

An evolutionary model of phonological inventories based on synchronic data

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The sound systems of the world's languages exhibit properties that fit the framework of complex adaptive systems well. Indeed, the structure of inventories is often explained in terms of constraints weighting on phonological units and on their interactions (Liljencrants & Lindblom, 1972 ; Lindblom et al., 1983 ; Lindblom & Maddieson, 1988). In this paper, we present an evolutionary model of phonological inventories based on the synchronic distribution of sounds in actual systems. More precisely, this model encapsulates phonetic and phonological constraints by considering the frequencies of occurrences of phonemes and of pairs of phonemes. We assume that these occurrences summarize, in an implicit form, a significant amount of the physical and cognitive factors bearing on real systems.

Our model relies on the UPSID database, a genetically and geographically balanced sample of 451 languages (Maddieson, 1984; Maddieson & Precoda, 1990). For each segment and each pair of segments, we count how many times it appears in the 451 languages and calculate the difference between this number and what could be expected by chance alone. For individual segment, the sign of the difference tells whether this segment is favored or disfavored in systems. For pairs of segments, it indicates whether these two elements attract or repulse each other. For both segments and pairs of segments, we assess the significance of the difference by a statistical test, which result is equated to the strength of these elements. It is hence possible for any given system to compute its "coherence" by combining the strengths of the segments and pairs of segments it contains. The higher this coherence, the more responsive the system (we assume) is to general phonetic-phonological constraints.

The previous synchronic measures can be turned into an evolutionary model which primary dynamics lies in the maximization of the coherence. To this end, we compute the range of possible evolutions from a given system - differing by a few units - and evaluate their coherence. These possible evolutions are ranked according to the gain in coherence they offer. A strict maximization - i.e. following only pure phonetic-phonological constraints - would entail choosing the highest ranked output as the next step. However, in order to incorporate external evolutionary factors such as sociolinguistic constraints, we add stochasticity to the model by assigning to each potential new system a probability of being chosen positively related to its coherence.

In our presentation, we will discuss:

- i) the outcomes of the model on specific vocalic and consonantal systems
- ii) general trends in terms of coherence and stability in the UPSID database in link with phonetic-phonological constraints
- iii) the differences between deterministic and stochastic dynamics
- iv) evolutionary paths in Bantu languages.

Keywords: phonological inventories, evolution, complex systems, coherence, synchrony, diachrony.

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