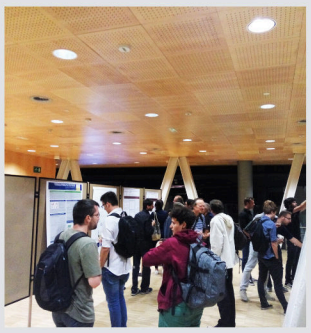
CENTRE DE RECERCA MATEMÀTICA

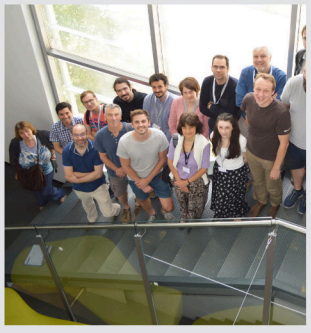
REPORT OF ACTIVITIES

2019







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Director's Foreword

Lluís Alsedà, Director of CRM

This report includes the research, training, transfer and dissemination activities carried out at the Centre de Recerca Matemàtica during 2019. It offers a good snap-shot of the center and its situation during this year, in which it is necessary to emphasize the success at the level of competitive projects. Specifically the concession and start of the CAFE project, which is an ITN dedicated to improve the sub-seasonal predictability of extreme weather events through the interdisciplinary training of 12 doctorate students in aspects such as climate science, complex networks and data analysis, and the HIPPOPLAST FLAG-ERA, which is a project aimed at helping bridge the gap between cellular and circuit analysis of hippocampal function and allow for a better understanding of how this structure functions in normal and pathological states, which could potentially help design new therapeutic procedures to restore network, cognitive and behavioural functions in pathologies such as epilepsy and Alzheimer's disease.

On the other hand, the Center for Mathematical Research has organized 4 international research programs with 14 internal activities, 13 high-level international conferences and we have had more than 15 seminars and outreach activities. Furthermore, Center for Mathematical Research has published several volumes in the collections *Advanced Courses in Mathematics* and *Extended Abstracts* (Birkhäuser) as well as several preprints.

All these activities have benefited a large number of visitors who have taken advantage of their stay at the center to do research.

www.crm.cat

Lluís Alsedà, Director del CRM

Aquesta memòria inclou les activitats de recerca, formació, transferència i divulgació desenvolupades al Centre de Recerca Matemàtica durant l'any 2019. És una bona fotografia del centre i la seva situació durant aquest any, en la que cal destacar l'èxit del centre a nivell de projectes competitius. Específicament la concessió i inici del projecte CAFE, que és una ITN dedicada a millorar la predicció a escala sub-estacional dels fenòmens climàtics extrems a través de la formació de 12 estudiants de doctorat en ciències del clima, sistemes complexos i anàlisi de dades i del projecte HIPPOPLAST; el qual és un FLAG-ERA del Human Brain Project: un projecte dirigit a ajudar a solucionar el buit existent entre l'anàlisi cel·lular i de circuït de la funció de l'hipocam i, així, permetre una millor comprensió de com són els estats d'aquesta estructura en un estat sa i amb alguna patologia. I, d'aquesta manera, ajudar en el futur disseny de nous procediments terapèutics per restaurar la xarxa, cognitiva i de comportament, en malalties com ara la epilèpsia o l'Alzheimer.

Per una altra banda, el Centre de Recerca Matemàtica ha organitzat 4 programes de recerca internacionals amb 14 activitats internes, 13 conferències internacionals d'alt nivell i ha tingut més de 15 seminaris i activitats de divulgació. A més a més, el Centre de Recerca Matemàtica ha publicat diversos volums de les colleccions Advanced Courses in Mathematics *i* Extended Abstracts *(Birkhäuser), així com diversos* preprints.

Totes aquestes activitats s'han beneficiat amb una gran quantitat de visitants que han aprofitat la seva estada al centre per fer recerca.

www.crm.cat

1 The CRM

1.1 Mission and Statement

As stablished by its statutes, the CRM's aim is to foster research and advanced training in mathematics by collaborating with the universities and research institutions in Catalonia, in order to become an international reference in its field.

The CRM is a transversal center in the sense that its activities benefit the whole mathematical research community in Catalonia. The scientific policy of the CRM towards fulfilling its mission is structured around two main core concepts, quoted in the strategic plan within the contract-program with the Generalitat de Catalunya for the period 2014-2019:

1. To give support to research groups by organising activities with a size or nature that goes beyond the capabilities of the teams, achieving broad visibility and hosting visitors for joint collaborations.

2. To design and execute strategies aimed at addressing the weaknesses of the mathematical research activity in Catalonia as a whole, encouraging emergent areas and creating its own research groups in these areas.

1.2 Legal Status

The CRM was founded in 1984 as a research center under the Institut d'Estudis Catalans (IEC), the Catalan Academy. In the same year, an agreement was signed with the Universitat Autònoma de Barcelona (UAB), by virtue of which the CRM became established in the UAB Campus. In 1993, the CRM opened its own premises at the UAB's Science Faculty, thanks to the financial support from CIRIT. On that occasion, the CRM became associated with the UAB as one of its research institutes.

The Government of Catalonia approved on July 9th, 2002 (DOGC No. 3693, August 6th, 2002) the creation of the CRM Consortium, comprised by the Generalitat de Catalunya and the IEC. The CRM Consortium is a public body with its own legal status. In December 2013, the Universitat Autònoma de Barcelona joined the Consortium.

The CRM is guided by its Governing Board and Director, and has a Scientific Advisory Board.

The CRM is one of the centers in the CERCA Institution of research centers sponsored by the Generalitat de Catalunya, and is a member of the Associació Catalana d'Entitats de Recerca (ACER). The CRM is a member of ERCOM, a committee of the European Mathematical Society (EMS).

1.3 Governing Board

The Governing Board is the highest level of decision and management at the CRM. It consists of the following:

- The Minister of Economy and Knowledge, or an appointed deputy, acts as President.
- The president of the IEC, or an appointed deputy, acts as Vice-President.
- Three representatives from the Generalitat de Catalunya.
- Two representatives from the Institut d'Estudis Catalans.
- One representative from the Universitat Autònoma de Barcelona.
- The Director of the CRM, who participates with a voice but not a vote.

The Governing Board met on the January 30th and June 17th, 2019. In that meeting, the Generalitat de Catalunya was represented by Joan Gómez Pallarès, in his capacity of Director General de Recerca.

The IEC was represented by Joan Domènec Ros, who assumed the Chairmanship of the Board, and by Joan Solà-Morales, replacing Joan Girbau. Francisco Javier Lafuente, the vice-rector of Strategic Projects and Planning of the UAB, attended the meeting on behalf of the rector of the UAB. The CRM director, Lluís Alsedà, and the general manager, José Antonio Fuentes, also attended the meeting. CERCA was represented by Lluís Rovira. Josep María Alcoberro acted as Secretary.

1.4 Scientific Advisory Board

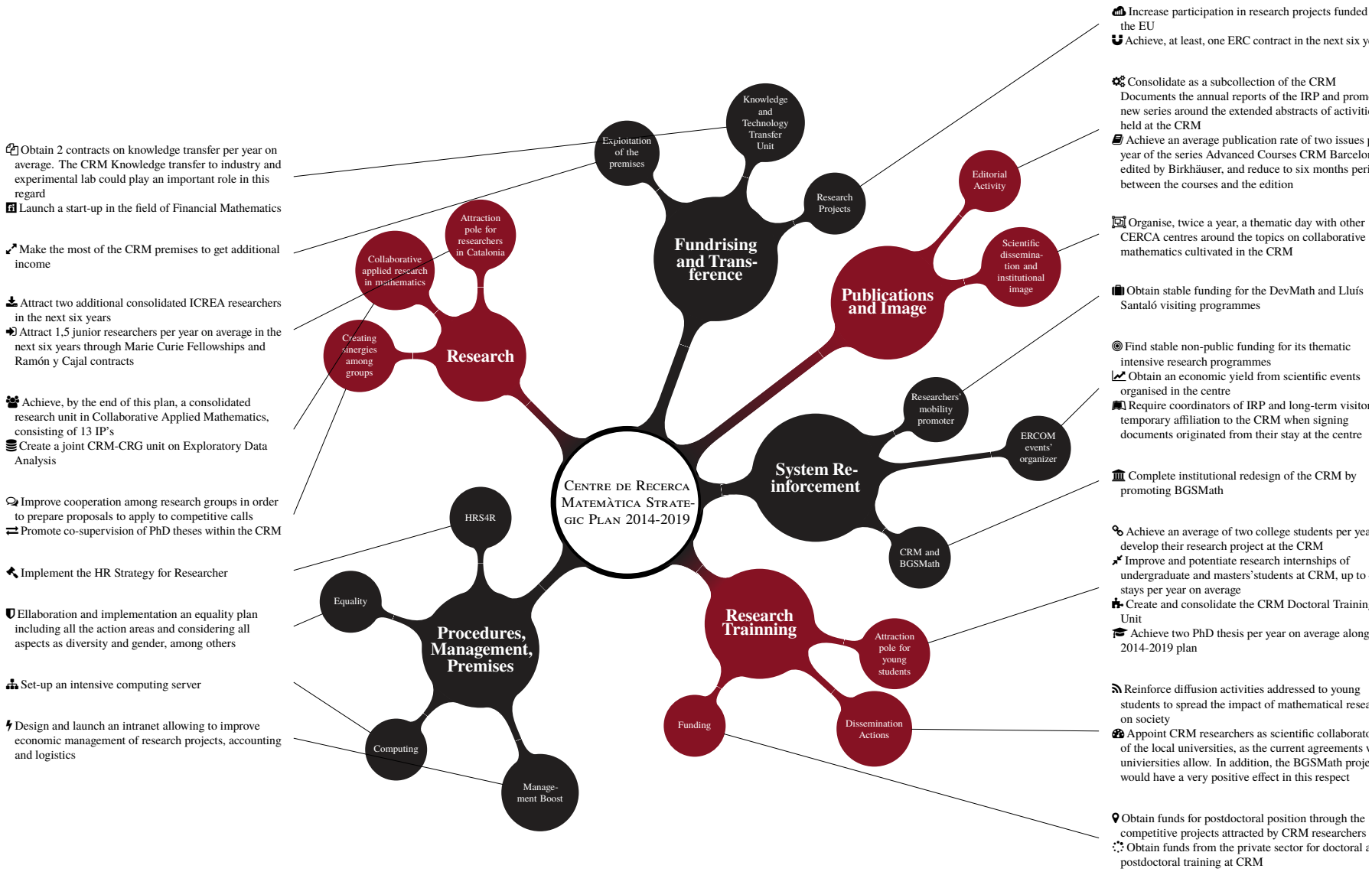
The Scientific Advisory Board (SAB) consists of prestigious personalities within the scientific scope of the Centre, appointed by the Governing Board after proposal by the Director. The SAB usually meets once a year before summer.

The Governing Board approved on June 15th, 2018, the new composition of the Scientific Advisory Board:

1.5 Strategic Plan

The first contract-program between CRM and the Catalan Government was signed on June 18th, 2003, originally valid until 2006, it was extended for a further year. On February 14th, 2009, a new contract-program, was signed for the period 2008–2013, and extended for a further year until 2014. Meanwhile, a new strategic plan was designed.

The CRM strategic plan for the period 2014–2019, approved by the Board of Governors on July 11th, 2014, contains an introductory section on "Mission and vision of CRM", followed by a section on "The CRM at the end of the strategic plan 2008–2013" which offered a description of the situation of CRM at that time. Next, the document addresses the new plan, which is a roadmap for the center, in line with its mission statement. The new plan proposes the development of policies oriented to different areas and to achieve specific goals, grouped as follows.



This strategic plan has been extended for one year

1.6 Institutional Collaboration

The CRM participates in a variety of initiatives with other academic institutions.

BGSMath

Barcelona has an internationally recognized unit of excellence in mathematics research at the highest level. In the latest years, the number of foreign graduate students enrolled in master's and doctoral programs in Mathematics offered by Catalan universities has increased significantly. In this scenario, the Barcelona Graduate School of Mathematics (BGSMath) was created in 2013 with the aim of providing coordinated and high quality research PhD training with international projection. Another mission of the BGSMath is the enhancement of employment of mathematicians within the industry and in non-academic environment in general, and becoming a platform for all active agents in mathematical research towards the development of collaborative projects.

The promoting institutions of the BGSMath are:

- The Mathematics Faculty of the Universitat de Barcelona;
- The Mathematics Department of the Universitat Autònoma de Barcelona;
- The Faculty of Mathematics and Stadistics of the Universitat Politècnica de Catalunya;
- Universitat Pompeu Fabra;
- Centre de Recerca Matemàtica;
- The Mathematics Institute of the Universitat de Barcelona also participates as a supporting entitiy.

In 2015 BGSMath was awarded a "Maria de Maeztu" grant by the Spanish Ministry of Economy and Competitiveness under its "Excellence Program", which concluded on June 30th, 2019. The award is aimed at Spanish research centers that are leaders in all areas of science and humanities. Grants provide funding for international PhD students and postdocs to complete stays in Barcelona.

People funded by the BGSMath are listed at the Appendix of this report.

www.bgsmath.cat

ERCOM

ERCOM is the acronym of the European Research Centers on Mathematics committee of the European Mathematical Society (EMS), composed by the scientific directors of European research centers in mathematics. Only centers for which the number of visiting staff substantially exceeds the number of permanent and long-term staff, and which cover mathematical sciences broadly, are eligible for representation in ERCOM. The CRM has been a member of ERCOM since its foundation in 1997.

The annual meeting of ERCOM in 2019 was held on March 29th and 30th, at the Isaac Newton Institute for Mathematical Sciences, Cambridge (United Kingdom).

European Mathematical Society

www.ercom.org

ICREA

The Catalan Institution for Research and Advanced Studies (ICREA) is a foundation supported by the Catalan Government whose aim is to recruit top scientists for the Catalan R&D system. The CRM participates actively in all the ICREA calls by presenting renowned mathematical researchers as candidates for ICREA positions. Current ICREA Research Professors based at the CRM are Sergey Tikhonov (since 2012) and Tomás Alarcón (since 2015).

ICREA

www.icrea.cat

Red Estratégica de Matemáticas

The Red Estratégica de Matemáticas (REM) was created in 2017 and its primary goal is to gather innovations to create a strategy that will improve the international position and foster synergies between the mathematical scientific community and the socio-economic impact of the Spanish research in mathematics. It encourages the dissemination and transfer of mathematical technology, orienting R&D to the needs of companies, industries, and public institutions. Its applications in the productive sector provide a vital added value to economic life, as well as being a very important part in technological advancement and the improvement of living conditions.

Its objectives are:

- Structure the mathematics research community and to position it at the vanguard both nationally and internationally.
- Boost transversal actions of Mathematical Technology Transfer, in particular through the Spanish mathematics-industry network (Math-in).
- Study the socio-economic impact of research and transfer of mathematical technology in Spain.
- Disseminate the activity and results of mathematical research in Spain to improve the public perception of this science.
- Promote the presence of Spanish mathematics in the world by participating in the activities of international organizations.
- Promote funding provision for research and transfer in mathematics.

REM editions:

1. From September 2017 to September 2019, coordinated by Dr. Tomás Chacón from the Institute of Mathematics of the Universidad de Sevilla (IMUS).

2. It is currently coordinated by Dr. Luis Vega, from the Basque Center for Applied Mathematics (BCAM).

Both the Centre de Recerca Matemàtica and the Barcelona Graduate School of Mathematics are active members of the REM.

Activities promoted by the REM:

1. Conference "European funding opportunities in mathematics", organized jointly by the BCAM, the CRM and the ICMAT, on September 30th in Madrid.

2. Presentation of the "Study of the socioeconomic impact of mathematical research and technology in Spain"; conducted by the consultancy AFI (International Financial Analysts) on May 23rd in Madrid.

3. Presentation of the Study of the economic impact of Mathematics in Spain by Diego Vizcaino Delgado, coordinator of the study (AFI), was to take place on October 29th, 2019 but due to the political issues and administrative blockade caused by the application of 155 article of the Spanish constitution, had to be delayed until January 8th, 2020.

Comité Español de Matemáticas

The Comité Español de Matemáticas (CEMat) was created in 2004 as a restructuring and extension of the Spanish Committee for the International Mathematical Union which was reconstituted on April 17th, 1998 as a joint initiative by the Real Sociedad Matemática Española (RSME), the Societat Catalana de Matemàtiques (SCM), the Sociedad Española of Matemática Aplicada (SEMa) and the Sociedad de Estadística e Investigación Operativa (SEIO).

Presently, the CEMat is in a process of refoundation to become a federation And to work on behalf of the entire Spanish mathematical community before the political and academic authorities.

Its Objectives are:

- Coordinate the Spanish mathematical activities of international nature related to the IMU and the CEISC (the Spanish Commission for the ISC: the International Science Council), reinforcing the Spanish presence in the commissions of these entities.
- Channel the initiatives of IMU and CEISC within Spain and, in general, when necessary, to advise and report to the corresponding ministries.
- Collectively, represent the Federated Entities interests before the public and private organisms, collaborating with them for the benefit of mathematics.
- Assist with achieving a greater awareness on the part of the scientific community, the Administration, companies and society in general, regarding the importance of Mathematics in today's world. It is worth saying CEMat shares the purposes of its federated entities and will collaborate in achieving them, as well as all those that are not available to the federated entities, when approved by the executive committee.

Fundació Jaume Bofill

Since the 2018, the Centre de Recerca Matemàtica participates in the program "Magnet, aliances per a l'èxit educatiu", promoted by the Jaume Bofill Foundation, Diputació de Barcelona, el Consorci d'Educació de Barcelona and UAB's Institut de Ciències de l'Educació.

The main goal of the Magnet program is to address scholar segregation by developing a collaboration between an educational institution and a research institution.

Joaquim Blume school, based in Sabadell, is one of the selected schools to develop, during the forthcoming 4 years, this innovation project. With the motto "Al Blume, tots hi comptem. Suma-t'hi!", Joaquim Blume school has started a collaboration with Centre de Recerca Matemàtica which will allow to develop an educational innovation project by using mathematics as a cornerstone.

On March 13th of this year, the Magnet team of the CRM organized a twinning activity with the teaching team at the Joaquim Blume school in Sabadell. With this activity, the CRM initiated an accompaniment project at this school for a 4 years period, within the framework of the aforesaid program.

On June 6th, Centre de Recerca Matemàtica presented an exhibition that illustrated how working with students in mathematics was instrumental in helping them better understand the world around them (issues related to poverty and the wealth of countries, wildlife, culture, gastronomy among other topics).

The meeting was held in a relaxed and learning atmosphere, as it also had the collaboration of the families of the students from the school, who provided samples of gastronomy, art, dance and traditions from various places in the world.

1.7 Sponsorships

In recent years, the CRM has made a considerable effort to attract funding from a variety of private and public entities. Fortunately, the efforts of the center to attract the interest of sponsors sensitive to mathematical research has had some success along 2019. The CRM is deeply grateful to the institutions listed below since their contributions can maintain and increase the quality of some of the activities consolidated at the center.

"la Caixa" Foundation

"la Caixa" Foundation is an institution committed to society through Welfare Projects, human rights, peace, justice, and people's dignity. The foundation also works in collaboration with research institutions to generate new scientific knowledge by opening up research horizons. The main focus for action of "la Caixa" Foundation in sponsoring science is giving research institutions more security when planning their research and facilitating the generation of synergies among different centers. At the end of 2013, "la Caixa" Foundation, within the framework of the agreement with the Catalan Government, approved funding for the training program on Collaborative Mathematics presented by the CRM. See

`www.crm.cat/en/Research/Training/CollabMathResearch/Pages/Description.aspx`

The aim of the program is to encourage interdisciplinary and collaborative mathematical research. Within the framework of this program, collaborative research means "*mathematical research located in an interface which purpose is the development, analysis and simulation of contextualized models, with interest beyond mathematics, contrasted by interacting with experimentalists*".

The funding of this program by "la Caixa" allows the CRM to support a number of doctoral students and postdoctoral fellows over a period of five years, starting January 2014. Our fellowship students receive 3-year contracts linked to a training project on a specific topic defined jointly by a researcher in mathematics as director and a co-director from another discipline.

Obra Social "la Caixa"

`www.obrasociallacaixa.org/en/home`

European Mathematical Society

The European Mathematical Society (EMS) promotes the development of all aspects of mathematics in Europe, in particular mathematical research, the links between mathematics and society, the relations among European institutions, and mathematical education. During 2019, the EMS support has allowed to enhance the economic conditions of lecturers and the possibility to offer several grants for young researchers.

European Mathematical Society

`www.euro-math-soc.eu`

Centre International de Mathématiques Pures et Appliquées

The Centre International de Mathématiques Pures et Appliquées (CIMPA), founded in France in 1978, is a nonprofit organisation that promotes research in Mathematics in developing countries. During 2019, CIMPA support has allowed to finance the program IRP on Spaces of Analytic Functions: Approximation, Interpolation, Sampling, funding the participation of two post-doctoral researchers of the program.

www.cimpa.info

1.8 Structure

Directing Team

The Governing Board elects a Director, at the proposal of the Chairman, to serve for a period of four years. The current Director is Lluís Alsedà, who was elected for the period from 2016 to 2019 in the Meeting of the Governing Board on December on December 1st, 2015.

The Executive Commission of the CRM, which meets regularly to discuss routine or urgent affairs is formed by

1. The Director.
2. The assistant director; represented by the principal investigator Tomás Alarcón.
3. The Manager.
4. A representative of the researchers; represented by the principal investigator Tim Myers.
5. The general scientific manager.

Manuel Castellet, who had been director of the CRM since its creation in 1984, was appointed Honorary Director by the Governing Board in 2007.

1.9 Equipment

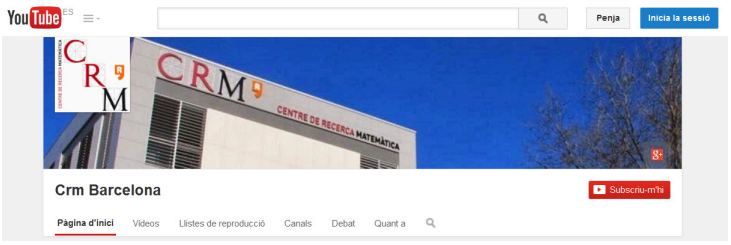
The CRM facilities are located in an adjoining wing to the UAB Faculty of Sciences with a total floor space of 2,125 m^2, after the completion of the extension of the CRM premises in October 2010, made possible by the funding provided by the Generalitat and FEDER. The facilities include management offices with capacity for up to 60 researcher places, three meeting rooms, three lecture rooms with capacity for 95 people and an auditorium with capacity for 100 people.

