GIMC SIMAI Young 2026 - 3rd Workshop for Young Researchers organized jointly by Gruppo Italiano di Meccanica Computazionale (GIMC) and Società Italiana di Matematica Applicata e Industriale (SIMAI)

Pisa, Italy
3–5 June 2026

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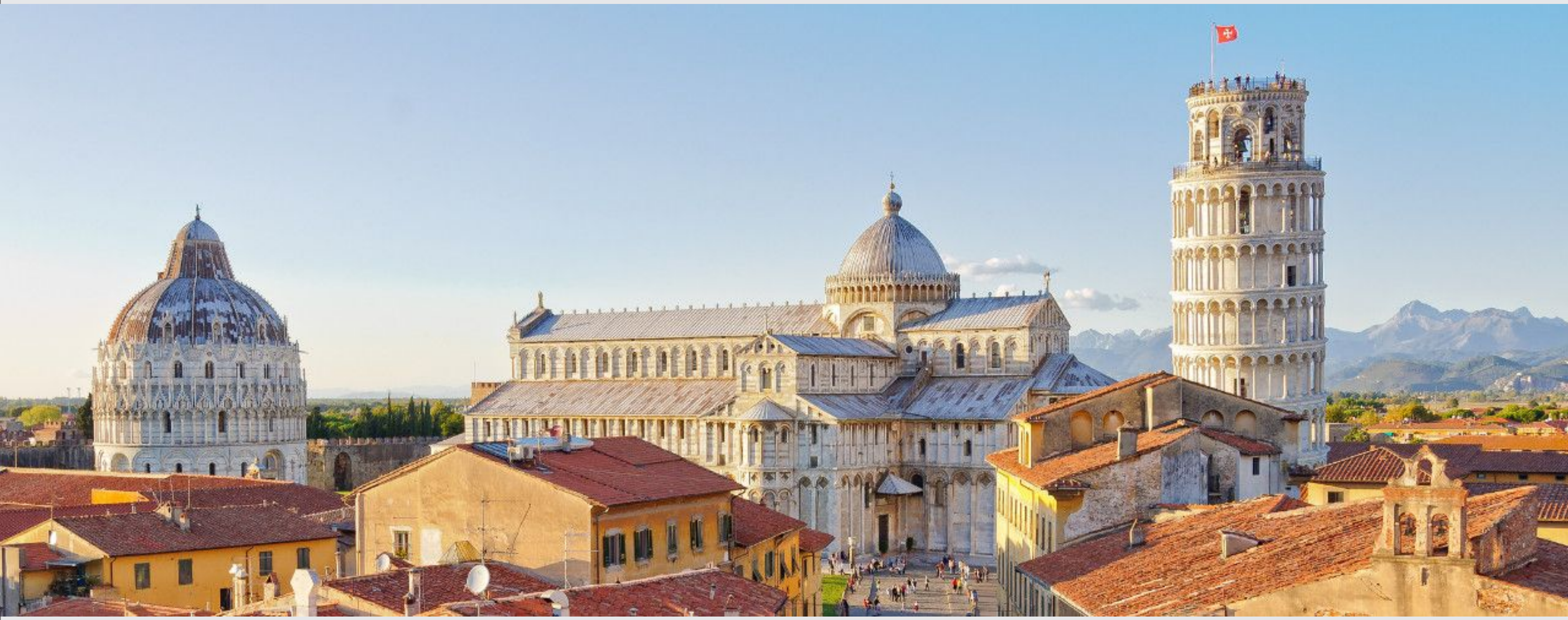

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Contents

MS01: Advanced Numerical Methods and Models for Coupled Solid Problems and Multiphysics Systems

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Keywords: Computational Solid Mechanics, Coupled Problems, Multiphysics, Advanced Numerical Methods

Summary

The proposed minisymposium addresses recent advances in computational solid mechanics and the numerical simulation of coupled and multiphysics problems, with emphasis on advanced numerical methods. Many applications in engineering and applied sciences require predictive models that capture linear/nonlinear solid responses together with strong couplings to additional fields and mechanisms, such as thermal effects, diffusion/transport, fluid–structure interaction, electro-mechanical coupling, or rate-dependent processes in complex media.

