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POSITION CLASS PRECLUSION: A COMPUTATIONAL RESOLUTION OF MUTUALLY EXCLUSIVE AFFIX POSITIONS

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THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in the College of Arts and Sciences at the University of Kentucky

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ABSTRACT OF THESIS

POSITION CLASS PRECLUSION:
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In Paradigm Function Morphology, it is usual to model affix position classes with an ordered sequence of inflectional rule blocks. Each rule block determines how (or whether) a particular affix position is filled. In this model, competition among inflectional rules is assumed to be limited to members of the same rule block; thus, the appearance of an affix in one position cannot be precluded by the appearance of an affix in another position. I present evidence that apparently disconfirms this restriction and suggests that a more general conception of rule competition is necessary. The data appear to imply that an affixation rule may in some cases override a rule introducing an affix occupying another, distinct position. I propose that each inflectional rule R carry two indices — the first, as usual, specifying the position of the affix introduced by R. The second, however, specifies the position(s) that R satisfies. By default, these two indices identify the same position. However, where one affix precludes another, the second index of the appearing affix specifies two affix positions: the one in which it appears and the one which it precludes. With both blocks satisfied, no other rules which fill either may be applied.

Keywords: Paradigm Function Morphology, inflectional morphology, morphology,

computational linguistics, affixation

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To Almighty God my Father,

without whose favor, guidance, and abundant blessings

this thesis would remain a thousand times unwritten.

ὅτι ἐξ αὐτοῦ καὶ δι’ αὐτοῦ καὶ εἰς αὐτὸν τὰ πάντα· αὐτῷ ἡ δόξα εἰς τοὺς αἰῶνας, ἀμήν.

For from him and through him and to him are all things; to him be the glory forever, amen. — Romans 11:36

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Section 1: Introduction to Morphological Theory

In inflectional morphology, there are four basic types of inflectional theory, along two binary axes of distinction (Stump 2001). First, a theory can be *incremental* or *realizational*. An incremental theory assumes that words obtain their morphosyntactic properties only by means of inflectional processes, while a realizational theory considers a word's morphosyntactic properties to "[license] the introduction of those properties' inflectional exponents" (Stump 2001). According to Stump (2001), incremental theories cannot adequately account for extended exponence or the underdetermination of an inflected word's morphosyntactic properties, but realizational theories do and are therefore preferable to incremental theories.

The second axis distinguishes *lexical* theories from *inferential* ones. A lexical theory of inflection is one in which the association between morphosyntactic properties and affixes is presumed to exist in the lexicon. By contrast, an inferential theory assumes this relationship to be made by use of a rule or formula (Stump 2001). Stump argues that an inferential theory must be preferred on the grounds that lexical theories invariably rely on assumptions that are not empirically motivated. The details of his argument can be found in (Stump 2001: 9-12).

	Inferential	Lexical
Realizational	**inferential-realizational** (e.g. Stump 2001, Anderson 1992)	lexical-realizational (e.g. Distributed Morphology: Halle & Marantz 1993)
Incremental	inferential-incremental (e.g. Steele 1995)	lexical-incremental (e.g. Lieber 1992)

In this paper, I will therefore be adopting an *inferential-realizational* approach. Other approaches such as Distributed Morphology (lexical-realizational) could feasibly be used to account for the data I will introduce, but as I will discuss later, such an approach would not be able to capture major generalizations the data seem to call for. An inferential-realizational approach will provide a much more elegant solution for the problems our data introduce.

Paradigm Function Morphology, as proposed by Gregory Stump (2001), is a framework based on an inferential-realizational approach to morphology. This approach, being empirically driven (in that no null affixes need be postulated) and rule-based, is ideal for consistently agglutinative languages such as Ciyao, from which comes the dataset driving this paper. In Paradigm Function Morphology (PFM), it is usual to model affix position classes by an ordered sequence of inflectional rule blocks such that each rule block determines how (or whether) a particular affix position is filled (Stump 2001).

In this model, competition among inflectional rules is assumed to be limited to members of the same rule block; i.e., the application of a rule from one block does not exclude that of any rule from a different block. This assumption poses no problem in relatively canonical inflection patterns such as those found in Turkish. For example, in the data shown in Table 1, the same affixational position classes are filled regardless of inflectional features. Position class A contains the number marker, and position class B marks for case, each independently of the other. The realization rules for this paradigm (in Table 2) produce affixes that satisfy the positions they occupy — that is, once a single rule has been selected for a given rule block, and the corresponding affix realized, nothing else may fill the position it occupies. This interpretation is standard and expected in PFM, particularly in canonical cases such as Turkish. However, I will show in the coming sections that the position occupied and the position satisfied do not always coincide.

Table 1: Turkish Nominal Inflection for 'man'

	Singular		Plural		
	stem	B	stem	A	B
Nominative	*adam*		*adam*	*-lar*	
Accusative	*adam*	*-i*	*adam*	*-lar*	*-i*
Dative	*adam*	*-a*	*adam*	*-lar*	*-a*
Locative	*adam*	*-da*	*adam*	*-lar*	*-da*
Ablative	*adam*	*-dan*	*adam*	*-lar*	*-dan*
Genitive	*adam*	*-in*	*adam*	*-lar*	*-in*

Table 2: Standard Affix Rule Positioning in Turkish

	Position occupied	Position satisfied
X, N, {plural} → X*lar*	A	A
Identity Function Default	A	A
X, N, {acc} → X*i*	B	B
X, N, {dat} → X*a*	B	B
X, N, {loc} → X*da*	B	B
X, N, {abl} → X*dan*	B	B
X, N, {gen} → X*in*	B	B

Section 2: The Problem

In Ciyao (a Bantu language spoken in portions of Tanzania, Mozambique, and Malawi by approximately three million speakers; Lewis, 2013), indicative verb forms exhibit the affix ordering shown in Table 3. Position C is filled by a subject agreement marker (all forms shown with first person plural *tu-*), and position E is filled by the verb root, which in conjunction with positions F and G, makes up the stem. Position D is occupied by a tense marker, and position A is used both for a future tense marker (in the affirmative) and for the negation marker *nga-*. For example, the affirmative remote past indicative, with affixes realized in positions C, D, E, F, and G, appears thus:

tw-	aa-	dim	-ile
1.PL-	PST2-	cultivate	-PST.POS

We cultivated.'

Table 3: Affirmative and Negative Forms of the Ciyao Verb DIM 'to cultivate'[1]

	Affirmative						Negative					
Indicative:	A	C	D	E	F	G	A	B	C	D	E	G
P1 (general past)		tu-		dim	-il	-e	nga-	ni-	tu-		dim	-a
P2 (remote past)		tw-	aa-	dim	-il	-e	nga-	ni-	tu-		dim	-a
Present		tu-	ku-	dim		-a	nga-		tu-	ku-	dim	-a
F1 (near future)	ci-	tu-		dim		-e	nga-		tu-		dim	-a
F2 (distant future)	ci-	tu-	ci-	dim		-a	nga-	ni-	tu-		dim	-a
Habitual (Present)		tu-	cinaa-	dim		-a	?nga-		tu-	cinaa-	dim	-a
Conditional: F2	?ci-	tu-		dim		-a	nga-	ni-	tu-		dim	-a

A peculiarity arises, however, in affix position B. In a few tenses (P1, P2, and F2), the affix *ni-* (position B) accompanies the negation marker *nga-* (shown in position A). However, the presence of this affix appears to preclude the realization of any tense marker in position D. Since the D-position affixes *ku-* and *cinaa-* appear in both the affirmative and the negative, we would also expect the other two, *aa-* and *ci-* (P2 and F2 indicative, respectively) to appear in position D. They do not, however, and this mysterious disappearance coincides with the appearance of the *ni-* negation marker. While Ngunga treats the morpheme combination *nga-ni-* (in Table 3 shown as two separate positions: A and B) as an allomorph of *nga-*, it can still be seen from the data he

[1] All forms shown with the first person plural subject *tu-*.

presents (2000:124) that it appears in complementary distribution with the "tense marker" (which I have attributed to position class D). In conjunction with this data, he does state that "only the allomorph *nga*" (which appears, from the data he has presented, to be the only "allomorph" with no *-ni-* at its end) "can co-occur with segmental tense markers," and that all others (presumably, those ending with *-ni-*) "do not co-occur with segmental tense markers."

