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INVERSE CARDIOVASCULAR MODELING

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MINI-SYMPOSIUM PROPOSAL

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Patient-specific predictive computational simulations require effective assimilation of clinical data in order to be predictive. This is usually done through the solution of an inverse problem, where certain model components (typically physical parameters, but also initial and boundary conditions, geometry) are estimated by minimizing an error measure between the underlying model's output and the measurements [1, 2].

Full cardiovascular models involve generally heavy computations. These follow from large and complex geometrical domains, heterogeneous components, the need of fine discretization in both space and time, the intrinsic nonlinear nature of dynamics of interest. The solution of inverse problems is usually performed by iterative methods, where the solution of those complex "forward" problems is required at each iteration. Devising efficient and effective methods that reduce the number of forward solves is critical for the successful use of inverse modeling and data assimilation in practice. Alternatively, reduced and surrogate models are gaining increasing popularity in this field as a viable approach to reduce the cost-per-iteration without giving up the accuracy of the procedure. They may be based on an offline/online paradigm, where the computational demanding part is confined to a preprocessing phase that is properly exploited during the actual solution of the problem; alternatively, they rely on customization of general purpose methods that take advantage from specific features of the problem at hand (e.g. a special morphology).

By using these methods, data assimilation and inverse problem solving allow more complete studies, including for example uncertainty quantification.

In this minisymposium we aim at gathering participants to share their newest results in this promising field.

We are particularly (but not exclusively) concerned with the following topics:

- Inverse problems in multiphysical and multiscale systems (e.g. electromechanics, fluid-structure interaction, 3D/0D coupled models, etc.). For example, how measurements in one physical field may improve identifiability in the others.
- Inverse problems from measurements coming from multiple sources (multimodal imaging, catheterizations, etc).
- New error measurements for complex data (e.g. medical images)
- Parametrization of physical quantities depending on spatial data resolution (e.g. model selection and averaging).

- Combination of low and high fidelity models in inverse problems.
- Measurement-driven control problems and design (e.g. heart pumps, fibrillation, etc).
- Efficient state estimation approaches: state of the art and comparison.

We will invite worldwide experts in these topics to share the most recent results and finding. At the end of the minisymposium we will dedicate some time to wrap up the most relevant indications from the scientific discussions, to draw a roadmap from numerical simulation to data assimilation and optimization in cardiovascular modeling.

REFERENCES

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