Course Information

Instructor:  
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Office: 475 Hill Center

Lectures: ARC 205, Busch, Wednesday 3.50 pm - 6.35 pm (Jan 17 – Feb 28, 2024)

Description: This is a half-semester special topics course on generative models (Jan 16 - Feb 28, 2024). It is intended for PhD students and masters students interested in research.

In many domains, high-dimensional data exhibits variability that can be summarized by low-dimensional latent representations, or factors. These factors can be useful in a variety of tasks including prediction, transfer learning, and domain adaptation. To learn such factors, it is increasingly common to fit deep generative models.

In this course, we focus on generative modeling with an eye towards learning meaningful representations of data. Topics include: classical generative models and deep generative models such as variational autoencoders, the challenges of learning meaningful and interpretable representations, learning representations from multiple types of data simultaneously, and learning causal representations.

Grading:

- 10% participation/discussion
- 10% final project proposal (abstract of project)
- 50% final project (e.g. 3 page literature review, or implementing a model from a paper)
- 30% presentation (final project, or discussing a paper)

The final project and presentations may be completed in groups of up to three.

Syllabus

- Week 1: Introduction
  - Overview of probabilistic modeling
  - Classical generative models
    * Gaussian mixture models
    * Factor analysis
    * EM algorithm
• **Week 2: Deep generative models**
  – Variational inference
  – Variational autoencoders
  – Different types of VAEs including multi-facet VAE, VQ-VAE

• **Week 3-4: Representation learning**
  – Interpretability and issues of identifiability
  – Approaches to solving the identifiability problem

• **Week 5: Multimodal representation learning**
  – Probabilistic canonical correlation analysis (CCA), group factor analysis
  – Multimodal neural network models and contrastive learning

• **Week 6: Causal representation learning**
  – Directed acyclic graphs (DAGs)
  – Causal representations

• **Week 7: Project presentations**