Accurate and reliable computations in these settings demand robust algorithmic tools, including high-order and mixed discretizations (Finite Element, Finite Volume, Discontinuous Galerkin, Meshless Methods etc.), stabilized formulations, adaptive meshing strategies, domain decomposition and scalable linear/nonlinear solvers, as well as structure-preserving time integration for transient problems. Increasingly, these classical pillars are complemented by modern modeling paradigms, such as variational and gradient-enhanced theories (e.g., strain-gradient, nonlocal and phase-field-type regularizations), enriched and hybrid formulations for complex interfaces and evolving microstructures, and multiphysics constitutive laws capturing inelasticity, plasticity, damage, transport, and electro-chemo-thermo-mechanical couplings.

This minisymposium aims to bring together young researchers working across applied mathematics, numerical analysis, and computational mechanics to discuss modeling choices, discretization strategies, and scalable implementations for coupled coupled solid–multiphysics systems. Contributions combining mathematical rigor, computational efficiency, and challenging multiphysics applications are particularly encouraged, with the goal of highlighting current progress and open problems in the simulation of coupled phenomena in solids.

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MS02: Advances in Neural Network Approximation and Surrogate Modeling for Scientific Machine Learning

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Keywords: Scientific Machine Learning, Surrogate Modeling, Operator Learning, Partial Differential Equations, Scientific Computing, Neural Network Approximation

Summary

The mathematical modeling of complex scientific and engineering phenomena is fundamentally grounded in the solution of differential equations, encompassing ordinary differential equations (ODEs), partial differential equations (PDEs), and integral equations. Modern applications increasingly involve high-dimensional PDEs, high-dimensional parameter spaces, multiscale physics, and multi-query settings such such as optimization, control and uncertainty quantification. In these regimes, classical numerical methods can become computationally prohibitive or impractical.

This minisymposium is dedicated to recent advancements in neural network approximation and surrogate modeling within the framework of Scientific Machine Learning (SciML). We explore data-driven and hybrid approaches in which neural networks approximate high-dimensional solution maps, operators, latent dynamics or solutions to differential equations, either as standalone surrogates or as components embedded in traditional numerical solvers. Representative methodologies include Physics-Informed Neural Networks (PINNs), operator learning approaches such as DeepONets and Fourier Neural Operators, neural-enhanced time-dependent models based on recurrent neural networks and transformers, as well as neural ordinary differential equations for continuous-time formulations and latent dynamics discovery. Alongside surrogate construction, the minisymposium highlights the role of optimization strategies for training neural-network-based PDE solvers, including methods that improve convergence, scalability, and robustness.

A central theme of the minisymposium is the development of robust and physically meaningful neural network approximation to differential problems. Contributions will address key challenges such as long-term stability, enforcement of physical consistency, robust optimization strategies, generalization across parameter spaces, and the treatment of stiff and multiscale systems with limited training data. The minisymposium welcomes theoretical, methodological and application-driven contributions, with particular emphasis on impactful use cases in areas such as computational mechanics, fluid dynamics, and biomedical modeling.

MS03: Graph Neural Networks for Computational Physics

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Keywords: Scientific Machine Learning, Graph Neural Networks, PDEs, PINNs.

Summary

Using deep learning strategies to approximate the solutions of Partial Differential Equations (PDEs) that describe complex physical systems is a primary frontier in computational science [1]. Indeed, traditional numerical methods are computationally costly and struggle when dealing with physical simulations defined on irregular, unstructured, and varying meshes. In these scenarios, Graph Neural Networks (GNNs) offer superior accuracy and versatility compared to standard deep learning architectures [2,3].

This session explores GNN developments, including novel architectures, specialized loss functions with a focus on physically informed losses, connection between mesh-based and meshless paradigms, and underlying approximation theory.

The purpose of this mini-symposium is to bring together young experts in GNNs to foster discussion and collaboration. Together, we will tackle critical challenges such as explainability, generalization, and performance comparisons against alternative numerical methods, illustrating the practical benefits and limitations in a wide range of academic, industrial, and engineering applications.

