Metrical phonology in HPSG

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Abstract

This paper proposes a new approach to the prosody-syntax interface in HPSG. Previous approaches to prosody in HPSG (Klein, 2000; Haji-Abdolhosseini, 2003) represent prosodic information by constructing metrical constituent structure in the tradition of (Selkirk, 1980; Liberman and Prince, 1977). One drawback of this approach is that it does not allow for a direct representation of purely metrical constraints, which are relegated to an unformalized performance component. By contrast, so called 'grid only' approaches (Prince, 1983; Selkirk, 1984; Delais-Roussarie, 2000) use a single data structure, a *metrical grid*, to encode prosodic constraints resulting from syntax and constraints of a rhythmic nature.

We first review relevant data from French showing that prosodic constituency is much less constrained by syntactic structure than is predicted by existing approaches. In all but very short utterances, many different prosodic groupings are possible for a given sentence with a determinate information structure, and rhythmic factors determine a preference ordering on the possible groupings. We then present an HPSG implementation of the metrical grid, and propose minimal syntactic constraints on relative prominence, leaving room for noncategorical rythmic constraints to choose between alternatives. We finish by discussing the interaction of the metrical grid with the rest of the prosodic grammar.

1 Rhythmic and syntactic constraints in metrical phonology

Within the autosegmental-metrical approach to prosody (Selkirk, 1984), it is assumed that prosodic information associated with an utterance is segregated in two distinct representations: a stress pattern and a tonal profile, composed of a nuclear contour and a series of autonomous pitch accents.

Current approaches to the prosody-syntax-pragmatics interface attempt to clarify what prosodic features depend on which dimension. For French, Beyssade et al. (2004) observe that the stress pattern reflects partially syntactic constituent structure, but is unconstrained by pragmatics. The dialogical status of an utterance determines the choice of a nuclear contour, while the informational focus-ground partition determines where the contour anchors. The stress pattern influences the contour only inasmuch as tonal elements must anchor on stressed syllables. Finally, the occurrence of autonomous pitch accents is determined by contrast.[1]

In the present section we will only discuss stress patterns, and concentrate on assertive utterances with an all-focus information structure and no prosodic indication of contrast.

[1]Following Vallduví and Vilkuna (1998) we insist that the information-structural notion of focus (or 'rheme') is strictly distinct from the notion of focus associated with alternative semantics ('contrastive focus' or 'contrast'). In the remainder of this paper we only use 'focus' in the information-packaging sense.

Metrical grids are used as a representation of prosodic prominence. These are usually represented by aligning columns of stars with syllable nuclei; a higher column represents a more prominent syllable, as in (1). This grid indicates a maximal prosodic prominence (level 4) on the final syllable [zɛ̃], with secondary prominence of level 3 on [swa] and of level 2 on [ne] and [fʁɛʁ]. All other syllables are nonprominent.

```
                                    *
                    *               *
      *             *       *       *
*  *  *  *  * * * * * * * * *  * *
```

(1) lə fʁɛʁ də fʁɑ̃swa a telefone a tɔ̃ kuzɛ̃
le frère de françois a téléphoné à ton cousin
'François's brother phoned your cousin.'

1.1 Syntactic constraints

The most important constraint on the syntax-prosody interface in French is the *Right Culmination Constraint* stated in (2).

(2) In any syntactic phrase, the rightmost syllable has maximal prominence.

The workings of the constraint are illustrated by the grid in (1): assuming the constituent structure outlined in (3), the final syllable [zɛ̃] has maximal prominence because it is the rightmost syllable of the whole sentence; and [wa] is locally prominent in the subject NP. There are other prominent syllables, but these are not the effect of (2). (4) illustrates a grid disallowed by (2): the syllable [fʁɛʁ] of the head noun of the subject can not be maximally prominent within the NP, because it is not on the right edge of that phrase.

(3) [[le [frère [de François]]] [a téléphoné [à [ton cousin]]]]

```
                                    *
      *                             *
      *           *         *       *
*  *  *  *  * * * * * * * * *  * *
```

(4) *lə fʁɛʁ də fʁɑ̃swa a telefone a tɔ̃ kuzɛ̃

It is important to note that, contrary to what is generally assumed in the literature (see Delais-Roussarie, 1996; Rossi, 1999, among others), the grammar does not constrain the relative prominence of the subject NP and the head verb. All other things being equal, the subject NP may be more or less prominent than the verb (see Dell, 1984), giving rise to alternative metrical prominence patterns in cases such as (5).

(5) Pierre conduit prudemment. 'Pierre drives safely.'

```
                    *
                    *
            *       *
    *  *  *  * *  *
a. pjɛʁkɔ̃dɥipʁydamã
                    *
    *               *
    *  *  *  * *  *
b. pjɛʁkɔ̃dɥipʁydamã
                    *
    *     *         *
    *  *  *  * *  *
c. pjɛʁkɔ̃dɥipʁydamã
```

A further constraint that must be taken into account is the special status of *leaners* (Zwicky, 1982; Klein, 2000). Leaners are independent words that are prosodically deficient.[2]. In French this has two effects. First, a leaner may not receive initial stress, which is found as an option for short phrases and results in creating a bipolar stress pattern (Di Cristo, 1999). This is shown by the contrast between the nonleaner determiner *certains* 'some' in (6) and the leaner determiner *les* in (7).[3] Second, a leaner can receive final stress if and only if it is phrase-final, as shown by the contrast between the two occurrences of the leaner verb *est* 'is' in (8) and (9).

