

Surfing uncertainty: prediction, action and the embodied mind

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Coniglio looks forward to sensing machines that will be able to reflect and intervene in performance, and do 'the impossible' – 'to *cheat*' (284), to break the rules and thereby inspire new ways of composing and performing. Overall, this is an accomplished collection that will be of interest to a wide range of readers. The variety of perspectives will appeal to students and teachers looking for an accessible entry into digital movement in performance, whilst experienced researchers and practitioners, working across dance, theatre and digital performance, will find it a highly valuable resource.

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Surfing uncertainty: prediction, action and the embodied mind, by Andy Clark,
Oxford, Oxford University Press, 2016, xvii + 424 pp., £19.99 (hardback), ISBN
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This book and book review are of general interest to the live-coding and performing arts communities, as they can facilitate understanding of the role of the technical environment and social context in the act of performance. Recent trends in cognitive science support the notion that cognition and action cannot be separated from their medium of expression. This means that the process of creation is not a property of the individual artist in isolation, but is rather an emergent property of the multitude of bodily, socially, and technically mediated interactions taking place between the artist and the totality of the surroundings.

The idea of the mind as being embodied, embedded, extended, and enactive is epitomized by the practice of live coding, which would be impossible without a range of advanced digital interfaces that help the artist to actively extend his/her mind and thereby realize a creative vision in terms of the developing computer code. Moreover, live coding relates to another hot topic in cognitive science, namely the key role of prediction for understanding the complexities of the human mind. Live coding as an artistic practice plays precisely with this fundamentally predictive aspect of our mind by making use of generative algorithms during the performance. This means that the artist partially relinquishes control over the exact unfolding of the artistic piece, in favor of making more space for the spontaneous emergence of surprising elements. Andy Clark has extensively worked on the philosophy of these trends in cognitive science, and his latest book takes a sustained look at the many facets of embodiment, extension, prediction, and surprise, while still leaving several profound philosophical puzzles open. Given his engaging and accessible style of writing, the book serves as a useful entry point for live coders and performance scholars interested in learning more about the latest science of the mind.

Clark's book *Surfing Uncertainty: Prediction, Action and the Embodied Mind* proposes a marriage between his famous work on embodied cognition and the paradigm of predictive processing in computational neuroscience, which revolves around the idea that brains are fundamentally in the business of minimizing prediction error of sensory information. That is, brains are tuned to predict sensory input and, in so doing, capture the dynamics of their environment. Although this neuroscientific framework is relatively recent, it is based on many older ideas, for example perception as hypothesis-testing (Gregory 1980), cybernetics (Ashby 1956), ideomotor theory (James 1890), and machine learning (Hinton and Dayan 1996).

The book heads in two complementary directions. On the one hand, it aims to provide a unifying account of the embodied predictive brain and discusses a great amount of phenomena from this perspective. On the other, it attempts to situate this account within recent discussion in philosophy of mind, for example regarding internalism versus externalism and direct versus indirect perception (Gallagher and Zahavi 2008; BonJour 2016). The book contains three parts: in the first part, Clark presents predictive processing as a 'cognitive package deal' able to conceptualize phenomena such as perception, action, imagination, and dreaming under the same umbrella. In the second part, Clark connects predictive processing to (pathological) human experience. In the third part of the book, he argues that our predictions are scaffolded by the structure of the human niche, which consists of social, cultural, and technological elements.

The core of the 'cognitive package deal' is the idea that the brain implements a hierarchical model. At each level of this hierarchy, top-down predictions are matched with bottom-up prediction errors. The resulting mismatch is then sent to the level above. At the lowest level, the system is able to generate mock sensory input that is compared with actual sensory input. By minimizing the prediction error between the top-down predicted input and the actual input, the hierarchy comes to infer the 'hidden state' of the environment. A distinguishing feature of predictive processing is the role of precision or uncertainty. Expected precision (or more precisely, the ratio between the expected uncertainty related to the top-down prediction and the bottom-up prediction error) mediates the impact that a prediction error has on the existing prediction. This basic theme gets reused and extended in several ways. For example, the same hierarchical model can be used without being coupled to actual sensory input for the purposes of planning and imagination.

This hierarchical prediction error framework can give the impression that Clark is returning to the cognitivist foundations of classical cognitive science. Yet many aspects of Clark's proposal continue his work on embodied cognition and are consistent with aspects of more radical versions of this paradigm such as enactivism (Di Paolo and Thompson 2014). In particular, like enactivism, his framework emphasizes the deep continuity between life and mind, and the 'cognitive package deal' is reminiscent of the enactive concept of 'sense-making', which similarly combines action, perception, and imagination into one process of relating meaningfully with the environment. Moreover, Clark's representationalism is mild: he focuses on action-oriented representations that are relative to the agent's perspective, rather than on how the independent physical environment is faithfully represented in an objective manner. Accordingly, he also emphasizes that we should not smuggle knowledge we have as external observers of the system and its relation with the world into our explanation of how that system operates internally – the brain learns in an unsupervised manner and does not have direct access to its external environment. Thus, the success of the brain's world model is measured by its role in ensuring the agent's continued viability via adaptive actions, rather than by its objective truth-value.

One fascinating consequence of the predictive processing framework is the bidirectional interaction between mind and world. Not only do we actively structure our environments, but the patterns in the environment also shape ourselves. As Clark notes, based on work by Roepstorff, Niewöhner, and Beck (2010):

By constructing a succession of designer environments, such as the human-built worlds of education, structured play, art and science, we repeatedly structure our own minds. These designer environments have slowly become tailored to creatures like us, and they 'know' us as well as we know them. (Clark 2016, 279)

It is here that the live-coding community might reciprocally inform the predictive processing community, for live-coding environments might be a very interesting example of such

human-built designer environments. While being tailored to the performer's skills, they also afford new and unexpected action possibilities on the side of the performer. As one foundational text of the live-coding community states: 'Live coding is the activity of writing (parts of) a program while it runs' (Ward et al. 2004, 243). It is this recurrent loop where one's actions constrain the patterns in the environment and the patterns in the environment constrain one's actions that lies at the heart of both predictive processing and live coding. On the predictive processing account attending, acting, learning, and developing (and on the most ambitious proposals even evolution, see Friston (2011)) are all seen as a part of this anticipating dynamic between agents and their environment. Although Clark's book does not delve into the connection between live-coding and predictive processing directly, it does provide an excellent basis to further explore these issues.

In summary, Clark's book does a great job in taking the best elements of a number of different current directions in cognitive science and unifying them under the umbrella of predictive processing. The practice of live coding, understood as the real-time enactment of an artistic experience that escapes predictability by extending the creative process via complex artist-technology interactions, could serve as a suitable context in which these approaches can be further explored.

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