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Imitating Chemical Motors with Optimal Information Motors

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Free energy stored in a thermodynamic system is a valuable work resource that can be exploited for doing useful tasks. In a similar way, information (or knowledge) of the microscopic state of a system can also be converted into work (or free energy) through feedback – by manipulating the system in response to the information gathered in a measurement. The most striking example is Maxwell's demon: a being that by observing the microscopic evolution of a gas is able to segregate the hot particles from the cold, increasing the gas's free energy.

Given the seeming similarity between free energy and information, one may wonder if the thermodynamic qualities of information are identical to free energy? Are free energy and information interchangeable in our thermodynamic accounting? In this talk, I argue that in fact the thermodynamics of information and free energy are quite different. To elaborate this distinction, I compare the entropy production rates of two motors with *identical* dynamics: a chemical motor powered by a chemical potential gradient and an information motor driven by feedback. Despite the identical dynamics, the information motor presents qualitatively different thermodynamics. I then trace the origin of this discrepancy to the features of the interaction between the information motor and the controller implementing the feedback.

[1] J.M. Horowitz, T. Sagawa, and J.M.R. Parrondo, "Imitating chemical motors with optimal information motors", arXiv:1210.6448.