Paradigm Function Morphology

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1 What is Paradigm Function Morphology?

'Paradigm Function Morphology' is a name, and like many names, it has more than one referent. On one hand, it refers to a collection of leading ideas for morphological (especially inflectional) theory; on the other hand, it refers to a collection of formal theories that have been proposed in the last 20 years to embody these leading ideas. In this paper we elucidate both senses of the term, explicitly separating the contingent from the essential in Paradigm Function Morphology (PFM). §2 presents the core assumptions that are shared by all instantiations of the theory. In §3, we present a streamlined version of the instantiation of PFM presented in Stump (2001). As this is the first fully articulated version of PFM, we will call it PFM1. In §4 we discuss a range of new approaches and directions for PFM; many of these necessitate modifications of the system of principles and formalisms that we present, but all are consonant with the leading ideas that are at the theory's core.

2 Core assumptions of PFM

The leading ideas of PFM are fairly few in number, but they impose important constraints on any formal instantiation of the theory. Some of these leading ideas are shared with other morphological theories, but no other theory shares the full set of core assumptions constituting PFM.

2.1 Core assumption: Morphology is an autonomous system.

This autonomy is manifested in two ways.

2.1.1 Purely morphological representations and categories

While there are interface representations and categories that a language's morphology shares with its syntactic, phonological, and semantic components, it also has purely morphological representations and categories to which these other components are blind. For instance, rules of morphology may be sensitive to (a) an expression's syntactic category and morphosyntactic properties, (b) an expression's segmental and prosodic properties, and (c) to aspects of its denotation, as in the respective examples in (1).

(1) a. In English, verbs take the suffix *-s* as an expression of third person, singular number, present tense, and indicative mood.
  b. In English, syncretism of a verb's infinitive and past-tense forms is limited to verbs that end in an oral dental stop (e.g. *beat*, *cast*, *shed*, *spread*); English morphology defines a correspondence between nouns with trochaic stress and verbs with iambic stress (e.g. *conflict*, *record*, *suspect*).
  c. In Breton, the suffix *-enn* joins with nouns lacking individual reference (including collectives, which are syntactically plural, and mass nouns, which are syntactically singular) to produce singulatives (count nouns capable of individual reference): *kelien* 'flies', *nez* 'nits', *plouz* 'straw', *glav* 'rain' → *kelienenn* 'fly', *nezenn* 'nit', *plouzenn* 'piece of straw', *glavenn* 'raindrop'.

But rules of morphology may also be sensitive to, for instance, (a) inflection-class membership or to (b) a word's headedness, as in the examples in (2); no other grammatical component is sensitive to categories or representations of these sorts.

(2) a. English morphology treats the verbs *knit*, *hit*, and *sit* as members of different conjugation classes, distinguishable by their past-tense forms *knitted*, *hit*, and *sat*.

b. In English morphology, the verb *understand* (unlike its synonym *comprehend*) functions as a headed structure, whose irregular past tense *understood* follows from that of its head *stand* (past tense *stood*).

2.1.2 Internal architecture

A language's morphology has its own internal architecture, whose structure is not reducible to that of any independent component(s) of grammar, whose internal workings aren't accessible to other components, and many of whose properties can be motivated and investigated independently of other grammatical components. At the foundation of this architecture are the concepts of 'lexeme', 'paradigm', and 'realization'. A lexeme is a meaningful lexical unit belonging to a syntactic category which may be associated with sets of morphosyntactic properties; each such association ordinarily has a realization, a phonological embodiment. A lexeme's full inventory of realizable associations of this sort is its paradigm. Different kinds of morphology are distinguished according to how they build on this conceptual foundation: rules of inflection determine a lexeme's realizations; rules of derivation derive one lexeme from another; and rules of compounding combine lexemes to produce compound lexemes.

2.2 Core assumption: The definition of a language's inflectional morphology is the definition of its paradigm function.

A language's paradigm function is a function PF from any cell in the paradigm of any lexeme in that language to the realization of that cell. In our formal articulation of this notion, a cell in the paradigm of a lexeme L is the pairing of L with a well-formed and complete set of morphosyntactic properties appropriate to L.[1] In addition, we follow Stewart & Stump 2007 in assuming that the value of a paradigm function applying to a cell $\langle L, \sigma\rangle$ is the pairing of this cell's realization R with the morphosyntactic property set σ: $PF(\langle L, \sigma\rangle) = \langle R, \sigma\rangle$. The latter assumption facilitates the definition of PF in terms of realization rules, whose output is always a ⟨form, property set⟩ pairing; see §3.3.

For concreteness, consider the inflection of verbs in modern Icelandic. Icelandic verbs inflect for the twenty-seven morphosyntactic property sets in (3);[2] the verbs in Table 1 illustrate. Given these facts, the Icelandic paradigm function PF must clearly be defined so that it produces values such as those in (4).[3]

(3)	{ind prs 1sg}	{ind pst 1sg}	{sbjv prs 1sg}	{sbjv pst 1sg}	
	{ind prs 2sg}	{ind pst 2sg}	{sbjv prs 2sg}	{sbjv pst 2sg}	{imp 2sg}
	{ind prs 3sg}	{ind pst 3sg}	{sbjv prs 3sg}	{sbjv pst 3sg}	
	{ind prs 1pl}	{ind pst 1pl}	{sbjv prs 1pl}	{sbjv pst 1pl}	{imp 1pl}
	{ind prs 2pl}	{ind pst 2pl}	{sbjv prs 2pl}	{sbjv pst 2pl}	{imp 2pl}
	{ind prs 3pl}	{ind pst 3pl}	{sbjv prs 3pl}	{sbjv pst 3pl}	

[1]A morphosyntactic property set is well-formed only if it doesn't contain incompatible properties (*{singular plural}) and is complete if no property can be added to it without producing ill-formedness. Whether a morphosyntactic property set σ is appropriate to lexeme L may depend on L's syntactic category membership (e.g. properties of tense and mood are appropriate to verbal lexemes in English, but not to nominal lexemes) or on L's membership in some subcategory (e.g. properties of degree are appropriate to adjectival and adverbial lexemes that have gradable semantics).

In the slightly different definition assumed by Stump 2001, a cell in the paradigm of lexeme L is a pairing of L's root with a well-formed and complete set of morphosyntactic properties appropriate to L.

[2] Here we restrict our attention to verb forms that are both finite and synthetic, leaving aside the infinitive, the participles and periphrastic realizations; see §3.8 for discussion of periphrasis.

[3] Here and below, we use the notation σ:{X} to restrict the possible values of σ (a metalinguistic variable over well-formed and complete morphosyntactic property sets) to (proper or improper) supersets of {X}.

TABLE 1. Finite synthetic realizations of four Icelandic verbs

		Indicative		Subjunctive		Imperative
		Present	Past	Present	Past	
KALLA 'shout' (Conjugation WEAK.4.A)	1sg	*kalla*	*kallaði*	*kalli*	*kallaði*	
	2sg	*kallar*	*kallaðir*	*kallir*	*kallaðir*	*kalla*
	3sg	*kallar*	*kallaði*	*kalli*	*kallaði*	
	1pl	*köllum*	*kölluðum*	*köllum*	*kölluðum*	*köllum*
	2pl	*kallið*	*kölluðuð*	*kallið*	*kölluðuð*	*kallið*
	3pl	*kalla*	*kölluðu*	*kalli*	*kölluðu*	
ÆTLA 'intend' (Conjugation WEAK.4.B)	1sg	*ætla*	*ætlaði*	*ætli*	*ætlaði*	
	2sg	*ætlar*	*ætlaðir*	*ætlir*	*ætlaðir*	*ætlaðu*
	3sg	*ætlar*	*ætlaði*	*ætli*	*ætlaði*	
	1pl	*ætlum*	*ætluðum*	*ætlum*	*ætluðum*	*ætlum*
	2pl	*ætlið*	*ætluðuð*	*ætlið*	*ætluðuð*	*ætlið*
	3pl	*ætla*	*ætluðu*	*ætli*	*ætluðu*	
GRÍPA 'grasp' (Conjugation STRONG.1.A)	1sg	*gríp*	*greip*	*grípi*	*gripi*	
	2sg	*grípur*	*greipst*	*grípir*	*gripir*	*gríp*
	3sg	*grípur*	*greip*	*grípi*	*gripi*	
	1pl	*grípum*	*gripum*	*grípum*	*gripum*	*grípum*
	2pl	*grípið*	*gripuð*	*grípið*	*gripuð*	*grípið*
	3pl	*grípa*	*gripu*	*grípi*	*gripu*	
FLJÚGA 'fly' (Conjugation STRONG.2.B)	1sg	*flýg*	*flaug*	*fljúgi*	*flygi*	
	2sg	*flýgur*	*flaugst*	*fljúgir*	*flygir*	*fljúg*
	3sg	*flýgur*	*flaug*	*fljúgi*	*flygi*	
	1pl	*fljúgum*	*flugum*	*fljúgum*	*flygjum*	*fljúgum*
	2pl	*fljúgið*	*fluguð*	*fljúgið*	*flygjuð*	*fljúgið*
	3pl	*fljúga*	*flugu*	*fljúgi*	*flygju*	

Source: Jörg 1989.

(4) a. PF(⟨KALLA, σ:{ind pst 2sg}⟩) = ⟨*kallaðir*, σ⟩
b. PF(⟨ÆTLA, σ:{ind prs 1pl}⟩) = ⟨*ætlum*, σ⟩
c. PF(⟨GRÍPA, σ:{imp 2sg}⟩) = ⟨*gríp*, σ⟩
d. PF(⟨FLJÚGA, σ:{ind pst 1sg}⟩) = ⟨*flaug*, σ⟩

2.3 Core assumption: The definition of a language's paradigm function is inferential and realizational.

The definition of an inflectional system is realizational if it is formulated as deducing a word's form from its content; the opposite of a realizational definition is one that is incremental, which constructs a word's content on the basis of its form. The definition of an inflectional system is inferential if it employs rules for deducing morphologically complex word forms from more basic stems; the opposite of an inferential definition is one that is lexical, which portrays morphologically complex word forms as arising through the combination of lexically listed formatives, including both stems and affixes. A core assumption of PFM is that inflectional morphology is both inferential and realizational in its definition. Thus, the content of the cell ⟨KALLA, {ind pst 2sg}⟩ is logically prior to its realization; it is this content that determines the form of its realization. In particular, the realization of ⟨KALLA, {ind pst 2sg}⟩ arises from KALLA's stem *kall* by means of a succession of realization rules, rules of exponence that license the inference of forms of progressively greater complexity marked by the suffixes *-a*, *-ði* and *-r*; each of these rules has a role in the definition of the Icelandic paradigm function.

