

Collective Learning of an Emergent Vocabulary: Naming Game with Reinforcement Learning

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Semiotic dynamics is the domain of research, which elaborately investigates the emergence and evolution of linguistic conventions among a population, with respect to the individual differences, by using computational multi-agent simulations. The previous research of the field models evolution of language over various distinct topologies and origination of the language (most of which only examines the emergence of shared vocabularies whereas recent works also try to capture the emergence of syntactic structures). Moreover, this domain formalizes problems that are mainly interested in observing emergent shared word-object maps and grammars within a society of rule-based acting agents. Current methodological approaches ground the discussion on rapidly changing social interactions among individuals. For the members of a society these conventions will be urgent for interchanging their experiences and knowledge about the environment, which they are continuously acting on. Therefore, it is essential for the agents to converge on a shared language to survive in an environment.

Accordingly, interpreting how these aforementioned linguistic conventions bootstrap is also a crucial step forward. Languages games, such as discrimination game and naming can provide the suitable simulation models to make such interpretations. Among these, specifically the naming game literature investigates the emergence of a shared lexicon within a society. Traditional naming game is a special conventional language game, which investigates how vocabulary spreads within a multi-agent community, where each and every agent has a perceptual channel to perceive the surrounding objects. The aim of the agents is to converge on a shared vocabulary by just collaboratively communicating with each other on iterative basis. In each episode of interaction a speaker and a hearer is randomly chosen from the population. They both attend to the same object among a set of objects, and try to agree on a shared name for that specific object.

In parallel, this paper presents an exploratory research, in which a psychologically plausible artificial intelligence method, reinforcement learning (RL) with an eGreedy learning algorithm, is implemented in a minimal naming game (the term minimal denotes that there is only one object in the environment). We introduce a value function which is updated respectively with reinforced rewards and punishments after every successful and unsuccessful interaction. Two separate models are implemented, where agents adopt a reinforcement learning strategy either to choose a partner to communicate (agent selection strategy) or a word to transmit to the hearer party (word selection strategy), by using their previous experiences. The study is exploratory in nature, because it aims to see whether the convergence trends are similar to traditional models, when the agents are equipped with such a constraining preliminary assumption that they are biased on choosing their communicative partners or the words they exchange.

Briefly, modified RL models also bootstrap shared vocabulary just like the traditional models. Convergence trends of the traditional naming game model and modified models are compared and contrasted. Specifically, the effects of varying exploration rates, reward and punishment values and memory complexities are comparatively overlaid. It is concluded that the convergence trends of our models behaves similarly to the traditional models.