44th Woudschoten conference

One-minute poster session

14:15-15:00 Line up in alphabetical order

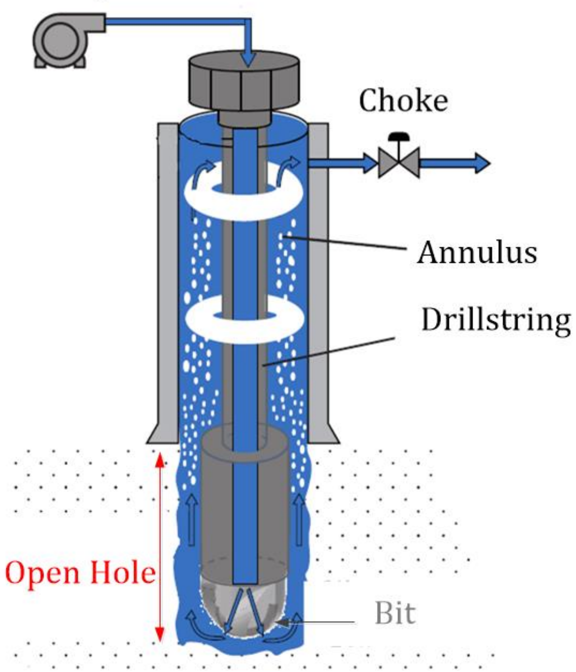
DUTCH-FLEMISH
SCIENTIFIC
COMPUTING SOCIETY

SCS

Error estimation in Model Order Reduction of Parametric Systems

M.H. Abbasi, L.Iapichino, B. Besselink, W. Schilders, N. van de Wouw

HYDRA



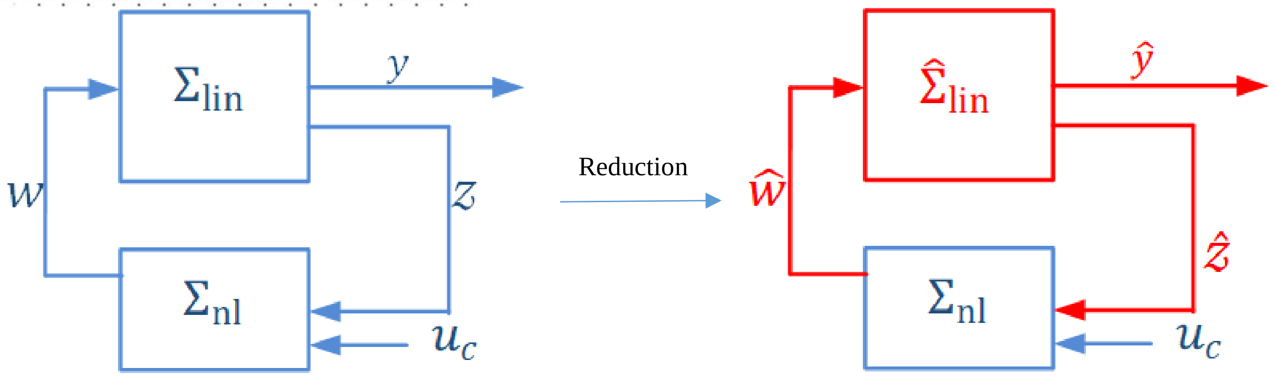
Computation time of virtual hydraulic simulator > Sensor sampling time

Nonlinear Systems

Local nonlinearities

Distributed nonlinearities

Hyper reduction



Is the decomposition always feasible?

Is small-gain condition always satisfied?

Are there any empirical error estimates?

Model Order Reduction for problems with moving discontinuities

H. Bansal, L. Iapichino, S. Rave, W.H.A. Schilders, N. van de Wouw

Technische Universiteit Eindhoven University of Technology

Where innovation starts

Applications:

- Nuclear Engineering
- Drilling
- …

Convection Dominated Problems

Features:

- Stationary or moving discontinuities
- Collision/ Interaction of moving fronts

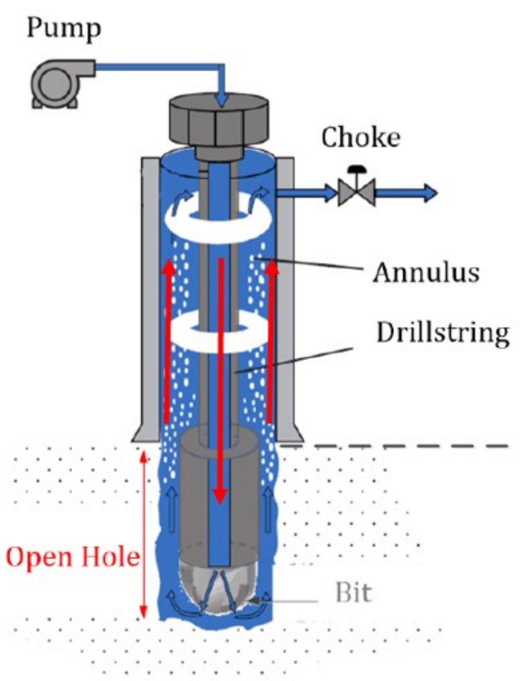
Conventional Reduced Order Modelling Technique

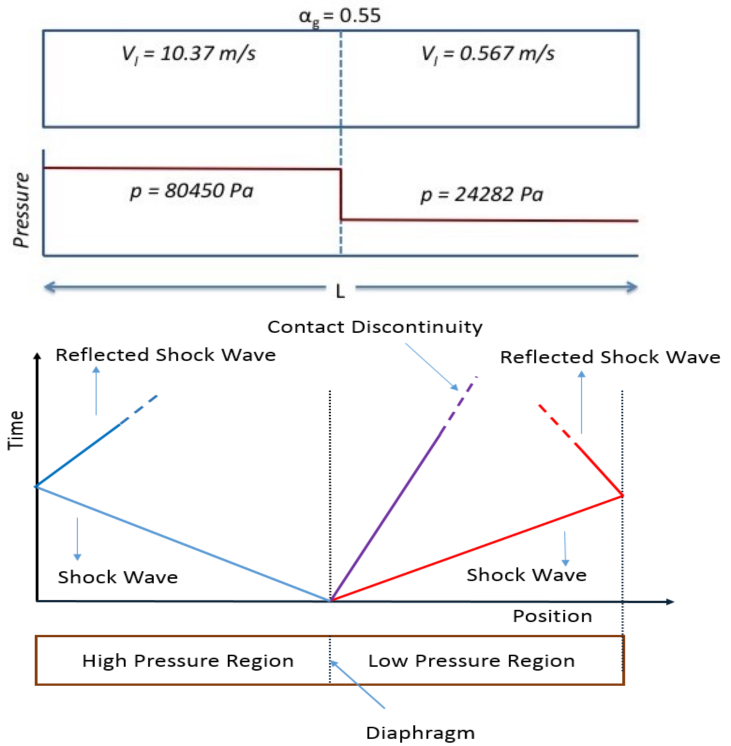
Gibbs Phenomenon and Slow decay of Kolmogorov N-width!

Alternative Reduced Order Modelling Technique:

(Modified) Method of Freezing + Reduced Basis Approximations

Can we extend the combined approach of (modified) method of freezing and reduced basis approximations to deal with non-linear wavefront interactions and merging fronts, and consequently obtain (accurate and stable) online efficient reduced-order models?





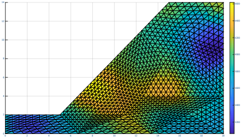
Visit Poster Number 'X' for more details.

Multilevel Monte Carlo Methods for Geotechnical Engineering

Situation: You are performing excavation works

Source: Schijnbare cohesie van onverzadigde gronden - Geotechniek - Januari 2011

Goal: Assess the stability of the slope which contains an uncertain parameter



Constraint: Time (= Money)

Source: https://www.scratchexchange.com/about/

Solution:

MLMC:

$$\mathbb{E}[P_L] = \frac{1}{N_0}\sum_{n=1}^{N_0} P_0(\omega^{(n)}) + \sum_{\ell=1}^{L}\left\{\frac{1}{N_\ell}\sum_{n=1}^{N_\ell}\left(P_\ell(\omega^{(n)}) - P_{\ell-1}(\omega^{(n)})\right)\right\}$$

MLQMC:

$$\mathbb{E}[P_L] = \frac{1}{R_0}\sum_{i=1}^{R_0}\frac{1}{N_0}\sum_{n=1}^{N_0} P_0(\mathbf{x}_{i,n}) + \sum_{\ell=1}^{L}\frac{1}{R_\ell}\sum_{i=1}^{R_\ell}\left\{\frac{1}{N_\ell}\sum_{n=1}^{N_\ell}\left(P_\ell(\mathbf{x}_{i,n}) - P_{\ell-1}(\mathbf{x}_{i,n})\right)\right\}$$

Machine Learning for Closure Models in Two-Phase Pipe Flow

High fidelity model

- 2D one-fluid model with VOF.