It could simply be that *aa-* and *ci-*, the two tense markers that disappear in the negative, realize both tense and affirmative polarity[2], but this analysis (shown in Table 4) is unsatisfying to the extent that it portrays the mutual exclusivity of affixes in positions B and D as a coincidence.

[2] For the PFM analysis which follows this assumption, see Appendix A.

* Rule (v) is unnecessary in classic PFM, because the Identity Function Default (Stump 2001) does exactly this for any form which does not trigger any other rule in the block. However, these rules will be modified later (cf. Table 9), so I have retained all possible similarities for easy comparison.

Table 4: Ciyao Analysis in Classic PFM

		Position Occupied	Position Satisfied
i.	X, V, {remote past, affirmative} → *aa*X	D	D
ii.	X, V, {present} → *ku*X	D	D
iii.	X, V, {future, affirmative} → *ci*X	D	D
iv.	X, V, {habitual, present} → *cinaa*X	D	D
v.	X, V, {near future} → X*	D	D
vi.	[SUBJECT AGR RULES]	C	C
vii.	X, V, {negative, general past/remote past/distant future} → *ni*X	B	B
viii.	X, V, {negative} → *nga*X	A	A
ix.	X, V, {future, affirmative} → *ci*X	A	A

One could also claim that B and D are in fact the same block of affix-producing rules (where only one affix may be realized), with different rule-block orderings for the tenses in question. This solution is also not particularly compelling, since in the clearest cases of rule block reordering, the same affix appears sometimes in one order, and sometimes in another (Stump 2001:149ff); here, by contrast, the prefix *ni-* invariably precedes a verb's subject agreement prefix, while the prefixes *ku-* and *cinaa-* invariably follow it. For example, a PFM analysis of Fula by Stump (2001) shows that verbs are marked for subject agreement and object agreement by different rule blocks: III and IV, respectively. Generally, block III is applied before block IV, except in forms where the subject marker realizes the first person singular *and* the object marker is singular and personal. In this case, block III and block IV reverse their order of application. A few examples are shown in Table 5, where it is clear that the same affixes are being used (and presumably also the same affix-generating rules), but the blocks are reordered in this special case.

Table 5: Fula Verb Conjugation

Block I stem	**III**	**IV**	**Gloss**
mball-u	*-don*	*-ɓe*	'you (pl) helped them'
help.REL.PST.ACT	-you:PL	-them:CL.2	
mball-u	*-don*	*-mo(o)*	'you (pl) helped him'
help.REL.PST.ACT	-you:PL	-him:CL.1	
mball-u	*-mi*	*-ɓe*	'I helped them'
help.REL.PST.ACT	-I	-them:CL.2	
	IV	**III**	
mball-u	*-mo(o)*	*-mi*	'I helped him'
help.REL.PST.ACT	-him:CL.1	-I	

Section 3: The Debate

In fact, it appears that *ni*-, an affix in rule block B, is preventing the realization of affixes in block D. PFM allows only competition among rules in the same rule block; it does not permit competition between rules from different rule blocks. To pursue a PFM analysis of the Ciyao data in Table 3, while ideal for the rest of the paradigm, would certainly miss this major generalization.

One significant objection that linguists have raised against rule-block based theories of morphology is just this — the inability of rule blocks to compete with each other causes generalizations to be missed. In his analysis of Tamazight Berber, the data for which are shown in Table 6, Noyer (1997) posits a set of affixational rules which he argues exhibit "discontinuous bleeding," by which he means the realization of one affix may preclude the realization of another (analysis shown in Table 7). Some of these instances would be in the same rule block of a reanalysis using PFM (as seen in Stump 2001:164)— for example, according to Noyer (1997), the rule generating the second person plural *-m*[3] (d) is said to "bleed[4]" the rule generating the plural marker *-n* (h). If, however, these two rules are considered to be part of the same rule block in a PFM analysis, Pāṇini's Principle selects the former in the event of conflict, being narrower in scope.

[3] Noyer (1997) interprets this affix as the second person *masculine* plural, assuming that the second person feminine plural *-n* is different. However, Stump (2001) argues, based on data from a related Berber dialect found in Noyer (1997), that the second person plural is the single affix *-m*, but realized as *-n* in the feminine due to phonological assimilation. I will continue my analysis based on Stump's (2001) interpretation.

[4] Noyer's (1997) term for the very phenomenon I have described, in which the realization of one affixational rule prevents the realization of another.

Table 6: Tamazight Berber Verb Conjugation

		Singular	Plural
1		*dawa-ɣ*	*n-dawa*
2	masc	*t-dawa-d*	*t-dawa-m*
	fem	*t-dawa-d*	*t-dawa-n-t*
3	masc	*i-dawa*	*dawa-n*
	fem	*t-dawa*	*dawa-n-t*

Data for dawa, 'cure' (Noyer 1997:88)

Table 7: Tamazight Berber Verb Conjugation Analysis (Noyer 1997)

Affixation	Features	
a. *n-*	1 pl	(bleeds b, h)
b. *-ɣ*	1	
c. *t-*	2	
d. *-m*	masc pl (2)	(bleeds h)
e. *i-*	masc sg	
f. *t-*	fem sg	(bleeds i)
g. *-d*	sg (2)	
h. *-n*	pl	
i. *-t*	fem	

Other affixational rules in this example, however, involve relations of mutual exclusivity in distinct blocks. Noyer interprets these situations (in addition to the conflicts remedied by Pāṇini's Principle) as being resolved by feature discharge, and argues against a rule-block analysis of the data[5] (as proposed by Anderson 1992, who permits limited rule-block competition under the "Elsewhere "Principle[6]). For example, Noyer states that rule (f) bleeds rules (b) and (h), capturing the generalization that no suffixes appear in forms where the first person plural *n-* is prefixed. In a PFM analysis of this phenomenon, the plural suffix *-n* (from rule h) is simply assigned a more specific feature set — rather than requiring only the feature NUM:{plural} to be realized, it requires both NUM:{plural} and PERS:{3}. Additionally, the *-ɣ* suffix (from rule b) is considered to be the more specific first-person singular marker (contrast with the feature first person in Noyer's analysis, Table 7).

Stump (2001) improves on Noyer's analysis with his own PFM analysis (shown in Table 8), but in doing so loses the generalization that certain affixes are blocked from appearing by other affixes (which appear in separate rule blocks in Stump's analysis). In this case, however, individual rules apparently block the appearance of affixes in other rule blocks, rather than the mutual exclusivity of entire position classes (as class B prohibits the expression of class D in the case of Ciyao). This situation arises because all affixes are generated *only for the forms in which they appear*, and their appearance is considered to have nothing to do with the rules in other blocks. As mentioned in the previous

[5] His analysis, however, requires inconsistent application of the feature {PERS: 2} as a "secondary exponent" which excludes it from consideration as a "discharged feature" that would otherwise bleed later rules. For a more detailed argument for a rule block analysis of this data, see Stump (2001:156ff.).

