

# Preface

Robots are here!

Service robots are beginning to live with us and occupy the same social space we live in. These robots should be able to understand human's natural interactive behavior and to respond correctly to it. To do that they need to learn from their interactions with humans. Considering the exceptional cognitive abilities of *Homo sapiens*, two features immediately pop up, namely, autonomy and sociality.

Autonomy is what we consider when we think of human's ability to play chess, think about the origin of the universe, plan for hunts or investments, build a robust stable perception of her environment, etc. This was the feature most inspiring the early work in AI with its focus on computation and deliberative techniques. It was also the driving force behind more recent advances that returned the interactive nature of autonomy to the spotlight including reactive robotics, behavioral robotics, and the more recent interest in embodiment.

Sociality, or the ability to act appropriately in the social domain, is another easily discerned feature of human intelligence. Even playing chess has a social component for if there was no social environment, it is hard to imagine a single autonomous agent coming up with this two-player game. Humans do not only occupy physical space but also occupy a social space that shapes them while they shape it. Interactions between agents in this social space can be considered as efficient utilization of natural interaction protocols which can be roughly defined as a kind of multi-scale synchrony between interaction partners.

The interplay between autonomy and sociality is a major theoretical and practical concern for modern social robotics. Robots are expected to be autonomous enough to justify their treatment as something different from an automobile and they should be socially interactive enough to occupy a place in our humanly constructed social space. Robotics researchers usually focus on one of these two aspects but we believe that a breakthrough in the field is expected only when the interplay between these two factors is understood and leveraged.

This is where data mining techniques (especially time-series analysis methods) come into the picture. Using algorithms like change point discovery, motif

discovery, and causality analysis, future social robots will be able to make sense of what they see humans do and using techniques developed for programming by demonstration they may be able to autonomously socialize with us.

This book tries to bridge the gap between autonomy and sociality by reporting our efforts to design and evaluate a novel control architecture for autonomous, interactive robots and agents that allow the robot/agent to learn natural social interaction protocols (both implicit and explicit) autonomously using unsupervised machine learning and data mining techniques. This shows how autonomy can enhance sociality. The book also reports our efforts to utilize the social interactivity of the robot to enhance its autonomy using a novel fluid imitation approach.

The book consists of two parts with different (yet complimentary) emphasis that introduce the reader to this exciting new field in the intersection of robotics, psychology, human-machine interaction, and data mining.

One goal that we tried to achieve in writing this book was to provide a self-contained work that can be used by practitioners in our three fields of interest (data mining, robotics, and human-machine-interaction). For this reason we strove to provide all necessary details of the algorithms used and the experiments reported not only to ease reproduction of results but also to provide readers from these three widely separated fields with the essential and necessary knowledge of the other fields required to appreciate the work and reuse it in their own research and creations.

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