Preface

In recent years there has been a move in information technology and computer science from a machine-centred approach to a human-centred and knowledge-based approach. Keywords such as ubiquitous computing, ambient intelligence, and cloud computing are used more and more to describe tomorrow’s paradigm of computing. In these systems, interacting with the user is often done in an implicit way, by reacting to the user’s behaviour. Examples of such systems are smart environments in which the user’s behaviour is perceived through sensors such as video cameras, motion sensors, RFID tags, etc., and then used to perform an action that adequately responds to that behaviour. The applications for this are widespread, ranging from behavioural monitoring for biosecurity and homeland security to market research and to monitoring the elderly in their own homes so that they can continue to live independently for longer.

Behaviour recognition has a multitude of facets. From the computational point of view, there is the question of how to detect human behaviour reliably from the sensor data that is available. The data is often noisy, and therefore, probabilistic approaches such as hidden Markov models seem to have an advantage over rule-based approaches that use predefined conditions to recognise the behaviour. On the other hand, the latter are usually easier to verify by a human, which facilitates validation of the system. A second question is where, when, and how can a behaviour occur. Consecutive behaviours carried out by one individual are easier to recognise than interleaved behaviours conducted by a group of individuals.

The second facet of behaviour recognition is concerned with the applications that it is used in. Some applications are more critical than others, and therefore less tolerant to errors in the recognition process. Behaviour recognition in a smart environment with the purpose of delivering the most appropriate environmental conditions (warm and cosy for less physically demanding activities such as reading a book versus fresh air and a cooler temperature in the case of the daily workout) can cope more easily with false positives than behaviour recognition at the airport to detect terrorists: reading a book in a room that is slightly too cold is generally less disturbing than spending a night in prison because of a false accusation.

Application-oriented aspects of behaviour recognition are closely related to the third facet of research in this area: the social, ethical, and legal implications. Monitoring people in their own homes is generally only acceptable if it is done in a non-obtrusive way and if the information gathered is only passed on to a very select group of people (like the carers of the people living in the smart home). This severely restricts the means by which we can collect data in smart environments: while video cameras might be acceptable at airports, they are not usually a good idea in a person’s private bathroom. As a result, it becomes more difficult to correctly recognise the behaviour, which might have ethical and legal implications: is it acceptable not to detect if something is wrong with the inhabitant of the home, and if as a result of this negligence the inhabitant is harmed, who is responsible?
As with any book that aims at covering different aspects of a research area, it is impossible to provide a thorough discussion of all of the aspects. As it turns out with this book, the bias is towards methods for behaviour recognition:

Artikis, Sergot, and Paliouras present a logic-based approach to behaviour recognition. They introduce a system for recognising human activities based on symbolic representations of video data. They define long-term activities as spatio-temporal combinations of short-term activities, and use constraints on short-term activities to recognise long-term activities from short-term activities. These constraints are expressed in a dialect of the event calculus.

Aztiria and Augusto link behaviour recognition with context awareness to assist the user in their daily activities. Their focus is on behaviours that happen frequently and therefore lend themselves towards automatic support. The multi-layer system that they introduce uses rules that are learned on the basis of sensor data.

Bohlken, Koopmann, Hotz, and Neumann aim at real-time behaviour interpretation. Their chapter describes a generic framework for model-based behaviour interpretation, using OWL-DL for concept definition and SWRL for constraints. The conceptual models are automatically converted into an operational scene interpretation system. This system is used to monitor aircraft service activities.

Chen and Cook look at novelty detection in human behaviour. Instead of interpreting sensor data from a smart home, they analyse the energy consumption in the home. They demonstrate that energy consumption and human activities are related. By looking at outliers in the energy consumption, they are able to identify novelties in human behaviour.

Chua, Marsland, and Guesgen investigate how unlabelled sensor data can be used to train a behaviour recogniser. After describing a general setting for behaviour recognition and discussing some issues that arise when performing this task, they introduce an unsupervised learning algorithm based on text compression. Their idea is to use the dictionary produced by the Lempel-Ziv-Welch compression algorithm as a basis and to modify this dictionary so that it contains typical entries that represent typical behaviours.

Crandall and Cook introduce a tracking system for multiple smart home residents. Their system uses a Bayesian updating method for tracking individuals through the space of a smart home. Unlike other approaches, their approach does not employ a carried wireless device or an imaging system, and therefore poses less social problems when deployed over long periods of time.

Gaddam, Sen Gupta, and Mukhopadhyay discuss different sensors for smart homes, using criteria such as availability, cost, installation, and performance. They then describe a case study that shows how some of these sensors can be used in a smart home monitoring system. The system includes units for monitoring electrical appliances, movements and locations in beds, and water usage in showers, baths, toilets, washing machines, dishwashers, etc.

Gottfried defines a framework for the design and analysis of behaviour monitoring and interpretation systems, which consists of five layers with different levels of abstraction. As an example scenario, he presents a pedestrian navigation and service tool, which guides the user navigating around a city by providing instructions through a hearing-aid similar device.

Han and Pereira present a coherent framework for decision making based on logic programming, which extends their previous work on evolution prospection for decision making. They demonstrate the usefulness of the system with several examples in different application domains, including moral reasoning, ambient intelligence, elder care, and game theory.

Nunes, Rebelo, Abreu, Gamboa, and Fred introduce a time series clustering algorithm for human behaviour recognition, which uses biosignals as input and captures the general morphology of the sig-
nal’s cycles in one mean wave. In their validation tests, they demonstrate that the algorithm has a high accuracy level and outperforms other algorithms.

Odella describes the sociological perspective of technologies for monitoring behaviour and debates implications from both the scientific and ethical point of view. She uses a number of specific implementations of technologies for this, ranging from healthcare automated assistance to mobile communication devices, RFID, and smart-meter technology.

Tian, Cao, Liu, and Zhang discuss an approach for detecting behaviours in crowds by analysing video data. They combine hierarchically filtered motion with spatiotemporal interest point features to overcome the problem of detecting behaviours in cluttered videos. Their approach uses a combination of Gaussian mixture models and branch-and-bound search.

Wernsdorfer and Schmid show a way from streams of observations to knowledge-level productive predictions of sequences of actions. They present an approach that combines sequence abstraction networks with inductive generalisation of recursive rule sets. The underlying assumption is that the benefits of ambient assisted living systems depend on the successful recognition of human intentions.

Zhao, Wang, and Sukthankar introduce two techniques for improving supervised learning of human behaviours from motion data. One is an active learning framework to reduce the number of samples required to segment motion traces. The other is an intelligent feature selection technique that both improves classification performance and reduces training time.

Zhu and Sheng discuss an approach for behaviour recognition in smart homes that combines motion data and location information. As one of its components, the system uses an inertial sensor to be worn by the inhabitant. This sensor provides motion data to the system, while a motion capture component is used to record the location of the inhabitant. The combination has the advantage of significantly reducing the obtrusiveness to the inhabitant while maintaining a high accuracy of recognition.

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