2.4 Core assumption: The definition of a language's paradigm function may include implicative rules

In many paradigms, two or more cells share the same realization; that is, they exhibit syncretism. In some instances, syncretism simply stems from a kind of poverty in a language's system of exponents: two cells have the same realization because there is no exponent for the morphosyntactic properties that distinguish them; an example of this sort from Icelandic is the syncretism of ⟨KALLA, {ind pst 2sg}⟩ and ⟨KALLA, {sbjv pst 2sg}⟩. In other instances, ⟨L, σ′⟩ is parasitic on cell ⟨L, σ⟩ in that it takes on a realization that the rules of exponence supply for ⟨L, σ⟩ but not for ⟨L, σ′⟩. In Sanskrit, for example, a neuter noun's nominative forms are invariably the same as its accusative forms, regardless of the morphology involved; the partial paradigms of the neuter nouns DĀNA 'gift' and JAGAT 'world' in Table 2 illustrate. Moreover, *a*-stem nouns such as DĀNA 'gift' reveal that it is the nominative that patterns after the accusative, since the *-m* suffix of *dānam* is restricted to the accusative singular in the paradigms of *a*-stem masculines, e.g. AŚVA.

TABLE 2. Partial declensional paradigms of three nouns in Sanskrit

	DĀNA 'gift' (neut.)			JAGAT 'world' (neut.)			AŚVA 'horse' (masc.)		
	SG	DU	PL	SG	DU	PL	SG	DU	PL
NOM	*dānam*	*dāne*	*dānāni*	*jagat*	*jagatī*	*jaganti*	*aśvaḥ*	*aśvau*	*aśvāḥ*
VOC	*dāna*	*dāne*	*dānāni*	*jagat*	*jagatī*	*jaganti*	*aśva*	*aśvau*	*aśvāḥ*
ACC	*dānam*	*dāne*	*dānāni*	*jagat*	*jagatī*	*jaganti*	*aśvam*	*aśvau*	*aśvān*
GEN	*dānasya*	*dānayos*	*dānānām*	*jagatas*	*jagatos*	*jagatām*	*aśvasya*	*aśvayoḥ*	*aśvānām*
LOC	*dāne*	*dānayos*	*dāneṣu*	*jagati*	*jagatos*	*jagatsu*	*aśve*	*aśvayoḥ*	*aśveṣu*

It is a core assumption of PFM that such parasitism is to be modeled by IMPLICATIVE rules, which explicitly relate the realization of one cell in a paradigm to that of another cell. Implicative rules may take the form of clauses in the definition of a language's paradigm function; for instance, the nominative-accusative syncretism may be modeled by clause (5) in the definition of the Sanskrit paradigm function.

(5) If L is a neuter nominal and PF(⟨L, σ:{acc NUM:α}⟩) = ⟨Y, σ⟩, then
PF(⟨L, σ′:{nom NUM:α}⟩) = ⟨Y, σ′⟩.

The use of implicative rules like (5) clearly puts PFM in the family of Word and Paradigm approaches to morphology (Hockett 1954), as such rules describe the realization of one cell in a lexeme's paradigm by reference to that of another cell in that paradigm.

2.5 Core assumption: Competition among inflectional rules is invariably resolved by Pāṇini's principle.

Pāṇini's principle is the principle that if two rules are in competition, then it is the rule that is applicable in a narrower class of cases that 'wins'. This principle can be appealed to in order to account for the distribution of 2sg exponents in Icelandic: in the general case, the exponent is *r*, but this is overridden by the absence of any exponent in the imperative 2sg, which is itself overridden by the exponent *ðu* for verbs belonging to weak conjugation 4.b.

Pāṇini's principle is central to PFM, not simply because it is appealed to in order to account for the resolution of rule competition in specific cases, but because it is hypothesized to be the only principle for the resolution of rule competition (= the Pāṇinian Determinism Hypothesis; Stump 2001: 23). This is in sharp contrast to the hypotheses of other realizational theories such as A-morphous Morphology (Anderson 1992) or Distributed Morphology (Halle & Marantz 1993).[4]

2.6 Core assumptions about word formation, heads and the Head-Application Principle

Recent work in morphological theory reveals considerable disagreement over the question of whether lexemes have heads; some have argued that all lexemes are headed, and others that no lexeme is headed. Stump (1995, 2001:118) argues for a kind of middle ground, according to which a lexeme is headed if and only if it arises through the operation of a category-preserving rule of lexeme formation[5]; on this view, UNLOAD is headed by LOAD and DOG HOUSE is headed by HOUSE, but DOG, WRITER and RIP-OFF are unheaded, as are inflected word forms such as *dogs* and *loaded*. A category-preserving rule of word-formation is one which allows properties of the base lexeme to which it applies to persist as properties of the complex lexeme that it defines; thus, UNLOAD is a verb because LOAD is, DOG HOUSE is a noun because HOUSE is.

In PFM, the inflection of a headed lexeme is regulated by the Head-Application Principle: where lexeme L_1 with root X_1 arises from lexeme L_2 with root X_2 through the application of a category-preserving rule R (so that $R(X_2) = X_1$), lexeme L_1 inflects through the inflection of L_2—that is, for any cell $\langle L_1, \sigma\rangle$ in the paradigm of L_1, if $PF(\langle L_2, \sigma\rangle) = \langle Y, \sigma\rangle$, then $PF(\langle L_1, \sigma\rangle) = \langle R(Y), \sigma\rangle$. This principle entails (i) that any irregularities inhering in the inflection of a lexeme L will also appear in the inflection of any lexeme headed by L (as in the case of *understood*, *rewrote* and *grandchildren*) and (ii) that a headed word's inflectional markings will appear "inside of" its marking of category-preserving word formation. Entailment (ii) is clearly confirmed in Sanskrit, where verbs such as PRATI-GAM 'go back' (which is headed by GAM 'go') have imperfect forms such as *praty-a-gacchat* 's/he went back', in which the preterite prefix *a-* is "inside of" the compounded adposition *prati* 'towards'. But entailment (ii) is also confirmed by the fact that the headed adjective UNHAPPY inflects as *unhappier*: although the rule for comparatives in *-er* only applies to short adjectives (*friendlier*, **gentlemanlier*), UNHAPPY inflects through the inflection of its head HAPPY, hence *unhappier* is fully as acceptable as *happier*.

The Head-Application Principle has a number of desirable consequences; for instance, it entails that the verbs UNDERSTAND and GRANDSTAND should inflect differently (*understood*, but *grandstanded*), because the former is headed while the latter is not. For detailed discussion of the Head-Application Principle and its consequences, see Stump 1993a, 1995, 2001.

3 The standard version of Paradigm Function Morphology: PFM1

Stump (2001) contains an intricate system of principles, modeling decisions, and analytic techniques that amount to a formally explicit instantiation of the leading ideas from §2. In the interest of clarity we will call this particular formal theory PFM1. In this section, we outline a streamlined version of PFM1, which differs minimally from Stump (2001) in adopting simpler notations and terminology.

The main design property of PFM1 is that the specification of a paradigm function takes the form of a set of realization rules organized in successive blocks. For instance, the analysis of KALLA's {ind pst 2sg} form *kallaðir* in Icelandic involves 4 successive steps:

[4] Network Morphology (Brown & Hippisley 2012) adheres to Pāṇinian Determinism, though it is interpreted quite differently from the way it is interpreted in PFM, because of the use of ordered features.

[5] We use 'lexeme formation' as a cover term for both derivation and compounding.

(6) a. Choosing a basic stem *kall* (Initial step: basic stem choice)
b. Suffixing the theme vowel *a* (Block I)
c. Suffixing the {pst sg} exponent *ði* (Block II)
d. Suffixing the {2sg} exponent *r* (Block III)

Rules in the same block are in paradigmatic opposition (only one of the rules in a block may apply) and choice among rules is arbitrated by Narrowness, the PFM1 implementation of Pāṇini's principle. Rules in different blocks are in syntagmatic opposition (one rule from each block must apply), and the order of blocks is stipulated rather than following from independent principles.

3.1 Rule types

PFM distinguishes three kinds of realization rules which, conceptually, do three different things. If a lexeme L has more than one basic stem, a rule of basic stem choice specifies which of these is to be used in the realization of a particular cell in L's paradigm. A rule of exponence specifies how the basic stem chosen for L is to be marked in the realization of a particular cell in L's paradigm. A rule of referral specifies that the realization of one cell in L's paradigm patterns after the realization of a different cell in L's paradigm. Realization rules of these three sorts are supplemented by morphological metageneralizations: generalizations about the phonological effects of rules of exponence.

3.1.1 Rules of basic stem choice

We must be clear at the outset about the two senses of 'stem' relevant to PFM. To distinguish these, consider the inflection of GRÍPA 'grasp' in Table 1. In the analysis that we will propose, we assume that this lexeme has six stems, that is, six strings that serve as input to rules of exponence: *gríp*, *greip*, *grip*, *gríp-i*, *grip-i* and *grip*. At the same time, the first three are 'basic' in the sense that they are directly associated with the lexeme GRÍPA by rules of stem choice; 'nonbasic' stems are inferrable from basic ones by means of rules of exponence. We use 'stem' in the more general, inclusive sense, and 'basic stem' in the more restrictive sense.

