

# Rajat Arora

SENIOR MACHINE LEARNING ENGINEER, APPLE

(+1) 412-616-5365 | rajat.arora9464@gmail.com | www.rajatarora.in | sairajat | rajatarora9464

## Experience

7+ Y.O.E.

### Apple

Seattle, WA

SENIOR MACHINE LEARNING ENGINEER : ML PERFORMANCE

Oct. 2024 - Present

- Develop and utilize end-to-end performance models and benchmarks to guide optimization efforts of Apple's in-house language models and hardware roadmap decisions across workloads and accelerator types
- Lead cross-functional initiatives to improve ML performance through in-depth profiling, data-driven analysis, and kernel efficiency enhancements
- Collaborate with cross-functional teams to co-design efficient deep learning frameworks, optimizing memory hierarchies, and execution graphs
- Optimize ML workloads by implementing hardware-aware scheduling and acceleration strategies, improving model inference efficiency on custom AI hardware

### Advanced Micro Devices, Inc. (AMD)

Austin, TX

SENIOR MEMBER OF TECHNICAL STAFF SOFTWARE SYSTEM DESIGN : ML PERFORMANCE

Feb. 2022 - Oct. 2024

- Research and develop techniques to accelerate high performance computing (HPC) and machine learning (ML) workloads running on AMD's instinct family of data center GPUs
- Collaborate directly with technical experts in various fields, including industry and academia, to perform in-depth analysis and optimization of complex AI and HPC algorithms to ensure the best possible resource utilization on modern CPU and GPU architectures.
- Actively collaborate with product management, cross-functional teams, and internal/external customers, providing valuable technical insights that contribute to the development of technical roadmaps for hardware (architecture) and software (libraries).
- Play a pivotal role in shaping the design of next-generation hardware architectures, software, and programming models in collaborative research efforts with AMD's research, hardware, system software, libraries, and tools teams.
- Published several optimization techniques for HPC and ML workloads in research-focused developer blogs or relevant conferences to engage and educate the Developer community [\[Link\]](#).

### Siemens Corporation

Princeton, NJ

RESEARCH SCIENTIST: PHYSICS AWARE ARTIFICIAL INTELLIGENCE

Aug. 2020 - Feb. 2022

- Work In interdisciplinary group of scientists, engineers, and software developers to perform research in the confluence of classical numerical methods in science and engineering and the emerging Data Analytics and Machine learning.
- Develop physics-informed neural network to model *real-time* Lithium metal behavior under different battery operating conditions - temperature and loading rates.

### Ansys, Inc.

Pittsburgh, PA

RESEARCH & DEVELOPMENT ENGINEER II: ANSYS TWIN BUILDER SOLVER

Mar. 2019 - Jul. 2020

- Lead developer (C++) of the digital twin development framework used for generating cross-platform digital twins.
- Develop and maintain core solver (C++) for physics-based, high-fidelity, circuit and system simulation software.
  - Added support for multiple linear algebra solvers to improve simulation convergence and speed.
  - Enabled multi-threaded output of high volume complex data collection to improve simulation speed and reduce file size.

### Eaton Technologies Pvt. Ltd.

Pune, India

ENGINEER

Aug. 2014 - Jan. 2015

- Performed bearing analysis using ROMAX software to optimize bearing life for various parameters: lubrication, clearance, misalignment

## Skills

### Programming

C/C++, Python, CUDA

### AI/ML

Transformer models, Diffusion models, PyTorch, TensorFlow, Large scale distributed training & inference

### Misc.

git, OpenMP, MPI, Data Visualization, Cloud Deployment

## Education

### Carnegie Mellon University (CMU)

PH.D. IN COMPUTATIONAL MECHANICS, GPA: 4.0

- Dissertation: Computational Approximation of Mesoscale Field Dislocation Mechanics (MFDM) at Finite Deformation
- Advisor: Prof. Amit Acharya

M.S. IN COMPUTATIONAL MECHANICS, GPA: 4.0

Pittsburgh, PA

Jul. 2015 - Feb. 2019

Jul. 2015 - Dec. 2017

### Indian Institute of Technology (IIT) Kanpur

M.TECH. IN MECHANICAL ENGINEERING, GPA: 9.7/10

- Dissertation: Shape Evolution of Precipitates using Extended Finite Element Method Coupled with Level Set Method
- Advisor: Prof. Anurag Gupta

B.TECH. IN MECHANICAL ENGINEERING, GPA: 8.2/10

Kanpur, India

Jan. 2013 - Oct. 2014

Jul. 2009 - Oct. 2014

## Academic Appointments

### Carnegie Mellon University

GRADUATE RESEARCH ASSISTANT: MECHANICS, MATERIALS, AND COMPUTING RESEARCH

- Developed (C++) a massively parallel finite element based theoretical-computational framework for modeling elasto-plastic deformation in metals
- The theory fundamentally accounts for static and dynamic (stress and energy) fields of dislocation distributions and their non-uniform spatio-temporal evolution at finite strain.

