Complex patterns in phonological systems

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The notion of complexity is intrinsically relative; we always define an object as more or less complex than another according to one or several properties of these objects. Thus, the main question is twofold: how to identify the relevant properties at the right level of description and how to calculate their complexity.

In phonology, both aspects of this question are still a challenge. First, what is the correct level at which complexity should be measured: features, segments or systems? And second, are the relevant properties to be considered from articulatory or perceptual perspectives, or even both?

To illustrate this point, typological studies (Liljencrants and Lindblom, 1972, Maddieson, 1984, Vallée & al., 2002) have shown for example that phonological systems tend to be organized in such a way to reach a balance between ease of articulation and perceptual salience. Therefore, any measure of complexity of phonological systems would have to consider both dimensions. However, we still don't have any objective and quantitative way to calculate complexity on either articulatory or perceptual dimensions, let alone when considered together.

Previous work by Lindblom and Maddieson, (1988) has tried to define a complexity scale for obstruent consonants, based mainly on intuition. The goal of this paper is to address their suggestion to find a way to define this scale of complexity from "quantitative phonetic considerations". Furthermore, we will not restraint our investigations to obstruents, but consider complete phonological systems.

Our data come from the UPSID database (Maddieson, 1984, Maddieson and Precoda, 1990), which contains the phonological systems of a representative sample of 451 languages. These systems are described by means of 100 features and 900 segments. We consider these three levels (features, segments, systems) as a good approximation of the extent of possible phonological elements. Our approach tries to capture the intra and inter levels constraints by defining a set of indices (Marsico & al., 2004) and different measures of phonological distance and complexity (Marsico& al., 2002).

Our previous results show that phonological systems tend to be organized around basic (neutral) segments. When the number of segments increases systems tend to saturate the existing dimensions (economy). Finally, it seems important that a system keeps an important adaptive potential by "recruiting" highly generative basic segments.

Our recent developments relies on the construction of different networks of features or segments, and the application of refined complexity measurements to these networks, in order to characterize the internal structure of phonological systems. More precisely, these networks capture in which way systems make use of features to constitute segments and to generate oppositions between them. To measure the networks complexity (one network per language), we rely on a recent proposal found in Claussen, (2004), called "offdiagonal complexity" based on node-node link correlations.

Our preliminary results show that the complexity of a system is not a function of the number of segments contrary to what could be intuitively expected. Our presentation will include more quantitative and qualitative analyses as well as a possible phonological distance derived from graph complexity measurements.

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