What is assimilation?

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About this course

This course examines a very common cross-linguistic phenomenon—assimilation. Two main questions are addressed. How can assimilation patterns differ from one another? Is it possible to come up with a unified analysis *all* assimilation patterns? We will examine many different types of assimilation, focusing on vowel, nasal, consonant harmony and consonant–vowel interactions. This empirical survey motivates the analysis, which should be able to capture the attested patterns and exclude the unattested ones. The analysis is based on two well-established phonological theories: Autosegmental Phonology and Optimality Theory.

Course Overview

Monday	What is assimilation?
Tuesday	Icy targets
Wednesday	Transparency and blocking
Thursday	Parasitic assimilation
Friday	Positional effects

Today's Outline

(1) a. What is assimilation?
b. What parameters are involved in assimilation?
c. How to capture these?

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1 What is assimilation?

(2) Assimilation is an alternation involving at least two segments. One of these segments (the target) alternates in the presence of the other segment (the trigger),

but not otherwise. The target acquires a phonological property of the trigger. This phonological property can be characterized in terms of phonological features. In the simplest of cases, a single phonological feature of a trigger affects a target.

(3) Example: Voicing assimilation in Russian (Padgett 2002:2)

a.	ot-jehat^j	‘to ride off’
	ot-stupit^j	‘to step back’
	od̲-brosit^j	‘to throw aside’
b.	pod-nesti	‘to bring (to)’
	pot̲-pisat^j	‘to sign’
	pod-ʒetʃ	‘to set fire to’

(4) Some observations:

a. Assimilatory property: obstruent voicing
b. Segments involved: obstruents
c. Directionality: rightwards

(5) Three variables in assimilation:

a. Spreading feature
b. Targeted structure
c. Domain

2 Spreading feature

(6) The phonological property in assimilation can be construed in terms of one (or more) spreading feature(s).

(7) If we look at assimilation patterns, we see that many features can spread.

(8) Example 1: Nasal harmony in Applecross Gaelic (Ternes 1973:134,135)

ˈã̲h̃ũç̃	‘neck’
ˈs̃ɔ̲̃h̃ĩ	‘tame’
f̃r̃ɪ̲̃ã̲ˑṽ	‘root.PL.’
kʰɔˈṽɪ̲̃ã̲ˑt	‘how much/many?’
tã̲ṽ̥	‘ox, stag.PL’
str̃ã̲ɪ̲̃ˑɣ̥̃	‘to be luxurious’
ˈkʰɔ̲̃ɪ̲̃s̃paxk	‘wasp’
ˈtʰã̲h̃ũs̃k	‘fool’

(9) Nasalization is the property of a stressed vowel which targets continuants rightwards until the process is terminated by a stop. Similarly, nasalization also targets the onset of the stressed syllable, but not if it is a stop.

(10) This pattern is similar to voicing assimilation in Russian in two respects. First, the alternation is triggered by some phonological property—a feature of the trigger. Recall that in Russian (3), this property is the value of voicing of an onset obstruent. In Applecross, on the other hand, it is the nasality of a stressed vowel. Second, the spreading feature affects adjacent segments. In Russian, voicing affects all obstruents in the (immediately preceding) coda, but not obstruents in the onset of the preceding syllable (cf. [p̲od̲-ʒetʃ] vs. [p̲ot̲-pisat^j]). In Applecross, nasality affects all following continuants, but no segment across a stop. In other

words, both processes involve a contiguous string of segments.

(11) Example 2: Emphasis spread in Southern Palestinian Arabic (Davis 1995:473−474)[1]

BALLAAṢ	'thief'
ħAð̣ð̣	'luck'
ʔABSAṬ	'simpler'
BAAṢ	'bus'
MAJAṢṢAṢiʃ	'it didn't become solid'
Ṭiin-ak	'your mind'
ʕAṬʃaan	'thirsty'

(12) Emphasis spread in Southern Palestinian Arabic (Davis 1995; Zawaydeh 1999; Watson 1999, 2002; henceforth, SPalestinian) also affects a contiguous string of segments. In this process, some consonants cause all preceding segments to become pharyngealized.

(13) Example 3: Front/back harmony in Finnish (Ringen 1975/1988:77; Ringen & Heinämäki 1999:305)

næh-køːn	'see-DIRECT.SG'	tul-koːn	'come-DIRECT.SG'
næk-ø	'sight'	tul-o	'coming'
pøytæ-næ	'table-ESSIVE'	poutɑ-nɑ	'fine weather-ESSIVE'

(14) Not all cases of assimilation involve a contiguous string of segments. Vowel harmony is an alternation which affects only vowels, while consonants are typically ignored. Finnish (Ringen 1975/1988; Kiparsky 1981; Ringen & Heinämäki 1999) suffix vowels alternate depending on the root vowels: suffix vowels are front after front root vowels, and back after back root vowels. The feature for vocalic place originates from the root and targets the suffix; it affects only vowels.

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(15) In sum, different features assimilate.

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3 Targeted structure

(16) So far I have looked at assimilation from the perspective of the trigger. Now let us turn to targets by showing some of the variation with respect to what segments can act as targets.

(17) The same spreading feature may target different classes of segments, which can be characterized in terms of another feature. This suggests that assimilation involves at least two variables: a spreading feature and a targeted structure.

(18) Example 1: Nasal harmony in Yaka (Hyman 1995:6,9)

a.	tsub-idi	'roam'	tsum-in̲i	'sew'
	kud-idi	'chase'	kun-in̲i	'plant'
	kik-idi	'obstruct'	wun-in̲i	'murmur'
b.	mak-ini	'climb'	finuk-ini	'sulk'
	nik-ini	'grind'	miituk-ini	'sulk'

[1] Pharyngealized segments are capitalized.

