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Fundamental Concepts of Generative Machine Learning

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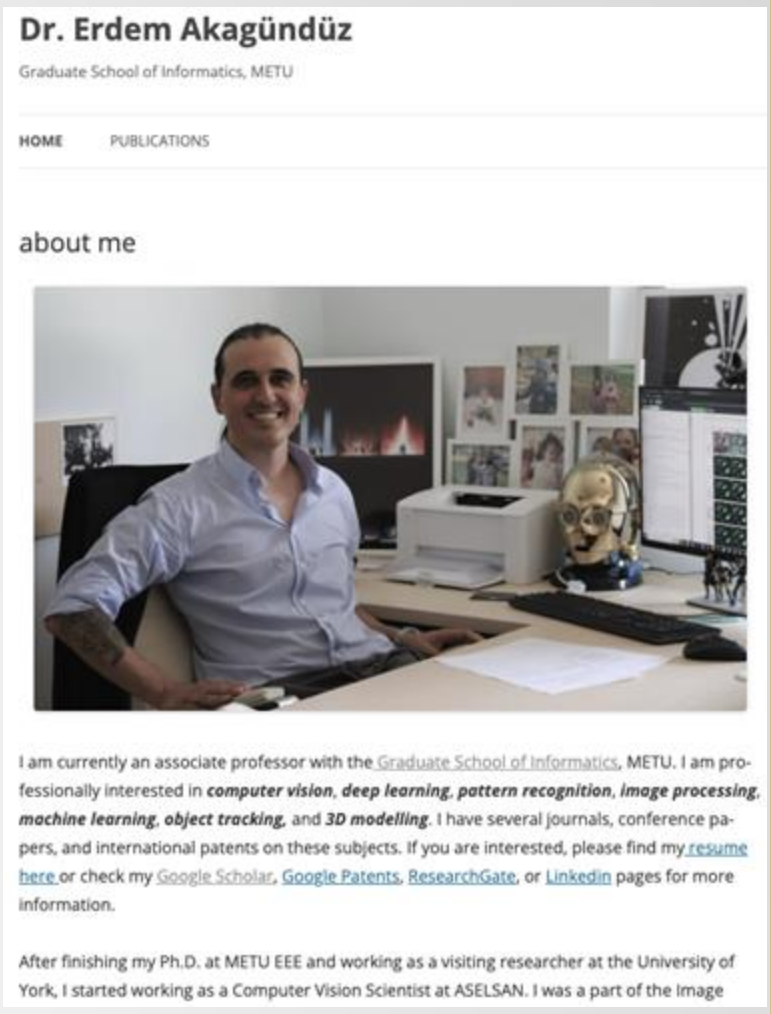
Meet the Instructor

- Education
  - B.Sc. EEE METU, Turkey (1997-2001)
    B.Sc. Minor Program, Sociology METU (1998-2001)
  - M.Sc. EEE, METU, Turkey
    on "3D Modelling and Graphics" (2001-2004)
  - Ph.D. EEE, METU, Turkey
    on "3D Object/Surface Representation" (2004-2011)
- Professional
  - Research and Teaching Assistant, EEE METU, (2001 - 2008)
  - Visiting Phd Student, the Univ. of York (2008 - 2009)
  - Applied Scientist, ASELSAN, Inc, (2009 - 2016)
  - Research Associate, the Univ. of York, (2016)
  - Assistant Professor, EEE Çankaya Uni. (2018 - 2021)
  - Research Associate, the Univ. of York, (2022-2023)
  - Associate Professor, MMI II METU (2021 - …)

https://blog.metu.edu.tr/akaerdem/



Dr. Erdem Akagündüz

Graduate School of Informatics, METU

HOME PUBLICATIONS

about me

I am currently an associate professor with the Graduate School of Informatics, METU. I am professionally interested in ***computer vision***, ***deep learning***, ***pattern recognition***, ***image processing***, ***machine learning***, ***object tracking***, and ***3D modelling***. I have several journals, conference papers, and international patents on these subjects. If you are interested, please find my resume here or check my Google Scholar, Google Patents, ResearchGate, or Linkedin pages for more information.

