

Abstract

The thesis presents a multi-agent computational model to explore a key question in language emergence, i.e., whether syntactic abilities result from innate, species-specific competences, or they evolve from domain-general abilities through gradual adaptations. The model simulates a process of coevolutionary emergence of two linguistic universals (compositionality, in the form of lexical items; and regularity, in the form of constitute word orders) in human language, i.e., the acquisition and conventionalization of these features coevolve during the transition from a holistic signaling system to a compositional language. It also traces a “bottom-up” process of syntactic development, i.e., agents, by reiterating local orders between two lexical items, can gradually form global order(s) to regulate multiple lexical items in sentences. These results suggest that compositionality, regularity, and correlated linguistic abilities could have emerged as a result of some domain-general abilities, such as pattern extraction and sequential learning.

In addition to individual learning mechanisms, the thesis further explores the effects of cultural transmission, social and semantic structures on language evolution. First, it simulates some major forms of cultural transmission, and discusses the role of conventionalization during horizontal transmission in language evolution. Second, it traces the emergence and maintenance of language in some stable social structures, and explores the role of popular agents in language evolution, the relationship between mutual understanding and social hierarchy, and the effect of exoteric communications on the convergence of communal languages. Finally, it studies language maintenance given different semantic spaces, and illustrates that the semantic structure may cause bias in the constituent word order, which can help to predict the word order bias in human languages. These explorations examine the role of self-organization in language evolution, provide some reconsideration on the bottleneck effect during cultural transmission, and shed light on the study of the social structure effects on language evolution.

摘要

本論文通過一個自行開發的多個體計算仿真模型來探索語言衍生中的一個關鍵問題，即語法能力是如何產生的，它是由天生的、人類所特有的能力決定；還是從一些人與動物普遍具有的簡單能力中逐步適應發展而來。該模型模擬了兩種語言普適特性（體現於詞彙上的合成性和體現於詞序上的規則性）的衍生過程，指出從整體語言向合成語言的轉化是一個詞彙與基本成分詞序共同演化的過程。該模型同時記錄了一個自底向頂的語法發展過程，即句子層面的（頂層的）詞序可通過複用詞項間的（底層的）局部詞序來得到。這些仿真結果表明語言的合成性和規則性，以及相關的語言能力可以從一些人與動物普遍具有的能力（如簡單的特徵提取和排序能力）中發展而來。

除了語言使用者的學習機制，本論文進一步討論了社群傳播，社會和語義結構對語言演化所施加的影響。首先，通過仿真幾種主要的社群傳播形式，本論文探討了“水平”傳播中的約定俗成效應對語言演化所起的作用。其次，通過記錄語言在幾種簡單社會結構中的產生與保持，本論文探討了受歡迎個體在語言演化中的作用，個體間對語言的理解與整個社會層次結構間的相互關係，以及社群間的交流對社群語言趨同所起的作用。最後，通過模擬在不同語義結構下的語言保持，本論文指出不同的語義結構會對語言的詞序產生影響，此因素可被用於解釋人類語言在基本詞序上的偏向性分佈。這些研究討論了自組織在語言演化中所起的作用，重新認識了社群傳播中的樽頸效應，並對其他研究社會結構對語言演化的影響的課題起了指導性作用。