Rishabh Singh

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SUMMARY

R&D Scientist at UtopiaCompression Corp. developing deep learning based intelligent vision systems with increased safety/trustworthiness features using novel uncertainty quantification techniques.

EXPERIENCE

R&D Scientist | UtopiaCompression Corporation

January 2023 - Present, Los Angeles, CA

• Spearheading deep learning pipeline development for object detection/classification/tracking in vision systems (Sense-and-Avoid platform: A vision based product for real-time navigation of unmanned aircraft using camera image streams. Co-Air: A visual analytics tool for real-time situational awareness & navigation of swarm UAVs).
• Improved object detection range by more than 150% over old pipeline, reduced false detection rate in noisy environments by at-least 75%.
• Developed a novel uncertainty quantification (UQ) method for the deep learning model (to increase user-trust in its results) with a 70% accuracy rate in detecting false model predictions.
• Utilized cutting-edge software for synthetic data generation & real-world data collection/labeling as well as MLOps tools: AirSim (cross-platform vehicle simulator), Gazebo (3D robotics software), TensorFlow Extended, PyTorch, ROS (Robot Operating System), Anyscale Ray, RoboFlow, MLFlow.
• Research Proposals: Wrote and submitted (to agencies including US Air Force, Navy and DHS) technical proposals containing novel ideas for tackling modern technological challenges using AI and computer vision to potentially acquire around $2-2.5 million for the company.

PhD Candidate and Research Assistant | Computational NeuroEngineering Lab (CNEL), University of Florida

August 2018 - December 2022, Gainesville, FL

• Developed a novel physics-inspired Uncertainty Quantification (UQ) framework for estimating a deep neural network's prediction uncertainty (for increasing user trust in machine learning algorithms under challenging operating environments). Work published in prestigious venues: Neural Computation, UAI, etc.
• Improved over latest UQ methods by 10-15% in terms of rate of detecting false model predictions (ROC-AUC, precision-recall metrics) and calibration (Brier score, expected calibration error) while being 60% faster (in DNN classification applications involving ResNet, VGGNet, CIFAR-10, MNIST, ImageNet) [paper link].
• Improved over latest UQ methods by 10-15% in the application of scene segmentation for autonomous vision using deep learning (Models used: SegNet, FCN-8, PSP-NET, and U-NET. Datasets: CamVid and Cityscapes. Metrics: patch-accuracy, patch-uncertainty and PA vs PU scores) [paper link].
• Other ML applications where the UQ method advanced over SOTA: Classification under data distributional shifts, anomaly detection & transfer learning.
• Developed a Hierarchical Linear Dynamical System (HLDS), that improved over the traditional Kalman filters in applications spanning video game action sequence segmentation (DARPA project), dynamic texture synthesis [paper link], and speech phoneme recognition [paper link].

Research Scientist Intern | Aventusoft LLC

May 2020 - August 2020, Boca Raton, FL

• Aventusoft is a dynamic startup developing cutting-edge medical devices for precise cardiac assessments, with a focus on analyzing heart valve movements.
• Spearheaded the development of a CRNN based deep learning algorithm for detecting anomalies and points of interest within Electrocardiography (ECG) data. This formed a critical component of arrhythmia detection within the flagship product, the HEMOTAG device [link].
• Achieved improvement of 30% (F1-score, ROC, accuracy) over company's existing algorithms on MIT-DB, European ST-T, and PhysioNet datasets [paper link].

Teaching Assistant | University of Florida

January 2022 - May 2022, Gainesville, FL

• Assisted in teaching a class of 40 students. Clarified concepts, developed & graded 4 assignments.
• Course: Machine Learning for Time Series (Instructor: Jose C. Principe). Duration: 4 months.

Research Collaborator | Jump Trading LLC

October 2018 - March 2019, Chicago, USA

• Developed a novel kernel-based time-series forecasting algorithm, inspired from quantum physics and Stratonovich's optimal filtering theory.
• Collaborated with a team at Jump Trading, a high-frequency algorithmic trading firm, to rigorously test the method for forecasting financial time-series data.
• Learnt about the multitude of theoretical challenges and practical complexities inherent in modeling financial data.

Assistant Manager | Tata Motors Limited

July 2014 - June 2016, Pune, India

• Oversaw and enhanced of vehicle assembly lines automation systems, prioritizing safety, maintenance, and productivity optimizations.
• Optimized the safety features and productivity of at-least 4 different PLC (programmable logic controller) based systems.
• Attained a top-tier employee performance rating, placing within the top 10% of my department.