We formulate rules of basic stem choice as clauses in the definition of a function ***Stem*** which applies to a cell ⟨L, σ⟩ in the paradigm of lexeme L to yield the pair ⟨W, σ⟩, where W is the basic stem choice for the realization of ⟨L, σ⟩. For the Icelandic verbs in Table 1, we propose the rules of basic stem choice in (7). Because σ is a variable over well-formed and complete morphosyntactic property sets, the rules in (7) are in fact rule schemata: each specifies the value of ***Stem*** for a set of cells. In the case of rule (7a), this is the full set of twenty-seven cells in the (finite synthetic) paradigm of KALLA; rule (7c), by contrast, specifies the value of ***Stem*** for only three cells (the singular past indicative cells in the paradigm of GRÍPA).

(7) Rules of basic stem choice for the Icelandic verbs in Table 1

a. ***Stem***(⟨KALLA, σ:{}⟩) = ⟨*kall*, σ⟩
b. ***Stem***(⟨ÆTLA, σ:{}⟩) = ⟨*ætl*, σ⟩
c. ***Stem***(⟨GRÍPA, σ:{ind pst sg}⟩) = ⟨*greip*, σ⟩
d. ***Stem***(⟨GRÍPA, σ:{pst}⟩) = ⟨*grip*, σ⟩
e. ***Stem***(⟨GRÍPA, σ:{}⟩) = ⟨*gríp*, σ⟩
f. ***Stem***(⟨FLJÚGA, σ:{ind pst sg}⟩) = ⟨*flaug*, σ⟩
g. ***Stem***(⟨FLJÚGA, σ:{ind pst}⟩) = ⟨*flug*, σ⟩
h. ***Stem***(⟨FLJÚGA, σ:{pst}⟩) = ⟨*flyg*, σ⟩
i. ***Stem***(⟨FLJÚGA, σ:{ind prs sg}⟩) = ⟨*flýg*, σ⟩
j. ***Stem***(⟨FLJÚGA, σ:{}⟩) = ⟨*fljúg*, σ⟩

There are occasional conflicts among the rules in (7). For instance, the value of ***Stem***(⟨GRÍPA, σ:{ind pst 1sg}⟩) is ⟨*greip*, σ⟩ according to (7c), ⟨*grip*, σ⟩ according to (7d), and ⟨*gríp*, σ⟩ according to (7e). Which is right? Because (7c) is narrower in its application than both (7d) and (7e) ((7c) applies to three cells, (7d) to twelve, and (7e) to twenty-seven), Pāṇini's principle dictates that (7c) overrides its competitors.

It is often the case that lexemes belonging to a given class pattern alike in terms of stem alternation (see e.g. Aronoff 1994; Pirelli & Battista 2000; Stump 2001; Bonami & Boyé 2002). For instance, the verb BÍTA 'bite' belongs to the same conjugation as GRÍPA 'grasp' (Conjugation STRONG.1.A, in Jörg 1989); such implicative patterns are captured by metarules of basic stem choice, as illustrated in (8) (in which X and Y serve as variables over phonological expressions).

(8) If verbal lexeme L belongs to Conjugation STRONG.1.A and ***Stem***(⟨L, σ:{}⟩) = ⟨X*í*Y, σ⟩,
then ***Stem***(⟨L, σ:{ind pst sg}⟩) = ⟨X*ei*Y, σ⟩
Stem(⟨L, σ:{pst}⟩) = ⟨X*i*Y, σ⟩.

Given the default basic stem specification in (7e), rules (7c) and (7d) are theorems of (8), and therefore needn't be stipulated; similarly, if we specify the default basic stem for BÍTA 'bite' as in (9), then we derive the rules in (10) as theorems of (8).

(9) ***Stem***(⟨BÍTA, σ:{}⟩) = ⟨*bít*, σ⟩

(10) a. ***Stem***(⟨BÍTA, σ:{ind pst sg}⟩) = ⟨*beit*, σ⟩
b. ***Stem***(⟨BÍTA, σ:{pst}⟩) = ⟨*bit*, σ⟩

As (7)-(10) suggest, we regard stems as morphologically unstructured expressions. We do, however, assume that all stems are covertly indexed with the name of the lexeme that they realize; this assumption is necessitated by the fact that rules of exponence applying to a stem sometimes need to access information about the lexeme that it realizes. Thus, though we refer to the singular indicative past-tense stem *greip* by means of its phonological representation, we assume that this expression carries the covert index GRÍPA. When necessary, a function ***L-index*** makes a stem's lexemic index overt: ***L-index***(*greip*) = GRÍPA. The convention in (11) guarantees the compatibility of the rules of basic stem choice with basic stems' lexemic indexing:

(11) If ***Stem***(⟨L, σ⟩) = ⟨X, σ⟩, then ***L-index***(X) = L.

3.1.2 Rules of exponence

We assume that both rules of exponence and rules of referral have the form in (12), where *n* is the number of the rule block to which the rule belongs; X is a variable over stems; C is the category to which ***L-index***(X) must belong (i.e. the category of lexemes in whose inflection the rule applies); τ is the set of morphosyntactic properties (well-formed but not necessarily complete) that the rule realizes; and *f* is a function from stems to stems or word forms.

(12) $n, X_C, \tau \rightarrow f(X)$

Given a pair ⟨W, σ⟩, where W is a stem and σ is (as above) a well-formed and complete set of morphosyntactic properties, a rule of exponence or rule of referral having the form in (11) applies to ⟨W, σ⟩ only if (i) ***L-index***(W) belongs to class C and (ii) τ is a subset of σ. If these requirements are met, then the rule applies to ⟨W, σ⟩ to yield the value ⟨*f*(W), σ⟩, where ***L-index***(*f*(W)) = ***L-***

index(W).[6] Because realization rules in format (12) apply to ⟨form, property set⟩ pairings to produce ⟨form, property set⟩ pairings, a rule of this sort may apply to the output of (a) a rule of stem choice or (b) another rule in format (12); a language's paradigm function may therefore be formulated as the composition of a series of realization rules whose output is itself a ⟨form, property set⟩ pairing.

Employing the notation in (12), we formulate the rules of exponence for the Icelandic verbs in Table 1 as in Table 3.

TABLE 3. Rules of exponence for the Icelandic verbs in Table 1

Block I	**Block III**
I, $X_{V[\text{WEAK.4}]}$, {pst pl} → X*u*	III, $X_{V[\text{WEAK.4.B}]}$, {imp 2sg} → X*ðu*
I, X_V, {sbjv prs} → X*i*	III, X_V, {imp 2sg} → X
I, $X_{V[\text{WEAK.4}]}$, {} → X*a*	III, X_V, {2sg} → X*r*
I, X_U, {} → X [IFD]	III, X_V, {ind prs 3sg} → X*r*
	III, X_V, {1pl} → X*um*
Block II	III, X_V, {2pl} → X*ið*
II, $X_{V[\text{WEAK}]}$, {pst sg} → X*ði*	III, X_V, {ind prs 3pl} → X*a*
II, $X_{V[\text{WEAK}]}$, {pst pl} → X*ðu*	III, $X_{V[\text{STRONG}]}$, {ind pst 2sg} → X*st*
II, X_U, {} → X [IFD]	III, X_U, {} → X [IFD]

These rules are organized into three blocks. As noted earlier, members of the same block are mutually exclusive in their application and the sequence in which members of separate blocks apply is determined by an ordering relation defined over these blocks. This ordering is specified by clause (13) in the definition of the Icelandic paradigm function.[7]

(13) Where L is a verbal lexeme having ⟨L, σ⟩ as a cell in its paradigm,
PF(⟨L, σ⟩) = [III : [II : [I : ***Stem***(⟨L, σ⟩)]]].

Definition (13) also guarantees the disjunctivity of rules belonging to the same block by means of the 'Nar notation' in (14). The conception of narrowness relevant in (14) is the Pāṇinian conception, according to which the more constrained rule overrides its competitor(s); as it applies to the definition in (14), we define this conception of narrowness as in (15).

(14) **Nar** [narrowest applicable rule] **notation**. Where ⟨W, σ⟩ is the pairing of a stem W with a well-formed and complete morphosyntactic property set σ, [*n* : ⟨W, σ⟩] is the result of applying the narrowest applicable realization rule in Block *n* to ⟨W, σ⟩.
Example: [III : ⟨*ætla*, σ:{imp 2sg}⟩] = ⟨*ætlaðu*, σ⟩

(15) **Narrowness**. Where (a) and (b) are realization rules, (a) is narrower than (b) iff either (i) C = C′ and τ_2 is a proper subset of τ_1 or (ii) C is a proper subset of C′.
(a) *n*, X_C, $\tau_1 \rightarrow f_1(X)$
(b) *n*, $X_{C'}$, $\tau_2 \rightarrow f_2(X)$
Example: more narrow III, $X_{V[\text{WEAK.4.B}]}$, {imp 2sg} → X*ðu*
↕ III, X_V, {imp 2sg} → X
less narrow III, X_V, {2sg} → X*r*

[6] The stipulation that ***L-index***(f(W)) = ***L-index***(W) enforces the persistence of L-indexing from a basic stem to all of the inflected forms inferred from it; see Stump 2001:45.
[7] The definition of the Icelandic paradigm function has other clauses accounting for the inflection of nominal categories; these are not at issue here.

