PRERNA PATIL

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SUMMARY

Highly motivated postdoctoral researcher at the University of Washington, Seattle with extensive research experience in mathematical modeling, data analysis and physics-informed machine learning techniques. In-depth knowledge of statistical analysis and algorithm development.

SKILLS

- ◇ Proficient programming skills in Python, MATLAB and C++
- ◇ Experience in building mathematical models in dynamical systems with the use of time series data
- ◇ Experience in machine learning techniques, surrogate modeling, reduced order modeling, statistics and deep learning
- ◇ Experience in using CFD softwares like COMSOL, ICEM CFD and GridGen
- ◇ Experience in numerical optimization and high performance computing

EDUCATION

University of Pittsburgh *August 2017 - August 2022*
Ph.D in Computational Modeling and Simulation

Brown University *August 2015 - June 2017*
Sc.M in Fluids and Thermal Sciences

Indian Institute of Technology, Madras *August 2010 - July 2014*
B.Tech in Aerospace Engineering
Minor: Systems Engineering

PUBLICATIONS

- ◇ Patil, Prerna, and Hessam Babaee. 'Real-time reduced-order modeling of stochastic partial differential equations via time-dependent subspaces.'Journal of Computational Physics 415 (2020): 109511.
- ◇ Patil, Prerna, and Hessam Babaee. 'Reduced-Order Modeling with Time-Dependent Bases for PDEs with Stochastic Boundary Conditions.'SIAM/ASA Journal on Uncertainty Quantification 11.3 (2023): 727-756.
- ◇ Patil, Prerna, Mohammad Hossein Naderi, and Hessam Babaee. 'A Spectral Deformable Basis for Numerical Solutions of Partial Differential Equations.'(Manuscript under preparation).
- ◇ Patil, Prerna, Eurika Kaiser, Steven Brunton and Nathan Kutz. 'Time delay embedding to extract unstable periodic orbits and exact coherent structures in chaotic fluid systems.'(Manuscript under preparation)

COURSEWORK

Graduate Courses
Advanced Heat Transfer
Computational Fluid Dynamics
Reduced Order Modeling
Advanced Thermodynamics

Machine Learning Courses
Introduction to Machine Learning
Deep Learning
Modern Control Theory
Computational Probability and Statistics
Data structures in Scientific Computing

TECHNICAL SKILLS

Coding experience	C++, MATLAB, Python, OpenMP, MPI, CUDA
Machine learning Tools	Pytorch, Tensorflow, NumPy, SciPy, Matplotlib, Pandas
CFD Software & Tools	ICEM-CFD, GridGen, Ansys, Nektar

CONFERENCE TALKS

American Physical Society - Division of Fluid Dynamics

- ◇ Presented a talk on 'Time delay embeddings to uncover unstable periodic orbits and exact coherent structures in chaotic fluid systems'at the at the 76th meeting of the American Physical Society- Division of Fluid Dynamics(APS-DFD) in November 2023 at Washington, DC.
- ◇ Presented a talk on 'Real-time reduced order modeling of deterministic partial differential equations using time dependent basis'at the at the 75th meeting of the American Physical Society- Division of Fluid Dynamics(APS-DFD) in November 2022 at Indianapolis, Indiana.
- ◇ Presented a talk on 'Dynamically bi-orthonormal formulation for stochastic partial differential equations'at the at the 72nd meeting of the American Physical Society- Division of Fluid Dynamics(APS-DFD) in November 2019 at Seattle, Washington.
- ◇ Presented a talk on 'Reduced order modeling of stochastic bifurcation in naturally convected flows'at the at the 71st meeting of the American Physical Society- Division of Fluid Dynamics(APS-DFD) in November 2018 at Atlanta, Georgia.
- ◇ Presented a talk on 'Multi-fidelity modelling for cylinder flow'at the 69th meeting of the American Physical Society- Division of Fluid Dynamics(APS-DFD) in November 2016 at Portland, Oregon.

