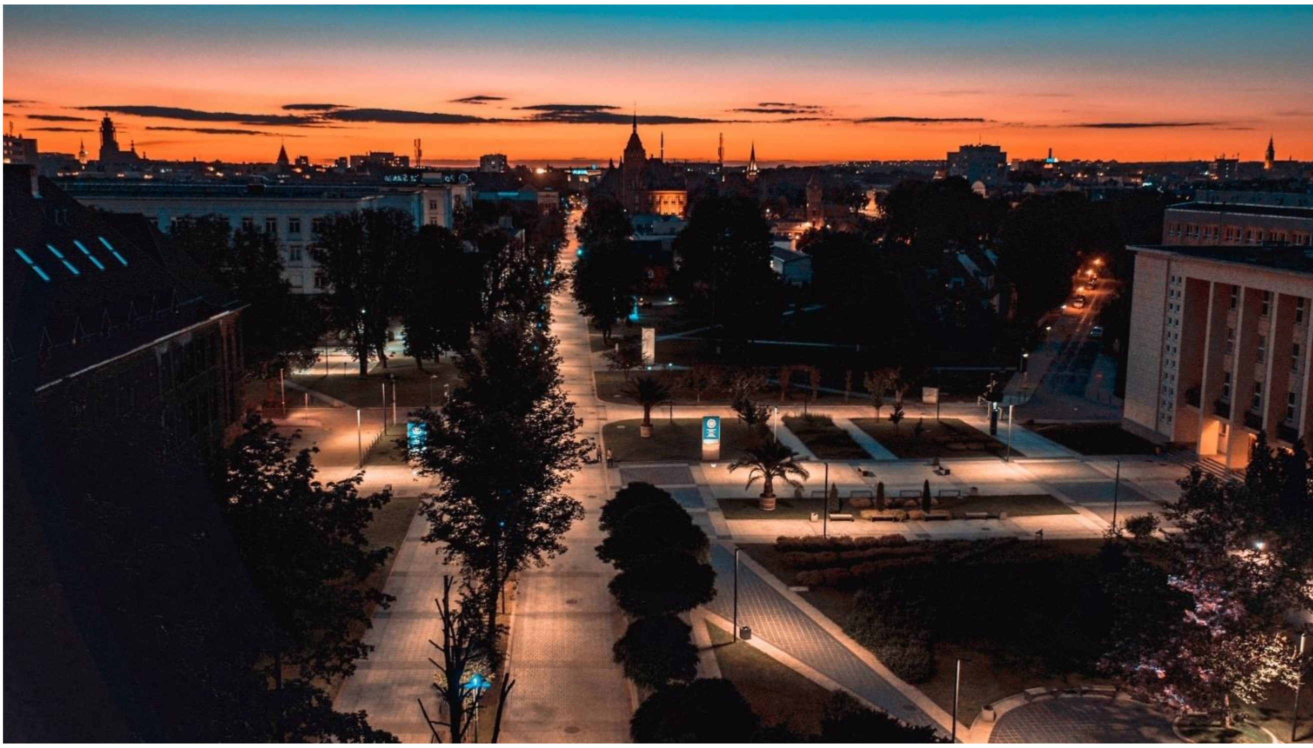
Norway grants

Silesian University of Technology

Summer School on vascular bioengineering

August 29th – September 1st, 2022 an online event @ Gliwice, PL



Silesian University of Technology (SUT), Gliwice, PL

Priority Research Area #1 Computational Oncology and Personalized Medicine

Norwegian University of Science and Technology (NTNU), Trondheim, NO

under auspices of
Committee of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences

Participation in the school is free of charge. **The school is addressed to PhD students and young researchers interested in vascular flow simulations.** The working language will be English. **Basic knowledge of MatLAB, Python and ANSYS is required.**

The number of participants is limited and cannot exceed 25 in the theoretical part (lectures) and 15 individuals in the hands-on training. Priority will be given to PhD students of SUT and NTNU. **The organizers reserve the right to select participants based on the application form submitted.**

For more details: **www.enthral.pl**

Registration form: **https://forms.office.com/r/4hUtstDkhN**

Event is organized within project ENTHRAL "Non-invasive in-vivo assessment human artery walls" funded from the Norwegian Financial Mechanism 2014-2021 under grant# UMO-2019/34/H/ST8/00624.

enthral.pl

2022 ENTHRAL Summer School Program

Inverse Methods

Instructors: **Prof. Ryszard Białecki, Prof. Ziemowit Ostrowski SUT, Gliwice, PL**

2 h lectures + 4 h assignment to simulate examples

Software: MatLAB, Python

Direct boundary value problems have a unique solution, provided that a set of data is known, known as the unambiguity conditions. This set encompasses the geometry of the domain, the boundary and initial conditions, material properties, and internal sources that act in the domain. The solution is a physical field, such as velocity, pressure, temperature, etc. If any element of the unambiguity data is unknown, the problem does not have a unique solution. To produce a unique solution, additional data are included in the process. These data come from the measurements of the fields that would be the solution to the associated direct problems. Computed tomography, image deblurring, and determination of unknown tissue properties belong to the class of inverse problems.