Consider how this analysis accounts for the definition of a verbal lexeme's paradigm in Icelandic; consider, specifically, the second-person singular indicative past-tense form of KALLA 'shout'. The paradigm of KALLA includes the cell ⟨KALLA, {ind pst 2sg}⟩, as required by the inventory of property sets for verbs in (3). The Icelandic paradigm function PF applies to the cell ⟨KALLA, {ind pst 2sg}⟩ to determine its realization. According to (13),

$$\mathrm{PF}(\langle \text{KALLA}, \sigma{:}\{\text{ind pst 2sg}\}\rangle) = [\text{III} : [\text{II} : [\text{I} : \boldsymbol{Stem}(\langle \text{KALLA}, \sigma\rangle)]]].$$

The rule of basic stem choice in (7a) has as one of its theorems the equation

$$\boldsymbol{Stem}(\langle \text{KALLA}, \sigma{:}\{\text{ind pst 2sg}\}\rangle) = \langle \textit{kall}, \sigma\rangle.$$

By (13) and Table 3,

$$\begin{aligned}[\text{I} : \langle \textit{kall}, \sigma{:}\{\text{ind pst 2sg}\}\rangle] &= \langle \textit{kalla}, \sigma\rangle,\\ [\text{II} : \langle \textit{kalla}, \sigma{:}\{\text{ind pst 2sg}\}\rangle] &= \langle \textit{kallaði}, \sigma\rangle, \text{ and}\\ [\text{III} : \langle \textit{kallaði}, \sigma{:}\{\text{ind pst 2sg}\}\rangle] &= \langle \textit{kallaðir}, \sigma\rangle.\end{aligned}$$

In summary,

$$\mathrm{PF}(\langle \text{KALLA}, \sigma{:}\{\text{ind pst 2sg}\}\rangle) = \langle \textit{kallaðir}, \sigma\rangle,$$

or in plain English: '*kallaðir* is the second-person singular indicative past-tense realization of KALLA.'

Each rule block *n* in Table 3 has a rule having the form in (16) as its least narrow member. In (16), U represents the class of all lexemes; accordingly, a rule of exponence in this form causes a stem X to remain unchanged in the default case. The notion that every rule block contains a rule in this form is assumed as a universal principle ('the Identity Function Default') in formal analyses in PFM; thus, the rules of exponence marked '[IFD]' in Table 3 needn't be stipulated, but may be seen as theorems of this principle.

(16) $n, X_U, \{\} \rightarrow X$

3.1.3 Rules of referral

The formalism of PFM allows rules of referral, like rules of exponence, to have the form in (12). As Stump (2001: 217) shows, rules of referral are necessary to account for the phenomenon of BLOCK SYNCRETISM, in which a pattern of syncretism is clearly confined to a specific rule block. An example of this sort is the Sanskrit vocative. The case suffix exhibited by a vocative form (regardless of number and gender) is, by default, the suffix exhibited by the corresponding nominative form, in accordance with the rule of referral in (17).[8] (In (17), the notation 'σ/{nom}' refers to that property set that is like σ except that its case specification is nominative.)

(17) Rule of referral for Sanskrit vocatives
$\text{I}, X_{\text{Nominal}}, \sigma{:}\{\text{voc}\} \rightarrow Y$, where $[\text{I} : \langle X, \sigma/\{\text{nom}\}\rangle] = \langle Y, \sigma\rangle$.

The syncretism modeled by (17) is confined to the rule block in which case suffixes are specified (Block I, we assume); it is absent from the block specifying rule-governed accentuation of case forms (Block II). Vocatives exhibit a special pattern of accentuation distinct from that of the corresponding nominatives: vocatives are unaccented unless they appear sentence-initially, in which case they are accented on their first syllable (Whitney 1889: §314); thus, nom. du. *dātā́rau*

[8] This default is overridden in some declensions (e.g. those of *a*-, *i*- and *u*- stems), in which the nominative and vocative singular have distinct morphology; cf. Tables 2 and 10.

'two givers', voc. du. *dātārau* (sentence-initially *dā́tārau*). Unlike this vocative-nominative syncretism, the nominative-accusative syncretism exemplified in Table 2 is not confined to a single block; there is therefore no obstacle to modeling it as a clause in the definition of the Sanskrit paradigm function, as in (5) above.

Thus, there are at least two kinds of implicative rules in PFM: rules of referral such as (17) and rules which, like (5), function as clauses in the definition of a language's paradigm function. The two kinds of rules are conceptually distinct: (17) models the nominative-accusative syncretism by means of a realization rule belonging to Block I, where it potentially competes with that block's other realization rules; (5), on the other hand, defines the syncretism as a whole-word phenomenon, not confined to a single block and not entering into competition with any realization rule.

3.1.4 Morphological metageneralizations

In formal analyses in PFM1, it is often assumed that the definition of a form by a rule of exponence *R* incorporates the effects of a set of morphological metageneralizations for which *R* is indexed (Zwicky 1994, Stump 2001:47ff). We assume, for example, that each of the rules of exponence in Table 3 is indexed for the morphological metageneralizations in (18). The effects of these metageneralizations are illustrated in Table 4.

(18) a. Stem-final *a* is lost prevocalically.
b. A stem-final vowel coalesces with an identical suffix-initial vowel.
c. Stem-final or suffix-initial *i* is lost when adjacent to *u*.
d. Stem-internal *a* mutates to *ö* before a syllable whose nucleus is rounded.

TABLE 4. Effects of the morphophonological metageneralizations in (18)

Morphological metageneralization	Without the effect of the metageneralization	With the effect of the metageneralization
(18a)	*ætla-um*, *ætli-um* *ætla-ið*	*ætlum* *ætlið*
(18b)	*ætluðu-um* *ætli-ið*	*ætluðum* *ætlið*
(18c)	*ætluðu-ið* *ætli-um*	*ætluðuð* *ætlum*
(18d)	*kall-um*	*köllum*

3.2 Templatic morphology in PFM1

PFM1 embodies an important set of assumptions about combinations of inflectional affixes; these assumptions are summarized in (19).

(19) a. The ordering of a word's inflectional affixes is not determined by syntactic or semantic considerations; to the extent that inflectional systems exhibit correlations between the ordering of a word's inflectional affixes and its syntax or semantics, these correlations are an effect of diachronic or functional pressures that have no necessary place in the formal synchronic definition of a language's grammar (Stump 2001: 17-27).[9]

[9] This is in sharp contrast to the position eloquently articulated by Rice (2000). Thus, the claim (Aronoff & Xu 2010:401-402) that PFM cannot capture 'universal scope generalizations' begs the question: do such generalizations constitute synchronic principles regulating the semantic composition of inflected words, or are they purely an observational reflex of diachronic or functional tendencies? See Spencer (2003) for discussion of this issue.

b. Inflection is a-morphous (Janda 1983, Anderson 1992): the input and output of realization rules are simply pairings of a phonological representation with a morphosyntactic property set.
c. The ordering of an inflectional affix Y is determined entirely by (i) the rule of exponence that introduces Y, which specifies Y's invariant status as a prefix, suffix or infix relative to the phonological structure of the stem with which it combines; and (ii) the membership of that rule of exponence in a particular rule block, whose ordering with respect to other rule blocks determines the ordering of Y with respect to affixes introduced by those other blocks.
d. The default ordering of a language's inflectional rule blocks is specified by the definition of its paradigm function.[10]

These assumptions afford a straightforward account of a variety of templatic phenomena, including parallel, reversible, ambifixal and portmanteau positions classes (Stump 1993b; 2001: Chapter 5).

Position classes *m* and *n* are PARALLEL if an affix Y_1 belonging to class *m* has a phonologically identical counterpart Y_2 belonging to class *n* such that the content realized by Y_1 differs in a systematic way from the content realized by Y_2. For example, in the inflection of Swahili verbs, the affixes expressing subject agreement in one affix position are mostly parallel to the affixes expressing object agreement in a distinct affix position. In a PFM1 analysis, this parallelism can be accounted for by means of default rules of referral, according to which the subject-agreement and object-agreement rule blocks refer the realization of person, number and noun class to the same block of rules. (Cf. Stump 2001: 144-9.)

Position classes *m* and *n* are REVERSIBLE if the affixes belonging to *m* are, in the default case, ordered before affixes belonging to *n*, but this ordering is reversed in the realization of specific morphosyntactic property sets. For example, in the relative past tense inflection of Fula verbs, subject-agreement suffixes ordinarily precede object-agreement suffixes, but they appear in the reverse order when first-person singular subject agreement coincides with either second-person singular or third-person singular Class 1 object agreement. In a PFM1 analysis, a default clause in the definition of the Fula paradigm function specifies one ordering of the subject- and object-agreement rule blocks, but in the realization of the exceptional property sets, this default ordering is overridden by the opposite ordering of the subject- and object-agreement rule blocks. (Cf. Stump 2001: 149-56.)

A position class is AMBIFIXAL if its inventory of paradigmatically opposed affixes includes both prefixes and suffixes. In some cases, the prefixes and suffixes constituting an ambifixal class simply contrast, but in other cases, they exist as matched pairs. For example, Swahili has an ambifixal class of relative affixes (verbal affixes expressing the number and noun class of a relativized subject or object): the default use of these affixes is as prefixes, but in tenseless affirmative verb forms, they are instead used suffixally. In one possible PFM1 analysis (Stump 1993b: 145-53), default rules of exponence introduce the relative affixes as prefixes, and there is a metarule M such that for each rule introducing a relative prefix Y, M induces a competing rule that suffixes Y if the property set being realized is both tenseless and affirmative. In another, perhaps preferable sort of analysis, each relative affix Y is introduced by a single rule of exponence whose formulation involves a conditional suffixation operator (Stump 2012b), which prefixes Y by default but suffixes Y if the relevant condition ('tenseless and affirmative') is met by the property set being realized.

[10] This default ordering is subject to override, as in the case of reversible position classes (discussed below).

In some languages, certain affixes vary freely in their ordering. In Chintang, for example, the order of a verb's prefixes is apparently unconstrained (Bickel et al. 2007), and comparable facts have been reported in other languages, e.g. Mari (Luutonen 1997) and Filomeno Mata Totonac (McFarland 2009). Such cases can be accommodated within PFM1 by relaxing the expectation that a language's paradigm function invariably specifies a default ordering of its rule blocks.