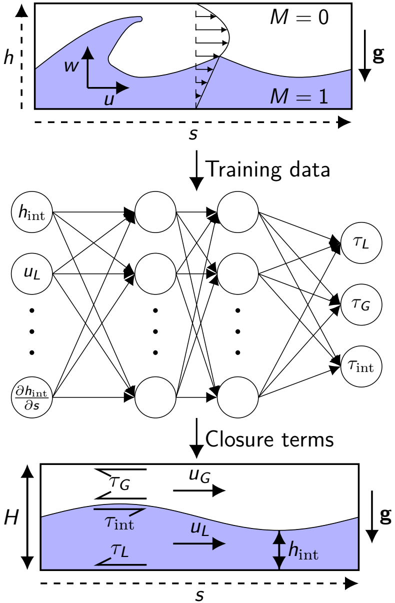
Neural network

$$\tau_L, \tau_G, \tau_{\text{int}} =$$

$$f(h_{\text{int}}, u_L, u_G, \rho_L, \rho_G, \mu_L, \mu_G, H, \frac{\partial h_{\text{int}}}{\partial s})$$

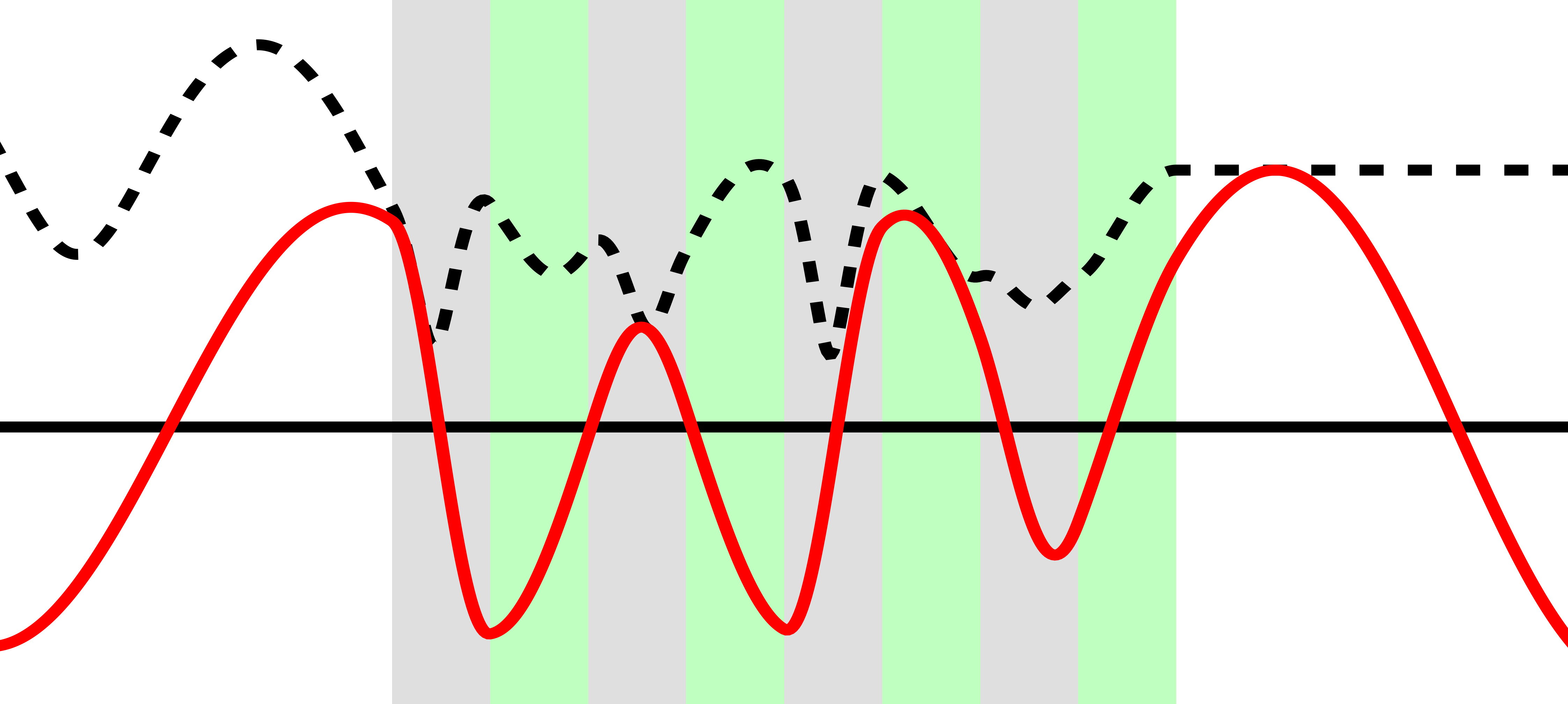
Low fidelity model

- 1D two-fluid model.

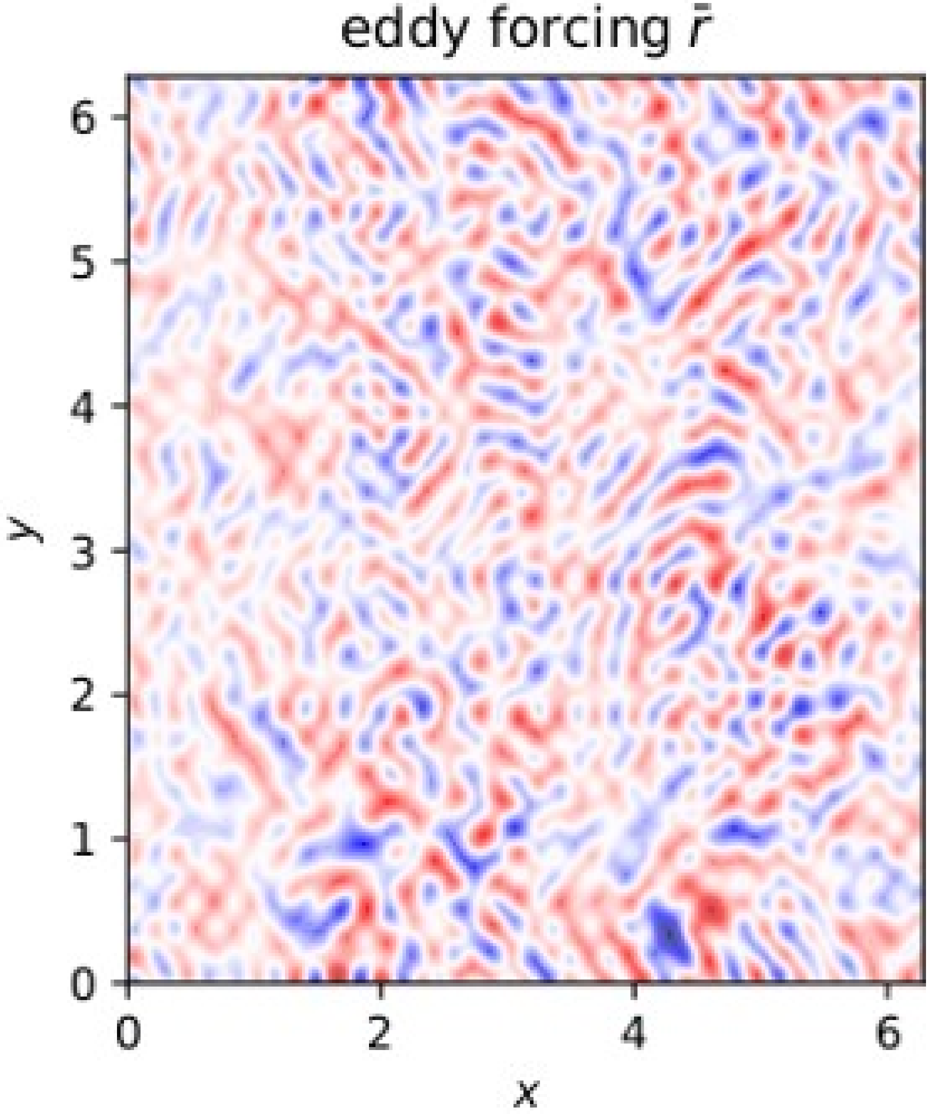


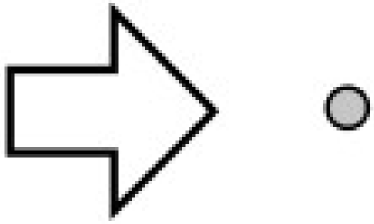
Reflection computation of a finite 1D photonic crystal using Bloch modes