[6] Also known as "disjunctive ordering" (Anderson 1992) or "Pāṇini's Principle" (Stump 2001), this principle simply refers to the mutual exclusivity of two affix-introducing rules. The PFM framework considers this principle to apply only to rules within the same rule block.

paragraph, the rules generating these affixes are more narrow in scope and only attempt to generate the affix in the forms whose final manifestation displays them.

Table 8: PFM Analysis of Tamazight Berber (adapted from Stump 2001)

Block A	AGR(subj):{PER:2}	*t-*
	AGR(subj):{PER:3, NUM:sg, GEN:masc}	*i-*
	AGR(subj):{PER:3, NUM:sg}	*t-*
	AGR(subj):{PER:1, NUM:pl}	*n-*
Block B	AGR(subj):{PER:1, NUM:sg}	-*ɣ*
	AGR(subj):{PER:2, NUM:pl}	-*m*
	AGR(subj):{PER:2}	-*d*
	AGR(subj):{PER:3, NUM:pl}	-*n*
Block C	AGR(subj):{PER:2/3, NUM:pl, GEN:fem}	-*t*

Halle & Marantz (1993) also interpret such affix competition as feature discharge and disagree with Anderson's (1992 and earlier) apparent inconsistency in applying the "Elsewhere" Principle across disjunctive rule blocks. As previously introduced, Anderson permits competition between rules in different rule blocks if and only if the morphosyntactic feature conditions of a rule in a later block is a subset of those of a rule in an earlier block, in which case the former rule is more specific and obstructing the application of the latter (Noyer 1997). Halle & Marantz (1993) note that if this competition is allowed, several rules in Anderson's own analyses would be unduly obstructed, yielding incorrect forms. It is clear, both from precedent and our own Ciyao example, that rules from different rule blocks can come into competition with one another, but featural discharge does not satisfactorily explain the phenomenon. To explain the Ciyao data with feature discharge, one must assume that the tense markers in position class D also realize negative polarity (in negative forms), even though these markers are exactly the same in the affirmative and would be better explained as pure tense markers. This feature discharge would allow the tense markers to prevent the appearance of the *ni*-prefix, but would it not also block the negative marker *nga*-? The *ni*-prefix could not be considered to be conducting the feature discharge, because block B is applied later than block D.

Section 4: A Proposal: Position Class Preclusion (PCP)

The data appear to imply that the rule introducing an affix occupying one position may in some cases override a rule introducing an affix occupying another, distinct position. I propose that each inflectional rule R carry two indices — the first, as usual, specifying the position of the affix introduced by R. The second index, however, specifies the position(s) that R satisfies. By default, these two indices identify the same position. However, in the case of the rule in the analysis of Ciyao that produces the affix *ni-,* the second index specifies two affix positions — B (also specified by the first index) and D. With position D satisfied, no other rules that fill it may be applied. Of course, any position that R occupies, it also satisfies. If multiple positions are satisfied, one of them must be congruent with the position occupied.

In cases where two rules, (1) and (2), are both applicable in the realization of a form, (1) overrides (2) if:

a. (1) and (2) occupy and satisfy the same position(s) and (1) is narrower (Pāṇini's principle);

b. (1) and (2) satisfy the same position(s) and (1) occupies an earlier position (D > C > B > A).

c. (2) satisfies a proper subset of the positions satisfied by (1)[7].

[7] For example, if (2) satisfies block D, but (1) satisfies blocks B and D.

Condition (a) is the same in classic PFM. Pāṇini's principle dictates that of two rules that compete within a rule block, the narrower rule applies. For example, in Table 9, rule block D, rule (ii) is always applicable anywhere (iv) is applicable, but (iv) is more narrowly defined and when it applies, it overrides (ii). In this modified version of PFM, Remote Preemption PFM (RP-PFM), condition (b) becomes necessary because rules may now compete across rule blocks — while they occupy different positions, they may satisfy the same positions. In this case, the original rule block ordering holds, and the rule that occupies an earlier position applies before the other, and the positions it satisfies may no longer be filled by any rule, including the one it competes with in this instance. In our Ciyao example, rule blocks A through D apply in reverse alphabetical order (block D, occupying the position closest to the stem, is filled first). Rules (ii) and (vii) both satisfy the same positions, B and D, so if rule (ii) (occupying an earlier block) is applied, it will override rule (vii), so that it cannot apply.

Table 9: Ciyao Analysis in RP-PFM

		Position Occupied	Position(s) Satisfied
i.	X, V, {remote past} → *aa*X	D	D
ii.	X, V, {present} → *ku*X	D	B, D
iii.	X, V, {future} → *ci*X	D	D
iv.	X, V, {habitual, present} → *cinaa*X	D	B, D
v.	X, V, {near future} → X	D	B, D
vi.	[SUBJECT AGR RULES]	C	C
vii.	X, V, {negative} → *ni*X	B	B, D
viii.	X, V, {negative} → *nga*X	A	A
ix.	X, V, {future affirmative} → *ci*X	A	A

Condition (c), on the other hand, necessitates a broader view of the order of application. To use an example from the Ciyao analysis in Table 9, rule (i) occupies and satisfies position D, but rule (vii) occupies B and satisfies both B and D; therefore, (vii) overrides (i)[8], even though it occupies a later position.

[8] Where rules (i) and (vii) are both applicable, of course.

Section 5: Other Applications of Position Class Preclusion

5.1 Tamazight Berber

Following this approach produces a much cleaner analysis of the Tamazight Berber data in Table 6, with fewer rules that better capture generalizations. With PFM modified to handle position class preclusion (PCP), the analysis requires only the eight rules in Table 10, rather than the nine required by Stump's analysis in Table 8 (full analysis in Appendix E). A slight improvement only, but the resulting rules are more general, relying less on assigning affixes to very narrow feature sets. In particular, the prefixation rules in block A have become more general, as the non-realization in the first person singular and third person plural can be explained by the rules in block B that satisfy positions A and B. In this case, only a few rules preclude the appearance of affixes from block A. This situation contrasts with the Ciyao analysis, in which entire position classes are mutually exclusive. Despite the differences in type of position blocking, the principles of PCP remain the same.

Table 10: Tamazight Berber Analysis in RP-PFM

	Position Occupied	Position(s) Satisfied
X, V, {PER:1} → *n*X	A	A, C
X, V, {} → *t*X	A	A
X, V, {PER:3, GEN:masc} → *i*X	A	A
X, V, {PER:2} → X*d*	B	B
X, V, {PER:2, NUM:pl} → X*m*	B	B
X, V, {PER:1, NUM:sg} → X*ɣ*	B	A, B
X, V, {PER:3, NUM:pl} → X*n*	B	A, B
X, V, {GEN: fem, NUM: pl} → X*t*	C	C

5.2 Latin

Position class preclusion can also account for present indicative passive forms in Latin. Take, for example, the verb ‘parāre,’ meaning ‘to prepare’ (data in Tables 11 and 12 — any differences in form are due to phonological changes).

Table 11: Latin: Active and passive present indicative forms of PARĀRE, 'prepare'

		Active	Passive
Singular	1	*paro*	*paror*
	2	*parās*	*parāris*
	3	*parāt*	*parātur*
Plural	1	*parāmus*	*parāmur*
	2	*parātis*	*parāminī*
	3	*parānt*	*parāntur*

Table 12: Latin: Expanded present indicative passive forms of PARĀRE, 'prepare'

		Active		Passive			
		stem	i	stem	i	ii	iii
Singular	1	*parā*	*-o*	*parā*	*-o*	*-r*	
	2	*parā*	*-s*	*parā*		*-r*	*-s*
	3	*parā*	*-t*	*parā*	*-t*	*-r*	
Plural	1	*parā*	*-mus*	*parā*	*-mus*	*-r*	
	2	*parā*	*-tis*	*parā*	*-minī*		
	3	*parā*	*-nt*	*parā*	*-nt*	*-r*	

In these forms, we see two major irregularities— (1) the displaced subject agreement *-s* in the second person singular and (2) the portmanteau morph in the second person plural.

