Arsh Kumbhat

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Education

Eidgenössische Technische Hochschule (ETH) Zürich (GPA: 5.81/6)
Master of Science, Computational Science and Engineering (Fluid Dynamics Specialization) *Sep '23 - Present*

- **Research Interests:** Computational Fluid Dynamics, Scientific Machine Learning, Scientific Computing

Birla Institute of Technology and Science, Pilani (CGPA: 9.57/10)
Bachelor of Engineering, Chemical and Minor in Data Science *Aug '19 - May '23*

- **Achievements:** Top 2% of students in Class of 2023, Department Rank 1, Merit Scholarship

Publications

- S. Wen, **A. Kumbhat**, L. Lingsch, S. Mousavi, P. Chandrashekar, S. Mishra, Geometry Aware Operator Transformer as an Efficient and Accurate Neural Surrogate for PDEs on Arbitrary Domains, arXiv Preprint, 2025
- **A. Kumbhat**, R. Goel, A. Madaan, S. Appari, A. S. Al-Fatesh, A. I. Osman, Predicting Nickel Catalyst Deactivation in Biogas Steam and Dry Reforming for Hydrogen Production Using Machine Learning, Process Safety and Environmental Protection
- M. Daneker, S. Cai, Y. Qian, E. Myzelev, **A. Kumbhat**, H. Li, L. Lu, Transfer Learning on Physics-Informed Neural Networks for Tracking the Hemodynamics in the Evolving False Lumen of Dissected Aorta, Nexus (2024) ($\geq$ **10 Citations**)
- G. Arora, **A. Kumbhat**, A. Bhatia and K. Tiwari, CP-Net: Multi-Scale Core Point Localization in Fingerprints Using Hourglass Network, 2023 11th International Workshop on Biometrics and Forensics (IWBF), Barcelona, Spain, 2023

Projects

High-Fidelity Compressible Flow Data Generation for Operator Learning [Semester Thesis]
Research Assistant, Mentor: Dr. Siddhartha Mishra, Full Professor, ETH Zürich

- Simulated inviscid flow past airfoils for Mach number ≤ 3 & angle of attack $\leq 15^\circ$, resolved shocks via adaptive refinement.
- Simulated unsteady inviscid flow past bluff bodies for Mach number ≤ 2 with space-time adaptive refinement.
- Generated large-scale data for airfoil and bluff-body aerodynamics by multi-node CPU parallelization on Euler cluster.

Development of High-Peformance Computing Code for Combustion Routines [GitHub]
Research Assistant, Mentor: Dr. Christos Frouzakis, Senior Scientist, ETH Zürich

- Augmenting CPU/GPU-based C++ kernels to compute chemical kinetics, thermodynamics, and transport properties.
- Evaluated thermal diffusion ratios similar to CHEMKIN on GPUs, addressing Cantera's limited capabilities.
- Enabled functionality for reaction mechanisms containing p-log reactions, important for carbon-free fuel mechanisms.

Multi-GPU 3D Simulation of Fluid Flow Across a Stationary Sphere/Cylinder [GitHub]
Course: Solving PDEs in Parallel on GPUs, ETH Zürich, Piz Daint Cluster

- Implemented a finite-difference solver comprising Chorin's projection method, and a semi-Lagrangian advection scheme.
- Utilised a pseudo-transient approach for iteratively solving the Poisson pressure equation.
- Scaled solver on multiple GPU nodes by exploiting seamless interoperability of ImplicitGlobalGrid.jl and ParallelStencil.jl.

Physics Informed Neural Networks (PINNs) for Blood Flow Predictions [Bachelor Thesis]
Research Intern, Mentor: Dr. Lu Lu, Assistant Professor, University of Pennsylvania

- Developed PINNs informed by Navier Stokes Equations to model blood flow in stenosed arteries and aneurysms.
- Generated velocity profiles by optimizing the number of cross-sections of the thrombus for training the PINN.
- Estimated parameters: shear rate and wall shear stress using PINN outputs; essential for heart disease detection.

Heat Exchanger Design for Decay Heat Removal [Certificate]
Research Intern, Indira Gandhi Centre for Atomic Research, Kalpakkam, Tamil Nadu

- Designed and simulated heat exchanger for decay heat removal via natural convection from radioactive waste storage tanks.
- Incorporated a finned-tube design to increase surface area for 100 kilowatts of decay heat removal.
- Optimized fin spacing and thickness to reduce coolant water outlet temperature to the lowest possible value.

Skills/Courses

Programming: C++/C, Python, Julia, MATLAB, R Programming, LaTeX
Computational Software: SU2, Trixi.jl, Gmsh, COMSOL Multiphysics, LehrFEM++, ANSYS Fluent
Libraries/Tools: NumPy, Matplotlib, scikit-learn, pandas, OpenMP, MPI, JAX, Git, GitHub
AI Frameworks: PyTorch, TensorFlow 2.0, DeepXDE (Contributions - 1, 2)

Relevant Coursework

Numerics: Numerical Methods for PDEs, Advanced Numerical Methods, Numerical Methods for Hyperbolic PDEs
Artificial Intelligence: AI in the Sciences and Engineering, SciML for Chemical Engineering Applications, Deep Learning
Fluid Dynamics: Advanced CFD Methods, Turbulent Flows, Compressible Flows, Theory and Modeling of Reactive Flows
High-Performance Computing: HPC Lab for CSE, Solving PDEs in Parallel on GPUs