Morphologische Theorien
Beschränkungen für Paradigmen 2

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SoSe 2015

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Background

Goal:
Systematic accounts of as many instances of syncretism as possible: one form – one function (i.e., feature specification)

Consequence:
Abstractness of morphological analyses of paradigms:

- underspecification of exponents
- competition of exponents (and principles that resolve the competition)
- abstract features on exponents encoding natural classes (like [oblique], [local person])
- subanalysis of exponents: obvious in some cases, possible in many more cases (e.g., du, dich = /d/-/uː/, /d/-/ɪ/-/ç/; see Pike (1965), Wiese (2001), Fischer (2006)).

Question:
Is there independent evidence for such an approach?

Carstairs-McCarthy's Constraints

(1) The Paradigm Economy Principle (Carstairs (1987, 51)):
When in a given language L more than one inflectional realization is available for some bundle or bundles of non-lexically-determined morphosyntactic properties associated with some part of speech N, the number of macroparadigms for N is no greater than the number of distinct "rival" macroinflections available for that bundle which is most genereously endowed with such rival realizations.

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(2) The No Blur Principle (Carstairs-McCarthy (1994, 742)):
Within any set of competing inflectional realizations for the same paradigmatic cell, no more than one can fail to identify inflection class unambiguously.

Problem

Observation:
(i) Constraints like the Paradigm Economy Principle and No Blur restrict the number of possible inflection classes that can be generated on the basis of a given set of inflection markers (for a given grammatical category).
(ii) If such constraints cannot be adopted for principled reasons, there is a danger that the theory is not restrictive enough.
(iii) Principled reasons that preclude adopting constraints on the number of possible inflection classes (on the basis of a given marker inventory):

- non-existence of paradigms in morphological theory
- decomposition of inflection class features in order to account for trans-paradigmatic syncretism (see Halle (1992), Oltra Massuet (1999), Stump (2001), Alexiadou & Müller (2007), and below).

(Compare Noyer's (2005) Interclass Syncretism Constraint, which is similar in its effects to No Blur, and fundamentally incompatible with a decomposition of inflection class features.)

Strategies

Two possible strategies:

1. argue that the question of how inflection classes can be constrained is irrelevant from a synchronic perspective;
2. argue that restrictions on the number of possible inflection classes (based on a given marker inventory) follow from independently motivated assumptions, without invoking specific constraints that explicitly impose restrictions on possible inflection classes.

I adopt the latter strategy.

Inflection Class Economy Theorem

(3) Inflection Class Economy Theorem:
Given a set of n inflection markers, there can be at most 2^{n-1} inflection classes, independently of the number of instantiations of the grammatical category that the markers have to distribute over.

Note:
The number of 2^{n-1} inflection classes encodes the powerset of the inventory of markers, minus one radically underspecified marker.

For instance: Assuming an abstract system with five markers and six instantiations of a grammatical category (e.g., case), the Inflection Class Economy Theorem states that there can at most be sixteen (i.e., $2^{5-1} = 2^4$) inflection classes, out of the 15.625 (i.e., 5^6) that would otherwise be possible.

Claim

Claim:
The Inflection Class Economy Theorem follows under any morphological theory that makes the three assumptions in (4), (5), and (6), which I call 'Syncretism', 'Elsewhere', and 'Blocking'.

(I basically presuppose an approach along the lines of Distributed Morphology (Halle & Marantz (1993, 1994), Noyer (1992)), but things are exactly the same under alternative morphological theories, e.g., Minimalist Morphology (Wunderlich (1996, 1997)), or Paradigm Function Morphology (Stump (2001)).)

Syncretism

(4) Syncretism (first assumption):
Identity of form implies identity of function: For each marker, there is a unique specification of morpho-syntactic features.
(within a certain domain, and unless there is evidence to the contrary).

Note:
The Syncretism Principle underlies much recent (and, based on the Jakobsonian tradition, some not so recent) work in inflectional morphology; it provides simple and elegant analyses, and it has been empirically confirmed for a variety of inflectional systems in the world's languages.

