Shubhkarman Singh

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Education

University of Washington, Seattle, WA, USA — September 2019 - March 2022
Bachelor of Computer Science — Graduation: March 2022
GPA: 3.73/4.0

University of Washington, Seattle, WA, USA — April 2022 - August 2023
Master of Computer Science — Graduation: August 2023
Specialization: Machine Learning GPA: 3.85/4.0

Publications

Under Review

S. Singh. *Empowering Families to Support their Child's Education: A Pilot Program.* Submitted to Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT '24).

S. Singh, Z. Toprakbasti, N. Osman, K. Lindberg, E. Alsilimy. *Afib Explainable Artificial Intelligence.* Submitted to International Conference on Machine Learning (ICML '24).

Presentations

VerbalEyes: A Large-Scale Inquiry into the State of Audio Description. [Co-presented]. University of Washington Undergraduate Research Symposium, 2021.

Comparing methods for Single-Cell RNA Sequencing analysis in the characterization of mir-190 during cell fate selection [Co-presented]. UW CSE Computational Biology Graduate Capstone, 2022.

Literature Review on the State of Explainable AI in Medicine. UW CSE AI in Medicine Graduate Capstone, 2022.

Reproducibility Report for Self-Supervised Quality Estimation for Machine Translation. [Co-presented]. University of Washington Allen School Research Night, 2022.

Bias and Fairness in Machine Learning Lecture. CSE 416 Intro to Machine Learning, 2022.

Combating Imposter Syndrome Workshop. [Co-presented]. CSE Startup, CSE STARS, and Rising in the 300s, 2020.

NASA SUITS Challenge with UW Reality Labs and AstroHuskies. UW CSE Capstone Demo Day, 2023.

Master's Thesis

S. Shubhkarman *Empowering Families to Support their Child's Education: A Pilot Program* submitted August 2023. Link to thesis

This thesis delves into the multifaceted landscape of computer science education within underprivileged and underrepresented communities, focusing on its impact on students' journey towards higher education. Grounded in the principles of cultural capital and asset-based teaching methodologies, this research endeavors to address the barriers confronting students by offering tailored workshops. These workshops provide a scaffolded framework that empowers students and families to navigate educational opportunities, financial aid, mental health, and more. The thesis explores the significance of cultural capital in shaping students' academic trajectories and advocates for an approach that acknowledges and leverages the diverse strengths within these communities. By integrating culturally relevant content, collaborative curriculum design, and dynamic teaching methods, the workshops aim to foster inclusivity and empowerment. The culmination of this effort reflects a commitment to creating an educational landscape characterized by equity, unity, and transformative growth.

- Collaborated with Dr. Lauren Bricker on a master's thesis aimed at introducing computer science education to underprivileged communities.
- Conducted in-depth interviews in the Seattle area with teachers, students, administrators, and parents to understand the landscape of computing education in low-resource settings.

- Engaged with Career Technical Education high school teachers to identify the need for interdisciplinary computer science curriculums and the crucial role of parental involvement in education.
- Directed research focus towards educating parents about higher education access and addressing foundational issues like building trust in the school system, clarifying opportunities post-high school, aiding financial accessibility, and promoting mental health awareness.
- Gained invaluable insights on empathy, community engagement, and the intersectionality of social issues, influencing both my efforts in democratizing computer science education and research in explainable AI.
- Shared research at the SIGCSE conference in Toronto and CSE 590E CS Education Pedagogy; submitted a Perspective on Policy paper for RESPECT '24.

Research Experience

Explainable AI in Medical Sciences with Prof. Richard Anderson April 2023-Present
Worked on *AFib-XAI* as the lead researcher and first author Link to paper

Abstract: Currently, there are many ML models that, given a patient's ECG, can diagnose whether that patient has AFib with high accuracy. The issue with many of these models is that they are black-box models which make it difficult for community healthcare workers to interpret their decisions. Our solution is AFib-XAI, a program that uses explainable AI methods to display the important data points and regions of interest in an ECG that were factored into a model's AFib diagnosis, as well as generate accurate, human-readable explanations for that model's diagnosis. AFib-XAI can be run through a command-line interface. The program offers a selection of 3 AFib diagnostic deep learning models and 4 SHAP-based explainability methods. The user must provide an ECG, make a model selection, and select an explainability method. Af- terward, the program will be run. Once the program has finished running, the user will be given a visual result from the SHAP explainability method, as well as a very basic text explanation generated from the results.