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MS04: High-Order Numerical Methods for Complex Mechanics and Higher-Order PDEs

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Keywords: High-Order Methods, High-Order Problems, Isogeometric Analysis, hp Finite Element Method, Virtual Element Method, Immersed Methods.

Summary

Recent technological advances in material science and manufacturing are offering unprecedented possibilities in the design of sophisticated engineering products. To fully exploit these opportunities, modern design and analysis pipelines increasingly rely on high-fidelity numerical simulations capable of accurately capturing multi-scale phenomena, coupled physical processes, and intricate geometric features. Moreover, many problems of practical relevance in solid and structural mechanics are governed by high-order partial differential equations (PDEs) or require numerical solutions with enhanced smoothness and regularity. Classical examples include plate and shell theories, strain-gradient and higher-order continuum models, phase-field formulations for fracture and damage, flexoelectricity, Cahn-Hilliard and other diffuse-interface models, as well as problems involving Bi-Laplacian and higher-order differential operators. The numerical approximation of such models poses significant challenges, since standard low-order discretization techniques may suffer from limited accuracy, excessive computational costs, and intrinsic difficulties in enforcing the required continuity of the solution and its derivatives.

In this framework, High-Order Methods (HOMs) have emerged as a cornerstone of modern computational mechanics, offering a powerful and flexible approach to overcome these limitations. By increasing the approximation order and the inter-element continuity, HOMs can achieve superior accuracy per degree of freedom, improved spectral properties, and enhanced robustness when dealing with complex geometries and high-order PDEs. Prominent examples include Isogeometric Analysis [3], p- and hp-versions of the Finite Element Method [2, 4], Virtual Element Methods [1], as well as immersed and unfitted high-order discretizations. These approaches naturally support higher-order continuity, high-fidelity geometric representations, and great flexibility in mesh generation, making them particularly attractive for advanced applications in computational mechanics.

The purpose of this minisymposium is to bring together researchers working on the development, analysis, and application of high-order numerical methods, with a particular emphasis on numerical techniques for high-order PDEs arising in computational mechanics. Contributions addressing theoretical foundations, algorithmic innovations, efficient solvers, and challenging engineering applications are welcome. The minisymposium aims to foster interaction between the applied mathematics and computational mechanics communities, highlighting recent advances,

practical successes, and open challenges in the field.

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MS05: Multiscale Cardiac Electrophysiology: From Scalable Computational Solvers to Patient-Specific Simulations

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Keywords: Computational Cardiology, Electrophysiology, Computational methods, Multiscale models, High Performance Computing

Summary

Multiscale cardiac electrophysiology modeling addresses a crucial yet challenging scientific topic: how computational methods can enhance the understanding of cardiac electrical activity and its pathological alterations. One keypoint is the understanding of the tight interplay between cellular-scale dynamics and organ-scale electrical behavior, in order to provide complementary perspectives on the mechanisms governing the electrophysiological function of the heart.

In this perspective, cell-by-cell models are central, since they describe the behavior and interaction of individual cells. While these models provide high biological fidelity, they are characterized by large-scale, high-dimensional, and often nonlinear systems of equations, making their efficient numerical solution a major computational bottleneck, especially in simulations involving millions of cells.

Another crucial point is the development of patient-specific models through the integration of clinical data into advanced computational frameworks. By leveraging high-performance computing and modern optimization techniques, these models can be tailored to individual patients paving the way toward more accurate diagnostic tools and personalized therapeutic planning in clinical practice.

Both aspects face computational challenges which can be overcome by recent advances in scalable solvers and computational techniques. By bringing together experts in computational biology, applied mathematics, and high-performance computing, this minisymposium aims to foster interdisciplinary collaboration, stimulate discussion on state-of-the-art tools and practical implementation strategies, and inspire new directions for scalable solutions in large-scale cardiac simulations.

MS06: Numerical Modeling for Sustainability Problems

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Keywords: Sustainability, Mathematical modeling, Numerical methods, Stiff differential equations, Parameter estimation, Data-driven modeling, Artificial intelligence.