Accommodation for visiting researchers is provided by Vila Universitària at Bellaterra.

The CRM computer equipment is based on a LAN Ethernet net of, approximately, eighty workstations, equipped both with Microsoft and Linux operating systems, and structured under a Windows domain. Among other services, the network includes a printing server, a file server and a *Firewall/Router* that linked it to the UAB infrastructure by means of a 1 Gb connection. The CRM network is endowed with systems that allow remote access (via SSH) to computing servers and a secure system through VPN allowing access to the rest of the center's services. During 2018, the mailing service was externalized to Google, by hiring Gsuite services.

Facilities also include wifi internet connection, seven projectors and recording systems for all the meeting rooms, resources for videoconferencing, digital control systems for the meeting rooms, a tactile CRM presentation screen and the infrastructure

for live broadcasting and streaming. Moreover, the CRM has opened a broadcast channel where you can find videos of lectures held at the center



www.youtube.com/user/CRMatematica

During 2019, the CRM's wireless network was improved by adding Unifi Access Points and segregating the network to increase security. The webpage is currently being renewed, with the addition of an intranet that will improve the management of the center. We have also changed the accounting program for a new ERP and, finally, we begun the valuation for the renovation of the administration and server computer park.

1.10 External Services

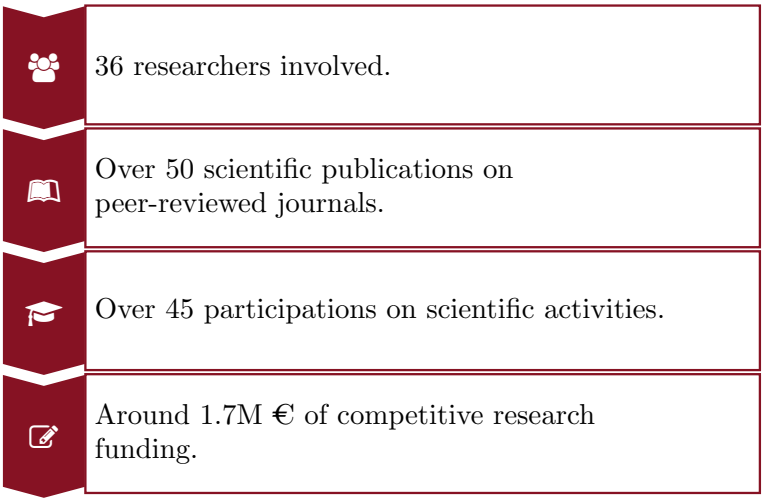
The firm "*Gestió laboral: 3F Consultors*" has service contracts with the CRM.

2 Research Groups

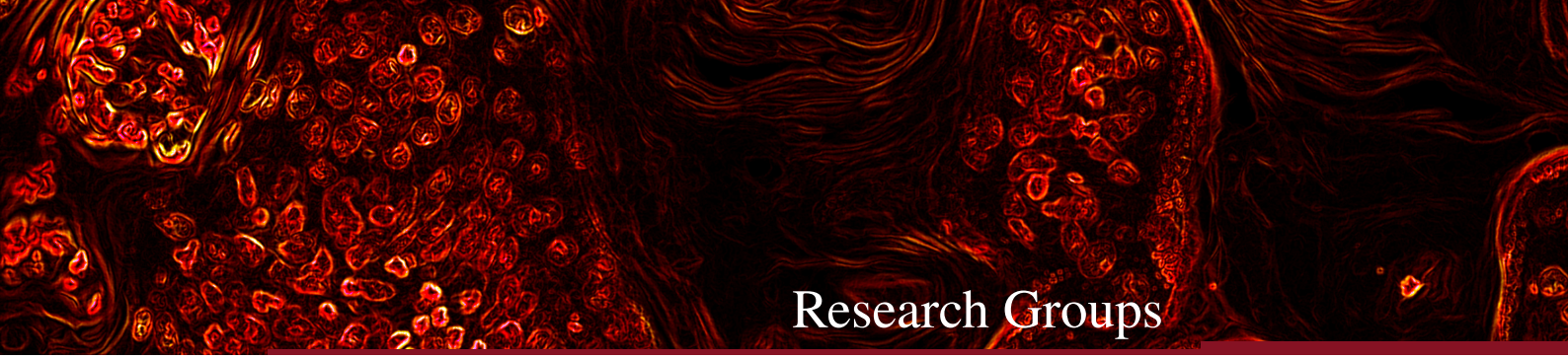
2.1 Introduction

As mentioned in Section 1.1, the scientific policy of the CRM has two main axes. The second one encourages the creation of research groups covering underdeveloped areas in Catalonia, by supporting its own research groups in such areas. It is worth to say that the aforesaid support includes Research Training. By investing in training programmes, the CRM fosters creativity and expertise in mathematics, promotes collaboration, encourages the exchange of ideas among research groups, networking, stimulates discussion, and promotes career development.

Nowadays, CRM has 7 research groups. The following table provides a snapshot of their scientific activities during 2019.



The research lines of each group and the main activities that they have carried out during 2019 are outlined along the following pages. The reader will also find the main tasks and duties performed by the Knowledge and Technology Transfer Unit.



Cancer Modelling Group

Tomás Alarcón

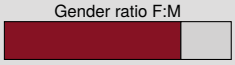
Most phenomena studied by the Natural Sciences, from Material Sciences to Astrophysics, are multi-scale processes, i.e. they involve the coupling of multiple different processes characterised by widely ranging time and length scales, with the macroscopic behaviour emerging from the complex interactions between them. Whilst considerable progress has been done in dealing with such problems in the Physical Sciences, the success achieved so far in the Biological Sciences is rather more limited. This is partly due to the fact that the individual components of biological systems (e.g. cells) are much more complex than their counterparts in physical systems and, therefore, new methods and models are needed to analyse multi-scale processes in Biology. Such is the remit of the Cancer Modelling Group at CRM: To propose new models relevant to experimental biologists and clinicians and develop the analytical and computational tools necessary for their analysis. We pay special attention to problems with clinical relevance, in particular those related to cancer.

The research activity of our group is developed along the following lines:

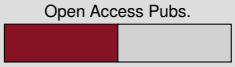
- Multiscale modelling of tumour growth and tumour-induced angiogenesis.
- Hybrid methods for multiscale models.
- Epigenetics and ageing.
- Stochastic models in population dynamics.
- Theoretical biophysics: modelling of complex fluids microfluidics.

Members: • Tomás Alarcón (team leader), • Aurora Hernández-Machado (scientific collaborator), • Daria Stepanova (PhD student), • Lourdes Méndez-Moral (Industrial Doctorate)

Gender ratio F:M



Open Access Pubs.



Current Projects: • MTM2015-71509-C2-1-R, Multiscale modelling and analysis in systems biology and biomedicine (Coordinated project CRM-UPC), 2016–2020 (Extended until the end of 2020). PI Tomás Alarcón • RTI2018-098322-B-I00. The mathematical underpinnings of integrative systems biology, 2019-2021, Co-PIs: Tomás Alarcón & Josep Sardanyés

Collaborators

- Simone Ballocco, Universitat de Barcelona
- Rafael Barrio, UNAM – México
- Helen M. Byrne, University of Oxford
- Juan Calvo, Universidad de Granada
- Pilar Guerrero, Universdad Carlos III
- Philip K. Maini, University of Oxford
- Javier Ménendez, ICO - IDIBGI
- Anna Meseguer, VHIR
- Karen M. Page, University College London
- Rubén Pérez-Currasco, University College London

2019 Activities

The research activity during 2019 has been devoted to consolidating the research lines on multiscale tumour modelling and ageing and epigenetics, specifically the experimental collaborations with Javier Menendez (ICO) and Anna Meseguer (VHIR). Tomás Alarcón has also continued to work in the subject of Mathematical Virology with Josep Sardanyés, previously a postdoc in this group and now a PI at CRM. During 2019, two of Tomás Alarcóns PhD students, Elisa Beltran-Saez and Victoria Ponce-Bobadilla, have successfully completed their PhDs. During 2019, Tomás Alarcón also secured funding from the Agencia Española de Investigación through a "Retos" project. A detailed description of the milestones achieved during 2019 is given below.

Scientific Publications

- Ponce Bobadilla, A.V., Carraro, T., Byrne, H.M., Maini, P.K., Alarcón, T;*Age Structure Can Account for Delayed Logistic Proliferation of Scratch Assays.*Bulletin of Mathematical Biology; 81 7 2706–2724 (2019)10.1007/s11538-019-00625-w
- De La Cruz, R., Perez-Carrasco, R., Guerrero, P., Alarcon, T., Page, K.M;*De la Cruz et al. Reply.*Physical Review Letters 122 5 (2019)10.1103/PhysRevLett.122.059802
- Bobadilla, A.V.P., Arévalo, J., Sarró, E., Byrne, H.M., Maini, P.K., Carraro, T., Balocco, S., Meseguer, A., Alarcón, T; *In vitro cell migration quantification method for scratch assays.*Journal of the Royal Society Interface 16151 (2019)10.1098/rsif.2018.0709
- Fornés, J., Tomás Lázaro, J., Alarcón, T., Elena, S.F., Sardanyés, J;*Viral replication modes in single-peak fitness landscapes: A dynamical systems analysis.*Journal of Theoretical Biology 460 170–183 (2019)10.1016/j.jtbi.2018.10.007
- Folguera-Blasco, N., Pérez-Carrasco, R., Cuyàs, E., Menendez, J.A., Alarcón, T ;*A multiscale model of epigenetic heterogeneity-driven cell fate decisionmaking,* PLoS Computational Biology 15 4 (2019) 10.1371/journal.pcbi.1006592
- Menendez, J.A., Cuyàs, E., Folguera-Blasco, N., Verdura, S., Martin-Castillo, B., Joven, J., Alarcón, T;*In silico clinical trials for anti-aging therapies*Aging 11 16 6591–6601 (2019)10.18632/aging.102180

Theses

- Elisa Beltrán Sáez CRM-UAB, *Information transmission through a nonlinear molecular signaling system: ErbB as a case study*, advisor:Tomás Alarcón (CRM-ICREA).
- Ana Victoria Ponce-Bobadilla (Heidelberg University), *Mathematical Models of Cell Migration and Proliferation in Scratch Assays* advisor: Tomás Alarcón (CRM-ICREA), Thomas Carraro (Heidelberg University).

Delivered Talks

- *Plastic behaviour of genes with bivalent epigenetic regulation*, Invited Mini-Symposium Talk, Coupled 2019, Sitges, Spain, June 2019 T. Alarcón
- *A multiscale model of complex endothelial cell dynamics during angiogenesis*. Invited Talk, Biomat 2019: Patterns in Life and Social Sciences, Universdad de Granada, Granada, Spain, June 2019 T. Alarcón
- *Plastic behaviour of genes with bivalent epigenetic regulation*, Invited Mini-Symposium Talk, ICIAM 2019, Valencia, Spain, July 2019 T. Alarcón
- *Coarse-graining and hybrid methods for efficient simulation of stochastic multi-scale models of tumour growth*, Seminar, Aragón Instute for Engineering Research, Universidad de Zaragoza, Zaragoza, Spain, July 2019 T. Alarcón
- *Multiscale methods in Systems Biology*, Invited Talk, Symposium of the Research Unit on Dynamical Systems and Computational Virology, Institute for Integrative Systems Biology, CSIC, Valencia, Spain, October 2019 T. Alarcón

Scientific Activities Organized

- Member of the Scientific Committe of the Summer School and Workshop on Mathematical Biology to be held at Samos, Greece, September 2019 organised by Jean Clairambault (INRIA, Paris)
- Co-organiser (jointly with Jean Clairambault, INRIA, France, and Thomas Hillen, University of Alberta, Canada), of the workshop on Mathematical challenges in the analysis of continuum models for cancer growth, evolution and therapy. November 2018, BIRS, Casa Matemàtica de Oaxaca, Oaxaca, México.

Supervision of intern and undergraduate students

- Laia Domingo, Departments of Physics and Mathematics, Universitat Autònoma de Barcelona. February 2018 – February 2019
- Sara Martinez-Buera, Departments of Physics and Mathematics, Universitat Autonoma de Barcelona. February 2019 – June 2019
- Andreu Arderiu-Romero, Departments of Physics and Mathematics, Universitat Autonoma de Barcelona. February 2019 – June 2019
- Alejandra de Lara, Department of Physics, Universitat Autonoma de Madrid. June 2019 – July 2019,

Other Activities

- Tomás Alarcón serves as a member of the Scientific Committes of the Barcelona Graduate School of Mathematics and the Catalan Mathematical Society
- Tomás Alarcón serves as Deputy Director and member of the Executive Committee of the Centre de Rcerca Matematica

Complex Systems

Álvaro Corral

We can consider complex systems to be those composed by a large number of strongly interacting elements. As a result, many of mankind's greatest challenges come from trying to unravel the behaviour of these systems, such as climate, economy, society, the brain, biological development, etc. Contrary to this, the hydrogen atom, the solar system or an ideal gas would be simple systems, despite the fact that in order to study them we need to use in-depth physics concepts and sophisticated mathematics. However, if everything that is complex is a complex system, what does the new science of complexity bring to the table? Can such wide-ranging systems be tackled with in a single perspective? One of the key ideas in complexity studies is that structures appear in these types of systems at all levels, including levels far in excess from those achieved by the interaction between components; in addition to this, the structures also show surprising statistical regularities.

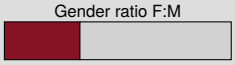
At the CRM Complex Systems Group, we focus on two major lines of research: one, natural disasters and meteorological phenomena, resulting from the complex activity of the Earth's system, and the other, the structure of information in human communication, produced by the areas of the brain responsible for this and the relationship between the communicating agents. Regarding natural hazards, we study the occurrence patterns of earthquakes, forest fires, hurricanes, rainfall, etc., with the idea that the statistical properties of these phenomena contain key information for their understanding, modeling and forecasting. In relation to human communication, we concentrate both in both natural language and music. Again, we study occurrence patterns, this time of the symbols that constitute the texts or the musical compositions, in order to better understand how these unique characteristics of humans work, and also to investigate whether machines could reproduce them.

Collaborators

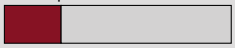
- Elsa Arcaute, University College London
- Joern Davidsen, University of Calgary
- Georg Dresen, German Research Center for Geosciences
- David Eaton, University of Calgary
- Abigail Jiménez, Ulster University
- Cristina Masoller, Universitat Politècnica de Catalunya
- Mehdi Pouragha, Carleton University
- Pere Puig, Universitat Autònoma de Barcelona
- Danijel Schorlemmer, GFZ-Potsdam
- Joan Serrà, Telefonica I+D
- Frederic Udina, Universitat Pompeu Fabra
- Eduard Vives, Universitat de Barcelona

Members: • Álvaro Corral (team leader), • Isabel Serra (associated researcher), • Jordi Baró (post-doctoral researcher), • Álvaro González (post-doctoral researcher), • Patrícia Paredes (Phd student), • Víctor Navas (PhD student), • Niclas Rieger (PhD student),

Gender ratio F:M



Open Access Pubs.



Current Projects:

• 2017-SGR-01735 AGAUR. CRM research group in Collaborative, Mathematics 2014–2017. PI: Á. Corral

• FIS2015-71851-P. Sistemas invariantes de escala: herramientas, evidencia empírica, modelos y limitaciones, Ministerio de Economía y Competitividad, 2016–2018. PI: Á. Corral.

• PGC-FIS2018-099629-B-I00. Herramientas probabilistas y estadísticas para los sistemas complejos, Ministerio de Ciencia y Universidades, 2019–2021. PI: Á. Corral.

• 813844-CAFE-H2020-MSCA-ITN-2018. Climate Advanced Forecasting of Subseasonal Extremes, Research Executive Agency, EU, 2019–2023. PI: Á. Corral.

• RheMechFail. Stochastic rheology models of mechanical failure to monitor the resilience of structures under severe conditions, AXA Research Fund, 2018–2020. PI: J. Baró.

2019 Activities

Scientific Publications

- Navas-Portella, V., González, A., Serra, I., Vives, E., Corral, A; *Universality of power-law exponents by means of maximum-likelihood estimation*; Physical Review E; 100 6 (2019)10.1103/PhysRevE.100.062106
- Moriña, D., Serra, I., Puig, P., Corral, Á; *Probability estimation of a Carrington-like geomagnetic storm*; Scientific Reports; 9 1 (2019)10.1038/s41598-019-38918-8
- Corral, Á., González, Á; *Power Law Size Distributions in Geoscience Revisited*; Earth and Space Science; 6 5 673 697 (2019)10.1029/2018EA000479
- Corral, Á., Serra, I; *Time window to constrain the corner value of the global seismic-moment distribution*PLoS ONE;14 8 (2019)10.1371/journal.pone.0220237
- del Castillo, J., Serra, I., Padilla, M., Moriña, D; *Fitting tails by the empirical residual coeficient of variation: The ercv Package* R Journal 11 2 56 68 (2019)

Delivered Talks

- *No Significant Effect of Coulomb Stress on the Gutenberg-Richter Law*. Invited talk at the International Workshop on Seismic Source Physics. Porto Pollo, Sardinia, Italy, June 1-3, 2019. Á. Corral
- *The path from micromechanical models to a point process description of failure and the prediction of catastrophic events*. Avalanche Dynamics and precursors of catastrophic events, Ecole de Physique des Houches, Les Houches (Chamonix), France, February 4, 2019. J. Baró
- *Aftershocks and triggering in mechanical avalanches: From the lab and field to models*., Workshop: Mechanisms of Extreme Events Generation. Lorentz Center, Leiden, Netherlands, July 10, 2019. J. Baró
- *Aftershocks and triggering in mechanical avalanches: From the lab to models*. Complexity Science Seminar. Invited talk at the University of Calgary, Canada, December 17, 2019. J. Baró
- *Avances en el pronóstico probabilista de terremotos*. Servei d'Estadística Aplicada, UAB, March 21, 2019, Á. González
- *Imagining the largest tectonic earthquakes on Earth*. Workshop on Fault Complex Interaction, Barcelona, June 2019. Á. González

Scientific Activities Organized

- Kickoff Meeting of the CAFE Project, Palma de Mallorca, March 13-15, 2019. Á. Corral
- Copernicus Climate Data Store Face-to-Face Training Event, Barcelona, November 13, 2019
- CAFE 1st Summer School, Sitges, Barcelona, November 14-22, 2019. Á. Corral
- CSH Workshop Higher-order Connectivity and Correlations in Complex Systems, Complexity Science Hub, Vienna, Austria, November 25-26, 2019. Á. Corral & B. Tadic
- VIII Complexitat Day, Barcelona, May 21, 2019. J. Baró, Á. Corral,

J. Sardanyés & I. Serra

- IX GEFENOL Summer School on Statistical Physics of Complex Systems, Santander, September 2-13, 2019 (member of the scientific committee). Á. Corral
- Co-organizer of session "Statistical analysis of spatio-temporal properties of earthquake occurrence" at the European Geosciences Union General Assembly, Vienna, Austria, April 8, 2019. Á. González

Outreach Activities

- CAFE stand in the “Ciència al Carrer” Exhibition, Sitges, November 15, 2019.
- Á. Corral, Á. González Press release “Earthquakes, hurricanes and other natural disasters obey same mathematical pattern”. Published in different media..
- Á. González, Invited external professor ("Colaborador extraordinario") at the University of Zaragoza (Spain). Delivered seminars to undergraduate students of the degrees of Geology and Physics, and the double degree on Physics & Mathematics.
- Á. González, Speaker at the press conference "New hazards research: Anak Krakatau, glacial lakes and giant quakes", at the European Geosciences Union General Assembly, Vienna, Austria, April 9, 2019.
- Serra I. “El origen físico de eventos extremos - ¿Podemos predecir el riesgo de eventos sin precedentes?” Invited talk at AXA XL meeting bianual Madrid, Spain.

Other Activities

- Á. Corral, external examiner of PhD viva of Nanxin Wei, Departament of Mathematics, Imperial College London, UK, October 29, 2019.
- Á. Corral, supervisor of the Bachelor thesis of Eder Rodríguez Perelló, Mathematics Degree, UAB.
- Á. Corral, supervisor of the internship of Marc Serra, Physics Degree, UAB.
- Á. Corral, member of the doctoral commission of the Department of Mathematics, UAB.
- Á. Corral, president of the Catalan Association for the Study of Complex Systems.
- J. Baró , host and supervisor as external professor of undergraduate research project by C. Carty (2019): ’The statistical behavior of aftershocks via the parameters of frictional sliding’ under the ‘Weinberg College (WCAS) Summer Research Grant’ program, Northwestern University, Il, USA
- Á. González: Host of research stay at CRM of Ángela María Gómez García (Universidad Nacional de Colombia), funded by the program "Research in Pairs", about complex geophysical modelling, February-May 2019.

Computational Neuroscience

Alex Roxin, Klaus Wimmer, Alexandre Hyafil

Computational neuroscience is a sub-field of neuroscience proper in which computational models are used to learn something about how the nervous system works. It is a broad field, encompassing many different types of models, from statistical or probabilistic models, to differential equations. As most experimental work in neuroscience already requires some degree of modeling, if only at the level of data analysis, there is no clear divide between experimental and computational neuroscience. This means that close collaboration between theorists and experimentalists is important. At the very least, modeling work must be constrained by experimental data.

In the Computational Neuroscience group at the CRM, we focus mainly on the dynamics of cortical microcircuits, that is ensembles of hundreds or thousands of neurons in the cerebral cortex. In particular, we study the role of the recurrent connectivity in shaping spontaneous activity in models of cortical microcircuits. This is a timely topic because data on cortical connectivity has been increasing over the past decade, as well as improved measurements of the simultaneous activity of large numbers of neurons. A future goal would be to identify which aspects of network connectivity are most important for cortical processing in models, and then direct experimentalists to look for similar patterns in the brain. We study models of memory formation and memory consolidation in order to explore the computational limits of biological memory systems and shed light on the physiological mechanisms involved in memory in the animal brain.

