



## MODELLING RHYTHMIC AND SYNTACTIC EFFECTS ON ACCENT IN LONG NOUN PHRASES

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### ABSTRACT

Rhythmic adjustments and structural effects on accentuation in complex noun phrases are potentially a source of difficulty for a left-to-right phonological approach to synthetic intonation. Rhythmic adjustments can be handled by creating accentual alternations; durational aspects of rhythm are treated without recourse to an overall rhythmic structure, by assigning different durations to different syllable types defined by the rules. Structural effects, though more of a problem, can be incorporated into the existing model as more sophisticated real-time grammatical and pragmatic analyses become possible.

### INTRODUCTION

In two companion papers (Ladd, this volume; Monaghan, this volume) we outlined some of the phonological and computational details of the approach to intonation used by the Edinburgh Text-to-Speech system. The most important features of this approach are that (1) abstract representations are maintained as long as possible in the generation of utterances, and (2) the syntactic, semantic, and pragmatic information presupposed by the system is kept to a minimum. While this strategy works quite well in general, certain types of structures present obvious problems. This paper discusses two major problems with long complex nominal constructions (henceforth "big NPs") and outlines some of the solutions we have developed within the framework of our overall approach.

### RHYTHMIC ADJUSTMENTS

The first problem is that stress and duration patterns may be modified in connected speech in order to fit an overall rhythmic organisation. The most conspicuous example of this sort is STRESS SHIFT. In citation form one says San FranCISco and interNAtional, but in a connected phrase one might say SAN Francisco INternational AIRport. This is related to a more general phenomenon of RHYTHMIC ALTERNATION, in which accents tend to occur on alternate words in a string (e.g. BIG bad WOLF). These two phenomena together account for a good deal of the impression of so-called stress timing in English; yet they can be modelled in terms of the abstract elements of our phonological analysis of intonation without any reference to relative duration or overall rhythmic structure. (Certain durational characteristics do need to be specified, but this can be done on a syllable-by-syllable basis, as discussed at the end of the paper.)

In order to generate rhythmically acceptable utterances, we first produce an "over-accented" representation from the existing default rules, then modify it (in two stages) to yield the final "rhythmic" representation. The algorithm is as follows:

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### General Noun Phrase Rhythm Rule.

Over-accented representation:

- 1 Assign \ (minor accent) and \\  
lexemes using various subrules.
- 2 Double-assign \ or \\  
to lexemes marked for secondary stress.

Fully-accented representation:

- 3 Reduce all \\  
except the rightmost in the phrase to \.

Rhythmic adjustments:

- 4 Delete all stress markets in unaccented words.
- 5 Delete EVERY ODD \ (except phrase-initial) leftward from  
the \\  
and EVERY \ rightward.
- 6 Shift any accent on hyphenated lexemes to the part before  
the hyphen.

Clauses 1 and 2 produce the over-accented representation by applying default accent-assignment rules based on word-class and limited syntactic information (some of these are outlined in Monaghan (ibid.)). Clause 3 then associates the major accent of the phrase with the rightmost constituent, in accordance with a default specification: this stage could be overridden in cases involving contrastive accent, for instance, where major accent would be determined by other criteria (see next section). Clause 4 removes lexical stress from any lexeme that is unaccented in the "fully-accented" representation output by clause 3; this provides for shorter duration on words (mostly function words) that have never had an accent at any time in the derivation (see further on duration rules below). Clauses 5 and 6 of the rule produce the final rhythmically modified representation by selective deletion and movement of accents: clause 5 produces the basic accent alternation, and clause 6 is one example of the kind of adjustment that will be needed to allow for syntactic, semantic, and pragmatic factors. Some of these problems are discussed in the next section.

### SYNTACTIC, SEMANTIC, AND PRAGMATIC ADJUSTMENTS

The serious problems of accent placement in big NPs have to do with syntactic, semantic, and pragmatic effects of accent. These include compounds (SUMMER place vs. summer VACATION), contextually-conditioned accent shifts and accent reductions ("deaccenting"), and accentual cues to structure (Labour LEGISLATION programme = "legislation programme proposed by Labour" vs. LABOUR Legislation Programme = "Programme of labour legislation"). These pose difficulties for any text-to-speech system that works without a full linguistic analysis of the text. This section outlines solutions to two such problems in the framework of our overall approach.