Summary

Real-world applications arising in the context of sustainability pose significant challenges due to the intrinsic complexity of the underlying physical, biological, and engineered processes. Investigating through the formulation of mathematical and numerical models, together with the development of advanced and robust numerical techniques, represents an open and stimulating challenge. Moreover, the integration of numerical modeling with modern computational and data-oriented techniques provides a powerful framework for the study of complex systems. Critical challenges often include strong nonlinearities, multiscale interactions, uncertainty, large-scale data, calling for innovative modeling strategies and reliable computational approaches. Numerical methods thus play a key role in supporting the understanding, prediction, and optimization of systems relevant to sustainable development.

The aim of this session is to bring together researchers working on mathematical modeling and advanced numerical methods for the simulation of complex systems. Contributions are expected to address both methodological and applied aspects, ranging from the formulation of innovative modeling strategies to the development of efficient computational techniques. Topics of interest include, but are not limited to: advanced numerical methods for stiff deterministic and also stochastic differential equations used to model complex real-world phenomena; parameter estimation and model calibration; integration of data-driven approaches such as deep learning and artificial intelligence. Particular attention will be given to applications to real-world problems, including material degradation, battery dynamics, vegetation modeling, and broader sustainability-related challenges.

MS07: Recent Advances in Data-Driven Surrogate Modeling

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Keywords: Surrogate modeling, Reduced Order Models, Scientific Machine Learning.

Summary

The increasing complexity of mathematical models arising in science and engineering has made the development of efficient surrogate models a central topic in applied mathematics. Data-driven approaches, often combined with physical knowledge, have recently emerged as powerful tools to approximate high-fidelity problems, enabling real-time prediction, control, and optimization [1, 2].

This minisymposium focuses on recent advances in data-driven surrogate modeling, with particular emphasis on the interplay between data, physics-based modeling, and reduced approximations. The aim is to bring together young researchers working on methodological developments and applications in areas such as model order reduction, scientific machine learning, and data-enhanced numerical methods for complex systems governed by partial differential equations.

Topics of interest include, but are not limited to: data-driven and physics-informed surrogates, reduced-order modeling and hybrid data–physics approaches, learning-based strategies for parametric and multiscale problems, efficient strategies for optimal control and inverse problems, reinforcement learning and data-driven control of dynamical systems.

The minisymposium aims to foster discussion across communities in applied mathematics, scientific computing, and computational engineering, highlighting both theoretical aspects and practical applications. It is particularly intended as an opportunity for early-career researchers to establish a fruitful environment and cooperative network to exchange ideas, present recent results, and explore future directions in data-driven surrogate modeling.

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MS08: Robust Preconditioning Techniques for Scientific Applications

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Keywords: Preconditioning, Saddle-Point Problems, Iterative Solvers, Multigrid Methods, Finite Element Method, High-Performance Scientific Computing.

Summary

The numerical treatment of partial differential equations (PDEs) often relies on the efficient solution of large-scale linear algebraic systems. However, these systems are frequently indefinite, poorly conditioned, and highly sensitive to underlying physical parameters. To cope with this complexity, the development of robust and efficient iterative solvers is crucial. A primary challenge for such methods is the design of effective preconditioners, which are typically tailored to the specific problem at hand.

The goal of this minisymposium is to encourage productive interaction among early-career researchers from scientific computing, numerical analysis, and applied mathematics who are currently developing efficient preconditioning approaches for a variety of scientific applications.

Topics of interest include the development of Schur complement-based preconditioners, multilevel methods, domain-decompositions, and novel preconditioning techniques that exploit particular problem structure to design robust and scalable solvers. Contributions addressing theoretical developments or practical applications in computational science and engineering, such as coupled or multiphysics problems, are particularly welcome. Neural networks and scientific machine learning approaches are also of significant interest.

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MS09: Advances and Open Problems in CFD and FSI for Bioengineering Applications

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Keywords: Fluid dynamics, FSI, bioengineering, biomedicine

Summary

Biological fluid dynamics play a central role in a wide range of bioengineering and biomedical applications, including cardiovascular and respiratory flows, as well as cellular- and tissue-scale transport phenomena. The mathematical modeling of such processes involves substantial mathematical and numerical challenges due to complex fluid rheology, multiscale behavior, intricate geometries, and strong fluid–structure interaction effects, thereby requiring advanced analytical and computational tools [1,2]. In addition, the availability of experimental or clinical data is often limited by uncertainty or noise, highlighting the relevance of data integration strategies in the modeling, calibration, and validation of biological flow simulations [3,4].

