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Cross-talk and interference can enhance information capacity of a signaling pathway SAHAND HORMOZ, Kavli Institute for Theoretical Physics, University of California Santa Barbara — A recurring theme in gene regulatory networks is transcription factors (TFs) that regulate each other, and then bind to overlapping sites on DNA, where they interact and synergistically control transcription of a target gene. TF binding is inherently a noisy process due to thermal fluctuations and the small number of molecules involved. A consequence of multiple TFs interacting at the binding site through competition or cooperativity is that their binding noise becomes correlated. Using concepts from information theory, we show that a correlated-noise channel can enhance its capacity if the TFs are no longer independent but regulating each other. Essentially, the frequency of observing each TF at a given concentration is no longer separable, but "entangled." The form of this entanglement elucidates the upstream TF cross-regulation (cross-talk). We demonstrate these ideas using a cartoon model of two TFs competing for the same binding site. Surprisingly, competition can enhance the information transmission rate. We suggest that this mechanism explains the motif of a coherent feed-forward loop terminating in overlapping binding sites commonly found in developmental networks, and discuss specific examples.

Sahand Hormoz
hormoz@kitp.ucsb.edu
Kavli Institute for Theoretical Physics,
University of California Santa Barbara

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