(19) In (18-a), the perfective suffix in Yaka is usually realized as [-idi]. However, when there is a nasal sonorant in the root, the suffix surfaces with a nasal sonorant as [-ini]. This also happens when the triggering nasal is not at the right edge of the root, which is shown in (18-b). As observed by Hyman (1995), nasality targets only voiced consonants, ignoring all other segments.

(20) This pattern contrasts with the one found in Applecross, where intermediate vowels are affected. The two languages are identical in terms of the spreading feature, but they differ in what segments are targeted.

(21) Example 2: Tongue root harmony in Twi (Berry 1957:127−128,130)

biri	‘black’	o-biri	‘3P-black’
bɪrɪ	‘red’	ɔ-bɪrɪ	‘3P-red’
firi	‘lend, borrow’	mi-be-firi-i	‘1P-FUT-borrow-it’
fɪrɪ	‘fail, miss’	mɪ-bɛ-fɪrɪ-ɪ	‘1P-FUT-miss-it’

(22) In Twi (23), the affix vowels depend on the root vowels (Berry 1957; Painter 1973). Tense root vowels may occur with tense affix vowels, while lax root vowels occur with lax affix vowels; consonants are unaffected.

(23) Recall that in SPalestinian emphasis spread (11), pharyngealized consonants affect the preceding segments. Most analyses (Davis 1995; McCarthy 1997) assume that the spreading feature in this case is the one responsible for tongue root retraction. In SPalestinian, this spreading feature affects all preceding segments (consonants and vowels).

(24) If we compare Twi tongue root harmony and emphasis spread in SPalestinian, we see that both involve the same spreading feature. The two languages crucially differ in terms of what segments are targeted.

(25) Example 3: Palatalization

a. Czech (Rubach 2007:107)

plot	‘fence-NOM.SG’	plotʲ-ɛ	‘-LOC.SG’
vod-a	‘water-NOM.SG’	vodʲ-ɛ	‘-LOC.SG’

b. Irish (Ní Chiosáin 1994:97)

ahnʲiːn	‘recognizes’	ahnʲiːŋʲ-kʲiːroːg	‘a beetle recog.’
gan	‘without’	giŋʲ-xʲiːl	‘without sense’

c. Karaim (Kowalski 1929; Nevins & Vaux 2004:178–179)

suv-dɑn	‘water-ABL’	kʰʲunʲ-dʲɑnʲ	‘day-ABL’
boł-uʃ-uv-tʃu	‘helper’	tʰʲuzʲ-vʲ-tʃʲu-dʲɑnʲ	‘from the author’

(26) Recall that in Finnish (13), the root vowel determines whether the suffix vowel will be front or back. The feature responsible for frontness/backness of root vowels affects suffix vowels.

(27) Many other languages show alternations in which a front vowel affects a consonant (25).

a. In Czech, a front vowel triggers an alternation that affects the secondary articulation of the immediately preceding coronal. When followed by a front vowel, coronals become palatalized.
b. In Irish, a palatalized dorsal consonant affects the preceding nasal.
c. Karaim exhibits palatalization of consonants, leaving intermediate (back) vowels unaffected.

(28) We can conclude that the same phonological feature is responsible for vocalic frontness and secondary palatalization. Nevertheless, individual languages can vary in terms of what segments are targeted.

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(29) The three examples strongly suggest that the targeted structure in any assimilation process is not predictable from the spreading feature. Thus, an analysis of an assimilation process must include at least two variables.
These two variables are independent, as the relationship between them is not entirely predictable.

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4 Domain

(30) Prosodic and morphological domains are known to affect many phonological patterns (McCarthy & Prince 1993b). So, it is unsurprising that domains also influence assimilation.

(31) So far, we have already seen how assimilation processes may differ with respect to directionality.

(32) Nasal harmony in Sundanese (Robins 1957:91,95)

mãro	'to halve'
ɲĩãr	'to seek'
ŋũliat	'to stretch (INTR.)'
kumãh̃ã	'how'
ŋãjak	'to sift'
mãwur	'to spread'
mõlohok	'to stare'

(33) In Sundanese, any vowel following a nasal sonorant is nasalized (Robins 1957; Langendoen 1968; van der Hulst & Smith 1982; Cohn 1990, 1993; Piggott 1992; Piggott & van der Hulst 1997; Benua 1997; Walker & Pullum 1999; Walker 1998/2000). Consonants cannot become nasal. Nasalization is triggered by a nasal sonorant {m, n, ɲ, ŋ} and applies rightwards until it encounters a consonant.

(34) Nasal harmony in Capanahua (Loos 1969:177,178)

põj̃ãn	'arm'
bõõn	'hair'
bĩmi	'fruit'
wɯrãnwɯ	'push it'
bãw̃ĩn	'catfish'

(35) In contrast, Capanahua displays leftward nasalization (Loos 1969; Halle & Vergnaud 1981; van der Hulst & Smith 1982; Safir 1982; Piggott 1987; Piggott & van der Hulst 1997; Piggott 2003; Walker 1998/2000). This assimilation process is triggered by a nasal sonorant stop and applies leftwards, targeting vowels and glides.

(36) By comparing Sundanese and Capanahua we see that assimilation may differ with

respect to directionality. Some assimilation processes apply rightwards (Sundanese), while others apply leftwards (Capanahua).

(37) One way to look at this cross-linguistic variation is to say that directionality is a separate parameter. This conclusion, however, is slightly misleading, as becomes evident if we compare the following three types of grammars.

(38) Three alternative grammars

a. Grammar $\mathcal{A}$ contains both directionality and domains as assimilation variables.
b. Grammar $\mathcal{B}$ contains only domains (but no directionality)
c. Grammar $\mathcal{C}$ contains only directionality (but no domains).

(39) In light of the reviewed data, grammar $\mathcal{C}$ is not feasible. This is because many assimilation patterns terminate at the boundary of some morphological or prosodic domain. For example, Finnish vowel harmony (13) is restricted to prosodic words.

