Decision Making Under Uncertainty: Theory and Application (MIT Lincoln Laboratory Series)

By Mykel J. Kochenderfer

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Many important problems involve decision making under uncertainty -- that is, choosing actions based on often imperfect observations, with unknown outcomes. Designers of automated decision support systems must take into account the various sources of uncertainty while balancing the multiple objectives of the system. This book provides an introduction to the challenges of decision making under uncertainty from a computational perspective. It presents both the theory behind decision making models and algorithms and a collection of example applications that range from speech recognition to aircraft collision avoidance.

Focusing on two methods for designing decision agents, planning and reinforcement learning, the book covers probabilistic models, introducing Bayesian networks as a graphical model that captures probabilistic relationships between variables; utility theory as a framework for understanding optimal decision making under uncertainty; Markov decision processes as a method for modeling sequential problems; model uncertainty; state uncertainty; and cooperative decision making involving multiple interacting agents. A series of applications shows how the theoretical concepts can be applied to systems for attribute-based person search, speech applications, collision avoidance, and unmanned aircraft persistent surveillance.

Decision Making Under Uncertainty unifies research from different communities using consistent notation, and is accessible to students and researchers across engineering disciplines who have some prior exposure to probability theory and calculus. It can be used as a text for advanced undergraduate and graduate students in fields including computer science, aerospace and electrical engineering, and management science. It will also be a valuable professional reference for researchers in a variety of disciplines.

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Editorial Review

Review

This book is a tour de force for its systematic treatment of the latest advances in decision making and planning under uncertainty. The detailed discussion on modeling issues and computational efficiency within real-world applications makes it invaluable for students and practitioners alike.

(David Hsu, Professor of Computer Science, National University of Singapore)

This book is a thorough and authoritative treatment of the mathematics of planning and reasoning under uncertainty. The real-life case studies that end the book help ground the theory with concrete examples that can serve as models for researchers developing new applications of these powerful ideas. It would make a terrific text for a semester-long course on the subject of algorithmic decision making.

(Michael L. Littman, Professor of Computer Science, Brown University)

An intuitive and accessible introduction to the exciting topic of decision making under uncertainty--very timely given the latest advances in robotics and autonomous systems. Problems are framed in the probabilistic inference formulation and provide a modern take on the classical reinforcement learning paradigm under partial observability, with natural links to real-world applications.

(Sethu Vijayakumar FRSE, Professor of Robotics, University of Edinburgh)

About the Author

Mykel J. Kochenderfer is Assistant Professor in the Department of Aeronautics and Astronautics at Stanford University. He is a consultant for the MIT Lincoln Laboratory.

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