Elsewhere

(5) Elsewhere (second assumption):
There is always one elsewhere marker that is radically underspecified with respect to inflection class (and more generally). Other markers may be underspecified to an arbitrary degree (including not at all).

Note:
(i) Underspecification as a means to account for syncretism is employed in most recent theories of inflectional morphology, including Distributed Morphology, Minimalist Morphology, and Paradigm Function Morphology.
(ii) The assumption that there is always one radically underspecified elsewhere marker in inflectional systems is quite common (see, e.g., Stump's (2001) Identity Function Default rule).
(ii-a) It is well-motivated empirically because it can account for 'discontinuous' occurrences of markers in paradigms (where natural classes captured by non-radical underspecification is unlikely to be involved).
(ii-b) It ensures that there are (usually) no paradigmatic gaps in inflectional systems (which should otherwise be an option, given underspecification).

Blocking

(6) Blocking (third assumption):
Competition of underspecified markers is resolved by choosing the most specific marker: For all (competing) markers α, β, either α is more specific than β, or β is more specific than α.

Note:
A Specificity constraint along these lines is adopted in Distributed Morphology (typically as part of the definition of the Subset Principle, see Halle (1997)), in Minimalist Morphology (see Wunderlich (1996, 1997, 2004)), and in Paradigm Function Morphology (Stump (2001) calls the relevant constraint Panini's Principle).

Consequence

Consequence:

1. Syncretism is systematic in the sense that only one specification of morpho-syntactic features is associated with any given inflection marker (with the qualifications mentioned above).
2. For any given fully specified context, there is always one inflection marker that fits.
3. For any given fully specified context, there is never more than one inflection marker that fits.

(Elsewhere and Blocking emerge as two sides of the same coin; see 'Completeness' and 'Uniqueness' in Wunderlich (1996, 99).)

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Two remaining issues:

- How does the Inflection Class Economy Theorem constrain inflectional systems?
- How does the Inflection Class Economy Theorem follow as a theorem from Syncretism, Elsewhere, and Blocking?

Basic Question

(7) Two versions of the basic question:

a. Given an inventory of markers for a certain domain (e.g., noun inflection), how many inflection classes can there be?

b. Given an inventory of markers with associated features encoding a grammatical category (e.g., case) for a certain domain (e.g., noun inflection), how many inflection classes can there be?

Assumption:

(7-a) is the more interesting question: It does not presuppose that the specification of a marker for a grammatical category (e.g., with respect to case and/or number) is somehow privileged, i.e., more basic than its inflection class features. (Carstairs (1987) only tries to answer (7-b).)

A system without restrictions

If, in a given domain (e.g., noun inflection), there are n markers for m instantiations of a grammatical category (e.g., case), the markers can be grouped into n^m distinct inflection classes (i.e., the set of m-tuples over an input set with n members).

Abstract example 1: 3 markers, 4 cases: 81 ($= 3^4$) possible inflection classes

a a a a	a b c a	b a b a	b c a a	c a c a	c c b a
a a a b	a b c b	b a b b	b c a b	c a c b	c c b b
a a a c	a b c c	b a b c	b c a c	c a c c	c c b c
a a b a	a c a a	b a c a	b c b a	c b a a	c c c a
a a b b	a c a b	b a c b	b c b b	c b a b	c c c b
a a b c	a c a c	b a c c	b c b c	c b a c	c c c c
a a c a	a c b a	b b a a	b c c a	c b b a	
a a c b	a c b b	b b a b	b c c b	c b b b	
a a c c	a c b c	b b a c	b c c c	c b b c	
a b a a	a c c a	b b b a	c a a a	c b c a	
a b a b	a c c b	b b b b	c a a b	c b c b	
a b a c	a c c c	b b b c	c a a c	c b c c	
a b b a	b a a a	b b c a	c a b a	c c a a	
a b b b	b a a b	b b c b	c a b b	c c a b	
a b b c	b a a c	b b c c	c a b c	c c a c	

Comments on Example 1

Note:
(i) The letters a, b, and c stand for the three markers.
(ii) All four-letter rows (4-tuples separated by either a vertical line or a line break) correspond to one inflection class, with the first marker in a row being used for the first instantiation of case (e.g., nominative), the second one for the second instantiation of case (e.g., accusative), the third one for the third instantiation of case (e.g., dative), and the fourth one for the fourth instantiation of case (e.g., genitive).
(iii) It is unlikely that a language can be found in which eighty-one inflection classes have been generated on the basis of three markers and four instantiations of a grammatical category.

