

Summary

AI/ML engineer & data scientist (5+ years) turning complex data into systems that forecast, control, and decide. I ship data-driven controllers (model-based RL, MPC/DPC), time-series & spatiotemporal models, physics-informed ML, and LLM/RAG pipelines, and I build the platforms to run them at scale (Airflow, Kafka/MQTT, TimescaleDB/Neo4j, Kubernetes). I connect rigorous math with practical engineering to drive clear outcomes across domains.

Experiences and Projects

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| Next Generation Cities Institute, Concordia University, Montreal, QC | Jan. 2025 - present |
| Data Manager (Data Scientist and Data Engineer) | |
| <ul style="list-style-type: none">Developed advanced lightweight HVAC controller for office buildings suitable for edge devices: (1) SINDy-RL (SINDy: Sparse Identification of Nonlinear Dynamics) hybrid controller blending symbolic dynamics with Dyna-style model-based reinforcement learning; (2) Differentiable predictive control (DPC) with offline policy optimization (<i>achieved almost 30% energy saving through environment control</i>).Developed a SINDy-based model that discovers the sparse CO₂ mass-balance equation and reconstructs real-time occupant count, using CO₂ sensor measurements and desk occupancy sensors (<i>suitable for controlling indoor environments</i>).Developed and deployed a scalable and secured IoT data pipeline for hundreds of sensors, integrating MQTT, Kafka, ontology-driven graph DB, and time-series storage. Built preprocessing layers, data warehouse, REST APIs, and Grafana dashboards. Deployed the system on Kubernetes (<i>delivered in collaboration with Desjardins and Schneider Electric</i>).Collaborating on data governance for a smart-building proof of concept at Desjardins (almost 500 IoT sensors across two floors of Complexe Desjardins, Montreal), defining standards for data quality, security, metadata, and lifecycle management.Developed an LLM-powered pipeline for the Global Covenant of Mayors (GCoM) to extract evidence and score Climate Action Plans (CAPs) against predefined indicators, producing structured JSON outputs with page-level references.Developed an end-to-end framework for full-field reconstruction from sparse sensor measurements, leveraging spatio-temporal models (spatio-temporal Transformers, attention-based LSTMs), sparse dimensionality reduction techniques (e.g., sparsity-promoting dynamic mode decomposition). Designed to reconstruct physical fields (e.g., temperature, pollution, wind speed) efficiently with minimal sensor measurements, enabling timely and accurate estimations.Developed a GPU-accelerated tool for Sparsity-Promoting Dynamic Mode Decomposition.Developed a scalable map-matching framework for noisy GPS data, leveraging PostGIS for efficient spatial data handling, segmentation, and tree-based querying. Enhanced kriging methods with covariance matrix reduction, enabling user-defined strategies for city-scale CO₂ emission estimation across Montreal’s road network (~7M trips) (<i>currently in use in CityLayers’ transportation mode</i>).Lead data scientist and data engineer in the IoT showroom project at the Next Generation Cities Institute to demonstrate smart building technologies in a live office environment (developed and deployed IoT data pipeline, metadata structuring using standard ontologies, real-time data visualization).Initiated and organized knowledge-sharing sessions within the team to foster collaboration and innovation.Designing coupled indoor–outdoor physics-based digital twins for smart building applications, aimed at enhancing occupant comfort and sustainability. Leveraging differentiable programming to integrate physical modeling with learning-based methods, enabling real-time sensor data assimilation and continuous model calibration. The system architecture will be optimized for edge AI inference and control. | |
| Next Generation Cities Institute, Concordia University, Montreal, QC | Jan. 2023 – Jan. 2025 |
| Postdoctoral Fellow (Machine Learning Researcher) | |
| <ul style="list-style-type: none">Developed various dimensionality reduction techniques: adversarial autoencoder (AAE) based on Wasserstein generative adversarial network (WGAN), variational autoencoder (VAE), convolutional autoencoder (CAE), sparsity-promoting dynamic mode decomposition (sp-DMD), proper orthogonal decomposition (POD).Developed reduced-order model (ROM) for predicting turbulent flow fields (spatial-temporal datasets) in urban areas, combining AAE and bidirectional LSTM (achieved five orders of magnitude speed-up on inference compared to conventional CFD simulations).Applied transfer learning (TL) to ROMs for predicting different flow field conditions to reduce the number of snapshots used for model training (reduced the number of the required snapshots for model training by 77%, with 21% of model performance improvement).Developed physics-informed neural network (PINN) using governing partial differential equations (PDEs) and automatic differentiation in TensorFlow to reconstruct velocity field from sparse and limited data points.Reconstructed the flow field around an isolated building from a limited number of data points using convolutional neural networks by taking advantage of Voronoi tessellation (captured 95% of the variance of 60×60×2 using 25 randomly distributed data points).Solved the sparse sensor placement optimization problem to find an optimal sparse representation of a 2D flow field in the wake of an isolated building using PCA (or POD) and QR factorization with column pivoting (captured 95% of the variance of 60×60×2 images using 71 sparse data points).Solved the sparse sensor placement optimization problem using active (adaptive) learning.Applied DMD to flow past a cylinder and airflow around an isolated building to identify the underlying physics.Data assimilation using Kalman filter to keep the digital twin model up to date (i.e., injecting data from sensors into trained models).Developed a parameterized fast-response model for predicting the flow past a cylinder using POD and CAE.Applied decomposition techniques (e.g., Fourier transform, wavelet transform, and singular value decomposition, SVD) on image datasets to compress them.Developed a Transformer model suitable for capturing both spatial and temporal dependencies among sparse data points.Developed a sparse reconstruction model, combining sp-DMD, various time-series algorithms (bidirectional LSTM with temporal attention mechanism, and spatio-temporal Transformer), and a deep neural network.Contributed to the expansion and adaptation of ontologies for integration with urban-related datasets, enhancing their suitability and applicability. | |
| Concordia University, Montreal, QC | Sep. 2019 – Sep. 2022 |
| Graduate Research Assistant (PhD Candidate) | |
| <ul style="list-style-type: none">Developed ROMs for predicting flow fields in urban areas using various convolutional autoencoders (i.e., conventional, multi-scale, and self-attention-based) and parallel LSTM.Developed a self-attention module for image datasets, designed to capture spatial dependencies among data points, integrating the physics of turbulent flow fields into a fully data-driven model.Performed POD and spectral analysis on urban turbulent flow fields to understand the underlying physics of the problem.Conducted CFD simulations using embedded large eddy simulation (ELES) to reduce computational costs. | |