Both of these can be expressed in classic PFM quite easily. However, the analysis is more streamlined in RP-PFM. Listed in Table 13 are the rules to which we must resort in classic PFM (full analysis in Appendix F). Notice the multiple more-specific rules to which we must resort in introducing the passive marker *-r*[9], as well as the fact that to account for irregularity (1), we reorder the rule blocks in the case of the second person singular.

Table 13: Latin Analysis in Classic PFM

	Position Occupied	Position Satisfied
X, V, {1 sg} → X*o*	i	i
X, V, {2 sg} → X*s*	i	i
X, V, {3 sg} → X*t*	i	i
X, V, {1 pl} → X*mus*	i	i
X, V, {2 pl passive} → X*minī*	i	i
X, V, {2 pl active} → X*tis*	i	i
X, V, {3 pl} → X*nt*	i	i
X, V, {sg pass} → X*r*	ii	ii
X, V, {1/3 pl pass} → X*r*	ii	ii
[[Order of rule block application reversed if {2 sg}]]		

[9] A more sensible analysis would be to realize -r in the passive, and let it be overridden in the form in which it does not appear. However, in PFM this override is impossible without PCP. An alternative analysis could place the -minī suffix in block ii, to allow it to override the passive -r, but the RP-PFM analysis would still be more general and require fewer rules.

These accommodations are not needed, however, in RP-PFM. If we consider that these irregularities are both due to PCP, we can write a more general analysis with fewer rules (Table 14; full analysis in Appendix G).

Table 14: Latin Analysis in RP-PFM

	Position Occupied	Position(s) Satisfied
X, V, {1 sg} → X*o*	i	i, iii
X, V, {2 sg} → X*s*	iii	i, iii
X, V, {3 sg} → X*t*	i	i, iii
X, V, {1 pl} → X*mus*	i	i, iii
X, V, {2 pl passive} → X*minī*	iii	i, ii, iii
X, V, {2 pl active} → X*tis*	i	i, iii
X, V, {3 pl} → X*nt*	i	i, iii
X, V, {pass} → X*r*	ii	ii

5.3 Portmanteau Position Classes

Position class preclusion also deals neatly with portmanteau position classes. Stump defines such a class as one whose affixes “simultaneously [occupy] two or more adjacent affix positions, excluding all other affixes that might otherwise occupy any of these positions” (2001:139). An example of a portmanteau position class can be found in Table

15, where in the negative first person singular, the prefix *si-* replaces both the expected position V negation marker *ha-* and the position IV subject agreement prefix *ni-*.

Table 15: Swahili: Partial inflectional paradigm of TAKA, 'want' (Stump 2001:140)

a. Past tense

	Affirmative			Negative				
	IV	III	Stem	V	IV	III	Stem	
1sg	*ni-*	*li-*	*taka*	*si-*		*ku-*	*taka*	
2sg	*u-*	*li-*	*taka*	*ha-*	*u-*	*ku-*	*taka*	(→ hukutaka)
3sg (class 1)	*a-*	*li-*	*taka*	*ha-*	*a-*	*ku-*	*taka*	(→ hakutaka)
1pl	*tu-*	*li-*	*taka*	*ha-*	*tu-*	*ku-*	*taka*	
2pl	*m-*	*li-*	*taka*	*ha-*	*m-*	*ku-*	*taka*	
3pl (class 2)	*wa-*	*li-*	*taka*	*ha-*	*wa-*	*ku-*	*taka*	

b. Future tense

	Affirmative			Negative				
	IV	III	Stem	V	IV	III	Stem	
1sg	*ni-*	*ta-*	*taka*	*si-*		*ta-*	*taka*	
2sg	*u-*	*ta-*	*taka*	*ha-*	*u-*	*ta-*	*taka*	(→ hutataka)
3sg (class 1)	*a-*	*ta-*	*taka*	*ha-*	*a-*	*ta-*	*taka*	(→ hatataka)
1pl	*tu-*	*ta-*	*taka*	*ha-*	*tu-*	*ta-*	*taka*	
2pl	*m-*	*ta-*	*taka*	*ha-*	*m-*	*ta-*	*taka*	
3pl (class 2)	*wa-*	*ta-*	*taka*	*ha-*	*wa-*	*ta-*	*taka*	

Contrast the example (3) with example (4), in which the prefix *si-* replaces both the negative marker *ha-* and the person agreement marker *ni-*:

(3)

ni-	ta-	taka
1sg-	FUT-	want

'I will want'

(4)

si-	ta-	taka
1sg.NEG-	FUT-	want

'I will not want'

To resolve this phenomenon with his PFM theory, Stump proposes a separate "portmanteau rule block, [...] which stands in paradigmatic opposition to two (or more) other rule blocks" (2001:141). Instead, I propose that portmanteau position classes are simply another manifestation of PCP. The portmanteau affix does not require that we postulate a portmanteau rule block; instead, I suggest that we introduce an ordinary realization rule that satisfies all of the position classes that the affix replaces.

In the proposed analysis in Table 16, the rule introducing the portmanteau affix is assigned to one of the two blocks it satisfies (IV and V; I have arbitrarily assigned it to V in the last rule shown), and is said to satisfy both of them. All other rules appear as they would in classic PFM and function normally except that the first person singular marker is precluded when the portmanteau rule applies (that is, in the first person singular negative).

Table 16: Swahili analysis in RP-PFM

	Position Occupied	Position(s) Satisfied
X, V, {affirmative past} → *li*X	iii	iii
X, V, {negative past} → *ku*X	iii	iii
X, V, {future} → *ta*X	iii	iii
X, V, {1 sg} → *ni*X	iv	iv
X, V, {2 sg} → *u*X	iv	iv
X, V, {3sg} → *a*X	iv	iv
X, V, {1 pl} → *tu*X	iv	iv
X, V, {2 pl} → *m*X	iv	iv
X, V, {3 pl} → *wa*X	iv	iv
X, V, {negative} → *ha*X	v	v
X, V, {1 sg negative} → *si*X	v	iv, v

5.4 Syntactic Theory

This notion that a linguistic item may satisfy more than just the position it occupies has implications beyond the field of morphology. For example, syntactic theory has long needed to account for this phenomenon. Called "trace" in transformational approaches and "gap" or "slash" in non-transformational models like HPSG, it has long been a concern of syntacticians that the gaps left behind in sentences like (3) (topicalization) and (4) (wh-trace) still appear to be satisfied, though nothing appears (Kathol, Przepiórkowski, & Tseng 2011, Sag & Fodor 1994).

(3)

(John and Mary are stingy with their children.)
But themselves$_i$, they pamper __$_i$.

(4)

Who$_i$ does Kim think __$_i$ will be late?

This phenomenon can perhaps be seen most clearly in examples of *wanna*-contraction. In the following example (5), sentences (a) and (b) have the same surface form, but are structurally ambiguous.

(5)

a. This is the man$_i$ I want __$_i$ to succeed.
b. This is the man$_i$ I want to succeed __$_i$.
c. This is the man$_i$ I wanna succeed __$_i$.

“This is the man I want to succeed” can mean either that the speaker wants the man to succeed, or that the speaker wants to succeed the man. Sentence (c), however, is unambiguous and can only reflect the meaning of (b). Proponents of trace theory claim that “*wh*-traces disallow the phonological contraction of *want* and *to*” (Kathol, Przepiórkowski, & Tseng 2011). HPSG proponents propose a traceless analysis, using a “slash” value to occupy the missing item’s position. Of course, this is generally interpreted as movement and is fundamentally different from PCP, a morphological phenomenon. However, the principles are similar in that words can satisfy displaced positions in addition to the ones they occupy. Since it has long been known to occur in syntax, evidence pointing to the phenomenon’s existence in morphology should, unsurprisingly, mandate its accommodation in morphological theory.

