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PROSODIC REPRESENTATIONS AND LEXICAL STRESS

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Representations and restrictions

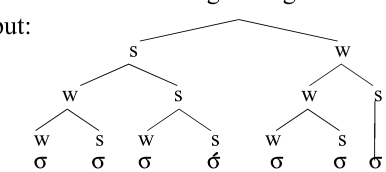
One of the most important questions in prosodic phonology is the question of representations. The stress systems of most of the world's languages can be informally described with accuracy and even elegance; for example, Latin stresses the penultimate syllable of a word if it is heavy, and otherwise the antepenult. Informal rules can, however, provide equally elegant descriptions of unattested stress systems: "Stress the fourth syllable if the penult is heavy; otherwise stress all prime-numbered syllables." The problem for the formal linguist is to construct rules that describe real systems just as concisely, but which are incapable of describing systems that do not and cannot exist in natural language.

The power of rules depends to a great extent upon the representations on which they operate. When more information is encoded in the representations, rules become more powerful without appearing to grow in complexity. If a grammar is encoded as a finite-state transducer, then its power depends not only on the number of states, but also on the size of the alphabet on which it operates. If representations can be made to include only as much information as necessary, then the rules that refer to them will be inherently constrained.

In the prosodic theory, the two principal forms of representations have been trees and grids. Tree structures are perhaps the most obvious means of encoding hierarchical constituency relations, and so they are intuitively appropriate for representing prosodic constituents. That there are such constituents, at varying degrees of granularity, is evidenced by the prevalence of alternating patterns of strong and weak prosodic elements, and by phonological rules whose application is sensitive to prosodic domains. Trees, however, allow rules to proceed both upward and downward—both from the leaves and from the roots. Consider the following hypothetical set of rules for building stress trees, and what it produces:

(1) a. Rules: 1. Build (maximally) binary constituents from left to right.
2. Repeat step 1 until all constituents are parsed.
3. Mark the left daughter of the root node as strong.
4. Mark as strong the right branch of all other branching nodes.

b. Output:



Applied to words of *n* syllables, where *n* is greater than one, the set of rules in (1a) will place main stress on syllable $2^{\mathrm{floor}(\log_2(n-1))}$ (i.e., the greatest power of two less than *n*). This is a rather unlikely stress system. Furthermore, a structure such as (1b) can in principle be used to distinguish as many degrees of stress as there are syllables in the word. The relatively restricted range of attested stress contrasts may be attributed to neutralization in the phonetic implementation of stress, but the fact remains that the tree structures themselves overgenerate.

Grid structures, on the other hand, must be built from the bottom up. Each element in a grid must be supported by a corresponding element on the line immediately below it. A grid structure can thus distinguish only as many degrees of stress as there are levels of prosodic representation, and strong positions at each level must be determined without reference to higher levels. This restriction predicts that the position of stress in a word must always be locatable by reference to one edge of the word or the other (for example, main stress may fall on 'the penultimate syllable' or 'the leftmost heavy syllable,' but not on 'the middle syllable' or 'syllable $2^{\text{floor}(\log_2(n-1))}$'). Grids can still encode constituency relations, but they do so by marking boundaries between constituents on the same level rather than dependencies between constituents on different levels.

A major advance in grid-based metrical theory was made by Idsardi (1992). Idsardi proposed that the parentheses that mark constituent boundaries need not always come in pairs; rather, individual parentheses may usefully be treated as independent objects. In earlier grid-based models, parentheses were well-formed only in configurations such as (2). The notation in (2) indicates that there is a constituent—delimited by the paired parentheses—that comprises X and Y.

(2) `(XY)`

In Idsardi's theory, however, an individual parenthesis is a well-formed object that can be interpreted by referring only to immediately adjacent material. Consider the representations in (3).

(3) a. `X)Y` b. `X(Y` c. `X)(Y`

(3a) indicates that X belongs to a constituent that does not contain Y; (3b) indicates that Y belongs to a constituent that does not contain X; and (3c) indicates that X and Y belong to separate constituents. All three representations are mutually compatible, but (3a) and (3b) are less fully specified than (3c). In (3a), Y may be extrametrical; in (3b), the same is true of X. In (3c), however, X and Y must each belong to some higher constituent. A representation with unmatched parentheses can be interpreted by assuming exactly as much structure as is necessary to accomodate all existing specifications.

