# Shreyas Sunil Gaikwad

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## EDUCATION

**The University of Texas at Austin**
*Ph.D. in Computational Science, Engineering, and Mathematics (CSEM), GPA: 4.0/4.0* — *2020–2025*
*M.S. in Computational Science, Engineering, and Mathematics (CSEM), GPA: 4.0/4.0* — *2019–2021*

**Indian Institute of Technology (IIT) Bombay, India**
*B.Tech with Honors in Mechanical Engineering (Minor in Computer Science), Rank: 4/150, GPA: 9.32/10.0* — *2015–2019*

## WORK EXPERIENCE

- **Graduate Research Assistant, UT Austin** — *2020–Present*
  *Ph.D. Thesis: Reconstructing Holocene Ice Sheet Dynamics over Greenland via Bayesian Inversion*
  - Developed a scalable **Bayesian inversion** framework for the Fortran-based ice sheet model SICOPOLIS using open-source **Algorithmic Differentiation (AD)** tools for efficient gradient computation [II][3]
  - Solved high-dimensional inverse problems constrained by partial differential equations (PDEs), estimating $\mathcal{O}(\mathbf{10^6})$ uncertain parameters in a continental-scale ice sheet model, accelerated using preconditioned quasi-Newton methods
  - Reduced sensitivity analysis cost from $\mathcal{O}(\mathbf{N^3})$ to $\mathcal{O}(\mathbf{1})$ model evaluations using adjoint-based gradients
  - Developed a novel interpretation technique for neural networks using physics-informed adjoints and **eXplainable-AI (XAI)** methods in **Keras**, validating learned insights against physically consistent adjoint sensitivities [1]
- **Machine Learning Intern, Ansys Inc.** — *Summer 2024*
  - Built a unified **Neural Radiance Field (NeRF)** architecture to implicitly represent multiple, diverse object geometries
  - Developed a scalable **GenAI** pipeline for image-to-3D synthesis in **PyTorch** (**106 million parameters**), combining the unified NeRF architecture with a pre-trained, 3D-aware, **multi-view 2D diffusion model** for 3D asset generation
  - Trained the NeRF without 3D data using 3D-aware diffusion priors and **Score Distillation Sampling (SDS)** loss
- **Visiting Scholar, Argonne National Laboratory** — *Summer 2022*
  - Developed the **first open-source**, **MPI**-parallel, AD-based Bayesian optimization framework for the atmospheric and ocean general circulation model MITgcm, an alternative to a proprietary tool costing ∼**$15,000/year per user** [I][2]

## RESEARCH PROJECTS

- **Machine Learning Applications in Geophysics** — *Spring 2021*
  - Developed CNNs & U-Nets in **Keras** for earthquake (**96% accuracy**) & seismic fault (**97% accuracy**) detection
  - Applied variational autoencoders for subsurface rock classification via latent-space clustering
- **Physics-Informed Machine Learning** — *Spring 2021*
  - Trained a deep neural network in **PyTorch** to emulate and assimilate a nonlinear PDE-based mountain glacier model by leveraging higher-order derivatives from PyTorch's computational graph
- **Laplacian 2D Finite Difference (FD) Solver Application** — *Fall 2020*
  - Features: OOP (**C++**); solvers (Gauss, Jacobi, PETSc); build (Autotools); testing (Bats, Travis CI, Docker); **98% coverage** (lcov); **0% memory errors** (Valgrind); HPC environment (SLURM); parsing & logging (GRVY)

## OPEN-SOURCE CONTRIBUTIONS

I **MITgcm-AD v2**, open-source adjoint-based data assimilation framework for a general circulation model
II **SICOPOLIS-AD v2**, open-source adjoint-based data assimilation framework for an ice sheet model

## TECHNICAL SKILLS

- **Languages**: Python (PyTorch, Keras, Tensorflow), Julia, C/C++, Fortran-77/90, MATLAB
- **HPC toolkit**: OpenMP, MPI, CUDA, SLURM, git, docker, shell scripts, CI, autotools, valgrind, lcov, GRVY

## HONORS AND AWARDS

- Reviewer for the *Journal of Open Source Software (JOSS)* — *2023–Present*
- Invited talk at SIAM TX-LA: *Computational Science to Enable Digital Twins of the Oceans* — *2023*
- Recipient of the Peter O'Donnell Graduate **Fellowship** (**$48,000**) — *2019*
- Ranked 509/1,500,000 (**99.97 percentile**) in India's national university entrance exam — *2015*

## SELECT JOURNAL AND CONFERENCE ARTICLES

1. H. Pillar*, **S.S. Gaikwad*** et al., "Pairing eXplainable AI with Adjoint Modeling for Flexible Investigation and Robust Attribution of Ocean Variability", *In preparation for Geophysical Research Letters (2025).*
2. **S.S. Gaikwad** et al., "MITgcm-AD v2: Open source tangent linear and adjoint modeling framework for the oceans and atmosphere enabled by the AD tool Tapenade", *Future Generation Computer Systems (2024).*
3. **S.S. Gaikwad** et al., "SICOPOLIS-AD v2: tangent linear and adjoint modeling framework for ice sheet modeling enabled by automatic differentiation tool Tapenade", *Journal of Open Source Software (2023).*

** Equal contributions to this manuscript.*