Bhushan Deshpande

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Research Summary

My research interests lie at the intersection of **Brain-Inspired AI**, **Computational Neuroscience**, and **Efficient Deep Learning**. I study how biological principles, like pruning, plasticity, information bottlenecks, and inductive biases, can be formalized into architectures and learning rules to improve parameter efficiency, generalization, and representation learning in artificial neural networks.

Education

Indian Institute of Science Education and Research (IISER), Pune — Pune, India
BS-MS Dual Degree in Interdisciplinary Sciences (MS Thesis in Data Science) — *2020 – 2025*

- Master of Science (CGPA: **8.4/10**) | Bachelor of Science (CGPA: 7.6/10)
- Recipient of the prestigious **DST INSPIRE Scholarship** and **Infosys Foundation Scholarship** (2020–2025).
- **Relevant Coursework:** NLP, Bayesian Theory, Parameter Estimation and Inverse Theory, Generalized Linear Models, Computational Neuroscience .

Research Projects

Dynamic Activity-Dependent Pruning (DADP) — First Author
A Reverse-Hebbian Structural Plasticity Framework for Neural Networks — *Mar. 2026 – Sep. 2026*
Status: *Under Review, ICLR 2027*

- Built a single-pass pruning method inspired by synaptic plasticity to compress neural networks efficiently.
- Discovered that pruned vision models naturally retain early sensory layers, while transformers keep late context layers.

Olfactory-Inspired Sparse Combinatorial Coding — Independent, First Author
Bio-Inspired Inductive Biases for Low-Resource Sequence Learning — *Dec. 2025 – Jun. 2026*
Preprint: *arXiv:2606.21895*

- Designed a biologically inspired sparse compression layer based on mammalian olfactory circuits.
- Implemented an Olfaction Module + BiLSTM-CRF architecture.
- Reduced model parameters by **44%** while improving low-resource F1 score by up to **6.23%** over dense baselines.

Retrieval-Augmented Large Code Generation and Evaluation — Coriolis Technologies / IISER Pune
Master of Science Thesis — *May 2024 – May 2025*

- Developed RAG system to synthesize complex 600– 800-line Python code. Improved zero-shot baseline accuracy from **20%** to **65–70%**.
- Designed an iterative generation and self-correction loop with feedback. Improved accuracy to **90%.**
- Formulated an LLM-as-a-Judge evaluation to assess synthesized code generated in every iteration.
- Benchmarked hallucination dynamics and instruction-following across 12+ open-source models (1B–24B parameters) under 40 GB VRAM

Industry Experience

Coriolis Technologies Pvt. Ltd. — Pune, India
Data Scientist (Project MIRA) — *Nov. 2025 – Present*

- Developed pretraining, SFT, IFT, and RLHF data acquisition and synthesis pipelines.
- Designed high emotional quotient (EQ) synthetic text and audio data generation pipelines.
- Built a SOTA language identification model (MIRA-IndicLID) for 22 constitutional code-mixed Indian languages.
- Build Orpheus-3B-TTS-Hindi, a speech-LLM model fine-tuned for English-mixed Hindi speech synthesis.
- Distilled larger teacher LLMs into smaller student SLMs for structured solution generation of physics problems

Coriolis Technologies Pvt. Ltd. — Pune, India
MTS(May 2025 – Oct. 2025) | *Research Intern (MS Thesis)* (May 2024 – May 2025) — *May 2024 – Oct. 2025*

- Deployed code-generation tool that cut script development time from 2 days to under 4 hours.
- Built an automated testing pipeline to catch model errors and code syntax bugs before production.
- Led a team of 4 engineers to implement research findings in production environment.

Publications & Preprints

- **B. Deshpande.** *Olfactory-Inspired Sparse Combinatorial Coding for Low-Resource Named Entity Recognition.* Preprint, Jun. 2026. arXiv:2606.21895.
- **B. Deshpande.** *Dynamic Activity-Dependent Pruning (DADP): A Reverse-Hebbian Structural Plasticity Framework for Neural Networks.* Under review, ICLR 2027. arXiv:2610.11853.

Invited Talks & Conferences

Chennai Mathematical Institute (CMI) Chennai, India
Invited Research Speaker *Apr. 2026*

- **Scalable Acquisition, Synthesis, and Curation of Data for Indic LLMs**: distribution shifts between pretraining and alignment data, and the need for high-quality synthetic datasets.
- **Beyond Native Scripts: Robust Language Identification for Romanized and Code-Mixed Indian Languages**: script loss, linguistic clustering, and curriculum-based training strategies.

Int'l Conf. on Advanced Scientific Computing & Machine Learning BITS Pilani, Goa Campus
Participant *Feb. 2026*

- Participated in sessions on scientific computing, AI-driven simulations, and deep learning applications.

Relevant Courses

- **Mathematics & Statistics:** Bayesian Theory and Application, Parameter Estimation and Inverse Theory, Generalized Linear Models (GLM), Graph Theory & Algorithms, Linear Algebra, Multivariable Calculus, Combinatorics, Probability & Statistics.
- **Machine Learning:** Mathematical Foundations of Generative AI, Natural Language Processing, Advanced Learning Algorithms.
- **Neuroscience & Biology:** Computational Neuroscience, Mathematical and Computational Biology.

Technical & Theoretical Skills

- **Languages**: Python (Advanced), R (Intermediate)
- **Libraries**: PyTorch, NumPy, SciPy, Pandas, t-SNE, UMAP,
- **Frameworks**: Hugging Face, LlamaIndex, Git, Linux, Docker, LaTeX
- **Techniques**: Few-Shot Learning, RAG, LLM-as-a-Judge, Fine-tuning (LLMs, TTS models), Knowledge Distillation.

Leadership, Communication & Outreach

- Mentored **two research interns** on fine-tuning, evaluating, and open-sourcing speech models.
- Previously **led a team of 4 engineers** during a research internship, translating research findings and client requirements into production implementation.
- Delivered two invited research seminars at the Chennai Mathematical Institute on Indic NLP and LLMs.
- **Exoplanet Conference (Aug. 2023):** Volunteered in event coordination and operations for *"Strange New Worlds: The Exploration of Exoplanets"* at IISER Pune.
- **Industry–Academia Conclave (Aug. 2023):** Coordinated logistics and speaker sessions at IISER Pune, hosting 100+ industry and academic delegates.
- Experience in teaching and mentoring graduate-level students in data science courses.

Honors & Achievements

- **DST INSPIRE Scholarship (SHE) (2020–2025):** Awarded by the Department of Science & Technology, Govt. of India, to top 1% performers in Higher Secondary examinations for academic excellence in natural and basic sciences across BS-MS studies.
- **Infosys Foundation Scholarship (2020–2025):** Merit-based full financial scholarship awarded throughout the 5-year BS-MS dual degree program.
- **Graduate Aptitude Test in Engineering (GATE) – Statistics (2024):** Secured **All India Rank (AIR) 266** in the national competitive examination.

Languages & Personal Interests

- **Languages:** English (Fluent), Hindi (Native), Marathi (Native), German (Basic)
- **Interests & Activities:** Badminton, Chess, Distance Running, Painting, Cooking, Traveling