Feature Geometry

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Background

- We now know that features are organized on autosegmental tiers; the simplest hypothesis seems to be that every feature occupies its own tier.
- However, this still leaves open the question how these tiers are organized with respect to each other.
- There is evidence that they are organized in a tree-like internal structure.

1 The Place node

If features are organized into tiers, we still have to find out how those tiers are related to each other. Last week, we have seen that there is evidence for one central timing tier, the skeleton. But this still leaves many different options. One possibility — maybe the simplest one — is to assume that all features are linked directly to this one central tier. This is sometimes called the *bottle brush* model:

$$\begin{tikzcd} & \text{[labial]} \arrow[d, dash] & \\ \text{[cor]} \arrow[r, dash] & x \arrow[r, dash] \arrow[d, dash] & \text{[velar]} \\ & \text{[+voice]} & \end{tikzcd}$$

(1)

However, there is evidence against this simple model, and pointing in the direction of features being organized in arborescent structures; the school of thought is called **feature geometry** (using a somewhat excentric definition of the term ‘geometry’). The most straightforward evidence here comes from the fact that sometimes certain features group together. A well known case is place assimilation. In many languages of the world, nasal consonants assimilate in place of articulation to the following consonant. The following examples are from Chuckchi (Odden, 1987; Clements & Hume, 1995), where we assume the assimilating nasal is ŋ underlyingly.

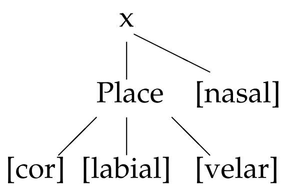
(2)	təŋ-əɬ-ən	‘good’
	tam-pera-k	‘to look good’
	tam-vairgin	‘good being’
	tam-waɣərɣ-ən	‘good life’
	tan-t^{s}ai	‘good tea’
	ten-leut	‘good head’
	tan-ran	‘good house’
	ten-yəɬqət-ək	‘to sleep well’

In these cases, the nasal assimilates in the value for the features [coronal], [velar] and [labial], but not for any other feature (e.g. it does not lose its nasality or turn into a fricative).

We could of course assume that Chuckchi has three different phonological rules which we could informally state as follows:

(3) a. Spread [coronal] from a consonant to a preceding nasal.
b. Spread [velar] from a consonant to a preceding nasal.
c. Spread [labial] from a consonant to a preceding nasal.

But this is very unattractive, especially because we find a similar phenomenon in many languages of the world, and it always involves these features. But more in general, we would want to give a uniform description of phenomena such as this. In order to achieve this, we posit an organizing node in our phonological representations, called a Place node. The place nodes are not linked individually to the central skeleton, but through this organizing node:



(4)

We can now formulate the relevant rule in a very simple and straightforward way:

(5) Spread the Place node from a consonant to a preceding nasal.

When we spread the place node, we spread all the relevant features at the same time. Nasal assimilation thus gets a simple and straightforward formalisation.

Another type of evidence pointing in the same direction comes from **debuccalization**. For instance in certain dialects of Malay, consonants in coda position change according to the schedule in (6) (Humbert, 1995; Botma, 2004):

(6) a. /p, t, k/ → [ʔ]
b. /s, f, h/ → [h]
c. /m, n, ŋ/ → [N] (a 'placeless nasal')

(7) a. /ikat/ → [ikaʔ] 'to tie'
b. /lipas/ → [lipah]
c. /ʔawan/ → [ʔawaN]

The traditional name for this process is 'debuccalisation', since all the oral articulators become inactive. On the other hand, the manner of articulation stays constant: a stop /t/ stays a glottal stop [ʔ], a fricative /s/ stays a fricative /h/, and a nasal /n/ stays a nasal, albeit a placeless one.

Again, we could formulate this in terms of three independent rules:

(8) a. Delink [coronal] at the end of the syllable.
b. Delink [labial] at the end of the syllable.
c. Delink [velar] at the end of the syllable.

This would come at a loss of generality, however, especially since again the three processes seem often linked. For instance, the same phenomenon can be found in London English (Lass, 1976; Gussenhoven & Jacobs, 1998).

