

Vispi Karkaria

2145 Sheridan Rd, Mechanical Eng., B224 – Evanston, IL 60208
📞 +1 (773) 807 0893 • ✉ vispikarkaria2026@u.northwestern.edu

🎓 Education

Northwestern University <i>Ph.D. in Mechanical Engineering, GPA: 3.87/4.00</i> Focus: Machine Learning, Digital Twins, Scientific Computing Honors: Winner of the Ph.D. Best Paper Presentation Award and the Inaugural Graduate Mentorship Award	Evanston, IL, USA <i>Sep. 2021 – March 2026</i>
Northwestern University <i>Master's Level Graduate Certificate in Predictive Science, GPA: 4.00/4.00</i> Focus: Engineering Optimization, Artificial Intelligence, Uncertainty Quantification Honors: Achieved 4.00/4.00 GPA in the Coursework	Evanston, IL, USA <i>Sep. 2022 – Sep. 2022</i>
Northwestern University <i>Master's of Science in Mechanical Engineering, GPA: 3.870/4.00</i> Focus: Engineering Optimization, Deep learning, Machine Learning Honors: Achieved 4.00/4.00 GPA in the Coursework	Evanston, IL, USA <i>Sep. 2021 – Dec. 2025</i>
College of Engineering, Pune (COEP) <i>Bachelor of Engineering in Mechanical Engineering, GPA: 9.84/10.00</i> Graduated with Gold Medal; Ranked 1st in university	Pune, India <i>Jul. 2018 – Jul. 2021</i>
Cusrow Wadia Institute of Technology <i>Diploma in Mechanical Engineering, Grade: 96.5%</i> Graduated with distinction; Received 4 Gold Medals and 11 Academic Awards	Pune, India <i>Aug. 2015 – May 2018</i>

🏢 Industry Experience

Lila Sciences <i>Machine Learning Scientist</i> <ul style="list-style-type: none">Building agentic AI systems and scientific foundation models for autonomous discovery in chemistry and materials science.Developing time series analysis frameworks and scientific machine learning pipelines for accelerating experimental design and optimization.	San Francisco, USA <i>March 2026 – Present</i>
Northwestern University <i>Graduate Research Assistant</i> <ul style="list-style-type: none">Developed transformer neural net and Uncertainty-Aware Reinforcement Learning frameworks, enhancing tire monitoring, extending longevity by 25%, and improving decision accuracy by 50%. This work was conducted on applied research projects in collaboration with Michelin Tires.Created U-LoRA for efficient machine learning updates and VR-SMOTE for data balancing, boosting F1-score by 50%.	Evanston, USA <i>September 2021 – March 2026</i>
Epsilon Data Management LLC <i>Ph.D. Machine Learning Scientist Intern</i> <ul style="list-style-type: none">Led development of a transformer-based model that improved win-rate prediction accuracy in AdTech systems by 25%.Built an interpretable model with integrated uncertainty quantification (UQ), increasing bidding decision reliability by 20% and reducing failed bids by 15%.	Chicago, USA <i>June 2025 – September 2025</i>
Ansys INC <i>Machine Learning Research Intern</i> <ul style="list-style-type: none">Developed a hybrid modeling framework using Transformers for time series analysis and temporal-spatial sensitivity analysis, improving predictive accuracy by 30%, with a patent applied for the machine learning algorithm developed.Integrated the framework into Ansys Twin AI software, reducing computational time by 25% and enhancing the scalability of the model, with the underlying technology Patented.	Evanston, USA <i>June 2024 – September 2024</i>

Tata Research Development and Design Center

Pune, India

Machine Learning Intern

August 2020 – August 2021

- Leveraged machine learning (Gaussian processes) to achieve a 50% reduction in material selection time for airplane wing manufacturing.
- Spearheaded a data-driven three-phase project encompassing digital twin creation, machine learning model development, and data uncertainty analysis.

Sun Moksha Power Pvt. Ltd.

Pune, India

Quantitative Researcher Intern

May 2020 – July 2020

- Enhanced a village's education outcomes by 20% over two years through data-driven policy modeling using System Dynamics.
- Employed analytical methods, including the Dynamic Triangle Method, to develop data-centric Smart Village interventions.