Skills

Programming & Computing

- **Languages:** Python, MATLAB
- **Big Data & Distributed Computing:** PySpark, Apache Kafka, MQTT

Machine Learning & Data Science

- **Frameworks & Platforms:** TensorFlow, Keras, PyTorch, AWS SageMaker, Scikit-learn, Pandas
- **Techniques:** Time-series analysis, Signal processing, Spatio-temporal modeling, Digital twin modeling, Large language models (LLM), Agentic AI, Retrieval-Augmented Generation (RAG)
- **Scientific / Hybrid ML:** Differentiable programming (PyTorch autograd), Physics-informed neural networks (PINN), Sparse sensing, Kalman data assimilation, Model-based reinforcement learning

Data Engineering & Databases

- **Databases:** PostgreSQL, TimescaleDB, PostGIS, Neo4j
- **Query Languages:** SQL, Cypher
- **Pipeline & Orchestration:** Apache Airflow, Docker, Kubernetes, AWS EC2, CI/CD (GitHub Actions)
- **APIs & Backend Development:** FastAPI

Data Visualization & Monitoring

- **Visualization Tools:** Matplotlib, Seaborn, Tecplot
- **Real-time Monitoring & Dashboards:** Grafana

Mathematics & Theoretical Foundations

- **Mathematics & Modeling:** Linear Algebra, Probability & Statistics, Dynamical systems, Control theory
- **Physics & Engineering:** Fluid Dynamics, Turbulence, Convective Heat Transfer

Miscellaneous & Tools

- **Version Control & Scripting:** Git, GitHub, Bash Scripting
- **Productivity & Analytics:** MS Excel

Education

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| Concordia University, Montreal, QC <i>PhD in Building Engineering</i> | Sep. 2019 – Sep. 2022 |
| Iran University of Science and Technology, Tehran, Iran <i>MSc in Mechanical Engineering</i> | Sep. 2016 – Feb. 2019 |
| Iran University of Science and Technology, Tehran, Iran <i>BSc in Mechanical Engineering</i> | Sep. 2012 – Aug. 2016 |