(9)	piʔtʃə	*picture*
	mɪiʔ wɪljəm	*meet William*
	nɪʔ næʔs	*knick-nacks*
	nɔʔ næʊ	*not now*
	kɪiʔ smɑɪlɪŋ	*keep smiling*

Introducing a Place node allows us to simplify the formalism considerably. Both Malay and London English are subject to the following rule:

(10) Delink the Place node at the end of the syllable.

Note that this means that we assume that segments such as [ʔ] and [h] lack a place of articulation node. It is not the case that these segments have a specification [-coronal, -labial, -velar]: they do not have any place features whatsoever.

This particular assumption also makes it easier to understand why the glottal stop very often functions as the 'default consonant'. For instance, we fill in this consonant in German if otherwise a situation of **hiatus** – two adjacent vowels – would ensue, or if a word starts with an open syllable:

(11) *Theater* 'theatre' [teʔátɐ], *Chaos* 'chaos' [káʔɔs], *atmen* 'to breathe' [ʔátmən]

The reason why a consonant has to be inserted here, probably is the same as why we have liaison in French (which we have seen last week):

(12) An x-slot has to precede the vowel in a syllable.

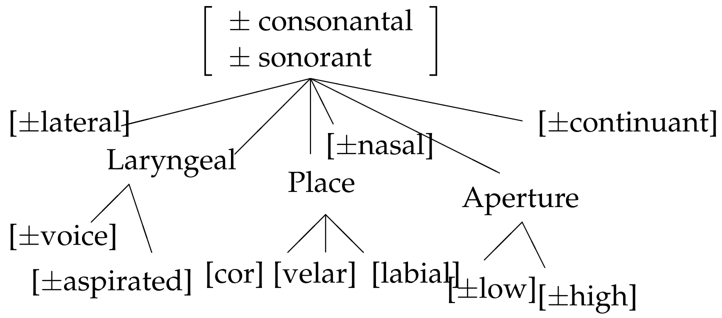
Different from the liaison context, there is no obvious neighbouring consonant to fill the empty slot in cases such as in (11). Therefore the slot is filled by the phonological rule component. We can understand why it is the glottal stop that is inserted in contexts like this, if we assume some principle of representational economy: if we have to insert something, we prefer to insert as little as possible to satisfy our needs. If we need to insert a consonant, it is better to insert one where we do not have to include a Place node (and Place features).

It is not the case, by the way, that glottal stop is the default consonant in all languages of the world. Some languages do not allow this type of segment at all — apparently, they disfavour Place-less consonants. In such cases, some other consonant such as /t/ fulfills that role.

2 The feature tree

The next question obviously is whether the Place features are the only ones which are organized into a seperate node. Most phonologists in the feature geometry paradigm would agree that this is not the case, and that there is more internal organisation to the segment. Although there is no general agreement on this point, the following structure may be considered as fairly representative for the mainstream:

(13)



Further structure is possible; for instance, Place and Aperture are often combined into a Supralaryngeal node, combining all the instructions for organs above the larynx. Also, the position of the features [±continuant], [±nasal] and [±lateral] has been the topic of debate.

It needs to be observed that the claim underlying virtually all work in Feature Geometry is that the structure in (13) — or whatever should be replacing it — is universal: if a language has a feature [continuant], it will be organized into the structure as indicated.

A prediction of this model is that all the organizing nodes should behave like the Place node. There should be processes — for instance of assimilation — which involve exactly the features that are dominated by some node and none of the others. We will briefly review some of this evidence for the Aperture node and the Laryngeal node.

As to the former, consider the following examples from Brazilian Portuguese (Wetzels, 1995; Clements & Hume, 1995):

(14)

2nd person			1st person		
/mɔr-a-s/	[mɔ́ras]	'you reside'	/mɔr-a-o/	[mɔ́ro]	'you reside'
/mɔv-e-s/	[mɔ́ves]	'you move'	/mɔv-e-o/	[móvo]	'you move'
/sɛrv-i-s/	[sɛ́rves]	'you serve'	/sɛrv-i-o/	[sírvo]	'you serve'

Like in many (Romance) languages, verbs in Portuguese have a so-called theme vowel, which behaves in some respects like a suffix, but which at the same time is determined by the stem: the verb 'to reside' has -/a/- as its theme vowel, 'to move' has -/e/-, and 'to serve' -/i/-. These theme vowel surfaces for instance in the second person singular, which has the consonant-initial suffix /s/, as is illustrated in the lefthand column. However, the first person singular suffix is -/o/, and this may be a reason why the theme vowel disappears — otherwise we would again create a hiatus.

