gauge Theory and Categorification; Extremal Graph Theory and Combinatorics, where T Sousa developed research in graph decomposition and its colored or Ramsey version. The following researchers are currently affiliated to CMA as Collaborators: C Perdigão, MF Rodrigues (Linear/Multilinear Algebra); M Silva, H Liu (Combinatorics, Number and Graph Theory); JV Carvalho, H Silva (Universal Algebra); J Cabral (Algebraic Geometry); J André (Semigroup Theory); J Gaspar (Proof Theory and Cryptography); B. Gohla (Higher categories). During 2008-12 they published 19 papers in peer-reviewed journals: *Commun Algebra*, *Algebra Univers*, *Discrete Appl Math*, *Discrete Math*, *Linear Algebra Appl*, *J Graph Theory*, *Siam J Discrete Math*, *Theor Comput Sci*, *Semigroup Forum*, *Math Log Q*, *J Comb Number Theory*, *Comptes Rendus L'Acad sci*, *Stud Logica*, *J Symb Log*, and *Notre Dame J Formal Logic*. An expansion of the Group is expected: new students and new collaborators.

The overall aim is to improve the current (already advanced) level of scientific research thereby increasing the number of published papers in highly reputed international peer-reviewed journals. Adding to the research objectives, the Group intends

to increase internal collaborations among members of the Center and to contribute to have a competitive PhD program in Mathematics at FCT-UNL, therefore bringing PhD students to the Center. The Group will address the important issues:

1) I Oitavem and R Kahle will focus on Foundational research in Proof Theory (PT) and Implicit Computational Complexity (ICC). PT: formal theories accessible to a proof-theoretic analysis and with wide syntactical expressive power. ICC: design and analysis of restricted recursion schemata suitable to characterize classes of computational complexity. Interdisciplinarity Philosophy: the notion of proof and intentionality; History: the legacy of the rise of modern logic; Linguistics: sense and denotation as proof and truth; Computer science: interactive theorem provers, functional programming, and computational complexity.

2) G Tabuada plans to bridge the gap between motives and noncommutative motives by constructing an explicit functor from Voevodsky's triangulated category of mixed motives to Kontsevich's triangulated category of noncommutative mixed motives.

3) JF Martins will address: a) Categorification of Drinfeld associators and the 4-term relations, via a Lie-2-algebra of chord diagrams, in order to extend the Kontsevich integral. b) Harmonic analysis for representations of Lie categorical-groups, in order to address path integrals for 2-BF theories.

4) In Graph Theory T Sousa will pursue research in graph decomposition, the main problem being finding the smallest number $f(n,H)$ such that, any graph on n vertices admits a decomposition into edge disjoint copies of a fixed graph H and single edges with at most $f(n,H)$ parts. T Sousa also intends to study the Ramsey/colored version of this problem, when the ground graph is colored, the goal being to find an optimal monochromatic H -decomposition. M Silva will address the Ramsey problems for infinite words and Interval Coloring.

5) In Algebraic Combinatorics we intend to obtain: a) Grobner-Shirshov basis for free associative algebras, arising from crystal graphs as in Kashiwara's theory. b) Characterization of linear independence in orbital subspaces by the RSK correspondence and pairs of Young semistandard tableaux.

6) The research topic in Linear Algebra is Inverse Eigenvalue Problems and eigenvalue multiplicities of Hermitian matrices with a given graph.

7) In Finite Fields the research topic concerns the classification of f -groups as standard/nonstandard, their link with the restricted period and with cyclic linear codes.

8) In Semigroup Theory and Universal Algebra, the group plans to: a) Study transformation semigroups under several different aspects: combinatorial properties, congruences, presentations, maximal subsemigroups, automorphisms, endomorphisms,

semidirect products, and other constructions, pseudovarieties generated by, etc. We note that transformation semigroups are strongly connected with automata, this being one of the deep links between Theoret Comp Sci and Abstract Algebra. b) Study special classes of semigroups, for instance block-groups or ordered semigroups. In particular, investigate elements of a semigroup that are structurally important (e.g. idempotents or the biggest idempotent with respect to a particular property). c) Study known algebras with an additional unary operation, such as semigroups, distributive lattices and Ockham algebras.

9) Algebraic and Differential Geometry: a) The topology and singularities of character varieties of free group representations in a real Lie group and the Schottky uniformization problem for principal bundles over algebraic curves. b) The geometric formulation of variational problems involving principal bundles. c) Local fundamental groups of plane curves

Research Group

Analysis

Highlights

1. Several members of the group were involved in the organization of the Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences, Escola de Ciências e Tecnologia, Universidade de Évora, Portugal, January 31- February 3, 2017. <http://dsabns2017.fc.ul.pt/>
2. Maira Aguiar: Vice-President of the European Society of Mathematics and Theoretical Biology, 2018-2020.
3. Fabio Chalub: Member of the Applied Mathematics Committee of the European Mathematical Society, 2018-2020.

.....

2.1. Team

...

2.1.1. Integrated Members

1. **Ana Margarida Fernandes Ribeiro** - amfr@fct.unl.pt
2. **Fabio Augusto da Costa Carvalho Chalub** - chalub@fct.unl.pt
3. **Filipe Serra de Oliveira** - fso@fct.unl.pt
4. **Gonçalo Nuno Rosado Moraes** - gnupost@gmail.com
5. **Luís Manuel Trabucho de Campos** - trabucho@fct.unl.pt
6. **Magda Stela de Jesus Rebelo** - msjr@fct.unl.pt
7. **Maria Fernanda Almeida Cipriano Salvador Marques** - mfsm@fct.unl.pt
8. **Maria Luísa Martins Macedo de Faria Mascarenhas** - mlfm@fct.unl.pt
9. **Nuno David de Jesus Lopes** - ndlopes@gmail.com
10. **Oleksiy Karlovych** - oyk@fct.unl.pt
11. **Paula Cristiana Costa Garcia Silva Patrício Rodrigues** - pcpr@fct.unl.pt
12. **Rogério Ferreira Martins** - roma@fct.unl.pt

...

2.1.2. Other Researchers/Collaborators

1. **Bento José Carrilho Miguens Louro** - bjl@fct.unl.pt
2. **Cláudio António Rainha Aires Fernandes** - caf@fct.unl.pt
3. **Maria de Serpa Salema Reis de Orey** - mssso@fct.unl.pt
4. **Maria do Céu Cerqueira Soares** - mcs@fct.unl.pt
5. **Paulo José Fernandes Louro Ribeiro Doutor** - pjd@fct.unl.pt

.....

2.2. Funding

...

2.2.1. Projects led by CMA members

1. Dispersive Evolution Equations, Convénio FCT-CAPES (2016-2017).
PI Portugal: **Filipe Oliveira**, PI Brazil: Felipe Linares (IMPA, Brazil)

Total funding: €9.200,00. CMA funding: €2.300,00.

2. Prémio “Estímulo à Investigação 2016”, Fundação Calouste Gulbenkian (2016-2017).

Monte Carlo na Equação Hamilton-Jacobi-Bellman

MSc student: Diogo Pereira, Supervisor: **Fernanda Cipriano**.

Total funding: €12.500,00 CMA funding: €10.000,00

...

2.2.2. Projects with the participation of CMA members

1. M. Aguiar is a MC Member of the COST ACTION CA16231 European Network of Vaccine Adjuvants (since November 2017). http://www.cost.eu/COST_Actions/ca/CA16231
2. M. Aguiar is a MC Member of the COST ACTION CA16227 Investigation and Mathematical Analysis of Avant-garde Disease Control via Mosquito Nano-Tech-Repellents (since September 2017). http://www.cost.eu/COST_Actions/ca/CA16227
3. M. Rebelo is a MC Member of the COST ACTION CA15225 Fractional-order systems; analysis, synthesis and their importance for future design (since May 2016). http://www.cost.eu/COST_Actions/ca/CA15225

.....

2.3. Publications

...

2.3.1. Publications in the Web of Science database

- [1] **M. Aguiar**, C. Braumann, B. W. Kooi, A. Pugliese, and N. Stollenwerk. Preface special issue “dynamics in bio-systems” (DSABNS 2016). *Ecol. Complex.*, 30(SI):1, JUN 2017.
- [2] **M. Aguiar**, S. B. Halstead, and N. Stollenwerk. Consider stopping dengvaxia administration without immunological screening. *Expert Rev. Vaccines*, 16(4):301–302, APR 2017.
- [3] S. S. Allaei, T. Diogo, and **M. Rebelo**. Analytical and computational methods for a class of nonlinear singular integral equations. *Appl. Numer. Math.*, 114(SI):2–17, APR 2017. 5th International Workshop on Analysis and Numerical Approximation of Singular Problems (IWANASP), Lagos, PORTUGAL, OCT 22-24, 2015.