Predictions for Example 1

(8)
a. Paradigm Economy Principle, worst case scenario:
3 inflection classes: the size of the inventory
b. No Blur Principle, worst case scenario:
9 inflection classes: $((3\text{-}1)\times 4)+1$
c. Inflection Class Economy Theorem, worst case scenario:
4 inflection classes: 2^{3-1}

Explanation of Worst Case Scenarios 1

(9) Explanation of worst case scenarios, Paradigm Economy Principle:
All three markers can be allomorphs for a single case specification (e.g., a, b, and c can all be accusative markers); still, there can then only be three distinct inflection classes.

Explanation of Worst Case Scenarios 2

(10) Explanation of worst case scenarios, No Blur Principle:

a. There is one default marker (say, a).
b. One class consists only of default markers (aaaa).
c. All the other inflection classes differ from this class by replacing one of the a's with either b or c (baaa, abaa, aaba, aaab, caaa, acaa, aaca, aaac), so that all classes respect the No Blur Principle.
d. Adding another class with more than one b, or more than one c, or a – perhaps minimal – combination of b's and c's (cf. bbaa, or aacc, or abca, etc.) will invariably lead to a violation of the No Blur Principle because either b or c (or both) will cease to be inflection-class specific.
e. In general, the No Blur Principle predicts that there can at most be $((n\text{-}1) \times m)+1$ inflection classes, for n markers and m instantiations of a grammatical category: Every marker except for one – the default marker, hence "–1" – can appear for a given instantiation of a grammatical category only in one inflection class; and "+1" captures a class consisting exclusively of default markers.

Explanation of Worst Case Scenarios 3

Note:

Assuming default markers that are specific with respect to instantiations of a grammatical category (such that, e.g., a is the default marker for the first instantiation, b for the second, c for the third, and perhaps again a for the fourth) instead of an extremely general default marker a, does not change things: This would be compatible with No Blur, but it could not increase the number of possible inflection classes. In the case at hand, the maximal set of inflection classes would include abca, bbca, cbca, aaca, acca, abaa, abba, abcb, abcc.

Another Abstract Example

Abstract example 2: 5 markers, 3 cases: 125 ($= 5^3$) possible inflection classes

a a a	a d a	b b a	b e a	c c a	d a a	d d a	e b a	e e a
a a b	a d b	b b b	b e b	c c b	d a b	d d b	e b b	e e b
a a c	a d c	b b c	b e c	c c c	d a c	d d c	e b c	e e c
a a d	a d d	b b d	b e d	c c d	d a d	d d d	e b d	e e d
a a e	a d e	b b e	b e e	c c e	d a e	d d e	e b e	e e e
a b a	a e a	b c a	c a a	c d a	d b a	d e a	e c a	
a b b	a e b	b c b	c a b	c d b	d b b	d e b	e c b	
a b c	a e c	b c c	c a c	c d c	d b c	d e c	e c c	
a b d	a e d	b c d	c a d	c d d	d b d	d e d	e c d	
a b e	a e e	b c e	c a e	c d e	d b e	d e e	e c e	
a c a	b a a	b d a	c b a	c e a	d c a	e a a	e d a	
a c b	b a b	b d b	c b b	c e b	d c b	e a b	e d b	
a c c	b a c	b d c	c b c	c e c	d c c	e a c	e d c	
a c d	b a d	b d d	c b d	c e d	d c d	e a d	e d d	
a c e	b a e	b d e	c b e	c e e	d c e	e a e	e d e	

