

# JAYDEEP RADE

Ph.D. Student | Electrical Engineering | Iowa State University | Ames, IA 50014

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## INTEREST AREAS

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Deep Learning, Computer Vision, 3D Reconstruction, Object Detection, Segmentation, Generative Models

## EDUCATION

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### Iowa State University

Ames, Iowa

Ph.D., Electrical Engineering **GPA: 3.85/4.00**

Jan 2021 – Dec 2024

Co-advised by Dr. Adarsh Krishnamurthy and Dr. Anwesha Sarkar

**Honors:** Graduate Research Excellence Award May 2024

### Iowa State University

Ames, Iowa

MS (thesis), Electrical Engineering **GPA: 3.70/4.00**

Aug 2018 – May 2021

Co-advised by Dr. Soumik Sarkar and Dr. Adarsh Krishnamurthy

### Veermata Jijabai Technological Institute (VJTI)

Mumbai, India

Bachelor of Technology in Electronics Engineering **GPA: 7.50/10.00**

Aug 2014 – May 2018

## TECHNICAL SKILLS

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**Programming:** Python, Matlab, C++, C#, Unity, LaTeX

**Deep Learning Frameworks:** PyTorch, TensorFlow, Keras, Scikit-Learn, OpenCV

## PROFESSIONAL EXPERIENCE

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### Bayer

May 2023 – Aug 2023

Computer Vision Intern, Crop Science Division

Chesterfield, Missouri

- Enhanced segmentation performance through the implementation of a **transformer**-based neural network.
- Investigated Domain Adaptation techniques for **transformer-based segmentation** network.
- Evaluated data drift detection methods to effectively monitor segmentation performance in the presence of new and evolving data.

### ANSYS, Inc.

Aug 2019 – Aug 2020

Machine Learning Intern, ML Team, CTO Office

Canonsburg, Pennsylvania

- Implemented **U-Net**, **U-SE-ResNet architectures** for Topology Optimization.
- Used **Keras**, **PyTorch** deep learning frameworks to develop **CNN and CNN-LSTM** based architectures for **2D and 3D geometries**.
- Integrated **python** with ANSYS Mechanical software for data generation pipeline.
- Delivered the talk on the **Introduction to Machine Learning** as part of Learning Series at ANSYS.

## RESEARCH EXPERIENCE

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### Research Assistant, Iowa State University

Jan 2019 - Present

#### 1. AI-AFM Assisted Structure Prediction of Protein Complexes

- Developing novel view synthesis methods for 3D **NeRF** reconstruction of protein structure using **diffusion models**.
- Created Virtual AFM:gpu-accelerated computer graphics program and accelerated data generation using GNU Parallel.
- Compiled an large dataset featuring multi-view virtual AFM images for over 550,000 voxelized 3D protein structures.

#### 2. Cell Shape Detection in AFM Microscopic Images

- Evaluated zero-shot performances of **VLMs** like **GPT-4o**, **Gemini** and **LLaVA** for cell shape classification.
- Implemented **YOLO object detection** algorithm using **PyTorch** for cell shape detection in AFM images.
- Incorporated intelligent vision-based navigation for traversing the AFM scanning probe.

#### 3. Deep Learning for High-resolution 3D Structural Topology Optimization

- Designed PSP-U-Net architecture in **Keras** for performing STO.
- Leveraged multigrid-style training to train up to **high-resolution** of  $128 \times 128 \times 128$  **3D** structures.
- Achieved  $5\times$  speed up using distributed training across multiple GPUs.

#### 4. Deep Learning for Structural Topology Optimization

- Designed multiple neural networks model to perform end-to-end topology optimization consistent with **SIMP** algorithm using **3D CNNs**.
- Built and accelerated the dataset generation pipeline using **GNU parallel** shell and created a dataset of 60K high-resolution of  $128 \times 128 \times 128$  3D voxelized structures.