(6) certains amis 'some friends'

```
            *
    * * *  *
a. sɛrtɛ̃zami
            *
      *     *
    * * *  *
b. sɛrtɛ̃zami
```

[2]Leaners differ from clitics in not being subject to the same kind of sandhi phenomena; clitics, but not leaners, are assumed to form a prosodic word with their host. French leaners include the definite and indefinite articles, monosyllabic prepositions such as *à* 'at' and *de* 'of', and monolyllabic forms of auxiliaries and of the copula. Note that we avoid the issue of French pronominal clitics (FPCs), whose prosodic status is somewhat problematic: since **?** it is well established that the peculiar morphophonological idiosyncrasies associated with FPCs are best accounted for by treating them as (quasi-inflectional) affixes rather than syntactic atoms; and **?** presents a detailed morphological analysis accounting for these properties. On the other hand, **?** shows that FPCs obey specific prosodic constraints setting them apart from other affixes. We leave the integration of these two lines of research for future work.

[3]Remember that we limit ourselves to all-focus, contrast-free utterances; thus the fact that a contrastive accent on *les* is possible in (7) does not affect our generalization.

```
        *
  *     *
  * * * *
```

c. sɛrtɛ̃zami

(7) les chocolats ‘the chocolate bits’

```
      *
  * * **
```

a. leʃokola

```
      *
   *  *
  * * **
```

b. leʃokola

```
       *
  *    *
  * * **
```

c. *leʃokola

(8) Il est à Paris. ‘He is in Paris.’

```
       *
  * * * *
```

a. ilɛtapaʁi

```
        *
   *    *
  * * * *
```

b. *ilɛtapaʁi

(9) C’est à Paris qu’il est. ‘It’s in Paris that he is.’

```
          *
     *  *
  * * * * **
```

a. sɛtapaʁikilɛ

```
        *
  * * * * **
```

b. *sɛtapaʁikilɛ

There are also some noncategorical syntactic constraints on metrical grids, which have sometimes been confused for hard constraints. For instance, all other things being equal, prominence on heads is favored over prominence on nonheads. This explains why (10b) is slightly more natural than (10a). However this constraint is not strict, and prominence on nonheads will occur if it is the only way of satisfying right culmination, e.g. if the final constituent of a phrase is a nonhead (11).

(10) un jeune ami de Marie ‘a young friend of Marie’s’

```
                  *
          *       *
    * * * * * * * *
```
a. ɛ̃ʒœnamidəmaʁi

```
                  *
    *             *
    *     *       *
    * * * * * * * *
```
b. ɛ̃ʒœnamidəmaʁi

(11) Un homme charmant est là.
'A charming man is here.'

```
                  *
              *   *
    * *   *   * * *
```
a. ɛ̃nɔmʃaʁmɑ̃ɛla

```
                  *
              *   *
      *       *   *
    * *   *   * * *
```
b. ɛ̃nɔmʃaʁmɑ̃ɛla

```
                  *
        *         *
     * *   *    * * *
```
c. *ɛ̃nɔmʃaʁmɑ̃ɛla

1.2 Rhythmic constraints

Some metrical configurations are strongly disfavored, despite respecting syntactic constraints on meter. For instance (12a) is a very unlikely grid. This is an effect of a rhyhtmic constraint no-clash which bars sequences of stressed syllables. This constraint however is not categorical, and is clearly violated in cases where a stress clash is the only way to satisfy a categorical constraint. This is the case e.g. when a VP following a phrasal subject is monosyllabic, as in (13): the VP has to have maximal prominence, and the final syllable in the subject must be locally prominent, giving rise to a configuration violating no-clash.

(12) le président serbe 'the Serbian president'

```
                  *
              * *
      *   * * * *
```
a. ??ləpʁezidɑ̃sɛʁb

```
          *
    *     *
*   * * * *
```

b. ləpʁezidɑ̃sɛʁb

(13) Paul et Marie dorment. ‘Paul and Marie sleep.’

```
          *
        * *
*       * *
** * * *
```

a. pɔlemaʁidoʁm

```
          *
*   *   *
** * * *
```

b. *pɔlemaʁidoʁm

All other rhythmic constraints are likewise of a gradual and/or noncategorical nature. Long sequences of unstressed syllables are disfavored, all the more so if the speech rate is low. Thus for instance (14a) is virtually impossible at a normal speech rate. We take this to be the effect of a constraint no-lapse whose exact formulation is complex. Furthermore, all other things being equal, rhythmically regular patterns are favored; this is why (14b) is better that (14c). The workings of this eurhythmy constraint are best seen by looking at sentences with the same syntactic structure but with a different metric makeup. The three sentences in (15) have the exact same structure, but the length of the subject NP and of the VP differs from one case to the other. Accordingly, we find different preferred metrical grids, because of the urge to realize a regular rhyhtm, which cannot be met in the same way.