Predictions for Example 2

(11) a. Paradigm Economy Principle, worst case scenario:
5 inflection classes: the size of the inventory

b. No Blur Principle, worst case scenario:
13 inflection classes: $((5\text{-}1)\times 3)+1$
(E.g., assuming a as a default marker, aaa, baa, aba, aab, caa, aca, aac, daa, ada, aad, eaa, aea, aae)

c. Inflection Class Economy Theorem, worst case scenario:
16 inflection classes: 2^{5-1}

Example 3: 5 markers, 4 cases: 625 ($= 5^4$) inflection classes

aaaa	acbb	aecc	bbdd	bdee	cbba	cdcb	dadc	dced	eaae	ecca	eedb
aaab	acbc	aecd	bbde	beaa	cbbb	cdcc	dadd	dcee	eaba	eccb	eedc
aaac	acbd	aece	bbea	beab	cbbc	cdcd	dade	ddaa	eabb	eccc	eedd
aaad	acbe	aeda	bbeb	beac	cbbd	cdce	daea	ddab	eabc	eccd	eede
aaae	acca	aedb	bbec	bead	cbbe	cdda	daeb	ddac	eabd	ecce	eeea
aaba	accb	aedc	bbed	beae	cbca	cddb	daec	ddad	eabe	ecda	eeeb
aabb	accc	aedd	bbee	beba	cbcb	cddc	daed	ddae	eaca	ecdb	eeec
aabc	accd	aede	bcaa	bebb	cbcc	cddd	daee	ddba	eacb	ecdc	eeed
aabd	acce	aeea	bcab	bebc	cbcd	cdde	dbaa	ddbb	eacc	ecdd	eeee
aabe	acda	aeeb	bcac	bebd	cbce	cdea	dbab	ddbc	eacd	ecde	
aaca	acdb	aeec	bcad	bebe	cbda	cdeb	dbac	ddbd	eace	ecea	
aacb	acdc	aeed	bcae	beca	cbdb	cdec	dbad	ddbe	eada	eceb	
aacc	acdd	aeee	bcba	becb	cbdc	cded	dbae	ddca	eadb	ecec	
aacd	acde	baaa	bcbb	becc	cbdd	cdee	dbba	ddcb	eadc	eced	
aace	acea	baab	bcbc	becd	cbde	ceaa	dbbb	ddcc	eadd	ecee	
aada	aceb	baac	bcbd	bece	cbea	ceab	dbbc	ddcd	eade	edaa	
aadb	acec	baad	bcbe	beda	cbeb	ceac	dbbd	ddce	eaea	edab	
aadc	aced	baae	bcca	bedb	cbec	cead	dbbe	ddda	eaeb	edac	
aadd	acee	baba	bccb	bedc	cbed	ceae	dbca	dddb	eaec	edad	
aade	adaa	babb	bccc	bedd	cbee	ceba	dbcb	dddc	eaed	edae	
aaea	adab	babc	bccd	bede	ccaa	cebb	dbcc	dddd	eaee	edba	
aaeb	adac	babd	bcce	beea	ccab	cebc	dbcd	ddde	ebaa	edbb	
aaec	adad	babe	bcda	beeb	ccac	cebd	dbce	ddea	ebab	edbc	
aaed	adae	baca	bcdb	beec	ccad	cebe	dbda	ddeb	ebac	edbd	
aaee	adba	bacb	bcdc	beed	ccae	ceca	dbdb	ddec	ebad	edbe	
abaa	adbb	bacc	bcdd	beee	ccba	cecb	dbdc	dded	ebae	edca	
abab	adbc	bacd	bcde	caaa	ccbb	cecc	dbdd	ddee	ebba	edcb	
abac	adbd	bace	bcea	caab	ccbc	cecd	dbde	deaa	ebbb	edcc	
abad	adbe	bada	bceb	caac	ccbd	cece	dbea	deab	ebbc	edcd	
abae	adca	badb	bcec	caad	ccbe	ceda	dbeb	deac	ebbd	edce	
abba	adcb	badc	bced	caae	ccca	cedb	dbec	dead	ebbe	edda	
abbb	adcc	badd	bcee	caba	cccb	cedc	dbed	deae	ebca	eddb	
abbc	adcd	bade	bdaa	cabb	cccc	cedd	dbee	deba	ebcb	eddc	
abbd	adce	baea	bdab	cabc	cccd	cede	dcaa	debb	ebcc	eddd	
abbe	adda	baeb	bdac	cabd	ccce	ceea	dcab	debc	ebcd	edde	
abca	addb	baec	bdad	cabe	ccda	ceeb	dcac	debd	ebce	edea	
abcb	addc	baed	bdae	caca	ccdb	ceec	dcad	debe	ebda	edeb	
abcc	addd	baee	bdba	cacb	ccdc	ceed	dcae	deca	ebdb	edec	
abcd	adde	bbaa	bdbb	cacc	ccdd	ceee	dcba	decb	ebdc	eded	
abce	adea	bbab	bdbc	cacd	ccde	daaa	dcbb	decc	ebdd	edee	
abda	adeb	bbac	bdbd	cace	ccea	daab	dcbc	decd	ebde	eeaa	
abdb	adec	bbad	bdbe	cada	cceb	daac	dcbd	dece	ebea	eeab	
abdc	aded	bbae	bdca	cadb	ccec	daad	dcbe	deda	ebeb	eeac	
abdd	adee	bbba	bdcb	cadc	cced	daae	dcca	dedb	ebec	eead	
abde	aeaa	bbbb	bdcc	cadd	ccee	daba	dccb	dedc	ebed	eeae	
abea	aeab	bbbc	bdcd	cade	cdaa	dabb	dccc	dedd	ebee	eeba	
abeb	aeac	bbbd	bdce	caea	cdab	dabc	dccd	dede	ecaa	eebb	
abec	aead	bbbe	bdda	caeb	cdac	dabd	dcce	deea	ecab	eebc	
abed	aeae	bbca	bddb	caec	cdad	dabe	dcda	deeb	ecac	eebd	
abee	aeba	bbcb	bddc	caed	cdae	daca	dcdb	deec	ecad	eebe	
acaa	aebb	bbcc	bddd	caee	cdba	dacb	dcdc	deed	ecae	eeca	
acab	aebc	bbcd	bdde	cbaa	cdbb	dacc	dcdd	deee	ecba	eecb	
acac	aebd	bbce	bdea	cbab	cdbc	dacd	dcde	eaaa	ecbb	eecc	
acad	aebe	bbda	bdeb	cbac	cdbd	dace	dcea	eaab	ecbc	eecd	
acae	aeca	bbdb	bdec	cbad	cdbe	dada	dceb	eaac	ecbd	eece	
acba	aecb	bbdc	bded	cbae	cdca	dadb	dcec	eaad	ecbe	eeda	