(40) This leaves us with grammars $\mathcal{A}$ and $\mathcal{B}$.

(41) In an overwhelming majority of cases the two grammars do not make different predictions. If so, parsimony prefers grammar $\mathcal{B}$ (that contains only domains) over grammar $\mathcal{A}$ (that contains directionality in addition to domains).

(42) Furthermore, if directionality were an *independent* variable in assimilation, we would predict at least one case of assimilation through any domain boundary (total assimilation). For example, a nasal sonorant would trigger nasalization of all subsequent segments (i.e., even across intonational phrase and sentence boundaries). We know of no language with total assimilation.

(43) Grammar $\mathcal{A}$ can generate total assimilation since it can specify directionality without reference to a domain. Grammar $\mathcal{B}$, on the other hand, can only specify directionality via a domain edge, and total assimilation is not restricted within any domain. Hence, grammar $\mathcal{A}$ has to be rejected over grammar $\mathcal{B}$.

(44) Directionality appears to be only epiphenomenal; assimilation is sensitive only to specific prosodic/morphological boundaries (Nespor & Vogel 1986; Zec 1988/1994; Peperkamp 1997).

(45) This conclusion about domains has at least one potential challenge. Many cases of assimilation are bidirectional. Nasalization in Applecross (8) is of this type.

(46) Is bidirectional assimilation a combination of rightward and leftward assimilation?

(47) Evidence for this comes from languages with *directionality asymmetries*.

(48) An example comes from Somali vowel harmony (Andrzejewski 1955; Saeed 1993, 1999; Krämer 2003).

(49) Example: Somali vowel harmony (Andrzejewski 1955:569,570; Saeed 1993, 1999; Krämer 2003)

a. Leftward assimilation within an Intonational Phrase

wɑ̲ː	sɑ̲ːn	fɑrɑs	wæ̲ː	sæ̲ːn	dibi
DM	hide	horse.GEN	DM	hide	bull.GEN
‘It is a horse’s hide.’			‘It is a bull’s hide.’		

b. Leftward, not rightward, assimilation

hilib	kɑː	kɑrɪ		hilib	kæː	iːbsɵ
meat	DEM	cook		meat	DEM	buy
'Cook that meat.'				'Buy that meat.'		

c. Rightward assimilation to the following clitic

mɑ	ʃɑbɛːl	bɑː		mæ	libæːħ	bæː
QM	leopard	FOC		QM	lion	FOC
'Is it a LEOPARD?'				'Is it a LION?'		

(50) What do the Somali data suggest?

(51) Directionality asymmetries
Somali exhibits disparities in leftward and rightward spreading. The Somali data strongly suggest that bidirectional assimilation consists of two separate unidirectional assimilations, each with its own domain of application.

(52) Domains
Somali exhibits vowel harmony that affects a domain much larger than the word. Andrzejewski (1955) reports up to ten-word sequences with exclusively lax or tense vowels. This pattern appears to be quite close to total assimilation discussed above. Somali appears to have directionality as independent variable that can apply across any domain boundary.
However, such a conclusion turns out not to be true. In particular, Somali vowel harmony never traverses pauses. Pauses are not random, but indicative of a prosodic domain, which makes Somali directly parallel to similar characteristics found in other languages. Nespor & Vogel (1986), Lahiri & Evers (1991) offer additional evidence that these restricted positions of pauses relate to a prosodic domain, such as the Intonational Phrase (IP). IPs are known to have effects on assimilation and other alternations (Selkirk 1980; Lahiri & Evers 1991).

(53) Several other languages exhibit leftward/rightward disparities in assimilation:

a. Emphasis spread (pharyngealization) in Southern Palestinian Arabic is unbounded within a phonological word but only leftwards. In the opposite direction, emphasis is blocked by {i, j, ʃ, dʒ} (Davis 1995, see also Zawaydeh 1999, Watson 1999, 2002).

b. In Epena Pedee, [nasal] spreads unboundedly rightwards, but only within the same syllable leftwards (Harms 1985, 1994, Walker 1998/2000).

c. In Vata, [ATR] spreads from roots to suffixes. In the opposite direction, [ATR] spreads optionally across word boundaries, but only to the first vowel (Kaye 1982).

d. Ikwere nasal harmony shows a difference in the behavior of nasal sonorant stops, which are regular targets in rightward, but not in leftward assimilation (Clements & Osu 2003, 2005).

(54) Sometimes, assimilation applies across domains. In Catalan less formal speech, the place of articulation of a non-continuant affects the preceding nasal both morpheme internally, across morphemes and across word boundaries (Wheeler 1979, 2005).

(55) Nasal place assimilation across word boundaries in Catalan (Wheeler 2005: 184)

só[m m]olts	'they are many'
só[m p]ocs	'they are few'
só[ŋ g]rossos	'they are large'

(56) The domain of assimilation is not immediately apparent. However, if our reasoning is correct, the relevant domain is larger than a prosodic word, for example a phonological (or intonational) phrase. The reason why segments preceding the word-final coronal nasal are not affected is because vowels terminate assimilation. Thus the closest the place of articulation can get to the left edge of a phonological phrase is one segment to the left (codas containing two nasal sonorants are illicit in Catalan).

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(57) To summarize, domains are the third parameter in assimilation.

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5 Assimilation as feature spreading

5.1 Feature spreading

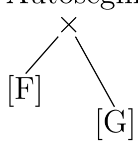
(58) One standard analysis of assimilation is autosegmental spreading.

(59) In Autosegmental Phonology (Goldsmith 1976, 1990; Clements 1976/1980, 1985a; Kiparsky 1981), features are represented as autosegments that may be associated with nodes.

