Rishabh Singh

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SUMMARY

R&D Scientist at UtopiaCompression Corp. developing deep learning based intelligent vision systems (for object detection, classification and tracking) with increased safety/trustworthiness features using novel uncertainty quantification techniques.

EXPERIENCE

R&D Scientist | UtopiaCompression Corporation

January 2023 - Present, Los Angeles, CA

• Developed an end-to-end deep learning pipeline that detects, classifies, and tracks aerial objects for the company's Sense-and-Avoid platform: A vision based product for unmanned aircraft to navigate in unregulated airspace using image streams from ordinary cameras. Improved detection range by more than 200% over existing methods and enhanced user-trust in the product through uncertainty quantification.

• Developed & implemented a novel uncertainty quantification method within the deep learning pipeline, which enabled an accurate estimation of uncertainty associated with the model's predictions (able to detect false predictions of the model at a rate of 70% in simulated environments), and thereby increased the overall product's user-trust.

• 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.

• Achievements: Drastic improvement in object detection range (by at-least 200-250%), reduction in false detection of objects in noisy environments (by at-least 250%), drastic improvement in below-horizon detection capability.

• 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 capable of single-shot estimation of a neural network's prediction uncertainty by leveraging kernel methods (work published in prestigious venues: Neural Computation, UAI, etc.).

• The new framework surpassed the performance of state-of-the-art uncertainty estimation methods by 10-15% in terms of ability to detect false model predictions (measured by receiver operating characteristics, precision-recall & correlation metrics) and by 10-15% in terms of calibration metrics (Brier score, expected calibration error) while decreasing computation time by 80% (Models: ResNet, VGG, LeNet. Data: CIFAR-10, MNIST, ImageNet) [paper link].

• Also achieved an average improvement of 10-15% over the state-of-the-art in the application of scene segmentation for autonomous vision (Models used: SegNet, FCN-8, PSP-NET, and U-NET. Datasets: CamVid and Cityscapes. Metrics: patch-accuracy, patch-uncertainty and PA vs PU scores). Other applications where the framework performed significantly well: Classification under data distributional shifts, anomaly detection & transfer learning [paper link].

• 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, and speech phoneme recognition.

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.

• Achieved an improvement of 30% over company's existing algorithms at the time on MIT-DB, European ST-T, and PhysioNet datasets using the F1-score, sensitivity, and specificity metrics [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.

• Curriculum: Adaptive signal processing for stationary signals, machine learning algorithms for time-series and performance measures.

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) and 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 2016 - 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.

Team Member: High Voltage Systems | **Formula Student Electric Car Team (https://www.ojasracing.in)**
September 2012 - September 2013, Vellore, India
• Collaborated within a 40-member team to develop an electric car for the prestigious Formula Student (FS) competition.
• Developed & implemented high-voltage electrical systems, collaborated closely with the mechanical engineering team to research & select optimal motor ratings, motor types, battery power specifications, and management systems 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: PyTorch, TensorFlow. MLOps Tools: Anyscale, Ray tools, Ray Tune, Ray Serve, MLFlow, Comet ML, TFX.
Object Simulator Platforms: AirSim (cross-platform object simulator), Gazebo Software.
LLM Finetuning: BERT models, GPT-4, Llama 2, Falcon 40B. Versioning tools: Git. Data handling tools: AirByte, MySQL.
Algorithms: 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]