Section 6: Computability

6.1 Paradigm Function Morphology Engine

The Paradigm Function Morphology Engine (PFME) is a web-based companion program to PFM that “generate[s] word forms from language theories expressed in PFM” (Finkel and Stump, 2013). For each query, the current version of PFME, version 2.1, applies the paradigm function, which specifies the rule block order of application. For each rule block, the single best rule is selected and applied, resulting in an affix (which can be null, if the Identity Function Default is invoked) realized in that position class. PFME 2.1 does not allow any interaction between rule blocks.

Without the ability to allow rule blocks to interact, however, PFME 2.1 is limited in its ability to accurately model the inflectional process in the Ciyao data of Table 3. To create a PFM analysis that generates the correct verb forms when given as input to PFME, one must rely on one of the two methods I discussed in Section 2 — that is, one would either have to treat the mutually exclusive affix positions as the result of coincidental affix absence, or consider them to be members of the same position class (and therefore the same rule block) which reorder in certain tenses of the negative. Appendix A contains a sample analysis using the former assumption. In this analysis, no rule block interaction occurs; each distinct rule block selects a realization rule based solely on inflectional features, regardless of the rules selected in other blocks.

Part of what makes Paradigm Function Morphology so compelling is its computability. For the modification to be as compelling, the entire new model should also be computable. Therefore, PFME (the computational engine for running PFM) must be adjusted to accommodate PCP if the modification can be expected to hold water. Of course, as always, it must continue to accurately generate the paradigmatic forms from the theoretical input. For the Ciyao data, an approximation of the theoretical modification can be forced in the current PFME, simply by using a paradigm function with several variants based on morphosyntactic properties — for example, in the tenses in which the *ni*-prefix appears and the tense markers disappear, it can simply ignore the block introducing the tense markers[10]. However, this organization is not preferable. A PFM syntax for PCP would be much more convincing of its validity.

I have worked closely with Raphael Finkel, the developer of PFME, in determining the best approach to modifying PFME to accommodate PCP. Because PCP cannot affect *which* rule is selected by another rule block, but can only *prevent the appearance* of the selected affix, the core organization and function of the program remain the same. The rule selection process must change, however, as each rule is sent to output immediately upon selection. The rule selection process must be reordered so that affix realization is delayed until after PCP has been accounted for. In my proposed modifications, rules are applied only after the entire chain of blocks and rules selection is complete and precluded blocks are removed from that chain.

[10] For the PFM analysis using this approach, see Appendix B.

6.2 PFME 2.2 Process

A rule is selected from each rule block just as in PFME 2.1, building a rule chain. This chain adheres to condition (a) in my earlier discussion of rule competition (all conditions repeated below). Before it applies the chain of rules, however, PFME checks for precluded rule blocks and only applies those not precluded. If a given rule block is not precluded, then PFME applies the rule it selects, just as it would have been in PFM 2.1. If, on the other hand, a rule in the chain precludes another rule block, that rule and the rule selected from the precluded block have come into competition.

> Where rule (1) and rule (2) are both applicable in the realization of a form, (1) overrides (2) if:
>
> a. (1) and (2) occupy and satisfy the same position(s) and (1) is narrower (Pāṇini's principle); *note: this condition only applies within a given rule block — it should not affect the final check for PCP.*
>
> b. (1) and (2) satisfy the same position(s) and (1) occupies an earlier position (D > C > B > A).
>
> c. (2) satisfies a proper subset of the positions satisfied by (1).

In PFME 2.2, all rules are ranked first with respect to number of positions satisfied (in accordance with condition c) and secondly by order of rule block application (in accordance with condition b). Rules that come into competition *after* PFME has established the chain of rules are subject to conditions (b) and (c) and thus refer to this ranking in determining precedence. In accordance with condition (c) in the list above, the rule that is a proper superset of the others is ranked above them, thus overriding them[11]. If two rules merely satisfy their own block and the block of the other, condition (b) applies and the original order of rule block application holds. The rules that lose such a competition are nullified; that is, the affixes introduced by those rules are suppressed and do not appear in the final word form.

Raphael Finkel has added PCP functionality (that adheres to all three of the aforementioned conditions required by RP-PFM) to PFME version 2.2, which is now available online (Finkel 2014b). For a new analysis of the Ciyao data, using RP-PFM (compatible with the modified PFME), see Appendix C. The output of this analysis, as well as a discussion of the new process, can be found in Appendix D.

[11] This functionality is necessary for an analysis such as the Latin one in Appendix G, in which the *-mini* suffix in the second plural passive competes with the second plural suffix *-tis* in another block, but satisfies a greater set of rule blocks and thus overrides it.

Appendix A: Ciyao Analysis in Classic PFM

Rebecca Hale, last edited 3/19/14.
Language: Ciyao
Verbs

Niger-Congo; Tanzania
Based on data from Ngunga (2000)

This file build by Rebecca Hale 2014
% Intended for use with Raphael Finkel's CATS CLAW PFM generator, available online
% (Finkel 2014a)

% Indicative verbs are here specified for the following inflectional categories:
POL: affirm/neg
TENSE: pastGen/pastRem/present/futNear/futDist/none
HABIT: plus/minus

Paradigm Function
PF(<L, σ>) = A(B(C(D(G(F(Stem(<L, σ>)))))))

Rules of referral

ParadigmSchema(V) = {
POL:{affirm/neg}
TENSE:{pastGen/pastRem/present/futNear/futDist/none}
HABIT:{plus/minus}
SUBJAGR:{1pl}

% As subject agreement is not at issue in this analysis, all forms will be generated with a default 1pl subject agreement
}

% Below are paradigm constraints; i.e., forms that do not exist in the language and need not be generated.

Disallow = {
(HABIT:{plus} TENSE:{pastGen/pastRem/present/futNear/futDist}) /
(HABIT:{minus} TENSE:{none})
% The habitual form does not mark for tense.
}

Lexeme: CULTIVATE
Meaning: cultivate
Syntactic category: V

Stem operations

Stem(<CULTIVATE, σ>) = dim

Rules of exponence

Block A

A, X, σ:{TENSE:{futNear/futDist} POL:{affirm} } ⟶ ciX

A, X, σ:{POL:{neg} } ⟶ ngaX

Block B

B, X, σ:{POL:{neg} TENSE:{pastGen/pastRem/futDist} } ⟶ niX

Block C

C, X, σ:{SUBJAGR:{1pl} } ⟶ tuX

Block D

D, X, σ:{TENSE:{pastRem} POL:{affirm} } ⟶ aaX

D, X, σ:{TENSE:{present} } ⟶ kuX

D, X, σ:{TENSE:{futDist} POL:{affirm} } ⟶ ciX

D, X, σ:{HABIT:{plus} } ⟶ cinaaX

% Note that the affixes which do not appear in the negative depend on affirmative polarity for their realization.