After finishing my Ph.D. at METU EEE and working as a visiting researcher at the University of York, I started working as a Computer Vision Scientist at ASELSAN. I was a part of the Image

Our Institute

- Associate Professor, MMI II METU
  - MSc, PhD Advisorships,
  - Research Project (TUBITAK) Administrations
  - Industrial Consultancies
  - Teaching
    - DI504 Foundations of Deep Learning
    - MMI711 Sequence Models in Multimedia
    - MMI714 Generative Models in Multimedia
    - IS566 Image Processing Algorithms
    - MMI704 Human Motion Capture, Analysis and Synthesis

https://ii.metu.edu.tr/full-time-faculty

Erdem Akagündüz, Assoc. Prof. Dr.

Multimedia Informatics

Room: B-216, **Phone:** 7886, **Email:** akaerdem[at]metu.edu.tr

Fields of Interest:

Computer Vision, Deep Learning, Pattern Recognition

Yeşim Aydın Son, Assoc. Prof. Dr. (Head of Health Informat

Health Informatics

Room: B-207, **Phone:** 7708, **Email:** yesim[at]metu.edu.tr

Fields of Interest:

bioinformatics; computational biology; genomics; GWAS microarra

research, personalized medicine, medical informatics, genomics,

next generation sequencing, neurogenetics, molecular genetics

Nazife Baykal, Prof. Dr.

Information Systems

Room: A-206, **Phone:** 7701, **Email:** baykal[at]metu.edu.tr

Fields of Interest:

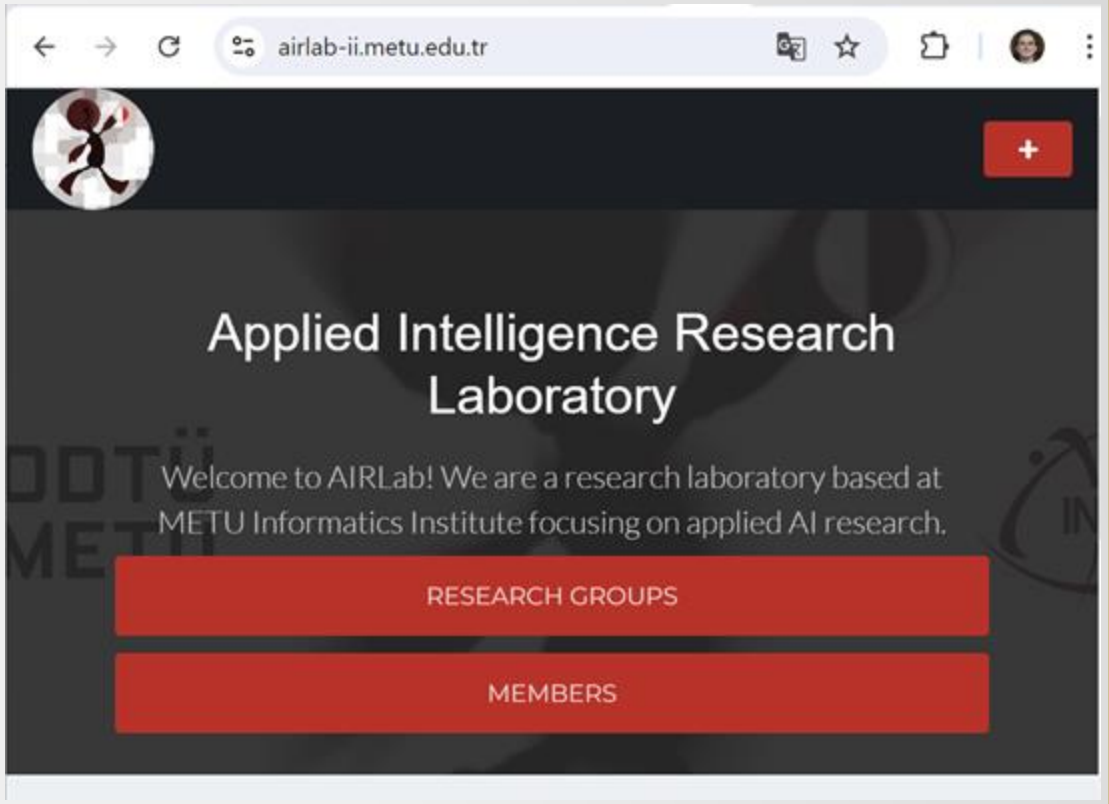
Cem Bozsahin, Prof. Dr.

