Tabla de Contenidos

Flack, Jessica, Life’s Information Theory (2017)

en Smari Walker, S. (ed), 2017, From Matter to Life – Information and Causality

I propose that biological systems are information hierarchies organized into multiple functional space and time scales. This multi-scale structure results from the collective effects of components estimating, in evolutionary or ecological time, regularities in their environments by coarse-graining or compressing time-series data and using these perceived regularities to tune strategies. As coarse-grained (slow) variables become for components better predictors than microscopic behavior (which fluctuates), and component estimates of these variables converge, new levels of organization consolidate. This process gives the appearance of downward causation – as components tune to the consolidating level, variance at the component level decreases. Because the formation of new levels results from an interaction between component capacity for regularity extraction, consensus formation, and how structured the environment is, the new levels, and the macroscopic, slow variables describing them, are characterized by intrinsic subjectivity. Hence the process producing these variables is perhaps best viewed as a locally optimized collective computation performed by system components in their search for configurations that reduce environmental uncertainty. If this view is correct, identifying important, functional macroscopic variables in biological systems will require an understanding of biological computation. I will discuss how we can move toward identifying laws in biology by studying the computation inductively. This includes strategy extraction from data, construction of stochastic circuits that map micro to macro, dimensionreduction techniques to move toward an algorithmic theory for the macroscopic output, methods for quantifying circuit collectivity, and macroscopic tuning and control.