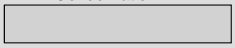
We also work on developing computational models of cortical circuits to shed light on the neural network dynamics underlying an animal's behaviour during elementary cognitive tasks such as working memory and perceptual decision making. Modelling efforts are complemented by analysis of typically high-dimensional neural data obtained by collaborators (e.g. simultaneous recordings from large populations of neurons or human neuroimaging data) involving state-of-the-art statistical and machine learning tools.

Since 2017, Klaus Wimmer joined the group as a Ramón y Cajal researcher and co-PI. His focus is on investigating the neural network dynamics underlying elementary cognitive functions such as working memory and perceptual decision making. He complements the study of neural network models with analysis of experimental data (obtained from neural recordings in behaving primates and from human neuroimaging in the laboratories of experimental collaborators). In particular, he will work on extending current local-circuit computational models of decision making processes towards a network of interacting circuits that will allow to study the contribution of different brain areas in the parietal and prefrontal cortex to decision build-up and memory maintenance.

Alexandre Hyafil joined in 2019 as a Ramón and Cajal researcher and third PI of the group. His scentific interest is in understanding the core computations that underly perception, decision-making and cognitive control in humans and mammals in general. His team uses a variety of techniques to tackle these questions. Computational modeling allows to formalize and test how the principled behavior can emerge from a set of cognitive operations, or directly from the dynamics of realistic neural networks. His team also runs psychophysics experiments and compare how different models

Members: • Alex Roxin (team leader) • Klaus Wimmer (team leader) • Alexandre Hyafil (team leader) • Federico Devalle (PhD student) • Genís Prat (PhD student) • José Mari Esnaola (Postdoctoral researcher) • Nicolás Pollán (PhD student) • Travis Steward (PhD Student) • Pau Blanco i Arnau (research assistant)

Gender ratio F:M



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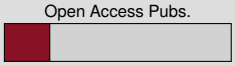


Current Projects:
• MINECO, BFU2017-86026-R, Neural network dynamics of distributed decision circuits, CRM, 1/1/2018–31/12/2020 PI: K. Wimmer.
• MINECO, RTI2018-097570-B-I00, El surgimiento de la memoria en circuitos neuronales, CRM, 01/01/2019–31/12/2021 PI: A. Roxin • MINECO, RYC2017-23231 PI: A. Hyafil • MINECO, RYC2015-17236 PI: K. Wimmer
• FI2019_FI_B1289, AGAUR, T. Steward

of behavior can qualitatively and quantitatively account for the observed behavioral metrics (responses, reaction times, etc.). These models are latter used to illuminate neural activations registered through neuroimaging devices in humans or intracranial recordings in non-human mammals. These neural recordings experiments are performed through collaboration with experimental and theoretical researchers in Barcelona (UPF, Idibaps) and outside (ENS Paris, Princeton, UT Austin). Finally, because inferring the structure of cognition from complex behavioral and neural data requires carefully crafted statistical analyses, the team also develops sophisticated tools from advanced statistics and machine learning that can be directly applied by cognitive neuroscientists.

Collaborators

- Nicolas Baumard, ENS Paris
- Albert Compte, IDIBAPS
- C. Constantinidis, Wake Forest Univ
- Rosa Cossart, INSERM at INMED
- Jaime de la Rocha, IDIBAPS
- Tobias Donner, UKE Hamburg
- Jerôme Epzstein, INSERM at INMED
- Jennifer Luebke, Boston Univ
- Ernest Montbrió, UPF
- Rubén Moreno Bote, UPF
- Tatiana Pasternak, University of Rochester
- Bijan Pesaran, NYU
- Jonathan Pillow, Princeton University
- Yingxue Wang, Max Planck Florida Institute for Neuroscience
- Yaniv Ziv, Weizmanm Institute of Science

2019 Activities

During 2019, we have focused on developing a model of neuronal turnover in the hippocampal code over time-scales of days and weeks. This work is in collaboration with experimental groups from Marseille and Budapest in the framework of a Flagera grant.

Also, the group included 1 PhD student with funding from La Caixa Foundation, and 1 postdoctoral researcher. Members from the group have started new collaborations (with Tobias Donner, UKE Hamburg; Jennifer Luebke, Boston Univ), presented their work at several international conferences including the Conference in Computational Neuroscience (CNS 2019), the Conference on Cognitive Computational Neuroscience (CCN 2019) and the Society for Neuroscience Meeting 2019, acted as local organizer of CNS 2019, and as co-organizer of the annual computational neuroscience retreat from the Barcelona Neuroscience Community (`barccsyn.org`). Full journal publications of the ongoing research work are expected starting next year.

We have also initiated a new summer school on modelling techniques for behavioral data (BAMB!, Barcelona, September 2019) that has attracted on its first edition 30 participants (PhD students, postdocs & faculty) from institutions all around the globe.

Scientific Publications

- *Exact firing rate model reveals the differential effects of chemical versus electrical synapses in spiking networks*. B. Pietras, F. Devalle, A. Roxin, A. Daffertshofer and E. Montbrió,Phys. Rev. E. 100-042412 (2019).
- *Drift-diffusion models for multiple-alternative forced-choice*

decision making Alex Roxin,J. Math. Neurosci. 9-5 (2019).

- *Firing rate distributions in spiking networks with heterogeneous connectivity* Marina Vegué and Alex Roxin, Phys. Rev. E 100-022208 (2019).
- *Neural mechanisms of vibrotactile categorization*; Malone, P.S., Eberhardt, S.P., Wimmer, K., Sprouse, C., Klein, R., Glomb, K., Scholl, C.A., Bokeria, L., Cho, P., Deco, G., Jiang, X., Bernstein, L.E., Riesenhuber, M. Human Brain Mapping 40 10 3078–3090 (2019) 0.1002/hbm.24581
- *Human confidence judgments reflect reliability-based hierarchical integration of contextual information*; Schustek, P., Hyafil, A., Moreno-Bote, R.Nature Communications 10 1 (2019)10.1038/s41467-019-13472-z

Theses

- Genís Prat CRM, *Attractor dynamics in perceptual decision making: from theoretical predictions to psychophysical experiments*, advisor:Jaime de la Rocha Vázquez (IDIBAPS) & Alexander Roxin (CRM).

Delivered Talks

- *Drift-diffusion models for multiple-alternative forced-choice decision making* (contributed). Barcelona Computational, Cognitive and Systems Neuroscience Conference, May 30-31, 2019. A. Roxin
- *A network model of place-cell turnover in CA1* Granada Seminar on computational and statistical physics: Stochastic and Collective effects in neural systems, U. Granada, Sept. 17-20 2019. A. Roxin
- Institut du Cerveau et de la Moëlle (ICM), Paris (France), July 2nd 2019 A. Hyafil
- *Circuit mechanisms underlying task-triggered changes in population codes in spatial working memory*. CNS 2019 Workshop The dynamics and limitations of working memory, July 2019, Barcelona, Spain, K. Wimmer.

Scientific Activities Organized

- Local organizer, Computational Neuroscience https://www.cnsorg.org/cns-2019 Conference, July 13-17, Barcelona. A. Roxin, K. Wimmer.
- Workshop organizer, Computational Neuroscience https://www.cnsorg.org/cns-2019 Conference, July 13-17, Barcelona. A. Hyafil.
- *BAMB! – Barcelona Summer School for Advanced Modeling of Behavior*, https://www.bambschool.org/ K. Wimmer, A. Hyafil

Outreach Activites

- A. Roxin. Instructor of the CIMPA Summer School on Mathematical Models in Biology and Related Applications of Partial Differential Equations, 11-22 June, 2019, La Habana, Cuba.
- K. Wimmer Participation at the Magnet school program (`https://magnet.cat/`) with several activities throughout the year.
- K. Wimmer hosted a high school intern for 1 week, under the framework of the "INNOBAT" program proposed by Escola Virolai and sponsored by CERCA.
- K. Wimmer hosted a 6 week summer intern (highschool student) that worked on recording and analyzing "brain waves" from a simple wireless EEG device.
- J. M. Esnaola, N. Pollán, K. Wimmer represented the CRM at the "Saló de l'Ensenyament", a fair for education and training options.
- K. Wimmer presented the computational neuroscience group at the CRM undergraduate day (mainly for Physics students).

Harmonic Analysis and Approximation Theory

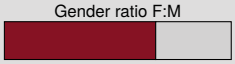
Sergey Tikhonov

Harmonic analysis studies the representation of functions or signals as the superposition of basic waves. It is currently one of the most applicable fields of modern mathematics. Among its many applications are signal processing/image transmission, various electrical and computer engineering applications, physics, probability theory and many fields of pure and applied mathematics.

Approximation theory considers the problem of how best approximating general and possibly complicated functions by simpler and more easily calculated ones. Concepts such as "best", "simpler" and "easily calculated" depend on the specific applications. Although approximation theory is a well-established area of mathematics, it is currently experiencing a significant rise due to its wide applications both in mathematics (e.g., numerical, wavelet analysis) and in computer science, signal processing, biomedical optics and geographic information systems. Recent developments in nonlinear approximation theory are aimed at carrying out fundamental mathematical (compress, denoise,...) and algorithmic study to increase our ability to process large data sets.

Members: • Sergey Tikhonov (team leader) • Kristina Oganesyan (PhD student) • Aizhan Ydyrys (PhD student)

Gender ratio F:M



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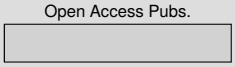


Current Projects: • MTM2017-87409-P. Teoría De La Aproximación Y Análisis Harmónico: Métodos y Aplicaciones, 2018-2020. PI: S. Tikhonov. • Grup de teoría de funcions de la UAB/UB, 2017-2019. PI: S. Tikhonov

Collaborators

- Andrey Bondarenko, Norwegian University of Science and Technology
- Feng Dai, Technology University of Alberta
- Laura de Carli Florida, International University
- Michael Dyachenko, Moscow State University
- Erlan Nursultanov, Eurasian University
- Andriy Prymak, University of Manitoba
- Alexei Shadrin, University of Cambridge
- Vladimir Temlyakov, University of South Carolina

2019 Activities

- January-June: Research stay of group members in the Isaac Newton Institute for Mathematical Sciences, Cambridge, UK

Scientific Publications

Books Edited:

- Abell, M., Iacob, E., Stokolos, A., Taylor, S., Tikhonov, S., Zhu, J. (Eds.) *Topics in Classical and Modern Analysis. Applied and Numerical Harmonic Analysis.* Birkhäuser (2019). 373pp. 10.1007/978-3-030-12277-5

Papers:

- Gorbachev, D.V., Ivanov, V.I., Tikhonov, S.Y. *Positive L p-Bounded Dunkl-Type Generalized Translation Operator and Its Applications* *Constructive Approximation* 49 3 555–605 (2019) 10.1007/s00365-018-9435-5
- Gorbachev, D., Tikhonov, S. *Doubling condition at the origin for non-negative*

positive definite functions Proceedings of the American Mathematical Society 147 2 609–618 (2019) 10.1090/proc/14191

- Dyachenko, M.I., Mukanov, A.B., Tikhonov, S.Yu. *Smoothness of functions and Fourier coefficients* Sbornik Mathematics 210 7 994–1018 (2019) 10.1070/SM9096
- Dai, F., Prymak, A., Temlyakov, V. N., Tikhonov, S. *Integral norm discretization and related problems*, Russ. Math. Surv., Vol. 74:4 579–630 (2019). Translation from Uspekhi Mat. Nauk, Vol. 74, Is. 4(448) 3-58 (2019). 10.1070/RM9892
- Dyachenko, M., Mukanov, A., Tikhonov, S. *Uniform convergence of trigonometric series with general monotone coefficients*, Canad. Jour. Math. 71, 6, 1445–1463 (2019). 10.4153/CJM-2017-046-9

Delivered Talks

- August 2019: First Analysis Mathematica Conference, Budapest, Hungary (Sergey Tikhonov)

Scientific Activities Organized

- January-June, 2019: Sergey Tikhonov was a main organizer (together with Anders Hansen, Vladimir Temlyakov, Alexei Shadrin) of the Research program "Approximation, sampling and compression in data science" in the Isaac Newton Institute for Mathematical Sciences, Cambridge, UK
- June 17-21, 2019: Sergey Tikhonov was a main organizer of the Workshop "Approximation, sampling, and compression in high dimensional problems", INI, Cambridge, UK

Outreach Activities

- September-October, 2019: PhD course by S. Tikhonov "Advanced Course on Constructive Approximation and Harmonic Analysis", CRM.
- December, 2019: Short Course (4 lectures) by S. Tikhonov "Topics on Approximation Theory", Shanghai Jiao Tong University, China

Other Activities

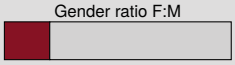
- Journal of Fourier Analysis and Applications, Member of Editorial board
- Journal of Mathematical Analysis and Applications, Member of Editorial board
- Analysis Mathematica, Member of Editorial board
- Demonstratio Mathematica, Member of Editorial board
- Jaen Journal on Approximation, Member of Editorial board
- Abstract and Applied Analysis, Member of Editorial board
- Bulletin of Mathematical Analysis and Applications, Member of Editorial board

Industrial Mathematics

Timothy G. Myers

Members: • Tim Myers (Team Leader), • Francesc Font (post-doctoral researcher), • Marc Calvo (PhD Student), • Claudia Fanelli (PhD Student), • Gary O'Keeffe (PhD student based at University of Limerick)

Gender ratio F:M



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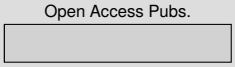


Current Projects: • MTM2017-82317-P. Mathematics in Nanotechnology and Industry, 2017 – 2019. PI: T. Myers.

Industrial mathematics can be defined as the application of mathematics to real-world problems. The field appears to be gaining in popularity throughout the world. In Europe the European Consortium for Mathematics in Industry has been promoting the subject for over 25 years, they have now been joined by EU-Math-In and until 2019 the EU COST Network MI-Net.

The Industrial Mathematics group at the CRM is currently contributing, in terms of research, primarily in the application of mathematics to nanotechnology. More traditional IM activities are not forgotten through the group's involvement in Study Groups. The primary research topics dealt with by group members included:

- Heat transfer at the nanoscale. This work is in collaboration with the physics department at UAB. The main goal is to develop and analyse mathematical models for heat flow in situations where Fourier's law breaks down. Results have compared very favourably with experiments on silicon nanowires.
- Energy capture using nanofluids in a Direct Absorption Solar Cell. This follows the work of Cregan & Myers in 2015. We are currently looking into different designs and flow configurations to improve efficiency.
- Nanocrystal growth from solution. This project grew from a problem presented at the 2016 European Study Group with Industry, held at the CRM in 2016. It is a collaboration with the Catalan Institute for Nanoscience and Nano-technology.
- Kirkendall effect. As a first attempt to analyse the production of hollow nanocrystals we developed a model for binary diffusion (between two metals). Initial work has progressed well, in the future we hope to include nano-effects.
- Imaging of nanoparticles with visible light. This is a collaboration with a French research centre, CEMES. The goal is to develop a mathematical model to help analyse the interference fringes produced by a nanoparticle on a light wave.

In industrial mathematics meetings in South Africa and Ireland group members worked on spontaneous combustion; flow near the walls of a sugar boiler and noise damping.

Collaborators

- Sarah Mitchell, University of Limerick
- Brian Wetton, University of British Columbia
- Matt Hennessy, University of Oxford
- Víctor Puntes, Institut Català de Nanociència i Nanotecnologia
- Neus Bastus, Institut Català de Nanociència i Nanotecnologia
- Vincent Cregan, University of Limerick
- Iain Moyles, York University
- Xavier Alvares, Universitat Autònoma de Barcelona
- Wolfgang Bacsa, Centre d'Elaboration de Matériaux et d'Etudes Structurales

2019 Activities

The primary research activities carried out by the IM group involve developing and analysing models for:

1. carbon capture by adsorption;
2. finding nanoparticles using visible light;
3. nanocrystal growth;
4. nanoscale heat transfer.

Much of this work is collaborative, 2) is with material scientists at a French CNRS centre, 3) is with the Catalan Institute of Nanoscience and Nanotechnology and 4) with physicists at UAB.

The IP and Dr Font successfully applied for a Juan de la Cierva grant. Ms Fanelli was awarded a Ferran Sunyer i Balaguer grant for 1 month stay at Cardiff University. She also received a Short Term Scientific Mission grant from COST Action TD1409 Mathematics for Industry Network, MI-Net for a further 2 months in Cardiff.

Scientific Publications

- R Moyles, MG Hennessy, TG Myers, BR Wetton;*Asymptotic reduction of a porous electrode model for lithium-ion batteries*.SIAM Journal on Applied Mathematics 79 (4), 1528-1549 (2019).
- M.G. Hennessy; M. Calvo; T.G. Myers;*Modelling ultra-fast nanoparticle melting with the Maxwell–Cattaneo equation*. Applied Mathematical Modelling. 69, pp.201-222. (2019)
- Tim Myers; Claudia Fanelli. *On the incorrect use and interpretation of the model for colloidal, spherical crystal growth*. Journal of Colloid and Interface Science. 536, pp.98-104. (2019)
- A Beardo, M Calvo-Schwarzwälder, J Camacho, TG Myers, P Torres, L Sendra, FX Alvarez, J Bafaluy; *Hydrodynamic Heat Transport in Compact and Holey Silicon Thin Films*. Physical Review Applied. 11-3. (2019)
- H. Ribera; T.G. Myers; M.M. McDevette.*Optimising the heat balance integral method in spherical and cylindrical Stefan problems*.Applied Mathematics and Computation. 354, pp.216-231. (2019)
- *What is Industrial Mathematics?* Editors I. Griffiths, K. Kaouri, T. Myers, H. Ockendon, e-book (2019) `https://minetworkdotorg.files.wordpress.com/2019/07/handbook_ss.pdf`
- *Thermal Transport Equations and Boundary Conditions at the Nanoscale*. M Calvo-Schwarzwälder, MG Hennessy, P Torres, TG Myers, FX Alvarez. Progress in Industrial Mathematics at ECMI 2018, 37-44, (2019)
- *Mathematical Modelling of Nanocrystal Growth*. C Fanelli, TG Myers, V Cregan. Progress in Industrial Mathematics at ECMI 2018, 67-73, (2019).
- *Mathematics in Nanotechnology*. Tim Myers, Marc Calvo, Claudia Fanelli, Matt Hennessy, Wolfgang Bacsa. Valencia Intelligencer (Magazine given out to all participants at ICIAM 2019).
- *Modelling carbon capture by adsorption*. T. Myers. Proc. Mathematics in Industry Study Group, South Africa (2019).

- Font, F., Moreno, E., Alonso, S. *Wave-Pinning by Global Feedback in the Bistable Schlögl Model* Trends in Mathematics 11 145–149 (2019) 10.1007/978-3-030-25261-8_22

Theses

- Marc Calvo, *Non-classical thermal transport and phase change at the nanoscale*, advisors: Timothy Myers (CRM) and Francesc Xavier Àlvarez Calafell (UPC)

Delivered Talks

- *Why are Industrial Mathematicians so useful?* Invited talk, OCIAM@30 years, Oxford Centre for Industrial and Applied Mathematics, University of Oxford, June 2019.T. Myers
- *Finding nanoparticles with visible light*, 9th International Congress on Industrial and Applied Mathematics, Valencia, July 2019. T. Myers
- *Imaging nanoparticles with visible light: an Industrial Mathematics case study*. British Applied Mathematics Colloquium, Bath April. T. Myers.
- *Invited International Expert at South African Mathematics in Industry Study Group*, Cape Town, January 2019. T. Myers
- *Continuum models and nonequilibrium molecular dynamics simulations of melting at the nanoscale* in THERMODYNAMICS2019, Huelva, Spain 2019. F. Font
- Contributed talk: "Mathematical modelling of carbon capture by adsorption" in ICIAM2019 (Valencia, Spain)
- Contributed talk: "Modelling and analysis of binder migration during drying of Li-Ion battery electrodes" in ICIAM2019 (Valencia, Spain)

Scientific Activities Organized

- T. Myers Minisymposium organiser (Collaborative Mathematics), International Conference on Industrial and Applied Maths, Valencia, June.
- T. Myers Founding editor of Mathematics in Industry Repository (a form of industrial mathematics ArXiv), Cambridge University Press. To be launched 2020.
- T. Myers Member of Scientific Committee for European Consortium of Mathematics in Industry Conference, to be held Limerick, June 2020.
- T. Myers A main organiser for 158th European Study Group with Industry (held at CRM, Jan 2020).

Outreach Activites

- T. Myers Student mentor, International Centre for Mathematical Sciences Modelling Camp, Imaging nanoparticles with visible light: an Industrial Mathematics case study. This involves presenting a practical problem to a group of doctoral students and guiding them through a solution during the week. Edinburgh, 7-10 May, 2019
- T. Myers Seminar within series “Bojos per a les matematiques”. This is a seminar series aimed final year high school students, for the past 5 years I have given a 3 hour talk on fluid mechanics and industrial mathematics, https://bojos-ciencia.fundaciocatalunya-lapedrera.com/cursos/matematiques

- T. Myers Programa Magnet. This is a collaboration between the CRM and a local primary school, Escola Joaquim Blume. This year I supervised a project for a 1st year class (6 yr olds) on “Why we float easier in the sea”
- T. Myers Supervisor for first year Master’s project placement from Supméca Institute of Mechanics of Paris, Oct. 2019 – Feb 2020.
- F. Font Evaluation Panel in "XX EXPORECERCA JOVE" (Exporecerca Jove is an international research fair held annually in Barcelona. Its objectives are to promote research among young people, to promote the exchange of experiences and knowledge and to promote participation in other fairs and congresses of national and international scope), (Hospitalet de Llobregat, Spain)

Other Activities

- T. Myers Member of management committee, COST Action TD1409 Mathematics for Industry Network, MI-Net. Final meeting April 2019, Bath, UK, `https://mi-network.org/`
- T. Myers Short Term Scientific Mission Manager for MI-Net: Evaluate and approve/reject applications for research visits between EU institutions.
- T. Myers Spanish Representative on council of European Consortium of Mathematics in Industry (finished March 2020).
- T. Myers Member of European Consortium of Mathematics in Industry Research and Innovation Committee, from Dec 2019.
- T. Myers Co-ordinator for all European Study Groups with Industry.
- T. Myers Adjunct Professor of Industrial Mathematics, University of Limerick.
- T. Myers Adjunct Professor, U. Politecnica Catalunya (also teacher on the course Mathematical Models in Technology).
- T. Myers Member of Editorial Board, Springer-RSME book series; Mathematics in Industry Case Studies.
- T. Myers Referee for Int. J. Heat Mass Trans (x3); IMA J. Appl. Math.; Int. J. Comp. Fl. Dyn.; Physica Scripta.
- F. Font Acting as editor of the upcoming book " Multidisciplinary Mathematical Modelling" (ICIAM2019 SEMA SIMAI Springer Series) containing contributions from CRM researchers at the conference ICIAM2019.
- C. Fanelli was awarded with the Ferran Sunyer i Balaguer grant for month stay at Cardiff University. She also received a Short Term Scientific Mission grant from COST Action TD1409 Mathematics for Industry Network, MI-Net for a further 2 months in Cardiff.

