# Emergence and evolution in computer simulation of speech

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This paper describes a cellular automaton (CA) that models language variation as the adaptive aspect of the complex system of speech (Kretzschmar 2009), which we will demonstrate in action. The simulation addresses the relation between language variation and human geography, as it models the interactions of speakers across a geographic space represented as a matrix of locations. The CA uses update rules to determine the status at a given location in a matrix with respect to the status of its neighboring locations; all locations in a matrix are evaluated, and then the new status for each one is displayed all at once (one iteration). In a continuing series of experiments we have demonstrated how simple rules, run over hundreds of iterations in the CA, create complex clustering patterns with respect to geography and social factors. Our simulation works best with rules that predict that any single feature will eventually fill geographic space, unless we include a random factor. We know that some features do become top-ranked, but that many other variants for the same thing exist at any moment at lesser frequencies. Thus, we can describe three phases of emergence in the CA: expansion to fill space, participation in everyday frequency profiles, and relatively fixed frequency for a top-ranked feature. We know, however, that features and languages never become truly fixed. Languages continue to fluctuate/change even in their most stable parts, such as in pronouns and common verbs. In this paper, we propose that there are three dimensions of the complex system of speech whose interactions can keep the system evolving: geographic subareas, text types, and aspects of the hierarchy of speech (pronunciation, lexicon, syntax). Any of these dimensions can over time provoke fluctuation/change even after a feature has achieved the fixed, top-ranked state. Such interaction augments change as it occurs in the three phases of emergence.