Research Experience

Multi-Agent LLM System for Automated Optimization Problem Solving

Algorithms: GPT, Agentic AI, RAG-based Systems, Language Models

2023–Present

- Initiated the creation of an innovative API using GPT, BART, and a Retrieval-Augmented Generation (RAG) system, allowing users to input optimization problems for intelligent solutions.
- Implemented a two-stage approach where the system first selects the appropriate optimization method using RAG and then invokes it, providing efficient and accurate solutions to users.

Federated Learning Foundational Models with Attention-based Neural Operator

Algorithms: Federated Learning, Neural Operator, Attention, Foundational Model

2024–Present

- Developed an Attention-based Neural Operator, enhancing the accuracy of neural operators by 25%, and facilitating the analysis of temporal-spatial relationships.
- Adapted the Attention-based Neural Operator into a foundational model, leveraging Federated Learning for transferability and scalability across different applications with Cyber-Security in mind.

Reinforcement Learning-Transformer based Tire Resource Allocation Algorithm

Algorithms: Transformers, Sequential Learning, Reinforcement Learning

2023–Present

- Boosted real-time tire lifespan prediction accuracy by 50% using an advanced Interpretable Temporal Fusion Transformer.
- Developed a reinforcement learning framework for tire resource allocation, extending tire health by 95% using the transformer model.

Transformer-based Digital Twin framework for Time Series Optimization

Algorithms: Deep Learning, Big Data, Transformers, Bayesian Optimization

2022–2024

- Reduced prediction time in Additive Manufacturing using a transformer-based surrogate model.
- Developed a transformer-based machine learning model to quantify uncertainty, enhancing the reliability of predictions.
- Created a digital twin using a novel method named Bayesian Optimization of Time Series (BOTS) which aid in time series optimization.

Latent-Variable Constrained Bayesian Optimization (with Hyundai Motors)

Algorithms: Mixed Variable Optimization, Gaussian Processes, PyTorch

2022–2023

- Delivered a 20% rise in Hyundai Motor Company's operational efficiency and cut costs by 15% by addressing optimization challenges with LV-CBO.
- Pioneered LV-CBO to seamlessly handle both continuous and categorical variables.

Publications All Papers on Google Scholar

1. Chen, Y-P., Tsai, Y-K., **Karkaria, V.**, and Chen, W., 2026. "Uncertainty-Aware Digital Twins: Robust Model Predictive Control Using Time-Series Deep Quantile Learning." *Journal of Mechanical Design*.
2. **Karkaria, V.**, Lee, D., Chen, Y., Yu, Y., and Chen, W., 2025. "An Attention-based Spatio-Temporal Neural Operator for Physics Prediction and Discovery." *Machine Learning: Science and Technology*
3. **Karkaria, V.**, Tsai, Y-K., Chen, Y-P., and Chen, W., 2025. "An Optimization-Centric Review on Integrating Artificial Intelligence and Digital Twin Technologies in Manufacturing." *Engineering Optimization*, 57(1), pp.161–207.
4. Chen, Y-P., **Karkaria, V.**, Tsai, Y-K., Rolark, F., Quispe, D., Gao, R. X., Cao, J., and Chen, W., 2025. "Real-Time Decision-Making for Digital Twin in Additive Manufacturing with Model Predictive Control Using

