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State-Trace Analysis: The Mathematics of Theoretical Inference in Cognitive Psychology

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The aim of psychology in general, and of cognitive psychology in particular, is to construct theoretical accounts of mental processes based on observed changes in performance on one or more cognitive tasks. The fundamental problem faced by the researcher is that these mental processes are not directly observable but must be inferred from changes in performance between different experimental conditions. This inference is further complicated by the fact that performance measures may only be monotonically related to the underlying psychological constructs. State-trace analysis provides an approach to this problem which has gained increasing interest in recent years. In this talk, I explain state-trace analysis and discuss the set of mathematical issues that flow from it. Principal among these are the challenges of statistical inference and an unexpected connection to the mathematics of oriented matroids.
