

Sequential dependencies in human decision making: A systems analysis approach

Complexity DTC Mini-project proposal
Supervisors: Dr Paolo Martini & Prof. Koen Lamberts
Centre for Cognitive and Neural Systems

The time it takes a human observer to choose between two alternatives (for example deciding whether a red or green target has been presented in a brief visual display) depends on choices that have been made before. Thus, reaction times in choice tasks exhibit sequential dependencies. While this fact has been known for many years, its functional significance and its source remain disputed. This phenomenon represents an intelligent, yet unconscious form of memory that is useful for deploying future actions without conscious effort. It can be thought of as a learning mechanism capable of extracting statistical regularities from its immediate input without supervision. This project aims at identifying the form of the sequential dependencies, develop an appropriate statistical framework for analyzing the data within and across observers and explore stochastic process models of reaction time generation that may be able to mimic the observed behaviour. The project can be carried out using existing datasets, although the student may also have the opportunity to collect further data if that should become necessary.

The behavioral task that produced the data is a simple form of visual search, which has been studied extensively in the past 15 years (Maljkovic & Martini, 2005, Maljkovic & Nakayama, 1994, Maljkovic & Nakayama, 1996, Maljkovic & Nakayama, 2000). The observer is presented with a sequence of discrete trials, each requiring a manual response that is timed. The display requiring a response consists of 3 polygons that differ in colour and shape; the observer is given instructions as how to choose a polygon based on its colour and is then required to report its shape as quickly as possible. The equipment consists of a calibrated computer monitor used as display and a keyboard for manual responses; the experimental procedure is programmed in house. The data to be analyzed consist of series of reaction times.

Analysis of the data will involve application of formal models, implementing various system identification techniques and time series analyses. In doing so, the student will learn about system identification (Marmarelis & Marmarelis, 1978) and process models of reaction times (Smith & Ratcliff, 2004). The student is expected to have basic knowledge of stochastic processes and probability theory and to be familiar with an analysis and modeling software package, for example Matlab.

The project is well defined and self contained, and is therefore likely to lead to at least one publishable manuscript. The problem under study is sufficiently general and relevant to provide the basis of a further, significant research project, on the scale required for a PhD. The work be of interest to a wide community of researchers in cognitive neuroscience, cognitive systems design and mathematical analysis of complex dynamic systems.

References

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