

Probability in phonological generalizations: modeling optional French final consonants

Most phonological frameworks assume phonological generalizations (*rules* or *constraints*) to be invariant. In other words, the object of a generalization (e.g. the phonological string to be changed by a rule), its context (its syntagmatic properties), and its content (e.g. a change of feature) are categorical. Since few phonological generalizations apply categorically in a surface-true manner, categorical generalizations must be overridden, by being ordered or ranked. These solutions are problematic, though, because they are psychologically implausible (Goldsmith 1993), and require rules to be innate to be learnable (Tesar and Smolensky 1996).

We propose an alternative solution to the variable surface generalization problem which does not make use of problematic ranking or ordering and additionally allows the complex combination of multiple modes of probabilistically interacting information. We do so by observing that language users' knowledge of phonological generalizations consists of an additional dimension of knowledge: the probability that a generalization applies. This proposal is independently supported in two ways. First, "creative" uses of language (the production or recognition of novel forms) display the same probabilities as "uncreative" language (Bybee and Slobin 1982). Second, conceptual categories in general are probabilistic (Lakoff 1987), thus we should expect phonological generalizations to be so as well.

In this paper, we apply the notion of generalizations' probability of application to the problem of optional final consonants in French. Certain lexical items in French have optional final consonants, which depend on their phonological, lexical, prosodic, syntactic, and extralinguistic environments. This class, peripherally related to *liaison*, includes (among others): *août* [ut] 'August', *ananas* [ananas] 'pineapple', *but* [byt] 'goal', *fait* [fEt] 'fact', and *cinq* [sEk] 'five'. Data extrapolated from Verluyten and Hendrickx's (1987) sociolinguistic study demonstrate that these consonants are present in 58.8% of all instances of the words (the prior probability of their occurrence). However, French speaker-hearers clearly know more than the independent (or prior) probability of a generalization, since the phonological generalizations they make depend on contextual phonological and other information. For example, the categorization of the segment following the optional final consonant is capable of affecting these values: the optional-consonant-presence generalization holds before consonants with a 64.8% probability, and before vowels at 48.8%. In our case study, complications arise since age (Fig. 1), national origin (Fig. 2), and social class (Fig. 3) of the speaker also contribute to the presence of the optional final consonant. A model which aims to extract multi-leveled probabilistic information from the phonological signal, and also to adapt its production to multi-modal factors impacting phonology must encode this knowledge, but until recently, the computational demands of this problem were too great. No categorical phonological models are able to model these phenomena.

Bayes Networks (Jensen 1996) are a recent computational technique used in A.I., which are made up of nodes with probabilistic values. Nodes are connected through causal links, which specify the dependent probabilities of a node's values given its relatives. Such a network, given observed values of its relatives, calculates the probabilities of the values for a node. Bayes Nets are shown in this paper to be appropriate for modeling phonological generalizations, specifically for the set of interactions responsible for the phenomena described above (Fig. 4). They also constitute a dynamic model of phonological use, displaying adaptive processing. In addition, the probabilities of the interactions between generalizations can be easily learned in a Bayesian model from surface-true generalizations. Finally, this computational mechanism has neural properties (Feldman 1988), making it a biologically plausible model.

Figures:

Age	x>30	30<x<50	50<x
% produced	65%	59%	52%

Fig. 1

Nationality	Belgian	French
% produced	47%	72%

Fig. 2

Social Class	1 (Lowest)	2	3	4	5	6 (Highest)
% Produced	65%	63%	60%	58%	57%	52%

Fig. 3

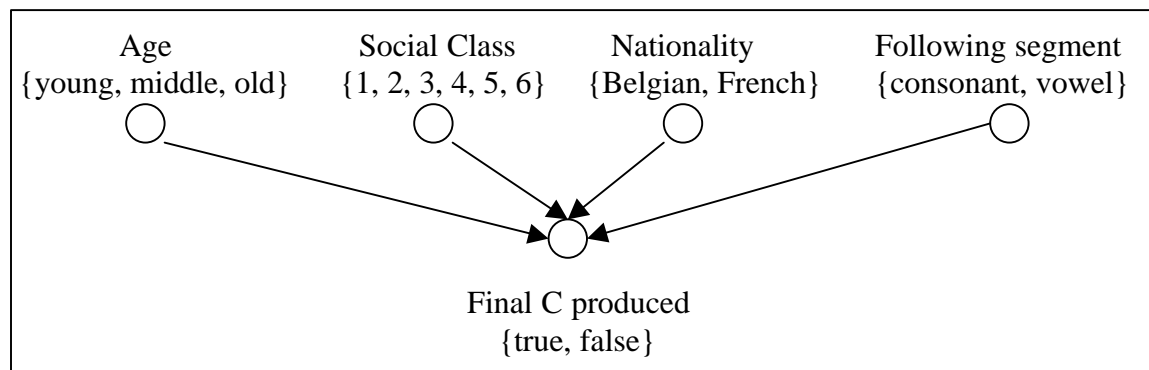


Fig. 4

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