#### Noun-Noun Compounds

Currently, any group of common nouns has major accent assigned to odd-numbered items and minor accent assigned to even-numbered items. This provides reasonable coverage, but is prone to errors in cases such as American structuralist levels analysis where the structure is ((Adj Noun)(Noun Noun)) and accent should be assigned to the second noun of the three. If structuralist were parsed as an adjective there would be no problem, but total accuracy in this respect cannot be guaranteed without an exhaustive semantic analysis. The strategy

used to distinguish between odd- and even-numbered items is one of syntactic labelling: when a noun is identified by its np(n) clause, if the next item is also a noun its syntactic category is changed to cnp(n) and it therefore receives a minor accent. This procedure will process indefinitely long compounds.

Proper noun compounds conform to the general rhythm-rule strategy, with two-item groups (e.g. Buckingham PALACE) having the major accent on the second item and larger groups fitting in with the overall rhythm. There are some exceptions, but the general rule seems to handle most cases.

There is a problem with the interpretation of accents on compounds by the rhythm rules's later stages, as many of the distinctions made by the rules just outlined will be obscured in the subsequent accent-reduction stage. The possibility of annotating the over-accented representation in a manner which will preserve these distinctions is currently being investigated, but an alternative method of resolving this problem is to split a big NP into its constituent smaller NPs wherever possible and to process these individually. This may well be necessary in some cases, but it may be totally redundant in many others and therefore some preliminary investigation is necessary before a commitment is made to either strategy. The question of sentence-level strategies is also relevant at this point, and little analysis of rhythm in units larger than NPs has yet been undertaken.

#### Structural Adjustments for OF

By far the most frequent preposition in NP data is of. If occurs in expressions like the following:

- (1) the very concrete models of phonology current at the time
- (2) an indispensable part of any adequate theory

and it appears to affect accentuation in a consistent way: if the noun following of is not preceded by a determiner, as in (1), the noun preceding of receives at most a minor accent; whereas if the following noun is preceded by a determiner, as in (2), then the preceding noun is rarely unaccented and may receive a major accent. This pattern is repeated throughout the data. Other prepositions (e.g. in, between, by) do not affect intonation in the same way. (This behaviour apparently results from the semantics of of, and specifically its adjectival use, i.e. theories of phonology = phonological theories.) In one test corpus, eighty-five per cent of the exceptions to the general rules for big NPs were attributable to this phenomenon. Consequently a set of rules to model the effect of of is implemented in the present system: if of precedes an indefinite NP, a deaccenting diacritic is associated with the item preceding of. The second PROLOG argument introduced in Monaghan (ibid.) is used to identify of and similar anomalous items: of has the clause

pp(p,1)

as its syntactic category. It is not yet clear how many distinctions are required within any word class, but the general concept of such

marking is extendable to other cases.

### STRESS, ACCENT, AND DURATION

Perhaps the most obvious theoretical assumptions of the rhythm rule proposed here are those concerning lexical stress. A distinction is made between lexical STRESS and intonational ACCENT. Stress is viewed essentially as accentability, i.e. all and only stressed syllables may be accented. The lexical representation distinguishes between primary (") and secondary(') stress, but both can take accents and indeed they may be equivalent after Clause 2 of the rhythm rule. The main distinction between them is that primary stress is by definition the last stress in a word, so that the final major accent of an intonational phrase will never be associated with a secondary stress. (Thus items like celebrate do not have a secondary stress mark on the final syllable, but only an unreduced vowel; cf. celibate). The overall system thus bears considerable resemblance to the analysis of stress, accent, and rhythm proposed by Bolinger (e.g. ref 1). In particular, it sees rhythm as the result of intersecting distinctions of accent, duration, and vowel quality, rather than as the manifestation of an overarching abstract rhythmic or metrical structure.

While there are various theoretical problems with this view - it appears in principle incapable of modelling certain very fine durational distinctions - it nevertheless makes possible a good approximation of rhythmic distinctions in synthesised output. As mentioned above, this can be done on a syllable-by-syllable basis. The rules outlined so far feed the lower-level segmental duration rules with six syllable types:

#### Syllable Types

WORD		SYLLABLE		TYPE
Stress	Accent	Stress	Accent	
yes	yes	yes	yes	1
yes	yes	yes	no	2
yes	yes	no	no	3
yes	no	yes	no	4
yes	no	no	no	5
no	no	no	no	6

This six-way distinction provides a useful approximation of metrical foot structure without expending any effort on constructing a metrical hierarchy: the distinctions are all drawn in the course of producing a rhythmic accent alternation. Most durational effects can be fairly accurately modelled in this way.

#### REFERENCE

- (1) Dwight Bolinger, Intonation and its Parts, Stanford UP. (1986).