

Sharan Sahu

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RESEARCH INTERESTS

My research interests lie in statistical machine learning and using statistical/machine learning tools to improve clinical decision-making and bridge the gap between machine learning methodology and clinical practice. In particular, I am interested in theory and methods in the areas of high-dimensional statistics, robust optimization and statistics, reinforcement learning, language and diffusion models, and differential privacy.

EDUCATION

Cornell University

Ithaca, NY

Doctor of Philosophy in Statistics and Machine Learning

Aug. 2024 – May 2028

- GPA: 4.086 / 4.000
- Activities: Vice President of Cornell Statistics Graduate Society (SGS)
- First Year Support: Cornell University Graduate Fellowship (2024-2025)

University of California, Berkeley

Berkeley, CA

Bachelor of Arts in Computer Science

Aug. 2020 – May 2024

- Advisors: Iain Carmichael, Ryan Tibshirani
- Relevant Graduate Coursework:
 - * **Statistics:** Mathematical Statistics (STAT 210A), High Dimensional Statistics (STAT 210B), Statistical Learning Theory (STAT 241B / CS 281B), Mean Field Asymptotics in Statistical Learning (STAT 260)
 - * **Computer Science / Electrical Engineering:** Parallel Computing (CS 267), Graduate Algorithms (CS 270), Deep Reinforcement Learning (CS 285), Convex Optimization and Approximation (EE 227C)
 - * **Mathematics:** Measure Theory and Topology (MATH 202A), Functional Analysis (MATH 202B), Measure Theoretic Probability Theory (MATH 218A / STAT 205A), Differential Topology (MATH 214)
- Relevant Undergraduate Coursework:
 - * **Computer Science / Electrical Engineering:** Machine Learning (CS 189), Deep Learning (CS 182), Algorithms (CS 170), Data Structures (CS 61B), Operating Systems (CS 162), Database Systems (CS 186), Optimization (EECS 127), Probability and Random Processes (EECS 126), Networking (CS 168)
 - * **Mathematics:** Real Analysis (MATH 104), Complex Analysis (MATH 185), Introduction to Differential Forms and Integration Theory (MATH 105), Linear Algebra (MATH 110)

RESEARCH EXPERIENCE

Graduate Researcher

Aug. 2024 - Present

Computational Pathology Lab At UNC-Chapel Hill

Chapel Hill, NC

- Advised by Iain Carmichael
- Developing an LLM-driven system for automated pathology report parsing, leveraging GLiNER for Named Entity Recognition (NER) and BioBERT for medical concept extraction, enabling structured diagnosis prediction by grounding concepts to standardized ontologies (NCIT, ICD-9/10, SNOMED CT).
- Implementing a workflow to extract diagnosis concepts, modifiers, uncertainty, and negation status from pathology reports, enhancing interoperability with electronic health records (EHRs) and supporting AI-driven clinical decision-making.
- Designing a hybrid retrieval framework integrating BM25 string matching, vector similarity (RAG), and LLM-based concept refinement, improving ontology grounding accuracy and reducing manual annotation effort.

Undergraduate Researcher

Jan. 2023 - Aug. 2024

Berkeley Artificial Intelligence Research Lab

Berkeley, CA

- Advised by Iain Carmichael and Ryan Tibshirani on high-dimensional statistical and deep learning models for Computational Pathology applications, specifically nonparametric estimation, conformal inference, and computer vision
- Developed "wsic", a parallelized image segmentation package for whole slide images (WSIs) including H&E, immunohistochemistry, and multiplex immunofluorescence with hyperparameter tuning using distributed computing across GPUs with Ray
- Developed a cell/nuclear segmentation model that can be trained on mixed annotations with masks, bounding boxes, and centroids to significantly reduce the amount of time it takes to annotate data sets for cell segmentation using DETR, ViTs, and U-Net under a representational stitching and multi-task learning framework with various loss balancing techniques such as grid searches and gradient normalization

- Designed tools for the "segT" package to quantitatively and qualitatively evaluate segmentation results, including detailed error metrics and visualization tools for various instance segmentation formulations

Undergraduate Researcher

May. 2022 - Aug. 2022

Stanford Artificial Intelligence Lab (SAIL)

