Active Inference: Computational Models of Motor Control Without Efference Copy

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Computational frameworks for the study of motor systems in neuroscience often rely on a mathematical formulation based on optimal control theory, e.g., forward and inverse models and linear quadratic Gaussian (LQG) control architectures. A forward model maps actions to (predicted) consequences, while an inverse model is thought to define how motor commands are generated from observations. One of the central tenets of the forward/inverse architecture is the presence of a copy of motor commands produced by an inverse model and provided to the forward counterpart. Such copy, usually referred to as ``efference copy'', is assumed to be necessary to model, and ultimately explain, motor control and behaviour. Over the years, different results have challenged the idea of an efference copy, suggesting that it may not be physiologically plausible, especially in humans. In this work we focus on a process theory that combines the mathematical richness of LQG models with efference-copy-free architectures, active inference. We provide a minimal computational model discussing and comparing the forward/inverse and the active inference architectures on an idealised model of a single-joint control system.

Keywords: efference copy, LQG, Kalman filter, forward/inverse models, active inference

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