Predictions for Example 3

(12) a. Paradigm Economy Principle, worst case scenario:
5 inflection classes: the size of the inventory

b. No Blur Principle, worst case scenario:
17 inflection classes: $((5\text{-}1)\times4)+1$
(E.g., aaaa, baaa, abaa, aaba, aaab, caaa, acaa, aaca, aaac, daaa, adaa, aada, aaad, eaaa, aeaa, aaea, aaae.)

c. Inflection Class Economy Theorem, worst case scenario:
16 inflection classes: 2^{5-1}

Conclusion so far:
The Inflection Class Economy Theorem restricts possible inflection classes in a way that is roughly comparable to the Paradigm Economy and No Blur Principles.

Assumptions

Recall:

1. Syncretism: Only one morpho-syntactic feature specification is associated with each marker of the inventory for a given morphological domain (exceptions apart).
2. Elsewhere: There is always one marker that in principle fits into every context of fully specified morpho-syntactic features.
3. Blocking: There is always only one marker that can in fact be used for any fully specified context of morpho-syntactic features.

Argument Based On Marker Deactivation Combinations 1

(13) a. Since each inflection marker M can only be associated with one specification of morpho-syntactic features (because of **Syncretism**), it follows that for each inflection marker M and for each inflection class I, it must be the case that M is either compatible with I or incompatible with I.

b. A marker is compatible with an inflection class I if it bears no inflection class feature, if it bears fully specified inflection class information that completely characterizes I, or if it is characterized by a set of underspecified inflection class features that is a subset of the fully specified set of features that characterize the inflection class.

c. M is activated for I if it is compatible with it; and deactivated for I if it is incompatible with it.
(If a marker is activated for an inflection class I, this does not imply that it will actually be used by I – there may well be a more specific marker that blocks it.)

