COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

Kavita Varma

for the degree of Doctor of Philosophy (Ph.D.)

"AI Computation of L_1-norm error Principal Components with Applications to Training Dataset Curation and Detection of Change"

May 31st, 2024, Time 2:00 p.m.
EE-96 Building, Room 303
777 Glades Road
Boca Raton, FL

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ABSTRACT OF DISSERTATION
AI Computation of L_1-norm error Principal Components with Applications to Training Dataset Curation and Detection of Change.

This research aims to develop a comprehensive algorithmic framework for enhancing data analysis in autonomous and artificial intelligence (AI) systems, focusing on data quality assurance through the creation of new mathematical theories and algorithms for outlier-resistant matrix decomposition using L_1-norm principal component analysis (PCA). L_1-norm principal-component analysis of data matrices has long been considered a robust, data-fault resistant, alternative to conventional L_2-norm) singular-value decomposition. Yet, to date, there is no known optimal algorithm for the joint computation of multiple minimum L_1-norm-error principal components of data matrices.

Given the paramount importance of accurate and comprehensive data in AI and machine learning (ML), this research introduces robust L_1-norm techniques, including novel neural network-based methods for L_1-norm error decomposition. Additionally, the dissertation presents innovative solutions using convolutional neural networks for joint L_1-norm error computation and showcases the Autonomous Conformity Evaluation (ACE) algorithm for holographic plankton image data curation. This method processes datasets of various dimensions, providing L_1-norm subspace summaries and conformity tensors to identify nominal data points and anomalies. Furthermore, a change detection technique for matrix data is validated through simulations and experimental campaigns on EEG and ECG data, highlighting the practical implications of L_1-norm techniques in AI learning and autonomous system operations.

BIOGRAPHICAL SKETCH
Born in Hyderabad, India
B.S., National Insititute of Technology, Surat, Gujarat, India, 2014
M.S., State University of New York, Buffalo, New York, USA, 2017
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CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2019 - 2024

Qualifying Examination Passed: Spring 2019

Published Papers:

- K. Varma, D. A. Pados, E. S. Bentley, and M. J. Medley, "L_1-norm-error principal-component computation on feedforward neural network," *IEEE Trans. Neural Networks and Learning Systems*, submitted Mar. 2024.
- K. Varma and D. A. Pados, "The virtues of overfitting: Joint computation of minimum- L_1-norm-error principal components on convolutional neural network," *Thirty-eighth Annual Conf. on Neural Information Processing Systems (NeurIPS'24)*, Vancouver, BC, Canada, Dec. 9–15, 2024, submitted.
- M. S. Pour, E. Bou-Harb, K. Varma, N. Neshenko, D. A. Pados, and Kim-Kwang R. Choo, "Comprehending the IoT cyber threat landscape: A data dimensionality reduction technique to infer and characterize internet-scale IoT probing campaigns," *Digital Investigation (Elsevier)*, vol. 28, pp. S40-S49, Jan. 2019.
- K. Varma, L. Nyman, K. Tountas, G. Sklivanitis, A. Nayak, and D. A. Pados, "Autonomous plankton classification from reconstructed holographic imagery by L_1-PCA-assisted convolutional neural networks," in Proc. MTS/IEEE OCEANS 2020, (Biloxi, MS and Singapore) Virtual, Oct. 19–22, 2020, pp. 1-6.
- G. Gallone, K. Varma, D. A. Pados, and S. Colonnese, "Detection of change by L_1-norm Principal-Component Analysis," in *Proc. of SPIE, Defense + Commercial Sensing, Big Data II: Learning, Analytics, and Appl. Conf.*, (Anaheim, CA) Virtual, April 26-30, 2020, pp. 1-7.
- K. Varma, G. Sklivanitis, and D. A. Pados, "Training robust neural networks for autonomous plankton recognition," *64th Annual Conference on Great Lakes Research*, Michigan Tech University, Houghton, MI, May 17 - 21, 2021.