L. J. Corbijn van Willenswaard
University of Twente



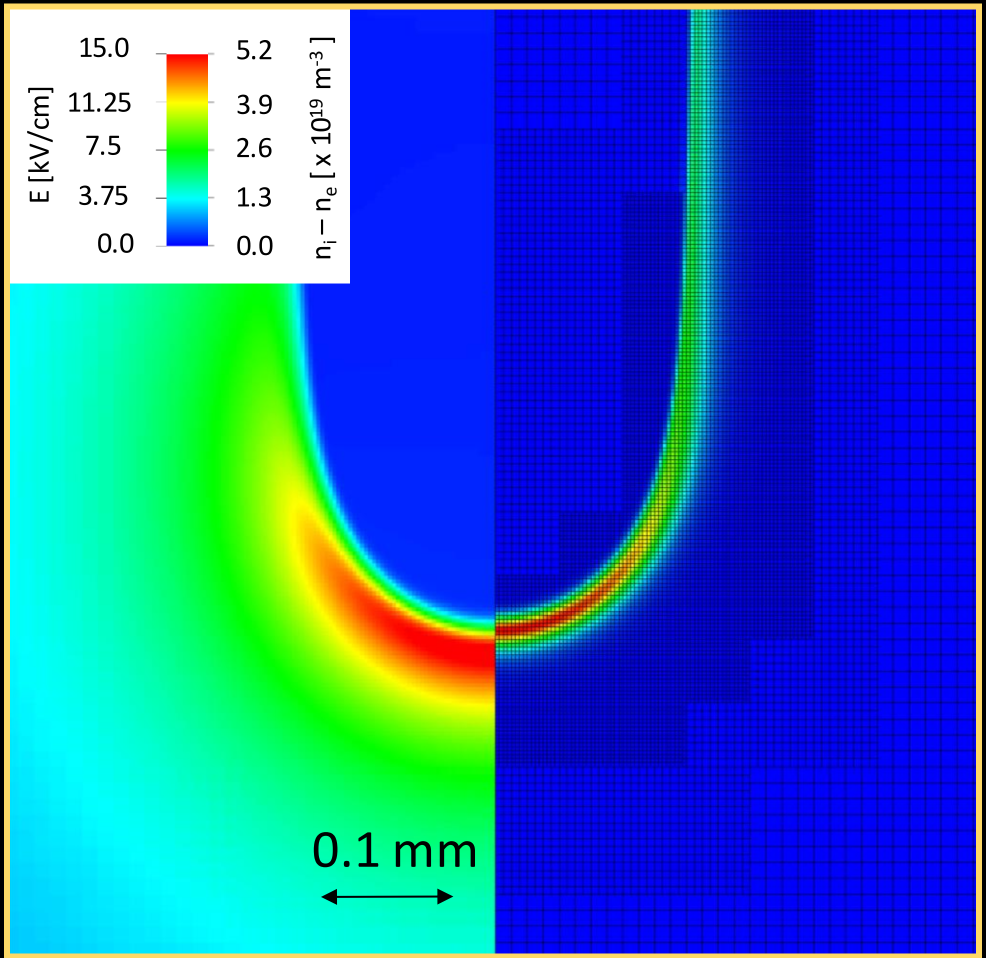
Reduced SGS models

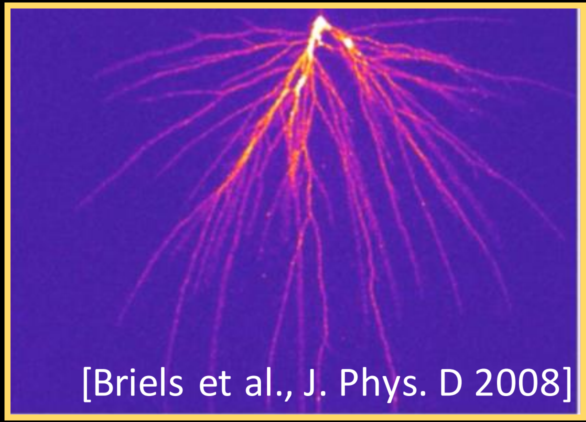




Positive streamer simulations with different electron attachment rates using the Afivo framework

Hani Francisco[1], Behnaz Bagheri[1], Jannis Teunissen[1,2], Ute Ebert[1,3]




[Briels et al., J. Phys. D 2008]

Framework includes:

- Quadtree adaptive mesh refinement
- Multigrid Poisson solver
- OpenMP Parallelism

[1]Centrum Wiskunde & Informatica, Amsterdam, The Netherlands
[2]Centre for Mathematical Plasma-Astrophysics, KU Leuven, Belgium
[3]Eindhoven University of Technology, The Netherlands

SAINT

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement SAINT 722337.

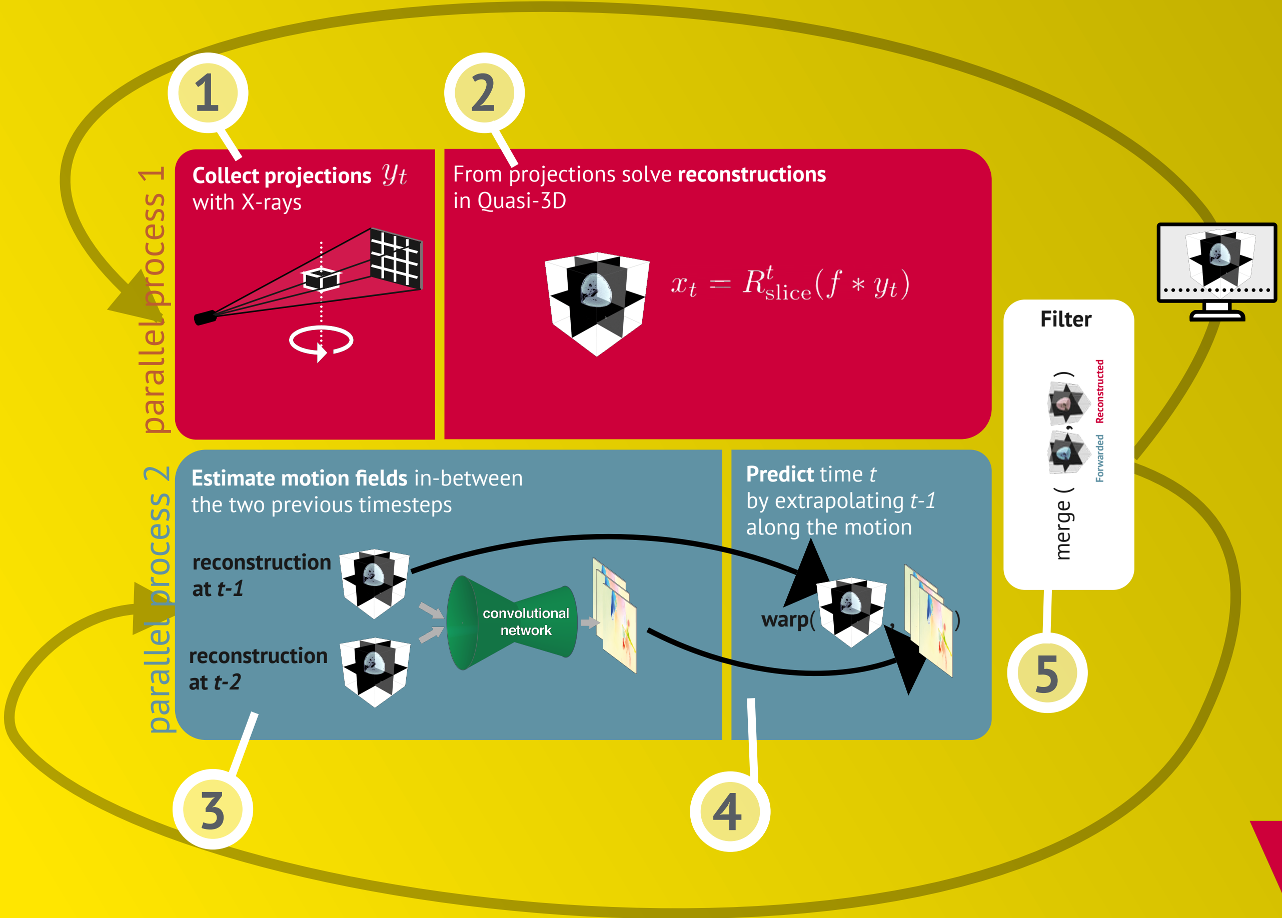
Science and Innovation With Thunderstorms

H2020 Marie Skłodowska-Curie Innovative Training Networks

Improving Real-time Quasi-3D Computed Tomography (CT)

by Deep-Learned Motion Estimation Filtering

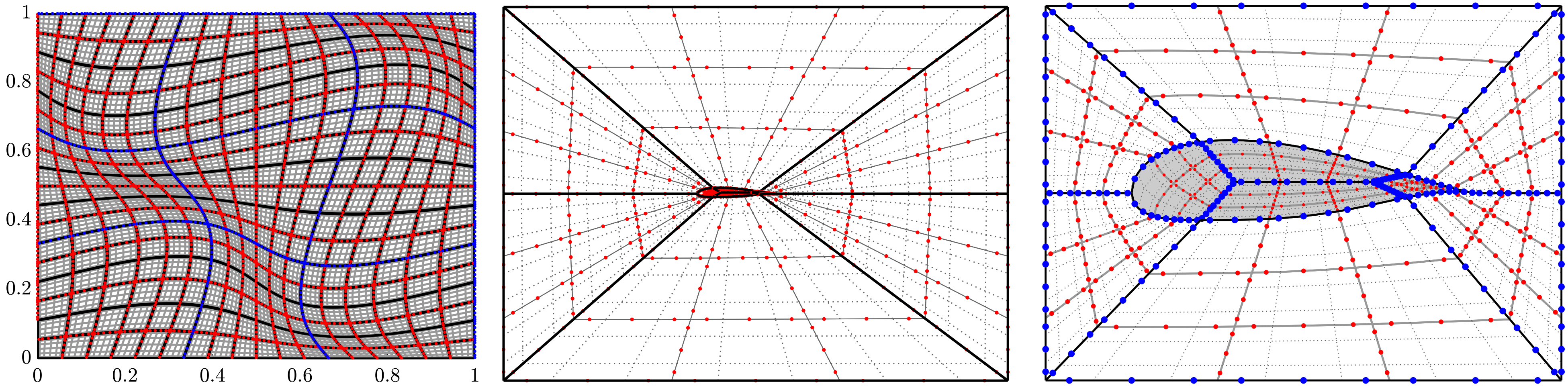
Adriaan Graas, Jan-Willem Buurlage, Felix Lucka



Centrum Wiskunde & Informatica

A multilevel hybrid discretization for Finite Element Methods

Varun Jain



(2019, S. Luesutthiviboon)

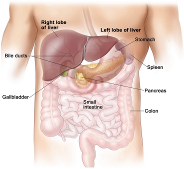
- A n-hybrid method
- You first solve for domain interfaces
- Followed by, sub-elements within a macro-element
- Then internal degrees of freedom within an element

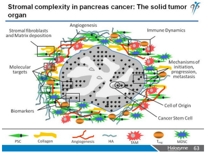
- **IMPORTANT !!!**

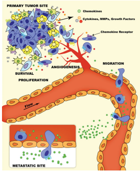
You do not loose any fine scale information

