Coupled echo state networks as a model of task-oriented alignment

Polyphony Bruna
University of California, Merced, Merced, California, United States

Rick Dale
University of California, Los Angeles, Los Angeles, California, United States

Michael Spivey
University of California, Merced, Merced, California, United States

Christopher Kello
University of California, Merced, Merced, California, United States

Abstract

Coordination studies reveal that groups can achieve performance exceeding the sum of individual contributions (Bahrami et al., 2010). Further evidence suggests that weak coupling maximizes the benefits of coordinated problem-solving (Abney et al., 2015; Schloesser et al., 2021). This work develops a computational framework to study coordination in coupled systems. We trained two echo state networks (ESNs) to classify cepstrum-coded speech signals from nine native Japanese speakers (Kudo et al., 1999). Coupling ESN feedback during testing reveals a nonlinear relationship between joint performance and coupling: moderate coupling (feedback integrates readout states from both networks) enhances performance, whereas full coupling (feedback is swapped between networks) returns performance to that of independent networks. These results suggest that while interaction between networks can enhance performance, excessive integration may diminish the benefits of independent contributions (cf. Fusaroli et al., 2012). Our model provides a novel, formal framework for explaining interaction dynamics in collective intelligences.

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