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Downward causation is the controversial idea that 'higher' levels of organization can causally influence behaviour at 'lower' levels of organization. Here I propose that we can gain traction on downward causation by being operational and examining how adaptive systems identify regularities in evolutionary or learning time and use these regularities to guide behaviour. I suggest that in many adaptive systems components collectively compute their macroscopic worlds through coarse-graining. I further suggest we move from simple feedback to downward causation when components tune behaviour in response to estimates of collectively computed macroscopic properties. I introduce a weak and strong notion of downward causation and discuss the role the strong form plays in the origins of new organizational levels. I illustrate these points with examples from the study of biological and social systems and deep neural networks.

This article is part of the themed issue 'Re- conceptualizing the origins of life'.

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