Agent-based Mathematical Modeling of Pancreatic Cancer Growth and Therapies

J. Chen, D. Weihs, and F. J. Vermolen







Cell-based models

- Cell migration
- Cancer metastasis
- Drug-oriented therapy

Cellular Automata

- Cancer progression
- Immune reponse
- Oncolytic virotherapy

Monte Carlo simulations

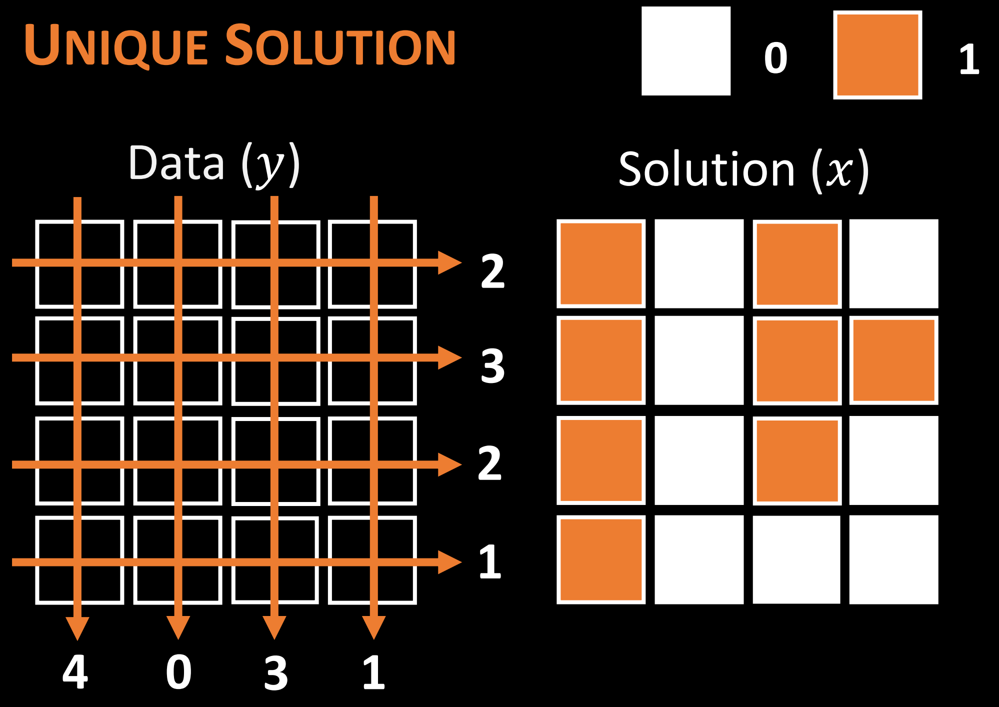
- Data analysis
- Correlations
- Prediction

Delft University of Technology

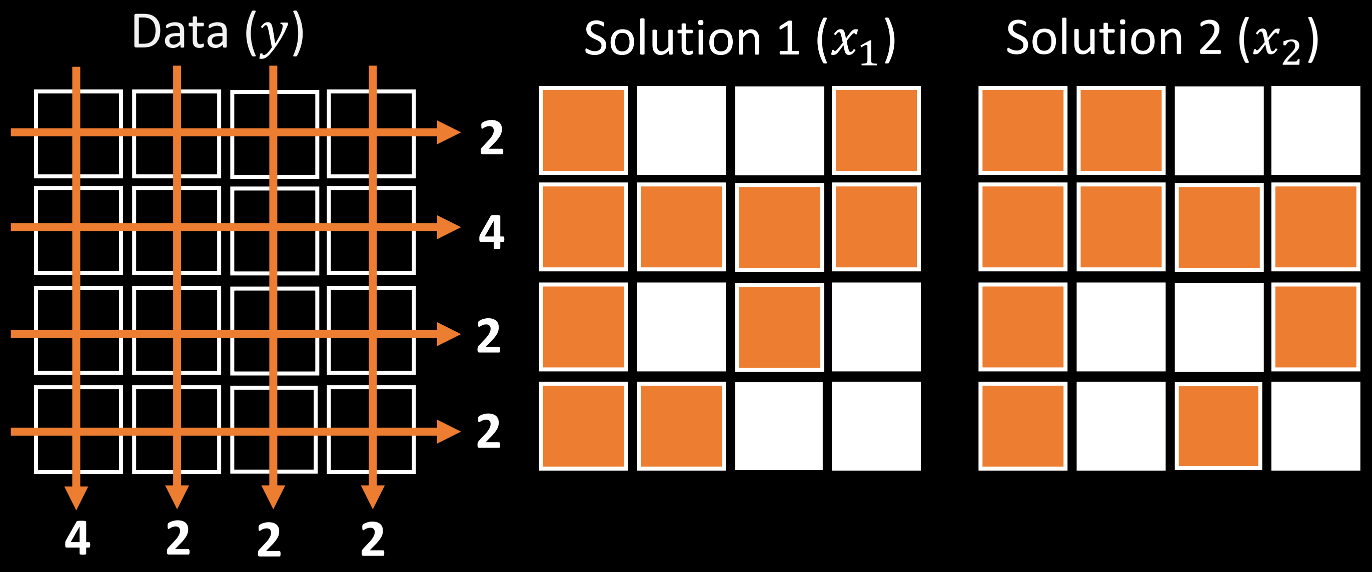
A Convex Program For Binary Tomography

Ajinkya Kadu and Tristan van Leeuwen
Utrecht University, the Netherlands

Unique Solution



Multiple Solutions



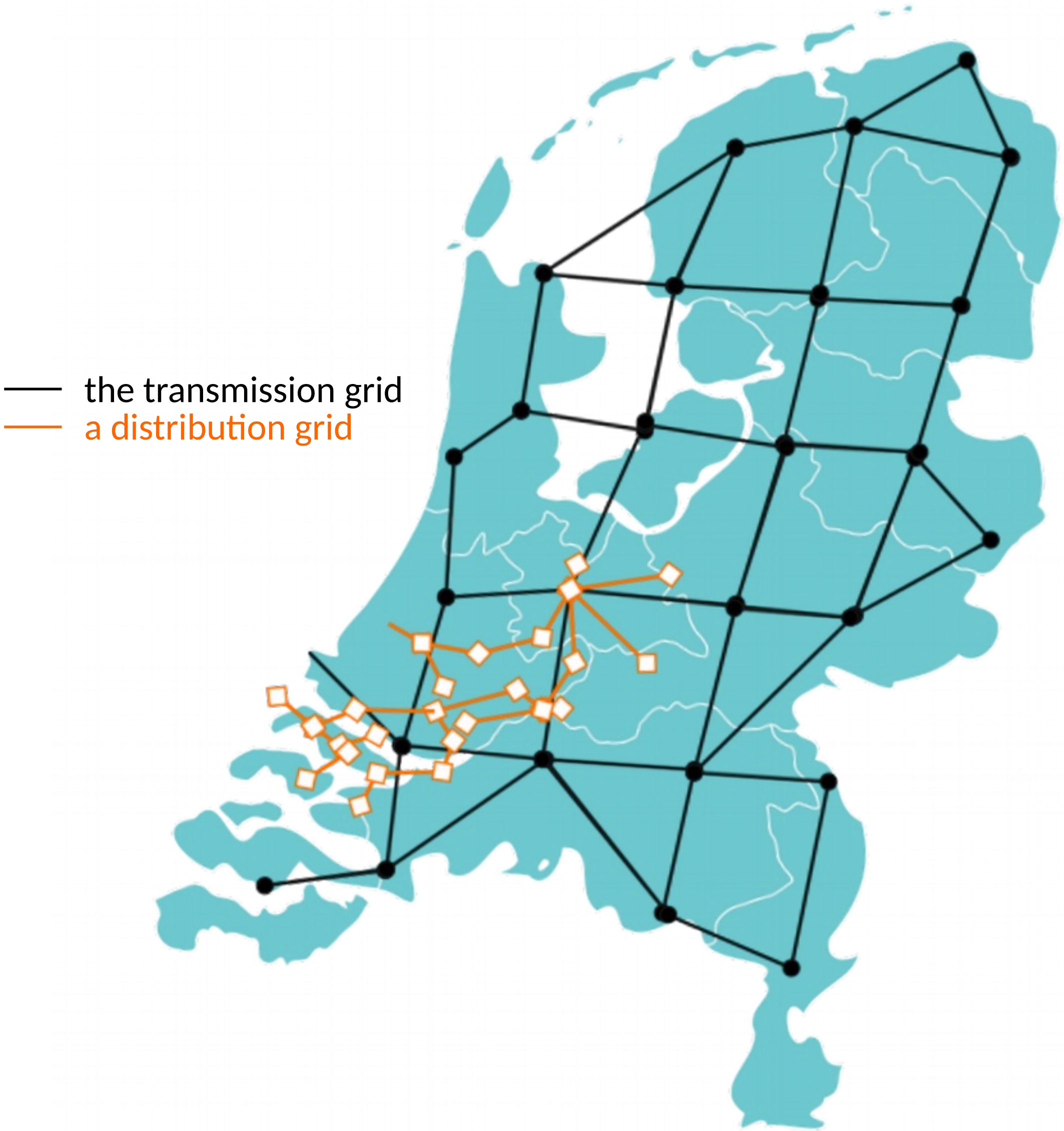
Find a **Binary** Solution(s) From Tomographic **Projections** (Row and Column Sums)

Find $x \in \{0,1\}^n$ Subject To $y = Ax$

Netherlands Organisation for Scientific Research

Fast, robust power flow computations

on integrated Transmission-Distribution grids



"In 2030, 70% of generated energy is from renewable resources"

-- the Dutch Climate Agreement

Our research investigates grid stabilitiy within these changing conditions

M. Kootte, B. Sereeter, C. Vuik

Numerical computation of the light confinement in realistic 3D cavity superlattices

Marek Kozon[1,2], Sjoerd A. Hack[1,2], Jaap J.W. van der Vegt[2], Ad Lagendijk[1], and Willem L. Vos[1]

[1] *Complex Photonic Systems (COPS), MESA+, University of Twente, Enschede, The Netherlands*
[2] *Mathematics of Computational Science (MACS), MESA+, University of Twente, Enschede, The Netherlands*
e-mail: m.kozon@utwente.nl

UNIVERSITY
OF TWENTE.

