1. Introduction

I Reasoning: Induction, deduction, abduction

2. Statistics

I Descriptive and inferential statistics: Population, sample, statistic, parameters, estimator.

II Population mean and standard deviation.

II Sample estimate of mean and standard deviation.

II Confidence interval for mean and proportion.

II Sample size estimate for mean and proportion.

3. Algorithms

I Algorithmic complexity.

I Understand an algorithm from description or Python code.

II Time complexity function.

II Best, average and worst case complexity.

II Big-O notation.

4. Symbolic AI

I Symbolic AI.

I Forward and backward chaining.

I Monte carlo search.

II Boolean logic.

II Rule-based systems and expert systems.

5. Natural language processing

I Data representation in the computer.

I Bag of words representation.

II Term frequency-inverse document frequency (TF-IDF).

6. Machine learning

I Types of machine learning problems.

I Generalization: Training and test error.

II Linear regression. Model, parameters, and cost function.

7. Image processing

II Feature normalization and standardization.

II K-means clustering. Model, cost function, parameters, and algorithm.

8. Optimization

II Gradient descent algorithm.

I Stochastic gradient descent.

II Gradient of cost function.

II Neural networks: Model (layers, activation functions), parameters, cost function.

9. Automatic differentiation

I Automatic differentiation: Forward and reverse accumulation.

II Computation graphs.

II Automatic differentiation in Pytorch.

II Implementation of neural networks in Pytorch.

10. Audio processing

I Frequency spectrum and spectrogram.

II Feature transformations and basis change.

11. Reinforcement learning

I Reinforcement learning: Markov decision process (state, action, reward).

I Epsilon-greedy action selection and optimistic initialization.

II RL algorithms: Value iteration and Q-learning.

II Optimal action and optimal policy.

II Discount factor.

II Value (of a state) and quality (of a state-action pair).

12. Causality

I Statistical dependency.

II Covariance and correlation coefficient.

I Causality and confounders.

I Randomized trials.

13. Algorithmic fairness

II Fairness criteria: Demographic parity, equalized odds, equal opportunity.

I Ethical challenges and dilemmas in AI