- [4] C. J. S. Alves, **N. F. M. Martins**, and S. S. Valtchev. Extending the method of fundamental solutions to non-homogeneous elastic wave problems. *Appl. Numer. Math.*, 115:299–313, MAY 2017.
- [5] **F. A. C. C. Chalub** and M. O. Souza. On the stochastic evolution of finite populations. *J. Math. Biol.*, 75(6-7):1735–1774, DEC 2017.
- [6] N. Chemetov and **F. Cipriano**. Well-posedness of stochastic second grade fluids. *J. Math. Anal. Appl.*, 454(2):585–616, OCT 15 2017.
- [7] J.-P. Dias and **F. Oliveira**. On a quasilinear nonlocal Benney system. *J. Hyperbolic Differ. Equ.*, 14(1):135–156, MAR 2017.
- [8] L. L. Ferras, N. J. Ford, M. L. Morgado, **M. Rebelo**, G. H. McKinley, and J. M. Nóbrega. A Primer on Experimental and Computational Rheology with Fractional Viscoelastic Constitutive Models. In Zatloukal, M, editor, *Novel Trends In Rheology VII*, volume 1843 of *AIP Conference Proceedings*, 2017. Conference on Novel Trends in Rheology VII, Tomas Bata Univ Zlin, Zlin, Czech Republic, JUL 26-27, 2017.
- [9] R. Ferreira, I. Fonseca, and **M. L. Mascarenhas**. A chromaticity-brightness model for color images denoising in a Meyer’s “ $u + v$ ” framework. *Calc. Var. Partial Differ. Equ.*, 56(5), OCT 2017.
- [10] P. Hasto and **A. M. Ribeiro**. Characterization of the variable exponent Sobolev norm without derivatives. *Commun. Contemp. Math.*, 19(3), JUN 2017.
- [11] **A. Y. Karlovich**. Toeplitz Operators on Abstract Hardy Spaces Built upon Banach Function Spaces. *J. Funct. space*, 2017.
- [12] **A. Y. Karlovich**, Y. I. Karlovich, and A. B. Lebre. Necessary fredholm conditions for weighted singular integral operators with shifts and slowly oscillating data. *J. Integral Equ. Appl.*, 29(3):365–399, FAL 2017.
- [13] **A. Y. Karlovich**, Y. I. Karlovich, and A. B. Lebre. The index of weighted singular integral operators with shifts and slowly oscillating data. *J. Math. Anal. Appl.*, 450(1):606–630, JUN 1 2017.
- [14] M. L. Morgado and **M. Rebelo**. Well-posedness and numerical approximation of tempered fractional terminal value problems. *Fract. Calc. Appl. Anal.*, 20(5, SI):1239–1262, OCT 2017. 8th International Conference on Transform Methods

and Special Function (TMSF), Bulgarian Acad Sci, Inst Math & Informat, Sofia, BULGARIA, AUG 27-30, 2017.

- [15] M. L. Morgado, **M. Rebelo**, L. L. Ferras, and N. J. Ford. Numerical solution for diffusion equations with distributed order in time using a Chebyshev collocation method. *Appl. Numer. Math.*, 114(SI):108–123, APR 2017. 5th International Workshop on Analysis and Numerical Approximation of Singular Problems (IWANASP), Lagos, PORTUGAL, OCT 22-24, 2015.
- [16] N. Stollenwerk, P. F. Sommer, B. Kooi, L. Mateus, P. Ghaffari, and **M. Aguiar**. Hopf and torus bifurcations, torus destruction and chaos in population biology. *Ecol. Comp.*, 30(SI):91–99, JUN 2017.

• • •

2.3.2. Other publications in peer-reviewed journals

- [1] **M. Aguiar** and N. Stollenwerk. Mathematical models of dengue fever epidemiology: multi-strain dynamics, immunological aspects associated to disease severity and vaccines. *Communication in Biomathematical Sciences*, 1:1–12, 2017.

• • •

2.3.3. Book (edited)

- [1] Bini, Dario and Ehrhardt, Torsten and **Karlovich, Alexei Yu.** and Spitkovsky, Ilya M. (eds.) Large Truncated Toeplitz Matrices, Toeplitz Operators, and Related Topics. The Albrecht Böttcher Anniversary Volume. Birkhäuser Basel, 2017.

• • •

2.3.4. Other (international) publications

- [1] D. Bini, T. Ehrhardt, **A. Y. Karlovich**, and I. M. Spitkovsky (eds.). *Large Truncated Toeplitz Matrices, Toeplitz Operators, and Related Topics. The Albrecht Böttcher Anniversary Volume*. Birkhäuser Basel, Basel, 2017.
- [2] P. Ghaffari, K. P. Wijaya, **M. Aguiar**, L. Mateus, T. Gotz, and N. Stollenwerk. Optimal control with linear versus quadratic cost functions in disease prevention: From analytically treatable toy models to numerical analysis. In *Proceedings of the 17th International Conference on Mathematical Methods in Science and Engineering*, 2017.
- [3] N. Stollenwerk, R. Filipe, L. Mateus, P. Ghaffari, B. Kooi, S. Halstead, and **M. Aguiar**. Effective parameters, likelihoods and bayesian model selection

in application to epidemiological models: from shar to effective sir models. In *Proceedings of the 17th International Conference on Mathematical Methods in Science and Engineering*, 2017.

- [4] J. Nogueira, F. Rodrigues, and **L. Trabucho de Campos**. Inheritance issues. In *Actas de Recreational Mathematics Colloquium V, 28-31 Jan, 2017*,.

• • •

2.3.5. Other (national) publications

- [1] **M. Aguiar**. Dsabns 2017 eight workshop dynamical systems applied to biology and natural systems. *CIM Bulletin*, 38:8, 2017.
- [2] **F. Chalub**. Isto ainda vai interessar-te. *Gazeta de Matemática*, 182:20-22, 2017.
- [3] **F. Chalub**. A matemática do planeta vulcano. *Gazeta de Matemática*, 183:17-20, 2017.
- [4] **F. Chalub**. O povo é quem mais ordena? *Gazeta de Matemática*, 181:23-26, 2017.
- [5] **F. Oliveira** and J. Buescu. O currículo de matemática para o século xxi. In *Lei de Bases do Sistema Educativo Volume I*, Comissão Nacional de Educação, pages 141-177, 2017.

.....

2.4. Activities

• • •

2.4.1. Organization of conferences & sessions

1. M. Aguiar, F. Chalub and P. Patrício are members of the Scientific and Organizing Committees of the Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences, Escola de Ciências e Tecnologia, Colégio do Espírito Santo, Universidade de Évora, Portugal, January 31-February 3, 2017.

<http://dsabns2017.fc.ul.pt/>

• • •

2.4.2. Seminars & Short-courses

Organized by Fenanda Cipriano and Paulo Doutor

11 January: *The impact of the newly licensed dengue vaccine in endemic countries*, M. Aguiar, CMA/FCT/NOVA.

8 February: *Vector borne diseases on an urban environment—a multi-group model approach*, M. Souza, Universidade Federal Fluminense, Brazil.

21 February: *Spectral Variation Under Congruence*, C. Johnson, College of William and Mary, USA.

2 March: *Equações de Navier-Stokes tri-dimensionais: escoamentos estacionários num domínio exterior*, A. Silvestre, University of Lisbon, Portugal.

8 March: *Chaos via torus destruction in models of dengue fever and predator-prey systems*, N. Stollenwerk, University of Lisbon, Portugal.

15 March: *Analytical and numerical methods for some improved Boussinesq models for surface water waves*, N. Lopes, ISEL & CMA/FCT/NOVA.

22 March: *A chromaticity-brightness model for color images denoising*, L. Mascarenhas, CMA/FCT/NOVA.

29 March: *Domínios extremos assintóticos do Laplaciano*, P. Freitas, University of Lisbon, Portugal.

5 April: *Stochastic variational principles on Lie groups*, A. B. Cruzeiro, University of Lisbon, Portugal.

12 April: *A short review on unbalanced gradient flows and applications*, L. Monsaingeon, Lorraine University, France.

26 April: *The Kimura equation*, F. Chalub, CMA/FCT/NOVA.

10 May: *Novel probabilistic-based numerical tools for fast analyzing electrical properties in large-scale electronic circuits*, J.A. Acebron, ISCTE-IUL and INESC-ID/IST, Portugal.

3 May: *Characterization of Sobolev spaces through functionals without derivatives dependence*, A.M. Ribeiro, CMA/FCT/NOVA.

6 June: *Bounded Domains of negative multipliers*, G. Morais, ISEL & CMA/FCT/NOVA.

7 June: *Effective numerical solution of neural field equations*, P.M. Lima, University of Lisbon, Portugal.

14 June: *Bistability of evolutionary stable vaccination strategies in the reinfection SIRI model*, J.Martins, LIAAD-INESC TEC, University of Porto and ESTG, IPL, Portugal.

21 June: *Sobre um sistema de Schrödinger quadrático*, F. Oliveira, CMA/FCT/NOVA.

28 June: *Fractional Pennes' bioheat equation: theoretical and numerical studies*, M. Rebelo, CMA/FCT/NOVA.

5 July: *Paths to uniqueness of critical points and applications to partial differential equations*, H. Tavares, University of Lisbon, Portugal.

12 July: *A C^* -algebra of singular integral operators with shifts and PQC coefficients*, Yu. Karlovich, Universidad Autónoma de Estado de Morelos, Cuernavaca, México.

26 July: *On the Amick-Fraenkel conjecture*, E. Shargorodsky, King's College London, UK.

4 October: *The Coburn-Simonenko theorem for Toeplitz operators acting between Hardy type subspaces of different Banach function spaces*, O. Karlovych, CMA/FCT/NOVA.

28 October: *Turbulent flows through porous media*, H. Borges de Oliveira, University of Algarve, Portugal.

25 October: *Regularity and time-inhomogeneity in the Wright-Fisher dynamics*, F. Chalub, CMA/FCT/NOVA.

8 November: *Asymptotic distribution of singularities of solutions to ODEs in the complex plane*, D. Masoero, University of Lisbon, Portugal.