Pittsburgh, PA

Jun. 2015 - Feb. 2019

### Indian Institute of Technology Kanpur

GRADUATE RESEARCH ASSISTANT

- Developed framework in C++ to analyze morphological evolution of arbitrarily shaped precipitates coherently embedded in a matrix.
- The approach involved coupling Extended Finite Element Method (XFEM) with PDE based Level Set Method (LSM) to capture interfacial motion.

Kanpur, India

Jan. 2013 - Oct. 2014

## Teaching Experience

CARNEGIE MELLON UNIVERSITY

- Introduction to Civil Engineering
- Engineering Mechanics

Pittsburgh, PA

Spring 2017 & 2018

Spring 2016

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

- Design of Machine Elements
- Experiments in Solid Mechanics

Kanpur, India

Spring 2014

Fall 2013

## Honors & Awards

2018 **Fenves Travel Grant**, Civil Engineering Department, CMU

Pittsburgh, PA

2015 **Dean's Fellowship**, Civil Engineering Department, CMU

Pittsburgh, PA

2014 **Inclusion & Diversity Council Member**, Eaton

Pune, India

2012 **Boeing Research Scholarship**, IIT Kanpur

Kanpur, India

2012 **5th Place**, Robotics Competition, IIT Bombay

Mumbai, India

2010 **3rd Award**, Robotics Competition, IIT Kanpur

Kanpur, India

2010 **3rd Award**, Electronics Competition, IIT Kanpur

Kanpur, India

2009 **Rank 761**, IIT Joint Entrance Examination (IIT-JEE) among over 0.40 million aspirants

India

2009 **99.42 percentile**, All India Engineering Entrance Exam (AIEEE) among over 1 million aspirants

India

2008 **Rank 671**, Uttar Pradesh State Entrance Examination (UPSEE) among over 0.25 million aspirants

India

## Professional Service Activities

- Member of PhD committee for a PhD student at Carnegie Mellon University
- Active **contributor** to the Deal.II repository, an open-source Finite Element library
- **Reviewer** for the following journals and conferences:

2015 - Present

2019 - Present

- Materials Science and Technology
- Computational Mechanics
- International Journal for Multiscale Computational Engineering
- Mechanics of Materials
- Modelling and Simulation in Materials Science and Engineering
- AAAI Conference on Artificial Intelligence
- Annual AAAI Workshop on AI to Accelerate Science and Engineering
- Conference on Neural Information Processing Systems
- International Conference on Machine Learning
- Journal of the Brazilian Society of Mechanical Sciences and Engineering
- Journal of Physics: Condensed Matter

## Patents

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- **Systems and methods for deep learning for discontinuous data**

R. ARORA, N. MALAYA. Patent filed with USPTO.

## Publications

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### PREPRINTS

- **Deep Learning Framework for Solving Hyperbolic Partial Differential Equations: Part I**

R. ARORA. In preparation.

### MACHINE LEARNING

- **Spatio-Temporal Super-Resolution of Dynamical Systems using Physics-Informed Deep-Learning**

R. ARORA, A. SHRIVASTAVA. 2nd Annual **AAAI** Workshop on AI to Accelerate Science and Engineering (AI2ASE).

- **Physics-Informed Neural Networks for modeling rate- and temperature-dependent plasticity**

R. ARORA, P. KAKKAR, B. DEY, A. CHAKRABORTY. Machine Learning and the Physical Sciences workshop at **NeurIPS** 2022.

- **PhySRNet: Physics informed super-resolution network for application in computational solid mechanics**

R. ARORA. **IEEE/ACM** International Workshop on Artificial Intelligence and Machine Learning for Scientific Applications in conjunction with **SC'22**.

- **Machine learning-accelerated computational solid mechanics: Application to linear elasticity**

R. ARORA. 1st Annual **AAAI** Workshop on AI to Accelerate Science and Engineering (AI2ASE).

### MECHANICS OF MATERIALS

- **Self-fields for disconnections with disclination, dislocation and step character**

E. ZEGPI, R. ARORA, A. ACHARYA. In preparation.

- **An experimentally informed grain boundary 2D model: addressing triple junctions, mobility and invariance of misorientation**

S. ANSARI, A. ACHARYA, R. ARORA, A. ALANKAR. *Acta Materialia*, 2024.

- **Modeling of experimentally observed topological defects inside bulk polycrystals**