Palo Alto, CA

- Advised by Despoina Paschalidou and Suyu You on evaluating generative networks' performance
- Developed reliable and efficient metrics for fidelity, diversity, and authenticity used to evaluate the performance of generative networks (GANs, VAEs, Flow-Based Models, Diffusion Models, etc)
- Refined Precision and Recall metrics using methods such as SimCLR, Barlow Twins, DeepCluster, and SwAV, integrating concepts from nonparametric statistics and manifold theory
- Addressed high-dimensional embedding challenges by implementing PCA and Robust PCA, improving metric reliability and accuracy in evaluating generative models
- Explored theoretical aspects of generative models' precision-recall trade-offs, developing new metrics based on f-divergences and topological significance, and provided formal performance guarantees using concentration inequalities and persistent homology

Undergraduate Researcher

Sept. 2021 - May. 2022

Stanford Artificial Intelligence Lab (SAIL)

Palo Alto, CA

- Advised by Stanford Postdoc Despoina Paschalidou and ARL West research scientist Suyu You on generative modeling, computer vision, and reinforcement learning
- Enhanced scene grammar and policy gradient methods in NVIDIA's Meta-Sim framework to improve the quality and relevance of synthetic datasets for downstream tasks
- Implemented differentiable rendering techniques, such as Differentiable Monte Carlo Ray Tracing, to achieve efficient backpropagation through non-differentiable rendering functions, optimizing for visual similarity to real data
- Explored alternative gradient estimation methods, including PPO, TRPO, and Generalized Advantage Estimators (GAE), to reduce variance and improve task performance in synthetic data generation
- Developed probabilistic scene grammar trees and parameter estimation techniques using hierarchical clustering, Bayesian networks, and deep learning algorithms, enhancing the synthesis of plausible scene structures without ground truth annotations

Undergraduate Researcher

Jan. 2021 - May 2021

UC Berkeley Electrical Engineering and Computer Science (EECS)

Berkeley, CA

- Developed and optimized machine learning models to accelerate Density Functional Theory (DFT) computations to identify efficient electrocatalysts in Hydrogen Energy Storage and methanation
- Redesigned neural network architectures, including SchNet, DimeNet++, and Crystal Graph Convolutional Neural Networks (CGCNN), to model quantum interactions more effectively
- Implemented feature selection using Lasso regularization and stability enhancements with Ridge regularization to improve model interpretability and performance in computational chemistry tasks
- Employed quasi-Newton optimization methods to increase efficiency in handling large datasets and achieve faster convergence, significantly reducing computational resources required for DFT calculations
- Enhanced SchNet framework performance, achieving lower loss and mean-average error through continuous-filter convolutional layers and rotationally invariant energy predictions

INDUSTRY EXPERIENCE

Cofounder & Lead Research Scientist

May. 2023 - Present

167 Labs

Fremont, CA

- Engineered an Employee Self Service framework for HR services, providing policy overviews and detailed information
- Utilized state-of-the-art LLMs (Mistral, OpenAI, Claude) with RAG (FAISS) using Langchain/Autogen, implementing reranking models and database optimizations for enhanced information retrieval
- Integrated framework with external APIs and models for real-time calculations, enabling context-based function calling and personalized responses based on employee details and organizational hierarchy and bonus and paycheck calculations, incorporating historical performance and fluctuating tax brackets

Data Science Intern

May. 2023 - Aug. 2023

Marine Corps Tactical Systems Support Activity (MCTSSA)

Camp Pendleton, CA

- Engineered Logistic Regression and fine-tuned BERT models to accurately classify various system requirements, slashing testing efforts by 500% and saving \$1M in system requirement classification tasks
- Developed a full-stack chat application interfaced with classified Marine Corps documents, employing Node.js, Express.js, Flask, and fine-tuned LLMs like Llama V2 and Falcon 7B

- Created a vector-based retrieval database using the pgvector extension in PostgreSQL for fast similarity search along with experimenting with Annoy, Milvus, and Pinecone
- Presented work and research to high-level leadership at the AIC2 I&E Sub Working Group, under the Joint Staff J6 at the Pentagon, and the Marine Corps Combat Development & Integration (CD&I), showcasing innovative AI/ML solutions to streamline system requirement classification, reduce redundancy, and save in operational costs