15 November: *Regularity of interfaces for a Pucci type segregation problem*, V. Quítalo, CoLab UT Austin, USA and University of Coimbra, Portugal.

22 November: *Weak-strong uniqueness for a fluid-rigid body interaction problem*, B. Muha, University of Zagreb, Croatia.

6 December: *The Monge-Ampere equation: Classical local applications and recent nonlocal developments*, F. Charro Caballero, University of Coimbra, Portugal.

• • •

2.4.3. Invited talks in international and national conferences

1. M. Aguiar, The impact of the newly licensed dengue vaccine in endemic countries, Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences, Escola de Ciências e Tecnologia, Colégio do Espírito Santo, Universidade de Évora, Portugal, January 31- February 3, 2017.
2. M. Aguiar, The impact of the newly licensed dengue vaccine in endemic countries, São Paulo School of Advanced Science in Arbovirology, Faculty of Medicine, University of São José do Rio Preto, São Paulo, Brazil, May 29 - June 9, 2017.
3. M. Aguiar, Modeling the implementation of dengue vaccine, 15th International Dengue Course. Challenges of Zika and Chikungunya transmission, Instituto Pedro Kouri, Havana, Cuba, August 7-11, 2017.
4. M. Aguiar, Modeling the implementation of dengue vaccine, Symposium on Biomathematics, SYMOMATH 2017, Bandung University of Technology, Indonesia, August 27-29, 2017.
5. M. Aguiar, Modeling the impact of dengue vaccine implementation, Simons Semester conference, Institute of Mathematics, Warsaw, Poland, December 7-9, 2017.
6. M. Aguiar, Modeling the implementation of dengue vaccine, IUIS-Brazil: Advanced Vaccine Course, Faculty of Medicine, São Paulo University, São Paulo, Brazil, December 11-15, 2017.
7. F. Chalub, The Kimura equation, Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences, Escola de Ciências e Tecnologia, Colégio do Espírito Santo, Universidade de Évora, Portugal, January 31- February 3, 2017.
8. F. Chalub, The Kimura equation, Mathematical Methods and Modeling of Biophysical Phenomena - 2017, IMPA, Rio de Janeiro, Brazil, November 30 - December 5, 2017.
9. P. Doutor, Rational behavior and social cost for vaccination in childhood diseases, Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences, Escola de Ciências e Tecnologia, Colégio do Espírito Santo, Universidade de Évora, Portugal, January 31- February 3, 2017.

10. O. Karlovych, Semi-Fredholm theory for singular integral operators with shifts and slowly oscillating data, International Workshop on Operator Theory and Applications, IWOTA 2017, Chemnitz, Germany, August 14-18, 2017.
11. R. Martins, A corrente que levita e todas as outras coisas que não sabemos, Bienal da Matemática, Rio de Janeiro, April 26, 2017.
12. R. Martins, My bike is an expert in Physics, Frontiers of physics, Annual IOPI Teachers of Physics Conference, University of Limerick, Ireland, September 23, 2017.
13. M. Aguiar, Dengue Vaccine for Travellers? The risks behind Dengvaxia recommendation, First Workshop Vaccines in Travelers promoted by the Sociedade Portuguesa de Medicina do Viajante, Lisbon, Portugal, November 24-25, 2017.
14. M. Aguiar, The impact of the newly licensed dengue vaccine in endemic countries, Workshop Day on Biomathematics. Centro de Matemática, Aplicações Fundamentais e Investigação Operacional (CMAFCIO), Lisbon University, Portugal, March 31, 2017.
15. L. Mascarenhas, A chromaticity-brightness model for color images denoising, Workshop Dedicated to the Memory of Graça Carita, Universidade de Évora, March 3-4, 2017.
16. A. M. Ribeiro, Supremal functionals: existence of minimizers in the scalar setting and obstacles when moving to the vectorial case, Workshop Dedicated to the Memory of Graça Carita, Universidade de Évora, March 3-4, 2017.
17. O. Karlovych, Semi-Fredholm theory for singular integral operators with shifts and slowly oscillating data, III CEAFEL Meeting, Universidade do Algarve, Faro, September 5-6, 2017.
18. N. D. Lopes, N. Santos, "A Matemática no Surf de Ondas Grandes - Previsão e Modelação", Escola de Verão da Sociedade Portuguesa de Matemática & MatOeste 2017 - Matemática do Mar, ESTG, Instituto Politécnico de Leiria, Portugal, July 13, 2017.

19. R. Martins, A minha bicicleta calcula áreas!, IV Encontro Internacional da Casa das Ciências, Lisboa, July 10, 2017.
20. M. Rebelo, “Numerical Analysis of Fractional Differential Equations of Caputo type (Mini-Course)”, Second Advanced Scholl on Integral Equations and Applications, Instituto Superior Técnico, Lisbon, May 18-20, 2017.

• • •

2.4.4. Contributed talks in international and national conferences

1. M. Aguiar, Modeling the implementation of dengue vaccine, IUIS-Brazil Advanced Course on Vaccines, São Paulo, Brazil, December 11-15, 2017.
2. F. Chalub, Regularity and time-inhomogeneity in the Wright-Fisher dynamics, Mathematical Models in Ecology and Evolution, City University of London, UK, July 10-12, 2017.
3. F. Cipriano, Optimal control for two-dimensional stochastic second grade fluids, International Conference on Stochastic Analysis and Applications: Stochastic Control, Information and Applications, Hammamet, Tunisia, October 24-27, 2017.
4. O. Karlovych, When does the norm of a Fourier multiplier dominate its L-infinity norm? Banach Spaces and Operator Theory with Applications, Poznan, Poland, July 3-7, 2017.
5. O. Karlovych, The Coburn-Simonenko theorem for Toeplitz operators acting between Hardy type subspaces of different Banach function spaces, Non-Linear Functional Analysis, Valencia, Spain, October 17-20, 2017.
6. P. Patrício, Barrier Vaccination, Eighth Workshop Dynamical Systems Applied to Biology and Natural Sciences, Escola de Ciências e Tecnologia, Colégio do Espírito Santo, Universidade de Évora, Portugal, January 31 - February 3, 2017.
7. M. Rebelo, Numerical approximation of tempered fractional terminal value problems, International Conference on Mathematical Modelling in Applied Sciences, ICMMAS'17, Peter the Great Saint Petersburg Polytechnic University, Saint Petersburg, Russia, July 24-28, 2017.

• • •

2.4.5. Master thesis completed, supervised by CMA members

1. Ângelo Martins, supervised by **F. Cipriano** and N. Martins (co-supervision).
Title of the Thesis: Application of the Malliavin Calculus the the study of the Greeks Date of defense: December 7, 2017.

• • •

2.4.6. Outreach activities

1. EXPO FCT 2017, FCT NOVA's open day, where the department received over 2000 students of secondary schools, April 19, 2017: M. Aguiar has prepared the activity "Epidemias e vacinas"; P. Doutor and M. Rebelo were co-organizers of the activities of the Department of Mathematics; M. Rebelo has prepared the activity "Como podemos usar a matemática para construir um molde ou desenho?"; M.C. Soares has prepared and supervised the activity "A yahyzoaogw e a tnoçrssãapio".
2. Summer School MathIngenious 2017 aimed at bright secondary school students (12th year), Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, July 5-7, 2017: M. Rebelo was a co-organizer; P. Doutor taught the module "Sabendo mais" of the course "Matemática e Vida"; A.M. Ribeiro taught the module "Sabendo mais" of the course "Matemática e Cosmos"; M.C. Soares taught the module "Sabendo mais" of the course "Matemática e Segurança"; L. Trabucho gave a lecture "A Matemática e o Cosmos - Conhecendo o Passado". <http://eventos.fct.unl.pt/mathingenious2017/>
3. Summer School MatNova 2017 aimed at bright secondary school students (10-11th years), Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, September 5-9, 2017: P. Doutor and A.M. Ribeiro were co-organizers; L. Trabucho gave a lecture "A Matemática de "O Número"; <http://eventos.fct.unl.pt/matnova2017/>
4. ProfNova 2017, a meeting of secondary school teachers. The meeting involved 50 participants, September 7-8, October 14 and November 25, 2017: P. Doutor was a co-organizer and gave a course on Integral Calculus
5. F. Chalub has a regular column at "Gazeta de Matemática", published by the Portuguese Mathematical Society.

6. P. Doutor, M.C. Soares are coordinators and M. Rebelo is a member of the Scientific Committee of “Concurso de Matemática Pangea-Portugal”, a math competition for basic and high school students (involving around 17,000 students at national level), academic year 2016/17.
7. P. Doutor and M.C. Soares supervised the activity “Laboratórios de Matemática - Criptografia” on the “Semana da Ciência e Tecnologia 2017”, promoted by Ciência Viva, November 22, 2017.
8. P. Doutor was a co-organizer of the internships of CMA for “Ciência Viva no Laboratório”, (involving 24 participants from secondary school and 21 investigators), June 26 - July 14, 2017.
9. P. Doutor was a co-organizer of the activities of CMA on the “Semana da Ciência e Tecnologia 2017”, promoted by Ciência Viva, November 20-24, 2017.
10. P. Doutor gave 3 lectures for students in secondary schools, about several topics in mathematics.
11. R. Martins gave a series of lectures for general public.
12. P. Patrício gave a series of lectures for students and general public at MatNova, “Ciência Viva no Laboratório”, “Noite Europeia dos Investigadores”, ExpoFCT.
13. M.Rebelo supervised the activity “Algoritmos Numéricos” for Ciência Viva students, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, July 14, 2017.
14. M.C. Soares is a co-organizer of ClubeMath, a Club for basic and secondary school students, which aims to show a different side of Mathematics, through fun and recreational activities, in order to stimulate skills and interest in this science <http://eventos.fct.unl.pt/clubemath>
15. M.C. Soares taught on the workshop “Mima-mãos na Matemática”, of the “IV Encontro Internacional da Casa das Ciências”, Faculdade de Ciências da Universidade de Lisboa, July 11, 2017.
16. M.C. Soares supervised the activity “Códigos e Criptografia” for Ciência Viva students, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, June 27, 2017.