Block F

F, X, σ:{TENSE:{pastGen/pastRem} POL:{affirm} } ⟶ Xil

Block G

G, X, σ:{TENSE:{pastGen/pastRem/futNear} POL:{affirm}} ⟶ Xe

G, X, σ:{} ⟶ Xa

PhonologicalClass vowel = a e i o u

Sandhi

{

u ⟶ w / _[vowel]

}

Truth = {

CULTIVATE:{POL:{affirm} TENSE: {pastGen} HABIT:{minus} SUBJAGR:{1pl} } = tudimile
CULTIVATE:{POL:{affirm} TENSE: {pastRem} HABIT:{minus} SUBJAGR:{1pl} } = twaadimile
CULTIVATE:{POL:{affirm} TENSE: {present} HABIT:{minus} SUBJAGR:{1pl} } = tukudima
CULTIVATE:{POL:{affirm} TENSE: {futNear} HABIT:{minus} SUBJAGR:{1pl} } = citudime
CULTIVATE:{POL:{affirm} TENSE: {futDist} HABIT:{minus} SUBJAGR:{1pl} } = citucidima
CULTIVATE:{POL:{affirm} TENSE: {none} HABIT:{plus} SUBJAGR:{1pl} } = tucinaadima
CULTIVATE:{POL:{neg} TENSE: {pastGen} HABIT:{minus} SUBJAGR:{1pl} } = nganitudima
CULTIVATE:{POL:{neg} TENSE: {pastRem} HABIT:{minus} SUBJAGR:{1pl} } = nganitudima
CULTIVATE:{POL:{neg} TENSE: {present} HABIT:{minus} SUBJAGR:{1pl} } = ngatukudima
CULTIVATE:{POL:{neg} TENSE: {futNear} HABIT:{minus} SUBJAGR:{1pl} } = ngatudima
CULTIVATE:{POL:{neg} TENSE: {futDist} HABIT:{minus} SUBJAGR:{1pl} } = nganitudima
CULTIVATE:{POL:{neg} TENSE: {none} HABIT:{plus} SUBJAGR:{1pl} } = ngatucinaadima

}

Appendix B: "Brute Force" Approach to Ciyao Data in Classic PFM

Rebecca Hale, last edited 3/19/14.
Language: Ciyao
Verbs

Niger-Congo; Tanzania
Based on data from Ngunga (2000)

This file build by Rebecca Hale 2014
% Intended for use with Raphael Finkel's CATS CLAW PFM generator, available
% (Finkel 2014a)

% Indicative verbs are here specified for the following inflectional categories:
POL: affirm/neg
TENSE: pastGen/pastRem/present/futNear/futDist/none
HABIT: plus/minus
SUBJAGR: 1pl

Paradigm Function
PF(<L, σ:{TENSE:{none/present/futNear}}>) = A(C(D(G(F()))))
PF(<L, σ:{POL:{neg} TENSE:{pastGen/pastRem/futDist}}>) = A(B(C(G(F()))))
PF(<L, σ>) = A(B(C(D(G(F())))))

Rules of referral

ParadigmSchema(V) = {
POL:{affirm/neg}
TENSE:{pastGen/pastRem/present/futNear/futDist/none}
HABIT:{plus/minus}
SUBJAGR:{1pl}

% As subject agreement is not at issue in this analysis, all forms will be generated with a default 1pl subject agreement
}

% Below are paradigm constraints; i.e., forms that do not exist in the language and need not be generated.

Disallow = {
(HABIT:{plus} TENSE:{pastGen/pastRem/present/futNear/futDist}) /
(HABIT:{minus} TENSE:{none})

% The habitual form does not mark for tense.
}

Lexeme: CULTIVATE
Meaning: cultivate
Syntactic category: V

Stem operations
Stem(<CULTIVATE, σ>) = dim

Rules of exponence
Block A
A, X, σ:{TENSE:{futNear/futDist} POL:{affirm} } ⟶ ciX
A, X, σ:{POL:{neg} } ⟶ ngaX

Block B
B, X, σ:{POL:{neg} } ⟶ niX

Block C
C, X, σ:{SUBJAGR:{1pl} } ⟶ tuX
Block D
D, X, σ:{TENSE:{pastRem}} ⟶ aaX
D, X, σ:{TENSE:{present} } ⟶ kuX
D, X, σ:{TENSE:{futDist}} ⟶ ciX
D, X, σ:{HABIT:{plus} } ⟶ cinaaX
D, X, σ:{TENSE:{futNear} } ⟶ X

% Note that the affixes which do not appear in the negative depend on affirmative polarity for their realization.
Block F
F, X, σ:{TENSE:{pastGen/pastRem} POL:{affirm} } ⟶ Xil

Block G
G, X, σ:{TENSE:{pastGen/pastRem/futNear} POL:{affirm}} ⟶ Xe
G, X, σ:{} ⟶ Xa

PhonologicalClass vowel = a e i o u

Sandhi
{
u ⟶ w / _[vowel]
}

Truth = {
CULTIVATE:{POL:{affirm} TENSE: {pastGen} HABIT:{minus} SUBJAGR:{1pl} } =
tudimile
CULTIVATE:{POL:{affirm} TENSE: {pastRem} HABIT:{minus} SUBJAGR:{1pl} } =
twaadimile
CULTIVATE:{POL:{affirm} TENSE: {present} HABIT:{minus} SUBJAGR:{1pl} } =
tukudima
CULTIVATE:{POL:{affirm} TENSE: {futNear} HABIT:{minus} SUBJAGR:{1pl} } =
citudime
CULTIVATE:{POL:{affirm} TENSE: {futDist} HABIT:{minus} SUBJAGR:{1pl} } =
citucidima
CULTIVATE:{POL:{affirm} TENSE: {none} HABIT:{plus} SUBJAGR:{1pl} } =
tucinaadima
CULTIVATE:{POL:{neg} TENSE: {pastGen} HABIT:{minus} SUBJAGR:{1pl} } =
nganitudima
CULTIVATE:{POL:{neg} TENSE: {pastRem} HABIT:{minus} SUBJAGR:{1pl} } =
nganitudima
CULTIVATE:{POL:{neg} TENSE: {present} HABIT:{minus} SUBJAGR:{1pl} } =
ngatukudima
CULTIVATE:{POL:{neg} TENSE: {futNear} HABIT:{minus} SUBJAGR:{1pl} } =
ngatudima
CULTIVATE:{POL:{neg} TENSE: {futDist} HABIT:{minus} SUBJAGR:{1pl} } =
nganitudima
CULTIVATE:{POL:{neg} TENSE: {none} HABIT:{plus} SUBJAGR:{1pl} } =
ngatucinaadima

}

Appendix C: Ciyao Analysis in RP-PFM

Rebecca Hale, last edited 4/2/14.
Language: Ciyao
Verbs

Niger-Congo; Tanzania
Based on data from Ngunga (2000)

This file build by Rebecca Hale 2014
% Intended for use with Raphael Finkel's CATS CLAW PFM generator, available online
% (Finkel 2014 b)

% Indicative verbs are here specified for the following inflectional categories:
POL: affirm/neg
TENSE: pastGen/pastRem/present/futNear/futDist/none
HABIT: plus/minus
SUBJAGR: 1pl

Paradigm Function
PF(<L, σ>) = A(B(C(D(G(F(Stem(<L, σ>)))))))

Rules of referral

ParadigmSchema(V) = {
POL:{affirm/neg}
TENSE:{pastGen/pastRem/present/futNear/futDist/none}
HABIT:{plus/minus}
SUBJAGR:{1pl}

% As subject agreement is not at issue in this analysis, all forms will be generated with a default 1pl subject agreement
}

% Below are paradigm constraints; i.e., forms that do not exist in the language and need not be generated.

