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M³: Meta-cognition and Meta-control with Markov Decision Processes

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Intelligent behaviour requires monitoring and adjusting ongoing cognitive processes to the changing demands and constraints of internal and external environments. This is studied in terms of meta-cognition, cognitive control and meta-reasoning, and, recently, as the expected value of control and the value of computation. However, integrated consideration of core problems such as state representation, generalization, and prospective versus retrospective calculations of the long-run value of meta-computational policies is lacking. We offer a recursive Markov decision process framework called recursive-MDP in which meta-cognition is a form of meta-level perception, and, just as for control itself, meta-control algorithms can be fractionated into costly but adaptive model-based, or fast model-free strategies. Understanding how the brain implements self-adjustment has significance to both psychiatry and artificial intelligence.