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Modelling endangered languages: The effects of bilingualism and social structure

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Abstract

The mathematical model for language competition developed by Abrams and Strogatz allows the evolution of the numbers of monolingual speakers of two competing languages to be estimated. In this paper, we extend the model to examine the role of bilingualism and social structure, neither of which are addressed in the previous model. We consider the impact of two strategies for language maintenance: (1) adjusting the status of the endangered language; and (2) adjusting the availability of monolingual and bilingual educational resources. The model allows us to predict for which scenarios of intervention language maintenance is more likely to be achieved. Qualitative analysis of the model indicates a set of intervention strategies by which the likelihood of successful maintenance is expected to increase.

Keywords: Language competition; Language death; Language maintenance; Dynamical system; Agent-based model

1. Introduction

The 6000 or so languages spoken on our planet today are the products of numerous millennia of cultural evolution. They encapsulate the experience and knowledge of diverse peoples collected in widely different environments, and are a precious part of the human heritage. With the explosive expansion of a few dominant languages in recent decades, at least half of the world's languages are critically endangered in that they will soon have no speakers and become extinct (Krauss, 1992; Crystal, 2000). Pagel (1995) estimates that roughly 140,000 languages have ever existed (median estimate), so it is the fate of the majority of languages to become extinct. Fishman (1991) argues that

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death of a language often leads to death of the underlying culture to which it is linked. It is, therefore, an important challenge to understand such situations as precisely as possible, and to recognize whether there are measures that can help us preserve some of this heritage.

Much work has been carried out on both theoretical and empirical issues of achieving language maintenance as evidenced by the numerous recent volumes on the subject (e.g. Fishman, 1991; Grenoble and Whaley, 1998; Crystal, 2000; Nettle and Romaine, 2000; Fishman, 2001; Bradley and Bradley, 2002; Grenoble and Whaley, 2006). Fishman (2001:1) begins his treatise by stating:

> What the smaller and weaker languages (and peoples and cultures) of the world need are not generalized predictions of dire and even terminal illnesses but, rather, the development of therapeutic understandings and approaches that can be adjusted so as to tackle essentially the same illness in patient after patient.

Toward this end, Abrams and Strogatz (2003) have proposed a mathematical model for studying language competition. The model predicts that whenever two languages compete for speakers, one language will eventually become extinct, the language that dies depending on the initial proportions of speakers of each language and their relative status. The model obtains a good fit to a number of empirical data sets, tracing the relative abundance of speakers of several endangered languages that have been undergoing competition with other, more prestigious languages. However, it does not account for either bilingual individuals or the social structure of the population within which the languages compete. The model also does not distinguish the vertical and horizontal transmission of language, and ignores the impact of the behaviour of individual speakers in the population, focusing instead on the expected aggregate behaviour of the population as a whole. Despite these limitations, the model has stimulated a burst of research into the dynamics of language competition and diversity (e.g., Patriarca and Leppänen, 2004; Mira and Paredes, 2005; Wang and Minett, 2005; Schulze and Stauffer, 2006; Stauffer et al., 2006), much of it performed by non-linguists.

In this paper, we extend the Abrams and Strogatz work to model bilingualism explicitly, accounting for the fact that some individuals may speak both of the competing languages. Our first step is to formulate a mathematical model that, like the Abrams and Strogatz model, deals with the expected aggregate behaviour of the whole population—this model also predicts that death of one of the two competing languages is inevitable (although the trajectories that lead to this state differ from those of the previous model). However, in order to investigate the range of possible trajectories that a system of two competing languages can potentially follow from the same initial state, and to devise a method by which the probabilities associated with them can be predicted, we also implement an agent-based model. In particular, we investigate the impact of simple strategies for language maintenance, allowing us to estimate for different scenarios the relative likelihood that a pair of competing languages can be maintained in a population comprising both monolingual speakers of each language and bilingual speakers. We then examine the role of social structure on the probabilities of maintenance, representing the social structure by a local-world network (Li and Chen, 2003) to encapsulate the patterns of sociolinguistic interactions among the individuals comprising the population.

The paper is laid out as follows: In section 2, we discuss deterministic models of language competition, first briefly describing the Abrams and Strogatz model for a population in which two languages compete for speakers, then introducing an extension of the model that incorporates modelling of bilingualism. In section 3, we apply the extended model to investigate the efficacy of simple strategies for language maintenance. The deterministic models that we discuss in sections 2