(60) The representations are nonlinear. The highest mother-node is a root node, which establishes linearity across segments. In (61), we see two features, [F] and [G], associated with a single root node (×).

(61) An association line represents a relationship between a feature and a root node; a segment consists of a root node and the features associated with that root node.

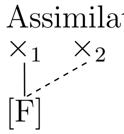
(62) Autosegmental representations



(63) Segmental alternations may also be represented in terms of autosegments. In Autosegmental Phonology, assimilation is associating (or linking) a spreading feature with a target root node.

(64) This process is also termed *feature spreading*: a feature *spreads* from a trigger to a target.

(65) Assimilation as feature spreading



5.2 Assumptions about representations

(66) Subsequent work on autosegmental representations has claimed that features are organized in a particular fashion (Goldsmith 1976; Halle & Vergnaud 1980; Archangeli 1985; Clements 1985a,b, 1991; Clements & Hume 1995; Kaye et al. 1985; Steriade 1987, 1995; McCarthy 1988; Padgett 1991/1995; Odden 1991, 1994; Halle 1995; Sagey 1990; Harris & Lindsey 1995; Halle et al. 2000; Morén 1999/2001, 2003, 2006, 2007; Blaho 2008, among many others).

(67) In this model, some features are directly associated with the root node, while others are not.

(68) Here, I assume a less restrictive model, in which features are not organized in any particular fashion; what matters is whether a feature is associated with a particular root node or not.

(69) Hence, the restrictions on feature spreading will never depend on organization of features within a segment.

(70) I will use phonological features that are (i) phonetically motivated, (ii) universal and (iii) privative.

6 Alignment constraints

(71) Autosegmental representations are referred to by OT constraints.

(72) Feature spreading is enforced by markedness constraints. The markedness constraint has to be able to capture the three parameters of assimilation (spreading feature, targeted structure, and domain).

(73) One established approach to assimilation is to extend Generalized Alignment (McCarthy & Prince 1993a) to segmental features (Kirchner 1993; Smolensky 1993; Cole & Kisseberth 1995; Itô & Mester 1995; Akinlabi 1996; Pulleyblank 1996; Golston 1996; McCarthy 1997; Ringen & Vago 1998; Archangeli & Pulleyblank 2002, among many others).

(74) The logic behind such analyses is simple: an alignment constraint prefers an output in which a feature is aligned with an edge of a phonological domain such as a syllable, prosodic word, or phonological phrase.

(75) As an example, let us consider the constraint ALIGN([nasal], R; PWd, R) in (76). This constraint penalizes outputs containing oral segments after a nasal segment within a Prosodic Word.

(76) ALIGN([nasal], R; Prosodic Word, R)
For every [nasal] autosegment there must be a Prosodic Word, such that the rightmost segment associated with [nasal] is also the rightmost segment of a Prosodic Word.

(77) The constraint in (76) contains four variables: a single feature, a domain, and two specified edges. However, the data reviewed suggest that feature spreading actually involves two features.

(78) This empirical fact is not consistent with the one feature plus one domain constraint template above.

(79) One solution would be to propose other constraints. For example, feature co-occurrence constraints could exempt a class of segments from being targeted. The problem with this solution is that it can exempt any segment, which predicts many unattested patterns.

(80) An alternative would be to propose a revision of alignment constraints, and this is the option I take. The revised version should include at least three variables: one spreading feature, one targeted structure, and one domain. It turns out that such a template has been proposed for prosody by Hyde (2008).

(81) Hyde (2008) proposes markedness constraints that have most characteristics of classical alignment constraints. In particular, the constraints prefer outputs in which two categories (features, domains) are aligned with one another.

(82) Hyde's constraints assign violation marks to sets of violating pairs or triplets of categories.

(83) This means that for a given input the number of violation marks will be dependent on both the aligned categories and the offending categories.

(84) One type of Hyde's alignment schema is presented in (85). This constraint assigns a violation mark for every triplet ⟨*Cat1, Cat2, Cat3*⟩, if and only if *Cat2* precedes *Cat3* within *Cat1*.

(85) Right edge distance sensitive alignment schema (Hyde 2008)

a. *⟨*Cat1, Cat2, Cat3*⟩ / *Cat1*

Cat2 *Cat3*

b. Assign a violation mark for every triplet ⟨*Cat1, Cat2, Cat3*⟩, iff

Cat1 is associated with *Cat2* and *Cat3*

and

Cat2 precedes *Cat3*.

(86) The constraint in (85) consists of two parts. The first one is the violating triplet ⟨*Cat1, Cat2, Cat3*⟩, while the second one is the arrangement of these categories.

(87) The relationship between *Cat1* and the two other categories is that of association.

(88) The relationship between *Cat2* and *Cat3* can thus be characterized in terms of precedence, which is a widely accepted temporal relation in phonology.

(89) As we have seen, assimilation patterns can be characterized in terms of three parameters: a spreading feature, a targeted structure, and a domain.

(90) These three categories are entirely consistent with Hyde's alignment schema, which also contains three variables: the first variable is associated with the other two, which are in turn in a precedence relation.

(91) In (92) we see an implementation of Hyde's template that captures feature spreading. The feature alignment constraint assigns a violation mark for every triplet ⟨*Domain*, [F], [G]⟩ if and only if (i) the *Domain* is associated with [F] and [G], and (ii) [F] precedes [G].

(92) Feature alignment

*⟨Domain, [F], [G]⟩ / Domain

[F] [G]

(93) However, there is an important difference between a precedence relation between

two root nodes and a precedence relation between two different features.

(94) In Autosegmental Phonology, precedence is established between like categories (Goldsmith 1976). For any two root nodes, there is a unique precedence relation: one always precedes the other. Similarly, for any two instances of the same feature, one always precedes the other.

(95) For now, we will assume that a root node that is association excludes precedence.

