Shreyas Sunil Gaikwad

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Research Interests

Computational Glaciology	PDE-constrained Inverse Problems	Uncertainty Quantification
Machine Learning	Ice-Ocean Interactions	Data Assimilation
High Performance Computing	Open Source Software Dev.	Automatic Differentiation

Education

Ph.D. in Computational Science, Engineering and Mathematics, 2019-2024
The University of Texas at Austin
Thesis: *Bayesian Inverse Methods for Greenland Ice Sheet Model Calibration and Reconstruction*
GPA: 4.0/4.0

M.S. in Computational Science, Engineering and Mathematics, 2019-2021
The University of Texas at Austin
GPA: 4.0/4.0

B.Tech in Mechanical Engineering with Honors, 2015-2019
Minor in Computer Science
Indian Institute of Technology Bombay
Thesis: *Computational Analysis of Subcooled Boiling*
GPA: 9.32/10.0, Department Rank: 4/150

Research Experience

Graduate Research Assistant, CRIOS, UT Austin 2020-Present
Advisor - Dr. Patrick Heimbach

- Integrated the open source Automatic Differentiation (AD) tool Tapenade with the SICOPOLIS ice sheet model source code in order to generate the adjoint and tangent linear codes. The adjoint calculation of the gradient is exponentially faster than the finite differences calculation
- Developing computational framework for glaciological parameter inversion and uncertainty quantification
- Leveraging Deep Learning to reduce the computational cost of simulating sea ice in the general ocean circulation model, MITgcm

Visiting Scholar, Argonne National Laboratory Summer 2022
Advisor - Dr. Patrick Heimbach, Dr. Sri Hari Krishna Narayanan

- Open source software development for ocean models in Julia, a programming language as fast as C and as easy as Python
- Integrating the open source AD tool Tapenade with the MITgcm general circulation model source code

Undergraduate Research Assistant, IIT Bombay 2018-2019
Advisor - Dr. Janani Srree Muralidharan

- Simulated air-water multiphase flow around nuclear rods, analyzing trends in void fraction distribution for different turbulence models and solvers in OpenFOAM

Undergraduate Research Assistant, IIT Bombay Summer 2017
Advisor - Dr. Shivasubramanian Gopalakrishnan

- Simulated the impact of subsonic, thin stream of air striking the surface of water, in order to mirror the industrial process of purification of molten steel, leveraged axial symmetry to reduce computation time

Undergraduate Research Assistant, IIT Bombay Summer 2017
Advisor - Dr. S.K. Maiti

- Developed codes in MATLAB to detect the position of transverse cracks with 95% accuracy in Euler-Bernoulli as well as Timoshenko beams using any three modes of natural vibration

Publications and Talks

Publications

Shreyas Gaikwad, Sri Hari Krishna Narayanan, Laurent Hascoet, Liz Curry-Logan, Ralf Greve, Patrick Heimbach (2022). "SICOPOLIS-AD v2: linearized forward and adjoint modeling framework for ice sheet modeling enabled by automatic differentiation tool Tapenade", *In preparation for Journal for Open Source Software*

Talks

Shreyas Gaikwad, Sri Hari Krishna Narayanan, Laurent Hascoet, Liz Curry-Logan, Ralf Greve, Patrick Heimbach (2021). "SICOPOLIS-AD v2: An open-source tangent-linear and adjoint modeling framework for ice-sheet simulation enabled by the AD tool Tapenade", *24th EuroAD Workshop*

Honors and Awards

- **Peter O'Donnell Fellow**, Awarded Fellowship worth $24,000 by the Oden Institute 2019-2020
- **Ph.D. Preliminary Exam**, Cleared exams in applied maths, scientific computing, and maths modeling 2020
- **AP grade**, in Computer Graphics, awarded sparingly for exceptional insights 2018
- **AP grade**, in Heat Transfer, awarded sparingly for exceptional insights 2017
- **KVPY Fellow**, Conferred by Govt. of India for demonstrating aptitude for research, (Rank - 27/50,000) 2015
- **IISc UG Admission offer**, India's top research institution, offered admission due to KVPY selection 2015
- **JEE Advanced qualification**, Stage II entrance exam for the IITs, Ranked 509/150,000 2015
- **JEE Main qualification**, Stage I entrance exam for the IITs, Ranked 983/1.5 million candidates 2015
- **INChO qualification**, Indian National Chemistry Olympiad, ranked top 1% among 30,000 students 2015
- **INSPIRE Scholar**, Scholarship for top 1 percentile in state high school exams 2015
- **BITSAT Qualification**, Entrance exam for the BITs, estimated rank top 200/300,000 2015
- **Bhaskar Genius Scholar**, Top 20 rank in India among 50,000 students 2012
- **MCSE PSS Scholar**, Awarded by Maharashtra State Council of Examination (99.9995 percentile) 2011

Software contributions

All of these tools are constantly under development.