- Time-Series Deep Neural Networks." *Journal of Manufacturing Systems*, 80, pp.412–424.
5. **Karkaria, V.**, Chen, J., Luey, C., Siuta, C., Lim, D., Radulescu, R., and Chen, W., 2024. "A Digital Twin Framework Utilizing Machine Learning for Robust Predictive Maintenance: Enhancing Tire Health Monitoring." *Journal of Computing and Information Science in Engineering*, 25, pp.01–11.
 6. Zemskov, A. D., Fu, Y., Li, R., Wang, X., **Karkaria, V.**, Tsai, Y-K., Chen, W., Zhang, J., Gao, R., Cao, J., et al., 2024. "Security and Privacy of Digital Twins for Advanced Manufacturing: A Survey." *arXiv preprint arXiv:2412.13939*.
 7. Dewberry, N. K., AlHmoud, I., Benton, K., Suarez, D., Chen, Y-P., **Karkaria, V.**, Tsai, Y-K., et al., 2025. "A Real-Time VR-Enabled Digital Twin Framework for Multi-User Interaction in Industry 4.0." *Manufacturing Letters*, 44, pp.1486–1497.
 8. **Karkaria, V.**, Goeckner, A., Zha, R., Chen, J., Zhang, J., Zhu, Q., Cao, J., Gao, R.X. and Chen, W., 2024. "Towards a Digital Twin Framework in Additive Manufacturing: Machine Learning and Bayesian Optimization for Time Series Process Optimization." *Journal of Manufacturing Systems*, 75, pp.322-332.
 9. **Karkaria, V.**, Chen, J., Siuta, C., Lim, D., Radelescu, R., & Chen, W., 2023. "A Machine Learning Based Tire Life Prediction Framework for Increasing Life of Commercial Vehicle Tires." *Journal of Mechanical Design*, 1–21.
 10. van Beek, A., **Karkaria, V. N.**, and Chen, W., 2023. "Digital Twins for the Designs of Systems: A Perspective." *Structural and Multidisciplinary Optimization*, 66(3), p.49.
 11. Jha, D., **Karkaria, V. N.**, Karandikar, P. B., Desai, R. S., 2022. "Statistical Modeling of Hybrid Supercapacitor." *Journal of Energy Storage*, 46, 103869. .
 12. **Karkaria, V. N.**, Pradeep, K., Rohith Kumar, T., Karandikar, P. B., Mistree, F., Allen, J. K., 2021. "Statistical Analysis Of Electrode-Electrolyte-Separator To Improve Effectiveness Of Supercapacitor." *Turkish Journal of Computer and Mathematics Education*, 2(14), 1600.
 13. Godse, L. S., **Karkaria, V. N.**, Bhalerao, M. J., Karandikar, P. B., and Kulkarni, N. R., 2020. "Process Based Modeling of Nylon Separator Supercapacitor." *Energy Storage*, e204. .
 14. Kokate, V. L., **Karkaria, V. N.**, Karandikar, P. B., and Holmukhe, R. M., 2020. "Implementation of Design of Experiments for E-Rickshaw Range Prediction." *Journal of Advanced Research in Dynamical and Control Systems*, 12, 1219–1227. .

Conference Papers

1. **Karkaria, V. N.**, Chen, Y-P., Tsai, Y-K., Erdogan, G., Radulescu, R., & Chen, W., 2025. "AI-Driven Digital Twin Framework for Predictive Maintenance: Dynamic Decision Making and Adaptive Model Updates." In *Proceedings of the ASME 2025 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE)*, Anaheim, California, August 17–20, 2025
2. Tsai, Y-K., **Karkaria, V. N.**, Chen, Y-P., & Chen, W., 2025. "Multi-Generation Control Co-Design for Digital Twin-Enabled Systems With Deep Reinforcement Learning." In *Proceedings of the ASME 2025 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE)*, Anaheim, California, August 17–20, 2025.
3. Chen, Y-P., Tsai, Y-K., **Karkaria, V. N.**, & Chen, W., 2025. "Real-Time Decision-Making Under Uncertainty in Digital Twins: Robust Model Predictive Control Using Time-Series Deep Quantile Learning." In *Proceedings of the ASME 2025 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE)*, Anaheim, California, August 17–20, 2025.
4. **Karkaria, V.**, Das, A. K., Yadav, A., Sharma, A., Allen, J. K., & Mistree, F., 2021. "A Computational Framework for Social Entrepreneurs to Determine Policies for Sustainable Development." In *Proceedings of the ASME 2021 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE)*, Vol. 3B: 47th Design Automation Conference (DAC), Virtual, August 17–19, 2021. Paper No. V03BT03A019. .
5. Darekar, R., Gawande, N., **Karkaria, V.**, and Karandikar, P. B., 2021. "Analysis of Critical Issues in Retrofitting of ICE Vehicles." *Journal of Physics: Conference Series*, 2070(1), 012151. .
6. Shinde, S., Momin, T., **Karkaria, V. N.**, Karandikar, P. B., 2021. "Investigation of Substitute Jar

Materials for Laboratory-Grade Ball Milling Machine to Process Electrode Materials for Energy Storage Devices." *IOP Conference Series: Materials Science and Engineering*, Vol. 1206, 012018. .