17. M.C. Soares supervised the activity “Criptografia e Criptoanálise” on the European Researchers Night - “Noite dos Investigadores 2017”, in Museu Nacional de História Natural e da Ciência, Lisboa, September 29, 2017. M.C. Soares participated in the Portuguese Mathematical Society’s Fair, in Museu Nacional de História Natural e da Ciência, Lisboa, November 11, 2017
18. L. Trabucho gave a series of lectures for general public.

• • •

2.4.7. Other

1. M. Aguiar will serve as the Vice-President of the European Society of Mathematics and Theoretical Biology (2018-2020). and member of the board of the same society (2018-2023).
2. F. Chalub is a Vice-President of the Portuguese Mathematical Society since September 2016 and member of the Applied Mathematics Committee of the European Mathematical Society, 2018-2020.
3. F. Cipriano is a member of the Editorial Board of the journal “Communications on Stochastic Analysis”.
4. A.M. Ribeiro is a member of the Editorial Board of "Monographs in Applied Mathematics", Universitatea din Craiova.
5. P. Patrício is a “Vogal da Mesa da Assembleia Geral da Delegação Sul e Ilhas” of the Portuguese Mathematical Society.

.....

2.5. Strategic Plan: 2015-2020

This text was written during the second semester of 2013, as part of the CMA’s strategic plan for 2015–2020 and includes all members.

Here we describe our main objectives for the next five years. We give focus to projects with guaranteed funding (calculus of variation/imaging restoration and math- biology/epidemics/vaccinations). Afterwards, we describe other projects, with highlights in partial differential equations, numerical and functional analysis. Due to the lack of space, collaborators are not discriminated.

The work of AMR, LM, NA, OK and RF will focus on some variational methods used in image restoration. The restored image, obtained as a minimizer of a suitable energy functional, is generally a solution of a highly nonlinear and severely ill posed partial differential equation. The aim is to set these problems in appropriate functional frameworks and to carry out the corresponding mathematical analysis and numerical implementation. Part of this research will be funded in 2014-15 by FCT (24 keuros). AMR also works on minimization of functionals to ensure existence of minima when there is a lack of lower semicontinuity.

PCR, FC, MCS, PD work in the intersection between epidemiology and game theory. The main objective is to address the impact of voluntary vaccination in the spread of diseases, particularly in seasonal epidemics. The SIR epidemic model with periodic coefficients and voluntary vaccination will be considered and the aim is to look for optimal vaccination strategies. It is expected that a rational choice with respect to pulse vaccination, in the beginning or in the end of the season, will have different impact on the epidemics. These conditions will be analyzed for different vaccination types. This research will be funded in 2014-15 by FCT (25 keuros). FO studies local well-posedness issues and the existence and stability of solitary waves for the Zakharov- Kuznetsov equation, which models the propagation of nonlinear ionic-sonic waves in a magnetized plasma. FO also plans to research on singularity formation of solutions and is interested in adapting these methods to Schrodinger-Debye and Davey-Stewartson systems.

OK, CF will study convolution type operators in more general spaces than Banach spaces. Typical examples are Lebesgue spaces L_p and l_p for p less than one as well as more general Orlicz spaces generated by non-convex Orlicz functions. CF intend to investigate the Fredholm property in C^* algebras of nonlocal type operators generated by partial isometries. OK will prove boundedness conditions and Fredholm criteria for pseudodifferential operators with certain symbols of limited smoothness on variable exponent Lebesgue spaces over \mathbb{R}^n . LT will study Boussinesq-like wave models and, in collaboration with chemists, diffusion of chemical substances through membranes. Both studies will include the analytical and the numerical points of view. MR intends to develop a robust, efficient and stable method with a reasonable order of convergence for the numerical solution of the time-fractional diffusion equations. NM will use mesh-free inverse numerical methods to identify thermal and acoustic sources and obstacles.

JMG will study properties of level sets of ground-states, i.e. minimizers of the Dirichlet integral under volume constraints (or shape constraints such as quasi-concavity).

The approach consists in using small perturbations of Lipschitz functions that preserve the imposed constraints such as 'local' translations or rotations of superlevel sets. FCM will proceed the study of the inviscid limit and boundary layer problem to deterministic and stochastic Navier-Stokes equation, using the entropy and the large deviations techniques. RM will study the periodic sine- Gordon equation with friction, to find a topological characterization of the attractor. MO and BL will use control techniques to study over-determined and under-determined boundary value problems in PDE.

Research Group

Operations

Research

Highlights

1. Jorge Orestes Cerdeira was member of the evaluation panel in Mathematics for the PhD Scholarships – 2017 call of Fundação para a Ciência e Tecnologia.
2. Ana Luísa Custódio was stream organizer in the 21st Conference of the International Federation of Operational Research Societies, IFORS 2017, Québec City, Canada, 17 to 21 July 2017.
3. One PhD thesis and three masters' theses, supervised by group members, were successfully defended. Manuel Vieira is supervising a new PhD, in collaboration with École Polytechnique de Montréal.
4. Jorge Orestes Cerdeira, Ana Luísa Custódio and Isabel Gomes were jury members of prizes Isabel Themido/IO 2017, APDIO Best PhD Thesis 2017, Augusto Queiróz Novais in Process Systems Engineering 2017, respectively, awarded at conference IO 2017.
5. Jorge Orestes Cerdeira is Vice-President of APDIO (the Portuguese Operations Research Society), since 2016.

.....

3.1. Team

...

3.1.1. Integrated Members

1. **Ana Luísa da Graça Batista Custódio** – alcustodio@fct.unl.pt
2. **Isabel Cristina Silva Correia** – isc@fct.unl.pt
3. **Jorge Orestes Lasbarreres Cerdeira** – jo.cerdeira@fct.unl.pt
4. **Manuel Valdemar Cabral Vieira** – mvcv@fct.unl.pt
5. **Maria do Carmo Proença Caseiro Brás** – mb@fct.unl.pt
6. **Maria Isabel Azevedo Rodrigues Gomes** – mirg@fct.unl.pt
7. **Nelson Fernando Chibeles Pereira Martins** – npm@fct.unl.pt
8. **Paula Alexandra da Costa Amaral** – paca@fct.unl.pt
9. **Rui Alberto Pimenta Rodrigues** – rapr@fct.unl.pt
10. **Susana Maria Marques Henriques Botelho Baptista** – sbb@fct.unl.pt

...

3.1.2. Other Researchers/Collaborators

1. **Graça Maria Marques da Silva Gonçalves** – gmsg@fct.unl.pt
2. **Lídia Ludovina Lampreia Caeiro Pica Lourenço** – lll@fct.unl.pt
3. **Maria Paula da Costa Couto** – mpcc@fct.unl.pt

.....

3.2. Funding

...

3.2.1. Projects led by CMA members

1. Spatial conservation planning: reconciling biodiversity and human development in a dynamic world, SFRH/BPD/104077/2014 (2016-2018).
PI: Diogo André Alves Salgado Rodrigues Alagador
CMA member: **Jorge Orestes Cerdeira**
Total funding: €87358. CMA funding: €5460

.....

3.3. Publications

...

3.3.1. Publications in the Web of Science database

- [1] A. Agra, **J. O. Cerdeira**, and C. Requejo. A decomposition approach for the p-median problem on disconnected graphs. *Comput. Oper. Res.*, 86:79–85, OCT 2017.
- [2] D. Alagador and **J. O. Cerdeira**. Meeting species persistence targets under climate change: A spatially explicit conservation planning model. *Divers. Distrib.*, 23(6):703–713, JUN 2017.
- [3] M. F. Anjos and **M. V. C. Vieira**. Mathematical optimization approaches for facility layout problems: The state-of-the-art and future research directions. *Eur. J. Oper. Res.*, 261(1):1–16, AUG 16 2017.
- [4] M. F. Anjos and **M. V. C. Vieira**. On semidefinite least squares and minimal unsatisfiability. *Discret Appl. Math.*, 217(2):79–96, JAN 30 2017.
- [5] **C. P. Bras**, A. Fischer, J. J. Judice, K. Schoenefeld, and S. Seifert. A block active set algorithm with spectral choice line search for the symmetric eigenvalue complementarity problem. *Appl. Math. Comput.*, 294:36–48, FEB 1 2017.
- [6] **I. Correia** and T. Melo. A multi-period facility location problem with modular capacity adjustments and flexible demand fulfillment. *Comput. Ind. Eng.*, 110:307–321, AUG 2017.
- [7] J. Goncalves, **M. I. Gomes**, **M. Fonseca**, T. Teodoro, P. P. Barros, and M.-A. Botelho. Selfie Aging Index: An Index for the Self-assessment of Healthy and Active Aging. *Front. Med.*, 4, DEC 22 2017.
- [8] S. D. Karamintziou, **A. L. Custodio**, B. Piallat, M. Polosan, S. Chabardes, P. G. Stathis, G. A. Tagaris, D. E. Sakas, G. E. Polychronaki, G. L. Tsirogiannis, O. David, and K. S. Nikita. Algorithmic design of a noise-resistant and efficient closed-loop deep brain stimulation system: A computational approach. *PLoS One*, 12(2), FEB 21 2017.
- [9] **B. Mota**, A. Carvalho, **M. I. Gomes**, and A. Barbosa-Povoa. Sustainable supply chain design and planning: the importance of life cycle scope definition. In Espuna, A and Graells, M and Puigjaner, L, editor, *27TH European Symposium*

On Computer Aided Process Engineering, PT A, volume 40 of *Computer Aided Chemical Engineering*, pages 541–546, 2017. 27th European Symposium on Computer-Aided Process Engineering (ESCAPE), Barcelona, SPAIN, OCT 01-05, 2017.