(96) Featural precedence
[G] f-precedes [H], iff
(i) $\exists \times_i$ associated with [G] but not with [H],
and
(ii) $\exists \times_j$ associated with [H] but not with [G],
and
(iii) $\times_i$ precedes $\times_j$.

(97) F-precedence is a crucial ingredient of feature alignment constraints. In (98), I repeat the featural alignment template and complement it with a definition.

(98) Featural alignment
a. *⟨Domain, [G], [H]⟩ / Domain
[G] [H]
b. Assign a violation mark for every triplet ⟨*Domain*, [G], [H]⟩, iff
the *Domain* is associated with [G] and [H]
and
[G] f-precedes [H].

(99) I will show that alignment constraints similar to the one in (99) can model feature spreading better than other approaches to feature spreading. This is despite the fact that they require an additional concept of f-precedence.

(100) Another good argument in favor of alignment constraints based on Hyde (2008) is purely formal. The constraint template in (100) is categorical rather than gradient.

(101) Gradient constraints have been shown to generate many unattested patterns (McCarthy 2003; Hyde 2008). One such example is the Midpoint Pathology, which involves a pattern in which stress will fall on the syllable furthest apart from both edges of a prosodic word.

7 Applecross Gaelic nasal harmony

(102) Recall the data in (103).

(103) Nasal harmony in Applecross Gaelic (Ternes 1973:134,135)

ˈãh̃ũç̃	‘neck’
ˈs̃ɔ̃h̃ĩ	‘tame’
f̃r̃ĩãˑṽ	‘root.PL.’
kʰɔˈṽĩãˑt	‘how much/many?’
tãṽ̥	‘ox, stag.PL’
str̃ãĩˑɣ̥̃	‘to be luxurious’
ˈkʰɔ̃ĩs̃paxk	‘wasp’
ˈtʰãh̃ũs̃k	‘fool’

(104) The spreading feature in Applecross is [nasal] and the domain is the prosodic word. The targeted structure is thus simply a root node.

(105) Hyde’s constraint schema allows for these three categories to be joined within a single constraint, defined in (106). Notice that f-precedence is applicable to a relationship between a root node and a feature, when they are not associated with one another. For expositional purposes, I use an abbreviated notation *PWd[nasal, ×] (“A root node must not f-precede [nasal] within a PWd”). I will use similar abbreviations throughout this thesis.

(106) *PWd[nasal, ×]

a. *⟨PWd, [nasal], ×⟩ /

$$\begin{array}{ccc} & \text{PWd} & \\ \swarrow & & \searrow \\ \text{[nasal]} & & \times \end{array}$$

b. Assign a violation mark for every triplet ⟨PWd, [nasal], ×⟩, iff
PWd is associated with [nasal] and ×
and
[nasal] f-precedes ×.

(107) In Applecross, the alignment constraint *PWd[nasal, ×] outranks the relevant faithfulness constraint.

(108) From the viewpoint of Autosegmental Phonology what is being added when a feature spreads is not a feature, but rather an association.

(109) Faithfulness constraints to associations are widely used in OT literature that makes use of autosegmental representations—see Morén (1999/2001) for a full discussion of faithfulness constraints for associations, and Blaho (2008) for an extension to segmental features.

(110) In this particular example, the faithfulness constraint being violated by candidates with spreading is a constraint against linking the feature [nasal] with a root node. The constraint DepLink[nasal] in (111) is violated once by every association line to [nasal], which is present in the output, but not in the input.

(111) DepLink[nasal] (cf. Itô et al. 1995; Myers 1997; Lombardi 1998; Morén 1999/2001; Archangeli & Pulleyblank 2002; Blaho 2008)
Let $\times_i$ be an input root node and $\times_o$ its output correspondent. Assign a violation mark, iff $\times_o$ is associated with the feature [nasal] and $\times_i$ is not.

(112) The effect of the two constraints can be seen in tableau (113).

(113) ˈãh̃ũç̃ ‘neck’

[nas] / ã h u ç /	*ω[nasal,×]	DepLink[nasal]
a. [nas] ã h u ç	⟨ω,[nas],h⟩! ⟨ω,[nas],u⟩, ⟨ω,[nas],ç⟩	
b. [nas] ã h̃ u ç	⟨ω,[nas],u⟩! ⟨ω,[nas],ç⟩	*
c. [nas] ã h̃ ũ ç	⟨ω,[nas],ç⟩!	**
d. ☞ [nas] ã h̃ ũ ç̃		***

8 Finnish vowel harmony

(114) One prediction of the current approach is that assimilation patterns may differ in terms of the spreading feature, the targeted structure, and the domain.

(115) It is not hard to imagine many other constraints that are similar, but not identical to *PWd[nasal, ×]. One option is to modify the spreading feature. For example, emphasis spread in SPalestinian (11) can be analyzed as regressive spreading of [RTR] that targets all segments (Davis 1995). If so, the relevant alignment constraint in SPalestinian contains [RTR] rather than [nasal].

(116) Another variable that can be changed is the targeted structure. I will now show a constraint that differs from *PWd[nasal, ×] in two variables: the spreading feature and the targeted structure. This is needed in the analysis of vowel harmony in Finnish (13), where only vowels act as targets, while consonants remain unaffected.

(117) Remember that Finnish—(13), repeated in (118) below—exhibits front/back vowel harmony. Front root vowels come with front suffix vowels, while back root vowels come with back suffix vowels; consonants are unaffected.

(118) Front/back harmony in Finnish (Ringen 1975/1988:77; Ringen & Heinämäki 1999:305)

næh-køːn	‘see-DIRECT.SG’	tul-koːn	‘come-DIRECT.SG’
næk-ø	‘sight’	tul-o	‘coming’
pøytæ-næ	‘table-ESSIVE’	poutɑ-nɑ	‘fine weather-ESSIVE’

(119) Here, I will analyze Finnish vowel harmony as spreading of the feature [back].

