**List of Projects – IST597**

1. **Hybrid JPEG Compression system.**
   * Compare compression ratio at lowest bit rate
   * Design objective function to optimize network to produce better images.
2. **Differentiable Stack for Dyck language or Context free languages.**
   * Compare various memory augmented models on Dyck languages and derive empirical limits of these models.
3. **Compare various state machine extraction methods on Dyck-1 languages (compare L-star with Quantized method)**
   * Compare 1st order and Tensor RNN performance
   * Report average success ratio
   * Test on longer sequences
4. **Design sparse MLP with various learning algorithms.**
   * You will be comparing backprop (BP) with sparse activation functions such as k-winner take-all.
   * Compare alternative of BP such as Difference Target Propagation and Local Representation learning.
5. **Compare Graph based NN vs Tree NN for mathematical reasoning task.**
   * In this project you will be comparing graph and tree embeddings and analyze the extrapolation power of such of difficult and challenging examples.
6. **Design computational model for NNPDA with differentiable Stack and test it on various context free grammars.**
   * You will be designing encodings for NNPDA and show equivalence between theoretical model and computational models.
   * You will also design training routine for this model, since Tensor RNNs are difficult to train using BPTT, you will learn about forward propagation methods such as RTRL and UORO and design learning algorithm to stably train these networks.
7. **Derive computational limitations of transformers in recognizing context free grammars.**
   * Show limitations of hard attention vs soft attention in recognizing CFGs
   * Add special symbols to input data to help transformers recognizing complex CFGs, Evaluate performance with and without such symbols.
   * Compare Transformers with other memory augmented models and Autoregressive models.
8. **Add memory module to Neural Coding Network (NCN) and its variant for lifelong learning or Continual learning task.**
   * In this we will design mathematical module inspired by neocortex learning in human brain and design short term and long term memory that can work stably and achieve respectable performance on deep learning task.
9. **Graph neural networks for author name disambiguation. The data comes from the S2AND paper from AllenAI.**
   * Compare with other ND algorithms at scale