

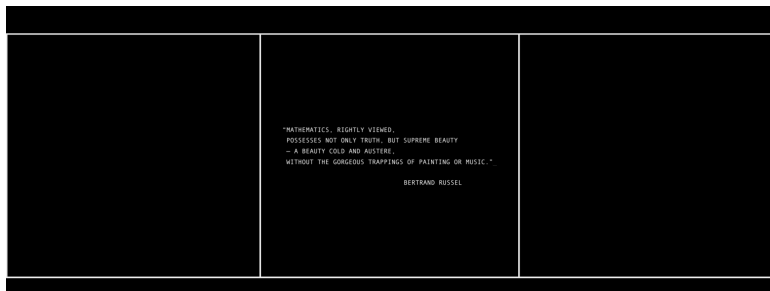
Research Day Department of Computer Science University of Verona

Research Area: Mathematics — applications and modelling

Department of Computer Science

April 11, 2017

What is applied mathematics



Applied mathematics is concerned with mathematical methods and models that are used in science, engineering, economics and industry.

What we do

- Mathematical Analysis
- Probability and Statistics
- Numerical Analysis

National Research Quality Evaluation (VQR) 2011–2014
Departments ranking (small segment)

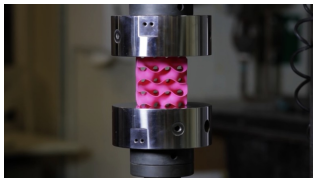
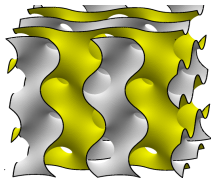
- Mathematical Analysis/Probability: **4-th** place / 42
- Mathematical Analysis: **3-rd** place / 41
- Numerical Analysis **5-th** place / 27

Competitive Research Projects

- *International/National*: Marie Curie Action
EU-H2020-MSCA-IF-2016, EU-COST Action TD1409
MI-NET Math in Industry Network (2016), INdAM-GNAMPA
n.4 projects (since 2015), INdAM-GNCS n.1 project (2017)
- *Higher education/internationalization*: EU-Erasmus+ Key
Action 107 (2015–17), MAECI-ITY (Invest your Talent in
Italy, 2016–17), MIUR-PLS Piano Lauree Scientifiche MIUR
(since 2009)
- *Placement/Contracts*: Univr-ESU-Moxoff-Calzedonia,
Math&Sport (2017), Iason SpA (2015), Sinergetica srl
(2016), Befree srl (2016), Fairmat SpA (2017)

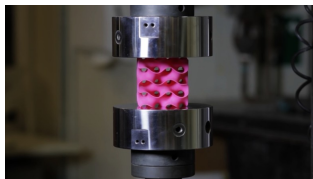
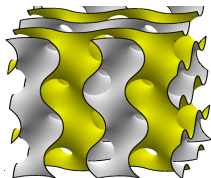
Partial Differential Equations and Minimal surfaces

Triply periodic minimal surfaces have been used in combination to graphene properties to design **lightweight high-resistance graphene assembly** (MIT)

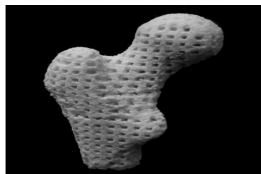
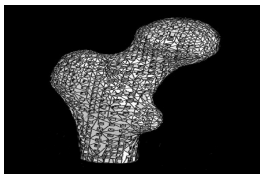


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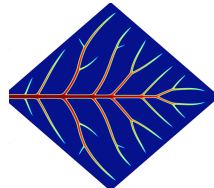


These structures have been used also for **optimal 3D-printed porous scaffold**



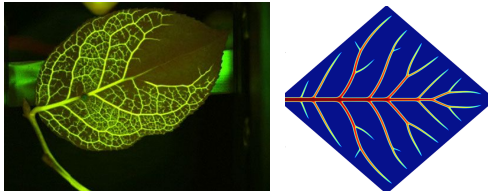
Optimization / Calculus of Variations

Optimal transportation theory has a wide range of applications from **biology** (angiogenesis, vessels and neuron formation, . . .), to **engineering problems** (urban network planning, traveling salesman, . . .).