In this paper, I explore the notion that prosodic constituency representations can be even further underspecified. Suppose that the three distinct representations in (3) were collapsed into (4).

(4) `X|Y`

What (4) says is that X and Y are not members of the same constituent. Unlike any of (3a-c), it leaves open the possibility that either X or Y (but not both) is extrametrical. Extrametricality is thus the chief potential empirical difference between (4) and (3a-c). If extrametricality can be determined without reference to the directionality of constituent boundaries, then the alphabet of prosodic computation can be reduced. Since extrametrical elements are usually no larger than single syllables, and generally occur at the edges of words, extrametricality may be derivable from a language's tolerance or intolerance of degenerate feet.

Syllables and moras

Another phenomenon that must be addressed in any theory of prosodic representations is quantity sensitivity. Trees and grids are commonly built on the assumption that each level of structure depends only on the level immediately below it; however, foot structure in some languages is sensitive to both the syllabic and moraic levels. So, for example, Prince and Smolensky (1993: 47) formulate the constraint "FOOTBINARITY (FTBIN): Feet are binary at some level of analysis (μ,σ)." Applied to a tree in which feet dominate syllables, and syllables moras, this would require that a foot either branch or dominate a branching syllable. In a grid with syllables represented by the symbols H and L, it would require a foot to consist of either two syllables or one H. In each of the two representations, footing depends on two distinct lower levels of structure.

This need not be the case if we use grids such as the one in (5), in which the lowest level (line 0) contains moras and syllable boundaries, rather than (as in Halle and Vergnaud 1987, Idsardi 1992, *inter alia*) syllables and foot boundaries.

(5)
```
line 2   |        x     |     | = word boundary; x = strong foot
line 1   |   x |x   |x  |     | = foot boundary; x = stressed syllable
line 0   |x|xx|x|x|xx|x|      | = syllable boundary; x = mora
```

Each level of the grid in (5) contains exactly two kinds of objects—prominence marks and constituent boundaries. The structure of the grid is constrained by the requirement that every object above line 0 must be projected by an object of the same type on the line immediately below it. Line 0 itself reflects the syllable structure assigned to a string of segments. The rules or constraints that assign foot boundaries and heads can now refer to syllable weight without having to look more than one line down or use special symbols for light and heavy syllables. A heavy syllable is simply two moras with no boundary between them.

FOOTBINARITY might now be expressed as the two constraints in (6):

(6) a. Between one line-1 | and the next, there must be at least two line-0 `x`'s.
b. Between one line-1 | and the next, there must be at most one line-0 |.

The proposed representations allow equally elegant derivational expressions of generalizations. For example, consider the following rule for building iambs:

(7) Starting from the left edge, iteratively count two `x`'s and project the next constituent boundary.

This formula will produce the iambs LL, LH, and H, but not *HL, *HH, or *L:

(8)
```
                                     |     |    |  |    |
|xx|x|xx|xx|x|x|x|xx|   →   |xx|x|xx|xx|x|x|x|xx|
                             12^1 2 ^12^1 2^1 2 ^
```

A grid structure that includes moras is also entirely compatible with quantity-insensitive systems. The rule in (9), applied to the same representation as in (8), produces a quantity-insensitive parsing, as shown in (10).

(9) Starting from the left edge, project every odd constituent boundary.

(10)
```
                              |    |      |  |  |
|xx|x|xx|xx|x|x|x|xx|   →    |xx|x|xx|xx|x|x|x|xx|
                              1  2 1  2  1 2 1 2 1
```

If it is true that all languages with contrastive vowel length are quantity-sensitive, then quantity-insensitive languages can be said to have only monomoraic syllables. Given a string of light syllables, (7) has the same effect as (9), and so the two types of rules could be conflated. If such is not the case, then some languages have rules that refer to line-0 x's, while others do not. Either way, the same formalism will serve for both quantity-sensitive and -insensitive languages.

Does the proposed grid structure allow us to account for the same range of data as other, more complex prosodic representations? I will first consider some of the simplest stress systems, and then move on to more complex ones.