Geometry is the knowledge of eternally existent.
- Pythagoras

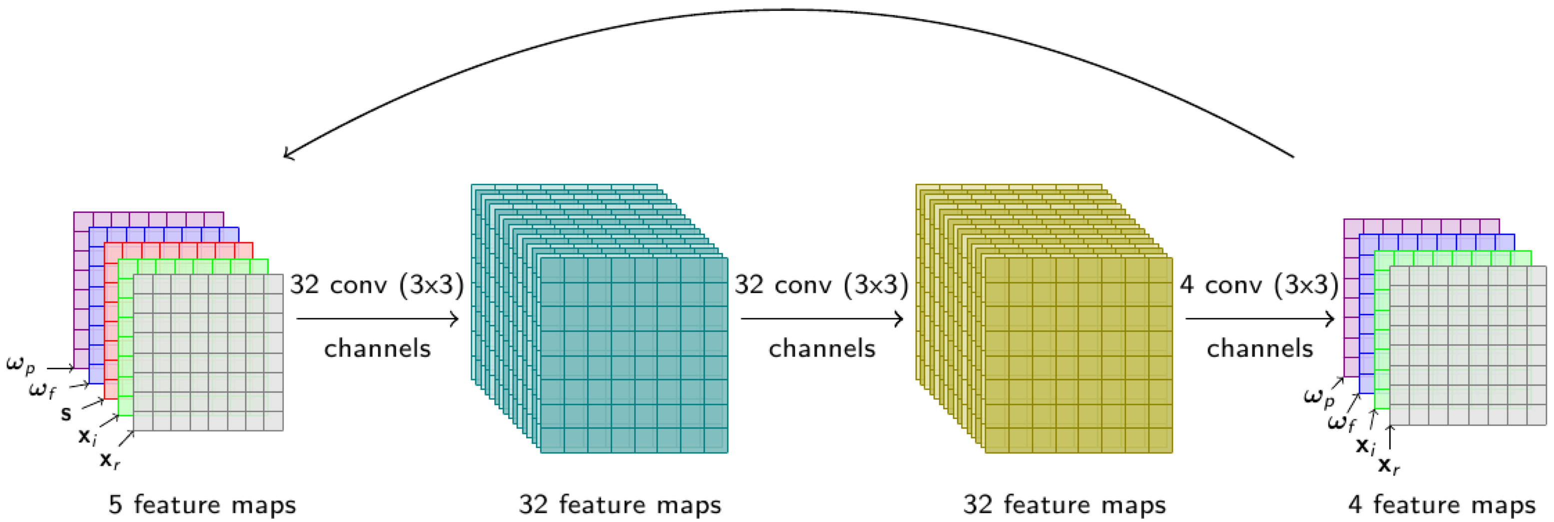
Discontinuous Galerkin Finite Element method for port-Hamiltonian system

Nishant Kumar, Jaap van der Vegt and Hans Zwart

Deep learning in low-field MRI

Joint image reconstruction and field map estimation

Merel de Leeuw den Bouter, Martin van Gijzen, Rob Remis



Netherlands Organisation for Scientific Research
WOTRO Science for Global Development

TUDelft Global Initiative

Error Analysis of Mixed Discontinuous Galerkin Discretization of the Maxwell Equations

Kaifang Liu[1], J.J.W. van der Vegt[1], Dietmar Gallistl[2], Matthias Schlottbom[1]

[1] University of Twente, [2] Friedrich-Schiller-Universität Jena

A machine learning method for fast model calibration

Shuaiqiang Liu, A. Borovykh, L.A. Grzelak, C.W. Oosterlee

Model calibration:

$$\operatorname*{argmin}_{\Theta \in \mathbb{R}^m} J(\Theta),\ \Theta \text{ parameters of math models.}$$

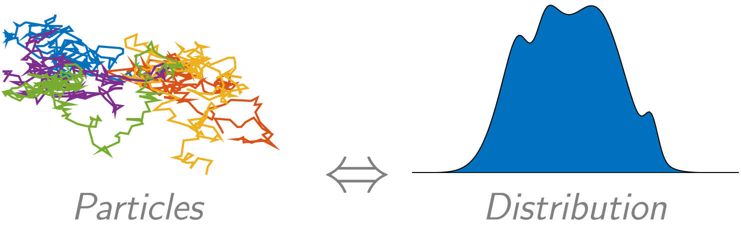
Supervised learning:

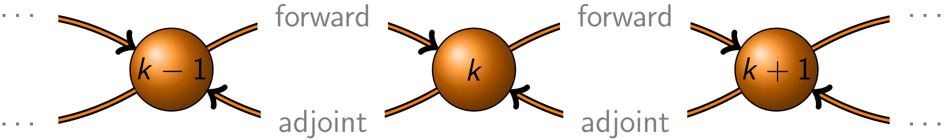
$$\operatorname*{argmin}_{\theta \in \mathbb{R}^M} L(\theta),\ \theta \text{ weights of hidden neurons.}$$

Calibration **N**eural **N**etworks (CaNN) can do ...

TU Delft CWI

Adjoint-based PDE-constrained optimization with particles





L. Vanroye, E. Løvbak, G. Samaey, S. Vandewalle

KU LEUVEN

NUMA

Semi-Implicit Time Integrations for the Navier-Stokes-Korteweg Equations

Xiangyi Meng, J.J.W. van der Vegt, Yan Xu

University of Twente & University of Science and Technology of China

Semi-intrusive Uncertainty Quantification for an in-stent restenosis model

Universiteit van Amsterdam

Anna Nikishova[1], Dongwei Ye[1], Lourens Veen[2], Pavel Zun[1,3], Alfons Hoekstra[1]

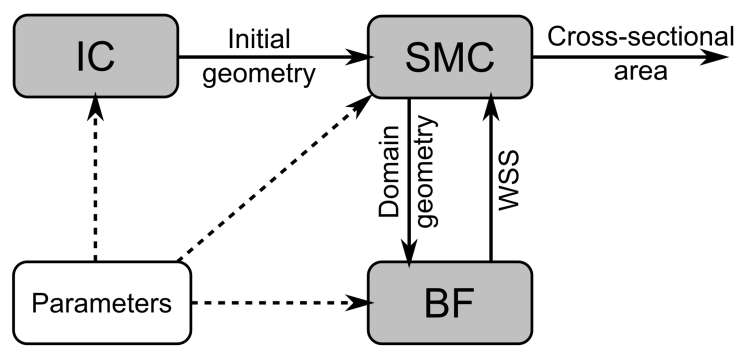
A.Nikishova@UvA.nl, D.Ye@UvA.nl

[1]Computational Science Lab, University of Amsterdam, [2]Netherlands eScience Center, [3]ITMO University, Saint Petersburg, Russia

Computational Science

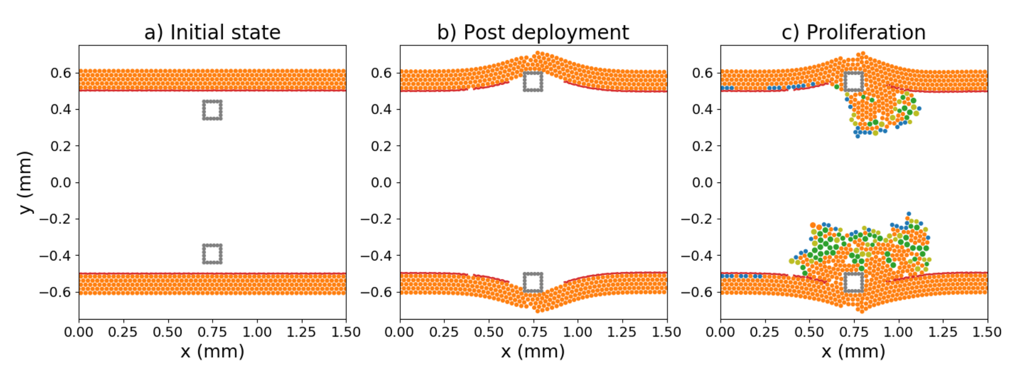
Abstract

Semi-intrusive uncertainty quantification is applied to efficiently analyse uncertainty in the result of a two-dimensional in-stent restenosis multiscale model (ISR2D) [1]. In the method, the surrogates based on Gaussian process and Convolutional Neural network substitute the expensive blood flow simulation model.



In-stent Restenosis model

The ISR2D model is a two-dimensional simulation of the post-stenting healing response of an artery.

