Leaving Andy Clark's 'safe shores': Scaling predictive processing to higher cognition

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Abstract: The predictive processing principle has gained considerable interest as a strong candidate for explaining the unifying principles that underlie the brain's activity, spanning the entire range of cortical activity from perception and motor control to social cognition and theory of mind. Yet, the current mathematical framework that supports predictive processing heavily relies on the Laplace assumption, i.e., stochastic dependencies are assumed to be (multivariate) Gaussian densities. This assumption becomes problematic when scaling the predictive processing principle to higher cognition, that is, when we "depart further and further from the safe shores of basic perception and motor control?" (Clark, 2013, p. 201). In order to be scalable to higher cognition, the mathematical framework underlying predictive processing should be able to represent structured, unordered, discontinuous, and non-monotone information and relations. We introduce a formulation of predictive processing in terms of structured Bayesian networks that overcomes the limitations of Gaussian densities.