## CSE 573 Spring 2022 Project Sample Topics

Proposal Deadline: May 6th, 2022

**Deep Reinforcement Learning Topics**

* [AI2-THOR](https://ai2thor.allenai.org/) Reinforcement Learning for Navigation : finding objects in scenes
  + Simulator using deep reinforcement learning algorithms
  + For a sample project setup please refer to [here](https://github.com/Swetko/cse573).
  + Resources: requires GPU
* Design and Implementation of game playing agent. (Coordinate the game with a TA or course instructor). AI has shown the ability to learn many complex games, sometimes better than human experts. Furthermore, it has been noted that AI often plays differently from experts in ways that are difficult to understand (check out the film AlphaGo for a great example of this in DeepMind’s games against a world Go champion, or Gary Kasparov’s reflections on playing chess against DeepBlue). This project can be accompanied with a demo at the presentation. We provide some examples here:
  + Deep Reinforcement Learning for Playing Attari
    - Please refer to this [paper](https://arxiv.org/pdf/1312.5602.pdf) for more information.
  + Alpha Go or MuZero
    - Please find the state of the art on go game [here](https://www.nature.com/articles/nature24270.epdf?author_access_token=VJXbVjaSHxFoctQQ4p2k4tRgN0jAjWel9jnR3ZoTv0PVW4gB86EEpGqTRDtpIz-2rmo8-KG06gqVobU5NSCFeHILHcVFUeMsbvwS-lxjqQGg98faovwjxeTUgZAUMnRQ), and the MuZero framework [here](https://www.nature.com/articles/s41586-020-03051-4).
  + Open AI Gym
    - Visit <https://gym.openai.com/envs/> to see the list of all the tasks.
    - Your goal is to implement the REINFORCE and A3C algorithm to solve various OpenAI-gym environments.
    - For this project you can use the library introduced [here](https://github.com/pjreddie/rl-hw) which provides a discrete action space. With this library you won’t need GPU resources to run the experiments
  + **Chess:** 
    - Optionally, compare human players with the learned play of your model. As an example, see this recent paper on Aligning Superhuman AI with Human Behavior: Chess as a Model System (KDD2020) [[link](https://www.kdd.org/kdd2020/accepted-papers/view/aligning-superhuman-ai-with-human-behavior-chess-as-a-model-system), [blog](https://blog.acolyer.org/2020/09/14/aligning-superhuman-ai-with-human-behaviour/)].
* Self driving car simulation
  + **Background:** Please refer to [this article](https://web.stanford.edu/~anayebi/projects/CS_239_Final_Project_Writeup.pdf) for more information. You can start by implementing along the ideas that are used here.
  + **Code:** Please look at this [link](http://vdrift.net/) for examples
  + Also take a look at the simulation platform introduced [here](https://medium.com/@jeremyscohen/deep-reinforcement-learning-for-self-driving-cars-an-intro-4c8c08e6d06b).

