Abstract

Although human cognitive processes may be complex, it is an interesting challenge to achieve some understanding of them. Knowledge of these processes contributes to the development of various application domains that involve human intervention; for example, health, aviation, energy, and safety critical domains. Such domains can only be developed when having sufficient knowledge of human cognitive processes. Understanding human cognition, designing working models based on such understanding, and using these models in application domains are non-trivial research challenges.

Supported by the developments in brain imaging and recording techniques, neurocognitive researchers are discovering more and more knowledge about many cognitive processes. Most of this research focuses on highly important but relatively specialised questions. Therefore, it is difficult to find detailed explanations of a certain cognitive phenomenon as an integrated, coherent process. Nevertheless, having such detailed understanding of cognitive processes is important for various application domains. Understanding the processes in the human brain demands a multidisciplinary approach. Cognitive modelling has increasingly become a prevalent multidisciplinary research theme for this. Dynamic modelling approaches provide insight in such processes, and can be used to obtain computational models that can explain many cognitive phenomena and situations. Combining knowledge of various neurocognitive findings and theories related to human awareness and control in behavioural choices, designing cognitive models based on such knowledge, and validating their behaviour are the main focus of this thesis. The scope of this work expands to various different but connected cognitive phenomena, namely: intentional inhibition, cognitive controlling, emotion generation, effect prediction, impact prediction, awareness generation, ownership generation, top-down effects, bottom-up effects, biased perception, cognitive conflicts, joint decision making, and analogy making. In addition to the contribution to dynamic computational cognitive models, this work includes two approaches for parameter estimation, which is essential in cognitive modelling.

The proposed models in this thesis have been applied to two practical domains: aviation and energy management. Simulation results that were generated for practical scenarios in those domains provided useful information about human cognition, while highlighting the strength and usability of the proposed models in practical context.