Artificial Intelligence Textbook

Part I: Foundations (Chapters 1–5)

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Chapter 1: Introduction to AI

Artificial Intelligence (AI) is the study and design of systems that can perform tasks requiring human
This includes problem solving, learning, perception, language understanding, and decision-making.
AI is divided into Narrow AI (task-specific) and General AI (human-level capability).

Topics in this chapter:
- Definitions of AI from various perspectives (engineering, cognitive science, philosophy)
- Examples of AI systems today (chatbots, self-driving cars, recommendation systems)
- Importance of AI in the modern world (automation, discovery, efficiency, new possibilities)
- AI vs. Human Intelligence
- Why AI is both exciting and challenging

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Chapter 2: History of AI

The roots of AI date back to philosophy and logic.
Early milestones include Turing's 1950 paper 'Computing Machinery and Intelligence' and the Dartm
which marked the formal birth of AI.

Key periods:
- Early optimism (1950s–1960s)
- Symbolic AI and expert systems (1970s–1980s)
- AI winters (funding and interest dropped due to lack of results)
- Machine Learning era (1990s–2000s)
- Deep Learning revolution (2010s–present)

Important pioneers:
- Alan Turing, John McCarthy, Marvin Minsky, Herbert Simon, Geoffrey Hinton, Yoshua Bengio, Ya

Lessons learned:
- Overpromising leads to setbacks
- Computing power and data availability drive progress
- Interdisciplinary research is crucial

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Chapter 3: Mathematics for AI (Part 1)

Mathematics forms the backbone of AI systems.

Core topics:
- Linear Algebra: vectors, matrices, dot product, eigenvalues (used in neural networks, dimensional
- Probability & Statistics: Bayes theorem, distributions, expectations (used in probabilistic models)
- Calculus: derivatives, gradients (used in optimization of ML models)
- Information Theory: entropy, cross-entropy loss (used in decision trees, neural nets)
- Optimization: convexity, gradient descent, stochastic methods

Example: Gradient Descent Algorithm
- Initialize parameters randomly
- Iteratively update parameters by moving opposite to the gradient of loss function
- Converge to a minimum if conditions satisfied

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Chapter 4: Search & Problem Solving

Search is a fundamental technique in AI.

Types of search:
- Uninformed search: breadth-first search (BFS), depth-first search (DFS), uniform cost search
- Informed search: A*, greedy search, heuristics

Applications:
- Pathfinding in robotics and games
- Puzzle solving (8-puzzle, Sudoku)
- Planning (route planning, logistics)

Example: A* Search Algorithm
- Combines path cost (g) + heuristic estimate (h)
- Expands nodes with lowest (g+h)
- Optimal if heuristic is admissible

Limitations:
- State explosion problem
- Memory and time constraints
- Need for heuristics

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Chapter 5: Knowledge Representation & Reasoning

To reason about the world, AI needs structured knowledge.

Representations:
- Logic-based (propositional, first-order logic)
- Semantic networks and ontologies
- Frames and scripts
- Probabilistic models (Bayesian networks)

Inference techniques:
- Forward chaining, backward chaining
- Resolution in propositional/first-order logic
- Probabilistic inference (belief propagation)

Applications:
- Medical diagnosis systems
- Intelligent personal assistants
- Expert systems in law and finance

Challenges:
- Representing uncertainty
- Scalability in real-world systems
- Balancing symbolic and statistical approaches

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