

# Sidhant R. Nair

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## SUMMARY

Final-year B.Tech student in Mechanical Engineering with Computer Science Minor at IIT Delhi specializing in privacy-preserving machine learning and federated optimization. Research experience in differential privacy, federated learning, and secure AI systems across IIT Delhi, IIT Hyderabad, and ISI Kolkata, with publications under review at IEEE T-PAMI and TMLR. Core expertise in second-order federated optimization with differential privacy guarantees, privacy accounting mechanisms, and privacy-preserving system deployment. Recognized through KVPY Fellowship, Amazon ML Summer School (top 3%), and research internships at Philips Healthcare and SONY Corporation.

## EDUCATION

<b>Indian Institute of Technology Delhi</b> <i>B.Tech. in Mechanical Engg., CGPA: 7.92/10.0</i>	New Delhi, India Oct'22 – Present
<b>Modern Vidya Niketan</b> <i>Class XII CBSE, Percentage: 96.8%</i>	Faridabad, India Mar'22
<b>Modern Vidya Niketan</b> <i>Class X CBSE, Percentage: 97.2%</i>	Faridabad, India Mar'20

## SCHOLASTIC ACHIEVEMENTS

- **Interdisciplinary Specialisation (Minor) in Computer Science:** Coursework in AI systems and Deep Learning
- **Summer Undergraduate Research Award:** Sole Mechanical Engg. team, awarded to **top 4%** among **1200+** peers
- **Amazon ML Summer School (MLSS'24):** Selected in the **top 3%** of **85,000+** applicants, trained in advanced ML
- **Joint Entrance Examinations(JEE):** Ranked among the **top 0.1** percentile qualifying JEE Mains and Adv exams
- **KVPY Research Fellowship (IISc Bangalore):** Twice awarded for clearing SA & SX streams out of **1.2 lakh+**

## PUBLICATIONS & PATENTS

<b>Accelerated Training of Federated Learning (FL) via Second-Order Methods</b> <i>Submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence (T-PAMI)</i>	Apr'25 <a href="#">arXiv:2505.23588</a>
• Co-authored research detailing the convergence behavior and communication efficiency of second-order FL methods	

## CONFERENCES

<b>DP-FedSOFIM:DP Federated Stochastic Optimization using Regularized FIM</b> <i>Submitted to Transactions on Machine Learning Research (TMLR)</i>	Jan'26 <a href="#">arXiv:2601.09166</a>
• Privacy-preserving second-order federated optimization with $(\epsilon - \delta)$ DP guarantees for heterogeneous distributions	
<b>FedDAF: Federated Domain Adaptation using Model Functional Distance</b> <i>Under review, Rejected at IEEE/CVF Winter Conference on Applications of Computer Vision</i>	Aug'25 <a href="#">arXiv:2509.11819</a>
• Developed a novel FL domain adaptation approach addressing limited target data and client distribution heterogeneity	
<b>Towards Support-Free Printing in Extrusion Manufacturing</b> <i>Presented at ASME International Mechanical Engineering Congress &amp; Exposition (IMECE)</i>	Mar'25 <a href="#">IMECE-160285</a>
• Optimized computational object slicing and multi-axis GCODE design for Industry-University collaboration with SONY	

## RESEARCH EXPERIENCE

<b>Differentially Private 2nd-Order Optimization in FL   ISI Kolkata</b> <i>Prof. Tanmay Sen, Statistical Quality Control &amp; OR Unit</i>	Jun'25 – Present
• Designing 2nd-order Federated Learning(FL) optimizers with momentum-corrected Newton steps for faster convergence	
• Implementing a federated privacy accountant with Rényi DP and subsampling amplification, ensuring $(\epsilon, \delta)$ -DP	
• Building a dimension-aware gradient clipping framework for ResNet, stabilizing updates under noisy Hessians	
• Achieved <b>8x</b> noise reduction via subsampling, demonstrating <b>70%</b> accuracy outperforming first-order baselines	
<b>Accelerated Training of FL via 2nd-Order Methods   IIT Hyderabad</b> <i>Prof. C. Mohan, Dept. of Computer Science Engg., Former Dean of Public &amp; Corporate Relations</i>	Oct'24 – Apr'25 <a href="#">arXiv:2505.23588</a>
• Benchmarked convergence of Newton-CG, L-BFGS and quasi-Newton methods on heterogeneous federated clients	
• Implemented Hessian-free and low-rank approximation schemes, reducing communication overhead by over <b>40%</b>	