An affix belonging to a PORTMANTEAU position class [*m*, *n*] is paradigmatically opposed to combinations of an affix from position class *m* with an affix from position class *n*. In Sanskrit, for example, the default expression of membership in the 9th conjugation is a suffix *-nī* (sandhi form *-ṇī*), as in the imperative form *krī-ṇī-ta* 'you (pl.) buy!', and the default expression of second-person singular subject agreement in active imperatives is *-hi*, as in *krī-ṇī-hi* 'you (sg.) buy!'. But if a 9th-conjugation verb root ends in a consonant, the expected sequence of *-nī-hi* in the second-person singular imperative active is supplanted by a special suffix *-āna*, as in *aś-āna* 'you (sg.) eat!' (Table 5). The rule of exponence introducing *-āna* is special: its application excludes that of both the rule of exponence introducing *-nī* (which belongs to rule Block I and is formulated in (20a)) and the rule of exponence introducing the subject marker *-hi* (which belongs to rule Block II and is formulated in (20b)). Stump (2001:139ff) therefore proposes that in instances of this kind, the rule of exponence introducing *-āna* is the sole member of a rule Block [II,I] that is in paradigmatic opposition to both Block I and Block II; this rule is formulated in (20c). The relevant clause in the definition of the Sanskrit paradigm function invokes rule Block [II,I] as in (21), allowing the *-āna* rule to override both the *-nī* rule and the *-hi* rule in the realization of the cell in (22). In the realization of the cell in (23), however, (20c) cannot apply (since ***Stem***(⟨KRĪ, σ:{2sg imp active}⟩) = ⟨*krī*, σ⟩ and *krī* doesn't end in a consonant); instead, Block [II,I] defaults to the composition of Blocks II and I, in accordance with the Function Composition Default (24).

TABLE 5. Second-person imperative active forms of two 9th-conjugation verbs in Sanskrit

	KRĪ 'buy'	AŚ 'eat'
2sg	*krī-ṇī-hi*	*aś-āna*
2du	*krī-ṇī-tam*	*aś-nī-tam*
2pl	*krī-ṇī-ta*	*aś-nī-ta*

(20) Three rules of exponence in Sanskrit

a. I, $X_{V[9th\ conjugation]}$, {} → X*nī*

b. II, X_V, {2sg imp active} → X*hi*

c. [II,I], $XC_{V[9th\ conjugation]}$, {2sg imp active} → XC*āna*, where C is a consonant.

(21) PF (⟨L,σ⟩) = [[II,I] : Stem(⟨L, σ⟩)]

(22) ⟨AŚ, {2sg imp active}⟩

(23) ⟨KRĪ, {2sg imp active}⟩

(24) Function Composition Default: By default, [[*m*,*n*] : ⟨X, σ⟩] = [*m* : [*n* : ⟨X, σ⟩]].

Some templatic phenomena have been claimed to require an approach to inflectional morphology that is at odds with the assumptions in (19). Luís & Spencer (2004) observe that in situations where two series of affixes can be realized either prefixally or suffixally, it sometimes happens that the affixes occur in the same relative order on either side of the stem. This is illustrated in (25) with Italian pronominal affixes. Luís & Spencer interpret this phenomenon as evidence that a language's morphology defines affix sequences as autonomous morphological constituents which are positioned as wholes with respect to the stem with which they join: [*me-lo*]-*spedisce*, *spedisci*-[*me-lo*]. This interpretation is not necessary, however. For example, one need only assume (a) that the pronominal affixes in (25) are introduced by rule blocks that are both reversible and ambifixal and (b) that the same morphosyntactic property sets that condition the override of the default prefixal status of the pronominal affixes also cause the default ordering of rule blocks to be overridden in (25b).

(25)	a.	*Me*	*lo*	*spedisce.*	b.	*Spedisci-me-lo!*
		1SG.DAT	3SG.ACC	sends		send.IPV-1SG.DAT-3SG.ACC
		'He sends it to me.'				'Send it to me!' (Monachesi 1999:44)

4 Extensions and alternatives

We now discuss various extensions and modifications that have been proposed for implementing the core assumptions of PFM. These proposals do not alter the core assumptions, but constitute new approaches to their execution. They take the formal articulation of PFM in various directions for varied reasons; not all proponents of PFM subscribe to all of them.

4.1 Content vs form: PFM2

Early work in Paradigm Function Morphology focused on complex inflectional systems in which the mapping of a paradigm cell ⟨L, σ⟩ to its realization W is relatively transparent—in which the status of W's inflectional markings as exponents of σ is comparatively straightforward. Recent work has, however, called attention to diverse phenomena in which the realization of a paradigm's cells fails to exhibit such transparency. These include phenomena such as DEPONENCY, SYNCRETISM, DEFECTIVENESS, HETEROCLISIS, SUPPLETION and OVERABUNDANCE. In a series of papers (Stump 2002, 2006; Stewart & Stump 2007; Spencer & Stump to appear), an extension of PFM has been proposed to account for such misalignments between content and form; following Spencer & Stump, we refer to this extension as PFM2. The central innovation of PFM2 is a conceptual distinction between CONTENT PARADIGMS and FORM PARADIGMS. A lexeme L's content paradigm specifies the full range of morphosyntactic property sets with which L may be associated in syntax; thus, each cell in L's content paradigm is the pairing of L with a morphosyntactic property set σ such that L and σ may occupy the same node in syntax. By contrast, the form paradigm of a stem S specifies the full range of morphosyntactic property sets for which S may inflect in the morphological component; thus, each cell in the form paradigm of S is the pairing of S with a morphosyntactic property set σ such that σ may be realized morphologically through the inflection of S.

In the simplest case, the content paradigm of a lexeme L aligns perfectly with the form paradigm of its lone stem S: for each cell ⟨L, σ⟩ in L's content paradigm (i.e. each CONTENT CELL), there is a single and definite corresponding FORM CELL ⟨S, σ⟩ (= ***Stem***(⟨L, σ⟩)). This is the CANONICAL CORRESPONDENCE between content paradigms and form paradigms. The observed misalignments between content and form are therefore instances in which this canonical correspondence is disturbed.

Paradigm functions continue to play a central role in PFM2. A language's paradigm function remains a function from paradigm cells to their realizations; but now, there are two sorts of paradigm cells to which a paradigm function may apply: content cells and form cells. Given a form cell ⟨S, σ⟩, the value of PF(⟨S, σ⟩) is defined (as before) in terms of blocks of realization rules. Realization rules still take the form in (12) (repeated here as (26)), but they are slightly different in their interpretation. In earlier PFM, inflection classes were regarded as classes of lexemes; in this new version of PFM, inflection classes are regarded as sets of stems. Thus, given a pair ⟨W, σ⟩, where W is a stem and σ is a well-formed and complete set of morphosyntactic properties, a realization rule having the form in (26) applies to ⟨W, σ⟩ only if (i) W belongs to class C and (ii) τ is a subset of σ. If these requirements are met, then the rule applies to ⟨W, σ⟩ to yield the value ⟨*f*(W), σ⟩, where by convention *f*(W) then belongs to the same inflection class(es) as W.

(26) $n, X_C, \tau \rightarrow f(X)$

For a content cell ⟨L, σ⟩, the value of PF(⟨L, σ⟩) is defined indirectly: where ***Stem***(⟨L, σ′⟩) is the form cell to which ⟨L, σ⟩ corresponds (i.e. where ***Stem***(⟨L, σ′⟩) is the FORM-CORRESPONDENT of ⟨L, σ⟩), the value of PF(⟨L, σ⟩) is equated with that of PF(***Stem***(⟨L, σ′⟩)).

The relation between content cells and their form correspondents is specified by RULES OF PARADIGM LINKAGE. The default rule of paradigm linkage may be formulated as in (27); this rule expresses the simple relation in which each morphosyntactic property set σ that is relevant for the syntax of L is likewise relevant for the inflectional morphology of ***Stem***(⟨L, σ⟩), and vice versa. This rule is, however, subject to override by more specific rules of paradigm linkage, in accordance with Pāṇini's principle. The default rule of paradigm linkage should not be equated with the canonical correspondence between content paradigms and form paradigms. In instances of canonical correspondence, there is a single stem S such that PF(⟨L, σ⟩) = PF(⟨S, σ⟩) for every cell ⟨L, σ⟩ in L's content paradigm; but (27) allows instances in which ***Stem***(⟨L, σ⟩) = ⟨X, σ⟩ and ***Stem***(⟨L, σ′⟩) = ⟨Y, σ′⟩ but X ≠ Y.

(27) Default rule of paradigm linkage
Given a lexeme L, PF(⟨L, σ⟩) = PF(***Stem***(⟨L, σ⟩)).

Deponency is one type of case where the default rule in (27) is overridden by a narrower rule of paradigm linkage. Consider Latin deponent verbs, in whose inflection passive forms are used to realize the active subparadigm (Table 6) and the passive subparadigm goes unrealized. This situation can be accounted for by means of the two rules of paradigm linkage in (28).[11]

TABLE 6. Present subparadigm of two Latin verbs

		simple verb AMŌ 'love'		deponent verb IMITOR 'mimic'	
		ACTIVE	PASSIVE	ACTIVE	PASSIVE
SG	1	*amō*	*amor*	*imitor*	
	2	*amās*	*amāris*	*imitāris*	
	3	*amat*	*amātur*	*imitātur*	
PL	1	*amāmus*	*amāmur*	*imitāmur*	
	2	*amātis*	*amāmini*	*imitāmini*	
	3	*amant*	*amantur*	*imitantur*	

(28) a. Where L is a deponent verb lexeme, {active} is a subset of σ and σ′ = σ/passive, PF(⟨L, σ⟩) = PF(***Stem***(⟨L, σ′⟩)).
b. If L is a deponent verb lexeme, PF(⟨L, σ:{passive}⟩) is undefined.

Pāṇini's principle causes these rules to override the default rule of paradigm linkage in the inflection of deponent verbs. By (28a), active cells in a deponent verb's content paradigm are mapped to passive form cells. By (28b), passive cells in a deponent verb's content paradigm lack form correspondents, and therefore go unrealized.

Directional whole-word syncretism is another phenomenon that may be modeled by means of overrides of the default rule of paradigm linkage; thus, the rule of paradigm linkage in (29) is a simple alternative to including clause (5) in the definition of the Sanskrit paradigm function.

