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The energy cost of accurate adaptation in networks with incoherent type-1 feed-forward loop GANHUI LAN, YUHAI TU, IBM T. J. Watson Research Center — The incoherent type-1 feed forward loop (I1-FFL) is a common regulatory motif in many biochemical networks, some of which are responsible for accurate sensory adaptation. In this work, we analyze the sensitivity and adaptation function of the I1-FFL type enzymatic reaction networks. We show that detailed balance is broken in I1-FFL and continuous energy dissipation is needed to improve both the sensitivity and the adaptation accuracy of the network. Our study revealed a relation between the performance improvement and the energy dissipation rate. We find that this energy-assisted improvement is bounded (limited) by intrinsic properties of the molecular reaction system. The performance-energy relation in I1-FFL is similar to the recently obtained Energy-Speed-Accuracy relation in networks with negative-feedback-loop, another key motif for accurate sensory adaptation.

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