• • •

3.3.2. Other (international) publications

- [1] **J. O. Cerdeira**, I. C. Lopes, and E. C. Silva. Scheduling the repairment of aircrafts' engines. In IEEE, editor, *International Conference on Control, Artificial Intelligence, Robotics & Optimization*, pages 259–267, 2017.
- [2] **N. Chibeles-Martins**, A. Marques, and T. Pinto-Varela. A bi-objective two step simulated annealing algorithm for production scheduling. In A. Espuña, M. Graells, and L. Puigjaner, editors, *27th European Symposium on Computer Aided Process Engineering*, volume 40 of *Computer Aided Chemical Engineering*, pages 1351 – 1356. Elsevier, 2017.
- [3] **A. L. Custódio**, K. Scheinberg, and L. N. Vicente. *Methodologies and software for derivative-free optimization*, chapter 37. MOS-SIAM Book Series. SIAM, Philadelphia, 2017.

• • •

3.3.3. Other (national) publications

- [1] **P. Amaral**. Matemática industrial em rede. *Gazeta de Matemática*, 181, 2017.
- [2] **P. Amaral**. O admirável mundo novo do big data. *Gazeta de Matemática*, 182, 2017.

• • •

3.3.4. Technical reports

- [1] **J. O. Cerdeira**, M. Cruz, and A. Gavina. Definition of the productivity regions: Problem presented by Raiz at the 127th european study group with industry 8th – 12th may 2017, university of aveiro, aveiro, portugal. Technical report, 2017.

• • •

3.3.5. Computational Applications

New version (0.13, 2017) of CRAN package subselect: Selecting Variable Subsets (a collection of functions which (i) assess the quality of variable subsets as surrogates for a full data set, in either an exploratory data analysis or in the context of a

multivariate linear model, and (ii) search for subsets which are optimal under various criteria), co-authored by Jorge Orestes Cerdeira.

<https://cran.r-project.org/package=subselect>

.....

3.4. Activites

...

3.4.1. Organization of conferences & sessions

1. 2nd Workshop for Ageing and Independent Living: Quantitative methods, Caparica, Portugal, 22nd February 2017, co-organized by Isabel Gomes
2. Big Data-Mathematics in Industry 4.0, Porto, Portugal, 2nd June 2017, Paula Amaral was member of the Organizing Committee and of the Program Committee
3. IO2017, 28 to 30 June 2017, Viana do Castelo, Portugal, Jorge Orestes Cerdeira, Ana Luísa Custódio, and Isabel Gomes were members of the Program Committee
4. 21st Conference of the International Federation of Operational Research Societies, IFORS 2017, Québec City, Canada, 17 to 21 July 2017, Ana Luísa Custódio was organizer of the Derivative-free Optimization stream
5. Optimization 2017, Lisbon, Portugal, 6 to 8 September 2017, Paula Amaral, Jorge Orestes Cerdeira, Ana Luísa Custódio, and Manuel Vieira were members of the Program Committee

...

3.4.2. Seminars & Short-courses at CMA

Organized by Jorge O. Cerdeira

22 March: *A multi-item inventory distribution problem: a Hospital case study*, Adelaide Cerveira, DM - UTAD.

22 March: *A general view on the Minimum Weighted Tree Reconstruction problem*, Cristina Requejo, DM - UA.

7 April: *Interior-point methods: complexity vs. superlinear convergence*, Florian Potra, Department of Mathematics and Statistics, University of Maryland, Baltimore County, USA.

31 May: *Multiresolution analysis for surfaces and applications*, Miguel Ángel Fortes, University of Granada, Spain.

24 November: *Dealing with messy data: optimization in an uncertain world*, Cláudia Soares, IST.

24 November: *Calibration of parameters in Dynamic Energy Budget models using Direct Search methods*, Jéssica Morais, IST.

13 December: *Lexicographic solutions for a tri-objective multi-period model to redesign a food bank supply chain network*, Margarida V. Pato, ISEG, CMAFCIO.

13 December: *Arc Routing Today - Theory vs Practice*, Maria Cândida Mourão, ISEG, CMAFCIO.

...

3.4.3. Ph.D. theses completed in 2017

1. Bernardo Ferreira de Almeida, Multi-skill resource-constrained project scheduling problems: models and algorithms, University of Lisbon, co-supervised by Isabel Correia

...

3.4.4. Supervision of Ph.D. students

1. William Ferreira, École Polytechnique de Montréal, co-supervised by Manuel Vieira
2. Bruna Mota, Programa Doutoral MIT Portugal Leaders for Technical Industries - EDAM: Integrated sustainable supply chain design and planning, co-supervised by Isabel Gomes

...

3.4.5. Invited talks in international and national conferences

1. S. Dias, P. Brito, P. Amaral, and A. Freitas, New insights in political and biological problems by symbolic discriminant analysis, Workshop on Symbolic Data Analysis, Ljubljana, Slovenia, June 2017
2. P. Amaral and I. Bomze, Min-max fractional quadratic over linear problems, EUROPT 2017, Montréal, Canada, July 2017

3. P. Amaral and I. Bomze, Completely positive lower bounds for min-max fractional quadratic problems, IFORS 2017, Québec City, Canada, July 2017
4. P. Amaral and I. Bomze, Completely positive formulations for minimax fractional quadratic problems, Optimization 2017, Lisbon, Portugal, September 2017
5. S. Baptista, A. P. Barbosa-Póvoa, L. F. Escudero, I. Gomes, and C. Pizarro, A matheuristic for the design and planning of a closed loop supply chain with time stochastic dominance constraints, European Conference on Stochastic Optimization - ECSO 2017, Roma, September 2017
6. C. P. Brás, A. Fisher, J. J. Júdice, K. Schönefeld, and S. Seifert, A block active set algorithm for fractional quadratic programming on the unit simplex and for the symmetric eigenvalue complementarity problem, Optimization 2017, Lisbon, Portugal, September 2017
7. Jorge Orestes Cerdeira, The train frequency compatibility problem, Optimization 2017, Lisbon, Portugal, September 2017
8. A. L. Custódio and J. F. A. Madeira, MultiGLODS: global and local multi-objective optimization using direct search, 15th EUROPT Workshop on Advances in Continuous Optimization, Montréal, Canada, July 2017
9. A. L. Custódio and S. Marcos, An approach based on nonmonotone directional direct search to noisy optimization, IFORS 2017, Québec, Canada, July 2017
10. A. L. Custódio and J. F. A. Madeira, MultiGLODS: global and local multi-objective optimization using direct search, Optimization 2017, Lisbon, Portugal, September 2017
11. Isabel Gomes, Modelling and optimization of sustainable logistics activities: two case studies, 2017 Big Data - Mathematics in Industry 4.0, Porto, Portugal, June 2017

• • •

3.4.6. Contributed talks in international and national conferences

1. Jorge Orestes Cerdeira, A model to minimize costs and promote species persistence under climate change, Eighth Workshop on Dynamical Sys-

- tems Applied to Biology and Natural Sciences (DSABNS 2017), Évora, Portugal, 31 January – 3 February 2017
2. Maria de Lourdes Afonso, Nelson Chibeles-Martins, and Joana Fradinho, Heuristic approach to evaluate the fire risk sub-module in Solvency II, IME 2017, Vienna, Austria, July 2017
 3. I. Correia and T. Melo, A multi-period facility location problem with modular capacity adjustments and flexible demand fulfillment, ISOLDE XIV – 14th International Symposium on Locational Decisions, Toronto and Huntsville, Canada, July 2017
 4. I. Correia and T. Melo, A dynamic capacitated location problem with modular capacity adjustments and flexible demand satisfaction, Optimization 2017, Lisbon, Portugal, September 2017
 5. Graça Marques Gonçalves and Lídia Lampreia Lourenço, Comparative study of mathematical formulations for the K clusters with fixed cardinality problem, Optimization 2017, Lisbon, Portugal, September 2017
 6. Manuel Vieira, A continuous formulation for the multi-row facility layout problem with rectilinear distances, Optimization 2017, Lisbon, Portugal, September 2017
 7. Maria de Lourdes Afonso, Nelson Chibeles-Martins and Joana Fradinho, Abordagem metaheurística na avaliação no submódulo de risco de Incêndio em Solvência II, IO2017, Valença, Portugal, June 2017
 8. A. L. Custódio and S. Marcos, An approach based on nonmonotone directional direct search to noisy optimization, IO 2017, Valença, Portugal, June 2017
 9. Isabel Gomes, A biased-randomized heuristic for the home healthcare routing problem, IO2017, Valença, Portugal, June 2017
 10. Manuel Vieira, A formulation for the multi-row layout problem, IO2017, Valença, Portugal, June 2017