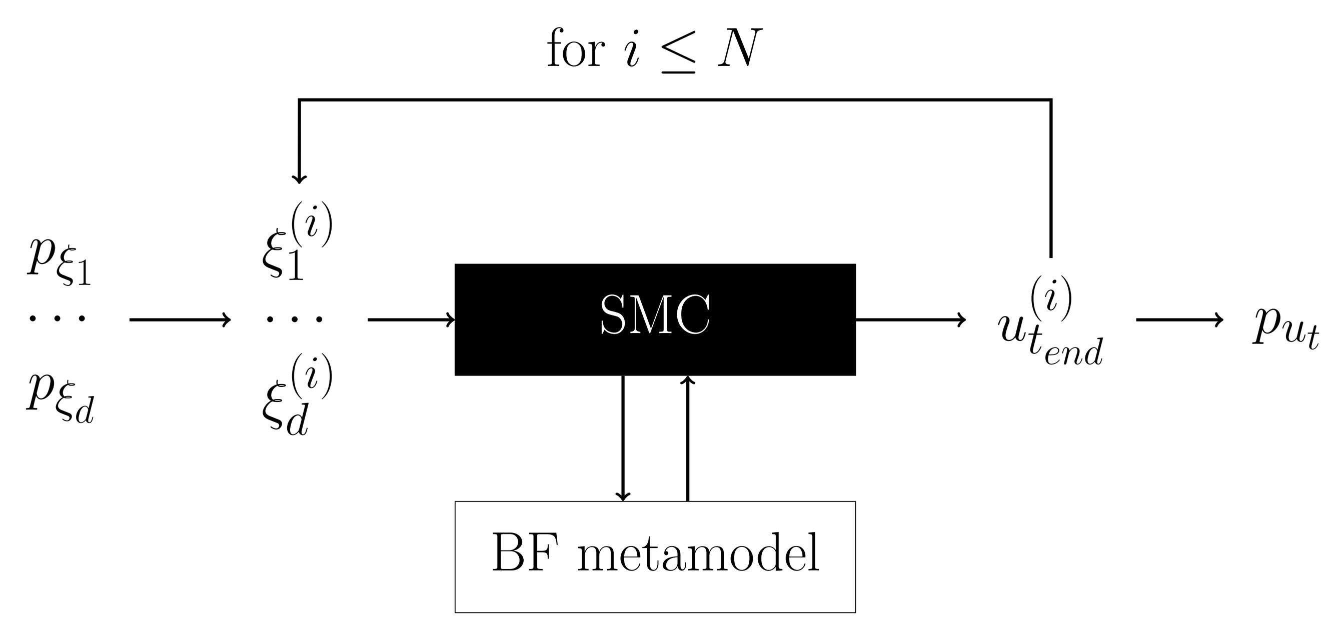


Uncertainty in the ISR2D response is due to the model stochasticity and uncertainty in the model parameters [2]:

- inlet blood flow velocity at 0.48 ± 10 m/s,
- maximum deployment depth at 0.11 ± 0.02 mm,
- endothelium regeneration time at 19 ± 4 days.

Semi-intrusive Metamodeling

The SI method involves replacing a computationally expensive single-scale submodel with a surrogate [3].



Blood flow model surrogates

Gaussian process

The function of the flow geometry that predicts the wall shear stress (WSS) is expected to be highly nonlinear. Therefore, the Matérn kernel with smoothness parameter $\nu = \frac{1}{2}$, which offers piece-wise prediction to cope with potential fluctuation, was chosen.

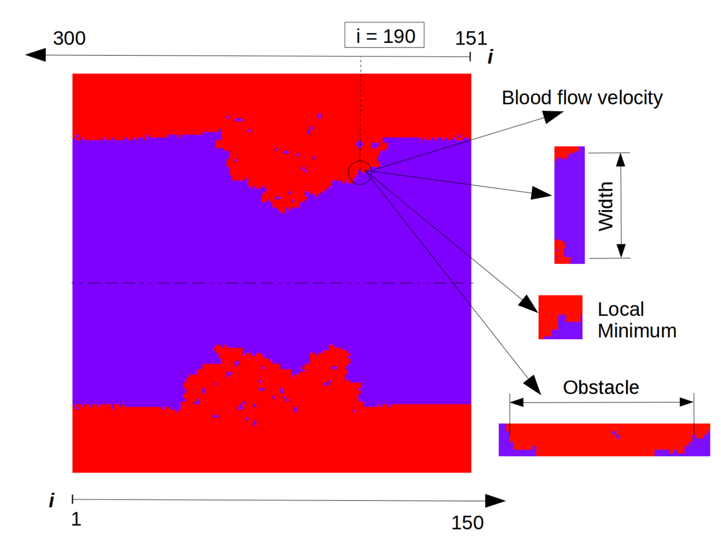


Fig. 4: Inputs of Gaussian process regression

Convolutional neural network

The shape encoding layers extract the features of the geometry to the shape code. A fully connnected layer maps the shape code together with the blood flow velocity to the stress code. The stress decoding part is responsible for a mapping from the stress code to the WSS.

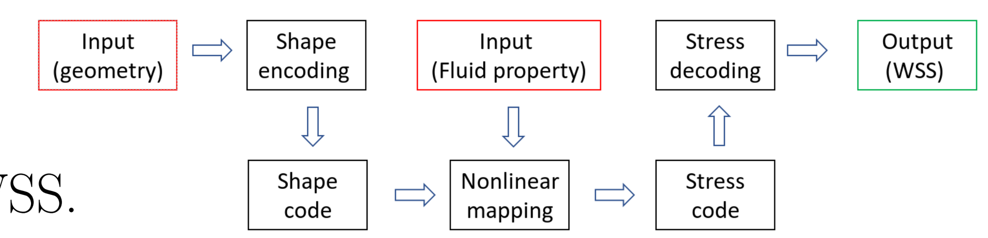
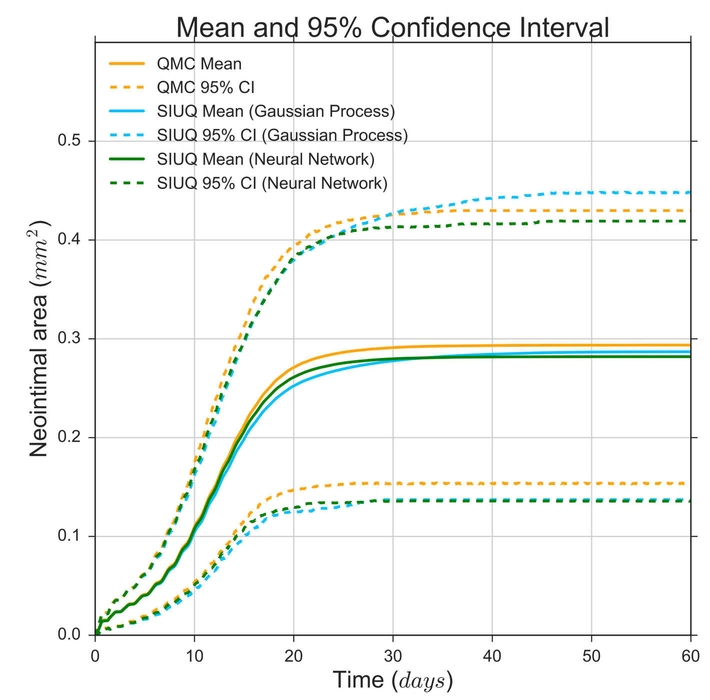
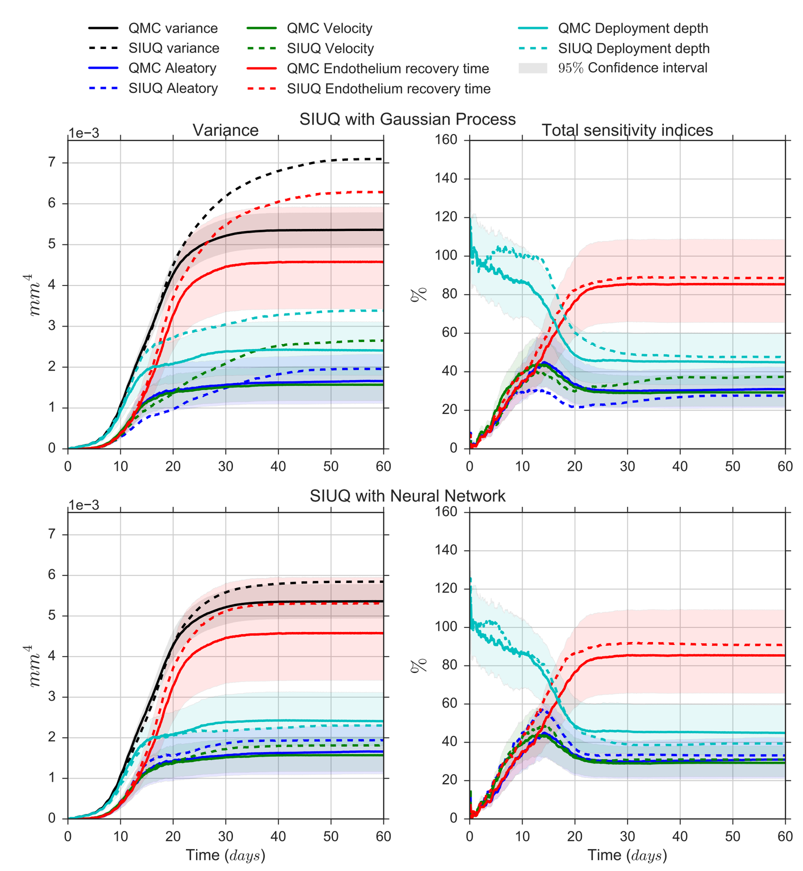


Fig. 5: The CNN model: shape encoding, nonlinear mapping and stress decoding.

Results

Both GP and NN surrogate models approximate well the wall shear stress for the micro model and significantly reduce the computational cost of UQ (about 6 and 7 times) [4].





References

[1] H. Tahir, C. Bona-Casas, and A. G. Hoekstra, "Modelling the effect of a functional endothelium on the development of in-stent restenosis," *PLoS One*, vol. 8, no. 6, p. e66138, 2013.