Alternating stress: Weri, Warao

Halle and Vergnaud (1987: 12), citing Boxwell and Boxwell (1966), say that in Weri, main stress falls on the final syllable of the word, and secondary stress on every second syllable before the final one. This system may be generated by the rules in (11), as shown in (13a), or by the rules in (12), illustrated in (13b).

(11) a. Starting from the right edge, project every even line-0 boundary.
b. Project every line-0 x to the immediate right of a projected boundary.
c. Project the rightmost line-1 x.

(12) a. Starting from the right edge, project every odd line-0 boundary.
b. Project every line-0 x to the immediate left of a projected boundary.
c. Project the rightmost line-1 x.

(13) a.

```
                                                      x
               |   |   |      |x  |x  |x      |x  |x  |x
|x|x|x|x|x| →  |x|x|x|x|x| →  |x|x|x|x|x| →  |x|x|x|x|x|
               2 1 2 1 2 1                    àkunètepál
```

b.

```
                                                      x
                 |   |   |      x|  x|  x|      x|  x|  x|
|x|x|x|x|x| →  |x|x|x|x|x| →  |x|x|x|x|x| →  |x|x|x|x|x|
               2 1 2 1 2 1                    àkunètepál
```

Both versions assign the correct stress pattern, but they make opposite predictions about footing. The choice between them thus depends on higher-level phenomena. All other things being equal, the rules in (12) seem preferable, because they make the final syllable head a binary foot, and because they place an explicit foot boundary at the right edge of the word, creating a parallel between the rule for right-headed feet (12b) and the rule for right-headed words (12c).

"The stress pattern of Warao is identical to that of Weri, except that it is 'shifted' one syllable to the left" write Halle and Vergnaud (1987: 18; based on Osborn 1966). This pattern can be generated by (14a-c), which produce (15).

(14) a. Starting from the right edge, project every even line-0 boundary.
b. Project every line-0 x to the immediate left of a projected boundary.
c. Project the rightmost line-1 x.

(15)

```
                                                    x
               |   |   |      |  x|  x|      |  x|  x|
|x|x|x|x|x| →  |x|x|x|x|x| →  |x|x|x|x|x| →  |x|x|x|x|x|
               2 1 2 1 2 1
```


The same stress pattern, with different foot boundaries, could be produced by changing 'even' to 'odd' in (14a) and 'left' to 'right' in (14b). The rules shown here essentially mimic the effect of final-syllable extrametricality in Halle and Vergnaud's analysis of Warao. Here, however, the 'extrametricality' of the final syllable is produced by the same mechanism that generates constituent structure in the rest of the word rather than by an additional rule.

Quantity-sensitive systems: Koya, Selkup, Khalka

The rules for quantity-sensitive languages are slightly more complex. For example, Koya has main stress on the initial syllable, and secondary stress on all heavy syllables (Halle and Vergnaud 1987: 12; Tyler 1969). This pattern may be generated by the rules in (16), which yield derivations such as (17).

(16) a. Project the leftmost line-0 boundary.
b. Project every line-0 boundary to the immediate left of two adjacent x's.
c. Project every line-0 x to the immediate right of a projected boundary.
d. Project the leftmost line-1 x.

(17)

```
                   |                  |   |      |          |x  |x      |x
|x|x|xx|x|x|xx| →  |x|x|xx|x|x|xx| →  |x|x|xx|x|x|xx| →  |x|x|xx|x|x|xx|
```

Main stress will always fall on the first syllable in Koya, because the first syllable always projects a prominence mark, which will always be the leftmost prominence mark on line 1. A more varied pattern may be seen in Selkup, in which the rightmost heavy syllable is stressed, but, if there are no heavy syllables, then the initial syllable is stressed (Idsardi 1992: 25; Kuznecova et al. 1980). This pattern can be derived simply by changing 'leftmost' to 'rightmost' in (16d). In a word with one or more heavy syllables, the rightmost of these will project the rightmost line-1 mark (18a); in a word with no heavy syllables, the first syllable will project the only—and thus the rightmost—line-1 mark (18b).