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(If a marker is activated for an inflection class I, this does not imply that it will actually be used by I – there may well be a more specific marker that blocks it.)

d. **Blocking** ensures that each inflection class can be defined in terms of the markers that are active in it: For all competing markers α and β, it is fixed once and for all by the markers' feature specifications (and independently of inflection classes) that either β is more specific than α, or α is more specific than β.

e. Hence, if the same set of markers is activated for two inflection classes I_1 and I_2, I_1 must be identical to I_2.

Argument Based On Marker Deactivation Combinations 2

(13) f. Conversely, since every marker is either activated or deactivated for any given inflection class, it also follows that if the same set of markers is deactivated for two inflection classes I_1 and I_2, I_1 and I_2 must be the same inflection class (because the same set of markers is then activated for I_1 and I_2, because a marker /x/ can only have one specification [ξ], and because specificity relations among competing markers are fixed).

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g. In order to determine the maximal number of inflection classes on the basis of a given inventory of markers, it now suffices to successively deactivate all possible marker combinations.

h. Starting with the full inventory of markers, we can proceed by successively deactivating all combinations of markers, which yields class after class.

i. Thus, all markers of the inventory are compatible with class I_1; all except for marker a are compatible with class I_2; all except for markers a, b are compatible with class I_3; and so forth.

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i. Thus, all markers of the inventory are compatible with class I_1; all except for marker a are compatible with class I_2; all except for markers a, b are compatible with class I_3; and so forth.

j. However, by assumption (**Elsewhere**), one marker always is the elsewhere (default) marker: It is compatible with all inflection classes because it is radically underspecified; and therefore it cannot be deactivated by definition.

k. Consequently, all possible marker deactivation combinations are provided by the powerset of the set of all the markers of the inventory minus the elsewhere marker: 2^{n-1}, for n markers.

l. Thus, given a set of *n* inflection markers, there can be at most 2^{n-1} marker deactivation combinations.

m. Marker deactivation combinations fully determine possible inflection classes. Hence: Given a set of n inflection markers, there can be at most 2^{n-1} inflection classes.

Inflection Class Economy as A Theorem

Note:
This reasoning is independent of the number of instantiations of the grammatical category (e.g., the number of cases) that a set of markers needs to distribute over. In contrast to what is the case under the No Blur Principle, an increase in instantiations of a grammatical category does not induce an increase in possible inflection classes over a given inventory of markers. Hence:

(14) Inflection Class Economy Theorem:
Given a set of n inflection markers, there can be at most 2^{n-1} inflection classes, independently of the number of grammatical categories that the markers have to distribute over.

The First Example

Note:
In order to illustrate the possible marker deactivation patterns, the case categories are now called 1, 2, 3, and 4. Given an inventory of three markers, there are $2^{3-1} = 4$ deactivation combinations.

(15) Example 1 revisited:

a. 3 markers: $\{$a, b, c$\}$
b. 4 cases: 1, 2, 3, 4
c. Deactivation combinations: $\{$ $\{$b, c$\}$, $\{$b$\}$, $\{$c$\}$, $\{\}$ $\}$

The First Example 2

Observation:
Of the 81 inflection classes that would logically be possible under, only four remain, given Syncretism, Underspecification, and Blocking (i.e., the Inflection Class Economy Theorem). This result holds under any specificity-induced order of the markers, and under any assignment of case features to markers.