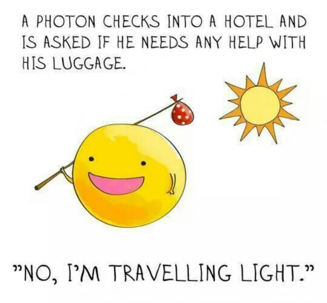
[2] A. Nikishova, L. Veen, P. Zun, and A. G. Hoekstra, "Uncertainty quantification of a multiscale model for in-stent restenosis," *Cardiovascular Engineering and Technology*, vol. 9, pp. 761–774, Dec 2018.

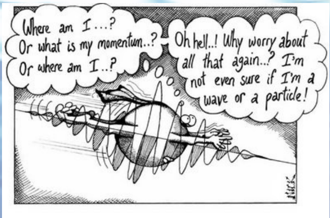
[3] A. Nikishova and A. G. Hoekstra, "Semi-intrusive uncertainty propagation for multiscale models," *Journal of Computational Science*, vol. 35, pp. 80 – 90, 2019.

[4] D. Ye, A. Nikishova, L. Veen, P. Zun, and A. G. Hoekstra, "Surrogate modelling with Gaussian process and Neural network for an in-stent restenosis model in semi-intrusive uncertainty quantification," *Submitted to Reliability Engineering & Systems Safety*, 2019.

DSA preconditioned source iteration for a DGFEM method for radiative transfer equation

$$\mathbf{s} \cdot \nabla \phi(\mathbf{x}, \mathbf{s}) + \sigma_{\mathbf{t}}(\mathbf{x})\phi(\mathbf{x}, \mathbf{s}) = \sigma_{\mathbf{s}}(\mathbf{x})\mathbf{K}\phi + \mathbf{q}(\mathbf{x}, \mathbf{s})$$





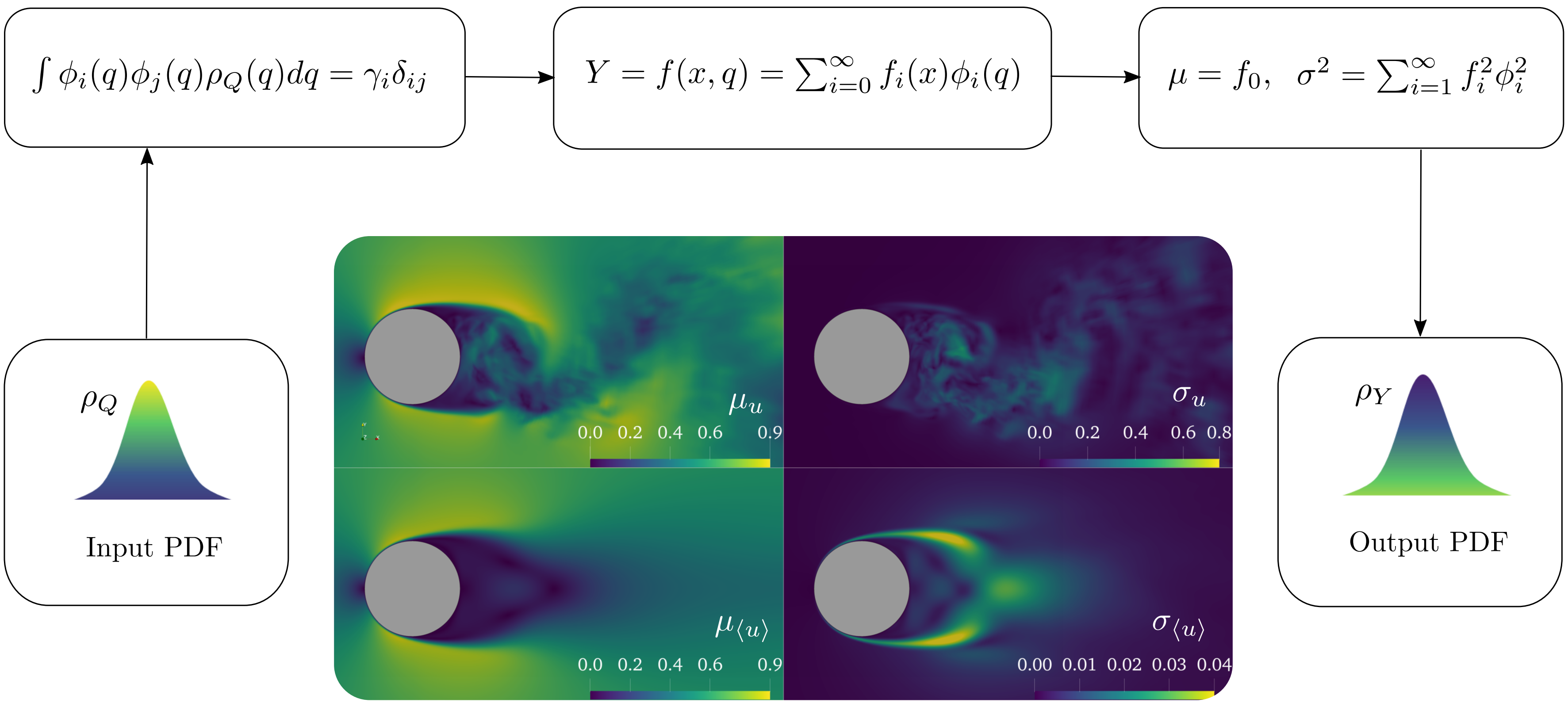
Photon self-identity problems.

left: http://www.funnyism.com/i/funnypics/photonadventures-1;
right: https://slideplayer.com/slide/3866488/

Intrusive Polynomial Chaos for CFD using OpenFOAM

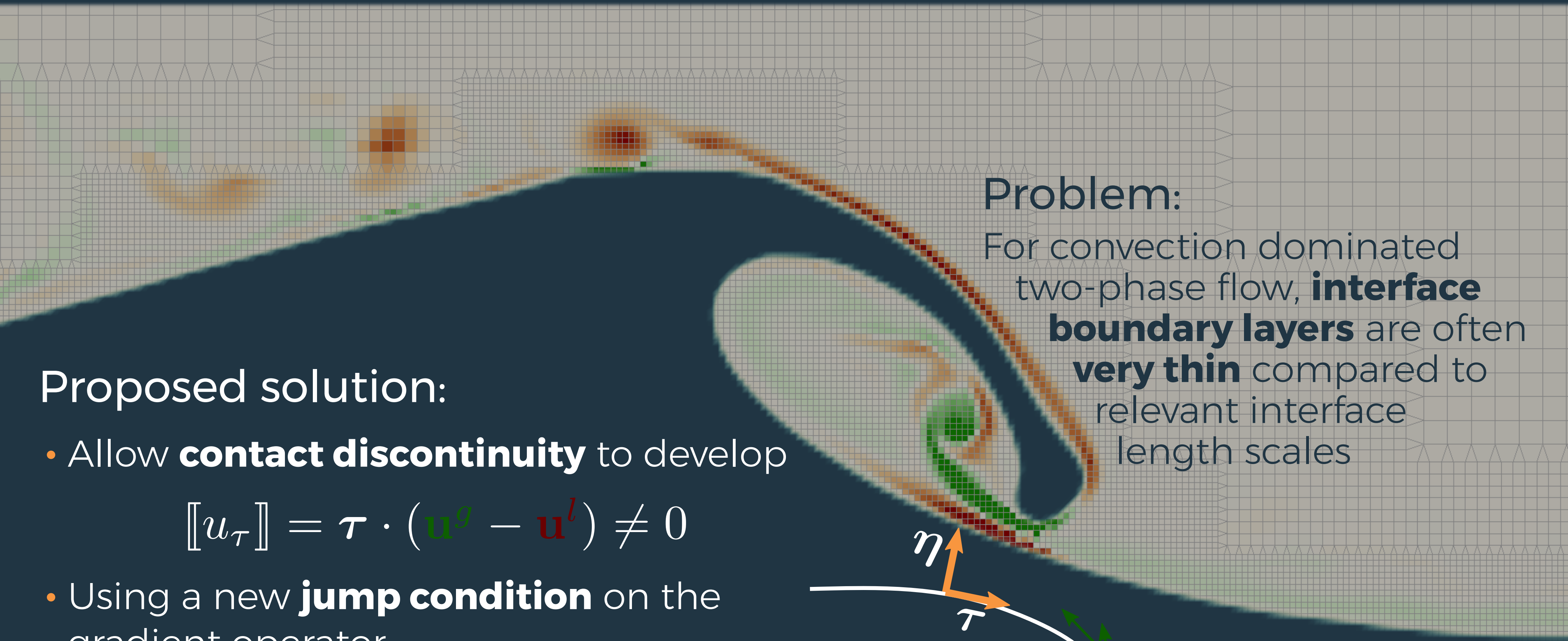
Jigar Parekh, Roel Verstappen

Bernoulli Institute, University of Groningen, Netherlands



https://github.com/parallelwindfarms/gPCPimpleFoam

Numerical Modelling of Contact Discontinuities
for the Simulation of Breaking Wave Impacts



Problem:

For convection dominated two-phase flow, **interface boundary layers** are often **very thin** compared to relevant interface length scales

Proposed solution:

- Allow **contact discontinuity** to develop

$$[\![u_\tau]\!] = \boldsymbol{\tau} \cdot (\mathbf{u}^g - \mathbf{u}^l) \neq 0$$

- Using a new **jump condition** on the gradient operator

$$\left[\!\!\left[\frac{1}{\rho}\partial_\eta p\right]\!\!\right] = -\boldsymbol{\eta} \cdot \left[\!\!\left[\frac{D\mathbf{u}}{Dt}\right]\!\!\right]$$

NWO Applied and Engineering Sciences

Ronald Remmerswaal & Arthur Veldman

university of groningen

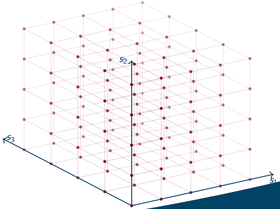
Low rank approximations to high dimensional diffusion dominated PDEs

Semi-discretization of the heat equation leads to a system of ODEs:

$$\frac{\mathrm{d}\boldsymbol{u}}{\mathrm{d}t}(t) = \dot{\boldsymbol{u}}(t) = L\boldsymbol{u}(t). \tag{1}$$

Given a time dependent low rank tensor $\boldsymbol{\mathcal{A}}(t) \in \mathbb{R}^{M\times\cdots\times M}$ and a linear differential operator L s.t. $\dot{\boldsymbol{\mathcal{A}}}(t) = L\boldsymbol{\mathcal{A}}(t)$.