- Diagonal and Nyström-based second-order updates tested for scalability in large-scale distributed optimization
- Developed preconditioning strategies for distributed second-order optimization with non-IID data heterogeneity

## WORK EXPERIENCE

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### Healthcare Design and Innovation Intern | Philips India Ltd May'25 – Jul'25

*Dr. Amar Banerjee, Research and Innovation Management, HIC Pune, India*

- Built an AI-driven CAD pipeline converting natural language prompts to structured JSON for parametric modeling
- Integrated SQL-backed ChromaDB retrieval with Fusion API to align JSON parameters for precise code mapping
- Deployed Qwen 2.5 Coder (7B) on Ollama, translating JSON into Autodesk Python APIs for automated CAD tasks
- Validated CAD-SQL workflow across multiple design tasks, cutting manual drafting by **60%** and boosting iterations

### SSUP Research Intern | SONY Corp. Apr'24 – Oct'24

*Prof. Sagar Sarkar & Prof. Amber Srivastava, Dept. of Mechanical Engg., IIT Delhi, India*

- Designed a native slicing and G-code generation framework in Blender for India's first 5-axis FDM based 3D printer
- Integrated Python APIs (PyDy, BlendPy) with Rhino3D workflows to enable precise multi-axis toolpath planning
- Optimized slicing routines to minimize redundant tool movements, improving deposition efficiency and accuracy
- Implemented CNN and ViT based anomaly detection for extrusion, enabling adaptive feedback and early fault alerts

## PROJECTS

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### Policy Gradient Methods in Parameterized RL Problems | BTech. Project Aug'25 – Present

*Prof. Amber Srivastava, Dept. of Mechanical Engg., IIT Delhi, India*

- Extending parameterized MDP framework to continuous action spaces via policy gradient methods versus Q-learning
- Implementing maximum entropy principle with deterministic annealing in actor-critic arch. for exploration control

### Federated Domain Adaptation using Functional Distance | Research Project Jun'25 – Aug'25

*Prof. C. Mohan, Dept. of Computer Science Engg., IIT Hyderabad, India*

[arXiv:2509.11819](https://arxiv.org/abs/2509.11819)

- Proposed FedDAF, a federated domain adaptation framework addressing both domain shift and limited target data
- Introduced functional distance-based aggregation, aligning target and source models via mean gradient fields
- Achieved **15–20%** accuracy gains over state-of-the-art FL, PFL and FDA methods on CIFAR-10, PACS and Caltech10

### fMRI-based Image Reconstruction | Advanced Functional Brain Imaging Course Project Jan'25 – May'25

*Prof. Rahul Garg, Dept. of Computer Science Engg., IIT Delhi, India*

- Trained a VAE-GAN decoder to reconstruct visual stimuli from fMRI BOLD signals, achieving a **0.73** SSIM score
- Preprocessed multimodal fMRI data with FSL pipelines, including motion correction and GLM feature extraction
- Mapped voxel activity to image space using ridge regression, improving voxel encoding accuracy across visual cortex
- Applied PCA/ICA for dimensionality reduction of voxel data, improving image reconstruction latency by nearly **25%**

### CV Fraud Detection System | Independent Project Oct'24

*Eightfold.AI Hackathon, IIT Delhi, India*

- Designed a risk scoring system leveraging autoencoder residuals and reciprocity analysis to flag inconsistencies
- Built a hybrid NLP pipeline integrating BERT embeddings, TF-IDF weighting, and sequencing for fraud detection
- Detected anomalies in recommendation letters and superlative usage, achieving around **65%** recall on validated data

