ECE 792-061 - Advanced Topics in Machine Learning

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While Machine Learning appears in all application areas, one should pay careful attention in their adoption when addressing a vast spectrum of technical challenges. Building on the achievements of Artificial Neural Networks and Convolutional Neural Networks, we will use an arsenal of principles from Neuro/Cognitive Science, Probability, Information Theory and Representation Theory (functional Analysis) to explore various state of the art Machine Learning tools spanning Generative models (e.g., Generative Adversarial Networks-GANS) to Implicit Neural Networks to Transformers inching closer towards primate Learning.

Pre-req: **Some background in NN/CNN, linear algebra, and Calculus and probability is assumed.** Course will be project-oriented (60%), Homework/Participation (20%) , and 1 mid-term (20%).

Topics: High-Level-Description

- Introduction to ML, Problems, task learning, Pac-Learning
- Regression: Linear regression, Linear Regression models, Non-linear regression models
- CNN-review
- Energy-based learning networks and other (e.g. VNN).
- Sparse and Robust Learning Networks
- Generalization and latent model learning
    - Meta-learning
    - Auto-encoder and VAE
    - Domain adaptation..
- Neural Tangent Kernel Learning
- Generative Models
    - Generative Adversarial Networks (GANs), DC-GANs, f-GANs, ….
    - Normalizing flowa
- Bayesian Neural Networks
- Learning Dynamic and time series (RNN, LSTM).
- Transformer Neural networks