(18) a.

```
         x
|x|x    |x
|x|xx|x|xx|x|
```

b.

```
 x
|x
|x|x|x|x|x|x|
```

The stress pattern of Khalka Mongolian, though very similar to those of Selkup and Koya, introduces a new complication. In this language, main stress falls on the leftmost heavy syllable, or (in the absence of heavy syllables), on the initial syllable (Idsardi 1992: 25; Street 1963). In forms that do contain heavy syllables, the rules in (16b)–(16d) generate the appropriate pattern, as in (19).

(19)

```
   x
  |x    |x
|x|xx|x|xx|x|
```

The difficulty comes with words that lack heavy syllables. If we reinstate the rule in (18a), so as to allow the initial syllable to project a line-1 mark, then we simply replicate the Koya system. If, however, we do not allow the first syllable to project, then there are no line-1 marks to project to line 2. One possibility would be to allow the rule in (18a) to apply if and only if (18b) fails to produce any line-1 constituent boundaries. In other words, (18a) would apply by default as a last resort. This approach works, but it appears somewhat arbitrary; a better solution would make it natural for a language that stresses leftmost heavy syllables by preference to stress leftmost light syllables by default.

An alternative would be to change the rule in (16d) so that it does not refer explicitly to line 1, but rather applies to the highest level of representation on which there are prominence marks. If line 1 contains marks, then the leftmost of these will project to line 2; otherwise, the rule will target the leftmost line 0 mark, which will project to line 1. It may not be necessary for this syllable to project to line 2, as its line 1 mark will give it greater prominence than any other syllable in the word. The association of word-level stress with line 2 is thus not absolute—if only two degrees of prominence are exhibited in a given word, then that word can be adequately represented using only two lines of the prosodic grid.

Another option would be to change the rule in (16c) to refer to feet, not boundaries. The rules discussed so far have simply been operations on symbols; a more sophisticated rule could take advantage of constituent relations inferred from the representations. Where (16c) projects a prominence mark to the right of each foot boundary, the revised rule could project the leftmost syllable in each foot. Such a rule could assume that a word with no foot boundaries is to be construed as a single foot (rather than a string of unparsed syllables); alternatively, an additional rule could foot the word by placing a boundary at the right edge. Either way, the initial syllable would be the leftmost syllable in a foot, and thus would project to line 1, and then again to line 2 by (16d).

Each of these last two options can be extended to provide simple treatments of languages in which stress appears only on the initial syllable (as in Czech) or only on the final syllable (as in French). In such languages, there need be no rules for projecting foot boundaries—only rules determining headedness.

Working from both ends: Garawa

While the languages discussed in the preceding section combine quantity-sensitive stresses with a default preference for marking one edge of the word, other languages combine two quantity-insensitive patterns. One of these patterns marks a single stress at one end of the word, while the other creates repeating stresses from the opposite end. One such language is Garawa, in which the first syllable bears stress, as do all even numbered syllables counted from the right, but never the second syllable (Halle and Vergnaud 1987: 12; Furby 1974).

The rules in (20) come close to generating this pattern, but they incorrectly predict stress on the second syllables of words with odd numbers of syllables. The patterns generated by (20) are shown in (21).

(20) a. Project the leftmost line-0 boundary.
b. Starting from the right edge, project every odd line-0 boundary.
c. Project every line-0 x to the immediate right of a projected boundary.

(21) a.
```
|x  |x  |x  |
|x|x|x|x|x|x|
1 2 1 2 1 2 1
```
b.
```
|x|x  |x  |x  |
|x|x|x|x|x|x|x|
2 1 2 1 2 1 2 1
```

The rules initially proposed by Halle and Vergnaud encounter the same difficulty in forms such as (21b). They propose a rule that destresses the second of two adjacent stressed syllables. A similar rule would work here. However, it might be preferable to replace the rule with a constraint that prevents (20b) or (20c) from causing two consecutive boundaries (or two consecutive x's) to be projected to line 1. Such a restriction does not follow automatically from the representations, but it reflects a general tendency toward alternation in phonology.
This constraint may be simply another manifestation of the Obligatory Contour Principle. It may also explain alternations of stressed and unstressed syllables: if there is a constraint against projecting two boundaries in a row, then rules such as (20b) can be made to try to project *all* boundaries, starting with the first or second from an edge. Binary constituents, and thus alternating stresses, would arise from the fact that the rule would be blocked at every other syllable boundary.