Mathematics of development and evolution

Isaac Salazar Ciudad

Members: • Isaac Salazar (Team Leader) • Tazzlo Tissot

Gender ratio F:M

Open Access Pubs.

Current Projects:
• MINECO, PGC2018-096802-B-I00,*Comprension de la relacion entre el desarrollo embrionario, la variacion genetica additiva, la variacion ambiental y el mapa genotipo-fenotipo* **PI** I. Salazar.

Our group is focused in understanding the mathematical bases of evolution.

The main question we want to address is: how did complex organisms arise in evolution? Or more in general, how can complexity evolve also in other systems like culture, society and molecular pre-biotic systems. In the case of multicellular organisms, such as us, the questions are:

1. How does a fertilized egg transform itself into a complex adult organism? Can we understand the mathematics of such a dramatic pattern formation process?
2. How did this complexity arose by a gradual process of evolution by natural selection. This implies explaining also the evolution of the development that produces such complexity in each generation.
3. Are there some logical or mathematical requirements or principles that gene networks need to fulfill in order to be able to produce complex morphologies during development? If so, can we approach question 1 and 2 above from understanding these principles?

Understanding question 1 is highly non-trivial: something very complex, e.g. our body, is produced from something much simpler and small, a simple cell, in a relatively short time.

This process can not be understood by looking at single genes. Embryonic development involves the interaction between huge numbers of genes and cells. Thus, for example, to understand which morphological changes will occur from specific mutations in a gene, we need to understand how that gene is embedded in a gene network and how that affects the dynamics of signaling and mechanical interactions between cells and tissues. In other words, we have a huge number of heavily interacting elements at different levels (e.g. genes, cells, tissues) that lead to the arising and variation of a macroscopic pattern, the body's.

To address these questions we build multi-scale models of embryonic development. Each such model includes a set of differential equations describing how genes regulate each other's expression and a set of differential equations describing how cells move, change shape and activate cell behaviors (cell growth, cell contraction, cell division, etc?). Each cell contains the same set of genes and equations, but, as a result of model dynamics, different cells end up expressing genes at different intensities. Genes affect the mechanical properties and behaviors of the cells in which they are expressed. As a result, cells move and rearrange themselves in space. In their turn, cell affect back gene expression by differentially affecting, through cell-cell signaling, where genes get expressed.

The research activity of our group is developed along the following lines:

- Multiscale modelling of pattern formation and morphogenesis in embryonic development.
- Modelling of evolution in biologic and non-biologic systems.
- Statistical developmental biology.
- Combining and contrasting developmental biology and quantitative genetics approaches to the genotype-phenotype map and evolution.

Collaborators

- Jukka Jernvall, University of Helsinki
- Osamu Shimmi, University of Helsinki
- Antonio Barbadilla, Universitat Autònoma de Barcelona
- David Houle, Florida State University
- Stuart A. Newman, New York Medical College

2019 Activities

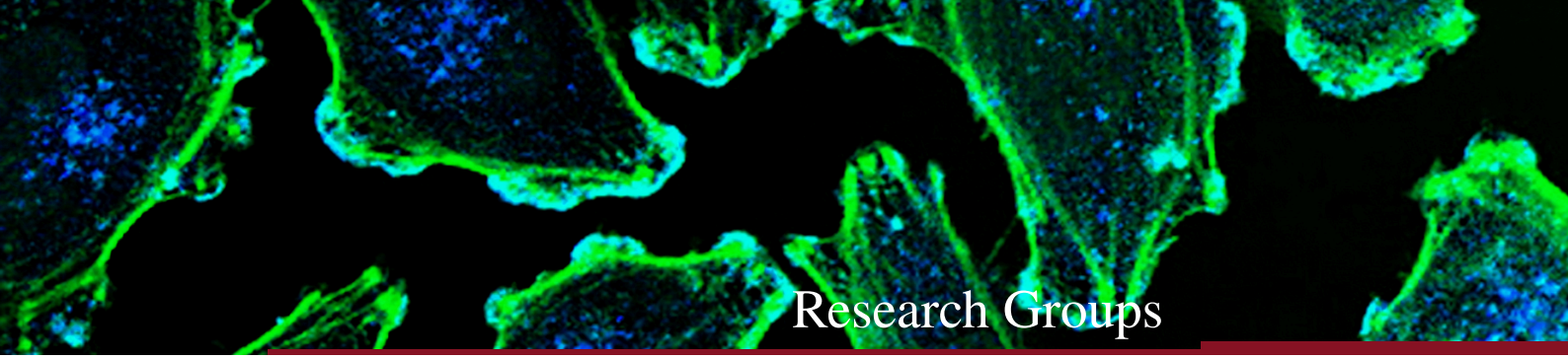
During 2019 we have had two main approaches and results. In the first one (Hagolani et al., 2019) we build a huge ensemble of random developmental mechanisms, e.g. gene networks coupled with cell behaviors and mechanical properties, and simulated them to explore which ones can lead to morphogenesis (e.g. the transformation of a simple morphology into a more complex one). We found that even very simple developmental mechanisms can lead to the development of complex morphologies but that for those morphologies to be stable to noise the gene network needs to be quite complex, involve cell-cell signaling and lead to the partition of morphology into roughly equally small territories of gene expression. In the other study (Coronado-Zamora et al., 2019) we use different statistical methods to estimate natural selection over the life cycle of the fly using genomic and transcriptomic data.

Defended Thesis

- Title: *On the development of the Turtle Scute Pattern and the Origins of its variation.* Candidate: Roland Zimm, University of Helsinki. Advisor: Isaac Salazar-Ciudad (UAB-CRM).

Scientific Publications

- Coronado-Zamora M.,Salvador-Martınez I., Castellano D. Barbadilla A., Salazar-Ciudad I.; *Adaptation and conservation throughout the drosophila melanogaster life-cycle*;Genome Biology and Evolution;**2019**;11,5;1463-148210.1093/gbe/evz086
- Hagolani P.F., Zimm R., Marin-Riera M., Salazar-Ciudad I.;*Cell signaling stabilizes morphogenesis against noise*;**2019**;Development;146;20;10.1242/dev.179309



Nonlinear Dynamics and Evolution Lab

Josep Sardanyés Cayuela

Our laboratory seeks to understand nonlinear phenomena. Our research is focused on different biological systems, from prebiotic replicators to complex ecosystems and disease dynamics. To do so we use the qualitative theory of dynamical systems and computer simulations (stochastic dynamics and spatially-extended systems). We investigate the dynamical evolution of nonlinear systems, paying special attention to the bifurcations and phase transitions separating relevant dynamical phenomena. Our investigations have the ultimate goal to identify potential useful dynamical scenarios such as ecosystems' recovery or tumor cells extinctions. Also, we are doing research in general topics of nonlinear dynamical systems such as bifurcations, universality phenomena, scaling, and transients.

`https://sites.google.com/site/nonlineardynamicsevolutionlab`

Members: • Josep Sardanyés (Team Leader), • Ernest Fontich (UB), • Antoni Guillamon (UPC), • Jorge Duarte (ISEL – IST), • J. Tomás Lázaro (UPC), • Blai Vidiella Rocamora (PhD candidate), • Marc Plana (PhD candidate)

Gender ratio F:M

Open Access Pubs.

Current Projects

• A dynamical systems analysis of microbial multi-species ecosystems **PI** J. Sardanyés.

• Los puntales matemáticos de la biología integrativa de sistemas **PI** T. Alarcón & J. Sardanyés.

Collaborators

- Tomás Alarcón, ICREA – CRM – UAB
- Santiago F. Elena, Instituto de Biología Integrativa de Sistemas, I2SysBio and The Santa Fe Institute
- Álvaro Corral, CRM – UAB
- Ricard Solé ,ICREA – Complex Systems Lab, UPF and The Santa Fe Institute
- Lluís Alsedà, CRM – UAB
- Sergi Valverde, Institut de Biologia Evolutiva - CSIC
- Carlos Peña, Instituto de Biología Integrativa de Sistemas, I2SysBio; Laboratorio Subterráneo de Canfranc
- Daniel Oro, Centre d'Estudis Avançats de Blanes – CSIC
- Frederic Bartumeus, ICREA – Centre d'Estudis Avançats de Blanes – CSIC – TheeLab
- David Alonso, Centre d'Estudis Avançats de Blanes – CSIC – TheeLab
- Cristina Januário, Instituto Superior de Engenharia de Lisboa (ISEL) and Instituo Superior Técnico de Lisboa
- Nuno Martins, Instituo Superior Técnico de Lisboa
- Anel Nurtay, Oxford University
- Matthew Hennessy, Oxford University
- Àngel Jorba, UB
- Joan Gimeno, UB

2019 Activities

Along 2019, NoDE lab has been doing research on dynamical systems applied to different biological subjects: theoretical ecology, cancer, origins of life, and virus dynamics and evolution. The lab has supervised a MSc thesis and co-supervised a BsC thesis. We have published 4 research articles and a book chapter. We have started long-term collaborations with different research centers:

1. Institute for Integrative Systems Biology (València)
2. Center for Advanced Studies (CEAB-CSIC) (Blanes)
3. Center for Agrogenomic Research (CRAG, Bellaterra)

Scientific Publications

- Sardanyés J, Piñero J, Solé R;*Habitat loss-induced tipping points in metapopulations with facilitation*. Population Ecology; 1-14 (2019)
- Sardanyés J.; *Viruses: Agents of evolutionary invention.* The Quarterly Review of Biology; 94(1): 90-91 (2019)
- Nurtay A, Hennessy MG, Sardanyés J, Alsedà Ll, Elena SF;*Theoretical conditions for the coexistence of viral strains with differences in phenotypic traits: a bifurcation analysis.* Royal Society Open Science; 6: 181179 (2019)
- Fornés J, Lázaro JT, Alarcón T, Elena SF, Sardanyés J; *Viral replication modes in single-peak fitness landscapes: A dynamical systems analysis*. Journal of Theoretical Biology 460: 170-183 (2019)
- Vidiella B, Lázaro JT, Alsedà Ll, Sardanyés J *On dynamics and invariant sets in predator-prey maps*. Ed. IntechOpen (2019).

Theses

- Anel Nurtay, *Mathematical modelling of pathogen specialisation*, advisors: Alsedà i Soler, Lluís (CRM-UAB) and Elena, Santiago (I2SysBio and CSIC-UV)

Delivered Talks

- *Strategies to bifurcate tumors to extinction*. International Conference on Industrial and Applied Mathematics, València, Spain 15-19th July 2019. J. Sardanyés
- *Characterising disease-free attractors using dynamical systems theory*. Keynote speaker at the BGSMath María de Maeztu Unit of Excellence 2015-2019 Closing Workshop, Universitat de Barcelona, Barcelona 6th June 2019. J. Sardanyés
- *Computational and mathematical approaches to virus complexity*, Seminar series of the Institute of Integrative Systems Biology (I2SysBio), 24th May 2019. J. Sardanyés
- *Some intimacies about the saddle-node bifurcation in one and more dimensions* UB-UPC Dynamical Systems Seminars, Facultat de Matemàtiques i Informàtica (Universitat de Barcelona), Barcelona, 24th April 2019. J. Sardanyés
- *Plants: about ecology, pathogens, and mathematics*, 1st Joint Workshop CRAG-CRM, Center for Agrogenomic Regulation, Bellaterra, Spain, 28 January 2019. J. Sardanyés

Scientific Activities Organized

J. Sardanyés was member of the organising committee of the VIII Jornada de Complexitat.cat. Institut d'Estudis Catalans, Barcelona, 22nd May 2019.

Outreach Activites

J. Sardanyés gave a seminar addressed to students entitled *Què és el caos?* Activity organised by EscoLab and the Centre de Recerca Matemàtica, 7 March 2019. This was an activity addressed to 16-17 years old students to foster mathematics curiosity and scientific interest. The activity was two hours long and included balckboard explanations, slides, and a show using a double pendulum.

Other Activities

- MsC thesis supervised entitled *Spatiotemporal dynamics of cancer phenotypic quasispecies*, Celia Penella from the Universitat Pompeu Fabra.
- BsC thesis supervised entitled *Lotka-Volterra models applied to cancer*, Alba Martínez from Universitat Autònoma de Barcelona.

2.9 Knowledge Transfer Team

The unit of technology and knowledge transfer of the CRM was created in 2017 in order to support the initiative of Transfer originated in 2012.

From the transfer point of view, the CRM has potential to promote the advance and innovation in science's key areas. Specifically, the nature of the CRM is to host interdisciplinary scientific knowledge, thanks to the support of the mathematical community of the Catalan universities that provide international networking and promote high quality scientific research. Therefore, the CRM offers advanced knowledge in the development of solutions to current problems of the industry, society and the environment.

Due to the complexity involved in the transfer of interdisciplinary areas, in September 2017, the CRM started the KTT Unit with the mission of strengthening the links between research and the real world, to endorse advising and understanding. This Unit guides and promotes the use of solutions based on science as the engine for innovation.

The objectives of the CRM's KTT Unit are to promote, collaborate and evaluate the transmission, transfer and creation of knowledge that links research with its application. Therefore, the KTT Unit is present in talent promotion processes, promotes the interdisciplinarity between researchers and acts as promoter of research results. In this last point, this year began an active participation by the CRM in studying and supporting innovation projects that begin within the industry. However, the KTT Unit participates in actions of outreach for the center, and this year it has participated in the MOOC of Coursera on Big Data.

Regarding the promotion of talent, KTT is attentive to attracting interest from students with interdisciplinary concerns, hosting them in stays at the center, as well as directing undergraduate and master's final projects. In addition, it encourages PhD students to participate in educational activities in order to enhance their communication skills, a key factor for transfer. This year, there has been a collaboration with the department of Mathematics of the UAB and the UPC's partner university, EAE.

With regard to the promotion of interdisciplinarity between researchers, the main purpose is to endorse the use of top research in mathematics with other disciplines, that is why you want to promote the creation of associations and other collaborations. This year, thesis co-direction projects have begun, together with other centers. Along with organising a meeting session between the CRAG and the CRM.

Finally, the main action carried out by the CRM this year has been the promotion of the results obtained in the field of mathematical biology. This has led to the creation of the Spin-Off Rheo dx. Rheo dx was born from the CRM and the Mobile World Capital through the Collider acceleration program. Rheo Dx has licensed the CRM patent on the viscosities of complex micro-scale fluids. It successfully initiated the first round of investment. It has completed two industrial doctorates supervised by CRM researchers. In addition, an agreement with the CRM has been signed so as to secure that the center will be its engine of innovation.

Complex Fluids Lab

The CRM Complex Fluids Lab is a service and experimental research unit. This unit is a joint venture between the Computational & Mathematical Biology and Industrial Mathematics groups, and the Knowledge and Technology Transfer Unit. The goal is to provide researchers with experimental facilities that allow to step up the research of these groups, providing the necessary tools to incorporate the experimental branch into the field of complex fluids.The scientific goal of this research unit is the study of the mechanical properties of fluids subjected to different dynamics, both by means of physical and mathematical models and by means of data analysis. The Complex Fluids Lab has been set up in collaboration with the group of Dynamics of Interfaces in Nanotechnology, Fluidics and Biophysics of the Faculty of Physics of the University of Barcelona, led by Prof. Aurora Hernández-Machado, scientific collaborator of the CRM. The main progress of the lab during 2019, has been the analysis and the set up of the facilities in order to offer a service of experimentation and analysis of fluids to other research groups.

Red Española Matemática-Industria

CRM signed a collaboration agreement with Math-In in May 2012, with the goal of involving CRM researchers in technology transfer, through the exchange of information, co-ordinating grant proposals, support to conference organization and establishing links with companies and research centres.

The creation of the Math-In Network was one of the priorities of the Technology Transfer Plan of the previous i-MATH project, and was intended to be the evolution of the mathematical platform CONSULTING. Math-In is a network made up of almost forty research groups focused on communication and exchange of information and experiences to promote the transfer of research results produced into the field of industrial mathematics.

[math-in].net
Red Española Matemática-Industria

http://www.math-in.net/

Industrial Doctorate

CRM has provided proposals for Industrial Doctorates since the set up of this plan by the Generalitat de Catalunya. At this moment, CRM has two insdustrial doctorates in collaboration with RheoDx, the CRM's spin-off. The doctorate students are Josep Ferré and Lourdes Méndez.

2.10 Research Training

The CRM is an internationally recognised research centre in Mathematics, with a focus on providing a meeting point for researchers from all expertise levels to work together and enhance their careers. The CRM offers pathways for young students and researchers to develop their careers and further their formation by collaborating with the experts currently working on their research at the CRM. The center, also offers research training programmes designed for both undergraduate and graduate students at all levels. Roughly speaking, there are three training levels at CRM:

- undergraduate students,
- master students, item doctoral and post-doctoral.

The latter has been explained in Section Master's Course of this report. Next, we explain the activity in the first two stages during 2019.

CRM's Doctoral Training Unit

CRM offers the possibility for graduate students to engage in a PhD project within a research group or thematic network of CRM. Doctoral students of CRM are enrolled in the CRM-Doctoral Training Unit (CRM-DTU). They are required to fulfill the requisites to be admitted to a doctoral programme in Mathematics in a Catalan university and they become automatically enrolled in the Barcelona Graduate School of Mathematics. The DTU is currently co-ordinated by Álvaro Corral with the support of the CRM direction team.

The DTU has a programme of activities consisting of:

- A cycle of advanced courses given by CRM researchers and/or collaborators from the thematic networks. These courses will be integrated within the Barcelona Graduate School of Mathematics, and thus made available to all the PhD students of the Barcelona area. The subjects of these courses will be of general interest for all students.
- A junior seminar organised by the students on a monthly basis and attended only by junior researchers (PhD students and postdocs).
- An annual workshop where students will present reports of the current state of their theses.

CRM PhD students are funded from different sources: competitive grants of the Generalitat de Catalunya or Spanish Ministeries, grants from the "la Caixa"-CRM program collaborative research, CRM-funded grants among others. PhD students associated to the CRM during this year are listed at Appendix of the present report.

Master's Course

The CRM master's course on Financial Mathematics was held for the twenty-first time in 2019 thanks to the collaboration of the Mathematics Department of the UAB and the CRM with several financial companies such as the Barcelona Stock Exchange, which is the sponsoring institution. Other collaborating institutions are the departments of Economics and Economics History, Applied Economics, and Business Economics of the UAB, the Department of Econometrics, Statistics and Spanish Economy of the UB, and several outstanding specialists who work in direct contact with the markets.

Participation companies promote practical training opportunities for the students by offering them internships. This facilitates a direct contact between the academic world and the professional world, allowing them to develop and teach innovative techniques about the valuation of derived financial products, calculation of coverage strategies, risk assessment and risk control.

The course is structured in three terms, two theoretical, each with 120 hours of teaching, and a third practical in a financial company. The master's responsibility lies on an Academic Commission and an Executive Committee. In 2019 more than 10 students completed the master's course.

Internships for Initiation to Research

CRM launched in 2012 a call for research stays aiming at attracting the interest of young people towards mathematical research. The CRM hosts, for a 2-month stay, undergraduate or master students willing to experience a training period in some of the CRM research groups. During 2019, 13 students visited the CRM within this program. Then names are listed at the Appendix of this report.

3 Activities

3.1 CRM Activities

The CRM has a long-standing tradition of organizing four types of activities on a c ompetitive basis through open calls on its website:

- Intensive Research Programmes
- International Conferences and Workshops
- Advanced Courses
- Thematic Days

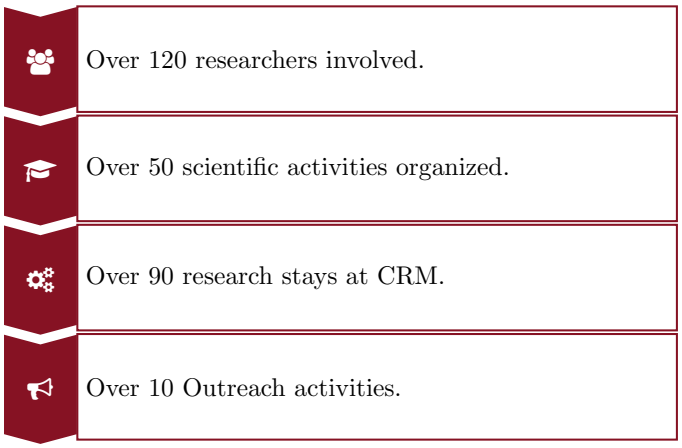
The scientific events and research programmes held at the CRM are open to participation by both local and international researchers at all stages of their careers. The CRM is particularly eager to serve as a meeting point for Catalan mathematicians and renowned specialists from all around the globe, inviting researchers to carry out long-term stays during the research programmes.

Applications can be submited at

`http://www.crm.cat/ca/Activities/Pagines/CallsForActivities.aspx`

CRM is socially committed to the popularization and dissemination of mathematics, also. One of the main goals of the center is to raise awareness of the usefulness of mathematics through an on-going dialogue with society. To this end, CRM also promotes Outreach activities.

The following table is as an outline of the research activities carried out during 2019:



3.2 Seminars

The CRM disseminates the activity of all the research seminars in mathematics in Catalonia, but it also organises seminars in emergent areas, either through its thematic networks or through the CRM's research staff.

Seminars Related to CRM's Research activity

1. The CRM Applied Mathematical and Physics (CAMP) Seminar. Coordinator: Víctor Navas (CRM).

2. Computational Neuroscience Seminar. Organisers: Alex Roxin (CRM), Albert Compte (Institut d'Investigacions Biom'ediques August Pi i Sunyer (IDIBAPS)), Gustavo Deco (UPF), Jaime de la Rocha (IDIBAPS), Antoni Guillamon (UPC), Ruben Moreno-Bote (Fundaci´o Sant Joan de D´eu), Jordi G. Ojalvo (UPC).

