“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 and lesion assessment in cardiac radiofrequency ablation.
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

3 Ikerbasque Professors

2 UPV/EHU Ikerbasque Prof. linked to BCAM

2 Ikerbasque Fellow

2 UPV/EHU Prof. linked to BCAM

30 PhD (PI excluded)

3 BCAM Researchers

5 Administration Staff Members

3 Ikerbasque Professors

2 IT Members

26 PhD Students

75 +

20 External Scientific Members

20
Scientific Output

92 publications indexed

78 % articles in Q1

39 % articles in D1

BCAM h-index 16

Source: Scopus
<table>
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<tr>
<th>Journal Title</th>
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<tbody>
<tr>
<td>Annales Scientifiques de l'Ecole Normale Superieure</td>
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<td>Chemical Reviews</td>
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<td>Coastal Engineering</td>
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<td>Computer Methods in Applied Mechanics and Engineering</td>
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<td>Computers and Mathematics with Applications</td>
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<td>IEEE Transactions on Automatic Control</td>
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<td>Journal of Differential Equations</td>
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<td>Journal of Statistical Mechanics: Theory and Experiment</td>
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<td>Mathematical Models and Methods in Applied Sciences</td>
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<tr>
<td>SIAM Journal on Imaging Sciences</td>
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<td>SIAM Journal on Scientific Computing</td>
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Master & PhD Thesis

3 Master thesis defended in 2015

1 Thesis defended in 2015

14 ongoing PhD students in 2015

12 new PhD students in 2015
Participants in our Programmes

27 Interns

116 Visitors

13 Visiting Fellows
International Agreements

Signed agreements in 2015
Dissemination Activities

2015

52 Seminars
14 Workshops
14 Courses
Public and Private Funding