Discussion 2

Note: *Your TA will probably not cover all the problems on this worksheet. The discussion worksheets are not designed to be finished within an hour. They are deliberately made slightly longer so they can serve as resources you can use to practice, reinforce, and build upon concepts discussed in lectures, discussions, and homework.*

1 Machine Learning Taxonomy

In this problem, we explore where current ML techniques fit into the Machine Learning Taxonomy introduced in Lecture 3.

(a) **Classical ML:** Below is a list of more "classical" machine learning solutions that are still be used for automated decision making today:

- PayPal Fraud Protection learns to recognize common fraud patterns to detect fraud.
- Amazon's SageMaker groups customers for targeted marketing and recommendations.
- Zillow Zestimate estimates the market value for homes based on on-sale home prices.
- UCLA Health's Epic model identifies the risk of patients for preventable hospital visits.

For each of these examples, decide where in our machine learning taxonomy the approach best fits. Briefly explain your reasoning for each.

Solution:

- **PayPal Fraud Detection**: PayPal uses historical transactions labeled as fraud/non-fraud to train cost-sensitive *classifiers*, so it relies on *supervised learning*.
- **Amazon's SageMaker**: Amazon utilizes a *clustering* algorithm (an *unsupervised learning* technique) to group customers based on behavioral data such as purchase history, browsing patterns, and engagement metrics.
- **Zillow Zestimate**: Zillow uses ensembles of classical *regression* models to predict the market value of homes that are not on sale based on the sale prices of other homes on the market, so it relies on *supervised learning*.
- **UCLA Health's Epic**: The Epic model is trained on patient health records and binary labels (did the patient have a preventable hospital visit?). The model then generates a probabilistic output that predicts whether a new patient is at risk of a preventable hospital visit. This is a form of *supervised learning* and, more specifically, *binary classification*.

(b) **Modern ML:** Below is a list of more "modern" machine learning solutions:

- Boston Dynamics Atlas does parkour and other neat tricks.
- ChatGPT helps you ~~do your homework~~ learn ML.
- Telsa's RoboTaxi drives itself home.
- GameNGen simulates popular video games.

For each of these examples, decide whether the content primarily falls under **supervised learning**, **unsupervised learning**, or **reinforcement learning**, and mention if it uses **self-supervised learning**. Briefly explain your reasoning for each.

Solution:

- **Boston Dynamics Atlas**: The Atlas robots learn to perform acrobatic and other locomotion tasks using *reinforcement learning* to optimize movement policies. The robot receives feedback (e.g., stability, success of a jump) as reward signals to learn how to complete its tricks.
- **ChatGPT**: ChatGPT is pretrained with *self-supervised* next-token prediction (the data provides its own labels), then is fine-tuned with *supervised* prompt-response examples, and finally its responses are aligned using *reinforcement learning* from human feedback.
- **Tesla's Robotaxi**: The perception stack (i.e., object detection, lane detection, traffic sign recognition) relies heavily on *supervised learning* with large labeled datasets. For driving policies, *reinforcement learning* and imitation learning (a form of *supervised learning*) are used to handle long-horizon decision-making and uncertainty.
- **GameNGen**: The data collection agent's behavior in GameNGen comes from *reinforcement learning*, while the game simulation itself (a world model) is trained via *self-supervised* learning of future frames.