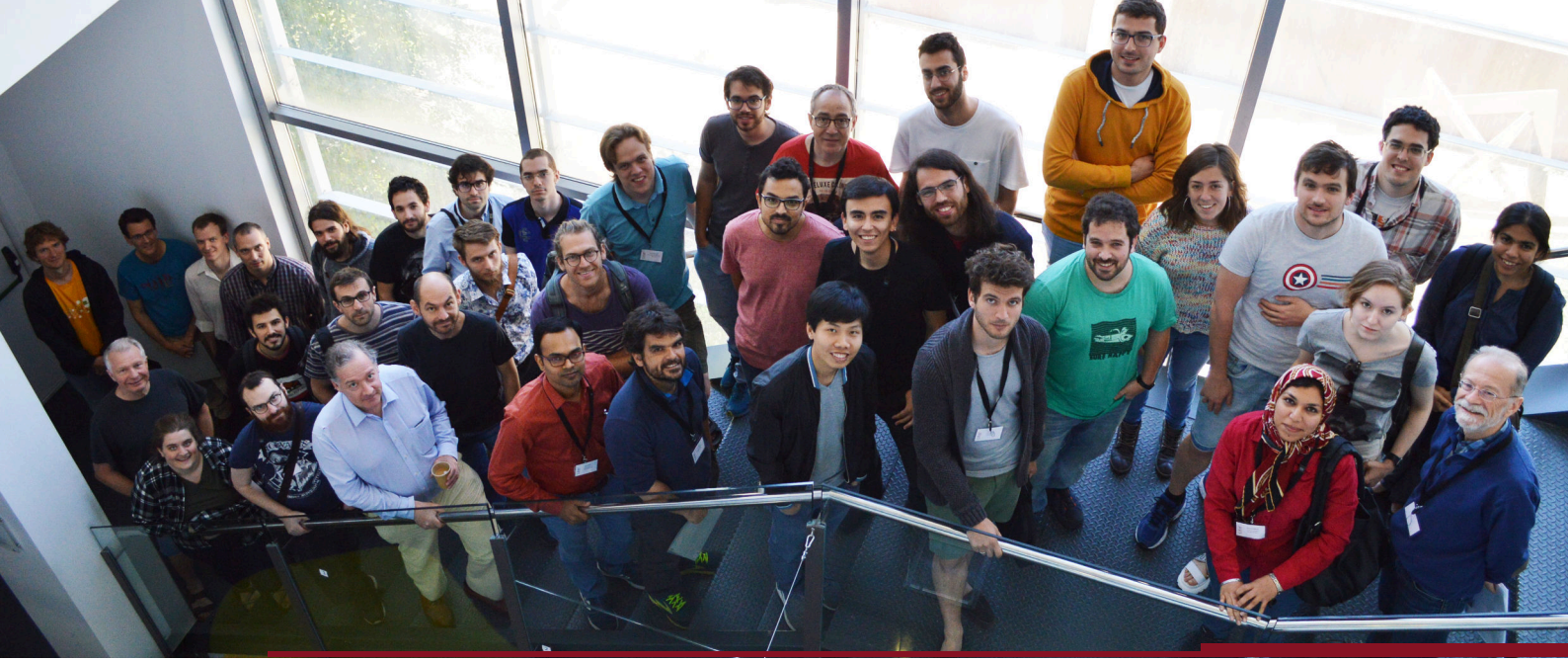
3.3 Intensive Research Programmes

The CRM Research Programmes consist of periods of intensive research in a particular area of the mathematical sciences and their applications, bringing together researchers from different institutions to work on open problems in the chosen area and to analyse its present state and perspectives.

Research Programmes can run for periods from two to five months, with both visiting researchers and activities organised within. Every programme has a scientific committee, which is fully responsible for the planning of all activities included in the programme, elaboration of the list of participants, and submission of a final report. Typically, participants in a programme include local full-time researchers, visitors on a full-time basis, post-doctoral fellows, and advanced doctoral students. A research programme generally includes one or two weekly seminars, one intensive workshop (preferably open to researchers not participating in the programme), a conference and an advanced course addressed to graduate students.

The CRM Research Programmes are called internationally two years in advance and are evaluated by the Scientific Advisory Board. The CRM Research Programmes that took place in 2019 are described below. General information of Research Programmes can be found at

`www.crm.cat/en/Activities/Pages/ResearchProgrammes.aspx`



LIGAT: Laboratory of Interactions between Geometry, Algebra, and Topology

MAY 15th TO JULY 15th, 2019

This intensive research programme aims to bring together top-level researchers in geometry, algebra, and topology with a particular focus on how these areas interact. The idea grew from the recently founded "Laboratory of Interactions between Geometry, Algebra, and Topology (LIGAT)" based at the Universitat Autònoma de Barcelona (UAB). The programme will consist of eight weeks of different activities conducted by senior research visitors and local researchers from the LIGAT. There will be an advanced course consisting of different lecture series on a variety of topics.

These courses are ideal for PhD students and young researchers and participants will also have the opportunity to present their own work. The central part of the programme is a series of workshops on selected topics in geometry, algebra, and topology. The programme is completed by weekly seminars, promoting interactions and collaborations among participants and facilitating communication between the different research directions. All together, we aim to promote high level and quality research in diverse but interrelated areas of research, and to facilitate the inclusion of younger researchers in these areas.

Main activities of the event:

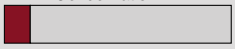
1. Advanced Course on Geometry, Topology and Algebra, *May 27th to 31st, 2019.*
2. Workshop on Geometry: Multiple Perspective on Geometric Inequalities, *June 3rd to 7th, 2019.*
3. Topology Workshop LIGAT CRM RP 2019, *June 17th to 20th, 2019.*

Acknowledgements: The organizers would like to acknowledge financial support by the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) and the European Mathematical Society (EMS).

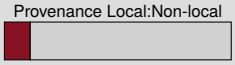
Organizers:
Florent Balacheff (UAB), Carles Broto (UAB), John Greenlees (University of Warwick), Francesc Perera (UAB)

General data:

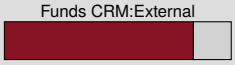
Gender ratio F:M



Provenance Local:Non-local



Funds CRM:External



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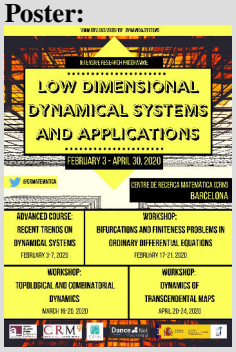


Advanced Course on Geometry, Topology and Algebra

Description **From 27th to 31st of May**

In May 2019 a week of Advanced Courses will be organized at the CRM (Barcelona). Each Advanced Course will consist of four 1h30 sessions and there will be three such advanced lectures in a day: one on a specific topic in algebra, one on a specific topic in topology and another one in geometry. In addition to the three Advanced Courses, participating doctoral students and postdocs will be given an opportunity to present their results during half an hour talks (most probably on Wednesday).

Lecturers

1. John Greenlees, University of Warwick
2. Mikael Rørdam, University of Copenhagen
3. Felix Schlenk, Université de Neuchâtel

Workshop on Geometry: Multiple Perspective on Geometric Inequalities

Description **From 3rd to 7th June**

Unexpected connections have been established between convex, metric, hyperbolic and symplectic geometries. Some of these multiple interfaces date back to the second part of 20th century, while others were only found recently.

Lecturers

1. Alberto Abbondandolo, Universität Ruhr-Universität Bochum
2. Gabriele Benedetti, Universität Heidelberg
3. Jeff Brock, Brown University
4. Dmitri Faifman, Université de Montréal
5. Federica Fanoni, Institut de Recherche Mathématique Avancée, Strasbourg
6. Maxime Fortier Bourque, University of Glasgow
7. Joe Fu, University of Georgia
8. Jean Gutt, Universität zu Köln
9. Umberto Hryniewicz, RWTH Aachen
10. Roman Karasev, Moscow Institute of Physics and Technology
11. Marco Mazzucchelli, École Normale Supérieure de Lyon
12. Alexander Nabutovsky, University of Toronto
13. Panos Papasoglu, University of Oxford
14. Bram Petri, Universität Bonn

15. Regina Rotman, University of Toronto
16. Franz Schuster, Technische Universität Wien
17. Anna Siffert, Max Planck Institut für Mathematik
18. Juan Souto, Université de Rennes
19. Alina Stancu, Concordia University

Topology Workshop LIGAT CRM RP 2019

Description **From 17th to 20th June**

The aim of this topology workshop is to cover a large spectrum of themes in algebraic topology, with a focus on homotopy theory. In particular, stable homotopy theory has had a rapid growth in recent years, motivated by the development of new techniques and connections with other areas of mathematics. This workshop addresses the interactions between stable and unstable homotopy theory and other aspects of algebraic topology and geometry.

Lecturers

1. Alejandro Adem, The University of British Columbia
2. Markus Banagl, Heidelberg University
3. Tobias Barthel, Københavns Universitet
4. Natàlia Castellana, Universitat Autònoma de Barcelona
5. David Chataur, Université de Picardie Jules Verne
6. Ivo Dell'Ambrogio, Université de Lille
7. Jelena Grbic, University of Southampton
8. Jesper Grodal, University of Copenhagen
9. Magdalena Kedziorek, Universiteit Utrecht
10. Bob Oliver, Université Paris 13
11. Irakli Patchkoria, University of Aberdeen
12. Stefan Schwede, Universität Bonn

Advances in Anthropological Theory of Didactic

June 3rd to July 26th, 2019

This intensive research programme focuses on the latest developments of the Anthropological Theory of the Didactic (ATD) and its links with other approaches in Mathematics Education. The programme brings together leading researchers from all over the world to present their works in recent trends and methodologies. The programme has been designed to be interesting for both junior and senior researchers, from graduate students to established scholars. Primary, secondary and tertiary teachers, as well as teacher educators interested in curriculum-related issues and research in didactics are also welcome. The planned activities combine presentations of recent research results, theoretical advances and new methodologies, including participatory sessions to discuss ongoing research.

Main activities of the event:

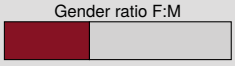
1. Advanced Course 1: Dialogue between Theories in Mathematics Education, *June 3rd to 14th, 2019.*
2. Advanced Course 2: Mathematics Teacher Education and the Professionalization of Teaching, *June 17th to 28th, 2019.*
3. Advanced Course 3: The Curriculum Problem and the Paradigm of Questioning the World, in Mathematics and Beyond, *July 1st to 12th, 2019.*
4. Advanced Course 4: Research in Didactics at University Level, *July 15th to 26th, 2019.*

All the courses consist of two weeks. The lectures and workshops will take place during the first week. During the second week, the working and interacting sessions will be held, including the participants contribution presentations. Registration fees include coffee breaks and lunches during the first week of the courses (with the exception of the advanced course 1, which also includes the coffee break and lunch for one day of the second week).

Scientific Committee: Berta Barquero Farràs, Marianna Bosc Casabò, Hamid Chaachoua, Yves Chevallard, Ignasi Florensa Ferrando, Josep Gascón Pérez, Britta Jessen, Catarina Lucas, Pedro Nicolás Zaragoza, Avenilde Romo Vázquez, Noemí Ruiz Munzon, Carl Winslow, Floriane Wozniak,

General data:

Gender ratio F:M



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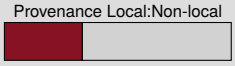
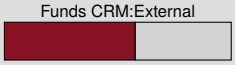


Funds CRM:External



Poster:

Advanced Course 1: Dialogue between Theories in Mathematics Education.

Description **From 3rd to 14th of June**

The course originates from the answers proposed by different theoretical frameworks to the question of the role played by normative prescription and value judgements in didactics (Gascón & Nicolás, 2017). This work highlighted the need to explain the relations between the assumed educational aims, on the one hand, and the basic assumptions and research results of each theory, on the other hand. In this course, we will scrutinise these relations in the case of the Theory of Objectification (Luis Radford), the APOS Theory (María Trigueros), the Theory of Didactic Situations (Claire Margolinas), the Onto-Semiotic Approach (Juan D. Godino), and the Anthropological Theory of the Didactic (Josep Gascón & Pedro Nicolás). There will be a collaborative seminar to jointly analyse how each theory deals with a given problem. The course will finish with a comparison between the different frameworks by Michèle Artigue and a closing lecture by Yves Chevallard.

Lecturers

1. Michèle Artigue, Université de París Diderot
2. Yves Chevallard, Aix-Marseille Université
3. Josep Gascón, Universitat Autònoma de Barcelona
4. Juan D. Godino, Universidad de Granada
5. Claire Margolinas, ESPE Clemont-Auvergne
6. María Trigueros, ITAM

Advanced Course 2: Mathematics Teacher Education and the Professionalization of Teaching

Description **From 17th to 28th of June**

This course focuses on the key role of didactics in teacher education and the experiences carried out at different instructional levels during the past decade. We will take as a starting point professional teaching problems and study the possibilities of locating them at the core of pre-service and in-service teacher education proposals. We will use two main concepts, firstly that of profession (as opposed to "semi-profession"), and secondly, the concept of problems of a profession, which refers to the difficulties one has to deal with when practising a profession. We will see the capacity of didactics to help teachers address these problems, and discuss the different teacher educational proposals provided by the ATD and the Theory of Didactic Situations (TDS).

The course is structured in lectures and parallel workshops in English and Spanish. During the second week, some collaborative activities are organised: a students' seminar to discuss participants' research works: a teacher educators' seminar to share teacher education proposals based on ATD or other frameworks; and more informal working and interacting activities.

Lecturers

- Lecturers
  1. Yves Chevallard, Aix-Marseille Université
  2. F. Javier García, Universidad de Jaén
  3. Claire Margolinas, ESPE Clemont-Auvergne
  4. Takeshi Miyakawa, Joetsu University
  5. Floriane Wozniak, Université de Montpellier
- Workshops
  1. Michèle Artaud, Aix-Marseille Université
  2. Gisèle Cirade, Université de Toulouse
  3. Vicenç Font, Universitat de Barcelona
  4. Avenilde Romo, CICATA - Instituto Politécnico Nacional de México
  5. Alicia Ruiz-Olarría, Universidad Autónoma de Madrid
  6. Tomás A. Sierra, Universidad Complutense de Madrid

Advanced Course 3: The Curriculum Problem and the Paradigm of Questioning the World, in Mathematics and Beyond

Description

From 1st to 12th of July

This course addresses the curriculum problem in the historical transition from the classical paradigm of visiting works to the emerging didactic paradigm of questioning the world. The former is based on the sequential access to previously established knowledge, while in the later one ideally starts from a question and tries to work out an answer to that question, without any prejudice regarding the kinds of tools needed to elaborate the answer sought. In this paradigm, the notions of inquiry (of a given question) and study and research paths (SRP) play a key role. However, the works of culture do not vanish: they are simply assigned a more functional role, which requires studying a given work-in synergy with other works-with the aim of providing an appropriate answer to a question or set of questions. Eventually, the questions, the studied works and the answers to these questions become part of a "new" curriculum based on the study of questions.

The course is structured in lectures and parallel workshops. During the second week, some collaborative activities are organised: a students' seminar to discuss participants' research works; a seminar on curriculum design experiences to share instructional proposals based on ATD or other frameworks; and more informal working and interacting activities.

Lecturers

- Lecturers
  1. Yves Chevallard, Aix-Marseille Université
  2. Marianna Bosch, Universitat Ramon Llull
- Workshops
  1. Hamid Chaachoua, Université de Grenoble
  2. Annie Bessot, Université de Grenoble

3. Britta Jessen, University of Copenhagen
4. Koji Otaki, Hokkaido University of Education
5. Verónica Parra, Universidad Nacional del Centro de la Provincia de Buenos Aires
6. Julia Pilet, ESPE de Créteil

Advanced Course 4: Research in Didactics at University Level

Description **From 15th to 26th of July**

University mathematics education (UME) designates a heterogeneus set of didactic practices, occurring in a variety of higher education institution (HEIs). A number of conditions are involved in these institutions that are not shared by secondary and primary education institutions, such as the proximity of scholarly knowledge and teaching practice, the fact that teaching is not the only activity performed in HEIs, the responsibilities assumed in the elaboration of curricula and syllabi, etc.

This course will present recent investigations in the field, addressing some didactic issues that appear to be specific to the teaching of mathematics at university level. Some of them concern the design and implementation of instructional formats to teach mathematics to mathematicians or as a service subject (to engineers, economists, scientists, etc.). Others relate to the analysis of the didactic transposition process and the apparent strong inertia of mathematical programmes and syllabi. Finally, we will address the new problem of university teacher education.

Lecturers

- Lecturers
  1. Michèle Artigue, Université de París Diderot
  2. Reinhard Hochmuth, Leibniz Universität Hannover
  3. Chris Rasmussen, San Diego State University
  4. Carl Winsløw, University of Copenhagen
- Workshops
  1. Alejandro González-Martín, Université de Montréal
  2. Ignasi Florensa, EUSS UAB
  3. Thomas Hausberger, Université de Montpellier
  4. Catarina Oliveira Lucas, Instituto Politécnico de Porto / Instituto de Saúde Pública da Universidade Porto (ISPUP)

IRTATCA: Interactions between Representation Theory, Algebraic Topology nd Commutative Algebra

JUNE 3rd TO JUNE 15th, 2019

The CRM and IMUB are pleased to announce the follow-up programme for the IRTATCA: Interactions between Representation Theory, Algebraic Topology and Commutative Algebra intensive research programme that was held in 2015 at the CRM. The program and its follow-up are devoted to promote interactions between researchers from different areas that share a common interest in homological techniques in a broad sense. The original programme gathered around 200 researchers from all over the world, and it is now time to have a look at some of the progress that took place since then.

Main activities of the event:

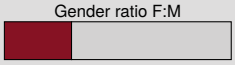
1. Advanced Course: Crossing Cohomological bridges (triangulated categories, singularity theory and 2-Segal spaces) (IMUB), *June 3rd to 7th, 2019.*
2. Conference: IRTATCA follow-up (CRM), *June 11th to 15th, 2019.*

Acknowledgements: The organizers would like to acknowledge financial support by the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), the Societat Catalana de Matemàtiques (SCM), the Universitat de Barcelona (UB) and the Institut de Matemàtica, Universitat de Barcelona (IMUB).

Organizers: Carles Casacuberta (UB), Dolors Herbera (UAB), Wolfgang Pitsch (UAB), Santiago Zarzuela (UB)

General data:

Gender ratio F:M



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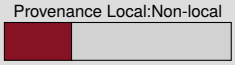
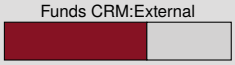


Funds CRM:External



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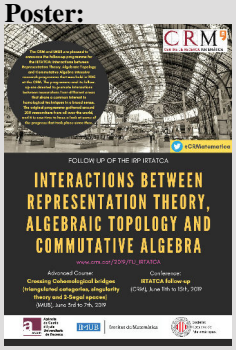


Advanced Course: Crossing Cohomological bridges (triangulated categories, singularity theory and 2-Segal spaces) (IMUB)

Description **From 3rd to 7th of June**

Homological algebra is a rich and ubiquitous area; it is both an active field of research and a widespread toolbox for many mathematicians.

The aim of this intensive course is to present three different aspects of recent applications and developments of homological methods in three areas: triangulated categories, singularity theory and combinatorics of 2-Segal spaces.

The course will consist of three series of lectures, each series will have 4 hours. It is mainly addressed to PhD students and post-docs in related areas, but experienced researchers willing to learn more about these exciting subjects are encouraged to participate.

1. Eleonore Faber, University of Leeds. McKay correspondence and noncommutative resolutions of singularities
2. Joachim Kock, Universitat Autònoma de Barcelona. Combinatorics of decomposition spaces (2-Segal spaces)
3. Gregory Stevenson, University of Glasgow. Tensor triangular geometry via tensor abelian categories

Conference: IRTATCA follow-up

Description **From 11th to 15th of June**

In 2015 a research semester on interaction between algebraic topology, commutative algebra, and representation theory was held in Barcelona, hosted by the CRM. The programme facilitated broader, and deeper, interaction between researchers from these different fields. Three years later we thought it meaningful to reconvene and asses the changes these fields have witnessed.

The speakers that have accepted to come cover wide range of subjects: representation theory, triangulated categories, k-theory, algebraic topology, etc. We hope that in the line of the previous programme, this conference will help to bring together researchers of cousin fields and prompt new collaborations or ideas.

1. Lidia Angeleri-Hügel, Università degli Studi di Verona
2. Tobias Barthel, Københavns Universitet
3. Benjamin Briggs, University of Toronto
4. Ivo Dell'Ambrogio, Université de Lille
5. item Javier J. Gutiérrez, Universitat de Barcelona
6. Magdalena Kedziorek, Universiteit Utrecht
7. Shane Kelly, Tokyo Institute of Technology
8. Martí Lahoz, Universitat de Barcelona
9. osanna Laking, Università degli Studi di Verona

10. Bob Oliver, Université de Paris 13
11. Michael Prest, University of Manchester
12. Baptiste Rognerud, Universität Bielefeld
13. Jan Šaroch, Charles University
14. Stefan Schwede, Universität Bonn
15. Johan Steen, University of California, Santa Cruz
16. Jan Stovicek, Charles University
17. Andrew Tonks, University of Leicester
18. Yuji Yoshino, Okayama University
19. Alexandra Zvonareva, Universität Stuttgart

SAFAIS: Spaces of Analytic Functions: Approximation, Interpolation, Sampling

OCTOBER 21st TO DECEMBER 15th, 2019

The aim of the intensive research programme SAFAIS-2019 is to bring together leading experts in topical domains in Complex analysis, Functional analysis, and Approximation theory. It will be mainly focused on approximation, interpolation and sampling problems in spaces of analytic functions, and their various applications.

Main activities of the event:

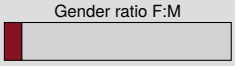
1. IRP SAFAIS Advanced Course 1, October 21 to 25, 2019.
2. Workshop on Emergent Trends in Complex Function Theory, *October 28th to 31st, 2019.*
3. Conference "Spaces of Analytic Functions: Approximation, Interpolation, Sampling" *November 25th to 29th, 2019.*
4. IRP SAFAIS Advanced Course 2, *November 4th to 8th, 2019.*
5. IRP SAFAIS Advanced Course 3, *December 2nd to 5th, 2019.*

Acknowledgements: The organizers would like to acknowledge financial support by the LabEx Bézout, the Norwegian Research Council, in the framework of the Project CO-MAN (298772), the Norwegian University of Science and Technology, the Centre International de Mathématiques Pures et Appliquées (CIMPA) and the Université Paris-Est Marne-la-Valleé.