## PUBLICATIONS

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1. N. Masud, **J. Rade**, Md. H. Hassan, A. Krishnamurthy, A. Sarkar; Machine learning approaches for improving atomic force microscopy instrumentation and data analytics, *Frontiers in Physics*, 2024. [[article](#)]
2. **J. Rade**, E. Herron, S. Sarkar, A. Sarkar, A. Krishnamurthy, “3D Reconstruction of Protein Structures from Multi-view AFM Images using Neural Radiance Fields (NeRFs)”, *Deep Learning for Geometric Computing (DLGC) Workshop, CVPR 2024*. [[article](#)]
3. E. Herron, **J. Rade**, A. Jignasu, B. Ganapathysubramanian, A. Balu, S. Sarkar, A. Krishnamurthy, “Latent Diffusion Models for Structural Component Design”, *Computer-Aided Design 2024, CAD 2024*. [[article](#)]
4. **J. Rade**, A. Jignasu, E. Herron, A. Corpuz, B. Ganapathysubramanian, S. Sarkar, A. Balu, A. Krishnamurthy, “Deep Learning-based 3D Multigrid Topology Optimization of Manufacturable Designs”, **EAAI 2023**. [[article](#)]
5. **J. Rade**, S. Sarkar, A. Sarkar, A. Krishnamurthy, “3D Reconstruction of Protein Complex Structures Using Synthesized Multi-View AFM Images”, *Machine Learning for Structural Biology (MLSB) Workshop, NeurIPS 2022*. [[article](#)]
6. **J. Rade**, J. Zhang, S. Sarkar, A. Krishnamurthy, J. Ren, A. Sarkar, “Deep Learning for Live Cell Shape Detection and Automated AFM Navigation”, Volume 9, Article No. 522, **Bioengineering Journal 2022**. [[article](#)]
7. **J. Rade**, A. Balu, E. Herron, A. Jignasu, S. Botelho, S. Adavani, S. Sarkar, B. Ganapathysubramanian, A. Krishnamurthy, “Multigrid Distributed Deep CNNs for Structural Topology Optimization”, **AAAI-22 Workshop on AI for Design and Manufacturing (ADAM)**. [[article](#)]
8. E. Herron, A. Jignasu, **J. Rade**, X. Lee, A. Balu, A. Krishnamurthy, S. Sarkar, “Fast Unsupervised Generative Design for Structural Topology Optimization”, **AAAI-22 Workshop on AI for Design and Manufacturing (ADAM)**. [[article](#)]
9. **J. Rade**, J. Zhang, S. Sarkar, A. Krishnamurthy, J. Ren, A. Sarkar, “AI Guided Measurement of Live Cells Using AFM”, *Modeling, Estimation and Control Conference, MECC 2021*.
10. **J. Rade**, A. Balu, E. Herron, J. Pathak, R. Ranade, S. Sarkar, and A. Krishnamurthy, “Algorithmically-Consistent Deep Learning Frameworks for Structural Topology Optimization”, *Engineering Applications of Artificial Intelligence* 106, 104483, **EAAI 2021**. [[article](#)]
11. **J. Rade**, “Deep Learning Frameworks for Structural Topology Optimization”, *Graduate Theses and Dissertations, Iowa State University*, 18592, 2021. [[thesis](#)]

## RELEVANT COURSEWORK

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|-----------------------------|-----------------------|---------------------|
| • Deep Learning             | • Concurrent Systems  | • Machine Vision    |
| • Machine Learning          | • Convex Optimization | • GPU Computing     |
| • Digital Signal Processing | • Data Analytics      | • Computer Graphics |

## TALKS

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1. “Multigrid Deep Learning for 3D Structural Topology Optimization.” 17th U.S. National Congress on Computational Mechanics, **USNCCM 2023**.
2. “Virtual AFM: Generating Synthetic 2D Multi-view Images from 3D Protein Structure.” Biomedical Engineering Society, **BMES 2022**.
3. “Deep Learning Guided Navigation of Live Cells for AFM.” Workshop on Scientific Machine Learning: Foundations and Applications at, **TrAC, Iowa State University 2022**.
4. “Deep Learning Accelerated Topology Optimization.” NVIDIA GPU Technology Conference, **NVIDIA GTC 2021**.
5. “Physics Aware Machine Learning for Structural Topology Optimization.” 16th U.S. National Congress on Computational Mechanics, **USNCCM 2021**.
6. “Deep learning frameworks for structural topology optimization.” Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering and Technology, **MMLDT 2021**.

## LEADERSHIP AND AWARDS

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- Recipient of **Graduate Research Excellence Award** at Iowa State University May 2024.
- **General Manager** at Technovanza’16 (Annual Technical Festival of VJTI). [[website](#)]
- Awarded with **Foundation for Excellence (FFE) Scholarship** which covered four years of undergrad tuition fees.