- **SICOPOLIS-AD v2**, a new inverse modeling framework for the ice sheet model SICOPOLIS that is enabled by source transformation using the open-source Automatic Differentiation (AD) tool TAPENADE
- **MITgcm-AD**, a new inverse modeling framework for the general circulation model MITgcm that is enabled by source transformation using the open-source Automatic Differentiation (AD) tool TAPENADE
- **ARGOVIS**, developed OOP-based Python tools for interactive plotting and binning of Argo data

Select graduate coursework

Data Science and HPC - Machine Learning applications in Geophysics, Foundational Techniques in Machine Learning, Engineering Data Mining, Design and Analysis of Algorithms, Tools and Techniques in Computational Science, Numerical Methods for Differential Equations, Numerical Linear Algebra, High Performance Scientific Computing, Operating Systems

Inverse Problems and UQ - Uncertainty Quantification in Computational Models, Computational & Variational Methods for Inverse Problems (observer)

Mathematics - Functional Analysis, Partial Differential Equations, Analytical Methods

Fluid Dynamics - Physical Oceanography, Mathematical Modeling in Science and Engineering, Computational Fluid Dynamics, Galerkin Methods

Computational Skills

Languages - Python (scikit-learn, Keras, PyTorch, FENICS, numpy, autograd, Pandas), C++ (GRVY, MASA, HDF5, PETSc), FORTRAN-90

Softwares - MATLAB, Scilab, Solidworks, ANSYS, ADAM, OpenFOAM, Simulink, LaTeX, Tapenade, MITgcm, SICOPOLIS

HPC and other tools - OpenMP, MPI, CUDA, SLURM, Github, Docker, Shell scripting, Travis-CI, Autotools, Valgrind, HTML, CSS, Jekyll, lcov

Student Membership

Society of Industrial and Applied Mathematics

International Association of Cryospheric Sciences (IACS)

Volunteer, Mentorship, Leadership and Community Experience

Volunteer Experience

Volunteer: CURED, Techfest-2016, IIT Bombay, Conducted 178 diabetes screening camps across 20 cities in a team of 100+, conducting more than 65,000 screenings in a day as part of CURED (Can You Really Cure Diabetes?), a PAN-India level initiative to raise awareness about diabetes

Volunteer: Educational Outreach, National Service Scheme, IIT Bombay, Mentored and taught 25 under-privileged students of secondary school over period of one year (2015-2016) as part of Educational Outreach program of National Service Scheme

Mentorship Experience

Mentor: UT Austin SIAM Applied Math Mentorship Program 2021-2022

- Mentored 2 students, with broad focus on careers in applied mathematics
- Students mentored - Martin Vu and Nan Shelden

Mentor: Department Academic Mentorship Program (DAMP), IIT Bombay 2018-2019

One of the 23 student mentors selected out of 85 applicants, selections based on interviews and peer reviews

- Mentored 6 students for smooth transition to department curriculum, motivating their academic and personal endeavours (Students mentored - Rishabh D'Souza, Ameya Mittal, Pranesh Parmar, Nishant Kumar, Harshit Madan, Swastik Sahoo)
- Part of the team tasked with suggesting modifications to the curriculum if necessary after consultation with the HoD, Faculty Advisors and Professors

Mentor: Academic Rehabilitation Program, IIT Bombay 2018-2019

- Counselled an academically weak student on one-on-one basis, helping him to clear his academic backlogs as part of Academic Rehabilitation Program

Informal career mentorship 2018-2022

- Mentored over 10+ students broadly about future careers in STEM, interview preparation, and resume reviews

- Mentored students include Aditya Patil (currently at Ketto), Rushikesh Borse (currently at George Mason University), Raj Lakhani (currently at University of Michigan Ann Arbor), Ritwik Kadu (currently at Flipkart), Devendra Waghulde (currently at BTS), Nishant Jannu (currently at Stanford University), Anonymous (currently at Lear corporation, prefers not being named)

Leadership Experience

Vice President, Austin Chapter of SIAM 2021-Present

- Hosted ANSYS, Two Sigma, Julia Computing, StriveWorks, Cerfe Labs (ARM), Sandia National Laboratories as part of our Industry Seminar Series
- Hosted Dr. Howard Stone (Donald R. Dixon '69 and Elizabeth W. Dixon Professor and the Department Chair of the Mechanical and Aerospace Engineering at Princeton University) for talk on "Beauty in Research and Intersections with Teaching" as part of our Distinguished Seminar Series
- Quadrupled our followers on Instagram and increased our Facebook following by 30%
- Helped organize Applied Maths Mentorship Program, which comprised of 34 mentors and 47 mentees in total
- Nominated as finalists for Best Graduate Organization category of Swing Out Awards, for second year in a row

Community Participation

Guest Lecture, Physical Oceanography Course 2021

Instructor: Patrick Heimbach

My guest lecture "Scaling Analysis" focused on 1) an overview of how scaling analysis is performed and 2) on how it can help greatly simplify the governing equations of ocean flow by eliminating most of the terms

ARGOVIS Hackathon 2022

I helped develop OOP-based Python tools for interactive plotting and binning of Argo data. The Jupyter Notebook will soon be available and help the community to better analyze and visualize the Argo data.

Industry Experience

KITES Intern, ITC Limited Summer 2018
ITC Limited is India's largest FMCG conglomerate; I interned in the packaging section of it's only fully owned flour plant in Uluberia, West Bengal, India

- Achieved Manpower Reduction in Primary Packing Machines by 50%
- Secondary Packing Machines worth a total of $165,000 made operational using PDCA-cycle based improvements

Junior Design Engineer, IIT Bombay Racing 2016-2017
A team of students which fabricates an electric race car for Formula Student U.K

- Developed 3-D CAD models for gearbox in SolidWorks and carried out FEA simulations in ANSYS to help select optimum gear ratio
- Routed the cooling system on SolidWorks Routing, reducing weight and increasing ease of priming of the pumps

References

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