While it is important to be cautious in introducing constraints into a rule-based theory (or vice versa), the current constraint is well suited to a derivational theory of prosody. It is evaluated locally, and serves only to block the immediate application of a rule, rather than requiring the intervention of another rule to 'repair' an ill-formed representation. However, it cannot be stated as an absolute restriction, since some languages do permit stress clashes. Still, although it cannot be categorical, the constraint against projecting consecutive constituent boundaries seems at least as appropriate a device as Halle and Vergnaud's stress deletion rule.

Quantity sensitivity and iterative stress: Aklan

One language that allows consecutive line-0 boundaries to project is Aklan. Halle and Vergnaud (1987: 45, based on Hayes 1980 and Chai 1971) say that "in Aklan stress falls on all closed syllables, on certain lexically marked syllables, and, in a sequence of open unmarked syllables, on every odd-numbered syllable counted from the end if the sequence is word-final, and on every even-numbered syllable if the sequence is not word-final." The language thus permits stress clashes (and monosyllabic feet) to the right of a heavy syllable, but not to the left, as shown in the schematized forms in (22). This pattern can be generated by (23).

(24) a.
```
 ' ' '
LLLLLL

|  x|  x|  x|
|x|x|x|x|x|x|
```
b.
```
'  '' '
LLHLLL

 x|   x|x|  x|
|x|x|xx|x|x|x|
```

(25) a. Project every line-0 boundary to the right of two adjacent x's.
b. Starting from the right edge, project every line-0 boundary iff the next line-0 boundary to the right is not already projected.
c. Project every line-0 x to the immediate left of a projected boundary.

The constraint against projecting consecutive boundaries is considerably weakend here. It does not affect heavy syllables at all, and the projection of alternate light syllables is sensitive to clashes only on one side. The asymmetrical restriction in (23b) appears arbitrary. A better approach might combine the quantity-sensitive and iterative projection rules into one procedure, and make the asymmetrical clash sensitivity follow from the direction of the calculation. The rules needed to do this can be expressed by the finite-state transducer in (24).

(24)

0.		1.
0. Project |. Move left to next |. If /#_, stop. Go to state 1.	→ ←	1. If /|x_, move left to next |. If /#_, stop. Go to state 0.

The device starts in state 0 at the right edge of the word. In state 0, it projects a syllable boundary, moves to the next boundary to the left, and enters state 1. In state 1, it moves to the next boundary if and only if the current syllable is light; either way, it then returns to state 0. When it reaches the left edge of the word (in either state), it stops. The device is sensitive only to whether it has just projected a boundary (indicated by which state it is in), and (when it is in state 1) whether the current syllable is heavy. Because it keeps track of whether it projected the last boundary, it will never create a clashing stress on a light syllable to the left of a stressed syllable. However, since it cannot look ahead or backtrack, it will create clashes like the one in (22b). The algorithm in (24) thus makes asymmetrical clash sensitivity follow from the serial operation of stress assignment.

Another approach would be to abandon serialism altogether and reformulate the analysis in terms of Optimality Theory. If it is necessary to introduce a violable constraint against projecting consecutive boundaries, then perhaps the entire system can be expressed in terms of violable constraints. The constraints in (25) show how OT might treat Aklan using the grid formalism proposed in this paper.

(25) MARKR: The rightmost line-0 | must be projected to line 1.
MARKXX: Project each | to the right of two adjacent line-0 X's.
FTMAX: A line-1 constituent may contain at most one line-0 | .
OCP-|: Do not project consecutive |'s.

Alternating stress is driven by FTMAX, which prohibits feet of more than two syllables, and OCP-|, which prohibits monosyllabic feet. If x's are placed to the left of line-1 boundaries by an undominated constraint or by a parameter setting, the constraints in (25) correctly generate (22a); this may be seen in (26). They do not, however, entirely succeed in generating (22b), as shown in (27).