(14) J’avais été découragé dans ma carrière de peintre par les grandes personnes.
‘I had been discouraged from being a painter by the grown-ups.’

```
                  *
  * * * * * * * *
```

a. ??ʒavɛzetedekuraʒe...

```
              *
      *       *
* * * * * * * *
```

b. ʒavɛzetedekuraʒe...

```
              *
   *  *       *
* * * * * * * *
```

c. ?ʒavɛzetedekuraʒe...

(15) a. Jean-Christophe voit ses amis.
‘Jean-Christophe is meeting his friends.’

```
                    *
       *            *
 *     *    *       *
 *  *  *    * * *  *
ʒɑ̃kʁistɔfvwasezami
```

b. Pierre écoute ces balivernes.
‘Pierre listens to this nonsense.’

```
      *        *
 *    *    *   *
 * * * * * * *
pjɛʁekutsebalivɛʁn
```

c. Jean-Christophe regardait la télévision.
‘Jean-Christophe was watching TV.’

```
                          *
       *        *        *
 *     *  *     *  *     *
 *  *  *  * *  * * * * * *
ʒɑ̃kʁistɔfʁəgaʁdɛlatelevizjɔ̃
```

To sum up, the construction of the metrical grid in French is influenced by at least three types of constraints:

- Categorical syntactic constraints, such as the right culmination constraint on phrases or the nonprominence constraint on nonfinal leaners.
- Noncategorical syntactic constraints, such as the affinity of heads for prominence.
- Noncategorical rhythmic constraints, such as the no-clash, no-lapse and eurhythmy constraints.

2 A previous HPSG approach to prosody

The approach to prosodic prominence defended here belongs to the tradition of *grid-only* approaches, and contrasts with approaches in the tradition of *metrical constituent structure*. Klein (2000) provides an HPSG version of a metrical constituent structure approach, which we discuss here.[4] Note that the following criticisms are really of a methodological nature: Klein’s work is focussed on English, and does not take into account prosodic phenomena below the word level, whereas

[4]Haji-Abdolhosseini (2003) improves on Klein (2000) by taking into account the influence of information structure on prosodic representation. While this is definitely something that must be done at some point (see section 4 for some proposals), the issue is orthogonal to the ones we discuss here, and Haji-Abdolhosseini’s approach suffers from the same drawbacks as Klein’s, as far as all-focus, contrast-free utterances are concerned.

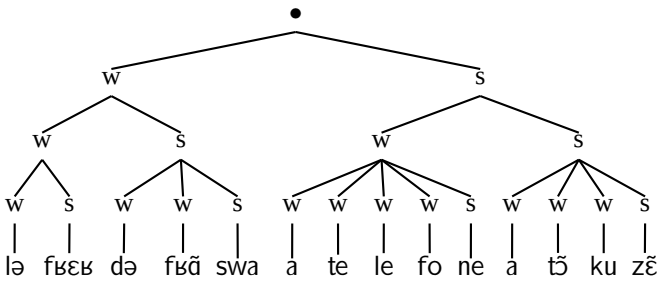


Figure 1: The metrical tree corresponding to (1)

this work is focussed on French and crucially involves phenomena that affect word-internal stress assignment. Thus we can only speculate as to how an approach such as Klein's would apply to the data we are interested in.

Metrical trees represent prosodic prominence by constructing a tree structure with nodes labelled either w ('weak') or s ('strong'). Leaves of the tree normally correspond to syllables.[5] Each local tree contains at most one strong node; the maximally prominent syllable within a tree is the syllable connected to the root by a uninterrupted sequence of strong nodes. Figure 1 contains a possible metrical tree for (1).

The prosody-syntax interface is usually specified as a top-down algorithm for building metrical trees from surface constituent structures (see e.g. Liberman and Prince, 1977; Selkirk, 1980). By contrast, Klein's HPSG approach uses relational constraints to build up metrical trees compositionally on a par with syntactic constituent structure. However, Klein's approach inherits most of the drawbacks of previous metrical tree approaches, which we review here rapidly.

2.1 Lack of underspecification

As other metrical tree approaches, Klein's proposal does not deal satisfactorily with the underspecified nature of the syntax-prosody interface. As we emphasized in section 1, the existence of alternative prosodic prominence patterns for a single sentence (with a given information structure, etc.) is the rule rather than the exception. A natural way to account for this is to design a grammar providing underspecified descriptions of proposdic representations. However, whereas it is quite easy to write underspecified descriptions of metrical grids, underspecified descriptions of metrical trees tend to be cumbersome. Let us illustrate with a concrete example. Sentences ending with an NP containing a PP can get a prosodic prominence on the N, just as if the PP had been outside the NP (16b).