(16) A possible assignment of case specifications to markers:

a. Markers:
   (i) /a/ $\leftrightarrow$ [ ]
   (ii) /b/ $\leftrightarrow$ [12]
   (iii) /c/ $\leftrightarrow$ [234]

b. Specificity:
   /b/ $>$ /c/ $>$ /a/

c. Deactivation combinations and inflection classes:
   {b, c} $\rightarrow$ aaaa
   {b} $\rightarrow$ accc
   {c} $\rightarrow$ bbaa
   { } $\rightarrow$ bbcc

The First Example 3

(17) Another possible assignment of case specifications to markers:

a. Markers:

(i) /a/ $\leftrightarrow$ [ ]
(ii) /b/ $\leftrightarrow$ [234]
(iii) /c/ $\leftrightarrow$ [4]

b. Specificity:

/c/ > /b/ > /a/

c. Deactivation combinations and inflection classes:

$\{$b, c$\}$ $\rightarrow$ aaaa
$\{$b$\}$ $\rightarrow$ aaac
$\{$c$\}$ $\rightarrow$ abbb
$\{ \}$ $\rightarrow$ abbc

Note:
The question of how the cases 1, 2, 3, 4 are derived from more primitive decomposed features (e.g., how [234] can be a natural class), and how systems with apparently unnatural classes (under minimal decomposition) are derived, is orthogonal.

The Third Example

(18) Example 3 revisited:

a. 5 markers: {a, b, c, d, e}

b. 4 cases: 1, 2, 3, 4

The Third Example 2

(19) A possible choice:

a. Markers:

(i) /a/ ↔ [ ]
(ii) /b/ ↔ [23]
(iii) /c/ ↔ [14]
(iv) /d/ ↔ [3]
(v) /e/ ↔ [34]

b. Specificity:

/d/ > /e/ > /c/ > /b/ > /a/

c. Deactivation combinations & inflection classes:

{b, c, d, e}	→	aaaa
{b, c, d}	→	aaee
{b, c, e}	→	aada
{b, c}	→	aade
{b, d, e}	→	caac
{b, d}	→	caee
{b, e}	→	cadc
{b}	→	cade
{c, d, e}	→	abba
{c, d}	→	abee
{c, e}	→	abda
{c}	→	abde
{d, e}	→	cbbc
{d}	→	cbee
{e}	→	cbdc
{ }	→	cbde

(20) Another possible choice:

a. Markers:

(i) /a/ ↔ [ ]
(ii) /b/ ↔ [ ]
(iii) /c/ ↔ [1]
(iv) /d/ ↔ [2]
(v) /e/ ↔ [34]

b. Specificity:

/c/ > /d/ > /e/ > /b/ > /a/

c. Deactivation combinations & inflection classes:

{b, c, d, e}	→	aaaa
{b, c, d}	→	aaee
{b, c, e}	→	adaa
{b, c}	→	adee
{b, d, e}	→	caaa
{b, d}	→	caee
{b, e}	→	cdaa
{b}	→	cdee
{c, d, e}	→	bbbb
{c, d}	→	bbee
{c, e}	→	bdbb
{c}	→	bdee
{d, e}	→	cbbb
{d}	→	cbee
{e}	→	cdbb
{ }	→	~~cdee~~

The Third Example 3

(21) A third possible choice:

a. Markers:

(i)	/a/ ↔ [ ]	
(ii)	/b/ ↔ [234]	
(iii)	/c/ ↔ [134]	
(iv)	/d/ ↔ [123]	
(v)	/e/ ↔ [123]	

b. Specificity:

/d/ > /e/ > /c/ > /b/ > /a/

c. Deactivation combinations & inflection classes:

{b, c, d, e}	→	aaaa
{b, c, d}	→	eeea
{b, c, e}	→	ddda
{b, c}	→	~~ddda~~
{b, d, e}	→	cacc
{b, d}	→	eeec
{b, e}	→	dddc
{b}	→	~~dddc~~
{c, d, e}	→	abbb
{c, d}	→	eeeb
{c, e}	→	dddb
{c}	→	~~dddb~~
{d, e}	→	cbcc
{d}	→	~~eeec~~
{e}	→	~~dddc~~
{ }	→	~~dddc~~

(22) A fourth possible choice:

a. Markers:

(i)	/a/ ↔ [ ]	
(ii)	/b/ ↔ [1]	
(iii)	/c/ ↔ [2]	
(iv)	/d/ ↔ [3]	
(v)	/e/ ↔ [4]	

b. Specificity:

/e/ > /d/ > /c/ > /b/ > /a/

c. Deactivation combinations & inflection classes:

{b, c, d, e}	→	aaaa
{b, c, d}	→	aaae
{b, c, e}	→	aada
{b, c}	→	aade
{b, d, e}	→	acaa
{b, d}	→	acae
{b, e}	→	acda
{b}	→	acde
{c, d, e}	→	baaa
{c, d}	→	baae
{c, e}	→	bada
{c}	→	bade
{d, e}	→	bcaa
{d}	→	bcae
{e}	→	bcda
{ }	→	bcde

The Third Example 4

Note:
Again, the issue of what the decomposed case and inflection class features that encode the deactivation patterns in systems like (19)–(22) would actually look like is strictly speaking orthogonal to present concerns. Still, for the case at hand, in the worst case there would have to be four binary inflection class features [$\pm\alpha$], [$\pm\beta$], [$\pm\gamma$] and [$\pm\delta$] whose cross-classification yields the sixteen inflection classes (with individual markers underspecified as, e.g., [$+\alpha$]); two abstract grammatical category features (e.g., case features such as [$\pm$governed], [$\pm$oblique], as in Bierwisch (1967)) would suffice for all systems but (21), where either reference to negated specifications would be necessary, or a third primitive feature would have to be invoked.

Abstractness of Inflection Markers

The notion of "marker" is to be understood in a somewhat more abstract way that ignores allomorphic variation which is phonologically or morpho-phonologically conditioned (and not morphologically, as with variation determined by inflection class membership). For instance, Halle (1994) argues that the marker realizations ov and ej for genitive plural in Russian are allomorphs whose choice is morpho-phonologically determined; on this view, there is but a single marker /ov/, accompanied a single underspecified set of morpho-syntactic features (perhaps involving underspecified inflection class features, as suggested in Alexiadou & Müller (2007) in order to account for fact that this marker exhibits trans-paradigmatic syncretism).

Scope of the Result

There may be minor imperfections in inflectional systems that can be traced back to historical factors. In particular, these deviations from optimal design show up in the form of isolated markers that cannot be given unique specifications, resulting in a case of non-systematic homophony. In such a situation, the set of possible inflection classes is mildly increased; it is 2^{n-1+x}, for x additional marker specifications required by unresolved, accidental homophony.

Disjunction, Alpha Notation

The same reasoning applies to

1. the use of disjunction or negation in marker specifications (see, e.g., Bierwisch (1967), Wunderlich (1996)), but only if contradictory feature specifications are involved;
2. the use of variables over feature values in marker specifications (i.e., α notation (see Chomsky (1965), Chomsky & Halle (1968) for the original concept, Noyer (1992), Harley (1994), Johnston (1996), Alexiadou & Müller (2007), Börjesson (2006), Georgi (2006), Lahne (2006), and Opitz (2006) on its use in morphology).

On the Other Hand

The 2^{n-1} formula captures worst case scenarios. Overlapping marker specifications reduce the number of possible inflection classes further. Moreover, for an inflectional system to fully exploit the logical possibilities for developing inflection classes as they arise under the Inflection Class Economy Theorem is extremely unlikely – typically, far from all marker deactivation combinations will be employed.

Consequences for Other Morphological Operations

(23) a. Fission (Distributed Morphology; Halle & Marantz (1993), Noyer (1992)), rule blocks (stem-and-paradigm accounts; Anderson (1992), Stump (2001)). Both concepts give rise to instances of subanalysis, in the sense that what may look like a complex marker at first sight turns out to be best analyzed as a sequence of smaller markers, each with its own specifications (Janda & Joseph (1992), Bierkandt (2006)): unproblematic as long as it is understood that no more than one inflection class can determine a sequence of subanalyzed markers in each case.

b. Impoverishment (Distributed Morphology): Given that standard impoverishment (as feature deletion) can be reanalyzed as insertion of a highly specific null marker (Trommer (1999)), each impoverishment rule also increases the set of n's (for which the powerset is created) by one.

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