Lecture 1, Jan 9, 2024

Types of Learning

- *Supervised learning*: given a training inputs and training targets, we want to learn a relationship for prediction purposes
  - Input data is specified as pairs: $\left\{ (\boldsymbol{x}^{(i)}, y^{(i)}) \right\}_{i=1}^{N}$
  - e.g. regression, classification, time series forecasting, even learning governing equations
  - Main goal is to make predictions
- *Unsupervised learning*: given training data without labels (targets), we want to learn meaningful patterns in the data
  - e.g. clustering, probability density estimation, dimensionality reduction, generative AI models
- *Semi-supervised learning*: targets are only known for a small subset of the training inputs
- *Reinforcement learning*: an agent continuously interacting with the environment learning to maximize a reward function
  - This is an approach for sequential decision making

Parameter Estimation

- Frequentist approach: estimate the model parameters by minimizing a loss function, resulting in a single point in parameter space $\boldsymbol{w}$
  - e.g. regression using least squares
- Bayesian approach: estimate the posterior distribution of the parameters using Bayes' theorem
  - This allows us to also estimate the uncertainty in the model
  - Frequentist estimation is more efficient, but carries no information about the uncertainty