[5] In a language with lexical stress such as English, one may simplify representations by taking leaves to correspond to whole words, since prosodic prominence within the word is determined by the lexicon rather than by interface constraints. This won't do for French however, where maximal prominence may fall on the initial or final syllable of a word depending on the syntactic and prosodic context.

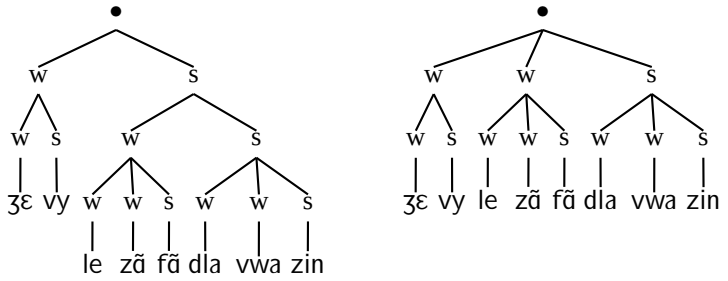


Figure 2: Alternate metrical trees for (16)

(16) J'ai vu les enfants de la voisine.
'I saw the neighbour's children.'

```
                    *
      *             *
    * * * * * * *   *
a.  ʒɛvylezɑ̃fɑ̃dlavwazin
                    *
      *     *       *
    * * * * * * *   *
b.  ʒɛvylezɑ̃fɑ̃dlavwazin
```

The two corresponding metrical trees are shown in figure 2. Whereas it is trivial to describe the relationship between these two trees in transformational terms, it is not that trivial to provide an underspecified description corresponding to that family of trees. Accordingly, Klein's strategy is not to use underspecified descriptions of metrical trees, but to embed the underspecification in the definition of the relational constraints relating fully specified descriptions of syntactic trees to fully specified descriptions of metrical trees. While there is no empirical problem as such with this general strategy, the result is a grammar that is not easy to manipulate, because prosodic constraints are embedded in the definition of the relation rather than stated directly. We hope that the alternative strategy of using underspecified descriptions of metrical grids will make for a more manageable grammar, where prosodic constraints contributed by different parts of the grammar can be stated in a modular way.

2.2 Rhythmic constraints

A first difficulty with Klein's approach is that rhythmic constraints cannot be modelled directly: the output of the grammar is a completely specified metrical tree, which must be turned into a more concrete prosodic representation by a performance model. Since the performance model is not described as such (see Atterer and Klein, 2002, for some hints of what Klein has in mind), it is not possible to evaluate the proposal as such; all one can say is that Klein's model outputs

a single metrical tree in cases where empirically more than one prosodic prominence pattern is possible. Even assuming that an adequate performance model will provide all licit prosodic realizations from a single tree, there are two conceptual drawbacks to such an approach. First, it assumes that one of the realizations is the normal, 'canonical' one generated by the grammar, and that alternatives arise as deviations from that canonical realization; yet there is no empirical evidence favoring one realization over the others. Second, this particular use of the competence-performance distinction seems to be more of a distinction between underlying structure and surface structure than between grammar and processing: Klein's metrical trees are abstract phonological representations which are not necessarily homomorphic to surface prosodic properties. Such an approach seems to go against the spirit of surface-orientation usually assumed in HPSG: it seems preferable to state all constraints on prosody on the same, concrete data structure, and to avoid abstract phonological representations just as we avoid abstract syntactic ones.

2.3 No motivation for prosodic phrases

A classical argument against grid-only approaches to prosodic prominence is that prosodic constituents are independently needed, since they serve to define the domain of some segmental phenomena, such as sandhi phenomena. Although Klein does not address this issue, it is clear that his metrical structures could be used to such an effect, while metrical grids do not contain enough information stemming from syntactic structure to do so.

However, the very hypothesis that there is a correspondance between prosodic phrasing and sandhi phenomena is disconfirmed by recent research carried out on the three clear sandhi phenomena that obtain in French. In *obligatory liaison*, a word-final consonant is obligatorily realized before a vowel but never before a consonant (17a). In *optional liaison*, a word-final consonant is optionally realized before a vowel but never before a consonant (17b). In *enchaînement*, a word-final consonant is syllabified at the beginning of the next word (17c).

(17) a. les enfants: [lezɑ̃fɑ̃]/*[leɑ̃fɑ̃]
'the children'

b. Ils sont arrivés: [ilsɔ̃taʁive]/[ilsɔ̃aʁive]
'They have arrived.'

c. chaque enfant: [ʃa.kɑ̃.fɑ̃]
'each child'

Recent research shows that the obligatory liaison occurs only in determiner-N′ sequences, a context that can be characterized only in syntactic terms (Bonami et al., 2004).[6] Post (2000) shows that the phonological phrase as usually defined

[6] Assuming that pronominal clitics are affixes (Miller and Sag, 1997). Note that even if pronominal clitics were analyzed as words, there is no non-circular way of characterizing obligatory liaison

is not the domain of optional liaison, contra e.g. Selkirk (1986). Finally, Fougeron and Delais-Roussarie (2004) shows that prosodic constituents such as the phonological phrase or the accentual phrase are the domain of neither liaison nor enchaînement.