But when the theme vowel disappears, something happens to the stem vowel: it changes from /ɔ/ to [o] in 'to move' and from /ɛ/ to [i] in 'to serve'. These are changes in vocalic aperture: /ɔ, ɛ, a/ are low vowels ([+low,-high]),

/e,o/ are mid vowels ([-low,-high]) and /i/ is a high vowel ([+high,-low]). What happens, then, is that the stem vowel takes over the aperture features of the disappearing theme vowel. In autosegmental terms, we can describe this as relinking of the Aperture node, rather than the individual relinking of the features [±high] and [±low].

The argument for the Aperture node thus comes from relinking; we will provide an argument in favour of the Laryngeal node from neutralisation. Korean has three series of stops, traditionally called voiceless, 'tensed' and aspirated (Rhee, 2002). There is no general agreement as to what exactly are the phonetic or phonological correlates of these three dimensions, but it is clear that they have to be described by Laryngeal features. It is also clear that they can contrast in a position before a vowel:

(15)

lenis	fortis	aspirated
[pal] 'foot'	[p'allɛ] 'laundry'	[p^{h}al] 'arm'
[tal] 'moon'	[t'al] 'daughter'	[t^{h}al] 'mask'
[kɨn] 'root'	[k'ɨn] 'string'	[k^{h}ɨn] 'big'

However, at the end of the syllable, we only find the lenis variants:

(16)

lenis	fortis	aspirated
[cip-to] 'hous EMPHATIC'	*[cip']	*[cip^{h}]
[mit-to] 'bottom side EMPHATIC'	*[mit']	*[mit^{h}]
[puək-to] 'kitchen EMPHATIC'	*[puək']	*[puək^{h}]

This looks very similar to a process which we know from languages such as Dutch, German, Turkish and Catalan and which is usually called *final devoicing* (the example is from Dutch, in case anybody did not realize):

(17) a. Beginning of syllable:

voiced	voiceless
[dɑk] 'roof'	[tɑk] 'branch'
[bɑk] 'bin'	[pɑk] 'suit'

b. End of syllable:

voiced	voiceless
*[hɔnd]	[hɔnt] 'dog'
*[ɛb]	[ɛp] 'ebb'

For Dutch — as well as the other languages just mentioned — it may be assumed that what is going on is that the feature [+voice] gets lost at the end of the syllable; the remaining structure is then interpreted as voiceless. Korean shows the same phenomenon, but with one difference: at least two different features have to be lost — the ones distinguishing tensed and aspirated consonants from lenis ones. Again, this can be profitably described if we assume that the relevant rule is something like the following:

(18) Delink the Laryngeal node from a consonant at the end of the syllable.

This rule can even be applicable to the final devoicing languages such as Dutch; in these languages there is only one Laryngeal feature, so it is hard to tell *a priori* whether it is just this feature which is delinked, or the node dominating it.

3 Root nodes and skeletal points

There is one more organizing node to be discussed: the *root node*, the node to which all other organizing nodes, as well as individual features, are eventually attached. This is the node in (13) which carries the features [$\pm$consonantal, $\pm$sonorant].

The fact that the root node carries these features has an important implication under autosegmental assumptions: we cannot spread either one of those features independently. Whereas it is possible to spread e.g. [nasal] without spreading any other part of the tree, spreading of e.g. [+consonantal] will always result in **total assimilation**, a famous instance of which is found in the Lesbian and Thessalian dialects of Ancient Greek, where /s/ assimilated completely to an adjacent sonorant segment (Clements & Hume, 1995):

(19)	*$\mathrm{g^w ols\bar{a}}$	>	bollā	'council'
	*$\mathrm{aws\bar{o}s}$	>	awwōs	'dawn'
	*esmi	>	emmi	'I am'
	*naswos	>	nawwos	'temple'

(Notice by the way that again we are not dealing with a synchronic phonological rule in this case, but with a phonological change; which is not necessarily the same thing.)

What is impossible, according to this model, is a change where a sonorant would change to a stop with exactly the same place features due to assimilation:

(20) amta > apta (impossible change; and impossible phonological rule).

Another implication of these assumptions, and of the analysis underlying (19), is that the root node organizes all the features, but is still distinct from an x-slot; for we see the process happening in (19) as spreading of the root node with all its features from one x-slot to the next.

