Trustworthy Machine Learning

Part 1 Introduction and Preliminaries

- 1 Establishing Trust
 - 1.1 Introduction
 - 1.2 Defining trust
 - 1.3 Organization of the book
 - 1.4 Limitations
 - 1.5 Positionality statement
 - 1.6 Summary

2 Machine Learning Lifecycle

- 2.1 Introduction
- 2.2 Problem specification
- 2.3 Data understanding
- 2.4 Data preparation
- 2.5 Modeling
- 2.6 Evaluation
- 2.7 Deployment and monitoring
- 2.8 Summary

3 Uncertainty

- 3.1 Introduction
- 3.2 Aleatoric uncertainty and probability
- 3.3 Conditional probability and independence
- 3.4 Bayesian networks
- 3.5 Epistemic uncertainty, possibility, and imprecise probability
- 3.6 Summary

4 Detection Theory

- 4.1 Introduction
- 4.2 Confusion matrix and costs
- 4.3 Bayesian detection
- 4.4 Receiver operating characteristic and calibration
- 4.6 Min-max and Neyman-Pearson detection
- 4.7 Information-theoretic concepts
- 4.8 Summary

5 Causality

- 5.1 Introduction
- 5.2 Interventions
- 5.3 Counterfactuals
- 5.4 Causal graphs
- 5.5 Summary

Part 2 Data

- 6 Modalities and Sources
 - 6.1 Introduction
 - 6.2 Modalities

- 6.3 Administrative data
- 6.4 Social data
- 6.5 Crowdsourcing
- 6.6 Data augmentation
- 6.7 Summary

7 Biases

- 7.1 Introduction
- 7.2 Temporal biases
- 7.3 Sampling bias
- 7.4 Cognitive biases
- 7.5 Poisoning
- 7.6 Data preparation biases
- 7.7 Summary

8 Privacy and Consent

- 8.1 Introduction
- 8.2 Statistical foundations of privacy
- 8.3 Causal foundations of privacy
- 8.4 Consent
- 8.5 Summary

Part 3 Basic Modeling

9 Risk Minimization

- 9.1 Introduction
- 9.2 Empirical risk minimization
- 9.3 Structural risk minimization
- 9.4 Summary

10 Decision Stumps and Their Generalizations

- 10.1 Introduction
- 10.2 Trees and forests
- 10.3 Perceptrons
- 10.4 Margin-based methods
- 10.5 Neural networks
- 10.6 Summary

11 Adversarial and Game-Theoretic Learning

- 11.1 Introduction
- 11.2 Game-theoretic interpretation of boosting
- 11.3 Generative adversarial networks
- 11.4 Summary

12 Causal Modeling

- 12.1 Introduction
- 12.2 Causal inference basics
- 12.3 Treatment effect estimation
- 12.4 Causal discovery
- 12.5 Summary

Part 4 Safety and Reliability

13 Epistemic Uncertainty in Machine Learning

- 13.1 Introduction
- 13.2 Definition of safety
- 13.3 Manifestations of epistemic uncertainty in machine learning
- 13.4 Summary

14 Distribution Shift

- 14.1 Introduction
- 14.2 Statistical foundations of distribution shift
- 14.3 Causal foundations of distribution shift
- 14.4 Domain adaptation
- 14.5 Invariant risk minimization
- 14.6 Performative prediction
- 14.7 Summary

15 Fairness

- 15.1 Introduction
- 15.2 Statistical foundations of fairness
- 15.3 Causal foundations of fairness
- 15.4 Bias mitigation algorithms
- 15.5 Summary

16 Adversarial Robustness

- 16.1 Introduction
- 16.2 Statistical foundations of adversarial robustness
- 16.3 Causal foundations of adversarial robustness
- 16.4 Attacks
- 16.5 Defenses
- 16.6 Summary

17 Testing

- 17.1 Introduction
- 17.2 Testing workflow
- 17.3 Testing components
- 17.4 Testing properties
- 17.5 Summary

Part 5 Interaction

18 Interpretability and Explainability

- 18.1 Introduction
- 18.2 Directly interpretable models
- 18.3 Post hoc local explanations
- 18.4 Post hoc global explanations
- 18.5 Explaining quantities other than predictions
- 18.6 Summary

19 Provenance and Transparency

- 19.1 Introduction
- 19.2 Documentation

- 19.3 Blockchain
- 19.4 Open platforms
- 19.5 Summary

20 Value Alignment

- 20.1 Introduction
- 20.2 Unified theory of trust
- 20.3 Preference elicitation
- 20.4 Specification gaming
- 20.5 Summary

Part 6 Purpose

- 21 Disinformation and Filter Bubbles
 - 21.1 Introduction
 - 21.2 Deepfakes
 - 21.3 Filter bubbles and echo chambers
 - 21.4 Summary
- 22 Professional Codes and Ethics Guidelines
 - 22.1 Introduction
 - 22.2 Landscape of codes and guidelines
 - 22.3 Ethicswashing
 - 22.4 From principles to practice
 - 22.5 Summary

23 Lived Experience

- 23.1 Introduction
- 23.2 Diversity and problem specification
- 23.3 Diversity and solution development
- 23.4 Summary

24 Social Good

- 24.1 Introduction
- 24.2 Examples of machine learning for social good
- 24.3 Common patterns in machine learning for social good
- 24.4 Open platforms for greater impact
- 24.5 Summary