(120) Disclaimer: I will also slightly abstract away from the data and simply assume that all vowels participate in vowel harmony (which is not the case). This will be revised on Wednesday.

(121) Comparison between Finnish and Applecross

	Finnish	Applecross
Spreading feature	[back]	[nasal]
Targeted structure	vowel	root node
Domain	word	word
Directionality	root-to-suffix	bidirectional

(122) The alignment constraint schema predicts these typological distinctions perfectly. In Finnish, the relevant constraint *PWd[back, vowel] in (123) contains a vowel instead of a root node. Consonants never appear in the constraint-violating triplets of this constraint.

(123) *PWd[back, vowel]

a. *⟨PWd, [back], vowel⟩ / PWd
[back] vowel

b. Assign a violation mark for every triplet ⟨PWd, [back], *vowel*⟩, iff
PWd is associated with [back] and *vowel*
and
[back] f-precedes *vowel*.

(124) Disclaimer: We will talk more about transparency on Wednesday.

(125) Tableau (125) shows the effect of *PWd[back, vowel].

(126) tulo 'coming'

[bk] / t u l - ø /	*ω[back,vowel]	DepLink[back]
a. [bk] t u l ø	⟨ω,[back],ø⟩!	
b. ☞ [bk] t u l o		*
c. [bk] t u $l^{ɣ}$ o		**!

(127) We have now seen the effect of two similar, yet crucially different alignment constraints—*PWd[nasal, ×] and *PWd[back, vowel]. They differ from one another in two variables: the spreading feature (which may be [nasal] or [back]) and the targeted structure (which may be × or a vowel).

(128) The alignment constraint schema can be similarly modified further to include other domains, other spreading features and targeted structures. This is consistent with the cross-linguistic variation in assimilation, which was demonstrated in the empirical part of this chapter.

9 Conclusions

(129) Assimilation patterns may differ in three basic variables: the spreading feature, the targeted structure, and the domain.

(130) I propose an analysis of feature spreading within Optimality Theory.

(131) This is based on a significant extension of a familiar approach that combines alignment with faithfulness constraints specific to features.

(132) I demonstrate that all three basic parameters can be modeled using a single class of markedness constraints.

References

Akinlabi, Akinbiyi (1996). Featural affixation. *Journal of Linguistics* **32**. 239–289.

Andrzejewski, B. W. (1955). The problem of vowel representation in the Isaaq dialect of Somali. *Bulletin of the School of Oriental and African Studies, University of London* **17**. 567–580.

Archangeli, Diana (1985). Evidence for coplanar representation in nonlinear phonology. *Linguistic Inquiry* **16**. 335–372.

Archangeli, Diana & Douglas Pulleyblank (2002). Kinande vowel harmony: domains, grounded conditions and one-sided alignment. *Phonology* **19**. 139–188.

Benua, Laura (1997). *Transderivational Identity: Phonological Relations between Words*. Ph.D. dissertation, University of Massachusetts Amherst, Amherst.

Berry, J. (1957). Vowel harmony in Twi. *Bulletin of the School of Oriental and African Studies, University of London* **19**. 124–130.

Blaho, Sylvia (2008). *The syntax of phonology: A radically substance-free approach*. Ph.D. dissertation, University of Tromsø, Tromsø.

Clements, George N. (1976/1980). *Vowel Harmony in Nonlinear Generative Phonology*. Bloomington: Indiana University Linguistics Club.

Clements, George N. (1985a). Akan vowel harmony: a nonlinear analysis. In D. L. Goyvaerts (ed.) *African Linguistics: Essays in Honor of W. M. K. Semikenke*, Amsterdam: John Benjamins. 55–98.

Clements, George N. (1985b). The geometry of phonological features. *Phonology* **2**. 225–252.

Clements, George N. (1991). Place of articulation in consonants and vowels: a unified theory. In *Working Papers of the Cornell Phonetics Laboratory*, Ithaca: Cornell University, vol. 5. 77–123.

Clements, George N. & Elizabeth V. Hume (1995). The internal organization of speech sounds. In John A. Goldsmith (ed.) *The Handbook of Phonological Theory*, Blackwell. 245–306.

Clements, George N. & Sylvester Osu (2003). Ikwere nasal harmony in typological perspective. In Patrick Sauzet & Anne Zribi-Hertz (eds.) *Typologie des langues d'Afrique et universaux de la grammaire, Vol. II*, Paris: L'Harmattan. 70–95.

Clements, George N. & Sylvester Osu (2005). Nasal harmony in Ikwere, a language with no phonemic nasal consonants. *Journal of African Languages and Linguistics* **26**. 165–200.

Cohn, Abigail C. (1990). *Phonetic and Phonological Rules of Nasalization*. Ph.D. dissertation, University of California, Los Angeles, Los Angeles.

Cohn, Abigail C. (1993). The status of nasalized continuants. In Marie K. Huffman & Rena A. Krakow (eds.) *Phonetics and Phonology 2: Nasals, Nasalization, and the Velum*, San Diego, CA: Academic Press. 329–367.

Cole, Jennifer & Charles Kisseberth (1995). An Optimal Domains Theory of vowel harmony. *Studies in Linguistic Sciences* **24**. 101–114. Available on Rutgers Optimality Archive, ROA 22, http://roa.rutgers.edu.

Davis, Stuart (1995). Emphasis spreading in Arabic and Grounded Phonology. *Linguistic Inquiry* **26**. 465–498.

Goldsmith, John A. (1976). *Autosegmental Phonology*. Ph.D. dissertation, Massachusetts Institute of Technology, Cambridge.

Goldsmith, John A. (1990). *Autosegmental and Metrical Phonology*. Oxford: Blackwell.

Golston, Chris (1996). Direct Optimality Theory: Representation as pure markedness. *Language* **72**. 713–748.