Software Engineering Intern

May. 2022 - Aug. 2022

Marine Corps Tactical System Support Activity (MCTSSA)

Camp Pendleton, CA

- Developed ML solutions utilizing CNN and Sparse Dictionary Learning for robust classification of standard waveforms in the EMF spectrum, significantly improving detection rates by 35% compared to traditional methods
- Designed and optimized data preprocessing and image extraction pipelines for a comprehensive application capable of extracting over 10,000 high-precision definitions from documentation, leveraging OpenCV, Tesseract, and the Schwartz-Hearst algorithm to automate 95% of manual extraction efforts, leading to a 40% reduction in processing time
- Engineered full-stack cloud applications for streamlined resource management and deconfliction, resulting in 30% faster allocation and reducing operational bottlenecks by 25%, leveraging the React JS framework and cloud infrastructure to support up to 1000 users concurrently

Product Data Science Intern

May 2021 – Aug. 2021

Novartis

Libertyville, IL

- Pioneered ML and data science innovations, including database optimizations and advanced statistical modeling, which resulted in over \$1.5M in operational savings and a 20% improvement in system efficiency by reducing query time and optimizing resource allocation
- Deployed ARIMA and LSTM models to forecast inventory and equipment values with an accuracy improvement of 95%, leading to a 30% reduction in overstocking costs and 25% better capital allocation. Utilized Pandas, SQL, and PyTorch to process millions of data points seamlessly across distributed environments
- Collaborated with cross-functional teams to institute OAuth/SSO protocols, increasing security measures and user authentication efficiency by 50% across revenue management business applications, resulting in a 35% reduction in system breaches and a 15% boost in customer satisfaction

Software Engineering and Data Science Intern

Sept. 2018 – June 2020

Northrop Grumman Corporation

Rolling Meadows, IL

- Was part of the data science team in leveraging Kalman Extended and Particle Filtering, AdaBoosting, and PCA with decisive logic for a self-autonomous system
- Crafted a CNN architecture with batch normalization, max pooling, and dropout, enhancing surface deformity detection using Keras and TensorFlow
- Authored a comprehensive 20-page research paper, showcased at the annual Northrop Grumman research conference

TEACHING EXPERIENCE

EECS 16A uGSI

Aug. 2021 - Dec. 2021

UC Berkeley Electrical Engineering and Computer Science (EECS)

Berkeley, CA

- Engaged in EECS 16AB sequence, imparting key knowledge on signal processing, control, circuit design, and machine learning, intertwined with practical linear algebra applications
- Conducted individual and group tutoring sessions, along with orchestrating EECS 16A review workshops
- Guided and supported 50 students in EECS 16A labs, bridging theoretical concepts with practical implementation
- Received an average rating of 4.9 / 5.0 in teaching quality, subject mastery, and proactive assistance from students

COMPSCI 61A Mentor (CSM)

Jan. 2021 - May. 2021

UC Berkeley Electrical Engineering and Computer Science (EECS)

Berkeley, CA

- Taught topics in the CS 61A series focusing on software construction, machine operation, and programming abstraction through Python 3, Scheme, and SQL languages
- Conducted weekly tutorials and bi-weekly labs, emphasizing key data structures like trees, binary search trees, and core concepts like recursion and induction
- Prepared and delivered review sessions pre-exams, collaborated in preparing problem sets, quizzes, and exams to ensure a coherent learning curve for students
- Provided individualized guidance during office hours, reflecting on improved student performance over the semester

ACADEMIC HONORS

G-Research Doctoral Fellowship
Cornell University Graduate Fellowship
Science, Mathematics, and Research For Transformation DoD Scholarship (SMART)
Citadel Datathon Top 5 (out of 125) Placement
UC Berkeley Department of Data, Society, and Computing Data Science Insights Award Winner
USA Physics Olympiad (USAPhO) Qualifier
Math Olympiad Program (MOP) Invitee
USA Mathematics Olympiad (USAMO) Qualifier
USA Junior Mathematics Olympiad (USAJMO) Qualifier
American Invitational Mathematics Examination (AIME) Qualifier
Northrop Grumman Engineering Scholarship
Lockheed Martin Engineering Scholarship