We thus conclude that at least in the case of French there is no evidence that reference to prosodic phrase boundaries is necessary to characterize segmental phenomena, and thus no independent evidence for the need for prosodic tree structures.

3 Modelling the metrical grid

3.1 Constructing the grid

We model metrical grids as lists of *columns*, where each column is a nonempty list of objects of type *star*. Thus the official representation for the grid in (18a) is (18b). The grid is a part of the phonological representation of a sign, on a par with the list of segments (19). The relation between segmental representations and metrical grids is mediated by two constraints. First, at the level of words, grid columns are aligned with vowels in the segment list (there are no syllabic consonants in French). Second, the grid of a phrase is the concatenation of the daughter's grids. Thus in a complete utterance we find exactly one grid column for each syllable nucleus.[7]

(18) Paul est venu. 'Paul came.'

```
        *
  *     *
  * *   *
```

a. pɔlɛvny

b. $\left\langle \langle star, star\rangle, \langle star\rangle, \langle star, star, star\rangle \right\rangle$

(19) $phon \rightarrow \begin{bmatrix} \text{SEG} & list(segment) \\ \text{GRID} & list(nelist(star)) \end{bmatrix}$

(20) a. $word \rightarrow \left(\begin{bmatrix} \text{PHON} & \begin{bmatrix} \text{SEG} & \boxed{1} \\ \text{GRID} & \boxed{2} \end{bmatrix} \end{bmatrix} \wedge \mathsf{align}(\boxed{1}, \boxed{2}) \right)$

b. $\mathsf{align}\Big(\langle vowel\text{—}\boxed{1}\rangle, \langle \boxed{2}\text{—}\boxed{3}\rangle\Big) \leftrightarrow \mathsf{align}(\boxed{1}, \boxed{3})$

c. $\mathsf{align}\Big(\langle cons\text{—}\boxed{1}\rangle, \boxed{2}\Big) \leftrightarrow \mathsf{align}(\boxed{1}, \boxed{2})$

d. $\mathsf{align}(elist, elist)$

contexts as a prosodically natural class.

[7] Note that we assume that [ə]-deletion is modelled by having underspecified representations of segment lists, rather than abstract segments which may or may not surface in actual phonetic realization. Thus 'mute *e*s' get a column in the grid when and only when they are actually realized.

(21) *phrase*→ $\left[\text{GRID} \quad \boxed{1} \oplus \cdots \oplus \boxed{n}\right]$

$\left[\text{GRID} \quad \boxed{1}\right] \quad \cdots \quad \left[\text{GRID} \quad \boxed{n}\right]$

3.2 Categorical constraints

Since there is no lexical stress in French, the grammar does not have much to say on the grid of words. Note that contrary to the received view, stress on the final syllable is not obligatory: in short phrases the final syllable of a non-final word can be unstressed, giving rise to a bipolar pattern (see examples (6c), (12b)). The only definite lexical constraint is that word-initial onsetless syllable of polysyllabic words cannot be prominent (Plénat, 1994).

(22) Anémone viendra. 'Anémone will come.'

```
          *
    *     *
* * * * * *
```

a. anemɔnvjɛ̃dʁa

```
          *
    *     *
*   *     *
* * * * * *
```

b. *anemɔnvjɛ̃dʁa

(23) $\begin{bmatrix} \textit{word} & \\ \text{SEG} & \langle \textit{vowel}, \ldots \rangle \\ \text{GRID} & \langle \textit{list}(\textit{star}), \textit{list}(\textit{star}), \ldots \rangle \end{bmatrix} \rightarrow \left[\text{GRID} \quad \langle \langle \textit{star} \rangle, \ldots \rangle\right]$

Next we turn to the issue of *leaners*. Remember that we want leaners to always be nonprominent except when they are phrase-final (8–9). To account for this behaviour, we follow Klein in assuming that *phon* objects are typed for their prosodic properties (24). The constraint in (25) checks that all nonfinal leaners are nonprominent.

(24) a. $\textit{phon} \rightarrow \textit{lnr} \vee \textit{full}$

b. $\textit{phrase} \rightarrow \left[\text{PHON} \quad \textit{full}\right]$

(25) *phrase*→

$$\left[\text{DTRS} \quad \left(\textit{list}\left(\left[\text{PH} \begin{bmatrix} \textit{lnr} \\ \text{GRID} \quad \textit{list}(\langle \textit{star} \rangle) \end{bmatrix}\right]\right) \bigcirc \textit{list}([\text{PH} \ \textit{full}])\right) \oplus \langle \textit{sign} \rangle\right]$$

Finally we need to implement right culmination. This can be done quite simply by inspecting the grid of phrases and checking that the last column is the highest one.

