

Utkarsh

📍 Cambridge, Massachusetts, USA

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• Scientific Machine Learning • Foundational Models • Differentiable Programming

EDUCATION BACKGROUND

Massachusetts Institute of Technology

Master of Science in Computational Science and Engineering, CSAIL
2nd year graduate student, **Current GPA: 5.0/5.0**

Cambridge, Massachusetts

September 2022- Present

Indian Institute of Technology Kanpur

Bachelor of Technology, **Double Major: Electrical Engineering, Chemical Engineering**
Minors: Computer Science & Engineering in Machine Learning, and Systems
GPA: 9.1/10.0 (EE Major)

Kanpur, India

July 2017-April 2022

RESEARCH PUBLICATIONS

- **Automated Translation and Accelerated Solving of Differential Equations on Multiple GPU Platforms**¹
Utkarsh, Valentin Churavy, Yingbo Ma, Tim Besard, Tim Gymnich, Adam R. Gerlach, Alan Edelman, Chris Rackauckas
Computer Methods in Applied Mechanics and Engineering
- **Parallelizing Explicit and Implicit Extrapolation Methods for Ordinary Differential Equations**²
Utkarsh, Chris Elrod, Yingbo Ma, Christopher Rackauckas
IEEE High Performance Extreme Computing (HPEC) (Oral Presentation)
- **Composing Modeling and Simulation with Machine Learning in Julia**³
Chris Rackauckas, Maja Gwozdz, Anand Jain, Yingbo Ma, Francesco Martinuzzi, Utkarsh, Elliot Saba, Viral B. Shah, Ranjan Anantharaman, Alan Edelman Shashi Gowda, Avik Pal, Chris Laughman
Annual Modeling and Simulation Conference
- **Enhancing Slot Tagging with Intent Features for Task Oriented NLU using Foundational AI models (BERT)**⁴
Shruthi Hariharan, Vignesh Kumar Krishnamurthy, Utkarsh, Jayantha Gowda Sarapanahalli
- **Stably Accelerating Stiff Quantitative Systems Pharmacology Models: CTESN as Implicit Machine Learning**⁵
R. Anantharaman, Anas Abdelrehim, Anand Jain, Avik Pal, Danny Sharp, Utkarsh, Alan Edelman, Chris Rackauckas
International Federation of Automatic Control (IFAC)

POSTER PRESENTATIONS

- **Improving System Identification of Kinetic Networks using Neural Stochastic Differential Equations**
Krystian Ganko, Nathan Stover, Utkarsh, Richard Braatz, Christopher Rackauckas
Foundations of Process/Product Analytics and Machine learning

PROFESSIONAL EXPERIENCE

Julia Lab, CSAIL MIT

Research Assistant, PI(s): Dr Alan Edelman, Dr Chris Rackauckas

Sept'22 - Present

- Unified **GPU-based Differential Equation** solvers to become **device-agnostic, high-performant** for batch simulations¹
- Improving **inference and identifiability** of **Neural Stochastic Differential Equations** in chemical kinetic networks
- Developing structure exploiting approximate **Jacobian matrix factorization schemes** for Ordinary Differential Equations
- Investigating faster and scalable parallelism in **stochastic optimization methods** for **non-convex** objective function
- Implemented **within-method parallel extrapolation solvers** achieving 4× speed-up on low-dimensional ODEs²

Julia Computing Inc.

Research Intern/Consultant, Modeling and Simulation

Jan'21-Aug'22

- Assisted with the testing of JuliaSim: a next generation cloud-based simulation platform, combining the latest techniques in SciML with equation-based digital twin modelling and simulation.
- Developed Pseudo-transient methods for fast and stable solving of steady states in differential equations. It is equipped with automatic sparsity detection, finite and **automatic differentiation**, and enabled with **CUDA support**.
- Extended the application of JuliaSim to Physiome project CellML Models by successful generation of **linear and non-linear surrogates** predicting ground truth within acceptable relative error %.
- Co-authored a research paper, based on **Quantitative Systems Pharmacology Models** describing how common deep learning methodologies, such as **RNNs, ResNets and PINNs** are fundamentally related to **solvers of ODEs**
- Developed the QSP JuliaSim Model Library Store curating over 3000+ models ready for surrogate generation with the new ModelingToolkit.jl acasual modelling platform