- Collaborating with Professor Richard Anderson on research to improve atrial fibrillation (A-fib) diagnosis, aiding community health workers in rural areas of India and Uganda.
- Leveraging previous experience in Explainable AI (XAI), led a team of four researchers in the development of AFib-XAI, a tool designed to enhance the interpretability of A-fib diagnostic models.
- Addressed the challenge of high-accuracy yet opaque models in diagnosing A-fib, a condition often undetected but associated with significant health risks like stroke.
- Developed AFib-XAI to visually highlight critical regions in electrocardiograms (ECGs) and provide human-readable explanations, enhancing understanding for community health workers.
- Overcame limitations of SHAP (SHapley Additive exPlanations) in analyzing data points independently by creating a translator that contextualizes ECG data, identifying regions supporting AFib-positive diagnoses and linking them to specific ECG components.
- Currently working on a publication for presentation at the International Conference on Machine Learning (ICML'24), showcasing the innovative approach and potential impact of AFib-XAI.

UW CREATE Accessibility ML with Prof. Richard Ladner Dec 2020 - Jan 2022
Engaged in VerbalEyes' mission to make videos accessible via AI-driven audio description. Worked alongside Professor Ed Lazowska, Greg Gottesman (Fosters School, Madrona Venture Labs, Pioneer Square Labs) as CTO and Co-Founder. VerbalEyes Pitch to Investors

Developed research study to learn preferences in cued speech for hearing impaired students. Understanding audio analysis in phoneme recognition and make novel machine learning model pipeline to accurately extract / display phonemes, using combined CNN / RNN along with fast Fourier transform and other mathematical audio concepts.

- Collaborated closely with the business and management team for customer engagement. Conducted interviews and collected user data to inform business strategy. Participated in the development of the VerbalEyes Business Plan. Sweet 16 Dempsey Startup Competition Finalist as well as Madrona Venture Labs Fellowship Winner ($25,000)
- Conducted extensive user research, including interviews across schools in Washington and other states. Investigated machine learning techniques for improving key frame extraction and de-

scription accuracy. Employed natural language processing and deep learning for detailed video frame captioning.

- Explored various machine learning models for effective video preprocessing and keyframe selection. Contributed to research papers detailing the advancements in audio description technology. "VerbalEyes: A Large-Scale Inquiry into the State of Audio Description" (UW Research Symposium '21)

Drug Protein/Gene Interactions Research with Prof. Sheng Wang Jan 2022 — Present

- Trained standard linear regression model with PCA and regularized regression. Based on low quantity of gene expression data, the linear methods coupled with regularization or PCA was able to find the most relevant features of the data more effectively than a neural network. We expanded further by implementing dimensionality reduction to utilize the low quantity of gene expression data more effectively. Link to paper
- Working on improving sequence-based prediction of drug-target interactions using MolT5 molecule captioning to accelerate drug discovery and improving the Morgan Fingerprint with novel embeddings, based on the ConPLex paper by MIT. Link to ConPLex paper (MIT)

Single-Cell RNA Sequence Research with Prof. Su-In Lee Sept 2022 — Jan 2023

- With PhD student from Department of Molecular and Cellular Biology, examined the role of microRNAs, specifically miR-190, in regulating cell fate within the Drosophila melanogaster larval central nervous system. Our focus is on comparing different single-cell RNA sequencing (scRNAseq) analysis methods, like Seurat, scVI, constrastiveVI, and linearVI, to validate the accuracy and interpretability of results regarding miR-190 deficient cells. Link to paper

UW Husky Satellite Lab with Prof. Robert Winglee Sept 2019 - June 2022

The PHAT-2 Mission demonstrates sustainability for satellites missions.

- For, HSAT-2 mission to Moon, worked on star tracking algorithm for orbit alignment and driving PWM signal through microcontroller for reaction wheels. Train models on RTI output waveform for coffee can radar. Worked on LOST: Open-Source Star Tracker, Reaction Wheels, Coffee Can Radar (CCR), Marketing/PR officer, managing blog and media
- Website: huskysatellitelab, GitHub Repository: UWCubeSat

UW AstroHuskies Virtual Reality Team with John Akers Dec 2020 - Jan 2022

Collaborated with UW Reality Labs and UW Astrohuskies on the NASA SUITS Challenge to aid astronauts on guiding to geological points of interest on lunar surface with image segmentation and Microsoft HoloLens. Link to NASA SUITS Website

- Presented research at the UW CSE Capstone Demo Day

Data Analysis & Intelligent Systems with Prof. Dong Si June 2020 - Jan 2021

DeepTracer uses deep learning to predict protein backbone structure from Cryo-EM density maps.

- Worked on Graph Neural and Graph Convolutional Networks to aid in binding site predictions. Mitigated security risks of file types and built mobile app for DeepTracer.
- Publications: J. Pfab, N. M. Phan, D. Si*, "DeepTracer for fast de novo cryo-EM protein structure modeling and special studies on CoV-related complexes", Proceedings of the National Academy of Sciences (PNAS), Jan 2021, 118 (2) e2017525118; DOI: 10.1073/pnas.2017525118. Website: DeepTracer

Grad Course Projects

CSE P 599A AI in Medicine with Prof. Sheng Wang Fall 2022

- Compiled a Literature Review on the State of Explainable AI in Medicine, going over the pitfalls of explanation metrics, the different types of evaluations, and presented the findings through a talk here.