7. **Karkaria, V. N.**, Karnadikar, A., Joshi, S., Aaditya, S. B. A., and Karandikar, P. B., 2023. "EV Charging Infrastructure Development Using Machine Learning." In *Proceedings of the 2023 4th International Conference for Emerging Technology (INCET)*, IEEE.

8. Godse, L. S., **Karkaria, V. N.**, Bhalerao, M. J., Khatua, S., Karandikar, P. B., 2019. "Electrode–Electrolyte Compatibility for Superior Performance of Supercapacitors." In *Proceedings of the International Conference on Power Electronics Applications and Technology in Present Energy Scenario (PETPES)*, IEEE, pp. 1–5. .

9. Kokate, V. L., Bankar, D. S., Holmukhe, R. M., **Karkaria, V. N.**, Karandikar, P. B., 2018. "E-Rickshaw: Present, Past and Future with Reference to Current Transportation in India." In *Proceedings of the International Conference on Recent Innovations in Electrical, Electronics & Communication Engineering (ICRIEECE)*, Vol. 1(1), pp. 1–15.

10. **Karkaria, V. N.**, Sarathchandran, V., Korgaonkar, P. R., Reddy, G. S. R., Mehta, S., Karandikar, P. B., 2018. "Review of Technologies for Making Electric Vehicles the Main Mode of Transport." In *Proceedings of the International Conference on Advances in Communication and Computing Technology (ICACCT)*, IEEE, pp. 142–148. .

11. Godse, L. S., **Karkaria, V.**, Karandikar, P. B., Kulkarni, N. R., 2017. "Innovative Methods of Ball Milling to Grind Activated Carbon as an Electrode Material for Enhancing the Performance of Ultracapacitors." In *Proceedings of the International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, IEEE, pp. 2034–2041. .

Book Chapters

1. **Karkaria, V.**, Chen, J., Siuta, C., Lim, D., Radelescu, R., and Chen, W., 2024. "Tire Life Assessment for Increasing Re-Manufacturing of Commercial Vehicle Tires." In *Technology Innovation for the Circular Economy: Recycling, Remanufacturing, Design, Systems Analysis and Logistics*, pp. 599–612.

Patent Applications

1. **Karkaria, V. N.**, Bhalerao, M. J., Wankhede, P., Kokate, V. L., and Karandikar, P. B., 2019. "Economic Test Setup for EV Motor Testing Using Innovative Coupling." Indian Patent No. 201921020439.

2. **Karkaria, V. N.**, Wardhekar, S. V., Prabhune, A. A., and Shinde, H. P., 2019. "Modified Hot Water Supply System for Water and Energy Saving." Indian Patent No. 201921021898.

3. **Karkaria, V. N.**, Bhalerao, M. J., Korgaonkar, P. R., Solanke, S. R., Kamble, U., and Karandikar, P. B., 2018. "Forward-Reverse Motion Multi-Cylinder Ball Milling Machine." Indian Patent No. 201821008148.

4. **Karkaria, V. N.**, Godse, L. S., Kulkarni, N. R., Choudhary, S., Singh, V., and Karandikar, P. B., 2017. "Motor/Bike Wheel-Driven Disc-Type Ball Mill Machine for Grinding Electrode Material of Electrochemical Storage Devices." Indian Patent No. 201721004818.

5. Godse, L. S., Karandikar, P. B., **Karkaria, V. N.**, Kulkarni, N. R., Kumar, P., Sharma, P., and Gadwal, P., 2016. "Advanced Ball Mill Machine for Grinding of Electrode Material for Electrochemical Devices." Indian Patent No. 201621023599.