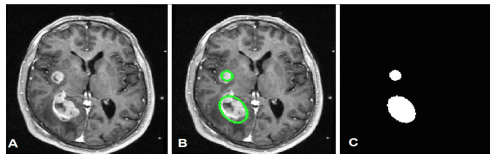


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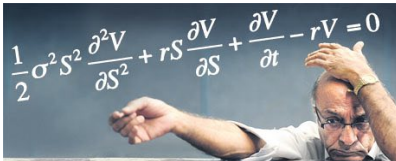


Variational techniques are used in **Inverse Problems** for **image reconstruction** in **arts restoration**, **biometrics**, **medical images (TAC)**,...



Mathematical Finance and SDEs

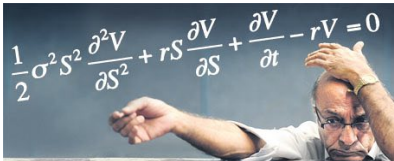
Black–Scholes–Merton equation is used to determine the price of **financial instruments** (options, futures, . . .), and it is one of the most solved equation every day!! (Financial crisis '08)


$$\frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} + \frac{\partial V}{\partial t} - rV = 0$$



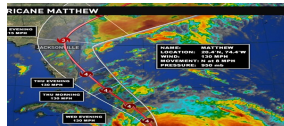
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Stochastic Differential Equations appear whenever phenomena do occur in presence of uncertainty, e.g. **weather, energy markets forecast**



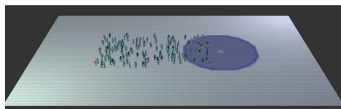
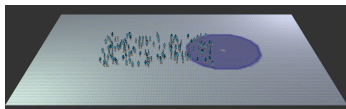
Monte Carlo Simulations and **Uncertainty Quantification**, are some of the methods used for the analysis.

Big Data analysis

High-dimensional data, are difficult to interpret. Mathematics offers several tools to understand such complex objects (**Big Data**), **Machine learning**, **Neural Networks (AI)**, **Bayesian inference**, **Data Mining**.

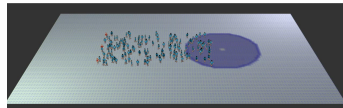
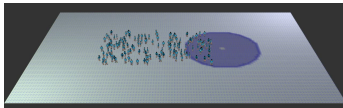
Optimal control theory

People have used **Cooperative Game Theory** to improve the **evacuation process of a crowd** introducing an **optimal control problem** which is solved by **coordinated leaders**.



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A complementary field is **Non-Cooperative Games**, where agents have different targets, thus the solution searched is the so called **Nash equilibrium**. These dynamics well describe **markets economies**, **price formation**, and **opinion leaders' strategies**.

Numerical methods for differential equations

- Exponential integrators and splitting methods (structure preserving algorithms, preservation of geometric properties, long-time integration)

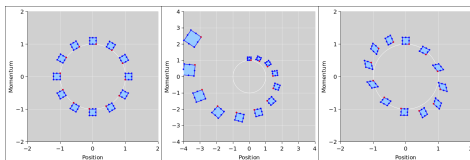
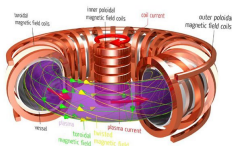


Figure: Exact, non-symplectic, symplectic

Who we are



[G. Albi](#), numerics for optimal control and kinetic equations.



[S. Baldo](#) calculus of variations and minimal surfaces



[L-P. Bos](#), multivariate approximation



[M. Caliari](#), numerical exponential integrators for ODE/PDE



[L. Di Persio](#), stochastic modelling, mathematical finance

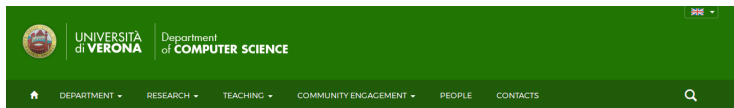


[A. Marigonda](#), optimization and optimal control



[G. Orlandi](#), calculus of variations and partial differential equations

Information



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Research

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ACTIVITIES

RESEARCH AREAS

- Bioinformatics and medical informatics
- Experimental and applied physics
- Theory of computation
- Software Engineering and Security
- Mathematics - applications and modelling**
- Discrete and computational mathematics
- Cyber-physical systems
- Information Systems
- Machine Intelligence

RESEARCH GROUPS +

PHD PROGRAMMES +



Research

The Department is organised into several research areas, where a team of around 200 researchers work on developing innovative research projects with national and international bodies and private industries. See the research section of the website for more details. Current research areas include:

- MATHEMATICS
 - Mathematics - applications and modelling