## TECHNICAL SKILLS

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**Programming:** Python, C/C++, SQL, MATLAB | **AI/ML:** VAE-GAN, Rényi DP, BiLSTM, L-BFGS, Newton-CG, Diffusion Models (Wavelet, DreamFusion) | **Neuroimaging:** fMRI, BOLD, GLM, FSL/SPM | **Tools:** PyTorch, TensorFlow Privacy, Opacus, ChromaDB, LangChain, Ollama, Git, CuPy, XGBoost | **Other:** Fusion360, Ansys, Blender, Rhino3D

## POSITIONS OF RESPONSIBILITY

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- **Academic Mentor (MEL1002):** Serving as the mentor for the first year course on Engineering Mechanics at IIT Delhi
- **Final Year UG Convener:** Unanimously elected out of **90+** peers to represent the Dept. of Mechanical Engg.
  - Actively represented the student body in departmental & institute forums, influencing policy and academic discussions
- **Coordinator, Rendezvous:** Managed logistics & coordinated events for IIT Delhi's annual cultural fest
  - Led 50+ volunteers in scheduling, logistics and execution of events attended by 10,000+ participants
- **Captain & Vice-Captain, Lawn Tennis Team:** Coordinated training & competition strategy for Inter-Collegiate meets

## REFERENCES

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- Prof. Rahul Garg** IIT Delhi  
*Professor, Department of Computer Science & Engineering*
- Prof. Chalavadi Krishna Mohan** IIT Hyderabad  
*Professor, Department of Computer Science & Engineering*
- Prof. Tanmay Sen** ISI Kolkata  
*Assistant Professor, Stochastic Quality Control & Operations Research Unit*
- Prof. Sagar Sarkar** IIT Delhi  
*Assistant Professor, Department of Mechanical Engineering*

## LINKS

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### Professional Profiles

GitHub: <https://github.com/sid0nair>

LinkedIn: <https://www.linkedin.com/in/sid0nair/>

ORCID: <https://orcid.org/0009-0009-7380-3553>

Google Scholar: <https://scholar.google.com/citations?user=xs57uAkAAAAJ&hl=en>

### Publications & Preprints

#### Accelerated Training of Federated Learning via Second-Order Methods

*Submitted, IEEE T-PAMI*

arXiv: <https://arxiv.org/abs/2505.23588>

#### DP-FedSOFIM: Differentially Private Federated Stochastic Optimization using Regularized Fisher Information Matrix

*Target Submission: ICML 2026*

arXiv: <https://arxiv.org/abs/2601.09166>

#### FedDAF: Federated Domain Adaptation using Model Functional Distance

*Under review, Rejected at IEEE/CVF WACV*

arXiv: <https://arxiv.org/abs/2509.11819>

#### Towards Support-Free Printing in Extrusion-Based Additive Manufacturing: Path Planning and Process Control

*Published, ASME IMECE 2025*

Paper ID: IMECE-160285

ASME: <https://doi.org/10.1115/IMECE-INDIA2025-160285>

### Project Repositories

#### DP-SOFIM (Differentially Private Second-Order Federated Optimization)

<https://github.com/sid0nair/Differentially-private-federated-learning>

#### Philips Healthcare CAD Pipeline

<https://github.com/sid0nair/parametric-cad-generator>

#### fMRI-based Visual Reconstruction (VAE-GAN)

<https://github.com/sid0nair/fMRI-Image-Reconstruction>

#### Policy Gradient Methods in Parameterized RL

<https://github.com/sid0nair/Parameterized-MDPs>

#### SONY SSUP 5 Axis GCODE Generator

<https://github.com/sid0nair/5Axis-Gcode-Generator>

#### CV fraud Detection System

[https://github.com/sid0nair/WhiteRose\\_CV\\_FraudDetection](https://github.com/sid0nair/WhiteRose_CV_FraudDetection)