(26)

<table>
<tr><th>|x|x|x|x|x|x|</th><th>MARKR</th><th>MARKXX</th><th>FTMAX</th><th>OCP-|</th></tr>
<tr><td>a. x| x| x|
☞ |x|x|x|x|x|x|</td><td></td><td></td><td></td><td></td></tr>
<tr><td>b. x|x|x|x|x|x|
|x|x|x|x|x|x|</td><td></td><td></td><td></td><td>*!****</td></tr>
<tr><td>c. x|
|x|x|x|x|x|x|</td><td></td><td></td><td>*!***</td><td></td></tr>
<tr><td>d. x| x| x|
|x|x|x|x|x|x|</td><td>*!</td><td></td><td></td><td></td></tr>
</table>

(27)

<table>
<tr><th>|x|x|xx|x|x|x|</th><th>MARKR</th><th>MARKXX</th><th>FTMAX</th><th>OCP-|</th></tr>
<tr><td>a. x| x|x| x|
☞ |x|x|xx|x|x|x|</td><td></td><td></td><td></td><td>*</td></tr>
<tr><td>b. x| x| x|x|
☞ |x|x|xx|x|x|x|</td><td></td><td></td><td></td><td></td></tr>
<tr><td>c. x| x|x| x|
|x|x|xx|x|x|x|</td><td></td><td></td><td></td><td>**!</td></tr>
<tr><td>d. x| x| x|
|x|x|xx|x|x|x|</td><td></td><td></td><td>*!</td><td></td></tr>
<tr><td>e. x| x| x|
|x|x|xx|x|x|x|</td><td></td><td>*!</td><td></td><td></td></tr>
<tr><td>f. x| x| x|
|x|x|xx|x|x|x|</td><td>*!</td><td></td><td></td><td></td></tr>
</table>

The ranking of MARKXX over OCP-| allows the marking of heavy syllables to create stress clash, so that candidate (e), which would be optimal in a quantity-insensitive language, is ruled out in Aklan. The high ranking of MARKR disallows shifting the entire alternating stress pattern to the left, as in candidate (f). FTMAX rules out candidate (d); the ranking of FTMAX over OCP-| here is analogous to ranking *LAPSE over *CLASH in other OT approaches to prosody, but the present constraints refer to constituent boundaries rather than stresses.

The system of constraints thus allows a violation of OCP-| for the sake of marking all heavy syllables, and it correctly predicts that the clash will occur to the right of the heavy syllable rather than to the left. However, it does not predict *how far* to the right the clash will be. The constraints in (25) offer no way to choose between candidate (a)—the desired winner—and candidate (b), in which the presence of a heavy syllable gives rise to a stress clash between two other syllables. No doubt it would be possible to formulate a constraint to select (a) over (b)—perhaps an OCP-type constraint requiring that adjacent syllables must differ in either quantity or prominence, so as to disallow clashing stresses on light syllables—but such a stipulation would miss the intuitively obvious generalization that syllables do not create stress clashes without participating in them. It would also fail to distinguish between (a) and (b) if the final syllable were heavy. The global harmonic evaluation of OT thus fails to predict a property of stress systems that follows automatically from serial derivation of prosodic structure.

Lexical exceptions to regular stress: Polish, Russian

One challenge that any theory of prosodic representations must confront is that posed by the existence of lexical exceptions to otherwise regular stress systems. The lexical representations of such exceptions must be made compatible with the theory as a whole, and the theory should make predictions about what sorts of exceptional forms a given system does and does not allow.

For example, Polish regularly has penultimate stress, but it also contains three classes of exceptional words in which penultimate stress alternates with final or antepenultimate stress. The stress assigned to the different types of words is shown in (28) (based on Idsardi 1992: 34).