Selected Honors and Awards

- **President, AI@NU** — Led AI research initiatives and student engagement at Northwestern University (2025).
- **Martin Outstanding Graduate Student Award** — Recognized for academic excellence and leadership in graduate research (2025).
- **NAMRC Best Paper Award** — Awarded for a paper published in the *Journal of Manufacturing Systems (JMS 2025)*.
- **NAMRC Student Research Award** — Recognized for a paper on digital twin frameworks in additive

- manufacturing (2024).
- **Inaugural Graduate Mentorship Award** — Honored for excellence in mentorship in the Mechanical Engineering Department at Northwestern University (2024).
- **NSF Fellowship Award** — Received at the 2nd International Association for Computational Mechanics (IACM) Conference (2023).
- **Predictive Science and Engineering Design Fellowship**, Northwestern University (2022–2023).
- **Walter P. Murphy Fellowship**, Northwestern University (2021–2022).
- **Gold Medalist**, University of Pune — Graduated first in undergraduate cohort (2021).
- **First Prize**, Paper Presentation Competition — Walchand College, Sangli (2021).
- **First Prize**, Project Presentation — Indian Institute of Technology (IIT) Roorkee (2021).
- **Best Research Paper Award** — International Conference on Communication, Computing, and Electronics Systems (2020).
- **First Prize**, Garrett Motion Project Competition — Army Institute of Technology (2020).
- **Second Prize**, Indian Institute of Metals Conference — College of Engineering Pune (2020).
- **First Rank**, Mechanical Engineering (Second Year) — College of Engineering Pune (2019).
- **First Prize**, Paper Presentation — Army Institute of Technology, Pune (2019).
- **Top Rank Holder**, Cusrow Wadia Institute of Technology — Awarded **4 Gold Medals** and **11 Academic Prizes** (2015–2018).
- **First Prize**, Paper Presentation — Anant Rao Pawar College of Engineering and Government Polytechnic, Pune (2018).
- **First Prize**, Diploma (First and Second Year) — Cusrow Wadia Institute of Technology (2018).

Training and Certification

- Earned certificate in Solid Works and Catia from Cusrow Wadia Institute of Technology (2018).
- Awarded certificate in Ansys and Dassault Abaqus from College of Engineering Pune (2019–2020).
- Received certificate in Systems Engineering for Industries Course from Siemens Company (2019).
- Earned certificate in Python coding from Coursera (2019).
- Earned certificate in Robotics from College of Engineering, Pune (2018).
- Received certificate in C, C++ from Disha Computer Classes (2018).
- Received certificate in Auto CAD from Cusrow Wadia Institute of Technology (2017).

Mentorship Experience

2025–Present: Ami Takamatsu — Undergraduate researcher exploring the use of genetic algorithms for engineering design optimization.

2024–2025: Christopher Leuy — Graduate mentee on a digital twin framework for remanufacturing; co-authored journal article published in *Journal of Computing and Information Science in Engineering (JCISE)*.

2022–2024: Vinamra Saxena — Master's student supervised on research in machine learning and mechanical engineering.

2022–2023: Dr. Dong Hyun Ha (Hyundai Motors) — Collaborated on applying latent-variable Bayesian optimization with trust-region methods for automotive design.

2023–2024: Arman Jain — Mentored in additive manufacturing and engineering design, with emphasis on digital twin integration.

Teaching Experience

Northwestern University

Grader, ME 341/441 – Engineering Optimization for Product Design and Manufacturing 2023–2025

- Assisted in developing quizzes and homework assignments focused on optimization algorithms and applications.
- Held regular office hours and provided project mentoring to 3–4 student teams, supporting technical development and implementation.
- Helped students debug code and interpret optimization results for course projects involving real-world design problems.

Northwestern University

Peer Mentor, CS 497 – Sports Technology

2023–2024

- Peer-mentored student groups working on machine learning applications in sports analytics.
- Advised on data preprocessing, model selection, and validation strategies for semester-long projects.

Grant Writing and Research Support

2024–2025: Assisted **Professor Wei Chen** in preparing major federal research proposals, including:

- **2025 Vannevar Bush Faculty Fellowship (VBFF)** — Supported literature review, technical framing, and alignment for project titled Foundation Models and Decisions for Digital Twins as a Learning System
- **DARPA Disruption Opportunity** — Contributed to proposal sections on foundational model development, uncertainty quantification, and digital twin integration in manufacturing