- Can we *factorize* $\boldsymbol{\mathcal{A}}(t)$ and find *efficient evolution equations* for its factors?
  - 2D: $\boldsymbol{A} = \boldsymbol{USV}^\top$
  - nD: $\boldsymbol{\mathcal{A}} = \boldsymbol{\mathcal{G}} \times_1 \boldsymbol{U}_1 \times \cdots \times_d \boldsymbol{U}_d$

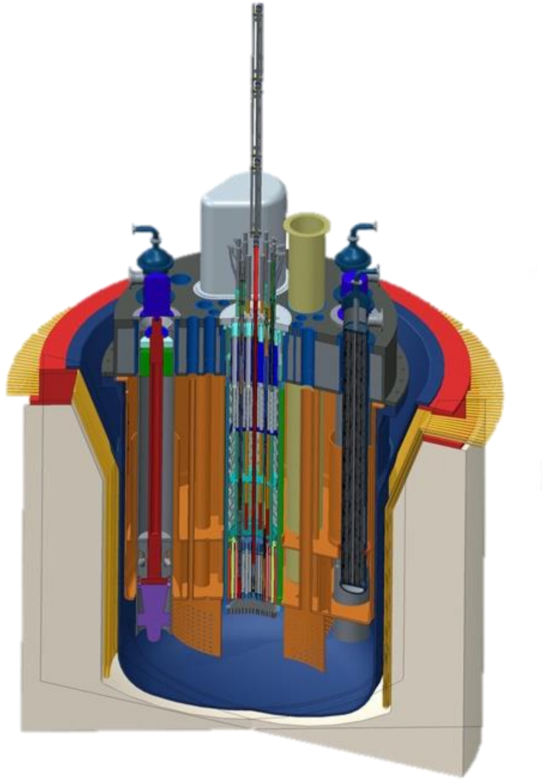


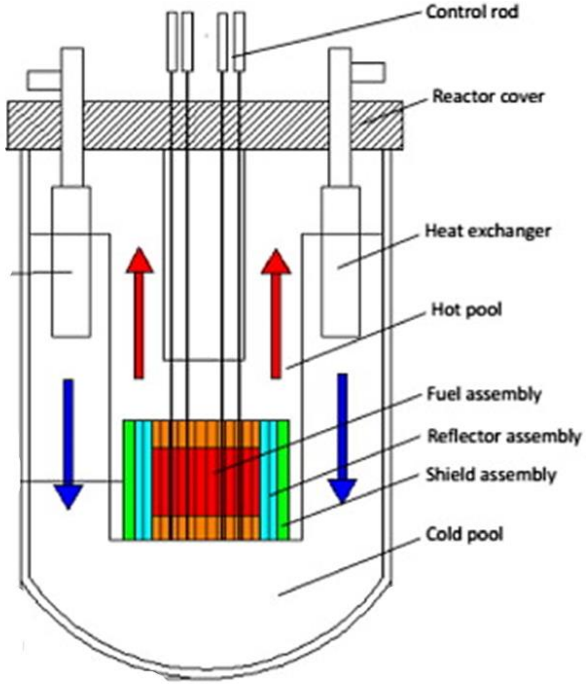
Jacob Snoeijer

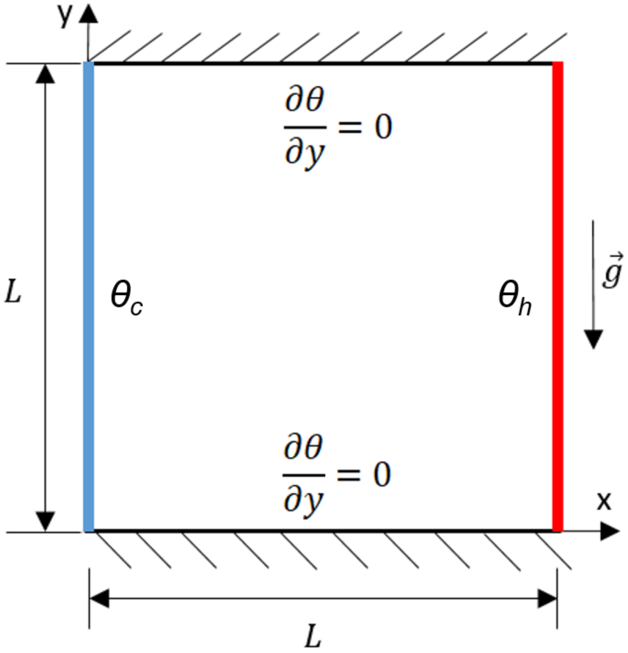
University of Antwerp

Boundary control of finite volume-based POD-Galerkin reduced order models for buoyancy-driven flows

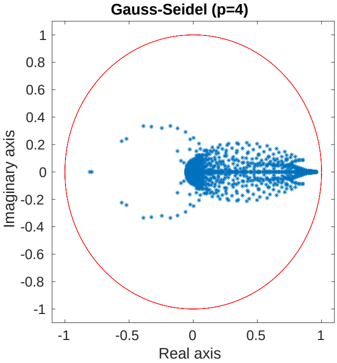
Kelbij Star

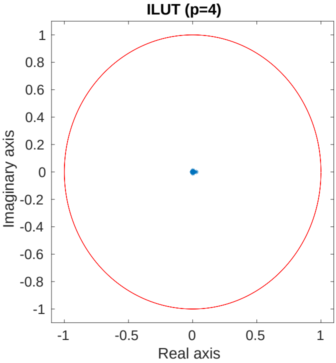






Efficient p-multigrid solvers for Isogeometric Analysis





OLD **NEW**

R.Tielen, M. Möller and C. Vuik

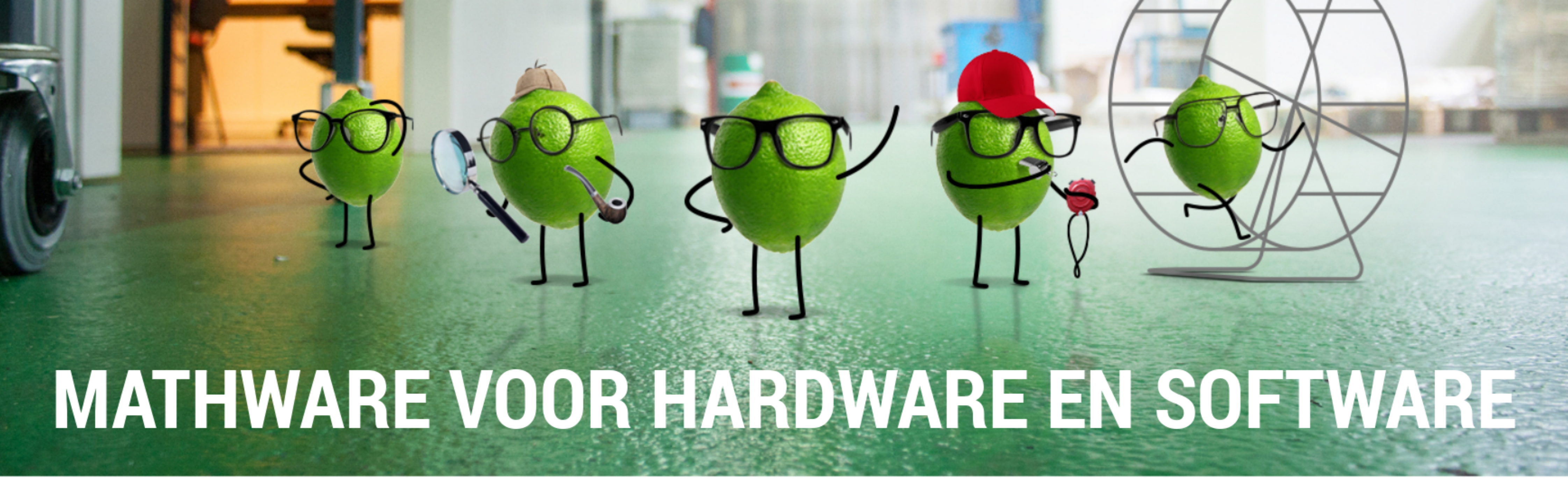
Delft Institute of Applied Mathematics, TU Delft

Positivity Preserving Higher Order Numerical Discretizations for Euler Equation

Fengna Yan,

University of Science and Technology of China & University of Twente

J.J.W. van der Vegt, Yan Xu, Yinhua Xia



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and 41 more

VORTECH

scientific software engineers   mathematical consultants   data scientists

- A challenging environment for scientific software engineers, applied mathematicians and data scientists
- Work on the heavy-duty computational software of mostly corporate customers, both from our office and at the customers’ office
- Wide range of application domains
- Offices in Delft, 25 colleagues

PhDays 2018


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14 25
FACULTY OF ENGINEERING SCIENCE
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SALLE DE BRASSAGE