PUBLICATIONS

Sahu, S. *Towards Optimal Differentially Private Regret Bounds in Linear MDPs*. April 2025.
<https://arxiv.org/abs/2504.09339>
Hovenga, V., **Sahu, S.**, Carmichael, I. *Mixed Annotation Cell and Nuclear Segmentation Model With Multi-Task Learning*. Conference on Neural Information Processing Systems (NeurIPS). May 2024.
Sahu, S., Li, J., Hovenga, V., Smith, K., Yin, N., Chen, A., Carmichael, I. *WSIC: A Python Package To Facilitate Running Nuclear/Cellular Segmentation On Whole Slide Images*. Journal on Open Source Software (JOSS). January 2024.
Sahu, S., Flaherty, D., Vinchure, A., Pei, J., You, S. *Developing Multi-Dimensional Metrics for Precision, Recall, Fidelity, Diversity, and Authenticity in Evaluating Generative Networks Performance using Deep Perceptual Embeddings*. SPIE DCS. Orlando, FL. May 2023.

CONFERENCE POSTERS AND ORAL PRESENTATIONS

Das, A., Patra, A., **Sahu, S.** *System Requirements Clustering with Machine Learning and Architecture Design*. Naval Applications of Machine Learning (NAML). San Diego, CA. February 2025.
Sahu, S., Johnson, T., Marsh, B., Kennedy, R., Kays, J., Das, A. *Enhancing Warfighter Capabilities: Leveraging Machine Learning and NLP in System Requirements Analysis and Clustering for C4ISR*. Naval Applications of Machine Learning (NAML). San Diego, CA. March 2024.
Sahu, S., Wadhwa, R., Yallapragada, L., Das, A. *Systems Requirement Clustering With Machine Learning*. Neptune Office of Naval Research (ONR) Conference. Davis, CA. November 2023.
Das, A., **Sahu, S.**, Johnson, T., Kennedy, R. *Systems Requirements Clustering With Machine Learning and Architecture Design*. Naval Applications of Machine Learning (NAML). San Diego, CA. March 2023.
Sahu, S., Flaherty, D., Vinchure, A., Pei, J., You, S. *Developing Multi-Dimensional Metrics for Precision, Recall, Fidelity, Diversity, and Authenticity in Evaluating Generative Networks Performance using Deep Perceptual Embeddings*. DoD 6.1 Research Conference. Arlington, VA. September 2022.
Li, P., **Sahu, S.**, Shen, T., Rizvi, S., Terrell-Perica, P., You, S. *Advancing Procedural Scene Synthesis through Enhanced Grammars and Gradient Policies in MetaSim*. UC Berkeley Data Science Conference. Berkeley, CA. May 2021.
Tong, S., **Sahu, S.**, Huynh, T., Zhang, E., Majmudar, J. *Using Machine Learning to Model and Discover New Catalysts To Address The Energy Challenges Posed by Climate Change*. UC Berkeley Data Science Conference, Berkeley, CA, May 2021.

INVITED TALKS AND GUEST LECTURES

Sahu, S. *Towards Optimal Differentially Private Regret Bounds in Linear MDPs.* Cornell University. Ithaca, NY. May 2025.

Sahu, S. *The Machine Learning Problems Behind Large Language Models: Self-Supervision, Fine-Tuning, and Reinforcement Learning.* University of North Carolina, Chapel Hill. Chapel Hill, NC. February 2025.

Sahu, S. *Unlocking the Power of Databases: The Crucial Role of Theory and Indices in Scalable Vector Databases for Machine Learning.* Naval Postgraduate School. Monterey, CA. August 2024.

Sahu, S. *How Do Neural Networks Learn.* Naval Postgraduate School. Monterey, CA. December 2023.

Sahu, S. *Anchored Intelligence: Navigating the Waters of Machine Learning And Charting the Course to Augmented Decision-Making.* Naval Postgraduate School. Monterey, CA. October 2023.