Topics:

- Definition and classification of inverse problems
- Examples of applications
- Ill posendess and regularization
- Methods of solution
- Solution of simple numerical examples.

Sensitivity Analysis and uncertainty quantification via the DAKOTA Code

Instructor: **Prof. Adam Klimanek, SUT, Gliwice, PL**

2 h lectures + 4 h assignment to simulate examples

Software: Dakota, Python, Matlab

Numerical simulations of physical processes yield the fields with a certain accuracy. The model parameters, as well as boundary and initial conditions, are uncertain and contribute to the uncertainty of the model predictions. The goal of sensitivity analysis is to identify the extent to which simulation results depend on model input and to determine the most important input data. The goal of uncertainty quantification is to reveal the variability and statistics of model predictions, which allow assessing the probability of typical and extreme outcomes. Using the methods, the question of how reliable the obtained results are can be addressed, which is a crucial aspect of engineering. Dakota, a Sandia Lab freeware, offers a flexible interface between the user's simulation code and iterative methods for uncertainty quantification, design optimization, parameter estimation, design of experiments, and sensitivity analysis.

Topics:

- Sensitivity Analysis
- Uncertainty Quantification
- Solution methods
- Applications
- Solution of simple numerical examples

continued next page

Event is organized within project ENTHRAL "Non-invasive in-vivo assessment human artery walls"
funded from the Norwegian Financial Mechanism 2014-2021 under grant# UMO-2019/34/H/ST8/00624.
enthral.pl

2022 ENTHRAL Summer School Program *(continued)*

Machine learning

Instructors: **Prof. Joanna Polańska, Dr Michał Marczyk, Aleksandra Suwalska**
SUT, Gliwice, PL
2 h lectures + 4 h assignment to simulate examples

Software: Python

The classic approach to building a mathematical model requires detailed knowledge of the processes involved. Often, however, we do not have such knowledge, or it is limited, and the analyzed phenomena are complex and/or highly nonlinear. Then, machine learning techniques, especially those using artificial neural networks (ANN), can be helpful. Regression ANNs predict an output variable as a function of the inputs. The input (explanatory) variables can be categorical or numerical, but we require a response variable to be numeric. We will focus on the regression analysis using ANN in the TensorFlow environment. The hands-on example will support the theoretical knowledge presented during the lecture.

Topics:

- Statistical versus machine learning approach
- Structure of artificial neural networks
- Model training and optimization
- Performance evaluation scenarios

Fluid-structure interaction

Instructors: **Prof. Joris Degroote, Prof. Patrick Segers**
Ghent University, Ghent, BE
2 h lectures + 4 h assignment to simulate examples

Software: Ansys Workbench

The interaction between a fluid flow and a moving or deforming structure is called fluid-structure interaction (FSI). In the arterial system, there is FSI between the blood flow and the arterial walls. This can be simulated in a partitioned way, by coupling a computational fluid dynamics (CFD) solver with a computational structural mechanics (CSM) solver. However, robust coupling techniques have to be applied to stabilize the coupling iterations between the solvers. Furthermore, an accurate simulation requires insight in the physics of the problem, with attention for the boundary conditions, the geometry from medical imaging, the meshing and the tissue properties.

Topics:

- Definition and classification of fluid-structure interaction problems
- Techniques for a deforming fluid domain
- Added mass effect
- Coupling techniques for partitioned simulation
- Wave propagation in elastic arteries
- Patient-specific simulations based on medical imaging

Contacts:

Prof. Ziemowit Ostrowski, Summer School Coordinator (ziemowit.ostrowski@polsl.pl)
Prof. Ryszard Białecki, Project Coordinator (ryszard.bialecki@polsl.pl)
Department of Thermal Technology, Silesian University of Technology
Konarskiego 22, 44-100 Gliwice, Poland   www.polsl.pl

Event is organized within project ENTHRAL "Non-invasive in-vivo assessment human artery walls" funded from the Norwegian Financial Mechanism 2014-2021 under grant# UMO-2019/34/H/ST8/00624.
enthral.pl