Our Research Laboratory

https://airlab-ii.metu.edu.tr/

- **AIRLab** is home to different research groups focusing on applying AI problems across diverse domains including, but not limited to, computer vision, geoinformatics, earthquake engineering, and decision systems.

- For comprehensive insights into specific projects, publications, and team members, please navigate to the individual pages of each research group.



Preknowledge/Prerequisite(s)

(Must)

- Familiarity with Probability Theory
- Familiarity with Fundamental Machine Learning Concepts

(Optional/Recommended)

- Experience with Deep Neural Networks
- Experience with Information Theory

Preknowledge/Prerequisite(s)

This course is designed for a broad audience,

- including students with basic knowledge of probability theory and machine learning,
- as well as those who are more experienced in deep learning and information theory.

What will you learn?

Fundamental Concepts of Generative Machine Learning

- **Foundational Concepts**: Gain a solid understanding of the core principles of generative modeling, including the necessity of modeling data as distributions within latent spaces.
- **Mathematical and Theoretical Tools**: Learn about essential mathematical concepts, evaluation techniques, and introductory information theory, such as entropy and divergence.
- **Latent Space and Generative Models**: Explore the properties of latent spaces, deep feature spaces, and their roles in self-supervised auto-encoder systems.

Why this course?

Fundamental Concepts of Generative Machine Learning

- Many practitioners in machine learning and deep learning often focus on model training and prediction without fully understanding the concept of generation and its connection to information theory.
- This short course is designed to bridge that gap, providing a dive into the principles of generative modeling and its critical role in understanding and shaping data distributions within the broader context of AI.

Course Outline

PART I: Mathematical Background

- Generation vs. Discrimination in Machine Learning
- Data Distribution, Sampling, Inference and Generation
- Expectation and Likelihood
- Evaluation for Generative Models, Distribution Distances, Divergence and Entropy

Course Outline

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PART II: Latent Spaces

- (Curse of) Dimensionality
- Deep Features vs. Latent Spaces
- Latent Space properties, Continuity, Entanglement, etc

Course Outline

PART III: Auto-Encoding

- Autoencoders and Dimensionality Reduction
- Variational Inference and VAEs
- Conclusions

What this course is

- **A Conceptual Foundation:** This course provides a deep understanding of the principles behind generative modeling, focusing on the importance of data generation through distributions.
- **Exploring Latent Spaces**: Gain insights into why modeling data within a latent space is crucial for effective generation and how it underpins various generative models.
- **Connecting with Information Theory**: Understand the relationship between generative modeling and key concepts in information theory, emphasizing why a simple distribution is often necessary.

What this course isn’t

- **Not Just Another Course on GANs, VAEs, or Diffusion Models**: This course does not focus on teaching specific generative model architectures or their technical details.
- **No Architecture-Specific Tutorials**: You won’t find step-by-step guides on how to build GANs or diffusion models here.
- **Not a Tool-Centric Approach**: The course emphasizes the underlying ideas and theory behind generation, rather than the application of specific tools or techniques.

Course Objectives

- **Understand the Core Principles**: Develop a solid grasp of the fundamental concepts in generative modeling, including the role of distributions in generating data.
- **Explore Latent Spaces**: Learn why latent spaces are essential for modeling and generation, and how they differ from deep feature spaces.
- **Evaluate Generative Models**: Understand the evaluation techniques used to assess the performance and accuracy of generative models.
- **Bridge Theory and Practice**: Connect theoretical concepts with practical applications, understanding how they underpin the generative models used in modern AI.

Set Up/Configure/Install …..

- **No Installation Required:** This course focuses on the theoretical foundations of generative modeling, so you won’t need to install any software or tools.
- **Conceptual Understanding:** Our emphasis is on understanding the underlying principles and ideas, rather than hands-on coding or model implementation.

Thanks

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