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Rishabh Singh

PhD Candidate (University of Florida)

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PhD candidate (advisor: Jose C. Principe) at the Computational NeuroEngineering Lab (University of Florida) working on *uncertainty quantification in machine learning*. Seeking a full-time research role in machine learning with a preference towards areas related to uncertainty in AI, physics inspired AI, AI interpretability, anomaly/attack detection and time-series analysis.

EDUCATION

Doctor of Philosophy in Electrical and Computer Engineering (GPA: 3.71/4) **May 2018 - 2022 (exp.)**
University of Florida *Gainesville, USA*
Research Areas: Kernel Methods, Information Theory, Uncertainty Quantification, Machine Learning.

Master of Science in Electrical and Computer Engineering (GPA: 3.71/4) **Aug 2016 - May 2018**
University of Florida *Gainesville, USA*
College of Engineering Achievement Award for New Engineering Graduate Students (May 2016 — May 2017)
Coursework: Deep Learning, Big Data Ecosystems, Machine Learning for Time Series, Pattern Recognition, Noise in Linear Systems, Image Processing and Computer Vision, Quantum Information Science.

Bachelor of Science in Electrical and Electronics Engineering (GPA: 8.46/10) **Aug 2010 - May 2014**
Vellore Institute of Technology *Vellore, India*

RESEARCH EXPERIENCE

University of Florida **Aug 2017 — Present**
Computational NeuroEngineering Lab (CNEL): PhD Candidate and Research Assistant *Gainesville, USA*

- Developed and formulated a *physics inspired multi-moment uncertainty decomposition framework* (capable of single-shot estimation of uncertainty) for data and deep learning models by leveraging functional operators in the RKHS (reproducing kernel Hilbert space).
- Elucidated, both theoretically and through rigorous comparative analysis, many practical advantages of the framework over conventional iterative uncertainty quantification techniques like approximate *Bayesian and ensemble approaches* for both classification and regression problems on benchmark datasets.
- Implemented and analyzed the uncertainty framework against the state-of-the-art for predictive *uncertainty quantification* of neural network models under test-set *data distributional shifts* (Models: LeNet, ResNet, VGG. Datasets: MNIST, K-MNIST, CIFAR-10).
- Implemented and analyzed the uncertainty framework against the state-of-the-art for uncertainty quantification of *semantic segmentation networks* (Models: Segnet, FCN-8, PSP, U-NET. Datasets: CamVid, Cityscapes (ongoing)) and for quantifying *transfer learning uncertainty* between learning models.
- Currently testing the framework for applications such as *adversarial attack detection* in neural networks, *time-series clustering and anomaly detection*.
- Developed Hierarchical Linear Dynamical System (HLDS) architectures for video game *action sequence segmentation* (DARPA project), *dynamic texture synthesis* and *speech phoneme recognition*.
- Implemented a deep CNN using *tensorflow* to construct photo-realistic versions of human face sketches (CELEB-A database).

AventuSoft LLC **May 2020 — Aug 2020**
Research Scientist Intern *Boca Raton, USA*

- AventuSoft LLC is a research startup that develops *medical devices for high-value cardiac assessments* by analyzing heart valve movements.
- I worked with the *HEMOTAG* device (link), the flagship product of Aventusoft for diagnosing and managing heart failure assessments.
- Implemented *deep learning algorithms for detecting fiducial points in Electrocardiography (ECG)* time-series data as part of a downstream task of arrhythmia detection. The work was incorporated into the HEMOTAG product.
- Tested and validated algorithm's performance on benchmark ECG datasets such as MIT-DB, European ST-T and PhysioNet.
- Collaborated with the research team to learn more about the HEMOTAG platform and discussed and suggested future research work to improve the technology further.
- Learnt about and discussed the challenges involved in the initial phases of a product launch.