CSE 481N Natural Language Processing Capstone with Prof. Noah Smith Spring 2021

- Reproducing the paper on Self-Supervised Quality Estimation for Machine Translation which offers a novel problem in quality estimation. Showcased paper and poster to Allen School Research Night and Allen School Graduation Open House.

CSE P 590B Explainable AI with Prof. Su-In Lee Spring 2022

- Presented a one-hour discussion on a research paper on A Benchmark for Interpretability Methods in Deep Neural Networks, highlighting the concerns and specific decisions that the author took. Presentation on ROAR.

Undergrad Course Projects

CSE 480E Computer Ethics with Prof. Jared Moore — Winter 2022

- Wrote a paper on the assessment generative pretrained transformers and highlighted implications in gender/racial/religious bias and financial/environmental costs.

CSE 442 Data Visualizations with Prof. Jeffery Heer — Winter 2022

- Introduced simple tutorial on NNs using linear regression and allowed user to play with residuals, weights, biases, and gradients. machine-learning-visualization

Industry Experience

Nokia — Sept 2023-Present

Machine Learning Engineer

- Improved the detection and diagnosis of performance metrics, faults, and optimization of configuration parameters in LTE/5G RF Systems using anomaly detection, correlation analysis, and sequence-to-sequence modeling using Bidirectional LSTM models with SHAP explanation method to point out important alarms.

Amdocs — June 2022-Oct 2022

Machine Learning Engineer Intern

- Worked on integrating Slackbot features into main coding pipeline, created multiple form modals, connected to Jira Server using REST APIs. Implemented Slack bot response classification model using customer data provided by T-Mobile partner team.
- Developed Linear SVC model and Distill-BERT Transformer model, and improved response accuracy from 35% to 75% with added nuance capacities.

Teaching Experience

Paul G. Allen School of Computer Science & Engineering — July 2020-August 2023

CSE 416 Intro to Machine Learning

- Taught students various practical machine learning concepts including regression, deep learning, classification, clustering, and recommender systems. Developed ethical ML curriculum to introduce idea of responsible ML development which include fairness and trust through lecture workshops and homeworks.
- Machine Learning Social Impact & Ethics Material: Link to materials

CSE 190E Startup Program

- Worked with TAs and professors to create engaging curriculum adjusted to online. Teaching students by walking through questions and concepts in JS/HTML/CSS. Presented Imposter Syndrome Workshop to CSE Startup, CSE STARS and Rising in the 300s, submitted Virtual Figma Charrette Curriculum to ACM CHI 2021.
- Imposter Syndrome Workshop: Link to workshop

CSE 190Y (CSE 143 Workshop):

- Worked with students on various topics in CSE 143 such as Arrays, Sets, Trees, and Recursion. I hosted check-ins with three students and incorporated individual teaching strategies to strengthen specific areas.

CSE 344/414 Databases:

- Head TA, Review lecture topics in SQL, NoSQL, Relational Database in section. Monitored lectures and answered student questions on Ed. Offered extended OH, Saturdays and graded class of 160 students.

CSE 484 Computer Security:

- Go over important security topics like Buffer Overflow exploits, cryptography, RSA encryption, social engineering. Run two sections per week with 100 students, doing demos and having office hours.

CSE 599A1 Software Entrepreneurship:

- Head TA, working with Ed Lazowska and Greg Gottesman, Co-Founder of Pioneer Square Labs, and guided startup teams towards viable business pitches and ran backend of class, with pitch voting and class grading.

Awards

2020 Sift Science Undergraduate Scholarship Award – $1,000

2021 Dempsey Startup Competition Sweet Sixteen Finalist
2021 Madrona Venture Labs Fellowship Grant Winner – $25,000
2021 Undergraduate Research Symposium Finalist (VerbalEyes)
2020 Featured on KOMO 4 TV with DeepTracer Research Team

Community Involvement

MEChA de UW Adelante Con Educacion Conference, *Mentor / Photographer*	April 2023
UW CSE Department Faculty Interviews, *Student Interviewer*	Jan 2022, 2023
UW CSE COMˆ2 Big / Little Program, *Mentor*	Sept 2021-Dec 2021
UW Sunrise Climate Change Circle, *Leader*	Jan 2020-March 2020
UW Medical Center, *Patient Transport Volunteer*	June 2019

References

Dr. Lauren Bricker
Professor of Computer Science at UW, **Email:** bricker@cs.washington.edu, **Tel:** (206) 685-9140.

Dr. Richard Anderson
Professor of Computer Science at UW, **Email:** anderson@cs.washington.edu, **Tel:** (206) 543-4305.

Dr. Ed Lazowska
Professor of Computer Science at UW and Chair Emeritus, **Email:** lazowska@cs.washington.edu, **Tel:** (206) 543-4755.