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Semi-Markov Models for Process Mining in Smart Homes

Process Mining has grown rapidly in recent years, encompassing related topics, principally from data science and business process analysis, with the general aim of using data to better understand processes, their underlying root causes of failure, changes, or poor performance. Initial approaches to Process Mining focussed onusing basic statistics, process discovery and data mining techniques. These methods often lack a structured model, or knowledge, to characterise the data related to the sequencing or duration of individual process activities. However, more recent work has tended to focus on patterns and variability. As a result, probabilistic approaches, such as Markov, or semi Markov, models have recently come into play to provide a way of including such complexities.

Although Process Mining initially focussed on Business Processes, there are many other areas where processes are encounteredHealthcare is one such topic where improvements in medicine and medical technology have led to huge increases in longevity, with a corresponding rise in demands for healthcare. Such changes have been accompanied by major developments in digital technologies including sensors and the Internet of Things. Generally, these days people live longer but often with increased impairment and disabilities. They can, therefore, benefit greatly from assistive technologies, such as those using sensor technology in smart homes.

We here focus on the completion of activities of daily living (ADLs) by such patients, using smart homes and sensor technology to collect ADL data, and intelligent data analysis to support the management of these conditions. ADLs are here represented as states of a Markov-type process, where changes of state are indicated by sensor activations. This facilitates the extraction of key performance indicators (KPIs) in Smart Homes, e.g., the duration of an important activity, such as sleep, as well as the identification of anomalies in activity transitions and durations. The semi-Markov models allows for diverse representations of duration distributions corresponding to different activities. The approach is illustrated and evaluated using a publicly available Smart Home dataset comprising an event log of sensor activations. Results indicate that the methodology is well-suited to such scenarios, as it facilitates the use of diverse activity duration profiles.

Smart homes provide a promising approach to supporting elderly patients. By profiling underlying activities, such assistive technologies can support older people in their homes through reminding them of routine activities, detection of anomalous behaviour, and sending alarms to care providers.

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Biography

Sally McClean received her first degree in Mathematics from Oxford University, and then obtained a MSc in Mathematical Statistics and Operational Research from Cardiff University, followed by a PhD on Markov and semi-Markov models at Ulster University. She is currently Professor of Mathematics at Ulster University. Her main research interests are in Stochastic Modelling and Optimisation, particularly for Healthcare Planning, and Computer Science, specifically Process Mining, Databases, Internet of Things, Sensor Technology and Telecommunications. She has been grant holder on over £13 million worth of funding, mainly from the EPSRC, Industry, the EU and charities. Sally is a Fellow of the Royal Statistical Society, Fellow of the Operational Research Society, Fellow of the IMA, past President of the Irish Statistical Association and Member of the IEEE. She has published over six hundred research papers and was previously a recipient of Ulster University's Senior Distinguished Research Fellowship.

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