**Sequential models**

* Sequential Neural Models, recurrent neural nets (RNNs) and LTSMs: In this area even an exploratory project comparing a few ideas/methods could make an interesting project.
  + **Some interesting blog posts:** [Recurrent neural nets](http://karpathy.github.io/2015/05/21/rnn-effectiveness/) and [n-gram models](http://nbviewer.ipython.org/gist/yoavg/d76121dfde2618422139)
* Word Embeddings: Explore ways of making vector representations of words. This would be an interesting project for anyone with NLP interests or unsupervised learning interests.
  + **Background:** These papers ([paper](http://www.cs.columbia.edu/~djhsu/papers/brown_alg.pdf) by Stratos, Kim, Collins, and Hsu and [paper](http://www.cs.columbia.edu/~stratos/research/acl15cca.pdf) by Stratos, Collins, and Hsu) are a good place to start.
  + **Code:** Please look at these libraries: ([link](https://github.com/karlstratos/singular) [link](https://github.com/karlstratos/cca) [link](http://www.cis.upenn.edu/~ungar/eigenwords/)). They provide interesting examples.
* Text classifier using pre-trained Transformers
  + Recommended library: [Huggingface Transformers](https://huggingface.co/docs/transformers/index)
  + Recommended models: [BERT](https://huggingface.co/docs/transformers/model_doc/bert), [RoBERTa](https://huggingface.co/docs/transformers/model_doc/roberta), [ELECTRA](https://huggingface.co/docs/transformers/model_doc/electra), [AlBERT](https://huggingface.co/docs/transformers/model_doc/albert)
  + Recommended classification problems:
    - Predicting the sentiment of the financial news statement ([link](https://huggingface.co/datasets/financial_phrasebank))
    - Predicting whether the given twitter post is offensive or not ([link](https://huggingface.co/datasets/tweet_eval/viewer/offensive/train))
    - Predicting the emotion of the statement ([link](https://huggingface.co/datasets/emotion))
* Text generation using pre-trained Transformers
  + Recommended library: [Huggingface Transformers](https://huggingface.co/docs/transformers/index)
  + Recommended models: [BART](https://huggingface.co/docs/transformers/model_doc/bart), [T5](https://huggingface.co/docs/transformers/model_doc/t5v1.1), [GPT-2](https://huggingface.co/docs/transformers/model_doc/gpt2)
  + Recommended multilingual models: [mBART](https://huggingface.co/docs/transformers/model_doc/mbart), [mT5](https://huggingface.co/docs/transformers/model_doc/mt5)
  + Recommended generation problems:
    - Translate from one language to another ([link](https://huggingface.co/datasets/wmt15))
    - Summarize news articles ([link](https://huggingface.co/datasets/cnn_dailymail))
    - Text-2-code ([link](https://huggingface.co/datasets/code_x_glue_tc_text_to_code))
* Next frame prediction using an LSTM
* Time series analysis of rat brain excitations
* Predicting retweet counts with live demo
* Dialog System with live demo
  + Recommended dataset: MultiWOZ
* Classification of macromolecular sequences

**Multimodal models:**

* Learn to combine different modalities (text, images, video and audio data) together, using multimodal architectures, and test on tasks that require combining together and reasoning about information from several modalities:
  + Visual Question Answering
    - Recommended models: [VilBERT](https://github.com/facebookresearch/vilbert-multi-task), [CLIP-ViT](https://huggingface.co/openai/clip-vit-base-patch32), [lxmert](https://huggingface.co/unc-nlp/lxmert-base-uncased)
    - Recommended datasets: [Visual Genome](https://visualgenome.org/), [VQA](https://visualqa.org/vqa_v1_download.html), [VQA 2.0](https://visualqa.org/download.html), [TVQA](https://tvqa.cs.unc.edu/)
  + Text-2-Speech, Automatic Speech Recognition (ASR)
    - Recommended models: [Wav2vec2 ,](https://huggingface.co/facebook/wav2vec2-base-960h) [Fastspeech2](https://huggingface.co/facebook/fastspeech2-en-ljspeech)
    - Recommended datasets: [Common\_voice](https://huggingface.co/datasets/common_voice), [librispeech\_asr](https://huggingface.co/datasets/librispeech_asr)
  + Image captioning:
    - Recommended models: VilBERT, [Dalle,](https://huggingface.co/flax-community/dalle-mini) [CLIP-ViT](https://huggingface.co/openai/clip-vit-base-patch32), [lxmert](https://huggingface.co/unc-nlp/lxmert-base-uncased)
    - Recommended datasets: Visual Genome, [MS-COCO](https://cocodataset.org/), [Flickr30K](https://www.kaggle.com/datasets/hsankesara/flickr-image-dataset) Conceptual Captions