(28)

	Unaffixed	With monosyllabic suffix
regular	penultimate	penultimate
gramatyk-type	penultimate	antepenultimate
uniwersytet-type	antepenultimate	penultimate
režim-type	final	penultimate

In Idsardi's account, all exceptional stress patterns can be expressed by the lexical specification of foot boundaries near the right edge of the word. The regular penultimate stress pattern is produced by inserting left parentheses to the left of every two syllables from the right. Feet are left-headed, words right-headed; the main stress thus falls on the left-hand syllable of the rightmost foot. *Gramatyk*-type words have a lexical right parenthesis to the right of the final syllable. When unaffixed, they receive normal penultimate stress. However, when a monosyllabic suffix is added, the final parenthesis prevents it from being parsed into a foot. Stress thus falls on the penultimate syllable of the stem, which is the antepenultimate syllable of the word. *Uniwersytet*-type words have a lexical right parenthesis to the left of the final syllable. When no suffix is added, the final syllable of the word is left unparsed, and antepenultimate stress results. If a monosyllabic suffix is added, the final syllable of the stem heads a foot containing itself and the suffix; penultimate stress results. The last class of exceptions, the *režim* type, have a left parenthesis to the left of the final syllable. This forces the stem-final syllable to be the leftmost syllable of a foot, even when nothing follows it. When there is no affix, word-final stress results. Given a monosyllabic suffix, the stem-final syllable heads a binary foot, and the form receives penultimate stress.

With directionless boundaries, a different set of rules is needed. The regular stress pattern is generated by projecting every odd boundary from the right edge; again, feet are left-headed, and words right-headed. This pattern is shown in (29).

(29)

```
            x
 |x  |x  |x  |
 |x|x|x|x|x|x|
 1 2 1 2 1 2 1
```

Gramatyk-type words have a lexical foot boundary after the final syllable. When no suffix follows, this has no effect, and penultimate stress results. A monosyllabic suffix, however, is left unfooted, as in Idsardi's analysis. The present analysis assumes that the constraint against projecting consecutive boundaries is in effect; that the rule which projects odd-numbered boundaries actually tries to project *all* boundaries, starting with the rightmost; and that a word-final syllable will be left unparsed if it cannot form a foot with the syllable to its left and there is no explicit foot boundary to its right. *Gramatyk*-type forms are derived as in (30). In (30a), the stem-final lexical boundary has no effect; the rules would place a boundary there anyway. In (30b), however, it stops the suffix from forming a foot with the stem-final syllable; the suffix is effectively extrametrical.

(30) a. *gramátyk*

```
                                           x
       |         |   |         |x  |      |x  |
 |x|x|x|  →  |x|x|x|  →  |x|x|x|  →  |x|x|x|
```

b. *gramátyk+a*

```
                                                 x
       |            |   |          |x  |        |x  |
 |x|x|x|x|  →  |x|x|x|x|  →  |x|x|x|x|  →  |x|x|x|x|
```

Uniwersytet forms have lexical boundaries to the left of the final syllable. As in *gramatyka*, the lexical foot boundary prevents the final syllable from being footed (31a). However, when an additional syllable is suffixed, the stem-final syllable can form a foot with the suffix, and penultimate stress results (31b).

(31) a. *uniwérsitet*

```
                                     x
         |          |   |   |    |x  |x  |
 |x|x|x|x|x|  →  |x|x|x|x|x|  →  |x|x|x|x|x|
```

b. *uniwersitét+u*

```
                                              x
         |            |   |   |   |     |x  |x  |x  |
 |x|x|x|x|x|x|  →  |x|x|x|x|x|x|  →  |x|x|x|x|x|x|
```

Finally, *režim*-type words have lexical foot boundaries to the left and the right of the final syllable. Since this syllable has foot boundaries on both sides, it

must be parsed (and thus stressed), even though there is no other syllable in the foot. The resulting patterns are in (32):

(32) a. *režím* b. *režím+u*

```
                   x                                  x
  | |      | |    |x|        | |        | |        |x|
 |x|x| → |x|x| → |x|x|    |x|x|x| → |x|x|x| → |x|x|x|
```

c. *režim+ámi*

```
                              x
  | |          |  |  |       |x|x  |
 |x|x|x|x| → |x|x|x|x| → |x|x|x|x|
```

A monosyllabic suffix cannot be footed with the final syllable of the stem, but a disyllabic suffix such as *-ámi* will form a foot by itself. In (32c), it does not matter whether the projection of the prominence mark on the final syllable of the stem is blocked; the first syllable of the suffix will receive main stress either way.