(26) $\mathit{phrase} \rightarrow \Big(\big[\textsc{grid} \quad \boxed{1} \oplus \langle \boxed{2} \rangle \big] \wedge \mathsf{sup}(\boxed{2}, \boxed{1}) \Big)$

(27) a. $\mathsf{sup}\Big(\boxed{1}, \langle \boxed{2} \text{—} \boxed{3} \rangle\Big) \leftrightarrow \Big(\boxed{1} > \boxed{2} \wedge \mathsf{sup}(\boxed{1}, \boxed{3}) \Big)$

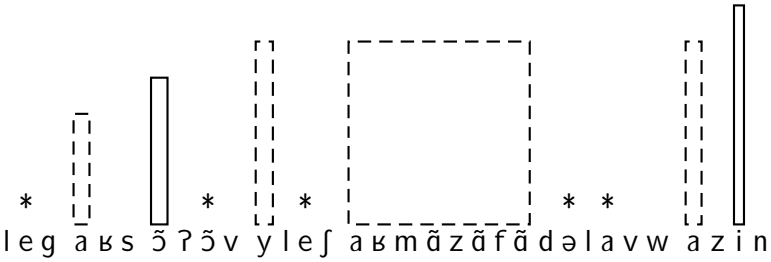
b. $\mathsf{sup}(\mathit{list}(\mathit{star}), \mathit{elist})$

(28) a. $\langle \boxed{1} \text{—} \boxed{2} \rangle > \langle \boxed{3} \text{—} \boxed{4} \rangle \leftrightarrow \boxed{3} > \boxed{4}$

b. $\mathit{nelist}(\mathit{star}) > \mathit{elist}$

The set of constraints so far is sufficient to exclude all examples marked as ungrammatical in the preceding pages—(4), (7c), (8c), (9b), (11c), (13a), (22b)—and to license all grammatical examples. The effect of the constraints is best seen by looking at possible grids for a rather complex example. Figure 3 is the syntactic tree for the sentence in (29). (30) sums up the set of constraints imposed by the grammar on the grid of (29). The only syllables which get a definite prominence value are those corresponding to leaners and word-initial vowels—which are constrained to be nonprominent. The effects of the right culmination constraint is represented by the relative height of boxes dominating vowels or sequences of vowels. Since all phrases but the subject NP are right-branching, all we know is that the final syllable [zin] must have maximal prominence, and that the final syllable of the subject [sɔ̃] must be locally prominent. Thus [zin] is strictly more prominent that [sɔ̃], which is strictly more prominent than all syllables preceding [sɔ̃]. The syllables between [sɔ̃] and [zin] must be less prominent than [zin], but are unconstrained with respect to [sɔ̃]. This is represented by the three dashed boxes of equal height, which indicate that the corresponding syllables may have any prominence strictly included in those boxes.

(29) Les garçons ont vu les charmants enfants de la voisine.
'The boys saw the neighbour's charming children.



(30) l e g a ʁ s ɔ̃ ʔ ɔ̃ v y l e ʃ a ʁ m ɑ̃ z ɑ̃ f ɑ̃ d ə l a v w a z i n

(31) is a sample of grids disallowed by the grammar: (31a) has a prominent word-initial vowel, (31b) has a prominent non-phrase final leaner, and (31c) does not respect final prominence.

```
                                        *
            *   *       *               *
          * *  * * * * *  * * * * *  * *
(31)  a. *legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
                                        *
            *   *     *     *           *
          * *  * * * * *  * * * * *  * *
      b. *legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
               *
            *   *         *             *
          * *  * * * * *  * * * * *  * *
      c. *legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
```

One design feature of our model is that we do not state absolute constraints on prominence: the grammar only attributes nonprominence to some syllables or constrains the relative prominence of two syllables, but it never states an absolute value for a prominent syllable. The motivation of this choice is that it allows for a simpler construction of the grid: since we never have to deal with absolute values, we can state relative prominence constraints locally on each phrase and leave most of the grid underspecified. However a consequence is that the number of grids licensed for each sentence is unbounded. Even if we limit ourselves to grids with a maximal prominence of 3 (that is, the flattest grids compatible with the constraits in (30)), the grammar licenses 32 distinct grids for (29). For lack of space we cannot discuss them all explicitly here. However (32) gives a representative sample of the types of grids licensed by the grammar.

```
                                        *
            *   *       *   *           *
          * *  * * * * *  * * * * *  * *
(32)  a. legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
                                        *
            *                           *
          * *  * * * * *  * * * * *  * *
      b. legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
                                        *
            *   *   *   *   *           *
          * *  * * * * *  * * * * *  * *
      c. legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
                                        *
            *   *       *   *       * *
          * *  * * * * *  * * * * *  * *
      d. legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin
```