This minisymposium focuses on the development, analysis, and application of computational fluid dynamics (CFD) and fluid–structure interaction (FSI) methods for biological flows, with particular emphasis on unresolved theoretical issues and advanced computational techniques. Topics of interest include, but are not limited to, the stability and accuracy of numerical schemes, coupling strategies, model reduction, uncertainty quantification, data assimilation, and subject-specific computational models. The minisymposium particularly welcomes young researchers from applied mathematics, numerical analysis, and bioengineering who are interested in sharing their latest findings and exchanging insights to foster future collaborations and advance research in the field. Contributions addressing open problems, novel methodologies, or challenging applications are especially encouraged.

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MS10: Data Assimilation and Uncertainty Quantification for Complex Flows

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Keywords: Data Assimilation, Uncertainty Quantification, Complex Flows

Summary

The primary objective of this mini-symposium is to bring together contributions that couple advanced Computational Fluid Dynamics (CFD) with Uncertainty Quantification (UQ) and Data Assimilation (DA) to enable end-to-end pipelines for scalable digital twins of complex flows. We aim to provide a stage for researchers to present methodological advancements and discuss challenges related to complex flow phenomena, fostering a dialogue on the integration of classical approaches with emerging data-driven techniques. To this purpose, submissions are encouraged to address open issues in fluid dynamics where observational data, whether experimental or numerical, can significantly enhance predictive capabilities and help in the development of fast, reliable, uncertainty-aware surrogates for CFD. We particularly welcome contributions focusing on:

- Novel UQ and DA algorithms suited for high-dimensional and non-linear problems.
- Data-driven and hybrid modeling, including methods bridging the gap between physical principles and data availability.
- Real-world applications involving bluff bodies and unsteady phenomena.

Applications are expected to deal with fundamental and applied analysis of turbulent and multi-physics flows. Investigations dealing with wind engineering, urban flows, and reacting flows, are particularly welcome.

References

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MS11: Advances in Computational Plasticity, Damage and Fracture

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Keywords: Plasticity, Damage, Fracture, Phase-field models, Multiscale modelling

Summary

The proposed mini-symposium aims to bring together young researchers working on the modelling and simulation of plasticity, damage and fracture in traditional and advanced materials. The focus is on the development and numerical implementation of innovative theories and computational methods able to describe complex inelastic and failure phenomena, including the onset and evolution of damage, strain localization, crack initiation and propagation, and fatigue-driven degradation.

Contributions are welcome that cover theoretical, numerical and experimental aspects, with particular emphasis on the interplay between modelling, analysis and large-scale computations. Applications may range from metals, composites and polymers to architected and metamaterials, porous media and other heterogeneous systems encountered in engineering and applied sciences. By fostering interactions among PhD students, postdoctoral researchers and early-career scientists from engineering, physics and applied mathematics, the mini-symposium aims to stimulate discussion on current challenges and future directions in computational plasticity, damage and fracture mechanics, and to promote new collaborations within the young GIMC–SIMAI community.

Topics of interest include, but are not limited to:

- Constitutive models coupling plasticity, damage and fracture in metals, composites, polymers and metamaterials;
- Anisotropic and rate-dependent plasticity for fibrous, layered and architected materials;
- Damage and failure under cyclic, fatigue and dynamic loading, including localization and instability phenomena;
- Nonlocal, gradient-enhanced and other regularized damage models;
- Phase-field and variational formulations for damage and fracture, possibly coupled with plasticity and other fields;
- Multiphysics inelastic and damage processes in porous and heterogeneous media (e.g., diffusion–mechanics, thermo–mechanics, fluid–structure interaction);

- Multiscale and homogenization approaches linking microstructural failure mechanisms to macroscopic responses and nonlocal models;
- Robust and efficient numerical methods for highly nonlinear problems up to failure (e.g., finite element, virtual element, enriched and embedded crack approaches, meshfree and isogeometric methods, adaptivity);
- Experimental characterization and identification strategies for plasticity and damage, including direct and indirect measurement techniques;
- Industrial and engineering applications, including damage tolerance assessment and structural integrity analysis.