Halle, Morris (1995). Feature geometry and feature spreading. *Linguistic Inquiry* **16**. 1–46.

Halle, Morris, Bert Vaux & Andrew Wolfe (2000). On feature spreading and the representation of place of articulation. *Linguistic Inquiry* **31**. 387–444.

Halle, Morris & Jean-Roger Vergnaud (1980). Three dimensional phonology. *Journal of Linguistic Research* **1**. 83–105.

Halle, Morris & Jean-Roger Vergnaud (1981). Harmony processes. In Wolfgang Klein & Williem Levelt (eds.) *Crossing the boundaries in linguistics: Studies presented to Manfred Bierwisch*, Dordrecht: Reidel. 1–22.

Harms, Phillip Lee (1985). Epena Pedee (Saija) nasalization. In Ruth Brend (ed.) *From Phonology to Discourse: Studies in Six Columbian Languages*, Dallas, TX: Summer Institute of Linguistics. 13–18.

Harms, Phillip Lee (1994). *Epena Pedee Syntax*. Arlington, TX: The Summer Institute of Linguistics and The University of Texas at Arlington.

Harris, John & Geoff Lindsey (1995). The elements of phonological representation. In Jacques Durand & Francis Katamba (eds.) *Frontiers of Phonology: Atoms, Structures, Derivations*, London, New York: Longman. 34–79.

Hyde, Brett (2008). Alignment continued: Distance-sensitivity, order-sensitivity, and the midpoint pathology. Ms. Available on Rutgers Optimality Archive, ROA 998, http://roa.rutgers.edu.

Hyman, Larry (1995). Nasal consonant harmony at a distance: The case of Yaka. *Studies in African Linguistics* **24**. 5–30.

Itô, Junko & Armin Mester (1995). The core-periphery structure of the lexicon and constraints on reranking. In Jill Beckman, Suzanne Urbanczyk & Laura Walsh (eds.) *University of Massachusetts Occasional Papers in Linguistics 18*, Amherst: GLSA, University of Massachusetts. 181–209.

Itô, Junko, Armin Mester & Jaye Padgett (1995). Licensing and underspecification in Optimality Theory. *Linguistic Inquiry* **26**. 571–631.

Kaye, Jonathan (1982). Harmony processes in Vata. In Harry van der Hulst & Norval Smith (eds.) *The Structure of Phonological Representations (Part II)*, Dordrecht: Foris. 385–452.

Kaye, Jonathan, Jean Lowenstamm & Jean-Roger Vergnaud (1985). The internal structure of phonological elements: a theory of charm and goverment. *Phonology Yearbook* **2**. 305–328.

Kiparsky, Paul (1981). Vowel harmony. Ms. Massachusetts Institute of Technology.

Kirchner, Robert (1993). Turkish vowel harmony and disharmony: An Optimality Theoretic account. Ms. University of Alberta. Available on Rutgers Optimality Archive, ROA 4, http://roa.rutgers.edu.

Kowalski, Tadeusz (1929). *Karaimische texte im dialekt von Troki*. Cracow: Nakładem Polskiej Akademji Umiejętności.

Krämer, Martin (2003). *Vowel Harmony and Correspondence Theory*. Berlin and New York: Mouton de Gruyter.

Lahiri, Aditi & Vincent Evers (1991). Palatalization and coronality. In Carole Paradis & Jean-François Prunet (eds.) *Phonetics and Phonology 2: Volume 2. The Special status of Coronals, Internal and External Evidence*, San Diego, CA: Academic Press. 79–100.

Langendoen, Terrence D. (1968). *The London School of Linguistics*. Cambridge, MA: MIT Press.

Lombardi, Linda (1998). Evidence for Max Feature constraints from Japanese. In Haruka Fukazawa, Frida Morelli, Caro Struijke & Yi-Ching Su (eds.) *University of Maryland Working Papers in Linguistics 7*, University of Maryland. 41–62. Available on Rutgers Optimality Archive, ROA 247, http://roa.rutgers.edu.

Loos, Eugene Emil (1969). *The phonology of Capanahua and its grammatical basis*. Summer Institute of Linguistics of the University of Oklahoma.

McCarthy, John J. (1988). Feature geometry and dependency. *Phonetica* **43**. 84–108.

McCarthy, John J. (1997). Process specific constraints in Optimality Theory. *Linguistic Inquiry* **28**. 231–251.

McCarthy, John J. (2003). OT constraints are categorical. *Phonology* **20**. 75–138.

McCarthy, John J. & Alan Prince (1993a). Generalized Alignment. In Geert Booij & Jaap van Marle (eds.) *Yearbook in Morphology 1993*, Dordrecht: Kluwer. 79–153.

McCarthy, John J. & Alan Prince (1993b). Prosodic Morphology I. Ms., University of Massachusetts and Rutgers University, Amherst, and New Brunswick, NJ. Available on Rutgers Optimality Archive, ROA 482, http://roa.rutgers.edu.

Morén, Bruce (1999/2001). *Distinctiveness, Coercion and Sonority: A Unified Theory of Weight*. New York, London: Routledge. Available on Rutgers Optimality Archive, ROA 349, http://roa.rutgers.edu.

Morén, Bruce (2003). The parallel structures model of feature geometry. In J. Brugman & A. Rhiel (eds.) *Working Papers of the Cornell Phonetics Laboratory*, Cornell University, vol. 15. 194–270.

Morén, Bruce (2006). Consonant-vowel interactions in Serbian: Features, representations and constraint interactions. *Lingua* **116**. 1198–1244.

Morén, Bruce (2007). The division of labor between segment-internal structure and violable constraints. In Sylvia Blaho, Patrik Bye & Martin Krämer (eds.) *Freedom of Analysis?*, Berlin: Mouton de Gruyter. 215–235.