(29) Where L is a neuter lexeme, {nom} is a subset of σ and σ′ = σ/{acc},
PF(⟨L, σ⟩) = PF(***Stem***(⟨L, σ′⟩))).

[11] We leave aside here both semi-deponent verbs and the realization of participles. See Hippisley (2007) for thorough discussion and analysis.

In the directional syncretism defined by (29), nominative realizations are parasitic on accusative realizations. But as Baerman et al. (2005) have shown, most syncretism is SYMMETRIC (or nondirectional): neither of two syncretized forms can be said to be parasitic on the other. A case in point is the syncretism of the genitive dual with the locative dual in Sanskrit. Such cases motivated Stump (2010) to propose a second, nondirectional approach to syncretism.[12] Adapting this approach, we allow a form cell to be either the pairing ⟨X, σ⟩ of a stem X with a morphosyntactic property set σ or the pairing ⟨X, Σ⟩ of X with a set Σ of morphosyntactic property sets; in the default case, a form cell ⟨X, Σ⟩ then serves as the form correspondent of any content cell ⟨L, σ⟩ such that ***L-index***(X) = L and σ is a member of Σ. For instance, a Sanskrit nominal's form paradigm doesn't contain distinct {gen du} and {loc du} cells, but a single {{gen du}, {loc du}} cell, to which the ***Stem*** function links both the {gen du} and {loc du} content cells: ***Stem***(⟨L, {gen du}⟩) = ***Stem***(⟨L, {loc du}⟩) = ⟨X, {{gen du}}⟩

The postulation of form cells with second-order property sets such as {{gen du}, {loc du}} makes it necessary to supplement the interpretation of realization rules having the form in (11): given a pair ⟨W, Σ⟩, where W is a stem and Σ is set of morphosyntactic property sets, a realization rule having the form in (11) applies to ⟨W, Σ⟩ only if (i) W belongs to class C and (ii) there is some property set σ in Σ such that τ is a subset of σ. If these requirements are met, then the rule applies to ⟨W, Σ⟩ to yield the value ⟨*f*(W), Σ⟩, where *f*(W) belongs to the same inflection class(es) as W.

Although symmetric syncretisms defined in this way conform to the default rule of paradigm linkage in (27), they do not conform to the canonical correspondence between content paradigms and form paradigms: they involve a many-to-one relation between content cells and forms cells, whereas canonical correspondence is a one-to-one relation.

Like deponency and directional syncretism, morphological defectiveness involves an override of the default rule of paradigm linkage. Defectiveness may coincide with deponency, as in (28), but need not; for instance, the defective French verb TRAIRE 'to milk' involves the simple rule of paradigm linkage in (30).

(30) PF(⟨TRAIRE, σ:{pst pfv}⟩) is undefined.

PFM2 models heteroclisis and stem suppletion as instances of the same phenomenon. The Russian nouns in Table 7 illustrate. Each nominal lexeme in Table 7 is associated with a default stem by the ***Stem*** function, as in (31). In the default case, a noun's realizations are all based on the form paradigm of its default stem. The nouns NEBO and ČELOVEK, however, have different stems in the plural, as specified in (32); that is, they get their singular realizations from one form paradigm (that of their default stem) but their plural realizations from a different form paradigm (that of the overriding stem). Thus, although NEBO and ČELOVEK both conform to the default rule of paradigm linkage, they diverge from the canonical correspondence of content paradigms to form paradigms. In the case of the suppletive noun NEBO, this divergence is purely a matter of phonological form; its stems *neb* and *nebes* belong to the same declension class. In the case of the heteroclite noun ČELOVEK, by contrast, the divergence is a matter of both the phonological form of the stem and its declension-class membership: its singular stem *čelovek* belongs to the *slon*-class and its plural stem *ljud* to the *gost'* class. (In this case, heteroclisis coincides with suppletion, but there are convincing cases of heteroclite lexemes with phonologically identical stems; an example is the Czech noun PRAMEN 'source', whose singular stem follows the soft-inanimate declension and whose plural stem follows the hard-inanimate declension but both of whose stems have the phonological form *pramen*.)

[12] See Stump (2001:222f) for a different approach to symmetrical syncretisms involving realization metarules.

TABLE 7. Paradigms of five Russian nouns

		MESTO 'place'	NEBO 'sky'	SLON 'elephant'	ČELOVEK 'person'	GOST′ 'guest'
SG	NOM	*mesto*	*nebo*	*slon*	*čelovek*	*gost′*
	GEN	*mesta*	*neba*	*slona*	*čeloveka*	*gostja*
	DAT	*mestu*	*nebu*	*slonu*	*čeloveku*	*gostju*
	ACC	*mesto*	*nebo*	*slona*	*čeloveka*	*gostja*
	INST	*mestom*	*nebom*	*slonom*	*čelovekom*	*gostem*
	PREP	*meste*	*nebe*	*slone*	*čeloveke*	*goste*
PL	NOM	*mesta*	*nebesa*	*slony*	*ljudi*	*gosti*
	GEN	*mest*	*nebes*	*slonov*	*ljudej*	*gostej*
	DAT	*mestam*	*nebesam*	*slonam*	*ljudjam*	*gostjam*
	ACC	*mesta*	*nebesa*	*slonov*	*ljudej*	*gostej*
	INST	*mestami*	*nebesami*	*slonami*	*ljudjami*	*gostjami*
	PREP	*mestax*	*nebesax*	*slonax*	*ljudjax*	*gostjax*

(31) Default rules of basic stem choice
  a. ***Stem***(⟨MESTO, σ:{}⟩) = ⟨*mest*, σ⟩ (where *mest* ∈ [DECLENSION: mesto])
  b. ***Stem***(⟨NEBO, σ:{}⟩) = ⟨*neb*, σ⟩ (where *neb* ∈ [DECLENSION: mesto])
  c. ***Stem***(⟨SLON, σ:{}⟩) = ⟨*slon*, σ⟩ (where *slon* ∈ [DECLENSION: slon])
  d. ***Stem***(⟨ČELOVEK, σ:{}⟩) = ⟨*čelovek*, σ⟩ (where *čelovek* ∈ [DECLENSION: slon])
  e. ***Stem***(⟨GOST′, σ:{}⟩) = ⟨*gost′*, σ⟩ (where *gost′* ∈ [DECLENSION: gost′])

(32) Overriding rules of basic stem choice
  a. ***Stem***(⟨NEBO, σ:{plural}⟩) = ⟨*nebes*, σ⟩ (where *nebes* ∈ [DECLENSION: mesto])
  b. ***Stem***(⟨ČELOVEK, σ:{plural}⟩) = ⟨*ljud′*, σ⟩ (where *ljud′* ∈ [DECLENSION: gost′])

Whole-word suppletion also involves overrides of the default rule of paradigm linkage. In suppletion of this sort, the suppletive word fails to exhibit either the expected stem or the expected inflectional marking; for example, the comparative adjective *worse* exhibits neither the stem *bad* nor the affix *-er*. In PFM2, instances of whole-word suppletion involve such local overrides of the default rule of paradigm linkage as that of (33).

(33) PF(⟨BAD, {comparative}⟩) = ⟨*worse*, {comparative}⟩

Paradigm Function Morphology is built on the premise that inflection is a *function* from the cells in a lexeme's paradigm (lexeme/property set pairings) to their realizations. It is natural to assume that each cell in a lexeme's paradigm has at most one realization. Although this expection is satisfied in the vast majority of cases, there are cases which do not conform to it. For instance, the past-tense cells in the paradigms of the English verbs DREAM, LEAP and BURN may be realized either as *dreamt*, *leapt* and *burnt* or as *dreamed*, *leaped* and *burned*. Thornton (in press) terms the phenomenon OVERABUNDANCE, and documents the fact that overabundance can affect either individual cells, slabs of cells, or even the full paradigm of a lexeme. In the cases she discusses, overabundance is an exceptional property of individual lexemes, but there are also cases of SYSTEMATIC OVERABUNDANCE such that all lexemes in some syntactic category have more that one way of expressing some morphosyntactic property sets. In Spanish, each verb has two sets of forms expressing the past subjunctive (Alcoba 1999), with one set exhibiting the stem-forming suffix *-ra*, the other exhibiting the suffix *-se*; the pair of verbs in Table 8 illustrates.

TABLE 8. Past subjunctive paradigms of two Spanish verbs

	CORTAR 'to cut'		VIVIR 'to live'	
	Form 1	Form 2	Form 1	Form 2
1sg	*cortara*	*cortase*	*viviera*	*viviese*
2sg	*cortaras*	*cortases*	*vivieras*	*vivieses*
3sg	*cortara*	*cortase*	*viviera*	*viviese*
1pl	*cortáramos*	*cortásemos*	*viviéramos*	*viviésemos*
2pl	*cortarais*	*cortaseis*	*vivierais*	*vivieseis*
3pl	*cortaran*	*cortasen*	*vivieran*	*viviesen*

One way of accommodating overabundance within the framework of PFM2 is to assume that in some languages, the ***Stem*** function isn't strictly a function at all, but a relation, potentially mapping the same content cell onto the same cell in more than one form paradigm, as in (34) and (35).

(34) a. ***Stem***(⟨DREAM, σ:{pst}⟩) = ⟨/dɹim/$_1$, σ⟩
(where /dɹim/$_1$ belongs to the *mean* conjugation)
b. ***Stem***(⟨DREAM, σ:{pst}⟩) = ⟨/dɹim/$_2$, σ⟩
(where /dɹim/$_2$ belongs to the *seem* conjugation)

(35) a. ***Stem***(⟨CORTAR, σ:{sbjv pst}⟩) = ⟨*cortara*, σ⟩
b. ***Stem***(⟨CORTAR, σ:{sbjv pst}⟩) = ⟨*cortase*, σ⟩

Such instances suggest that a language's paradigm function should be reconceived as a function mapping each content cell onto a SET of realizations; in most cases this is a unit set, but not invariably so.[13] That is, given the rules in (36), the English paradigm function might be partially defined as in (37); accordingly, PF(⟨DREAM, {pst}⟩) would have the pair of realizations in (38).