PROJECTS

Photo Sketch Inversion using Deep Learning | **University of Florida, USA** |
February 2017 - May 2017

- Developed a deep CNN based model (using CELEB-A database) for converting hand-drawn & b/w face sketches into colored photo-realistic images.
- Model did not generalize well & showed high bias towards certain demographics. Recognized the importance of responsible AI training and safety features.
- Project motivated pursuit of a PhD in uncertainty quantification in AI.

Team Member: High Voltage Systems | **Vellore Institute of Technology, India** | **Formula Student Electric Car Team**
September 2012 - September 2013

- Part of a 40-member team [link], of diverse technical backgrounds, to develop an electric car for the prestigious Formula Student (FS) competition.
- Implemented high-voltage electrical systems: Electrical motors, batteries and battery management system (BMS) to meet ambitious performance targets.
- Vehicle showcased and judged against global competitors at Silverstone circuit, UK. Attained top 10 rank in its business feasibility report.

EDUCATION

Doctor of Philosophy in Electrical and Computer Engineering | **University of Florida (Computational NeuroEngineering Lab)**
3.71, Gainesville, FL, 2022

- Uncertainty Quantification in Deep Learning, Kernel Methods, Bayesian Methods, Adaptive Filtering, Time-Series Analysis.

Master of Science in Electrical and Computer Engineering | **University of Florida**
3.71, Gainesville, FL, 2018

- Courses: Deep Learning, Big Data Ecosystems, ML for Time Series, Pattern Recognition, Computer Vision, Quantum Information Science.

Bachelor of Science in Electrical and Electronics Engineering | **Vellore Institute of Technology**
8.46 / 10, Vellore, India, 2014

SKILLS

Programming languages (Python: incl. Pandas, Numpy, Scikit-learn libraries, MATLAB, C++), ML platforms & MLOps tools (PyTorch, TensorFlow, MLFlow, TFX, Anyscale Ray, Apache Airflow, Docker, Roboflow), cloud computing platforms (AWS, Microsoft Azure), ROS (robot operating system), Linux, Versioning tools (Git), Data handling tools (AirByte, MySQL), Object Simulator Platforms (AirSim, Gazebo), Computer Vision DL Models (YOLO, RCNN, Vision Transformers, ResNet, VGGNet), LLM Finetuning (BERT models, GPT-4, Llama 2), Algorithmic knowledge (Data Structures & algorithms, ML methods, Bayesian & Kernel methods, Computer Vision, Time-series analysis).

RELEVANT PUBLICATIONS

1. Singh, R. & Principe, J.C. (2022). A Physics inspired Functional Operator for Model Uncertainty Quantification in the RKHS. under review at IEEE Transactions of Pattern Analysis and Machine Intelligence (PAMI). [paper link]

2. Singh, R. & Principe, J.C. (2021). Toward a Kernel-based Uncertainty Decomposition Framework for Data and Models. Neural Computation 2021; 33 (5): 1164–1198. [paper link]

3. Singh, R. & Principe, J.C. (2022). Quantifying Model Uncertainty for Semantic Segmentation using Operators in the RKHS. under review. [paper link]

4. Hssayeni, Murtadha; Andalib, Arash; Singh, R.; Pava, Diego; Li, Kan; Chait, Robert & Kale, Kaustubh. (2022). ECG Fiducial Points Localization Using a Deep Learning Model. 21st IEEE International Conference on Machine Learning and Applications (ICMLA) (related to work done at Aventusoft LLC) [paper link].

5. Principe, J.C. & Singh, R. (2022). Functional Operators in RKHS for Epistemic Uncertainty Quantification in Machine Learning. LION16: The 16th Learning and Intelligent Optimization Conference.

6. Singh, R. & Principe, J.C. (2020). Time Series Analysis using a Kernel based Uncertainty Decomposition Framework. Conference on Uncertainty in Artificial Intelligence 2020 (UAI). [paper link]

7. Singh, R.; Yu, S., & Principe, J.C. (2020). Composite Dynamic Texture Synthesis using Hierarchical Linear Dynamical System. 2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). [paper link]

8. Singh, R. & Principe, J.C. (2018). Correntropy Based Hierarchical Linear Dynamical System for Speech Recognition. In proceedings of 2018 International Joint Conference on Neural Networks (IJCNN).[paper link]

9. Singh, R.; Li, K. & Principe, J.C. (2018). Nearest-Instance-Centroid-Estimation Linear Discriminant Analysis. In proceedings of 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). [paper link]