Myers, Scott (1997). OCP effects in Optimality Theory. *Natural Language and Linguistic Theory* **15**. 847–892.

Nespor, Marina & Irene Vogel (1986). *Prosodic Phonology*. Dordrecht: Foris.

Nevins, Andrew & Bert Vaux (2004). Consonant harmony in Karaim. In Anikó Csirmaz, Youngjoo Lee & MaryAnn Walker (eds.) *MIT Working Papers in Linguistics 46: The Proceedings of the Workshop on Altaic in Formal Linguistics*, Cambridge, MA: MITWPL. 175–194.

Ní Chiosáin, Máire (1994). Irish palatalisation and the representation of place features. *Phonology* **11**. 89–106.

Odden, David (1991). Vowel geometry. *Phonology* **8**. 261–289.

Odden, David (1994). Adjacency paramaters in phonology. *Language* **70**. 289–330.

Padgett, Jaye (1991/1995). *Stricture in Feature Geometry*. Stanford, CA: CSLI Publications.

Padgett, Jaye (2002). Russian voicing assimilation, final devoicing, and the problem of [v]. Ms. University of California Santa Cruz. Available on Rutgers Optimality Archive, ROA 528, http://roa.rutgers.edu.

Painter, Colin (1973). Cineradiographic data on the feature 'covered' in Twi vowel harmony. *Phonetica* **28**. 97–120.

Peperkamp, Sharon (1997). *Prosodic Words*. The Hague: Holland Academic Graphics.

Piggott, Glyne (1987). On the autonomy of the feature Nasal. In Anna Bosch, Barbara Need & Eric Shiller (eds.) *Chicago Linguistic Society (CLS) 23-2: Parasession on Autosegmental and Metrical Phonology*, Chicago: Chicago Linguistic Society. 223–238.

Piggott, Glyne (1992). Variability in feature dependency: The case of nasality. *Natural Language and Linguistic Theory* **10**. 33–77.

Piggott, Glyne (2003). Theoretical implications of segment neturality in nasal harmony. *Phonology* **20**. 375–424.

Piggott, Glyne & Harry van der Hulst (1997). Locality and the nature of nasal harmony. *Lingua* **103**. 85–112.

Pulleyblank, Douglas (1996). Neutral vowels in Optimality Theory: A comparison of Yoruba and Wolof. *Canadian Journal of Linguistics* **41**. 295–347.

Ringen, Catherine (1975/1988). *Vowel harmony: Theoretical Implications*. New York: Garland.

Ringen, Catherine & Orvokki Heinämäki (1999). Variation in Finnish vowel harmony: An OT account. *Natural Language and Linguistic Theory* **17**. 303–337.

Ringen, Catherine & Robert Vago (1998). Hungarian vowel harmony in Optimality Theory. *Phonology* **15**. 393–416.

Robins, R. H. (1957). Vowel nasality in Sundanese, a phonological and grammatical study. In *Studies in linguistic analysis*, Oxford: Blackwell. 87–103.

Rubach, Jerzy (2007). Feature geometry from the perspective of Polish, Russian, and Ukranian. *Linguistic Inquiry* **38**. 85–138.

Saeed, John (1999). *Somali*. Amsterdam: John Benjamins.

Saeed, John Ibrahim (1993). *Somali Reference Grammar*. Kensington, MD: Dunwoody Press.

Safir, Ken (1982). Nasal spreading in Capanahua. *Linguistic Inquiry* **13**. 689–694.

Sagey, Elizabeth (1990). *The Representation of Features in Non-Linear Phonology: The Articulator Node Hierarchy*. New York and London: Garland.

Selkirk, Elisabeth (1980). Prosodic domains in phonology: Sanskrit revisited. In Mark Aronoff & Mary-Louise Kean (eds.) *Juncture: A Collection of Original Papers*, Saratoga, CA: Anma Libri. 107–129.

Smolensky, Paul (1993). Harmony, markedness, and phonological activity. Paper presented at Rutgers Optimality Workshop 1, Rutgers University. Available on Rutgers Optimality Archive, ROA 87, http://roa.rutgers.edu.

Steriade, Donca (1987). Locality conditions and feature geometry. In *Proceedings of NELS 17*, Amherst: GLSA, University of Massachusetts. 595–618.

Steriade, Donca (1995). Underspecification and markedness. In John A. Goldsmith (ed.) *The Handbook of Phonological Theory*, Oxford: Blackwell. 114–174.

Ternes, Elmar (1973). *The Phonemic Analysis of Scottish Gaelic: Based on the Dialect of Applecross, Ross-shire*. Hamburg: Helmut Buske Verlag.

van der Hulst, Harry & Norval Smith (1982). Prosodic domains and opaque segments in Autosegmental Theory. In Harry van der Hulst & Norval Smith (eds.) *The Structure of Phonological Representations (Part II)*, Dordrecht: Foris. 311–336.

Walker, Rachel (1998/2000). *Nasalization, Neutral Segments, and Opacity Effects*. New York: Garland.

Walker, Rachel & Geoffrey Pullum (1999). Possible and impossible segments. *Language* **75**. 764–780.

Watson, Janet C. E. (1999). The directionality of emphasis spread in Arabic. *Linguistic Inquiry* **30**. 289–300.

Watson, Janet C. E. (2002). *The Phonology and Morphology of Arabic*. Oxford: Oxford University Press.

Wheeler, Max W. (1979). *Phonology of Catalan*. Oxford: Blackwell.

Wheeler, Max W. (2005). *The Phonology of Catalan*. Oxford: Oxford University Press.

Zawaydeh, Bushra (1999). *The phonetics and phonology of gutturals in Arabic*. Ph.D. dissertation, Indiana University, Bloomington.

Zec, Draga (1988/1994). *Sonority Constraints on Prosodic Structure*. New York: Garland.