

Mustafa Kerem Kurban

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Machine Learning Engineer | Physics & AI Solution Developer

Innovative Machine Learning Engineer with 8+ years of experience developing physics-informed AI solutions and scalable ML systems. Extensive experience in 3D simulation environments, high-performance computing, and deep learning frameworks. Strong background in computational neuroscience, applied mathematics, and materials science enables me to bridge complex physical modeling with cutting-edge ML approaches. Proven ability to translate technical AI solutions into business value and communicate complex concepts to diverse stakeholders.

Top Skills

- **Physics-Informed ML Solutions:** Experience in building AI systems for complex physical simulations and 3D modeling
- **Deep Learning & Python:** Advanced expertise in PyTorch, TensorFlow, and scientific Python for complex modeling tasks
- **Customer-Facing Technical Communication:** Proven ability to translate complex AI insights into actionable outcomes for stakeholders
- **3D Data Processing & Simulation:** Extensive experience with large-scale 3D modeling and simulation workflows

Work Experience

EPFL Blue Brain Project, Geneva, Switzerland

Machine Learning Engineer (04/2024-01/2025)

- Designed physics-informed ML pipelines for processing 3D neural simulation data, implementing PyTorch-based deep learning models to predict physical responses of neural systems
- Developed multi-agent LLM systems using LangChain and OpenAI for simulation automation, reducing manual analysis time by 90%
- Integrated AWS cloud services (S3, EC2, SageMaker) with on-premise HPC infrastructure to create scalable simulation environments
- Engineered knowledge graph systems using Neo4j to model complex 3D relationships between neural structures
- **Customer-Facing Experience:** Built intuitive interfaces and visualization tools for collaborating scientists, regularly presenting technical solutions to non-technical stakeholders.

Scientific Software Developer (03/2020-09/2020 & 04/2021-04/2024)

- Architected high-throughput brain simulation pipelines processing over 100TB of multimodal physical data to reconstruct and validate detailed 3D neural circuits
- Implemented physics-based numerical models for neural dynamics, integrating differential equations with machine learning predictions
- Applied 3D point cloud processing techniques (similar to PointNet) for analyzing neural morphologies across different physical scales
- Designed and optimized complex 3D data visualization workflows, creating interactive dashboards for exploring simulation results
- Led collaborative projects with external research partners, effectively translating technical implementations to diverse scientific audiences

Education

- **MSc in Material Science and Nanotechnology** (2021), Bilkent University, Turkiye & co-supervised in EPFL, Switzerland
 - Thesis: "Numerical Simplification of the Data-Driven Hippocampal CA1 Microcircuit"
 - Relevant coursework: Applied Mathematics (EPFL) , Computational Methods for Material Science and Complex Systems, Neural Networks, Nanoscience and Nanotechnology, Self-Organized and Self-Assembled Systems, Deep Learning
- **BSc in Life Sciences** focusing on Neuroimaging and Deep Learning (2018), Bogazici University, Turkiye
 - Relevant coursework: Physics for Engineers, Biophysics, Data Science and ML for Physicists, Matrix Theory, Calculus

Technical Skills

- **Programming Languages:** Python (expert), SQL, Bash, JavaScript, C++, CUDA, Go, Cyper, C, GraphQL
- **Deep Learning Frameworks:** PyTorch, TensorFlow, Scikit-learn, Hugging Face Transformers
- **3D/Physical Modeling:** Experience with simulation environments, 3D point cloud processing, physical system modeling
- **Cloud Solutions:** AWS (S3, EC2, SageMaker, Lambda), Infrastructure as Code, Terraform
- **Scientific Computing:** NumPy, SciPy, Pandas, NetworkX, Matplotlib, Jupyter
- **DevOps & ML Engineering:** Docker, Kubernetes, Git, FastAPI, ML pipelines, MLOps

Certificates

- Neo4j Certified Professional (2024)
- AWS Foundations, AWS Bedrock (AWS, 2024)
- Infrastructure as Code in Google Cloud Platform (LinkedIn Learning, 2024)
- LLMOps and Fine-Tuning Large Language Models (DeepLearning.AI, 2024/25)
- Quantization Fundamentals with Hugging Face (DeepLearning.AI, 2024/25)

Selected Projects

Physics-Informed Neural Networks for Simulation Acceleration:

- Developed hybrid physics-ML models to accelerate complex NEURON simulations by 10x.
- Integrated physical constraints into spiking neural network architectures to ensure physically plausible predictions

3D Neural Morphology Analysis , Classification and Synthesis Pipeline:

- Created a 3D point cloud processing framework for analyzing complex neural morphologies using algebraic topology.
- Generated Graph Neural Networks for classification of different graph structures of neurons and brain connectomics.
- Synthesized novel morphologies in 3D constrained atlas using topologically constrained generative algorithms in micro and meso scale.

Cloud-Based Simulation Infrastructure and LLMOps:

- Designed and implemented AWS-based infrastructure for large-scale neural simulations
- Used Terraform for infrastructure as code, enabling reproducible deployment of compute resources
- Integrated with on-premise HPC systems for hybrid computing solutions
- Designed LLM pipelines (front and backend) that ground answers on in-house vectorDB and generate configs for large scale simulations, all integrated with cloud infrastructure (AWS).

For open-sourced projects, publications, and additional details, visit

<https://keremkurban.created.app/>