An interesting consequence of this analysis of lexical stress in Polish is that representations that cannot be generated by rules (projections of consecutive syllable boundaries) can be specified in the lexicon. This indicates that the constraint against consecutive projections operates only as a local constraint blocking the application of a rule, and not as a global well-formedness condition.

Russian provides examples of lexically specified foot boundaries in affixes as well as roots. Halle (2000) provides an account of Russian stress using the unmatched parentheses of Idsardi (1992); in this section, I will show how some of the same data can be treated using directionless constituent boundaries.

At first glance, Russian stress can appear almost chaotic; consider for example the different stress patterns in the six trisyllabic forms in (33). Halle, however, presents a set of representations, shown in (34), that permit the forms in (33) to be generated by a surprisingly straightforward set of rules.

(33) (based on Halle 2000)

	'nut'	'king'	'town'
dative singular	oréx+u	korol'+ú	górod+u
dative plural	oréx+am	korol'+ám	gorod+ám

(34) a. o(rex b. korol'(c. gorod d. -u e. -(am

Halle's rules insert a right parenthesis on line 0 at the right edge; build left-headed feet; insert a left parenthesis on line 1 at the left edge; and construct a left-headed prosodic word. When the suffix has no lexical foot boundary (as in *-u*), stress will fall to the immediate right of any left parenthesis in the stem (*oréxu*, *korol'ú*), or, if the stem also has no lexical boundary, on the first syllable (*górodu*). The suffix *-am*, on the other hand, has a lexical foot boundary and so attracts stress to itself (*korol'ám*, *gorodám*), unless there is a parenthesis within the stem (*oréxam*). This elegant analysis can be made even more minimal by eliminating the distinction between left and right parentheses. The requisite rules are in (35), and the forms in (33) are derived as shown in (36).

(35) a. Project the rightmost line-0 boundary.
b. Project every x to the immediate right of a projected boundary.
c. Project the leftmost line-1 x to line 2. (Or, if there are no x's on line 1, project the leftmost line-0 x to lines 1 and 2.)

60

```
(36)      +u                                  ||  +|am

  |                                   x         ||                                x
|x|x|       |        |   |    |x  |    |x  |  ||    | |      | | |    |x|x|    |x|x|
 orex     |x|x|x|  |x|x|x|  |x|x|x|  |x|x|x|  ||  |x|x|x|  |x|x|x|  |x|x|x|  |x|x|x|

    |                                    x  ||                                 x
|x|x|         |        | |      |x|      |x|  ||      |        | |      |x|      |x|
korol'    |x|x|x|  |x|x|x|  |x|x|x|  |x|x|x|  ||  |x|x|x|  |x|x|x|  |x|x|x|  |x|x|x|

                                    x       ||                                 x
|x|x|                    |   x    |   x    |  ||      |        | |      |x|      |x|
gorod     |x|x|x|  |x|x|x|  |x|x|x|  |x|x|x|  ||  |x|x|x|  |x|x|x|  |x|x|x|  |x|x|x|
```

In (36), I have shown (35a) applying regardless of whether it projects consecutive boundaries. This need not be the case if (36b) is allowed to project prominence marks that have neither a foot boundary nor another syllable to their right, but Russian must differ from Polish in at least one of these respects. The projection of the initial syllable in *górodu* is analogous to the default initial stress in Khalka Mongolian, and it may be assigned by any of the methods discussed above. Directionless boundaries can thus be used to restate Halle's account of these Russian forms with an even more restricted set of symbols, and with a flexibility that may become crucial as this formalism is applied to still other stress systems.

Conclusions

Although the stress systems considered in this paper are only a few of the many attested in the world's languages, their amenability to directionless constituent boundaries is promising. The languages discussed so far include quantity-sensitive and quantity-insensitive systems; systems that combine quantity-sensitivity with iterative stress; and systems that combine regularity with lexical exceptions. In each, it has been possible to analyze the attested patterns using a limited vocabulary of symbols, rules, and restrictions. Although the data from Aklan suggest that a derivational approach is more likely to be successful, the grid formalism proposed in this paper is in principle compatible with constraint-based theories. If the analyses presented here can be extended to other languages, then it should be possible to build prosodic representations out of almost nothing.

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