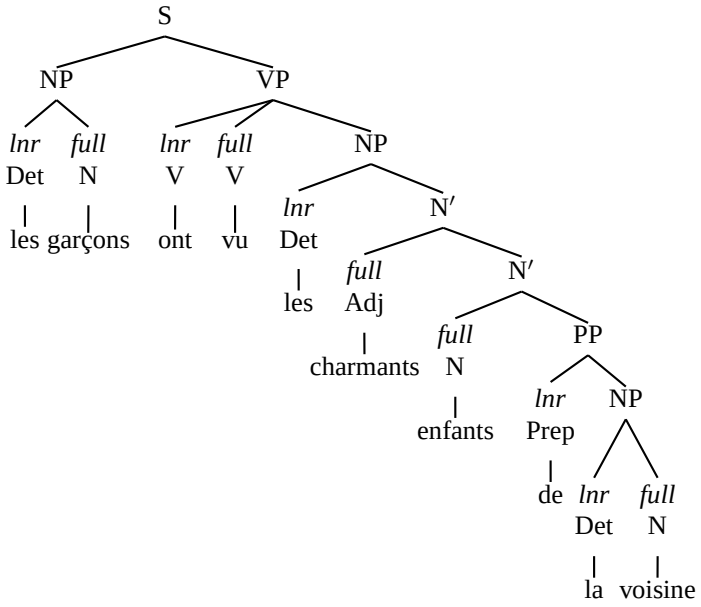


Figure 3: Syntactic constituent structure of (29)

```
                                  *
      *   *       *               *
* *  * * * *  * * * * *  * *
```

e. legaʁsɔ̃ʔɔ̃vyleʃaʁmãzãfãdəlavwazin

3.3 Noncategorical constraints

Among the grids in (32), only (32a) is completely satisfactory: (32b) is strongly disfavored because of the very long sequence of nonprominent syllables. (32c) and (32d) both contain a sequence of stressed syllables. Finally (32e) is not very good because the nonhead *charmant* is stressed whereas the adjacent head *enfants* is an equally good candidate for prominence.

The encoding of the metrical grid we propose has the advantage of allowing for an easy formulation of the constraints which are at play here. As an example, we provide a definition of no-clash. Intuitively, we want to count as clashing any grid which contains either a monotonous rise in prosodic prominence or a plateau of adjacent prominent syllables (monotonous descents do not count as clashing; see e.g. (14a)). Thus we can define no-clash as the property of a grid which contains neither monotonous rises nor plateaus.

(33) a. $\text{no-clash}(\langle \boxed{1},\boxed{2},\boxed{3}\text{—}\boxed{4}\rangle) \leftrightarrow \Big(\neg\text{rising}(\langle \boxed{1},\boxed{2},\boxed{3}\rangle) \wedge \neg\text{plateau}(\langle \boxed{1},\boxed{2}\rangle) \wedge \text{no-clash}(\langle \boxed{2},\boxed{3}\text{—}\boxed{4}\rangle)\Big)$

b. $\text{no-clash}(\langle \boxed{1},\boxed{2}\rangle) \leftrightarrow \neg\text{plateau}(\langle \boxed{1},\boxed{2}\rangle)$

c. no-clash($\langle \boxed{1} \rangle$)

(34) rising($\langle \boxed{1},\boxed{2},\boxed{3} \rangle$)$\leftrightarrow \Big(\boxed{2} > \boxed{1} \wedge \boxed{3} > \boxed{2} \Big)$

(35) plateau($\langle \boxed{1},\boxed{2} \rangle$)$\leftrightarrow \neg \Big((\boxed{1} > \boxed{2}) \vee (\boxed{2} > \boxed{1}) \vee (\boxed{1} = \langle \mathit{star} \rangle) \Big)$

What is not easy is to account for the noncategorical status of such constraints in an HPSG setting. A previous attempt at on optimality-theoretic treatment (Delais-Roussarie, 1996) has shown that gradual constraint violations and gang violations of constraints are at play, which clearly call for a stochastic model. The construction of such a model will have to await future work.

4 The metrical grid within the prosodic grammar

In this section we outline how the account of French stress patterns can be integrated in a grammar producing tonal profiles. According to Beyssade et al. (2004), the following constraints must be taken into account:[8]

(36) a. The *nuclear contour* realized by an utterance is a sequence of tones whose choice is determined by the dialogical status of the utterance. For instance, the contour **H* L* L%** signals that the speaker does not expect to be forced to revise their commitments by the addressee's reaction (Marandin, 2004).

b. The elements of the contour are realized on prosodically prominent syllables.

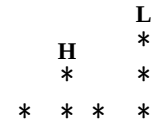
c. Each contour contains a distinguished pitch accent which anchors on the prominent syllable of the (information) focus.

d. Other tones in the contour anchor relative to the position of that pitch accent.

The effect of these constraints is illustrated in (37-38). (37b) is an all-focus utterance; thus the most prominent syllable is the last one. The **L*** tone anchors there. The **L%** must realize on *all* prominent syllables following the end of the focussed phrase. Here it does not realize at all, since there is no more room on the right. The **H*** anchors on *one* prominent syllable on the left, if there is one; otherwise it anchors on the first syllable. Here [fʁɛʁ] is the only available prominent syllable.

(37) a. Qu'est-ce qui s'est passé ?
'What happened?'

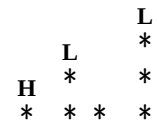
[8] For lack of space we avoid discussion of contrast.



b. mɔ̃fʁɛʁɛvny
Mon frère est venu.
'My brother came.'

(38b) has narrow focus on the subject NP. Thus the **L*** tone falls on the final syllable of the NP; **L%** falls on the only following prominent syllable; and **H*** falls on the first syllable.

