Scientific Computing at DTU Compute

Computational mathematics fuels engineering innovation

We tackle complex mathematical and computational challenges in science and engineering.

Analysing and solving these problems requires the interplay of advanced mathematical models, data analysis, and computer simulations.

Our research in **scientific computing** focuses on developing the mathematical models and methods that make this possible.

Scientific computing for applications

Our research involves the complete scientific computing workflow, including model development, mathematical analysis, development of efficient computational methods, and numerical simulations.

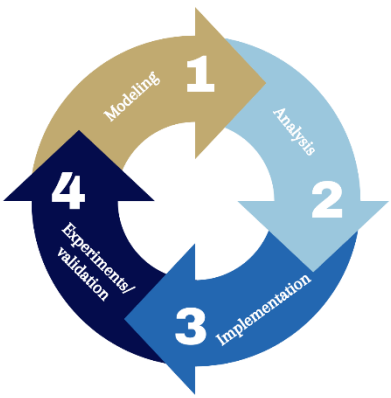
We address the challenges via collaborations with industrial users, engineers, and scientists for model development, data analysis, verification, etc. This involves student projects that prepare students to apply state-of-the-art mathematics to real-world problems.

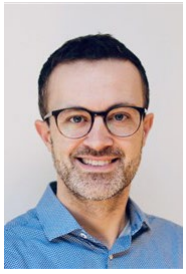
Computational mathematics research

We also perform research that zooms in on specific mathematical aspects.

For example, we develop methods for data analysis that characterize and quantify the influence of measurement errors.

Moreover, we design high-performance computing methods for handling large amounts of data in applications such as computed tomography, industrial design, and data analysis.





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Research areas

Our research addresses fundamental and applied challenges in computational science and engineering – organized around three key areas:

Mathematical modelling and analysis, together with numerical simulation, are at the heart of scientific computing. Starting from complex challenges rooted in real-world applications, we provide a combination of mathematical and computational insight essential for discovery and innovation in science and engineering. This frequently involves ordinary, partial, or stochastic differential equations, complemented by uncertainty quantification. Applications include inverse problems in imaging and tomography, photonics, nanometrology, insulin and energy systems control, computational structural biology, and computational marine hydrodynamics.

Optimization and control are central to solving many challenging problems across science and engineering. We develop optimization models and methods for a wide range of tasks, ranging from parameter estimation and data fitting to design and control of systems where some notion of system performance must be optimized while satisfying design goals and operational requirements. Automatic control complements this by enabling dynamic systems to respond intelligently to changing conditions. Our research covers both theory, practical implementations, and applications in, e.g., smart energy systems, medical systems, and process control.

Scientific machine learning combines data-driven modelling with domain-specific knowledge. We develop new, improved methods for complex problems in computational science and engineering, thereby enabling accelerated discovery in fields like physics, biology, and climate science. Our research involves both mathematical-physical modelling, methodological development, and applications in areas such as fluid dynamics.

Education

Our broad expertise is part of the foundation for the Applied Mathematics (BSc) and Mathematical Modelling and Computation (MSc) programmes.

Students explore everything from advanced mathematical models and numerical simulations to high-performance computing while developing a computational mindset and strong problem-solving skills.

Our research is supported by **strong capabilities in high-performance computing** and further reinforced by close collaboration with partners:

- **Collaboration** is central to our approach. We work closely with domain experts and industrial partners to deliver solutions with practical impact by addressing relevant challenges with mathematical models and computational methods.
- **High-performance computing** is an essential part of scalable computing solutions. Building on a strong foundation in high-performance computing and computational science, we turn complex mathematics into fast, reliable software.