(36) a. Rules of exponence
I, $X_{V[\text{Conjugation: } \textit{mean}]}$, {pst} → /X′t/ (subject to (36b))
I, $X_{V[\text{Conjugation: } \textit{seem}]}$, {pst} → /Xd/
b. Morphological metageneralization
Where X has a high, tense vowel Y, X′ is like X except in that Y is replaced by its mid, lax counterpart.

(37) For each value ⟨X, σ′⟩ of ***Stem***(⟨L, σ⟩), [I : ⟨X, σ′⟩] is a member of PF(⟨L, σ⟩).

(38) PF(⟨DREAM, {pst}⟩) = {[I : ⟨/dɹim/$_1$, {pst}⟩], [I : ⟨/dɹim/$_2$, {pst}⟩]}
= {⟨/dɹɛmt/, {pst}⟩, ⟨/dɹimd/, {pst}⟩}

PFM2 is attractive because it allows the diverse phenomena of deponency, heteroclisis, suppletion, syncretism, and defectiveness to be given similar diagnoses: each disturbs the canonical correspondence between content paradigms and form paradigms. (See Spencer & Stump to appear for discussion of another phenomenon that is subject to the same diagnosis, that of FUNCTOR-ARGUMENT REVERSAL in the inflection of Hungarian pronouns.) Moreover, PFM2 affords a simple

[13] Bonami & Boyé 2007 draw upon similar evidence to argue that paradigm functions should be seen as relations rather than as functions. The solution suggested here, that of regarding paradigm functions as set-valued functions, is equivalent and allows for the name 'Paradigm Function Morphology' to keep its transparent meaning.

account of the interface between inflectional morphology and syntax and semantics: this interface is the set of content paradigms. Information present in content paradigms (the association of lexemes with morphosyntactic property sets) is accessible to rules of syntax and semantics; information which is instead situated in form paradigms (the phonology and inflection-class membership of stems, noncanonical form correspondents) is inaccessible.

4.2 Wackernagel affixes

Nevis & Joseph (1992) draw attention to the existence of 'Wackernagel affixes'—affixes that appear in second position within a word. Such affixes are unusual among affixes in that their placement is determined by their position relative to the edge of a word rather than by their position relative to a word's stem. A case in point is that of endoclitic person markers in Sorani Kurdish (Mackenzie 1962; Samvelian 2007). In the past tense of transitive verbs, subject-agreement markers are normally realized enclitically on the first major constituent of VP, as in (39).[14] If, however, that first constituent happens to be the verb itself, then the clitic is not realized at the periphery of the verb, but has to be enclitic to the verb's first morph, irrespective of whether this first morph is the verb stem (as in (40a)), the negative prefix (as in (40b,c)), or an aspect prefix (as in (40d)).

(39) *bâzirgân-akân* [VP *Sirwan=jân* *nard*].
merchant-DEF.PL Sirwan=3PL send.PST
'The merchants sent Sirwan.'

(40) a. *bâzirgân-akân* [VP *nard*=***jân***=*im*].
merchant-DEF.PL send.PST=3PL=1SG
'The merchants sent me.'

b. *bâzirgân-akân* [VP *na*=***jân***=*nard-im*].
merchant-DEF.PL NEG=3PL=send.PST-1SG
'The merchants did not sent me.'

c. *bâzirgân-akân* [VP *na*=***jân***=*da-nard-im*].
merchant-DEF.PL NEG=3PL=IPFV-send.PST-1SG
'The merchants were not sending me.'

d. *bâzirgân-akân* [VP *da*=***jân***=*nard-im*].
merchant-DEF.PL IPFV=3PL=send.PST-1SG
'The merchants were sending me.'

This evidence casts doubt on the a-morphousness hypothesis (19b): according to that hypothesis, rules of exponence apply to phonological representations, yet the positioning of the Sorani Kurdish endoclitic seemingly requires reference to a representation in which individual morphs are delimited.

Two general approaches to this phenomenon have been proposed. One approach involves an enrichment of the representations on which realization rules operate; the other instead involves an enrichment of the rules themselves. Pursuing the former approach, Crysmann (2002), Bonami & Samvelian (2008) and Walther (2012) have developed the idea that rules of exponence create unordered sets of morphs whose ordering is specified by independent rules of linearization. This idea requires a relaxation of assumptions (19b-d)—that is, it entails that the representations on

[14] These same agreement markers serve as object pronouns in the present, exhibiting an instance of morphological reversal (Baerman 2007). This has no consequences for the analysis of the data at hand.

which realization rules operate are not strictly "a-morphous", but consist of discrete morphs; that the rule introducing an affixal exponent does not determine its order with respect to the stem with which it joins; and that although a language's paradigm function determines the rule blocks relevant for a word's inflection, it does not determine the relative order of the affixes introduced by those rule blocks, and indeed imposes no ordering whatever on the rule blocks themselves. This approach makes it possible for a linearization rule to position an endoclitic after a word's first morph, in that way accounting for the special distribution of Wackernagel affixes in a straightforward way. Moreover, this approach opens the way to an account of ambifixal and reversible position classes that is very different from that of §3.2—an account in which both the ordering of an affix with respect to the stem with which it joins and the relative ordering of a word's affixes are regulated purely by linearization rules.

An alternative approach builds on the hypothesis that Wackernagel affixes are akin to infixes. Infixes are positioned relative to a particular phonological substring of the host word form W. This 'pivot' (Yu 2007: 67ff) may be characterized in segmental terms (e.g. 'W's first consonant') or in terms of syllabification ('W's first syllable') or prosody ('W's first foot'). There are also inflectional systems in which some infixation pivots are determined morpholexically. In Dakota, for example, subject agreement markers are sometimes prefixed and sometimes infixed (Riggs 1893: 55-6). Monomorphemic verb stems having initial vowels exhibit infixation (*opa* 'follow': *o-wa-pa* 'I follow'). Consonant-initial verb stems vary in their behavior. Some monomorphemic stems exhibit prefixation (*daka* 'have an opinion of': *wa-daka* 'I have an opinion of') while others exhibit infixation (*paḣta* 'bind': *pa-wa-ḣta* 'I bind'). Verb stems with instrumental prefixes likewise vary: stems with the instrumental prefix *ba-* (which implies a cutting instrument, such as a knife) exhibit infixation, but those formed with the instrumental prefix *ka-* (which implies a striking instrument, such as an axe) exhibit prefixation; thus, from the root *ksa* 'separate' come the derived verbs *ba-ksa* 'cut off (as with a knife)' and *ka-ksa* 'chop off (as with an axe)', whose first-person singular present-tense forms are *ba-wa-ksa* 'I cut off' and *wa-ka-ksa* 'I chop off'. Vocalic prepositional prefixes do not alter the location of a stem's subject marker: *wa-kaśtaŋ* 'I pour out', *o-wa-kaśtaŋ* 'I pour out in'; *pa-wa-ḣta* 'I bind', *a-pa-wa-ḣta* 'I bind on'. As these examples show, infixation pivots in Dakota verbs are identified by a mix of phonological, morphological and lexical principles including those in (41). (The formulation of these principles presumes that subject markers are infixed after a verb stem's pivot but prefixed in the absence of a pivot.) The important point here is that although the principles defining the Dakota infixation pivots make reference to morphological and lexical information, the stems over which they are defined are merely phonological representations, of which the infixation pivots are phonological substrings; that is, the principles in (41) do not necessitate a weakening of the a-morphousness hypothesis (19b).

(41) a. By default, a verb stem's pivot is its first syllable, e.g. *<u>o</u>pa* 'follow', *<u>pa</u>ḣta* 'bind', *<u>ba</u>ksa* 'cut off', *<u>o</u>kaśtaŋ* 'pour out in'.
b. A verb stem formed by means of the instrumental prefix *ka-* lacks a pivot, e.g. *kaksa* 'chop off'.
c. By lexical stipulation, *daka* 'have an opinion of' lacks a pivot.
d. Where Y is a vocalic prepositional prefix and X is a stem with pivot Z, the pivot of YX is Z, e.g. *a<u>pa</u>ḣta* 'bind on'.

A similar account may be given for the Sorani Kurdish pronominal endoclitics. In particular, one might postulate a morphological metageneralization to the effect that if a rule of exponence concatenates the phonological expressions X and Y as XY, then the pivot of XY is X. This suffices to determine the endoclitic placement in (38) in a manner compatible with the a-morphousness hypothesis.

At the time of writing it seems that the two competing strategies for modeling Wackernagel affixes (that of enriching the representations of a language's stems and words and that of enriching a language's system of morphological rules) can both account for the observed facts, but both come at a conceptual cost. More work on varied inflection systems is needed to ascertain whether one strategy is definitely preferable over the other.

4.3 Periphrasis and the morphology-syntax interface

Since the seminal studies of Börjars & Vincent (1996) and Ackerman & Webelhuth (1998), there is a growing consensus that some syntactic constructions express the pairing of a lexeme with a morphosyntactic property set, and should thus be incorporated into inflectional paradigms as INFLECTIONAL PERIPHRASES. Although the exact limits of periphrasis are hard to pin down, examples such as that of the Persian perfect (Bonami & Samvelian 2009) are reasonably clearcut. Table 9 illustrates the relevant properties. In the past indicative and the subjunctive, the perfect is expressed by a combination of the perfect participle of the main verb with a form of the copula. In the present indicative, the periphrase has been morphologized into a synthetic form.[15]

TABLE 9. Third-person singular forms of Persian FORUXTAN 'sell'

		Indicative		Subjunctive
		Present	Past	
Affirmative	Perfective		*foruxt*	*beforušad*
	Imperfective	*miforušad*	*miforuxt*	
	Perfect	*foruxte=ast*	*foruxte bud*	*foruxte bašad*
Negative	Perfective		*naforuxt*	*naforušad*
	Imperfective	*nemiforušad*	*nemiforuxt*	
	Perfect	*naforuxte=ast*	*naforuxte bud*	*naforuxte bašad*

The Persian past perfect possesses two diagnostic properties of periphrases identified by Ackerman & Stump (2004). It is FEATURALLY INTERSECTIVE: the combination if the feature values *past* and *perfect* is expressed periphrastically, but both values can also be expressed synthetically in other cells of the paradigm. It also exhibits DISTRIBUTED EXPONENCE: polarity is realized on the main verb while TAM and agreement are realized on the auxiliary.

