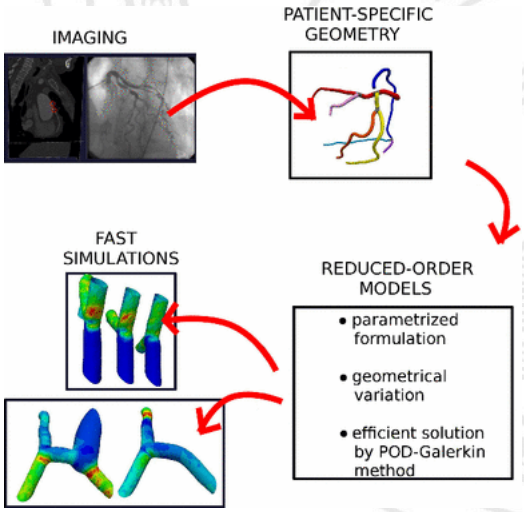
Parametric reduced order modelling approaches for computational hemodynamics simulations

Problem: Computational modelling of patient-specific vascular districts is a topic of growing interest in the computational mechanics community, with a diverse set of applications [1, 2]. Being a virtual model, the computational scientist can perform a non-intrusive comparison of several different scenarios (associated to some parameters of the model). Unfortunately, simulations are usually time consuming, especially for a large number of considered scenarios.

Objective: The goal of this thesis is to study the applicability of parametric reduced order modelling techniques in patient-specific hemodynamics [3, 4]. Interested students will apply these techniques through the implementations developed in [5] for selected case studies.

Collaborations: this thesis is developed in the framework of a collaboration between the UniPV CompMech group (http://www-2.unipv.it/compmech/) and SISSA mathLab, Trieste (https://mathlab.sissa.it/). Interested students will carry out an internship at SISSA in Trieste as part of the thesis activity (students could apply to a fellowship provided by SISSA in order to cover expenses).



Thesis proposal

Type: Numerical

Prerequisites:

- basic knowledge of computational fluid dynamics
- basic knowledge of the finite element method

References

[1] Morganti, S., Conti, M., Aiello, M., Valentini, A., Mazzola, A., Reali, A. and Auricchio, F., 2014. Simulation of transcatheter aortic valve implantation through patient-specific finite element analysis: two clinical cases. Journal of biomechanics, 47(11), pp.2547-2555.

[2] Romarowski, R.M., Faggiano, E., Conti, M., Reali, A., Morganti, S. and Auricchio, F., 2018. A novel computational framework to predict patient-specific hemodynamics after TEVAR: Integration of structural and fluid-dynamics analysis by image elaboration. Computers & Fluids.

[3] J. S. Hesthaven, G. Rozza, and B. Stamm, Certified reduced basis methods for parametrized partial differential equations, 1 ed., Springer, 2015.

[4] M. Tezzele, F. Ballarin, and G. Rozza, "Combined parameter and model reduction of cardiovascular problems by means of active subspaces and POD-Galerkin methods", in Mathematical and Numerical Modeling of the Cardiovascular System and Applications, D. Boffi, L. F. Pavarino, G. Rozza, S. Scacchi, and C. Vergara (eds.), Springer, pp. 185-207, 2018. http://dx.doi.org/10.1007/978-3-319-96649-6_8
or https://arxiv.org/abs/1711.10884

[5] https://mathlab.sissa.it/cse-software

Contact persons:

- Prof. Ferdinando Auricchio, UniPV, auricchi@unipv.it, http://www-2.unipv.it/auricchio/
- Prof. Gianluigi Rozza, SISSA, gianluigi.rozza@sissa.it, http://people.sissa.it/~grozza
- Dr. Michele Conti, UniPV, michele.conti@unipv.it, http://www-2.unipv.it/compmech/members/micheleconti.html
- Dr. Francesco Ballarin, SISSA, francesco.ballarin@sissa.it, http://www.francescoballarin.it/
- Rodrigo M. Romarowski, PhD 3D and Computer Simulation Laboratory IRCCS Policlinico San Donato, San Donato Milanese MI Rodrigo.Romarowski@grupposandonato.it