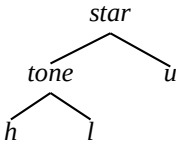
(38) a. Qui est venu ?
'Who came?'



b. mɔ̃fʁɛʁɛvny

To implement such an analysis in an HPSG grammar, we take advantage of the fact that metrical grids have been modeled as lists whose members play no role in the analysis. Thus we can use the typing of list members to encode tonal information. We assume three subtypes of *star*, corresponding to a high tone (*h*), a low tone (*l*), or the absence of a tonal specification (*u*).[9] Only prominent syllables may carry a tone.[10]

(39) a.



b. $\textit{sign} \rightarrow \left[\text{GRID} \;\; \textit{list}(\textit{2-list}(\textit{tone})) \bigcirc \textit{list}(\textit{list}(u)) \right]$

We assume with De Kuthy (2002) that focus is encoded by a list-valued feature taking as value the list of semantic contribution of focal signs. Focal signs are identifiable as signs whose semantic contribution coincides with the single element on their FOCUS list. For the purposes of contour anchoring, we need to keep track of the syllable ending the focal sign. We thus assume that *star* carries a binary feature EFS (End of Focal Sign). The constraints in (40) ensure that exactly one syllable per focus will be [EFS +], and that it will correspond to the most prominent syllable of the focal signs.

[9] As is usual with autosegmental tonal representations, the tonal profile is a properly phonological representation, which will be interpreted phoneticaly in specific ways. Stating that a syllable is unspecified for tone just means that phonetics will interpolate an appropriate pitch for that syllable depending on the neighbouring tones.

[10] *2-list*(σ) is shorthand for a list of at least two elements of type σ.

(40) a. $sign \rightarrow \begin{bmatrix} \text{FOCUS} & \boxed{1} \\ \text{GRID} & list(list([\text{EFS} -])) \bigcirc \\ & \boxed{2}\, list(list([\text{EFS} +])) \end{bmatrix}$

where $\mathsf{length}(\boxed{1}) = \mathsf{length}(\boxed{2})$

b. $\begin{bmatrix} \text{FOCUS} & \langle \boxed{1} \rangle \\ \text{CONT} & \boxed{1} \end{bmatrix} \rightarrow \begin{bmatrix} \text{GRID} & list(list(star)) \oplus \\ & \langle list([\text{EFS} +]) \rangle \end{bmatrix}$

Contours can then be seen as types of utterances. For lack of space we cannot discuss in detail the grammar of contours; however we can assume with Marandin (2004) that contours relate types of dialogue gameboards (Ginzburg, to appear) to tonal realizations. (41) outlines what the grammar must state on the effect of one particular contour, **H* L* L%**, in the case of a single-focus utterance. (41a) anchors the low pitch accent at the end of the focal sign, and checks that the grid up to the end of the focal sign contains exactly one tone, a high pitch accent, falling on a prominent syllable if possible; and that each prominent syllable after the focal sign carries a low boundary tone.

(41) a. $h*l*l\% \rightarrow \begin{bmatrix} utterance & \\ \text{FOCUS} & \langle sign \rangle \\ \text{GRID} & \boxed{1} \oplus \left\langle 2\text{-}list\left(\begin{bmatrix} l \\ \text{EFS} + \end{bmatrix}\right) \right\rangle \oplus \boxed{2} \\ \text{CXT}|\text{DGB} & \text{“no revision expected”} \end{bmatrix}$

where $\mathsf{pitch\text{-}accent}(h, \boxed{1})$ and $\mathsf{bnd\text{-}tone}(l, \boxed{2})$

b. i. $\mathsf{pitch\text{-}accent}\Big(\boxed{1}, \langle \langle \boxed{1} \rangle \oplus list(\langle u \rangle) \Big)$

ii. $\mathsf{pitch\text{-}accent}\Big(\boxed{1}, \langle 2\text{-}list(\boxed{1}) \rangle \bigcirc list(list(u))) \Big)$

iii. $\mathsf{pitch\text{-}accent}(tone, elist)$

c. $\mathsf{bnd\text{-}tone}\Big(\boxed{1}, list(2\text{-}list(\boxed{1})) \bigcirc list(\langle u \rangle) \Big)$

5 Conclusion

This paper proposes a new approach to prosodic representations in HPSG with two important design properties: first, prosodic representations are impoverished structures encoding only minimal information directly useful to phonetic interpretation. Second, the grammar makes heavy use of underspecification in the description of prosodic representations. As a result, it is quite easy to approach prosody in a modular way, where syntactic, lexical, pragmatic, rhythmic, etc., conditions provide independent constraints that are monotonically added to the overall description.

While this paper shows how such an approach can be succesfully applied to the basic prosodic profile of French, two aspects of the analysis are in need of

more work: first, we have shown that many rhythmic and syntactic constraints are of a noncategorical and/or gradual nature, and are thus not easy to state within a classical HPSG grammar. Second, while we have shown how the description of intonation contours can be integrated with the current approach on a particular case, it remains to be seen how a general HPSG grammar of contours is to be written.

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