Vellore Institute of Technology **Jan 2013 — May 2014**
Undergraduate Researcher *Vellore, India*

- Collaborated with a *team of 40* members (Team Ojas) to build an electric car for *Formula Student (FS)* competition, UK (July, 2013). Worked specifically with high voltage electrical systems of the vehicle. Collaborated with the mechanical engineering team to research appropriate motor ratings, type of motors, battery power and management system required to achieve target vehicle performance levels.
- Performed a comparative analysis of induction motor *dynamic braking* schemes using *MATLAB and Simulink* as part of an independent research work with a course professor. Work resulted in a publication (paper link).
- Performed simulations to demonstrate a novel rotor position estimation technique for switched reluctance motors where the vibration pulses being sensed on the stator frame were used as signatures to determine the rotor position (senior year project). Work resulted in a publication (paper link).

RELEVANT PUBLICATIONS

- **Singh, R.** & Principe, J.C. (2022). **A Physics inspired Functional Operator for Model Uncertainty Quantification in the RKHS**. under review. [paper link]
- **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]
- Principe, J.C. & **Singh, R.** (2022). **Functional Operators in RKHS for Epistemic Uncertainty Quantification in Machine Learning**. LION16: The 16^{th} Learning and Intelligent Optimization Conference.
- **Singh, R.** & Principe, J.C. (2020). **Time Series Analysis using a Kernel based Uncertainty Decomposition Framework**. Conference on Uncertainty in Artificial Intelligence (UAI) 2020. [paper link]
- **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. [paper link]
- **Singh, R.** & Principe, J.C. (2019). **A New Uncertainty Framework for Stochastic Signal Processing**. arXiv preprint arXiv:1904.13038 (2019). [paper link]
- **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]
- **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.[paper link]

TALKS

- **Invited Talk:** A Functional Operator for Model Uncertainty Quantification in the Reproducing Kernel Hilbert Space: *Machine Learning Group, UIT Arctic University of Norway*.
- **Contributed Talk:** A Quantum Theory Inspired Framework for Uncertainty Quantification: *IEEE International Conference on Data Science and Advanced Analytics (DSAA).* Speaker: Jose C. Principe (Distinguished Professor, University of Florida).
- **Contributed Talk:** Making Deep Neural Networks Transparent by Information Theory: *Presentation at Microsoft.* Speaker: Shujian Yu (Associate Professor, UIT Arctic University of Norway).
- **Conference Presentation:** Time Series Analysis using a Kernel based Uncertainty Decomposition Framework: *Conference on Uncertainty in Artificial Intelligence (UAI) 2020*.
- **Conference Presentation:** Composite Dynamic Texture Synthesis Using Hierarchical Linear Dynamical System: *International Conference on Acoustics, Speech and Signal Processing (ICASSP) 2020*.

ACADEMIC POSITIONS

Research Assistant **Aug 2017 — present**
Computational NeuroEngineering Lab (CNEL), University of Florida *Gainesville, USA*
- Grants: DARPA - FA9453-18-1-0039, ONR - N00014-21-1-2345
- Job: Uncertainty quantification in machine learning.

Teaching Assistant **Jan 2022 - May 2022**
Department of Electrical and Computer Engineering, University of Florida *Gainesville, USA*
- Course: *Machine Learning for Time Series (Instructor: Jose C. Principe)* - Theory of adaptation with stationary signals, performance measures, LMS, RLS algorithms, implementation issues and applications.
- My role included clarifying concepts and questions posed by students, grading assignments, help develop curriculum and assist in delivering lectures.

INDUSTRY EXPERIENCE

Research Scientist Intern **May 2020 - Aug 2020**
AventuSoft LLC *Boca Raton, USA*
- Fiducial point detection in Electrocardiography (ECG) time-series data using deep learning for arrhythmia detection.

Assistant Manager **Aug 2014 - May 2016**
Tata Motors Limited *Pune, India*
- Oversaw and improved vehicle *assembly line automation systems* with respect to safety, maintenance and productivity.
- Achieved top 10% employee performance rating in my department.

SKILLS

Programming	Python, MATLAB, LaTeX, Linux Command Line.
Python Libraries	Scikit-learn, Pandas, NumPy, Keras, TensorFlow.
	Basic data structures, ML algorithms, Bayesian & ensemble methods for uncertainty quantification.

REVIEWER SERVICE

- IEEE Transactions on Neural Networks and Learning Systems.
- Journal of the Franklin Institute.
- Chemometrics and Intelligent Laboratory Systems (Elsevier).
- IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).
- International Joint Conference on Neural Networks (IJCNN).