2014
Annual Report

basque center for applied mathematics
BERC Programme
2014-2017

Severo Ochoa Excellence
Accreditation 2014-2018
“If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is”

von Neumann, 1947
Objective: To develop new mathematical methods, robust numerical schemes and software to solve complex and large-scale challenging real-life problems on massively parallel computers.

Description: A strong mathematical framework is key to obtain reliable algorithms and simulations. We analyse modern numerical methods such as advanced Finite Element (AFE) or Discontinuous Petrov-Galerkin (DPG) and Finite Volume methods applied to stationary and time dependent problems. We also simulate open industrial problems, working on two platforms: BBIPED and FEniCS (CFD and multi-physics).

Applications: Characterisation of the Earth’s subsurface composition for CO2-sequestration and oil or gas extraction; CFD applied to biomedicine, meteorology, oceanography, aeronautics, naval architecture, acoustics and turbomachinery.
Objective: Efficient and detailed simulation of complex phenomena stemming from real life problems in biology, medicine, public health and society.

Description: The challenge lies in developing novel algorithmic approaches, sampling techniques and improved computational models, in order to fully exploit the capabilities of modern HPC. We also couple numerical simulation with the applications specific observation data, e.g. individual anatomies reconstructed from imaging, experimental data in controlled radical polymerization, recorded data on the reservoir's production.

Applications: Patient-specific simulation (cardiovascular and brain), virtual screening for drug design, self-assembly in biological/chemical processes, modelling electroactive energy materials and uncertainty quantification in reservoir simulation.
Objective: At the interface between Mathematics and Physics is the so-called Mathematical Physics that at BCAM is represented by the research lines in Fluid Mechanics, Quantum Mechanics and Statistical Physics.

Description: We study several questions of classical physics that although known long ago, are still not understood from the mathematical perspective, such as the dynamics of fluids, microscopic origin of macroscopic laws (like in electricity) and natural phenomena of front motion embedded into random environments.

Applications: Our methods could apply to generate pseudo-random numbers, future applications of quantum technologies or forecast of wildland fire propagation to preserve natural heritage.
Objective: We develop accurate adaptive numerical methods mimicking the evolution of solutions of PDEs to assist on control and design processes. We also study nonlinear partial differential and kinetic equations.

Description: The challenge is to develop numerical methods for which the presence of possible high frequency numerical components does not destroy the true dynamics of continuous solutions and to identify those that eventually diverge because of the spurious numerical solutions.

Applications: Shape design in aeronautics and aerospace, electrical and hydraulic networks and social behaviour and population dynamics, quantum gases and aerosols.
Objective: The increase in data generation (Big data) has made indispensable the development of new statistical and machine learning methods and algorithms for knowledge extraction.

Description: In the applied statistics field, the main topics of our research are semi-parametric regression, multidimensional smoothing, (Bayesian) hierarchical models, computational statistics...Regarding Machine learning, we work on probabilistic graphical models (PGM), mainly focused on the automatic learning of PGMs from data.

Applications: Massive data problems from particle physics to e-commerce, social media, financial, marketing, medical domains (diagnosis and prognosis), genetics, environmental modelling, demography and biostatistics.
People

- 1 Scientific Director
- 12 Principal Investigators
- 5 Administration Staff Members
- 19 PhD Students
- 2 IT Members
- 16 External Scientific Members
- 16 PhD (PI excluded)
Scientific Output

- 86 publications indexed
- 75% articles in Q1
- 36% articles in D1
- h-index: 13

Source: Scopus
1st Decile Journals

Calculus of Variations and Partial Differential Equations
Communications in Partial Differential Equations
Computer Physics Communications
Computers and Mathematics with Applications
Foundations of Computational Mathematics
Fractional Calculus and Applied Analysis
IEEE Transactions on Automatic Control
Inventiones mathematicae
Inverse Problems
Journal des Mathematiques Pures et Appliquees
Journal of Computational Physics
Journal of Differential Equations
Journal of Scientific Computing
Macromolecules
Mathematical Models and Methods in Applied Sciences
Nonlinear Analysis, Theory, Methods and Applications

Source: JCR 2013
Master & PhD Thesis

- **4** Master thesis defended in 2014
- **3** Thesis defended in 2014
- **6** ongoing PhD students in 2014
- **8** new PhD students in 2014
Participants in our Programmes

15 Interns

118 Visitors

10 Visiting Fellows
2014 Main Collaborators

EUSKAMPUS
Ingeniaritza Goi Eskola Teknikoa
Escuela Técnica Superior de Ingeniería Bilbao

POLYMAT

tecnalia

bc³
BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

B/S/H/

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Red Española Matemática-Industria

BioCrucces
HEALTH RESEARCH INSTITUTE
International Agreements

université PARIS-SACLAY
IME-USP
KTH VETENKAP OCH KONST
FUNDACAO LUIZ ENGLERT DESDE 1925
KYUSHU UNIVERSITY
King Abdullah University of Science and Technology
KAUST
Università degli Studi di Padova
Universita degli Studi di Torino
Universita degli Studi di Bari ALDO MORO
Dissemination Activities

2014

48 Seminars
14 Workshops
7 Courses

European Mathematical Society

2014 Donostia San Sebastián Executive Meeting
Public and Private Funding
Participating Institutions

EUSKO JAURLARITZA  GOBIERNO VASCO

Universidad del País Vasco  Euskal Herriko Unibertsitatea

BFA DFB  Bizkaiko Foru Aldundia  Diputación Foral de Bizkaia

ikerbasque  Basque Foundation for Science

innobasque  agencia vasca de la innovación
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