Disallow = {
(HABIT:{plus} TENSE:{pastGen/pastRem/present/futNear/futDist}) /
(HABIT:{minus} TENSE:{none})
% The habitual form does not mark for tense.
}

Lexeme: CULTIVATE
Meaning: cultivate
Syntactic category: V

Stem operations

Stem(<CULTIVATE, σ>) = dim

Rules of exponence

Block A

A, X[V], σ:{TENSE:{futNear/futDist} POL:{affirm} } ⟶ ciX

A, X[V], σ:{POL:{neg} } ⟶ ngaX

Block B

B, X[V], σ:{POL:{neg} } ⟶ niX <D>

Block C

C, X[V], σ:{SUBJAGR:{1pl} } ⟶ tuX

Block D

D, X[V], σ:{TENSE:{pastRem}} ⟶ aaX

D, X[V], σ:{TENSE:{present} } ⟶ kuX <B>

D, X[V], σ:{TENSE:{futDist}} ⟶ ciX

D, X[V], σ:{HABIT:{plus} } ⟶ cinaaX <B>

D, X[V], σ:{TENSE:{futNear} } ⟶ X <B>

% Note that the affixes which do not appear in the negative depend on affirmative polarity for their realization.

Block F

F, X[V], σ:{TENSE:{pastGen/pastRem} POL:{affirm} } ⟶ Xil

Block G

G, X[V], σ:{TENSE:{pastGen/pastRem/futNear} POL:{affirm}} ⟶ Xe

G, X[V], σ:{} ⟶ Xa

PhonologicalClass vowel = a e i o u

Sandhi

{

u ⟶ w / _[vowel]

}

Truth = {
CULTIVATE:{POL:{affirm} TENSE: {pastGen} HABIT:{minus} SUBJAGR:{1pl} } = tudimile
CULTIVATE:{POL:{affirm} TENSE: {pastRem} HABIT:{minus} SUBJAGR:{1pl} } = twaadimile
CULTIVATE:{POL:{affirm} TENSE: {present} HABIT:{minus} SUBJAGR:{1pl} } = tukudima
CULTIVATE:{POL:{affirm} TENSE: {futNear} HABIT:{minus} SUBJAGR:{1pl} } = citudime
CULTIVATE:{POL:{affirm} TENSE: {futDist} HABIT:{minus} SUBJAGR:{1pl} } = citucidima
CULTIVATE:{POL:{affirm} TENSE: {none} HABIT:{plus} SUBJAGR:{1pl} } = tucinaadima
CULTIVATE:{POL:{neg} TENSE: {pastGen} HABIT:{minus} SUBJAGR:{1pl} } = nganitudima
CULTIVATE:{POL:{neg} TENSE: {pastRem} HABIT:{minus} SUBJAGR:{1pl} } = nganitudima
CULTIVATE:{POL:{neg} TENSE: {present} HABIT:{minus} SUBJAGR:{1pl} } = ngatukudima
CULTIVATE:{POL:{neg} TENSE: {futNear} HABIT:{minus} SUBJAGR:{1pl} } = ngatudima
CULTIVATE:{POL:{neg} TENSE: {futDist} HABIT:{minus} SUBJAGR:{1pl} } = nganitudima
CULTIVATE:{POL:{neg} TENSE: {none} HABIT:{plus} SUBJAGR:{1pl} } = ngatucinaadima

}

Appendix D: Output of Ciyao Analysis in RP-PFM

Paradigm Function Morphology Engine (PFME)
Ciyao

Version 2.2

If you use results from this tool, please acknowledge its creators: Raphael Finkel and Gregory Stump at the University of Kentucky. Send suggestions and comments to Raphael Finkel.

CULTIVATE | skip over theory results

CULTIVATE: (cultivate)											
12 queries from paradigm schema V.											
POL:{affirm} TENSE:{pastGen} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{affirm} SUBJAGR:{1pl} TENSE:{pastGen} >	dim	F 1: ↩ dimil	G 1: ↩ dimile	Block D: default	C 1: ↩ tudimile	Block B: default	Block A: default	tudimile	✔
POL:{affirm} TENSE:{pastRem} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{affirm} SUBJAGR:{1pl} TENSE:{pastRem} >	dim	F 1: ↩ dimil	G 1: ↩ dimile	D 1: ↩ aadimile	C 1: ↩ tuaadimile	Block B: default	Block A: default	twaadimile	✔
POL:{affirm} TENSE:{present} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{affirm} SUBJAGR:{1pl} TENSE:{present} >	dim	Block F: default	G 2: ↩ dima	D 2: ↩ kudima	C 1: ↩ tukudima	Block B: default	Block A: default	tukudima	✔
POL:{affirm} TENSE:{futNear} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{affirm} SUBJAGR:{1pl} TENSE:{futNear} >	dim	Block F: default	G 1: ↩ dime	D 5: ↩ dime	C 1: ↩ tudime	Block B: default	A 1: ↩ citudime	citudime	✔
POL:{affirm} TENSE:{futDist} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{affirm} SUBJAGR:{1pl} TENSE:{futDist} >	dim	Block F: default	G 2: ↩ dima	D 3: ↩ cidima	C 1: ↩ tucidima	Block B: default	A 1: ↩ citucidima	citucidima	✔
POL:{affirm} TENSE:{none} HABIT:{plus} SUBJAGR:{1pl}	<dim, HABIT:{plus} POL:{affirm} SUBJAGR:{1pl} TENSE:{none} >	dim	Block F: default	G 2: ↩ dima	D 4: ↩ cinaadima	C 1: ↩ tucinaadima	Block B: default	Block A: default	tucinaadima	✔
POL:{neg} TENSE:{pastGen} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{neg} SUBJAGR:{1pl} TENSE:{pastGen} >	dim	Block F: default	G 2: ↩ dima	Block D: default	C 1: ↩ tudima	B 1: ↩ nitudima	A 2: ↩ nganitudima	nganitudima	✔
POL:{neg} TENSE:{pastRem} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{neg} SUBJAGR:{1pl} TENSE:{pastRem} >	dim	Block F: default	G 2: ↩ dima	Block D: precluded	C 1: ↩ tudima	B 1: ↩ nitudima	A 2: ↩ nganitudima	nganitudima	✔
POL:{neg} TENSE:{present} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{neg} SUBJAGR:{1pl} TENSE:{present} >	dim	Block F: default	G 2: ↩ dima	D 2: ↩ kudima	C 1: ↩ tukudima	Block B: precluded	A 2: ↩ ngatukudima	ngatukudima	✔
POL:{neg} TENSE:{futNear} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{neg} SUBJAGR:{1pl} TENSE:{futNear} >	dim	Block F: default	G 2: ↩ dima	D 5: ↩ dima	C 1: ↩ tudima	Block B: precluded	A 2: ↩ ngatudima	ngatudima	✔
POL:{neg} TENSE:{futDist} HABIT:{minus} SUBJAGR:{1pl}	<dim, HABIT:{minus} POL:{neg} SUBJAGR:{1pl} TENSE:{futDist} >	dim	Block F: default	G 2: ↩ dima	Block D: precluded	C 1: ↩ tudima	B 1: ↩ nitudima	A 2: ↩ nganitudima	nganitudima	✔
POL:{neg} TENSE:{none} HABIT:{plus} SUBJAGR:{1pl}	<dim, HABIT:{plus} POL:{neg} SUBJAGR:{1pl} TENSE:{none} >	dim	Block F: default	G 2: ↩ dima	D 4: ↩ cinaadima	C 1: ↩ tucinaadima	Block B: precluded	A 2: ↩ ngatucinaadima	ngatucinaadima	✔

Appendix E: Tamazight Berber Analysis in RP-PFM

Rebecca Hale, last edited 4/6/14.
Language: Tamazight Berber
Verbs

Afro-Asiatic; Morocco
Based on data from Noyer (1997)

This file build by Rebecca Hale 2014
% Intended for use with Raphael Finkel's CATS CLAW PFM generator, available online
% (Finkel 2014b)

% Indicative verbs are here specified for the following inflectional categories:
PER: 1/2/3
NUM: sg/pl
GEN: fem/masc

Paradigm Function
PF(<L, σ>) = C(B(A(Stem(<L, σ>))))