This assumption seems necessary also for most of the analyses we presented last week, where it was equally the case that all the features spread together from one skeletal point to the next.

At the same time it may be seen as a little unfortunate that we now have two tiers which organize all the segments. Furthermore, there is an empirical problem with this particular implementation of segmental structure in autosegmental phonology. We know that complex segments can be for instance **affricates** (sharing place features but differing on continuancy: [t͡s, p͡f]), prenasalised segments (sharing place features but differing in nasality: [^{n}d, ^{m}b]), or doubly articulated stops (sharing all features except for place). There has never been found any evidence for complex segments where the two parts differ on many different dimensions (e.g. *[t͡ŋ], *[p͡a]). This is unexpected, given the autosegmental model.

As a methodological aside, note that an assumption underlying this criticism is that every structure which can be generated by the formal model, also needs to be attested in some of the world's languages. In principle, it is of course possible that structures such as *[p͡a] do indeed exist, but only in languages which have not yet been considered in sufficient detail: we simply do not know about them yet. However, it is good practice in phonological theorizing to assume that structures do not exist until somebody points out that we do need them in the analysis of some language. If we would not take this as our guideline, it would be almost impossible to compare theories: a model which would say that 'anything goes in natural language' would beat everybody else; but it would not be very interesting. In other words, we try to make our model as **restrictive** as possible. The model developed so far is not restrictive enough from this point of view; it **overgenerates**.

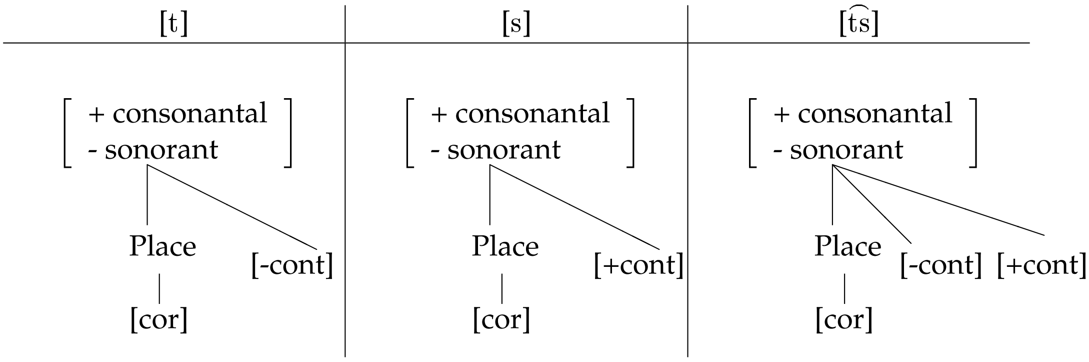
This problem still awaits a full formal solution at present. Somehow we have to assume (without an explanation) that one timing slot cannot host more than one root node. Therefore, we have to find a different representation for complex segments.

From what we have seen so far, we can already conclude the following:

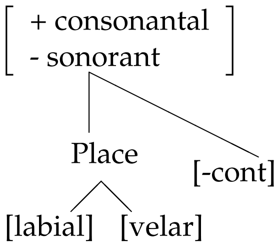
(21) Complex segments bear more than one feature (value) of a specific type.

For instance, [t͡s] is exactly like [t] and [s], except for one point: whereas [t] is [+continuant] and [s] is [-continuant], [t͡s] is *both* [+continuant] and [-continuant]. Heavily simplifying our feature trees, we can draw the three segments as follows:

(22)



In the structure for the affricate, two feature values (on the same tier) are now linked to the same segment (in this particular case, to the same root node). This parallels two tones being linked to one segment. A similar picture can be drawn for prenasalised segments.[1] Multiply articulated segments might be a little bit different; the following represents [k͡p] (again, abstracting away from certain complexities):



(23)

This representation is different because the two Place features are probably not on the same tier; they are linked to the same node, but they still represent different dimensions. Because they are not on the same tier, they are also not temporally ordered with respect to each other; which gives the (correct) prediction that they are realised at the same time.

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[1] It should be noted that in the most recent literature, alternative analyses have become available for both affricates and prenasalised segments which do not use this particular type of representation;cf. van Oostendorp & van de Weijer (2005).

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Exercise 4