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Detection and Identification of Rare Audiovisual Cues
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Machine learning builds models of the world using training data from the application domain and prior knowledge about the problem. The models are later applied to future data in order to estimate the current state of the world. An implied assumption is that the future is stochastically similar to the past. The approach fails when the system encounters situations that are not anticipated from the past experience. In contrast, successful natural organisms identify new unanticipated stimuli and situations and frequently generate appropriate responses.

The observation described above led to the initiation of the DIRAC EC project in 2006. In 2010 a workshop was held, aimed at bringing together researchers and students from different disciplines in order to present and discuss new approaches for identifying and reacting to unexpected events in information-rich environments. This book includes a summary of the achievements of the DIRAC project in chapter 1, and a collection of the papers presented in this workshop in the remaining parts.

Specifically, in chapter 1 we define the new notion of incongruent events, aimed to capture “interesting” anomalous events. In part (ii) we present papers that describe how this conceptual approach can be turned into practical algorithms in different domains. Thus chapter (2) describes the detection of novel auditory events, chapter (3) describes the detection of novel visual events, chapter (4) describes the detection of out of vocabulary words in speech, and chapter (5) describes the detection of novel audio-visual events when the audio and visual cue disagree. Chapter (6) describes the data collected within the DIRAC project to test the approach and the different algorithms.

The chapters in part (iii) provide alternative frameworks for the identification and detection of interesting anomalous events. Both chapters deal with the detection of interesting events in video. Chapter (7) seeks the recognition of abnormal events, defining anomalies via trajectory analysis. Chapter (8) starts from the notion of Bayesian surprise, and develops a framework to detect surprising events based on the Latent Dirichlet Allocation model.

In part (iv) we focus on the question of what to do next? How to deal with those anomalous events we have detected? Thus chapter (9) talks about transfer learning from one rule-governed structure to another. Chapter (10) describes a retraining mechanism which learns new models once incongruence has been detected. Chapter (11) describes how to use a transfer learning algorithm in order to update internal models with only small training samples.
In part (v) we go back to the initial motivating observation, asking ourselves how biological systems detect and deal with unexpected incongruent event. In chapter (12) we present evidence that perception relies on existing knowledge as much as it does on incoming information. In chapter (13) we study mechanisms which allow the biological system to recalibrate itself to audio-visual temporal asynchronies. In chapter (14) we present a comparative study between biological and engineering systems in incongruence detection, in the context of locomotion detection.
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