• • •

3.4.7. Outreach

1. “Boas decisões com Matemática”, activity in EXPO FCT 2017, 19th April 2017 and in Noite dos Investigadores, 29th September 2017, co-organized

by Paula Amaral and Isabel Correia

2. “Ir ali e voltar: um problema de 1 milhão de dólares”, activity in EXPO FCT 2017, 19th April 2017
3. “Ciência Viva no Laboratório 2017”, June 2017, activity organized by Susana Baptista
4. “Matemática e Biologia da Conservação: Mundos à parte?”, seminar in 60 Minutos de Ciência, National Museum of Natural and Science History, Caleidoscópico, Lisbon, 16th March 2017, lectured by Jorge Orestes Cerdeira
5. “A Matemática na conservação da biodiversidade”, seminar in Tardes de Matemática em Lisboa, SPM, bookstore Almedina-Saldanha, Lisbon, 22nd March 2017, lectured by Jorge Orestes Cerdeira
6. “A Matemática na seleção de áreas prioritárias para a conservação da biodiversidade”, seminar in Jornadas de Matemática, Instituto Superior Técnico, Lisbon, 4 to 7 April 2017, lectured by Jorge Orestes Cerdeira
7. “Matemática e Biologia da Conservação: mundos à parte?”, seminar in MatNova 2017, FCT-UNL, Caparica, 5 to 9 September 2017, lectured by Jorge Orestes Cerdeira
8. Ana Luísa Custódio was member of the Organizing Committee of the 7th Journey of Mathematics of FCT-UNL, 14th March 2017, FCT-UNL, Portugal
9. Ana Luísa Custódio was project evaluator for the contest FCT Challenge 2017, organized by FCT-UNL, May 2017
10. Ana Luísa Custódio was Coordinator of the Organizing Committee of the Summer School in Mathematics for merit senior high school students, MathIngenious 2017, 5 to 7 July 2017, FCT-UNL, Portugal Calculando a Idade das Estrelas: Uma breve introdução à Optimização, seminar in MathIngenious 2017, FCT-UNL, Caparica, 5 to 7 July 2017, lectured by Ana Luísa Custódio
11. Nelson Chibeles-Martins was “FCT/NOVA Ambassador”

• • •

3.4.8. Master theses completed, supervised by CMA members

1. Joana Fradinho, Metaheuristic method to evaluate the fire risk sub-module in Solvency II, Mestrado em Matemática e Aplicações - Ramo Atuariado, Estatística e Investigação Operacional, FCT-UNL, co-supervised by Nelson Chibeles-Martins
2. Joana Bernardo, Reorganização e políticas de gestão de armazenamento: o problema da Distrinews II, Mestrado em Matemática e Aplicações - Ramo Atuariado, Estatística e Investigação Operacional, FCT-UNL, supervised by Isabel Gomes
3. Ana Raquel Pena de Aguiar, Planning home health care services – a routing and scheduling problem, Mestrado em Engenharia Biomédica, IST, University of Lisbon, co-supervised by Isabel Gomes

• • •

3.4.9. Other supervisions

1. Tiago Monteiro-Henriques, Pos-Doc scholarship SFRH/BPD/115057/2016 “Native Forests”, initiated in 2017, supervised by Jorge Orestes Cerdeira
2. Diogo André Alagador, framed in project SFRH/BPD/104077/2014: Spatial conservation planning: reconciling biodiversity and human development in a dynamic world, initiated in 2016, supervised by Jorge Orestes Cerdeira
3. Jéssica Vanessa Vaz Morais, scholarship framed in the project MARETEC 2015-2017, co-supervised by Ana Luísa Custódio

.....

3.5. Strategic Plan: 2015-2020

This text was written during the second semester of 2013 as part of the CMA's strategic plan for 2015–2020 and includes all members.

The group develops research in two main areas: Non-Linear Optimization (NLO) and Combinatorial Optimization (CO). The topics addressed in NLO include: Derivative-free Optimization (DFO), Complementarity Problems (CP), Semi-definite Programming (SDP); in CO include: Networks Design Models (NDM), Hub Location Problems

(HL), Vehicle Routing Problems (VRP), Resource Constraint Project Scheduling Problem (RPS). Besides theoretical results, part of the work has been directed to real applications (as retail distribution [SBN10], electric and electronic equipment [FGB11]), reports in the scope of European Study Groups in Industry (<http://www.maths-in-industry.org>), and to the development of free available software, e.g DMS (<http://www.mat.uc.pt/dms>), SID-PSM (<http://www.mat.uc.pt/sid-psm/>), GLODS (<http://ferrari.dmat.fct.unl.pt/personal/alcustodio>) MulTyLink (<http://pascal.iseg.utl.pt/rbras/MulTyLink/>), subselect (<http://cran.r-project.org/web/packages/subselect/index.html>). Brief description of specific work to be carried out on the topics above follows.

DFO will address (i) the development of algorithms for global multiobjective problems, with applications in engineering. Software will be developed integrating ideas from previous codes (DMS and GLODS) (ii) noisy DFO problems, motivated by questions arising in Chemical Engineering, and for which a study on derivative-free estimates of the Lipschitz constant will be developed.

CP will, in particular, address the Second Order Cones for the Eigenvalue Complementarity Problem (EiCP), and Inverse and Quadratic EiCP, both for symmetric and non-symmetric cases by designing algorithms to solve the problem and explore the solution of the problems that occur in different classes of applications, as control theory and structural analysis.

SDP will investigate connections between SDP and the Satisfiability problem (SAT), namely between the infeasibility of the SDP relaxation and unsatisfiability of the SAT.

The group addresses a number of different problems in the scope of NDM: (1) previous work has focus on supply chain design with cost minimization [SBN10]; the work will now continue into a multiobjective approach to model sustainability by considering economic, environmental and social objectives; (2) the development of single and multiobjective metaheuristics to tackle computational complexity when the modelling of supply chain following previous work [CPBN12], (3) the modelling of sources of supply chain uncertainty by stochastic formulation with the development of decomposition based solution strategies as previous work follow up [BGB12], (4) work will continue on water network design problem considering piecewise-linear relaxations and applying principles of bilinear relaxation, (5) development of new quantitative models for variants of the classical hub location problems; (6) Past work on a generalization of the (node version of the) minimum Steiner tree and the minimum Steiner forest focused on the development of heuristics to handle very large instances (ENVIRON MODELL SOFTW, 40:336-339). The work will now be directed to the study of the polyhedra associated to a cut-covering formulation. The problem has

applications in the design of ecological corridors linking habitats for multiple species. VRP will continue its study on the modelling of multi-compartment vehicles and periodic issues intrinsic to collection problems, and on the dial-a-ride problem arising within the context of medical services. RPS will, in particular, focus on (1) the formulation of new variants for the resource constrained project scheduling problem with flexible resources following the previous work, (2) the tailoring of solution procedures to improve the quality of obtained feasible solutions.

The group will develop a PhD program on Operations Research or integrate Operations Research as a discipline in the PhD program on Mathematics already in place at the Department of Mathematics of FCT/UNL

Research Group

**Statistics and Risk
Management**

Highlights

1. Participation in one national and three international projects (one bilateral with Germany).

.....

4.1. Team

...

4.1.1. Integrated Members

1. **Ayana Maria Xavier Furtado Mateus** - amf@fct.unl.pt
2. **Carla Maria Lopes da Silva Afonso dos Santos** - mailcmlsas@yahoo.com
3. **Carlos Manuel Agra Coelho** - cmac@fct.unl.pt
4. **Célia Maria da Silva Fernandes** - cfernandes@deetc.isel.pt
5. **Cristina Paula Silva Dias** - cpsilvadias@gmail.com
6. **Dina Maria Morgado Salvador** - dina.salvador@estsetubal.ips.pt
7. **Dora Susana Raposo Prata Gomes** - dsrp@fct.unl.pt
8. **Elsa Estevão Fachadas Nunes Moreira** - efnm@fct.unl.pt
9. **Filipe José Gonçalves Pereira Marques** - fjm@fct.unl.pt
10. **Francisco Paulo Vilhena Antunes Bernardino Carvalho** - fpcarvalho@ipt.pt
11. **Frederico Almeida Gião Gonçalves Caeiro** - fac@fct.unl.pt
12. **Gracinda Rita Diogo Guerreiro** - grg@fct.unl.pt
13. **Inês Jorge da Silva Sequeira** - ijs@fct.unl.pt
14. **Isabel Cristina Maciel Natário** - icn@fct.unl.pt
15. **João Beleza Teixeira Seixas e Sousa** - jsousa@deetc.isel.ipl.pt
16. **João Tiago Praça Nunes Mexia** - jtm@fct.unl.pt
17. **Luís Miguel Lindinho da Cunha Mendes Grilo** - lgrilo@ipt.pt
18. **Luís Pedro Carneiro Ramos** - lpcr@fct.unl.pt
19. **Manuel Leote Tavares Inglês Esquível** - mle@fct.unl.pt
20. **Maria de Lourdes Belchior Afonso** - lbafonso@fct.unl.pt
21. **Marta Cristina Vieira Faias Mateus** - mcm@fct.unl.pt
22. **Miguel dos Santos Fonseca** - fmig@fct.unl.pt
23. **Paulo José Raimundo Ramos** - pramos@deetc.isel.ipl.pt
24. **Pedro José dos Santos Palhinhas Mota** - pjpm@fct.unl.pt

25. **Ricardo Jorge Viegas Covas** - rjvc@fct.unl.pt
26. **Ricardo Pinto Moura** - ricardo.moura.rpm@gmail.com
27. **Rui Manuel Rodrigues Cardoso** - rrc@fct.unl.pt
28. **Sandra Cristina Dias Nunes** - sandra.nunes@esce.ips.pt
29. **Sandra Inês da Cunha Monteiro** - sandra.ines.monteiro@esce.ips.pt
30. **Vanda Marisa da Rosa Milheiro Lourenço** - vmml@fct.unl.pt

...