Rules of referral

ParadigmSchema(V) = {
PER:{1/2/3}
NUM:{sg/pl}
GEN:{fem/masc}

}

Lexeme: CURE
Meaning: cure
Syntactic category: V

Stem operations
Stem(<CURE, σ>) = dawa

Rules of exponence
Block A
A, X[V], σ:{PER:{1}} ⟶ nX <C>
A, X[V], σ:{} ⟶ tX

A, X[V], σ:{PER:{3} GEN:{masc}} ⟶ iX

Block B

B, X[V], σ:{PER:{2} } ⟶ Xd

B, X[V], σ:{PER:{2} NUM:{pl} } ⟶ Xm

B, X[V], σ:{PER:{1} NUM:{sg} } ⟶ Xɣ <A>

B, X[V], σ:{PER:{3} NUM:{pl} } ⟶ Xn <A>

Block C

C, X[V], σ:{GEN:{fem} NUM:{pl} } ⟶ Xt

Sandhi
{
m ⟶ n / _t
}

Truth = {
CURE:{PER:{1} NUM: {sg} GEN:{fem}} = dawaɣ
CURE:{PER:{1} NUM: {sg} GEN:{masc}} = dawaɣ
CURE:{PER:{1} NUM: {pl} GEN:{fem}} = ndawa
CURE:{PER:{1} NUM: {pl} GEN:{masc}} = ndawa
CURE:{PER:{2} NUM: {sg} GEN:{fem}} = tdawad
CURE:{PER:{2} NUM: {sg} GEN:{masc}} = tdawad
CURE:{PER:{2} NUM: {pl} GEN:{fem}} = tdawant
CURE:{PER:{2} NUM: {pl} GEN:{masc}} = tdawam
CURE:{PER:{3} NUM: {sg} GEN:{fem}} = tdawa
CURE:{PER:{3} NUM: {sg} GEN:{masc}} = idawa
CURE:{PER:{3} NUM: {pl} GEN:{fem}} = dawant
CURE:{PER:{3} NUM: {pl} GEN:{masc}} = dawan

}

Appendix F: Latin Analysis in Classic PFM

Rebecca Hale, last edited 4/6/14.
Language: Latin
Verbs

This file build by Rebecca Hale 2014
% Intended for use with Raphael Finkel's CATS CLAW PFM generator, available online
% (Finkel 2014a)

% Indicative verbs are here specified for the following inflectional categories:
PER: 1/2/3
NUM: sg/pl
VOI: act/pass

Paradigm Function
PF(<L, σ>) = II(I(Stem(<L, σ>)))
PF(<L, σ:{PER:{2} NUM:{sg}}>) = I(II(Stem(<L, σ>)))

Rules of referral

ParadigmSchema(V) = {
PER:{1/2/3}
NUM:{sg/pl}
VOI:{act/pass}
}

Lexeme: PREPARE
Meaning: prepare
Syntactic category: V

Stem operations
Stem(<PREPARE, σ>) = parā

Rules of exponence
Block I
I, X[V], σ:{PER:{1} NUM:{sg}} ⟶ Xo
I, X[V], σ:{PER:{2} NUM:{sg}} ⟶ Xs
I, X[V], σ:{PER:{3} NUM:{sg}} ⟶ Xt
I, X[V], σ:{PER:{1} NUM:{pl}} ⟶ Xmus
I, X[V], σ:{PER:{2} NUM:{pl} VOI:{pass}} ⟶ Xminī

I, X[V], σ:{PER:{2} NUM:{pl} VOI:{act}} ⟶ Xtis
I, X[V], σ:{PER:{3} NUM:{pl}} ⟶ Xnt

Block II

II, X[V], σ:{NUM:{sg} VOI:{pass} } ⟶ Xr
II, X[V], σ:{PER:{1} NUM:{pl} VOI:{pass}} ⟶ Xr
II, X[V], σ:{PER:{3} NUM:{pl} VOI:{pass}} ⟶ Xr

Sandhi
{
ā → Ø / _o
s → Ø / _r
r → ri / _s
t → tu / _r
}

Truth = {
PREPARE:{PER:{1} NUM: {sg} VOI:{act}} = paro
PREPARE:{PER:{2} NUM: {sg} VOI:{act}} = parās
PREPARE:{PER:{3} NUM: {sg} VOI:{act}} = parāt
PREPARE:{PER:{1} NUM: {pl} VOI:{act}} = parāmus
PREPARE:{PER:{2} NUM: {pl} VOI:{act}} = parātis
PREPARE:{PER:{3} NUM: {pl} VOI:{act}} = parānt
PREPARE:{PER:{1} NUM: {sg} VOI:{pass}} = paror
PREPARE:{PER:{2} NUM: {sg} VOI:{pass}} = parāris
PREPARE:{PER:{3} NUM: {sg} VOI:{pass}} = parātur
PREPARE:{PER:{1} NUM: {pl} VOI:{pass}} = parāmur
PREPARE:{PER:{2} NUM: {pl} VOI:{pass}} = parāminī
PREPARE:{PER:{3} NUM: {pl} VOI:{pass}} = parāntur
}

Appendix G: Latin Analysis in RP-PFM

Rebecca Hale, last edited 4/6/14.
Language: Latin
Verbs

This file build by Rebecca Hale 2014
% Intended for use with Raphael Finkel's CATS CLAW PFM generator, available online
% (Finkel 2014b)

% Indicative verbs are here specified for the following inflectional categories:
PER: 1/2/3
NUM: sg/pl
VOI: act/pass

Paradigm Function
PF(<L, σ>) = III(II(I(Stem(<L, σ>))))

Rules of referral

ParadigmSchema(V) = {
PER:{1/2/3}
NUM:{sg/pl}
VOI:{act/pass}
}

Lexeme: PREPARE
Meaning: prepare
Syntactic category: V

Stem operations
Stem(<PREPARE, σ>) = parā

Rules of exponence
Block I
I, X[V], σ:{PER:{1} NUM:{sg}} ⟶ Xo <III>
I, X[V], σ:{PER:{3} NUM:{sg}} ⟶ Xt <III>
I, X[V], σ:{PER:{1} NUM:{pl}} ⟶ Xmus <III>
I, X[V], σ:{PER:{2} NUM:{pl} } ⟶ Xtis <III>
I, X[V], σ:{PER:{3} NUM:{pl}} ⟶ Xnt <III>

Block II

II, X[V], σ:{VOI:{pass} } ⟶ Xr

Block III

III, X[V], σ:{PER:{2} NUM:{sg}} ⟶ Xs <I>

III, X[V], σ:{PER:{2} NUM:{pl} VOI:{pass}} ⟶ Xminī <I II>

Sandhi
{
ā → Ø / _o
s → Ø / _r
r → ri / _s
t → tu / _r
}

Truth = {
PREPARE:{PER:{1} NUM: {sg} VOI:{act}} = paro
PREPARE:{PER:{2} NUM: {sg} VOI:{act}} = parās
PREPARE:{PER:{3} NUM: {sg} VOI:{act}} = parāt
PREPARE:{PER:{1} NUM: {pl} VOI:{act}} = parāmus
PREPARE:{PER:{2} NUM: {pl} VOI:{act}} = parātis
PREPARE:{PER:{3} NUM: {pl} VOI:{act}} = parānt
PREPARE:{PER:{1} NUM: {sg} VOI:{pass}} = paror
PREPARE:{PER:{2} NUM: {sg} VOI:{pass}} = parāris
PREPARE:{PER:{3} NUM: {sg} VOI:{pass}} = parātur
PREPARE:{PER:{1} NUM: {pl} VOI:{pass}} = parāmur
PREPARE:{PER:{2} NUM: {pl} VOI:{pass}} = parāminī
PREPARE:{PER:{3} NUM: {pl} VOI:{pass}} = parāntur
}

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