Such data motivate introducing RULES OF PERIPHRASTIC EXPONENCE which enter into Pāṇinian competition with ordinary rules of exponence. An informal statement of the relevant rule for the Persian perfect is given in (42), which will apply to realize the property 'perfect' unless it is overridden by more specific rules applying to realize the property set {present perfect}.

(42) The word form realizing ⟨L, σ:{perfect finite}⟩ is the combination of the word form realizing ⟨L, σ/{perfect participle}⟩ and the word form realizing ⟨BUDAN, σ/{nonperfect}⟩.

How is the word 'combination' in (42) to be understood? Existing proposals can be grouped in two families. PHRASE-STRUCTURE BASED ACCOUNTS follow Ackerman & Webelhuth (1998) in

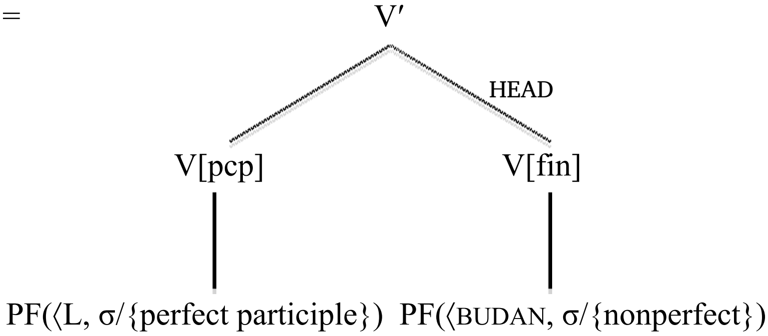
[15] This difference is most immediately seen by looking at topicalization data: the participle in a past perfect can be topicalized (i), but not in the present perfect (ii). Note that for simplicity we ignore here forms expressing indirect evidentiality. See Bonami & Samvelian (2009) for a fuller discussion of Persian conjugation in the context of PFM.

(i) *Foruxte* in tâblo=râ Maryam *bud*.
sold DEM picture=DDO Maryam be.PST.3SG
'Maryam had sold this picture.'

(ii) * *Foruxte* in tâblo=râ Maryam=*ast*.
sold DEM picture=DDO Maryam=be.PRS.3SG
(intended) 'Maryam has sold this picture.'

assuming that the right hand side of rules of periphrastic exponence is a specification of a schematic phrase structure (Sadler & Spencer 2001; Stump 2001; Ackerman & Stump 2004; Blevins ms). A possible formulation of that kind is given in (43a). FUNCTIONAL ACCOUNTS (Bonami & Samvelian, 2009; Stump & Hippisley, 2011; Bonami & Webelhuth, in press) assume that rules of periphrastic exponence define a word form carrying requirement that this word form enter a specified grammatical relation to another word form. The rule in (43b) is a simplification of Bonami & Samvelian's proposal for Persian.

(43) a. PF(⟨L, σ:{perfect finite}⟩) = ⟨W, σ⟩,
where W =



b. Where {perfect finite} is a subset of σ,
τ = σ/{nonperfect},
PF(⟨BUDAN, τ⟩) = ⟨W, τ⟩, and
W′ is like W except that it subcategorizes for L's perfect participle:

PF(⟨L, σ⟩) = ⟨W′, σ⟩.

As Bonami & Webelhuth (in press) emphasize, functional accounts are preferable because they are more clearly compatible with the phrase-structural diversity of periphrases. Normally, a periphrase in a given language presumes a functional relation between its auxiliary and main elements and is compatible with the various phrase-structural instantiations of that relation that are independently licensed by that language's syntax. In addition, the diversity of phrase-structural configurations that can be involved in periphrasis entails that a phrase-structure based account would need to endow rules of periphrastic exponence with the full power of syntactic description, including nested syntactic structure and arbitrary embedding.

The difficult issue is to find a way of expressing (43b) that is compatible with the core assumptions of PFM discussed in §2. Bonami & Samvelian's (2009) proposal has a definite INCREMENTAL flavor, since rules of exponence may modify a word's subcategorization requirements. Stump & Hippisley (2011) propose to avoid this problem by relying on a combination of feature cooccurence restrictions and rules of referral; Bonami & Webelhuth (in press) choose to model rules of periphrastic exponence as an alternative to PFM-based synthetic exponence, rather than as part of the PFM system. Both solutions have advantages and drawbacks, and a fully satisfactory PFM account of periphrasis is still to come.

4.4 Exponence-based and implicative generalizations in inflectional morphology

Implicative rules such as (5) deduce the realization of one cell in a lexeme's paradigm from that of another cell; in this way, they make it possible to describe instances of directional whole-word syncretism in a precise way. But one can imagine generalizing the role of implicative rules in the definition of a language's inflectional system. In particular, implicative rules might be formulated to deduce the realization of one cell from that of a distinct cell even in cases in which the two realizations are phonologically distinct; for instance, one might postulate the implicative rule in (44) for Latin verbs; according to this rule (which, in formal terms, is a clause in the definition of the

Latin paradigm function), a verbal lexeme whose present active infinitive realization is of the form X*e* has a first-person plural imperfect active subjunctive realization of the form X*ēmus*. This rule correctly deduces the subjunctive forms *laudārēmus* 'we praised', *monērēmus* 'we advised', *dūcerēmus* 'we led', *audīrēmus* 'we heard' and *caperēmus* 'we took' from the corresponding infinitive forms *laudāre*, *monēre*, *dūcere*, *audīre* and *caperēmus*.

(44) Where σ_1 = {prs active inf} and σ_2 = {1pl impf active sbjv},
If PF(⟨L, σ_1⟩) = ⟨X*e*, σ_1⟩, then PF(⟨L, σ_2⟩) = ⟨X*ēmus*, σ_2⟩.

Implicative rules such as (64) make it possible to dispense with inflection-class diacritics because they allow all of a lexeme's realizations to be deduced from certain key forms, traditionally referred to as PRINCIPAL PARTS. (Latin verbs are traditionally assumed to have four principal parts: the first-person singular present active indicative, the present active infinitive, the first-person singular perfect indicative active, and the perfect passive participle.)

We can therefore distinguish beween exponence-based and implicative generalizations in the definition of a language's inflectional morphology: exponence-based generalizations include rules of exponence (e.g. those in Table 3), while implicative generalizations include rules of referral (e.g. (17)) as well as implicative clauses in the definition of a language's paradigm (e.g. (5), (44)). It is wrong, in our view, to regard these as competing alternatives: the most perspicuous description of a language's inflectional morphology may involve generalizations of both sorts. Indeed, some implicative generalizations specifically apply to rules of exponence.

Consider, for example, the partial declensional paradigms in Table 10. Given a locative singular form X*au*, one cannot deduce any other form in the paradigm, since the stems for the remaining case forms could either be X*i* and its alternants or X*u* and its alternants; nevertheless, a locative singular form X*au* does allow one to deduce the rules of exponence through whose application the remaining case forms arise from their stems (whatever their form may be). By the same token, given an accusative singular form X*am*, one cannot deduce the rule of exponence by which the corresponding nominative singular is formed: this could be a rule suffixing *-s* or a rule suffixing *-m*. Even so, an accusative singular form X*am* does allow one to deduce that the corresponding nominative singular form is based on the stem X*a*.

TABLE 10. Partial declensional paradigms of four Sanskrit nouns

		AŚVA 'horse'	ĀSYA 'mouth'	AGNI 'fire'	ŚATRU 'enemy'
Singular	NOM	*aśva*-s	*āsya-m*	*agni-s*	*śatru-s*
	VOC	*aśva*	*āsya*	*agne*	*śatro*
	ACC	*aśva-m*	*āsya-m*	*agni-m*	*śatru-m*
	GEN	*aśva-sya*	*āsya-sya*	*agne-s*	*śatro-s*
	LOC	*aśve*	*āsye*	*agnau*	*śatrau*
Dual	NOM/VOC/ACC	*aśvau*	*āsye*	*agnī*	*śatrū*
	GEN/LOC	*aśvay-os*	*āsyay-os*	*agny-os*	*śatrv-os*
Plural	NOM/VOC	*aśvā-s*	*āsyā-ni*	*agnay-as*	*śatrav-as*
	ACC	*aśvā-n*	*āsyā-ni*	*agnī-n*	*śatrū-n*
	GEN	*aśvā-nām*	*āsyā-nām*	*agnī-nām*	*śatrū-ṇām*
	LOC	*aśve-ṣu*	*āsye-ṣu*	*agni-ṣu*	*śatru-ṣu*

These examples show that it is not simply words, but also rules of stem choice and rules of exponence that participate in implicative relations. The modeling of these relations has important consequences for lexical representations, e.g. for the choice between marking lexemes with inflection-class diacritics such as '1st declension' and specifying lexemes' principal parts. This is a complex issue whose resolution remains to be worked out; for details, see Finkel & Stump (2007, 2009) and Stump & Finkel (to appear 2013: Chapter 7).

5 Conclusion

The core assumptions of PFM presented in §2 are very robust. Although they impose important constraints on the formal definition of a language's inflectional morphology, they are also flexible; various instantiations of PFM are imaginable within the compass of these core assumptions. This, in our view, is one of the theory's virtues; progress in morphological theory (and in linguistics generally) depends on the comparison of alternative analyses that are precise in their formulation. As we have seen in §4, a variety of morphological issues (e.g. deponency, defectiveness, syncretism, heteroclisis, suppletion, variable affix order, endoclisis, periphrasis, implicative relations among a paradigm's cells) suggest a range of new directions for the formal elaboration of PFM; our conviction is that the investigation of these new directions will ultimately afford a more fully articulated set of core assumptions.

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