Organizers:
Evgeny Abakumov, Anton Baranov, Alexander Borichev, Konstantin Fedorovskiy, Eugenia Malinnikova, Joaquim Ortega-Cerdà, Alexei Poltoratski

General data:

Gender ratio F:M



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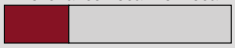
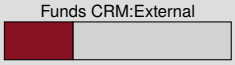


Funds CRM:External



Poster:

Workshop on Emergent Trends in Complex Function Theory

Description **From 28th to 31st of October**

The goal of this research workshop is to explore new advances in complex analysis and investigate further the interplay between complex function theory and harmonic analysis, operator theory, mathematical physics. We hope to promote the exchange of new ideas and recent trends in the subject and to formulate some new and ambitious problems, as well as brainstorm various ideas for solving them. Our expectation is that a number of new and exciting collaborations will be initiated due to this workshop. The participation of young researchers is specially encouraged.

Lecturers

1. Nikolai Makarov, Caltech
2. Stefanie Petermichl, University of Würzburg
3. Alexei Poltoratski, Texas A&M University
4. Ilia Binder, University of Toronto
5. Sergey Denisov, University of Wisconsin–Madison
6. Håkan Hedenmalm, KTH
7. Pertti Mattila, University of Helsinki
8. Sergei Treil, Brown University

IRP SAFAIS Advanced Course 1

Description **From 21st to 25th of October**

The Advanced Course 1 consists of two mini-courses.

The first mini-course, given by Professor Olevskii (Tel Aviv University) deals with the well-known phenomenon called the uncertainty principle. In the Fourier analysis terms it tells that a function cannot have a small support and a small spectrum at the same time.

The second mini-course is given by Professor Pushnitski (King's College). It concerns with the compact Hankel operators acting on the Hardy class and the corresponding Schmidt subspaces.

Lecturers

1. Alexander Olevskii, Tel Aviv University
2. Alexander Pushnitski, King's College London

Conference "Spaces of Analytic Functions: Approximation, Interpolation, Sampling"

Description **From 25th to 29th of November**

The aim of this conference, which is the main event of the eponymous Intensive Research Programme, is to present the latest research results, to exchange ideas, and to strengthen cooperation in the fields of Complex analysis, Harmonic Analysis, and Functional analysis. The conference will be mainly focused on topical problems in operator related function theory, reproducing kernel Hilbert spaces, sampling and interpolation problems, approximation theory, and their various applications.

Lecturers

1. Alexandru Aleman, Lund University
2. Alexander Aptekarev, Keldysh Institute of Applied Mathematics
3. Nicola Arcozzi, Università di Bologna
4. Frédéric Bayart, Université Clermont Auvergne
5. Yurii Belov, Saint Petersburg State University
6. Roman Bessonov, Saint Petersburg State University
7. Andrii Bondarenko, Norwegian University of Science and Technology
8. Alexander Bufetov, Université d'Aix-Marseille
9. Igor Chyzhykov, University of Warmia and Mazury in Olsztyn
10. Evgeny Dubtsov, Steklov Mathematical Institute
11. Omar El-Fallah, Mohammed V University of Rabat
12. Eva Gallardo-Gutierrez, Universidad Complutense Madrid
13. Karlheinz Groechenig, Universität Wien
14. Oleg Ivrii, Tel Aviv University
15. Alexei Karlovich, Universidade NOVA de Lisboa
16. Dmitry Khavinson, University of South Florida
17. Alexander Komlov, Steklov Mathematical Institute
18. Anna Kononova, St. Petersburg State University
19. Gady Kozma, Weizmann Institute of Science
20. Arno Kuijlaars, Katholieke Universiteit Leuven
21. Nir Lev, Bar-Ilan University
22. Jürgen Müller, Universität Trier

23. Artur Nicolau, Universitat Autònoma de Barcelona
24. Shahaf Nitzan, Georgia Tech
25. Hervé Queffélec, Université de Lille
26. Kristian Seip, Norwegian University of Science and Technology
27. Xavier Tolsa, ICREA and Universitat Autònoma de Barcelona
28. Joan Verdera, Universitat Autònoma de Barcelona
29. Maxim Yattselev, Indiana University–Purdue University Indianapolis
30. Peter Yuditskii, Johannes Kepler University Linz

IRP SAFAIS Advanced Course 2

Description **From 4th to 8th of November**

The Advanced Course 2 consists of two mini-courses:

The first mini-course, given by Professor Kristian Seip (Norwegian University of Science and Technology, Trondheim) deals with the function theory problems associated to the Riemann zeta function and related questions on the zeros, values distribution and universality. The second mini-course is given by Professor Omer Friedland (Sorbonne University, Paris). It concerns with the Remez inequality, its extensions including the Turán-Nazarov inequality, and applications to the uncertainty principle.

Lecturers

1. Kristian Seip, NTNU
2. Omer Friedland, Sorbonne University, Paris

IRP SAFAIS Advanced Course 3

Description **December 2nd to 5th of December**

The Advanced Course 3 consists of three mini-courses:

The first mini-course is given by Professor Yurii Belov (St. Petersburg University). It deals with the spectral synthesis problem for exponential systems on an interval, and, more generally, for systems of reproducing kernels in de Branges and Fock spaces.

The second mini-course is given by Professor Alexander Bufetov (CNRS, Marseille, Steklov Institute, IITP RAS, Moscow). It is devoted to the determinantal point processes, the gaussian analytic functions, and the extrapolation using their zero sets.

The third mini-course, given by Professor Nikolai Nikolski (University of Bordeaux), deals with the asymptotic spectral distributions for large Toeplitz-like matrices when the size goes to infinity.

The multiplicative Toeplitz matrices are also considered, and the links to the dilation completeness problem are briefly discussed.

3.4 Standalone CRM Activites

This section provides a list of the congresses and workshops sponsored and organized by CRM during 2019.

Thomas Poguntke Memorial Workshop

Description **January 31st to February 1st**

Thomas Poguntke passed away on September 24, 2018, after a serious illness, just a few weeks after arriving in Barcelona. He was 28 years old and about to hand in his PhD thesis (University of Bonn) on higher Segal spaces, K-theory and Hall algebras, the main parts of which are available as two papers on the `arXiv`.

This workshop is dedicated to his memory and to his mathematics, which will live on.

`www.math.uni-hamburg.de/home/dyckerhoff/thomas/TPMW.html`

Organizers

- Tobias Dyckerhoff, Universität Hamburg
- Joachim Kock, Universitat Autònoma de Barcelona

VIII Complexitat day

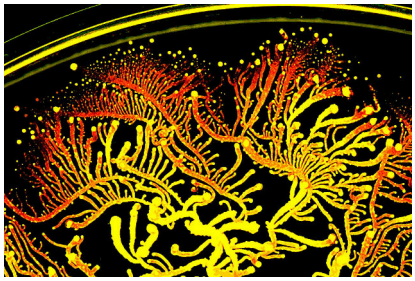
Description **May 21th**

The foundations of classical coding theory are described with specific attention to the MacWilliams relations and the Singleton bound. The transfer of these fundamental ideas to coding theory over more general alphabets is described. The use of rings in coding theory is also highlighted. We end with a discussion of the major open problems in coding theory.

`bgsmath.cat/event/viii-complexitat-day/`

Organizers

- Jordi Baró
- Álvaro Corral
- Josep Sardanyés



BARCCSYN 2019

Description **May 30th to 31st**

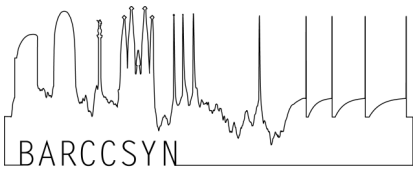
Barcelona computacional, cognitive and systems neuroscience (BARCCSYN) is about bringing together researchers from computational, systems and cognitive neuroscience. Our goal is to provide a forum for lively discussion and promote active collaboration between Barcelona-based research groups, especially between theorists and experimentalists.

This is the eighth annual BARCCSYN conference. The conference will be held on Thursday and Friday, May 30th and 31st, 2019, at the Institut d'Estudis Catalans. Each day we will have 8-10 brief oral presentations from local researchers, a poster session and a longer keynote lecture from a renowned researcher from abroad.

www.crm.cat/en/Activities/Curs_2018-2019/Pages/BARCCSYN-2019.aspx

Organizers

- Jaime de la Rocha
- Gabriela Mochol
- Ernest Montbrió



JISD 2019

Description **June 17th to 21st**

The "School on Interactions between Dynamical Systems and Partial Differential Equations" is an international summer school that has taken place at the Facultat de Matemàtiques i Estadística of the Universitat Politècnica de Catalunya (UPC) every summer since 2002. Since 2017 it has taken place at the Centre de Recerca Matemàtica. It is an annual meeting between scientists dedicated to Dynamical Systems and/or to PDEs to exchange knowledge and methods which may help to study new leading border problems in these two fields of mathematics. The conference is aimed at researchers from any country, as well as at local researchers. It consists of four advanced courses of about 6 hours each, complemented by some seminar talks as well as communications and posters by young attending researchers. This is the 17th edition.

http://www.crm.cat/en/Activities/Curs_2019-2020/Pages/BCN_2nd_Operator_Algebras.aspx

Organizers

- Xavier Cabré, ICREA and Universitat Politècnica de Catalunya
- Gyula Csato, BGSMath and Universitat Politècnica de Catalunya
- Amadeu Delshams, Universitat Politècnica de Catalunya
- Marcel Guàrdia, Universitat Politècnica de Catalunya
- Tere M. Seara, Universitat Politècnica de Catalunya

BAMB

Description **September 4th to 10th**

The goal of Summer School on Advanced Modeling of Behavior (BAMB) is to teach advanced techniques in model-based analysis of behavior (humans and other species) to cognitive and computational neuroscientists at PhD and early career levels. This will be achieved through structured lectures, talks, hands-on tutorials and group project aimed at making knowledge obtained directly applicable to the participants' own research. We want the trainees to acquire both the conceptual bases and the technical skills that will enable them to pursue a full modelling approach on their own when they come back to their lab.

www.bambschool.org/bamb-2019

Organizers

- Alex Hyafil, Centre de Recerca Matemàtica
- Klaus Wimmer, Centre de Recerca Matemàtica

II Barcelona Weekend on Operator Algebras and NonCommutative Algebra

Description **September 19th to 21st**

This meeting will be the second installment of the annual event aimed at creating synergies between Algebra, Geometry, and Topology. This time we take the opportunity to also have renowned experts that have been collaborators of Prof Pere Ara, on the occasion of his 60th birthday. In this regard, the workshop represents a look at the past, the present, and, more importantly, the future.

http://www.crm.cat/en/Activities/Curs_2019-2020/Pages/BCN_2nd_Operator_Algebras.aspx

Organizers

- Joan Bosa, Universitat Autònoma de Barcelona
- Francesc Perera, Universitat Autònoma de Barcelona – BGSMath

Women in Geometry and Topology

Description **September 25th to 27th**

The workshop Women in Geometry and Topology is an endeavour organized by the GEOMVAP research group at UPC and financed under the AGAUR project 2017SGR932.

The group GEOMVAP focuses in Geometry and Topology in the broad sense and its applications to several topics suchs as Celestial Mechanics, Control Theory, Mathematical Physics, Phylogenetics and Robotics. GEOMVAP promotes, in particular, Responsible, Research and Innovation within the framework of Horizon 2020. Among the RRI initiatives we strive for gender equality, public engagement, science communication and the visibility of women in Science and Society.

The Workshop Women in Geometry and Topology will feature several plenary talks by top female mathematicians and some contributed talks (contributed by speakers of any gender identity).

www.crm.cat/en/Activities/Curs_2019-2020/Pages/Women-in-Geometry-and-Topology.aspx

Organizers

- Maria Alberich, Universitat Politècnica de Catalunya
- Anton Alekseev, Université de Genève
- Roisin Braddell, Universitat Politècnica de Catalunya
- Marta Casanellas, Universitat Politècnica de Catalunya
- Imma Gálvez, Universitat Politècnica de Catalunya
- Eva Miranda, Universitat Politècnica de Catalunya
- Narciso Román-Roy, Universitat Politècnica de Catalunya

Women in Mathematics and Science: From Inequalities to Equalities

Description **September 26th**

As part of the Women in Geometry and Topology workshop, there will be two public lectures by Marta Macho (Scientific Culture Chair UPV/EHU, RSME Medal 2015, Emakunde Equality Prize 2016) and Carme Torras (Narcís Monturiol Medal 2000) addressed to the general public (you don't need to be a mathematician to follow them you just need to be curious!). A panel (open to the public) will also be organized in order to discuss the situation of women in mathematics, the gender gap and strategies for breaking the glass-ceiling inside and outside academia.

www.crm.cat/en/Activities/Curs_2019-2020/Pages/Women-in-Geometry-and-Topology-Public-Lectures.aspx

Organizers

- Maria Alberich, Universitat Politècnica de Catalunya
- Anton Alekseev, Université de Genève
- Roisin Braddell, Universitat Politècnica de Catalunya
- Marta Casanellas, Universitat Politècnica de Catalunya
- Imma Gálvez, Universitat Politècnica de Catalunya
- Eva Miranda,Universitat Politècnica de Catalunya
- Narciso Román-Roy, Universitat Politècnica de Catalunya

First CAFE School

Description

November 13th to 22nd

The school will provide the Early Stage Researchers (ESRs) with essential skills and knowledge required to begin their CAFE Research Projects, as well as identifying future training needs and identifying the opportunity to network with other members of the CAFE consortium. Also, this school will be the first opportunity for newly recruited ESRs to meet and form lasting professional bonds with each other and the wider CAFE team.

`www.cafes2se-itn.eu/communications/events/first-cafe-school`

Organizers

- Álvaro Corral, CRM

Copernicus Climate Data Store Face-to-Face Training Event

Description

November 13th

The Copernicus Climate Change Service (C3S) User Learning Services (ULS) provide learning resources and events to support those who need to use climate data to assess climate change impacts. Past, current and future climate data are accessed via the Copernicus Climate Data Store (CDS). The Copernicus Climate Change Service is implemented by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the European Commission.

In the CDS you can find quality assured, free of charge climate information. The CDS provides an extensive collection of climate datasets, easily searchable through a catalogue. In addition, an online toolbox allows users to build workflows and applications suited to their needs.

The C3S ULS uses a blended training approach. Once the individual self-paced learning is completed, using online resources available on the ULS Learning Experience Platform, participants will attend a full day face-to-face training event with expert trainers to discuss complex concepts encountered during the self-paced study. With the

experts's guidance, participants will apply their acquired knowledge to practical case studies.

All the lectures will be given by Tecnalia trainers with the exception of "CDS User Experience and Engagement" which will be delivered by a Barcelona Supercomputing Center expert.

www.cafes2se-itn.eu/copernicus-climate-data-store-face-to-face-training-2

Organizers

- Álvaro Corral, CRM

3.5 BGSMath

This section provides a list of the congresses and workshops sponsored by BGSMath during 2019.

FACARD 2019 Workshop

Description **January 16th**

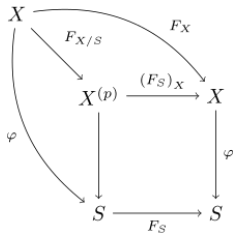
Commutative algebra is the branch of pure mathematics which studies commutative rings, and their ideals and modules. Many fundamental problems and questions in commutative algebra originated from the neighbouring fields of algebraic geometry and algebraic number theory, and it still benefits from the mutual interactions with them. This is particularly evident when one studies rings of positive characteristic. For example, the geometric theory of vector bundles and their relations with the Frobenius homomorphism has been successfully applied to tight closure and Hilbert-Kunz problems in commutative algebra. More recently, the theory of perfectoid spaces developed by Peter Scholze in the context of arithmetic geometry has been used to tackle The Homological Conjectures in the case of mixed characteristic?

The focus of the workshop is on these recent developments and other related topics. It is addressed to Ph.D. students, postdocs and interested researchers in general. There will be two mini-courses at graduate level and research talks given by international experts and young emerging scientists.

`bgsmath.cat/event/facard-2019-workshop/`

Organizers

- Alessio Caminata
- Santiago Zarzuela Armengou



Course on Networks and Optimisation

Description **Feburary 11th to 14th**

The course in an introduction to Network and Optimisation economics or businessrelated application. We will focus on optimal paths in a network with applications for dynamic programming and project management:

- The notion of networks, paths and wals and examples of models.
- Optimality conditions and optimisation algorithms.
- Examples of problems that can be modelled as an optimal path problem-dynamic programming.
- Project management: Activity on Nodes graph, link with optimal paths, solution strategies, sensitivity.

www.upf.edu/web/barg/inici/-/asset_publisher/f6xt7tsv36wO/content/id/221066759/maximized#.XpRl7MgzY2y

Organizers

- Prof. Marc Demange (RMIT).

International Day of Women and Girls in Science 2019

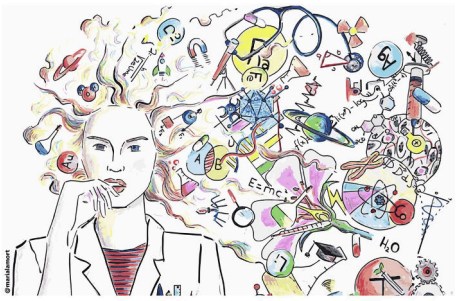
Description **February 14th**

In 2015, 11 February was declared by the UN as International Day of Women and Girls in Science. BGSMath supports this initiative and shares its ideals of equality in science.

After the positive experience of last year, BGSMath and the Societat Catalana de Matemàtiques have jointly decided to organise once again a special event at the Institut dEstudis Catalans in Barcelona to discuss gender gap in mathematics and successful communication strategies.

This event will be held in Catalan, Spanish and English, and is for all public, but its especially designed for students in their last years of high school (batxillerat i últims anys de lESO).

bgsmath.cat/event/dia-dona-ciencia-2019



An introduction to Malliavin calculus and its applications

Description **February 21st to March 14th**

The Malliavin calculus extends the classical calculus of variations from deterministic functions to stochastic processes. It was introduced by Paul Malliavin in the 70s to provide a probabilistic proof of ormander hypoellipticity theorem. The main application of Malliavin calculus is to establish the regularity of the probability distributions of functionals of a Gaussian process. Basic examples are diffusion processes and solutions to stochastic partial differential equations. In addition to this main application and starting from the pioneering work by Ivan Nourdin and Giovanni Peccati, the Malliavin calculus, combined with Steins method for normal approximations, has proved to be a useful tool to derive quantitative central limit theorems.

The goal of this course is to introduce the basic elements of Malliavin calculus and discuss its applications to regularity of probability laws, normal approximations and mathematical finance.

Motivation

Malliavin calculus is an active research area in stochastic analysis, with a wide scope of applications in a number of fields including statistics, functional analysis and finance. The combination of Malliavin calculus and Steins method has proved to be a powerful theory leading to new results in areas as diverse as cosmology and statistical inference. In mathematical finance, the Malliavin calculus has played an important role in designing numerical computations of price sensitivities and finding hedging portfolios.

`bgsmath.cat/event/introduction-malliavin-calculus-applications/`

Introduction to statistical learning theory

Description

February 27th to March 6th

The theory of Machine Learning is a field that lies at the intersection of statistics, probability, computer science, and optimization. This mathematical theory is concerned with theoretical guarantees for machine learning algorithms. Over the last decades the statistical learning approach has been successfully applied to many problems of interest in machine learning, such as bioinformatics, computer vision, speech processing, robotics, and information retrieval. This success story crucially relies on a strong mathematical foundation.

The goal of this 10-hour course is to lay out some of the basic principles and introduce mathematical tools that help understand and analyze machine learning algorithms.

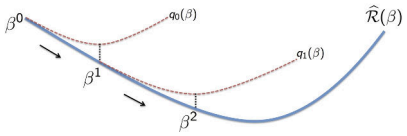
The focus will be on elements of empirical processes, concentration inequalities, kernel methods, and stochastic optimization of convex functions.

The course will be mostly of interest to PhD students in probability, statistics, optimization, and theoretical computer science. Only some basic background in probability at graduate level is required.

`bgsmath.cat/event/introduction-statistical-learning-theory/`

Organizers

- Gábor Lugosi



$$q_t(\beta) = \widehat{\mathcal{R}}(\beta^t) + \langle \nabla \widehat{\mathcal{R}}(\beta^t), \beta - \beta^t \rangle + \frac{1}{2} \langle \beta - \beta^t, \mathbf{H}^t (\beta - \beta^t) \rangle$$

$$\beta^{t+1} = \operatorname*{argmin}_{\beta} q_t(\beta) = \beta^t - [\mathbf{H}^t]^{-1} \nabla \widehat{\mathcal{R}}(\beta^t)$$

A 21st century model for disseminationg knowledge

Description **March 6th**

In the early years of the third millenium, most professors are still teaching in virtually the same way they were taught and their teachers were taught, stretching back centuries. As we all know, this situation is ripe for change. University students seeking to learn a topic who now have little if any choice are about to be presented with a vast array of choices. What student would not want to swap a tired professor writing slowly on a chalkboard for a well-produced series of videos and associated content, given by a world leader in the field? We are on the verge of a transformation on the scale of the transformation wrought by Gutenburg. This imminent change raises a host of fascinating and far-reaching questions. In this talk, we describe a scalable model for teaching and learning that has already enabled us to reach millions of people around the world.

Elliptic curves over Q and the Birch and Swinnerton–Dyer conjecture

Description **March 6th**

The SIMBa is a young seminar organized by the PhD students of the Faculties of Mathematics and Computers of Barcelona. It is aimed at doctoral, masters degree students and, also, for those who are in the last grade courses. Our goal is that each one can make known the research which they are doing, as well as, to get new knowledge of other areas of mathematics other than his own.

