Muhammed Ustaomeroglu

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Education

Carnegie Mellon University *Pittsburgh, PA*
- *Ph.D. in Electrical and Computer Engineering, GPA: 4.0/4.0* *08/2023–05/2028*

Bilkent University *Ankara, Türkiye*
- *B.Sc. in Physics, CGPA: 3.99/4.0, Ranking:* $1^{st}/51$ *09/2018–01/2023*
- *B.Sc. in Electrical and Electronics Engineering, CGPA: 3.98/4.0, Ranking:* $2^{st}/256$

Experience

Graduate Researcher (Machine Learning) *Pittsburgh, PA*
Carnegie Mellon University *08/2023–05/2028*
- Develop high-level theoretical frameworks to understand and guide the design of large-language models. For instance, information-theoretic pipelines to probe how language models *plan* their outputs, quantifying horizon, branching, and history dependencies across tasks.
- Perform mechanistic, block-level, analyses of Transformer components, proving convergence and generalization properties and introducing novel self attention variants.
- Propose and empirically validate new model architectures inspired by theoretical insights.
- Formalize long-horizon dependencies in multi-agent networked control and analyze the capacity of Transformer-based policies to capture and exploit long-range interactions.

Undergraduate Researcher (Quantum Information Theory) *Ferrara, Italy*
University of Ferrara *07/2022–10/2022*
- Proposed a new phase space structure and Wigner function formulation for composite systems. Regardless of the system's degrees of freedom, the function defines states in a 2D phase space, which has applications in systems with high degrees of freedom.

Undergraduate Researcher (Computer Vision) *Ankara, Türkiye*
Nurol Makina *10/2021–05/2022*
- Designed an AI system that detects anomalies on the road, prospective application of which was mine detection for military convoys.

Undergraduate Researcher (General Relativity Theory) *Ankara, Türkiye*
Middle East Technical University *09/2021–04/2022*
- Used *differential geometry* to work on the relativistic theory of tidal Love Numbers for spinning and nonspinning black holes.

Undergraduate Researcher (Quantum Random Number Generation) *İstanbul, Türkiye*
TUBITAK *06/2021–07/2021*
- Generated quantum random numbers via the Homodyne detection method and used *information theory* to develop new methods for measuring the randomness level of the quantum random numbers.

Undergraduate Researcher (Photonic Simulation) *Ankara, Türkiye*
Bilkent University *02/2021–03/2021*
- Used probabilistic differential equations such as *master equation* to make some small changes on an exiting detailed code to simulate physics of ultrafast nonlinear lasers.

Undergraduate Researcher (Transmission Lines) *Ankara, Türkiye*
Bilkent University, NANOTAM *07/2020–08/2020*

Related Projects and Publications

- **A Theoretical Study of (Hyper) Self-Attention through the Lens of Interactions**
  M. Ustaomeroglu, G. Qu

  International Conference on Machine Learning (ICML), 2025 [Paper]
- **Language Model Planning from an Information Theoretic Perspective**
  M. Ustaomeroglu*, B. Askin*, G. Joshi, C. Joe-Wong, G. Qu
  Under review [Paper]
- **Hyper-Feature Attention**
  Work in progress
- **Long-Range Multi Agent Networked Control**
  Work in progress
- **Distance Map Extraction and Road Defect Detection Using Stereo Vision**
  B. Askin*, S. Callioglu*, F. B. Sarpkaya*, E. Ilhan*, **M. Ustaomeroglu***, Y. Yarici*
  Anadolu Agency

Skills

Machiene Learning: Have a grasp of the field thanks to courses I took (Advanced Deep Learning, Theoretical and Empirical Foundations of Modern Machine Learning, Advanced Machine Learning, Advanced Introduction to Machine Learning, Fundamentals of MDPs and Reinforcement Learning, Intermediate Statistics) at Carnegie Mellon University.

Mathematical Maturity: Thanks to my background in theoretical physics and engineering I learned several applied math subjects such as; linear algebra, information theory, differential geometry, differential equations, complex calculus, advanced calculus, probability theory, geometric algebra, group theory, signals&systems, statistical mechanics, stochastic models.

Programming: Libraries relevant to machine learning (e.g. pytorch, numpy, tensorboard etc.) and experience with HPC platforms (SLURM).

Selected Awards and Other Experience

- Teaching Assistant for Introduction to ML for Engineers (18-661) in Spring 2024.
- 2023-2024 Carnegie Institute of Technology Dean's Fellowship at CMU
- Bilkent University Department of Electrical and Electronics Engineering Senior/Voluntary Projects, Enterpreneurship, Social Awareness, and Academic Eccelence Awards.
- One semester tuition scholarship at the National University of Singapore.
- Bilkent University Comprehensive Scholarship: full tuition waiver & stipend during the B.Sc. Program
- TUBITAK Scholarship: additional stipend during the B.Sc Program.
- TURING Scholarship: additional stipend during the B.Sc Program.
- Ranked 506th/2.5 million in nationwide university enterence exam in Türkiye.
- Ministry of National Education Scholarship: stipend during secondary and high school education.
- Board member of Carnegie Mellon University Turkish Student Society.
- Conducted a responsible research and innovation (RRI) inquiry on hydroelectric power plants, investigated Teknopar firm via RRI guidelines.
- Hosted and guided ambassadors from more than fifty different countries in a Turkish national celebration event.