BrainComp2022 - Computational Challenges of Connectivity

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## The Thermodynamics of Mind

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Finding precise signatures of different brain states is a central, unsolved question in neuroscience. The difference in brain state can be described as differences in the detailed causal interactions found in the underlying intrinsic brain dynamics. We use a thermodynamics framework to quantify the breaking of the detailed balance captured by the level of asymmetry in temporal processing, i.e. the arrow of time. We also formulate a novel whole-brain model paradigm allowing us to derive the generative underlying mechanisms for changing the arrow of time between brain regions in different conditions. We found precise, distinguishing signatures in terms of the reversibility and hierarchy of large-scale dynamics in three radically different brain states (cognition, rest, deep sleep and anaesthesia) in fMRI and electrocorticography data from human and non-human primates. Overall, this provides signatures of the breaking of detailed balance in different brain states, perhaps reflecting levels of conscious awareness.

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