`www.ub.edu/simba/anuncis/simbaFrancescaGatti06032019.pdf`

Organizers

- Francesca Gatti

Jornada Kovalevskaya FME 2019

Description **March 6th**

The Kovalevskaya Conference of the Faculty of Mathematics and Statistics of the UPC will take place on Wednesday, March 6th, 2019 in the auditorium of the FME, this year with the novelty of the performance of the theatre group FEM TEATRE FME with a dramatized reading of the play “Sofia Kovalevskaya: Childhood Memories”.

fme.upc.edu/ca/la-facultat/activitats/2018-2019/Jornada_Kovalevskaya_FME_2019

Tutorial – Data-driven text simplification

Description **March 13th**

In this tutorial, we aim to provide an extensive overview of automatic text simplification systems proposed so far, the methods they used and discuss the strengths and shortcomings of each of them, providing direct comparison of their outputs. We aim to break some common misconceptions about what text simplification is and what it is not, and how much it has in common with text summarisation and machine translation. We believe that deeper understanding of initial motivations, and an in-depth analysis of existing TS methods would help researchers new to ATS propose even better systems, bringing fresh ideas from other related NLP areas. We will describe and explain all the most influential methods used for automatic simplification of texts so far, with the emphasis on their strengths and weaknesses noticed in a direct comparison of systems outputs. We will present all the existing resources for TS for various languages, including parallel manually produced TS corpora, comparable automatically aligned TS corpora, paraphrase- and synonym- resources, TS-specific sentence-alignment tools, and several TS evaluation resources. Finally, we will discuss the existing evaluation methodologies for TS, and necessary conditions for using each of them.

www.upf.edu/web/mdm-dtic/tutorial-data-driven-text-simplification

Organizers

- Sanja Štajner
- Horacio Saggion

Fourteenth Barcelona Weekend in Group Theory

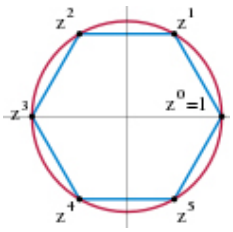
Description **March 15th to 16th**

This is a meeting specialized in Theory of Groups, organized for the benefit of local specialists in Theory of Groups and in Geometry and Topology, and which contributes to the dissemination of the latest results obtained in our field, with the participation of international experts in the area. The thirteen previous meetings have been a success, with good speakers from around the world.

bgsmath.cat/event/fourteenth-barcelona-weekend-group-theory/

Organizers

- Enric Ventura
- Pep Burillo



Interacció entre música i matemàtiques: passat i present

Description **March 21st**

We will review some of the most notable interactions between music and mathematics produced over the course of history. On the one hand, we will consider the influence that music may have had on the development of mathematical concepts. On the other hand, we will consider the basic mathematical resources involved in sound processing today.

www.racab.cat/noticies/2019/2019-mar-21

Organizers

- Pilar Bayer Isant

Topics in Complex Dynamics 2019

Description **March 25th to 29th**

This conference aims to bring together (experienced and junior) researchers in holomorphic dynamics from several different perspectives.

bgsmath.cat/event/topics-complex-dynamics-2019/

Organizers

- Anna Miriam Benini
- Jordi Canela
- Núria Fagella
- Antonio Garijo
- Xavier Jarque

Bernouilli numbers, Eisenstein series and cyclotomic units

Description **April 3rd**

I will recall what are the objects of the title and explain how one can combine them in a new way to explain a deep Theorem of Mazur and Wiles (proving a conjecture of Iwasawa) that gives a formula for the cardinality of the p-part of the class groups of cyclotomic fields in terms of Bernouilli numbers.

fme.upc.edu/ca/recerca/col-loqui-fme-upc/Conferencia%20Eric%20Urban%20%28Columbia%20University%2C%20New%20York%2C%20USA%29

Conferència del doctor Josep Pla a l'Aula Magna: Hilbert versus Euclides

Description **April 3rd**

On Wednesday, April 3rd, at 12:15 pm, Dr. Josep Pla i Carrera will give the lecture Hilbert vs Euclid: reflections on the Elements, books I, II, III, IV, V and VI in the Great Hall of the Historic Building.

blocmat.ub.edu/2019/03/28/conferencia-del-doctor-josep-pla-a-laula-magna-hilbert-versus-euclides/

Organizers

- Josep Pla i Carrera

IMUB Colloquium: Metaheurísticas y taxonomización de problemas de optimización combinatoria

Description **April 3rd**

The IMUB is devoted to fostering and supporting research in all areas of Mathematics since June 2000, by hosting conferences, workshops, seminars and advanced courses, and promoting interdisciplinary collaboration among researchers from different fields.

bgsmath.cat/short-event/imub-colloquium-metaheuristicas-y-taxonomizacion-de-problemas-de-optimizacion-combinatoria-h-12-15-aula-t1/

Organizers

- José Antonio Lozano

Seminari d'edps i aplicacions. Darboux theorem, Symplectic factorization and ellipticity

Description **April 4th**

edps.upc.edu/en/news/04-04-2019-seminari-dedps-i-aplicacions-bernard-dacorogna-ecole-polytechnique-federale-de-lausanne-tba-15-h-aula-s01-fme-upc

Organizers

- Bernard Dacorogna

Tutorial – Wikimedia Public (Research) Resources

Description **April 8th**

The Wikimedia Foundation's mission is to disseminate open knowledge effectively and globally. In keeping with this mission, the Wikimedia Foundation support research in areas that benefit the Wikimedia community. We aim to make any work with our support openly available to the public. At the same time that we do a minimalist user data collection, all the material (text and multimedia) available in our projects is public and reusable by everybody. Moreover, all the revisions history and interactions among users are also public, and we offer a set of tools for accessing such data. In this tutorial we are going to give an overview on all the data sources, and a detailed explanation of how to interact with this content, including data and tools such as the Wikipedia Dumps, Quarry (SQL Replicas), Pageviews, PAWS (Jupyter Public Notebooks), Wikimedia Commons (multimedia content) and WikiData.

`www.upf.edu/web/mdm-dtic/tutorial-wikimedia-public-research-resources`

Studying the Fatou set for a generalization of Milnors family of cubic maps

Description **April 10th**

The SIMBa is a young seminar organized by the PhD students of the Faculties of Mathematics and Computers of Barcelona. It is aimed at doctoral, masters degree students and, also, for those who are in the last grade courses. Our goal is that each one can make known the research which they are doing, as well as, to get new knowledge of other areas of mathematics other than his own.

`www.ub.edu/simba/anuncis/simbaDanAlexandru08042019.pdf`

Organizers

- Dan Alexandru Paraschiv

An introduction to wavelets and their applications

Description **April 24th to June 5th**

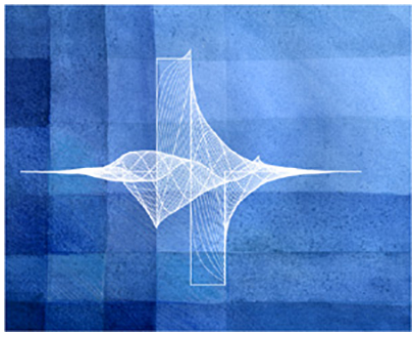
The theory of wavelets, built with the join effort of different scientific communities in the 80s, is said to be the most important development in signal analysis since the FFT. Wavelets provide a flexible tool to represent functions in a suitable way for many

applications in image and sound processing, geophysics and many other areas. At the same time, they are of great theoretical importance in mathematics and physics, giving birth to active research areas today, such as time-frequency analysis and time-scale analysis. The goal of this course is to present the mathematical approach to wavelets starting from a basic knowledge of the Fourier representation and to show some of their applications using a free toolbox (to be specified).

bgsmath.cat/event/introduction-wavelets-applications/

Organizers

- Joaquim Bruna
- Josep Maria Mondelo



Factorización de un morfismo

Description **April 24th**

By studying a function between sets it is possible to factorize it by means of its image, this construction can be generalized by the theory of categories due to its functional behaviour, where an arbitrary morphism is assigned the category of all its possible factorizations; in addition, this construction can also be taken for the simplicial case. In this talk I will give an outline of the ideas that led to this result.

www.ub.edu/simba/anuncis/simbaWilsonForero24042019.pdf

Organizers

- Wilson Forero

Potencia tu talento #STEM

Description **April 25th**

It will be a round table with leading international professionals and directors in research and in multinational technology companies.

us11.campaign-archive.com/?u=12c36d880be464c290df9813a&id=ebb420756a

An introduction to derivators with applications to the study of T-structures

Description **May 2nd to 6th**

The theory of stable derivators can be thought of as a minimal enhancement of triangulated categories that allows for a good theory of homotopy co/limits. The idea of a derivator has been introduced independently by several authors in different areas of Pure Mathematics: Heller (in Algebraic Topology), Grothendieck (in Algebraic Geometry), Franke, Keller (in Representation Theory), and possibly others. This theory has recently found several applications to classical problems that had remained open for a long time in the setting of triangulated categories.

In the first class of this short course will first recall the needed background in (2-)category theory and use it to introduce the notion of prederivator. We will then go on defining derivators, pointed derivators and strong derivators. In the context of pointed derivators we will present some basic constructions, such as the cone/fiber and the suspension/loop adjunctions. We will illustrate the theory with some canonical examples.

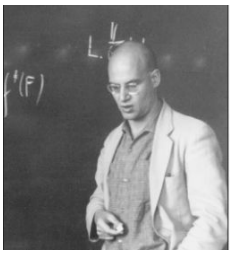
The second class will be devoted to the concept of stability. We will start recalling some basic facts about triangulated categories, we will then introduce the notion of stability for an abstract pointed derivator and we will show that, when it is also strong, the images of a stable derivator are canonically triangulated. In this way, a strong and stable derivator becomes an enhancement of a triangulated category, called its underlying category. We will illustrate the theory with a brief analysis of the natural derivator enhancing the derived category of an Abelian category.

In the third and last class we will concentrate on a recent application of the theory of stable derivators. We will start recalling the notion of a t-structure on a general triangulated category and we will show how to put this classical notion in the setting of derivators. The advantage of this enhancement is that we will gain a good control of co/limits in the heart of a t-structure and, in this way, we can give very natural sufficient conditions for the heart of a t-structure to be a Grothendieck category.

`bgsmath.cat/event/introduction-derivators-applications-study-t-structures/`

Organizers

- Dolors Herbera
- Wolfgang Pitsch



Algebraic versus semi-algebraic conditions for phylogenetic varieties.

Description **May 8th**

It is well known that there exists a close relationship between Phylogenetics and Algebraic Geometry. It is common to model evolution adopting a parametric statistical model which allows to define a joint probability distribution at the leaves of the trees. When these models are algebraic, one is able to deduce polynomial relationships between these probabilities, and the study of these polynomials and the geometry of the algebraic varieties that arise from them can be used to reconstruct phylogenetic trees. However not every point in this algebraic varieties has biological sense. In this talk we would like to discuss the importance of studying the subset of these varieties with biological sense and explore the extent to which restricting to these subsets can provide insight into existent methods of phylogenetic reconstruction.

www.ub.edu/simba/anuncis/simbaMarinaGarroteLopez08052019.pdf

Organizers

- Marina Garrote López

Bringing young mathematicians together

Description **May 20th**

The conference is especially directed at PhD students in all areas of mathematics and related disciplines, and indeed any young people who use mathematics in their daily lives/jobs. Everyone, from undergraduates to university professors or industry professionals, is more than welcome to attend!

We expect contributed talks and posters to come mainly from PhD students, young industry professionals, masters students and recent PostDoc. The official language of the conference will be English.

We will have short talks (15-20 minutes), distributed in thematic parallel sessions, a poster session, 7 plenary talks given by young professors and industry professionals, workshops and plenty of social activities.

www.icmat.es/congresos/2019/BYMAT/

Organizers

- Alberto Redondo Hernández
- Ángela Capel
- Blanca Fernández Besoy
- Jesús Ocáriz
- Makrina Agaoglou
- Patricia Contreras Tejada
- Roi Naveiro
- Teresa Luque

Viajando en el tiempo con las matemáticas

Description **May 21th**

Eva Miranda, Juan Margalef, Cédric Oms and Robert Cardona will contribute with their talks to the next Pint of Science event in Barcelona the next May 21st, under the common title “Viajar al pasado (matemáticamente)”.

pintofscience.es/event/viajando-en-el-tiempo-con-las-matematicas

On a theorem of Waring for plane algebraic curves.

Description **May 22th**

Warings theorem is a classic result about the intersection of plane algebraic curves. Roughly speaking, it asserts that the barycenter of the intersection points is determined by the asymptotes of the curves. After a short historical introduction, in this talk we present the ideas that allow to obtain an extension of Warings theorem. Finally, we see some consequences; the most important of them will be a theorem due to Chasles.

www.ub.edu/simba/anuncis/simbaAndresRojasGonzalez22052019.pdf

Organizers

- Andrés Rojas González

Pricing valuation adjustments by correlation expansion

Description **May 23th**

We consider firstly the problem of computing the Credit Value Adjustment (CVA) of a European option in a default intensity setting and in presence of the so-called Wrong Way Risk (WWR): that is, a decrease/increase in the credit quality of the counterparty produces a higher exposure in the portfolio of the derivatives holder. This effect may be modeled by the correlation between the stochastic factors driving our market model. We consider a method, introduced in the papers [F. Antonelli, S. Scarlatti, Finance and Stochastics, 13, (2009)] and [F. Antonelli, A. Ramponi, S. Scarlatti, Review of Deriv. Research, 13, (2010)], which expands theoretically the solution of the PDE system in a Taylors series with respect to the correlation parameters.

Indeed, under quite general hypotheses, it is possible to verify that the solution to the PDE is regular with respect to the correlation parameters and therefore it can be expanded in series around the zero value for all of them. The coefficients of the series are characterized, by using Duhamels principle, as solutions to a chain of PDE problems and they are therefore identified by means of Feynman-Kac formulas and expressed as expectations, that turn to be easier to compute or to approximate.

Finally, we show that under appropriate conditions, the method can be extended to include several XVAs, such as bilateral CVA, DVA (Debt Value Adjustment), FVA (Funding Value Adjustment) and LVA (Liquidity Value Adjustment) due to collateralization. In fact, we remark that the adjusted value of a defaultable claim (with default risk of both parties) that takes into account the funding and collateralization costs verifies a (possibly nonlinear) BSDE and that, under some hypothesis, it may be approximated by using the correlation expansion method.

bgsmath.cat/event/pricing-valuation-adjustments-correlation-expansion/

Organizers

- Elisa Alòs Alcalde

An introduction to equilibrium problems and their applications

Description

June 3rd to 7th

The term equilibrium has been widely used in mathematics, physics, chemistry, biology, engineering and economics within different frameworks. Many equilibrium problems can be formulated through different mathematical models such as complementarity, variational inequalities, multiobjective optimization, noncooperative games and inverse optimization among others.

All these mathematical models share an underlying common structure that allows to formulate them in a unique format: the so-called Ky Fan inequality. The goal of this course is to provide a comprehensive overview of the main theoretical results and solution algorithms for Ky Fan inequalities, together with a wealth of applications. Particular emphasis is given to the role of nonlinear optimization techniques as valuable tools for analyzing and solving Ky Fan inequalities.

bgsmath.cat/event/introduction-equilibrium-problems-applications/

Organizers

- Mauro Passacantando

$$\begin{aligned}\ln\frac{\prod_{i=1}^n x_i^{\gamma_i}}{\prod_{i=1}^n (1-x_i)^{\gamma_i}} &= \ln\prod_{i=1}^n \left(\frac{x_i}{1-x_i}\right)^{\gamma_i}\\ &= \sum_{i=1}^n \gamma_i f(x_i)\\ &< f\left(\sum_{i=1}^n \gamma_i x_i\right)\\ &= \ln\frac{\sum_{i=1}^n \gamma_i x_i}{\sum_{i=1}^n \gamma_i (1-x_i)},\end{aligned}$$

On an efficient implementation of the Roe scheme for large hyperbolic systems.

Description **June 5th**

There exist several schemes to solve numerically hyperbolic systems of Partial Differencial Equations. Two of them are the Simple Riemann solvers (SRS) and the Polynomial Viscosity matrix (PVM) methods.

The results obtained by Morales de Luna et al. (2014) concerning the relation between SRS and the PVM methods are revisited and applied to the efficient implementation of the Roe method for large hyperbolic systems either conservative or non-conservative. This implementation, based on the Newtons form of the interpolation polynomial, will be applied to the two-layer shallow water model and a non-conservative model for rarefied gas flow.

www.ub.edu/simba/anuncis/simbaErnestoGarcia05062019.pdf

Organizers

- Ernesto Pimentel García

The why and how of randomness

Description **June 5th**

Randomness is ubiquitous in all biological systems. The nervous system is hugely affected by stochasticity, and noise and variability are fundamental of brain function. Information processing is faced with the challenge of acting in this unpredictable and random world, but even if cellular and molecular processes of life itself are noisy and variability in perception and behavior is observed for equal sensory inputs, the brain displays a remarkable precision, essential for survival. Is this ever-present noise a caprice of nature, which evolution has taught us to deal with the best we can? Or does stochasticity play a constructive role, increasing reliability and robustness, and the brain is a probabilistic device because this makes us more fit to survive? Is the noise beneficial or detrimental? Modeling with stochastic processes becomes more and more popular in neuroscience, not only because of the powerful mathematical tools from stochastic analysis, but also because of the increasing availability of measurements and data for dynamical processes, where randomness plays a major role.

In this talk I will discuss stochastic models of biological systems, and show some surprising and different dynamics not present in the deterministic models. The standard approach to deal with the noisy and highly variable data is to average over trials, to presumably get a more reliable output for further analysis. This might blur or entirely remove essential characteristics and mechanisms, which are fundamental for understanding the underlying function of the system under study. More advanced statistical methods and stochastic models are paramount to disentangle the finer mechanisms, because single trials carry information, which is not maintained in the average behavior.

fme.upc.edu/ca/recerca/col-loqui-fme-upc/the-why-and-how-of-randomness-a-carrec-de-susanne-ditlevsen-department-of-mathematical-sciences-of-the-university-of-copenhagen

Organizers

- Susanne Ditlevsen

BGSMath María de Maeztu unit of excellence 2015-2019: Closing workshop

Description

June 6th

The Barcelona Graduate School of Mathematics was recognized in 2015 as a María de Maeztu (MdM) Excellence Centre by the Spanish Government. The recognition was supported by a 2-million-euro grant for the period 2015-2019. The MdM grant has been essential for the consolidation and success of the BGSMath project and for its international recognition. Through the MdM grant, 20 PhD and 15 postdoctoral positions have been covered with talented national and international researchers. Many activities have been funded through the MdM grant, including Advanced Graduate Courses, Intensive Research Programs, Junior Meetings, Colloquia, Workshops with industry, events celebrating International Day of Women and Girls in Science, and internships for masters students, among others.

The BGSMath/MdM excellence program finishes this year. To celebrate this success story we organize on 6 June 2019 a workshop highlighting the most relevant scientific results obtained within the program in the main research areas of BGSMath. We invite all BGSMAth faculty, students and friends to participate in this event.

`bgsmath.cat/event/bgsmath-maria-de-maeztu-unit-excellence-2015-2019-closing-workshop/`

Workshop on the theory and applications of stochastic partial differential equations

Description

June 10th 14th

The area of SPDEs has been growing steadily in the past 30 years, providing new techniques for analyzing complex systems whose behaviour is subject to random perturbations. SPDEs can be used for modelling a wide range of physical phenomena, encountered in statistical mechanics, mathematical physics, theoretical neuroscience, fluid dynamics and mathematical finance.

`www.fields.utoronto.ca/activities/18-19/SPDEs`

Organizers

- Raluca Balan
- Lluís Quer-Sardanyons
- Jian Song

Sun Tzu approach to the Riemann Hypothesis

Description

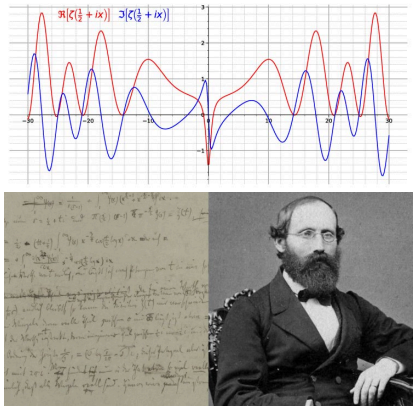
June 11th to 14th

We give an introduction to the Riemann Hypothesis and a panoramic overview of the conjecture. We start with a historical introduction to transalgebraic ideas and continue with the classical theory of Riemann zeta function. We discuss some of the developments after Riemann that have contributed to a better understanding of the conjecture.

`bgsmath.cat/event/sun-tzu-approach-riemann-hypothesis/`

Organizers

- Eva Miranda



3.6 Outreach

CRM contributes to the popularization of mathematics among the general public through different programmes, some of them specifically targeted to attract the interest of young people for mathematical research. The following lines contain the outreach activities carried out by CRM along 2019.

Activities carried out by the CRM along 2019

YOMO, 26 February 2019

Aimed at children and young people between the ages of 8 and 16, the YoMo Festival is a space interactive and experimental science and technology. YoMo is designed to carry real-life classroom learning, by demonstrating exciting and rewarding career opportunities available in the mobile ecosystem and the STEAM industry.

Saló Ensenyament, 20 March 2019

The Saló de l'Ensenyament is the ideal environment for presenting your educational programme. It is an essential date for young people and students looking for information to help them decide upon and direct their professional careers.

International Visit, 20 April 2019

A Danish high school come to see up close CRM.

ACEF, 29 May 2019

The Associació Catalana d'Estudiants de Física organized a meeting where the Principal Investigators presented their own research and the PhD students present a poster related with their work.

Research Night, 30 May and 20 September 2019

European Researchers' Nights are public events dedicated to bringing researchers closer to the public. They showcase the diversity of research and highlight the impact of research on our daily lives. The aim is also to motivate young people to embark on research careers. The events promote how researchers contribute to our society by displaying their work in an interactive and engaging forum. The catalan meeting was organized by UB, UAB, UdG, URV, UdL, UOC and ISGlobal, with the collaboration of l'ACCC, the delegation of the CSIC at Catalunya and the FCRi.

EscoLab, from October 2019 to May 2020

EscoLab is an initiative of Barcelona City Council coordinated by the Barcelona Science, Barcelona Institute of Culture and Scientific Culture, Barcelona Municipal Institute of Education programs, with the participation of the research centers that offer the various activities. EscoLab offers more than 200 different proposals, from the hand of researchers from research groups of universities, research centers, hospitals and companies, ready to satisfy the curiosity of students.

In this frame, CRM's IP Josep Sardanyés gave a Seminar addressed to students entitled *Què és el caos?* Activity organised by EscoLab and the Centre de Recerca

Matemàtica, 7 March 2019. This was an activity addressed to 16-17 years old students to foster mathematics curiosity and scientific interest. The activity was two hours long and included balckboard explanations, slides, and a show using a double pendulum.