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MS12: Computational Mechanics of Bioinspired Materials

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Keywords: Bioinspired materials, Structure–property relationships, Computational modeling, Finite element analysis, Materials optimization

Summary

Bioinspired materials exhibit complex hierarchical architectures and multifunctional behaviors that challenge conventional design approaches. Computational modeling provides a powerful framework to analyze these systems, revealing structure–property relationships across scales, and guiding the development of new materials with enhanced mechanical, functional, and adaptive performance.

This minisymposium focuses on recent advances in numerical methods to study bioinspired materials including, but not limited to, multiphysics and multiscale approaches for hierarchical composites, data-driven techniques, and computational frameworks for structure optimization. Contributions are expected to highlight the reliability of modeling tools towards the prediction of physico-mechanical behavior of bioinspired materials, and how the integration of biological design principles can be translated into engineered systems.

All in all, this minisymposium will showcase emerging methodologies, promote cross-disciplinary discussion, and outline future directions for computational research on bioinspired materials.

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MS13: Mechanics and microstructural behavior of Biological Media: from multiscale modeling to simulations

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Keywords: Microstructure, Biological media, Continuum Mechanics, Growth and remodeling, Multi-scale Modeling

Summary

Continuum modeling provides a sound foundation for the description of living matter when it is subjected to internal or external stimuli. In the past years, the continuum approach was vastly employed to characterize the behavior of various biological tissues and bio-fluids, including the mechanics of articular cartilage, arterial walls, ocular tissues, skin, brain tissue, growth and remodeling in multicellular aggregates and bones, and the flow of lymph and blood. In particular, among the study of these bio-materials, we emphasize the presence of a common praxis, that is the determination of how the macroscopic behavior is influenced by material heterogeneities or interactions taking place at a scale lower than the one of the tissue. Such microscopic interactions can be related, for example, to remodeling phenomena occurring in the extracellular matrix, to the geometry of the composite, or to the active reorientation of fibers.

The main scope of our mini-symposium is to bring together young researchers that work in the field of multi-scale biological media, and that share a common interest for the mechanical characterization of biological tissues with an underlying microstructure. By proposing this mini-symposium, we wish to create a meeting point among researchers for communicating ideas, sharing viewpoints and comparing mathematical techniques, based on the common ground of Continuum Mechanics, with the perspective of building knowledge from different, but synergic, areas in the bio-mechanical field.

The mini-symposium covers the mechanical and hydraulic behavior of multi-scale media, including inelastic processes such as remodeling and growth. Topics range from rigorous upscaling methods and Physics-Informed Neural Networks (PINNs) to the specific numerical techniques required for the efficient resolution of these models. Furthermore, the development of robust and innovative numerical schemes is regarded as a fundamental pillar for translating theoretical multi-scale frameworks into reliable and predictive computational tools. In general, we welcome contributions that can spark interest, give new insights or that can bring interesting ideas in the field of the mechanics of materials with a microstructure.

MS14: Mechanics of Metamaterials: from modeling to applications

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Keywords: Metamaterials, elasticity, instability, wave propagation, homogenization

Summary

In recent years, metamaterials have increasingly attracted interest within the scientific community due to their ability to produce mechanical effects beyond the limits of classical materials. By carefully designing their microstructure, metamaterials enable control over elastic properties, instability mechanisms, and wave propagation. These unconventional properties play a key role in the development of advanced engineering solutions, including energy-absorbing systems, vibration isolation devices, ultralight structures, and biomedical stents, with high-impact applications across civil, mechanical, biomedical, and aerospace engineering.

This minisymposium focuses on recent advances in the modeling and application of mechanical metamaterials, with emphasis on theoretical frameworks, computational aspects and experimental realizations. Particular attention will be devoted to instability-driven functionalities and wave manipulation in both small and large deformations, highlighting how these phenomena can be exploited to develop innovative engineering solutions across multiple length scales.

The topics of the minisymposium may include, but are not limited to:

- Stability and multistability of metamaterials
- Wave propagation in periodic structures
- Topological metamaterials
- Higher-order homogenization
- Origami/kirigami-like metamaterials
- Extreme features in metamaterials.