**Other sample categories:**

* fMRI Brain Imaging:
  + **Background:** Brain scans were taken of a subject in the process of a word reading task. We want to be able to predict what word the participant is reading based off of the activation patterns in their brain. In this project you will use the fMRI image to predict the semantic features of the word, and then use the provided dictionary to find our best guess as to which word it is.For more infor on FMRI data please refer to: [CMU Background](http://www.cs.cmu.edu/afs/cs/project/theo-73/www/science2008/data.html)
  + **Data:** [fmri.zip](http://www.cs.washington.edu/education/courses/cse599c1/13wi/datasets/fmri.zip) (See 3.3.3 of [this homework](http://www.cs.washington.edu/education/courses/cse599c1/13wi/homework/hw3/homework3.pdf) from last quarter's Big Data class for a description of the dataset
  + **Task:** Given an image and two candidate words, predict which of those words was being read by the subject.
* Job Salary Prediction:
  + **Background:** This is another task taken from a Kaggle competition. Given an advertisement for a job opening, the goal is to predict the starting salary for the job being posted. For more information please refer to [Kaggle Description](https://www.kaggle.com/c/job-salary-prediction)**.**
  + **Data:** [Kaggle Dataset](https://www.kaggle.com/c/job-salary-prediction/data)**.** Much of the data about the ads is unstructured text
  + **Task:** Predict a salary from a job posting
* Student Performance Prediction:
  + **Background**: Predict student performance on mathematical problems from logs of student interaction. This [link](http://kdd.org/kdd-cup/view/kdd-cup-2010-student-performance-evaluation/Tasks) provides more information regarding the task.
  + Create a model that deals with challenges of sparsity, temporality, and selection bias. This project was the KDD Cup 2010.
  + **Data:** [Kdd cup 2010](http://kdd.org/kdd-cup/view/kdd-cup-2010-student-performance-evaluation/Data)
* Disaster Prediction
  + **Background:** A new task from a Kaggle competition. Given a twitter post, predict if it is about a disaster or not. For more information please refer to [Kaggle Description](https://www.kaggle.com/competitions/nlp-getting-started).
  + **Data:** [**Kaggle Dataset**](https://www.kaggle.com/competitions/nlp-getting-started/data)
* House Price Prediction
  + **Background**: Another new task from a Kaggle competition. You are given 79 variables describing aspects of residential homes in Ames, Iowa, and predict the final price of each home. For more information please refer to [Kaggle Description](https://www.kaggle.com/competitions/house-prices-advanced-regression-techniques).
  + **Data**: [Kaggle Dataset](https://www.kaggle.com/competitions/house-prices-advanced-regression-techniques/data)
* Netflix
  + Background: Netflix is one of the most popular media and video streaming platforms. They have over 8000 movies or tv shows available on their platform, as of mid-2021, they have over 200M Subscribers globally. This tabular dataset consists of listings of all the movies and tv shows available on Netflix, along with details such as - cast, directors, ratings, release year, duration, etc. Interesting Task Ideas: Understanding what content is available in different countries, Identifying similar content by matching text-based features, Network analysis of Actors / Directors and find interesting insights
  + Data: [Kaggle Dataset](https://www.kaggle.com/datasets/shivamb/netflix-shows)
* Kepler Exoplanet Search Results
  + Background: Data on 10000 exoplanet candidates examined by the Kepler Space Observatory, launched in 2009. Kepler had verified 1284 new exoplanets as of May 2016. As of October 2017 there are over 3000 confirmed exoplanets total (using all detection methods, including ground-based ones). Some intersting explorations on this dataset include: How often are exoplanets confirmed in the existing literature disconfirmed by measurements from Kepler? How about the other way round? What general characteristics about exoplanets (that we can find) can you derive from this dataset?
  + Data: [Kaggle Dataset](https://www.kaggle.com/datasets/nasa/kepler-exoplanet-search-results)
* [List of interesting machine learning datasets](https://rubikscode.net/2021/07/19/top-23-best-public-datasets-for-practicing-machine-learning/)