Setmana de la Ciència, November 2019

The Setmana de la Ciència, a pioneering communication initiative, offers a wide range of multdisciplinary activities of scientific and technological dissemination throughout Catalonia, including conferences and round tables, conferences of open doors to research centers and museums, courses and workshops and exhibitions, all of them free and for many different audiences. In this frame, the ITN coordinated by the CRM's IP Álvaro Corral named CAFE participates in the "Ciència al Carrer" exhibition in Sitges.

Premi Extraordinari Batxillerat

A one week stay at CRM where the center is committed to designing one program so that the student can know first-hand how a center works research, and can get a basic idea of the research that the center develops.

Treballs Recerca Batxillerat

Program aimed at certain high school students to develop their own research work supervised by the tutor of your institute and additionally by a researcher at an ACER research center.

Bojos per les Matemàtiques

Within series "Bojos per a les matematiques", CRM's IP Tim Myers gave a talk aimed final year high school students.

4 CRM Publications

The publication of research documents is one of the CRM channels for spreading mathematical knowledge. Apart from publishing singular texts, the CRM has several stable publication series: *Advanced Courses in Mathematics*, *Research Perspectives CRM Barcelona*, *CRM Documents*, *Quaderns*, *Preprints*, *Series on Popularization*, master's projects and PhD theses.

With the purpose of coordinating this activity, the *CRM Editorial Board* was created in November 2011. During 2019, it was formed by Enric Ventura – David Romero (Editor-in-Chief) and Raquel Hernández – Claudi Lleyda (editing tasks). The Editorial Board meets every two months.

Hereunder, we provide an overview of the different series and a list of the preprints issued during the year 2019.

4.1 Advanced Courses in Mathematics CRM Barcelona

The volumes of this series, published by the Swiss publishing company Birkhäuser, cover the content of some of the advanced courses taught by specialists at the CRM. They are based on lecture notes handed out to students and later reworked by the authors. These volumes are specifically addressed to advanced doctoral and young post-doctoral students.

From 2008 to 2013, the responsible editor of this series was Carles Casacuberta (UB); he replaced Manual Castellet (UAB), who started the series in 2001. Starting in

2014, and until November 2019, the new editor of the series was Enric Ventura (UPC). At the end of November 2019, David Romero (CRM) became the new editor.

In 2019 one volume of this series has been published:

1. Glendinning, Paul, Jeffrey, Mike R. *An Introduction to Piecewise Smooth Dynamics*, edited by Bossolini, Elena, Lázaro, Tomàs, Olm, Josep M. Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel 2019, ISBN 978-3-030-23688-5.

4.2 Research Perspectives CRM Barcelona

In 2012, the CRM Editorial Board took over the edition of extended conference abstracts, collected among the contributions to the conferences and workshops organized by the center. The aim was to bring the opportunity to quickly spread recent research, including interesting new results not yet published, consolidating the scientific profit of CRM meetings and helping to fluently update the state of the art in each field. An agreement was reached allowing Birkhäuser to publish these materials as a new subseries of the series *Trends in Mathematics*; the new subseries is named *Research Perspectives CRM Barcelona*. During the 2019 series' editors were Enric Ventura and David Romero.

1. Extended Abstracts Spring 2018, *Singularly Perturbed Systems, Multiscale Phenomena and Hysteresis: Theory and Applications* Editors: Korobeinikov, A., Caubergh, M., Lázaro, T., Sardanyés, J.

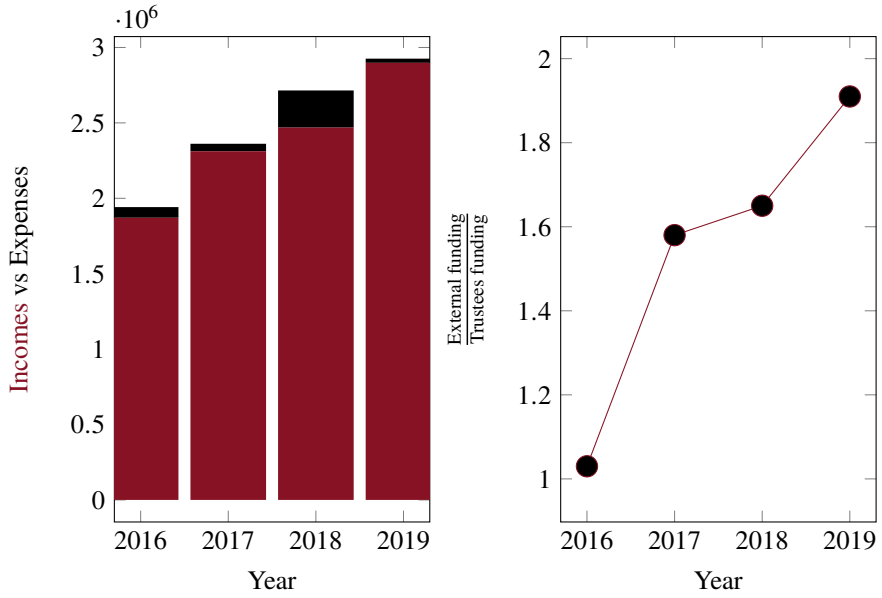
4.3 Preprints

The CRM preprint series grew with the following 3 issues in 2019:

1. Fernando Saldaña, Andrei Korobeinikov, Ignacio Barradas. *Optimal control against the human papillomavirus: Protection versus erradication of the infection*, preprint no. 1241. 11/2019.
2. N.T. Tleukhanova, K. K. Sadykova. *O'Neil type inequalities for convolutions in anisotropic Lorentz spaces*. preprint no. 1242. 11/2019.
3. Jesper M. Møller. *Euler characteristics and p-elements in finite groups*. preprint no. 1243. 12/2019.

5 Economic summary

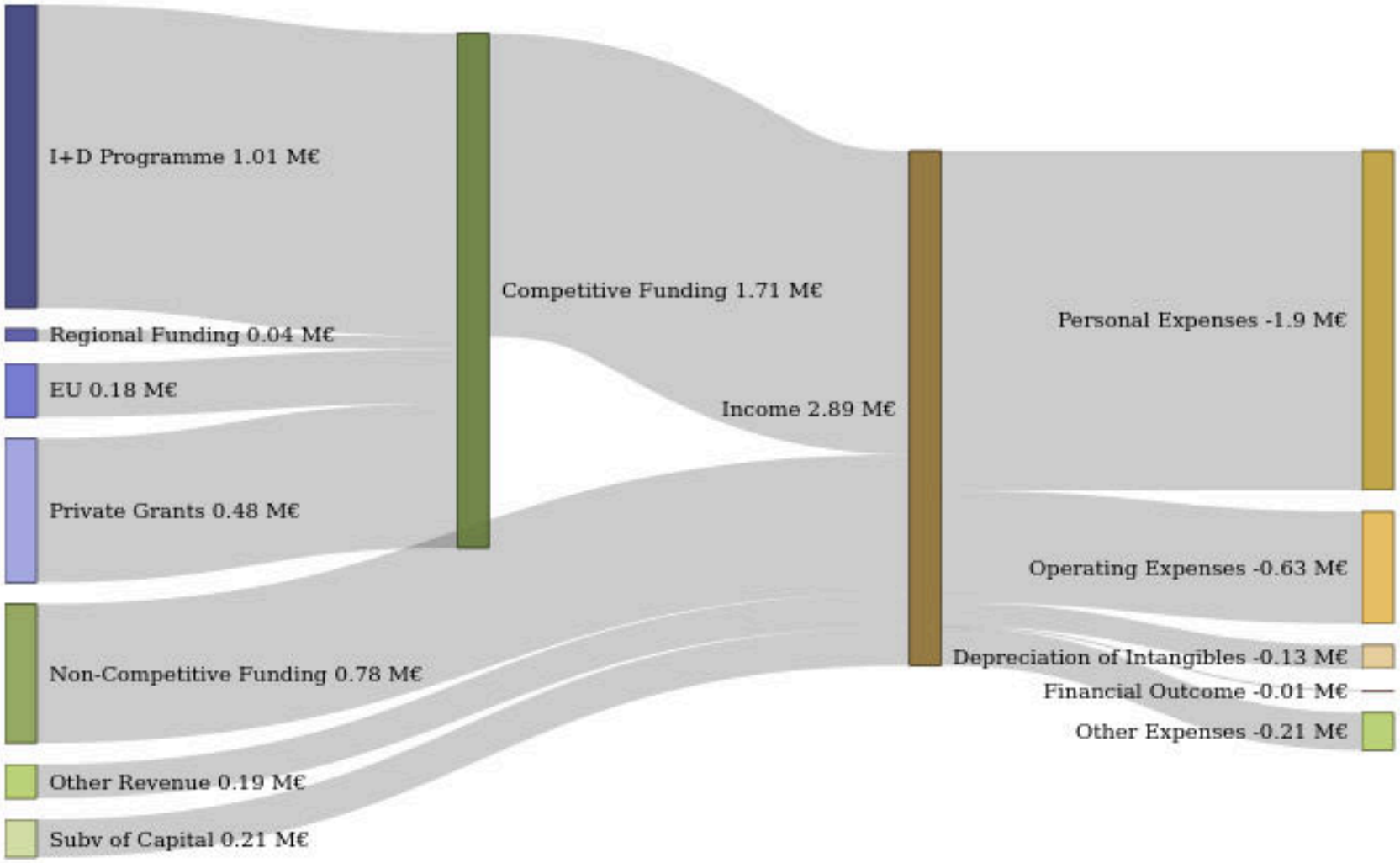
The following charts portray the expenditure and income that the CRM has carried out during the 2016-2019 period. In the first graph we can see that in the year 2019 the budget balance Income = Expenses has been nearly achieved, and in the following graph we show the evolution of the ratio between external funds versus funds contributed by the patronage, in 2019 for each euro contributed by the Generalitat de Catalunya the CRM has been able to get two euros from external funds.



5.1 2019 Income Application (Capital Flow)

In the following chart, we want to portray how the CRM gets its resources and what its applications have been. It should be noted that 34% of the income comes from the Generalitat de Catalunya, 27% for the center's operation and the remaining 7% in capital grants, almost 60% of the resources are obtained through competitive calls, and 17% of these come from private entities, mainly the La Caixa Banking Foundation, Banco Santander and AXA, and finally we have to highlight that 7% of the income comes from transfer activities and research programs.

Of all this revenue, the vast majority goes to personnel expenses (66%), 22% to other operating expenses (material, cleaning, telephony, maintenance, allowances and travel and training, among others) and 7% are returns from project justification.


I+D Programme 1.01 M€
Regional Funding 0.04 M€
EU 0.18 M€
Private Grants 0.48 M€
Non-Competitive Funding 0.78 M€
Other Revenue 0.19 M€
Subv of Capital 0.21 M€
Competitive Funding 1.71 M€
Income 2.89 M€
Personal Expenses -1.9 M€
Operating Expenses -0.63 M€
Depreciation of Intangibles -0.13 M€
Financial Outcome -0.01 M€
Other Expenses -0.21 M€

6 Appendix

6.1 People

Director

- Lluís Alsedà i Soler

Deputy Director

- Tomás Alarcón Cor

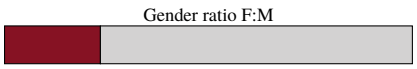
Managing Director

- José Antonio Fuentes Pérez

Principal Investigators

- Tomás Alarcón Cor (ICREA)
- Álvaro Corral
- Alexandre Hyafil
- Andrei Korobeinikov
- Tim Myers
- Alex Roxin
- Isaac Salazar
- Josep Sardanyés (Ramón y Cajal)
- Sergey Tikhonov (ICREA)
- Klaus Wimmer (Ramón y Cajal)

Researchers Classified by Funding



BGSMath Postdoctoral Fellows

- Gyla Csato, Universitat Politècnica de Catalunya
- Alvaro Leitao, Universitat de Barcelona
- David Moriña, Universitat Autònoma de Barcelona
- Alessandro Oneto, Universitat Politècnica de Catalunya
- Stefano Pasquali, Universitat Politècnica de Catalunya
- Antti Perälä, Universitat de Barcelona
- Sune Precht, Universitat Autònoma de Barcelona

BGSMath PhD Students

- Marta Bofill, Universitat Politècnica de Catalunya
- Laurent Cantier, Universitat Autònoma de Barcelona
- Damian Dabrowski, Universitat Autònoma de Barcelona
- Gladston Duarte, Universitat de Barcelona
- Claudia Fanelli, Centre de Recerca Matemàtica
- Juan Carlos Felipe Navarro, Universitat Politècnica de Catalunya
- Marina Garrote, Universitat Politècnica de Catalunya
- Joan Gimeno, Universitat de Barcelona
- Anastasia Matveeva, Universitat Politècnica de Catalunya
- Waleed Mirza, Universitat Politècnica de Catalunya
- Carmelo Pulliati, Universitat Autònoma de Barcelona
- Andrés Rojas (Universitat de Barcelona
- Mallika Roy, Universitat Politècnica de Catalunya
- Martí Salat, Universitat de Barcelona
- Iñigo Urtiaga, Universitat Politècnica de Catalunya
- Jordi Vila, Universitat Politècnica de Catalunya
- Maximilian Wötzel, Universitat Politècnica de Catalunya

BGSMath Interns

- Román Moreno
- Álvar Pineda
- Eduard Vilalta

La Caixa Collaborative Mathematics Program

- Francesc Font Martínez (Postdoctoral Fellow)
- Marc Calvo (PhD Student)
- Víctor Navas (PhD Student)
- Nicolás Pollán (PhD Student)
- Daria Stepanova (PhD Student)

Postdoctoral Fellows

- Jordi Baró (AXA Postdoctoral Fellowship)
- Jordi Canela (Banco Santander Fellowship)
- Federico Devalle (FLAG-ERA)
- Jose Mari Esnaola (MINECO)
- Alvaro González (Juan de la Cierva Formación)
- Dmitry Todorov (Marie Curie Fellowship)

Phd Students

- Mónica Minjares (ITN – CAFE)
- Niclas Rieger (ITN – CAFE)
- Travis Stewart
- Citlalli Vivar (MINECO)

Industrial Doctorate

- Josep Ferré
- Lourdes Méndez

Research Technician

- Pau Blanco

Project Manager

- Arantxa Sanz (Project Manager)

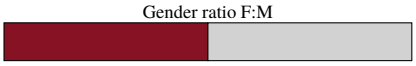
KTT Unit

- Isabel Serra (KTT Manager)

Collaborators

- Ricard Alemany
- Aurora Hernández-Machado (Universitat de Barcelona)
- Néstor Costa (Hohner Automáticos, S.L.)
- Albert Pitarque (Universitat de Barcelona)

Undergraduate & Master students

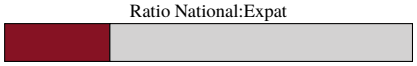


- Barry Iyare, Samuel Adegboyega University
- Raquel García Bellés, Universitat Autònoma de Barcelona
- Andrea Pistillo, Università degli Studi di Verona
- Silvia Di Pietro, Università degli Studi dell'Aquila
- Enrico Aquilano, Universitat Autònoma de Barcelona
- Miquel Saucedo Cuesta, Universitat Autònoma de Barcelona
- Sonia de Arriba García, Universitat Autònoma de Barcelona
- Alejandra de Lara, Universidad Autónoma de Madrid
- Román Moreno González, Universitat Politècnica de Catalunya
- Christina Carty, Northwestern University

Visitors

Gender ratio F:M

Ratio National:Expat

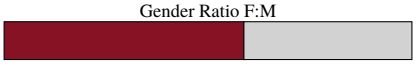


- Evgeny Abakumov, Université Paris-Est Marne-la-Vallée
- Alejandro Adem, The University of British Columbia
- Maria Aguareles, Universitat de Girona
- Sergei Artamonov, NRU-Higher School of Echonomics
- Michèle Artaud, Université d'Aix-Marseille
- Michèle Artigue, Université Paris Diderot-Paris 7
- Ivan Babenko, Université de Montpellier
- Amangul Bakhyt
- Florent Balacheff, Université de Lille 1
- Anton Baranov, St. Petersburg State University
- Berta Barquero Farràs, Universitat de Barcelona
- Tobias Barthel, Københavns Universitet
- Yury Belov, Norwegian University of Science and Technology
- Andriy Bondarenko, Norwegian University of Science and Technology
- Alexander Borichev, Université d'Aix-Marseille
- Marianna Bosch Casabò, Universitat Ramón Llull
- Carles Broto, Universitat Autònoma de Barcelona
- Maria Bruna Estrach, University of Oxford
- Alexander Bufetov, Université d'Aix-Marseille
- Carles Casacuberta, Universitat de Barcelona
- Hamid Chaachoua, Université de Grenoble
- David Chataur, Université de Picardie Jules Verne
- Yves Chevallard, Université d'Aix-Marseille
- Gisèle Cirade, University of Toulouse
- Alberto Debernardi Pinos, Bar-Ilan University
- Matias Luis del Hoyo, Universidade Federal Fluminense
- Juan Díaz Godino, Universidad de Granada
- Eleonore Faber, University of Leeds
- Konstantin Fedorovskiy, Bauman Moscow State Technical University
- Ignasi Florensa Ferrando, Escola Universitària Salesiana de Sarrià
- Pedro Gajardo, Universidad Técnica Federico Santa Maria
- Imma Gálvez Carrillo, Universitat Politècnica de Catalunya
- María Guadalupe García, Universidad Nacional de La Plata
- Josep Gascón Pérez, Universitat Autònoma de Barcelona
- Angela María Gómez, Universidad Nacional de Colombia
- Alejandro González-Martín, Université de Montréal
- John Greenlees, University of Sheffield
- Jean Gutt, Universität zu Köln
- Thomas Hausberger, Université de Montpellier
- Drew Heard, Universität Regensburg
- Dolors Herbera, Universitat Autònoma de Barcelona
- Joan Hernanz
- Reinhard Hochmuth, Universität Hannover
- Srikanth B. Iyengar, University of Utah
- Britta Eyrich Jessen, University of Copenhagen
- Danielly Regina Kaspary dos Anjos, Université de Grenoble
- Dániel Katona, Hungarian Academy of Sciences
- Neda Khodabakhshi, Amirkabir University of Technology

- Nitu Kitchloo, Johns Hopkins University
- Henning Krause, Universität Bielefeld
- Tomás Lázaro, Universitat Politècnica de Catalunya
- Ran Levi, University of Aberdeen
- Huanhuan Li, Western Sydney University
- Jaume Llibre, Universitat Autònoma de Barcelona
- Nikolai G. Makarov, California Institut of Technology
- Yohanna Paulina M. Mancilla, Universidad del Bío-Bío
- Claire Margolinas, Université Clermont-Auvergne, Institut Pascal
- Richard Moeckel, University of Minnesota
- Jesper M. Moller, University of Copenhagen
- Pedro Nicolás Zaragoza, Universidad de Murcia
- Nikolai Nikolski, Université Bordeaux I
- Alexander Olevskii, Tel Aviv University
- Bob Oliver, Université de Paris 13
- Joaquim Ortega Cerdà, Universitat de Barcelona
- Eduard Ortega Esparza, Norwegian University of Science and Technology
- Koji Otaki, Hokkaido University
- Chara Pantazi, Universitat Politècnica de Catalunya
- Verónica Ester Parra, UNCP de Buenos Aires
- Francesc Perera, Universitat Autònoma de Barcelona
- Muthukumar Perumal, Indian Statistical Institute Kolkata
- Julia Pilet, Université Paris Est Créteil
- Wolfgang Pitsch, Universitat Autònoma de Barcelona
- Alexei Poltoratski, Texas A&M University
- Luis Radford, Université Laurentienne
- Chris Rasmussen, University of San Diego
- Avenilde Romo Vázquez, CICATA-IPN
- Noemí Ruiz Munzón, Tecnocampus - Universitat Pompeu Fabra
- Alicia Ruiz-Olarría, Universidad Autónoma de Madrid
- Kelbet Sadykova
- Kristian Seip, Norwegian University of Science and Technology
- Aliya Seitova, Al-Farabi Kazakh National University
- Tomás Ángel Sierra Delgado, Universidad Complutense de Madrid
- Yannick Sire, Johns Hopkins University
- Wilfredo Sosa, Universidad Católica de Brasilia
- Andrew Tonks, University of Leicester
- Maria Trigueros Gaisman, Instituto Tecnológico Autónomo de México
- Gabriel Eduardo Valenzuela Vásquez, Max Planck Institute für Mathematiks
- Sebastian Walcher
- Carl Winsløw, University of Copenhagen
- Floriane Wozniak, Université de Montpellier
- Jianchao Wu, University Park
- Santiago Zarzuela Armengou, Universitat de Barcelona

Administration Staff

Gender Ratio F:M



- Jordi Cuní
- Ana García-Donas
- Raquel Garrido
- Núria Hernández
- Raquel Hernández
- Gemma Martínez
- Jordi Mullor
- Vanessa Ramírez
- Consol Roca
- David Romero
- Luca Tancredi
- Alba Tomàs
- Mari Paz Valero
- Pau Varela

UAB Interns

- Claudi Lleyda
- Alejandra Marques
- Albert Martorell

7 Publications

Azagra, R., P. Gabriel, A. Aguyé, and D. Moriña
2019. La aplicación de la calibración FRIDEX de la herramienta FRAX® para determinar el riesgo absoluto de fractura osteoporótica en mujeres españolas. *Reumatología Clínica*, 15(5):e68–e69.

Banwait, B., F. Fité, and D. Loughran
2018. Del pezzo surfaces over finite fields and their frobenius traces. *Mathematical Proceedings of the Cambridge Philosophical Society*, 167(01):35–60.

Beardo, A., M. Calvo-Schwarzwälder, J. Camacho, T. Myers, P. Torres, L. Sendra, F. Alvarez, and J. Bafaluy
2019. Hydrodynamic heat transport in compact and holey silicon thin films. *Physical Review Applied*, 11(3).

Bobadilla, A. V. P., J. Arévalo, E. Sarró, H. M. Byrne, P. K. Maini, T. Carraro, S. Balocco, A. Meseguer, and T. Alarcón
2019a. In vitro cell migration quantification method for scratch assays. *Journal of The Royal Society Interface*, 16(151):20180709.

Bobadilla, A. V. P., T. Carraro, H. M. Byrne, P. K. Maini, and T. Alarcón
2019b. Age structure can account for delayed logistic proliferation of scratch assays. *Bulletin of Mathematical Biology*, 81(7):2706–2724.

Cardona, R. and E. Miranda
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