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MS15: Theoretical and Computational Mechanics of Time-Dependent Materials

Organizers: Federico Califano[1] and Giulio Lucci[1]

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Keywords: time-dependent materials, viscoelasticity, damage, constitutive modelling, machine learning

Summary

Time-dependent behaviour is a defining characteristic of a vast class of engineering and biological materials, from polymers and soft tissues to advanced composites and architected metamaterials. Understanding, predicting, and exploiting this behaviour remains a central challenge in solid mechanics, which demands continued advances in both theoretical formulations and computational methods.

This minisymposium aims to bring together young researchers working on the mechanics of materials exhibiting time-dependent behaviour, including history-dependent responses, rate-dependent effects, and internal restructuring. We invite contributions addressing phenomena such as viscoelasticity and viscoplasticity, damage accumulation and failure, biological growth and active remodelling, among others, across material classes including polymers, fibre-reinforced composites, soft biological tissues, magneto-rheological materials, and liquid crystal elastomers.

Contributions may address foundational questions in continuum thermomechanics, novel constitutive theories, multiscale and homogenisation strategies, or advanced numerical methods. We particularly encourage submissions exploring the integration of data-driven and machine learning techniques with classical continuum mechanics frameworks.

The symposium will provide a forum for exchange between theoretical and computational mechanicians, fostering new collaborations among early-career researchers and identifying open problems concerning time-dependent material behaviour.

MS16: Advanced FEM techniques with engineering applications

Organizers: Lucia Lottici[1] and Paolo Fisicaro[1]

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Keywords: Isogeometric Analysis (IGA), Meshless Methods, Particle Finite Element Method (PFEM), enriched Finite Element Methods (e-FEMs), Virtual Element Method (VEM)

Summary

The Finite Element Method (FEM) is one of the most powerful procedure for solving partial differential equations (PDEs) in engineering fields. However, the standard FEM has some drawbacks when modelling thin structural geometries, incompressible or nearly incompressible materials, weak and strong discontinuities, and multi-physics problems in evolving domains, e.g., fluid-fluid, fluid-solid or free surface.

The proposed minisymposium aims to bring together recent developments in the formulation, implementation and engineering application of advanced finite element methods that overcome the aforementioned limitations of the standard FEM.

Potential topics include, but are not limited to, Mixed Finite Element Methods, Isogeometric Analysis (IGA), Meshless Methods, Particle Finite Element Method (PFEM), enriched Finite Element Methods (e-FEMs), Virtual Element Method (VEM), and their engineering applications in Solid, Fracture, and Contact Mechanics, Fluid Dynamics, Fluid-Structure Interaction, and Coupled Problems, with a special focus on the advantages and disadvantages.

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MS17: Inverse Problems in Structural Engineering

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Keywords: Inverse problems, Load identification, Regularization, Bayesian inference, SHM.

Summary

The identification of external loads and internal structural states from sparse and noisy measurements is a key challenge in modern Structural Health Monitoring (SHM), operational monitoring, and digital twin frameworks. These tasks naturally lead to inverse problems that are often ill-posed and require robust mathematical and computational strategies.

This minisymposium focuses on recent advances in inverse problems for structural and vibrational mechanics, with particular emphasis on load monitoring and shape sensing techniques. The session aims to bring together young researchers working at the interface between applied mathematics, computational mechanics, and experimental methods.

Topics of interest include:

- Strain-based load identification and state estimation in structural dynamics;
- Shape sensing and inverse reconstruction methods for smart structures;
- Regularization and Bayesian approaches to inverse problems in structural mechanics.

The minisymposium aims to foster interaction between applied mathematicians and structural engineers, bridging theoretical developments and real-world applications, with particular attention to robustness against measurement noise and model uncertainties.

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MS18: Modeling of Elastic Multiphase Structures for Bio-Mechanics

Organizers: Gabriele Fioretto[1], Chiara Lonati[1]

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Keywords: Multiphase materials, biological applications, soft matter, Continuum Mechanics.

Summary

The proposed minisymposium aims to bring together young researchers (PhD students and post-doctoral fellows) whose work focuses on the modeling of biological elastic structures within the framework of Continuum Mechanics. The goal is to foster the exchange of ideas, results, and methodological approaches in this field.