4.1.2. Other Researchers/Collaborators

1. **Adilson de Jesus Martins da Silva** - adilson.dasilva@docente.unicv.edu.cv
2. **Célia Maria Pinto Nunes** - celian@ubi.pt
3. **Dário Jorge da Conceição Ferreira** - dario@ubi.pt
4. **Gonçalo José Nunes dos Reis** - g.dosreis@ed.ac.uk
5. **Iola Maria Silvério Pinto** - ipinto@deetc.isel.ipl.pt
6. **José Moniz Lopes Fernandes** - jose.fernandes@docente.unicv.edu.cv
7. **Rita Cristina Pinto de Sousa** - ritasousa03@hotmail.com
8. **Rui Manuel Pesado Alberto** - rui.pesado@sapo.pt
9. **Sandra Maria Bargão Saraiva Ferreira** - sandraf@ubi.pt
10. **Sónia Maria Timóteo Inácio** - sonia.maria.inacio@gmail.com

...

4.1.3. Ph.D. Students

1. **Adilson Marques Almeida** - ama.almeida@campus.fct.unl.pt
2. **Alberto Chicafo Mulenga** - mulengamz@yahoo.com.br
3. **Cristina Isabel Fernandes Nobre** - cris_nobre@hotmail.com
4. **Inês Isabel Susano Gomes Mota** - i.mota@fct.unl.pt
5. **Ivanilda Maria dos Santos Cabral Semedo** -
ivanilda.cabral@docente.unicv.edu.cv
6. **Sheyla Ratan Rodrigues Cassy** - sheylaratan@hotmail.com

.....

4.2. Funding

1. Luso-German Actions: Robust statistical methods in plant genomic selection and prediction studies (PT/A13/17-DE/57339863).
Funding: 4.000,00 Euro (PT); 2.846,00 Euro (DE).
PI: Vanda Lourenço.
2. Statistical Distribution Theory- Impact and Reach, COMPETITIVE PROGRAMME FOR RATED RESEARCHERS (CPRR) 160403161466, Grant No: 105840 (2017-19).
Principal investigator: Andriëtte Bekker.
Total funding: 600 kRands (circa 40 k€).
CMA member: Filipe Marques.
3. Improving Drought and Flood Early Warning, Forecasting and Mitigation using real-time hydroclimatic indicators (IMDROFLOOD), WATER JOINT PROGRAMMING INITIATIVE/0004/2014 (2014-18).
Principal investigator: Ricardo Machado Trigo (Instituto Dom Luiz, IDL/FC/UL).
CMA member: Elsa Moreira.
4. SealTall - Sistema para Gestão Integrada de Pescas, CENTRO-01-0247-FEDER-017693 (2016-19).
Principal Investigator: João Carlos Amaro Ferreira (ISCTE-IUL).
CMA member: Iola Pinto.

.....

4.3. Publications

...

4.3.1. Publications in the Web of Science database

- [1] T. Adragao, A. Ferreira, J. M. Frazao, A. L. Papoila, **I. Pinto**, M.-C. Monier-Faugere, and H. H. Malluche. Higher mineralized bone volume is associated with a lower plain X-Ray vascular calcification score in hemodialysis patients. *PLoS One*, 12(7), JUL 7 2017.
- [2] **L. B. Afonso**, **R. M. R. Cardoso**, A. D. Egidio Dos Reis, and **G. R. Guerreiro**. Measuring the impact of a bonus-malus system in finite and continuous time

- ruin probabilities for large portfolios in motor insurance. *Astin Bull.*, 47(2):417–435, MAY 2017.
- [3] P. Afonso, **M. Fonseca**, and J. F. Pires. Impact of working hours on sleep and mental health. *Occup. Med.-Oxf.*, 67(5):377–382, JUL 2017.
- [4] N. M. Alam, G. C. Sharma, **E. Moreira**, C. Jana, P.K. Mishra, N.K. Sharma and D. Mandal. Evaluation of drought using SPEI Drought Class Transitions and Log-linear Models for different agro-ecological regions of India. *Phys. Chem. Earth*, 100:31-43, AUG 2017.
- [5] F. Bernal, **G. Dos Reis**, and G. Smith. Hybrid PDE solver for data-driven problems and modern branching. *Eur. J. Appl. Math.*, 28(6):949–972, DEC 2017.
- [6] J. Bielagk, A. Lionnet, and **G. Dos Reis**. Equilibrium Pricing Under Relative Performance Concerns. *SIAM J. Financ. Math.*, 8(1):435–482, 2017.
- [7] R. Campos, G. Dias, A. M. Jorge, and C. Nunes. Identifying top relevant dates for implicit time sensitive queries. *Inf. Retr. J.*, 20(4):363–398, AUG 2017.
- [8] F. Carvalho, **J. T. Mexia**, and **R. Covas**. Models with Orthogonal Block Structure, with Diagonal Blockwise Variance-Covariance Matrices. In Simos, T and Tsitouras, C, editor, *Proceedings Of The International Conference On Numerical Analysis And Applied Mathematics 2016 (ICNAAM-2016)*, volume 1863 of *AIP Conference Proceedings*, 2017. International Conference on Numerical Analysis and Applied Mathematics (ICNAAM), Rhodes, GREECE, SEP 19-25, 2016.
- [9] **C. A. Coelho** and A. Roy. Testing the hypothesis of a block compound symmetric covariance matrix for elliptically contoured distributions. *Test*, 26(2):308–330, JUN 2017.
- [10] E. Costa E Silva, A. Borges, M. Filomena Teodoro, M. A. P. Andrade, and **R. Covas**. Time Series Data Mining for Energy Prices Forecasting: An Application to Real Data. In Madureira, AM and Abraham, A and Gamboa, D and Novais, P, editor, *Intelligent Systems Design And Applications (ISDA 2016)*, volume 557 of *Advances in Intelligent Systems and Computing*, pages 649–658, 2017. 16th International Conference on Intelligent Systems Design and Applications (ISDA), Porto, PORTUGAL, DEC 16-18, 2016.
- [11] **M. L. Esquivel**, **G. R. Guerreiro**, and J. M. Fernandes. Open Markov chain scheme models fed by second order stationary and non stationary processes. *REVSTAT-Stat. J.*, 15(2):277–297, APR 2017.

- [12] **M. Faias** and J. Luque. Endogenous formation of security exchanges. *Econ. Theory*, 64(2):331–355, AUG 2017.
- [13] **M. Faias** and J. Pablo Torres-Martinez. Credit market segmentation, essentiality of commodities, and supermodularity. *J. Math. Econ.*, 70:115–122, MAY 2017.
- [14] **C. Fernandes** and **P. Ramos**. A Method To Minimize The Sum Of The Variances Of The Estimators Of The Variance Components In Stair Nested Designs. *Adv. Appl. Stat.*, 51(4):277–282, OCT 2017.
- [15] **D. Ferreira, S. Ferreira, C. Nunes, M. Fonseca, A. Silva,** and **J. T. Mexia**. Estimation and incommutativity in mixed models. *J. Multivar. Anal.*, 161:58–67, SEP 2017.
- [16] **D. Ferreira, S. S. Ferreira, C. Nunes,** and **J. T. Mexia**. Estimation in mixed models through three step minimization. *Commun. Stat.-Simul. Comput.*, 46(2):1156–1166, 2017.
- [17] **L. M. Grilo, H. L. Grilo, S. P. Goncalves,** and **A. Junca**. Multinomial Logistic Regression in Workers' Health. In Simos, TE and Kalogiratou, Z and Monovasilis, T, editor, *Proceedings Of The International Conference Of Computational Methods In Sciences And Engineering 2017 (ICCMSE-2017)*, volume 1906 of *AIP Conference Proceedings*, 2017. International Conference of Computational Methods in Sciences and Engineering (ICCMSE), Thessaloniki, GREECE, APR 21-25, 2017.
- [18] G. Kalucha, **R. Sousa**, S. Gupta, and J. Shabbir. Improved Ratio and Regression Estimators of the Mean of a Sensitive Variable in Stratified Sampling. *Stat. Appl.*, 15(1-2, SI):63–78, 2017.
- [19] A. Koziol, A. Roy, R. Zmyslony, R. Leiva, and **M. Fonseca**. Best unbiased estimates for parameters of three-level multivariate data with doubly exchangeable covariance structure. *Linear Alg. Appl.*, 535:87–104, DEC 15 2017.
- [20] **V. M. Lourenco**, P. C. Rodrigues, A. M. Pires, and H. P. Piepho. A robust DF-REML framework for variance components estimation in genetic studies. *Bioinformatics*, 33(22):3584–3594, NOV 15 2017.
- [21] **F. J. Marques, C. A. Coelho,** and P. C. Rodrigues. Testing the equality of several linear regression models. *Comput. Stat.*, 32(4):1453–1480, DEC 2017.
- [22] R. Moura, M. Klein, **C. A. Coelho,** and B. Sinha. Inference for multivariate regression model based on synthetic data generated under fixed-posterior predictive

