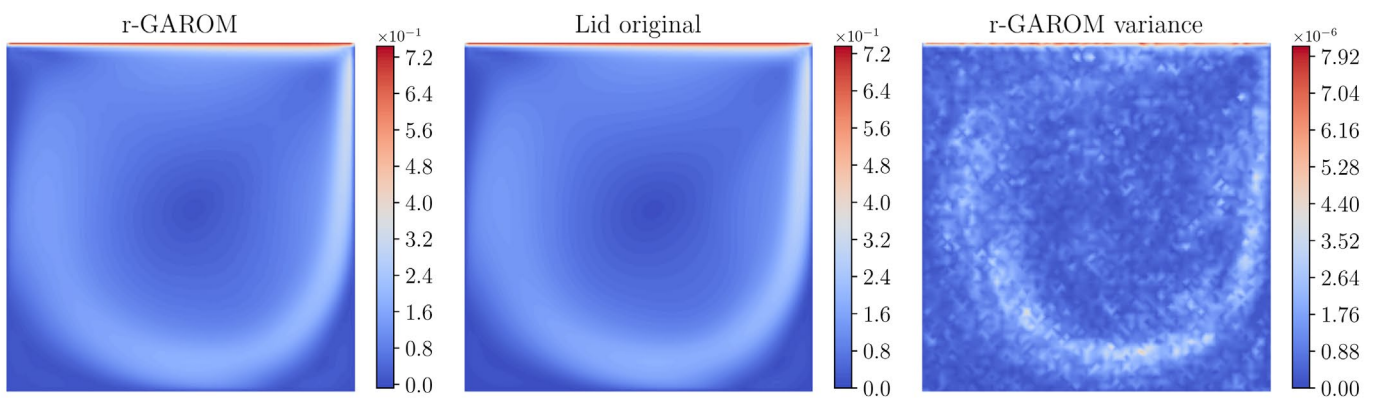


PRESS RELEASE

GAROM: Artificial intelligences compete to build better real-time simulations

A new approach from SISSA for mathematical models that can “recognize” when they make errors



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Reduced Order Models (ROM) are increasingly important mathematical tools for industry and engineering. By reducing the parameters of a system, they enable real-time simulations in scenarios that require numerous simulations for various system configurations, such as in Formula One car design or ship propeller design. This is crucial for scenarios demanding multiple simulations under slightly varying conditions or when full-scale simulations are impractical. Despite computational advantages, these methods struggle to reliably quantify the uncertainty of the models and simulations, making their integration into industrial pipelines challenging.

A recent study by SISSA, published in *Nature Scientific Reports*, proposes a new approach called GAROM, to simulate complex physical systems by combining artificial intelligence with reduced order methods. This creates a new type of model capable of quantifying associated uncertainty and thus “recognizing” when they make errors.

“The approach relies on the use of two neural networks: the generator, which produces simulation results with related uncertainties, and the discriminator,

which tries to distinguish whether the input data comes from a simulation or has been generated,” explains Dario Coscia of SISSA mathLab, the mathematical modeling and scientific computing laboratory at SISSA, and the lead author of the research. “The goal is for the generator to fool the discriminator, while the discriminator becomes increasingly accurate at recognizing genuine simulations.”

This training process of two neural networks in competition with each other (Generative Adversarial Networks, GAN) was combined with Reduced Order Models (ROM) to create GAROM. This reduces computational costs like traditional ROMs but with additional advantages over both approaches. The article demonstrates how GAROM can be applied to complex fluid dynamics problems, a crucial discipline for applications in fields such as aeronautics, maritime, medicine, and meteorology. The results are comparable to or even superior to the state-of-the-art, with the crucial addition of uncertainty quantification, addressing one of the most common problems of Data-Driven reduced models.

LINKS**Paper:**[Scientific reports](#)

Image credits:

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