Voice Intelligence Team, Samsung Research

- Investigated the strengths & bottlenecks in the existing **slot identification and tagging** Machine Learning algorithms
- Researched on applications of **BERT** models on **slot labelling with intent** oriented corpus of conversational sentences
- Attempted to examine and test various pre-trained **Foundational AI models** such as **ALBERT & DistilBERT** with different configurations such as no. of layers, hidden dimensions etc with hyper-parameter tuning on the BERT models
- Submitted a research paper⁴ with a publication in progress; received a return offer to work in CTO's research lab

OTHER PROJECTS

Inference and identifiability of noisy chemical kinetic processes

Prof. Richard Braatz, Dept. of Chemical Engineering, MIT

May'23 - Present

- Improving **identifiability and dynamics discovery** of chemical reactions using **Neural Stochastic Differential Equations**
- Researching on statistical inference of the system using **Chemical Langevin Equation** and parameter posterior estimates

DiffEqGPU.jl

Open-source GPU acceleration

[Code]

Aug'22- Mar'23

- GPU-acceleration routines for DifferentialEquations.jl and the broader SciML scientific machine learning ecosystem
- Developed custom GPU kernels which can accelerate models upto 100× in massively **parameter-parallel simulations**
- **Device-agnostic framework methodology** supporting compilation to NVIDIA, AMD, Intel and Apple (M-series) GPUs

Personalized Knowledge Graphs

Samsung Research

Jan'22- Apr'23

- Investigated techniques to draw inferences for **Personalized Knowledge Graphs** in Bixby Artificial Intelligence
- Surveyed techniques on acquisitions and representation of Knowledge Graphs in Natural Language Processing
- Assisted in developing graph ML based techniques to migrate from rule-based systems for predicting relations

Simulation of multi-phase transport in porous media using finite differences

Prof. Himanshu Sharma, Dept. of Chemical Engineering, IIT Kanpur

[Report]

Aug'20- Dec'20

- Identified the bottle-necks in the simulation of MATLAB code and **performed memory optimisations, vectorization and non-linear equation solvers**. Migrated the code-base to the Julia Language with extending support to multi-threading
- Achieved a 10× speed over the bench-marked MATLAB code with extended API for special data-structures

GRID 2.0 Machine Learning Challenge, Semi-Finalist

Flipkart

[Report & Code]

Jun'20- Aug'20

- Qualified for semi-finals across registered 9000+ teams; designed a **speech extraction system**, capable of identifying & separating out speech utterances from various urban household **background noises** when using the voice assistant
- Contrived an **U-DenseNet architecture** with **Generative AI models** to compare ground truth with training data converted to a spectrogram using **Short-Time FFT** along-with fed to a **Pix2Pix Generative Adversarial Network**

Google Summer of Code

The Julia Language

[Report & Code]

May'20- Aug'20

- Amongst 16 students worldwide to work with The Julia Language in **Scientific Machine Learning**
- Implemented SOTA IMEX numerical algorithms and performed optimizations for **native Differential Equation solvers**
- Enhanced **parallelized implicit & explicit extrapolation methods** which automatically multithread the computations and **Jacobian/Hessian instantiation and factorization**, allowing for a higher degree of within method parallelism

TECHNICAL SKILLS

- **Programming Languages:** C, C++, Julia, Java, Python, Kotlin, Dart
- **Modelling and Simulation:** SolidWorks, JuliaSim, AutoCAD, Aspen Plus, MATLAB
- **Software Utilities:** Keras, Numpy, JAX, PyTorch, Pandas, Scikit-Learn, LATEX, Git, Android, PostgreSQL & Flutter

AWARDS & ACHIEVEMENTS

- Academic Excellence, IIT Kanpur, top 10% students every year, 2022
- KVPY Scholarship Awardee, Indian Institute of Science and Government of India, 2016
- Secured an All India Rank of 665 amongst 1.7 million candidates appearing in the Joint Entrance Examination 2017
- CBSE Merit Award, Ranked in National top 1% for securing 100% in Chemistry CBSE Board Class XII