THE NECESSITY OF COMPUTATIONAL SIMULATION IN EVOLUTIONARY LINGUISTICS

TAO GONG, BERNARD COMRIE
Department of Linguistics, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 4
Leipzig, 04103, Germany

WILLIAM S-Y. WANG
Department of Electronic Engineering, The Chinese University of Hong Kong, Shatin, New Territories
Hong Kong, China

Ever since the advent of the computer in 1945, *computational simulation* (CS) has become pervasive in many new as well as traditional fields. Recently, it has joined the endeavor to tackle problems in evolutionary linguistics (Hauser et al., 2007). It provides a necessary means of exploring language evolution, which manifests itself in the following three aspects:

First, CS can assist empirical studies of language evolution. The critical difficulty in evolutionary linguistics is the lack of direct evidence of language development in its prehistoric states. There are some ways to try and overcome this difficulty: a) studying language ontogeny, but the "ontogeny recapitulates phylogeny" analogy (Bickerton, 1990) has to be applied cautiously in language phylogeny (Mufwene, 2008); b) evaluating the communication systems of other animals, but the complexity of these systems is incomparable to that of human language, which makes this comparative approach (Oller & Griebel, 2004) of only limited usefulness; and c) examining the performance of normal or deficient human subjects in linguistic or cognitive tasks, but the scarcity of language-deficient subjects and the crucial differences between modern- and proto- languages restrict this approach as well. Unlike these means that rely heavily on empirical findings, CS offers a new perspective: by abstracting processes and manipulating parameters, it can recapitulate the histories of language evolution, evaluate the effects of various factors on this process,

examine the internal coherence of linguistic theories, and compare in principle the simulation results with the empirical data.

Second, CS can study language as a *Complex Adaptive System* (CAS, the 'five graces' group, 2008). Human language, consisting of multiple interacting entities that are constructed in a hierarchical way, is adaptive; that is, personal experiences, social interactions, and cognitive processes can all trigger language evolution. CS provides an efficient way to handle human language and its evolution. It adopts a synthetic, bottom-up strategy, and builds up a foundation to implement theoretical scenarios that involve multiple components and complex interactions among these components. By arbitrarily isolating various components, it can systematically analyze particular factors and their collective effects on language evolution. Such delicate control over various conditions is necessary for studying a CAS like human language, but it is usually impossible in empirical studies.

Finally, CS can be validated in many respects. Many simulations adopt objective mechanisms and follows traceable procedures to obtain replicable results. The assumptions and scenarios adopted in these behavioral or mathematical models can be supported by empirical findings in linguistics and other disciplines, and the mechanisms used have been broadly discussed in evolutionary computation and artificial intelligence. The simulations that are equipped with these mechanisms can provide both qualitative and quantitative understanding of human language and its evolution.

These arguments point to the necessity of adopting CS in evolutionary linguistics research. They also reveal the multi-disciplinary nature of this field, whose future development will rely greatly on the collaborations between linguists and scholars from a number of relevant disciplines.

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