Over the past decades, Continuum Mechanics has progressively evolved to provide theoretical frameworks capable of describing the complex behavior of biological materials. In particular, many biological tissues consist of two or more interacting constituents whose interplay is essential to reproduce experimental observations. This has led, for example, to the development of mixture theories, which extend classical continuum approaches and capture multiphase interactions. Typical examples include biological systems where a solid matrix is coated or permeated by fluid components, as in cancer formation, or by other substances such as liquid crystals, as observed for instance in the eye and lungs. Moreover, several tissues, such as skin and blood vessels, can be represented as layered structures composed of cells and substrates with distinct thicknesses and mechanical properties. In this context, realistic mathematical models of biological matter are becoming increasingly crucial, especially in view of emerging technologies such as digital twins and regenerative medicine, which aim to enable personalized therapeutic strategies.

The thematic session will address, but will not be limited to, the modeling of multiphase biological systems such as the cornea, lymph nodes, and fluid flow in capillaries, as well as related phenomena including hemolysis, embryogenesis and cell alignment on elastic membranes. These topics will provide the opportunity to highlight a variety of modeling strategies, including mixture theory, asymptotic homogenization and incremental elasticity, together with the integration of theoretical and numerical approaches, as well as modern physics-based machine learning techniques.

We hope that the minisymposium will stimulate fruitful discussions and serve as an opportunity for young researchers to become acquainted with new problems, techniques, and perspectives. The exchange of ideas and experiences among participants will be strongly encouraged.

MS19: Optimization Methods in Structural Mechanics: Numerical Models and Applications

Organizers: Nicola Grillanda[1], Mattia Schiantella[2]
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Keywords: Numerical optimization, optimization-based structural methods, nonlinear structural mechanics, engineering applications.

Summary

Numerical optimization methods have a fundamental role in analysis, design and assessment of structural systems, in particular in the presence of material nonlinearities and complex geometrical configurations. The recent advances in computational mechanics have been accompanied by the development of several optimization strategies capable of addressing high-fidelity models and complex structural problems arising in engineering practice.

This minisymposium focuses on the development and application of optimization-based methodologies in structural mechanics, including both classical mathematical programming techniques and emerging optimization strategies within the context of structural analysis. Topics of interest include linear, quadratic, and nonlinear programming approaches applied to structural problems, such as limit analysis, rigid body dynamics, and plasticity-based formulations. Contributions addressing topology and geometry optimization for structural design and discontinuity layout optimization for collapse analysis are particularly welcome. In addition, the minisymposium aims to highlight alternative optimization approaches, such as meta-heuristic and nature-inspired methods, especially when applied to complex or existing structural systems, such as reinforcement layout optimization, retrofitting strategies, and damage mitigation.

Both methodological developments and practical case studies in engineering practice are highly welcome, with the objective of encouraging the interaction among young researchers active in numerical optimization, computational and structural mechanics.

MS20: Synchronization Dynamics, Collective Behaviors and Nonlinear Mechanics

Organizers: Mario Argenziano[1], Enrico Babilio[2], and Stefania Palumbo[2]

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Keywords: nonlinear elasticity, elastic syncronisation, collective dynamics, nonlinear dynamics

Summary

Collective behavior stemming from the interactions of single oscillators is an intriguing trait of natural systems, where some sources of nonlinearity shape the dynamics, often characterized by synchronization. The knowledge of laws governing such phenomena can be profitably exploited in engineered structures and may offer unique opportunities for innovation, motivating a paradigm shift in how mechanical systems may be conceived and designed. The MS aims to collect contributions focusing on analytical, computational, and experimental studies in nonlinear mechanics, including also emphasis on elastic synchronization phenomena and collective dynamics arising from mechanical coupling. Contributions may address continuous or discrete systems, nonlinear elastic structures, non-smooth interactions, and advanced architectures such as smart, lattice, metamaterials or tensegrity systems. Also opening to the wide panorama of nonlinear dynamics, topics also include parametric excitation, internally resonant behavior, and periodic, quasi-periodic, or chaotic responses.

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