Willian T. Lunardi

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Education

University of Luxembourg — Luxembourg City, Luxembourg
Doctor of Philosophy (Ph.D.) in Computer Science — 2020
Recipient of the Excellent Thesis Award for outstanding research.

PUC of Rio Grande do Sul — RS, Brazil
Master of Science (M.Sc.) in Computer Science — 2016
Recipient of two scholarships from Dell in recognition of academic excellence.

University of Passo Fundo — RS, Brazil
Bachelor of Science (B.Sc.) in Computer Science — 2014
Recipient of a full scholarship and an undergraduate research scholarship in recognition of academic excellence.

Experience

Technology Innovation Institute — Abu Dhabi, United Arab Emirates
Senior Machine Learning Researcher — Jan 2022 – Present

- Developed and implemented an innovative adversarial training method to enhance autoencoder performance in detecting network traffic anomalies, with successful deployment on embedded devices.
- Developed out-of-distribution detection techniques employing contrastive learning with outlier exposure for learning one-class representations, subsequently employed in training unsupervised classifiers such as OCSVM and KDE.
- Devised cutting-edge voice recognition and authentication DL solutions. Integrated a blend of contrastive learning with outlier exposure, spectrograms, and raw waveforms, achieving remarkable accuracy on well-known audio datasets.
- Actively involved in groundbreaking research that applied one-class classification techniques to various data types, including images, audio, and time series.

University of Luxembourg — Luxembourg City, Luxembourg
Research Associate — Jun 2020 – Jan 2022

- Engineered advanced Neural Combinatorial Optimization strategies by integrating graph neural networks with reinforcement learning, generating powerful heuristics that significantly enhance the efficiency in tackling diverse optimization challenges.
- Developed advanced neighborhood functions and metaheuristics to solve complex vehicle routing challenges, concentrating on optimizing delivery vehicles' routing and scheduling by considering both coverage and energy constraints.
- Successfully deployed parallel scheduling and vehicle routing algorithms using C++ in an industrial environment for a company operating across Europe with its headquarters in Germany, substantially improving operational efficiency and productivity.
- Engaged in several research endeavors, fostering collaboration with team members and external associates to create and apply cutting-edge optimization algorithms and mathematical models.
- Provided mentorship and supervision to graduate students and early-stage researchers, extending support in research methodology, technical proficiency, and academic writing.

University of Luxembourg — Luxembourg City, Luxembourg
Doctoral Researcher — Jun 2016 – Jun 2020

- As a salaried employee at the University of Luxembourg, I developed innovative MILP and CP models to solve an industrial scheduling problem, effectively managing complex availability, overlapping, and sequence-dependent setup constraints.
- Developed groundbreaking optimization algorithms that achieved top-level results for recognized scheduling problems, as confirmed by publications in more than 10 international scientific conferences and journals, including the European Journal of Operational Research and Computers & Operations Research.
- Engaged in research collaboration with European companies, such as IBM Paris, to implement and evaluate the proposed models in real-world settings, significantly boosting production capacity and revenue for various businesses.

Latest Publications

- W. T. Lunardi, M. A. Lopez, and J.-P. Giacalone, "ARCADE: Adversarially Regularized Convolutional Autoencoder for Network Anomaly Detection," *IEEE Transactions on Network and Service Management*, 2022, arXiv
- W. T. Lunardi, E. G. Birgin, D. P. Ronconi, *et al.*, "Metaheuristics for the Online Printing Shop Scheduling Problem," *European Journal of Operational Research*, vol. 293, no. 2, pp. 419–441, 2021, arXiv
- W. T. Lunardi, E. G. Birgin, P. Laborie, *et al.*, "Mixed Integer Linear Programming and Constraint Programming Models for the Online Printing Shop Scheduling Problem," *Computers & Operations Research*, vol. 123, p. 105 020, 2020, arXiv

Skills

- Strong background in machine learning and deep learning, including neural networks, convolutional neural networks, recurrent neural networks, generative models, and reinforcement learning.
- Knowledge of mathematical optimization techniques, including mixed-integer programming, constraint programming, and metaheuristics.
- Proficient in programming languages such as Python, C++, C#, Java, and JavaScript, with experience developing and deploying machine learning models and parallel algorithms.
- Experience with machine learning frameworks like PyTorch, scikit-learn, and libraries like NumPy, Pandas, and SciPy.
- Skilled in designing and implementing end-to-end machine learning pipelines, from data preprocessing and feature engineering to model training and evaluation, using state-of-the-art techniques and tools.
- Strong problem-solving skills and the ability to analyze complex data and derive meaningful insights.

Additional Information

Dual Citizenship: Brazil and Italy.
Languages: Portuguese (native), English (fluent), Spanish (basic), and Italian (basic).
Programming Languages: Python, C++, Javascript, C#, and Java.
ML Libraries and Frameworks: PyTorch, Scikit-Learn, Numpy, SciPy, among others.
Additional Libraries: OpenMP, Boost (C++), Unity 3D (C#), p5js (JS), processing (Java).

Personal ML Projects

Adversarial Training for Out-of-Distribution Detection: Developed using PyTorch an adversarial training strategy using WGAN and SSIM loss to improve the performance of convolutional autoencoders for out-of-distribution detection. Evaluated the model on benchmark and real-world datasets, achieving near-perfect F1-scores on most malware and 99% on attacks with only two packets as input. With five packets as input, the model can detect DDoS attacks with an F1 score of 91%.

Learning One-Class Representations with Contrastive Learning and Outlier Exposure: Implemented in PyTorch, this project adapted Google's TensorFlow-based research on deep one-class representations through contrastive learning. Enhanced the original by incorporating a supervised variation of contrastive loss, which removes the constraint of very small batch sizes and allows training with large batch sizes. Moreover, employed outlier exposure for improved representation learning.

Semi-supervised Anomaly Detection: Applied Deep SVDD approach to a custom dataset generated using my p5js data generator for semi-supervised anomaly detection. Evaluated the resilience of the method to corruption resulting from mislabeling anomalies as normal and measured its performance as the number of correctly labeled anomalies increased.

Multivariate Time Series Jamming Detection: Developed a jamming detection system based on multivariate time series analysis using SepConv and GRU models, achieving over 99% accuracy. Implemented custom time series augmentations such as RandomCropResize, Time Warp, and Window Warp and deployed the model on a Raspberry Pi after quantization.

Olympic Games Event Recognition: Used state-of-the-art image models such as EfficientNetV2 to achieve 99% accuracy in recognizing Olympic Games events from images. Implemented well-known image augmentations, including MixUp, CutMix, Hybrids, AutoAugment, RandAugment, and TrivialAugment, and state-of-the-art training recipes.