RESEARCH EXPERIENCE

Time-dependent basis to solve partial differential equations
Doctoral research *University of Pittsburgh*

Advisor: Hessam Babaee

- ◇ Implemented the time dependent basis to solve deterministic partial differential equations by exploiting the low-dimensional correlations in the flow field.
- ◇ Implemented this technique to solve compressible Navier-Stokes equation.

Reduced-order modeling of stochastic partial differential equations via time-dependent subspaces
Doctoral research *University of Pittsburgh*

Advisor: Hessam Babaee

- ◇ Implemented reduced order modeling techniques to solve problems in fluids mechanics using time-dependent basis. The stochasticity is introduced in the flow using random initial conditions, boundary conditions and/or random parameters.
- ◇ Developed new methodology called the dynamic bi-orthonormal (DBO) method for decomposition of the random field and demonstrated better numerical computational properties. Application of the method include problems in uncertainty quantification, linear sensitivity analysis, passive and reactive species transport and compressible flows.
- ◇ Using the variational principle the evolution equations were developed for SPDEs with stochastic non-homogeneous boundary conditions. The method was implemented for stochastic Dirichlet, Robin and Neumann boundary conditions.

Time delay embedding to uncover unstable periodic orbits and exact coherent structures in chaotic fluid systems.
Postdoctoral research *University of Washington, Seattle*

Advisors: Steven Brunton & Nathan Kutz

- ◇ Evaluated the use of long-time delay embeddings to capture progressively sophisticated unstable periodic orbits (UPOs) of a chaotic system.
- ◇ The time delay embeddings obtained for these UPOs can be further used to predict the global characterizations of the dynamics of the attractor including natural measure, fractal dimensions, and Lyapunov exponents.
- ◇ Demonstrated that for long time delay embeddings, UPOs disentangle and converge to a discrete Fourier decomposition.

Surrogate multi-fidelity Modelling for fluid flow
Master's Thesis *Brown University*

Advisor: George Karniadakis

- ◇ Implemented multi-fidelity framework to obtain the response surfaces for $C_{P(mean)}$, $C_{L(RMS)}$ and $C_{D(RMS)}$ vs Reynolds Number.
- ◇ The stochastic response surface is obtained by implementing the auto-regressive stochastic modeling and Gaussian process regression to combine data from variable levels of fidelity.
- ◇ Implemented Co-kriging to combine data from 3D DNS simulations(high fidelity) and 2D simulations (low-fidelity) and predict values at new points. This method effectively reduced the computational cost and time to obtain response surfaces which depend on multiple parameters.

Identify duplicate questions on Quora using neural network models
Course project *Carnegie Mellon University*

Advisors: Pradeep Ravikumar & Ziv Bar-Joseph

- ◇ Implemented two deep learning architectures that capture the semantic similarity between questions-pairs on Quora.
- ◇ Implemented Siamese convolutional neural network (CNN) and recurrent neural network (RNN) architectures and compared their performance to baseline models from literature.
- ◇ Concluded that the Siamese architectures prove to be very effective for analyzing sentence pairs.

INTERNSHIP EXPERIENCE

Parallel Computing Summer Research Internship
Los Alamos National Laboratory *June 2017 - August 2017*

- ◇ Classified hyper-spectral imaging data using ARock asynchronous algorithm and demonstrated parallel high-performance computing is readily applicable to machine learning algorithms.
- ◇ Poster presented at Los Alamos National Laboratory Student Symposium poster session-2017.

OTHER ACTIVITIES

- ◇ Obtained private pilot's license (PPL) from Moore Aviation (Beaver County, PA) on July 2022. Trained on a Cessna 172R single engine land aircraft.
- ◇ Chaired the session on 'Non linear Dynamics-Coherent structures 'at the 76th metting of the American Physical Society- Division of Fluid dynamics (APS-DFD) in November 2023 at Washignton, DC.
- ◇ Co-instructor for ME 599 H (Special topics) with Prof. Steven Brunton and Prof. Krithika Manohar during Spring 2023.