- sampling: comparison with plug-in sampling. *REVSTAT-Stat. J.*, 15(2):155–186, APR 2017.
- [23] **R. Moura**, B. Sinha, and **C. A. Coelho**. Inference for Multivariate Regression Model Based on Multiply Imputed Synthetic Data Generated via Posterior Predictive Sampling. In Ntalianis, K, editor, *Applied Mathematics And Computer Science*, volume 1836 of *AIP Conference Proceedings*, 2017. 1st International Conference on Applied Mathematics and Computer Science (ICAMCS), Rome, ITALY, JAN 27-29, 2017.
- [24] Y. K. M. Nobrega, B. C. de Carvalho, N. Nitz, T. E. Vital, F. B. Leite, **I. J. Sequeira**, **E. E. Moreira**, J. K. B. de Andrade, L. Gandolfi, R. Pratesi, and M. M. Hecht. Rubella Seropositivity in Pregnant Women After Vaccination Campaign in Brazil's Federal District. *Viral Immunol.*, 30(9):675–677, NOV 2017.
- [25] **S. Nunes**, T. Oliveira, and A. Oliveira. Item Response Theory - A First Approach. In Simos, T and Tsitouras, C, editor, *Proceedings Of The International Conference On Numerical Analysis And Applied Mathematics 2016 (ICNAAM-2016)*, volume 1863 of *AIP Conference Proceedings*, 2017. International Conference on Numerical Analysis and Applied Mathematics (ICNAAM), Rhodes, GREECE, SEP 19-25, 2016.
- [26] **S. Nunes**, T. A. Oliveira, and A. Oliveira. Problem Based Learning - A Brief Review. In Simos, T and Tsitouras, C, editor, *Proceedings Of The International Conference On Numerical Analysis And Applied Mathematics 2016 (ICNAAM-2016)*, volume 1863 of *AIP Conference Proceedings*, 2017. International Conference on Numerical Analysis and Applied Mathematics (ICNAAM), Rhodes, GREECE, SEP 19-25, 2016.
- [27] C. Santos, **C. Nunes**, C. Dias, and **J. T. Mexia**. Joining models with commutative orthogonal block structure. *Linear Alg. Appl.*, 517:235–245, MAR 15 2017.
- [28] M. Stehlik, C. Helperstorfer, P. Hermann, J. Supina, **L. M. Grilo**, J. P. Maidana, F. Fuders, and S. Stehlikova. Financial and risk modelling with semicontinuous covariances. *Inf. Sci.*, 394:246–272, JUL 2017.
- [29] P. D. Vitoria, **C. Nunes**, and J. Precioso. Parents' educational level and second-hand tobacco smoke exposure at home in a sample of Portuguese children. *Rev. Port. Pneumol.*, 23(4):221–224, JUL-AUG 2017.

• • •

4.3.2. Other publications in peer-reviewed journals

- [1] **S. Monteiro, D. Salvador** and **J. T. Mexia**. Structured Stair Nesting Models-Two Approaches. *Discussiones Mathematicae Probability and Statistics*, 37 (1-2): pp 135-136, 2017.
- [2] **M. L. Esquível**, R. M. Gaspar and **J. B. Sousa**. Default propensity implicit in pulled to par V@R for bonds. *Discussiones Mathematicae Probability and Statistics*, 37 (1-2), 79-81, 2017.

• • •

4.3.3. Other (international) publications

- [1] M. C. Oliveira, **M. L. Esquível**, S. Nascimento, H. R. Lopes and **G. Guerreiro**. Estimation of Markov transition probabilities via clustering. *Extended Abstract in the Book of Abstracts and Extended Abstracts of the Symposium in Big Data in Finance Retail and Commerce*, 85-90, ISBN: 978-989-733-059-9, Lisbon, 2017.
- [2] **M. L. Esquível**, M. C. Oliveira, **G. Guerreiro** and C. Nobre. Calibration and Simulation of a Continuous Time Markov Chain Model for Long Term Care. *Book of Abstracts and Extended Abstracts of the Second International Conference on Computational Finance 2017*, Lisbon.

.....

4.4. Activities

• • •

4.4.1. Seminars & Short-courses

Organized by Inês Sequeira and Dora P. Gomes

20 February: *A Spatial Econometrics Analysis of The Calls to The Portuguese National Healthline*, Paula Simões, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa.

23 February: *More on explicit estimators of covariance matrices with linear structure*, Martin Singull, Linköping University.

22 March: *Risk neutral probabilities recovery from options prices by maximum entropy using linear goal programming*, José Luis Vilar-Zanón, Universidad Complutense de Madrid.

24 March: *Estimation and testing hypotheses of parameters in normal multivariate models with BCS covariance structure*, Roman Zmyslony, University of Zielona Gora.

24 May: *Statistical methods for cost-effectiveness analysis: A selected review*, Thomas Mathew, University of Maryland Baltimore County.

7 June: *Joint modeling of zero-inflated longitudinal count and severity outcomes*, Giovanni Loiola da Silva, IST & CEAUL.

8 June: *On sufficiency of linear and quadratic statistics in linear models*, Augustyn Markiewicz, Poznan University of Life Sciences.

25 October: *Modelo Logístico Multinível: Aplicação em estudo sobre do uso da rede mosquiteira pelas mulheres dos 15-49 anos, em Moçambique (2011)*, Sheyla Cassy, FCT NOVA.

25 October: *Nonparametric regression by property matching of kernel density estimates*, Theodor Loots, University of Pretoria.

...

4.4.2. Supervision of Ph.D. students

Theses presented in the year 2017.

1. Adilson de Jesus Martins da Silva, *Variance Components Estimation in Mixed Linear Models*

.....

4.5. Strategic Plan: 2015-2020

This text was written during the second semester of 2013 as part of the CMA's strategic plan for 2015-2020 and includes all members.

The group will pursue the same research themes that have received peer recognition and appreciation in the recent past: only some of these are detailed below. The group will look for establishing a solid net of industry relationships aiming at diversifying the financing sources for research.

JTMexia, CNunes, EMoreira, DFerreira, SSFerreira: F-tests with random non-centrality parameters and random degrees of freedom for the errors. Determination of the statistics and their distributions, and the development of techniques for calculating

critical values for models with random sample sizes. Applications on real and simulated data.

CACoelho, FMarques, LGrilo, will pursue the development of near-exact distributions for elaborate covariance structures used in multivariate Growth Curve, Time Series and Mixed Models (Khatri, 1973; Lee, 1991; Yokoyama and Fujikoshi, 1992; Pollock, 2002; McCullagh, 2006, 2008, Srivastava et al., 2009). The covariance structures used in those models assume a block structure, related with some Kronecker product so, we aim at developing near-exact distributions for the distributions of likelihood ratio test statistics for such structures.

GGuerreiro: The study of Ruin Probability under the presence of a Bonus Malus System on an automobile insurance portfolio is a project with industry. Using data from two Portuguese insurance companies and using the model on Afonso et al. (2009) we intend to develop a model for estimation of ruin probability under a BMS following classical and open approach for BMS.

MFonseca, JTMexia: The main research activities will be in univariate models with constraints on fixed and random effects, regarding estimation, hypothesis testing and confidence regions. For multivariate models, inference will be developed for structured data in complex model, also incorporating time dependency. These methods will be applied in analysis and forecasting in long-term care services. Comfort Keepers, a personal assistance services provider, is involved in this research.

RRCardoso: In one published and 1 acceptor paper, the classical risk model was considered modified in two different ways by the inclusion of a dividend barrier: numerical algorithms were presented to approximate or bound the expected discounted value of dividends up to a finite time horizon. Also it was established a closed connection between the dual and the classical risk. In the following, we will extend the results for ruin probabilities, time to ruin and expected present dividend amounts for the dual risk model considering inter-claim distributions Erlang(n), generalized Erlang(n) and Phase-Type(n). Calculate the ruin probability for an auto insurance policy portfolio with a bonus malus system.

FCaairo will work on Second-order Parameters Estimation for reduced-bias parameter estimation of extreme events and in "adaptive selection of thresholds". We now intend to apply an idea of Gomes & Oliveira (2001) - bootstrap threshold selection - to adaptive selection of thresholds in reduced bias estimation procedures. DGomes: will work on the estimation of relevant parameters in statistics of extremes using an adaptive algorithm on "Probability Weighted Moment Estimator of Extreme Quantiles" and modelling spatial extremes in real cases studies.

MBdeCarvalho: will work on Bayesian nonparametrics, multivariate extreme value

modelling and Inference methods for diagnostic data.

MFaias: We used club theory for the first time to provide an equilibrium setting where traders sort into bourses to trade their securities. Our aim now is to show that trading complementarities and bourse formation costs explain market fragmentation and the emergence of bourses with an incomplete security structure. We will study a game with incomplete information and stable residual demand functions where firms compete in prices. The stability in the demand is provided by a new variable, the type of the firm, reflecting its ability to attract customers.