Stochastic Dynamics of Lexicon Learning in an Uncertain and Nonuniform World

Richard Blythe <R.A.Blythe@ed.ac.uk>

We study the time taken by a language learner to correctly identify the meaning of all words in a lexicon under conditions where many plausible meanings can be inferred whenever a word is uttered. We show that the most basic form of cross-situational learning—whereby information from multiple episodes is combined to eliminate incorrect meanings—can perform badly when words are learned independently and meanings are drawn from a nonuniform distribution. If learners further assume that no two words share a common meaning, we find a phase transition between a maximally efficient learning regime, where the learning time is reduced to the shortest it can possibly be, and a partially efficient regime where incorrect candidate meanings for words persist at late times. We obtain exact results for the word-learning process through an equivalence to a statistical mechanical problem of enumerating loops in the space of word-meaning mappings. We further discuss implications of our results to the dynamics of social learning in populations of agents.