S. SINGH, H. LIU, R. ARORA, R. SUTER, A. ACHARYA. *Modelling and Simulation in Materials Science and Engineering*, 2023.

- **Interface-Dominated Plasticity and Kink Bands in Metallic Nanolaminates**

A. ARORA, R. ARORA, A. ACHARYA. *Crystals*, 2023.

- **Mechanics of micropillar confined thin film plasticity**

A. ARORA, R. ARORA, A. ACHARYA. *Acta Materialia*, 2022.

- **Dislocation pattern formation in finite deformation crystal plasticity**

R. ARORA, A. ACHARYA. *International Journal of Solids and Structures*, 2020.

- **Finite element approximation of finite deformation dislocation mechanics**

R. ARORA, X. ZHANG, A. ACHARYA. *Computer Methods in Applied Mechanics and Engineering*, 2020.

- **Equilibrium shape of misfitting precipitates with anisotropic elasticity and anisotropic interfacial energy**

T. JOSHI, R. ARORA, A. BASAK, A. GUPTA. *Modelling and Simulation in Materials Science and Engineering*, 2020.

- **A unification of finite deformation  $J_2$  Von-Mises plasticity and quantitative dislocation mechanics**

A. ARORA, A. ACHARYA. *Journal of the Mechanics and Physics of Solids*, 2020.

## Technical Publications

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### MASTER'S THESIS

- **Shape Evolution of Precipitates using Extended Finite Element Method Coupled with Level Set Method.**

Indian Institute of Technology Kanpur, Department of Mechanical Engineering, Kanpur, India. 2014.

### PH.D. THESIS

- **Computational Approximation of Mesoscale Field Dislocation Mechanics at Finite Deformation.**

Carnegie Mellon University, Department of Civil & Environmental Engineering, Pittsburgh, PA. 2019.

## Technical Presentations

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1. **Interface-dominated plasticity and kink bands in metallic nanolaminates**  
*17th U. S. National Congress on Computational Mechanics*, Albuquerque, Jul. 2023
2. **Mechanics of Micropillar Confined Thin Film Plasticity**  
*The 10th International Conference on Multiscale Materials Modeling*, Baltimore, Oct. 2022
3. **Accelerated Battery Design using Physics-Informed Machine Learning**  
*1st IACM Conference on Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology*, San Diego, Sept. 2021
4. **Field Dislocation Mechanics**  
*Mechanical Engg. Dept. Colloquium, IIT Bombay*, Mumbai, India, Nov. 2019
5. **Finite Deformation Mesoscale Field Dislocation Mechanics**  
*International Mechanical Engineering Congress & Exposition 2019*, Salt Lake City, Utah, Nov. 2019
6. **Dislocation patterning in Finite Deformation Dislocation Mechanics and toward plasticity without phenomenological assumptions**  
*Dislocations 2019*, Haifa, Israel, Sept. 2019
7. **Finite Deformation Mesoscale Field Dislocation Mechanics**  
*XV Conference on Computational Plasticity, Fundamentals and Applications*, Barcelona, Spain, Sept. 2019
8. **Finite Deformation Mesoscale Field Dislocation Mechanics**  
*Multiscale Materials Modeling*, Osaka, Japan, Oct. 2018
9. **Computational Approximation of Mesoscale Field Dislocation Mechanics (MFDM) at Finite Deformation**  
*World Congress of Computational Mechanics (WCCM)*, New York, NY, Jul. 2018
10. **Computational Approximation of Mesoscale Field Dislocation Mechanics (MFDM) at Finite Deformation**  
*Society of Industrial and Applied Mathematics*, Portland, OR, Jul. 2018
11. **Finite Deformation Mesoscale Field Dislocation Mechanics**  
*Physics and Mechanics of Random Structures: From morphology to material properties, Conference in honor of Dominique Jeulin*, Peninsula of Oléron, France, Jun. 2018
12. **Finite Deformation Mesoscale Field Dislocation Mechanics**  
*Euromech symposium on Micromechanics of Defects*, Sevilla, Spain, Jun. 2018
13. **Towards modeling longitudinally propagating shear bands**  
*Nonconvexity, Nonlocality and Incompatibility: From Materials to Biology*, Pittsburgh, PA, May. 2017

## Invited Talks

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1. **Machine Learning Accelerated Computational Solid Mechanics**  
*Advanced Micro Devices*, Austin, TX, Oct. 2021
2. **Computational Approximation of Mesoscale Field Dislocation Mechanics at Finite Deformation**

*Siemens Corporate Technology*, Princeton, NJ, Feb. 2020

3. **Computational Approximation of Mesoscale Field Dislocation Mechanics at Finite Deformation**

*Ansys, Inc.*, Canonsburg, PA, Dec. 2018

## Workshops

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- One day **OpenMP** workshop organized by *XSEDE HPC* *Oct. 2016*
- Two day training session on **Scientific Visualization** organized by *XSEDE HPC* *Oct. 2016*
- Two day workshop on **MPI** conducted by *XSEDE HPC* *Sept. 2015*