French Pronominal Clitics and the Design of Paradigm Function Morphology

Olivier Bonami
Université Paris 4 & LLF (UMR 7110)
olivier.bonami@paris4.sorbonne.fr

Gilles Boyé
ERSS (UMR 5610) & Université Nancy 2
gilles.boye@univ-nancy2.fr

Realizational approaches to inflectional morphology (e.g. Matthews, 1972; Anderson, 1992; Zwicky, 1992; Aronoff, 1994; Stump, 2001) generally presuppose that the realization relation is a function: for each cell in a lexeme's paradigm, the morphology provides a single realization. Although there are well known exceptions to this generalizations (e.g. individual lexemes with two distinct paradigms) these are usually assumed to be very local and are taken to be exceptional irregularities.[1]

In this paper we exhibit an extended example of an inflectional system that is highly non-functional, the system of French Pronominal Clitics (henceforth FPCs). Although many authors have argued that FPCs should be treated within inflectional morphology, the fact that they violate functionality has not been discussed previously. After reviewing the relevant data we provide an analysis of the FPC system within Paradigm Function Morphology (Stump, 2001), and propose a modification of the framework to allow for a single feature combination to give rise to more than one realization.

1. Features of French Pronominal Clitics

Starting with Miller (1992), a number of authors have argued that French pronominal clitics are best analyzed as inflectional affixes, rather than syntactic atoms.[2] Arguments in favour of this position fall in three broad classes. First, FPCs give rise to positional effects which are reminiscent of templatic inflectional morphology, but are quite alien in ordinary syntax (§1.1). Second, in informal varieties, clitic-host combinations give rise to idiosyncratic phonological realizations that are not attributable to regular phonology, and are typical of morphological combinations (§1.2). Third, there are

[1] This paper was presented as a poster at the Fifth Mediterranean Morphology Meeting, and orally at a meeting of the GDR 2220 *Description et modélisation en morphologie*. We thank the audiences of both events for their questions, comments and criticisms, and in particular Anne Abeillé, Denis Creissels, Georgette Dal, Bernard Fradin, Ana Luís, Philip Miller and Andrew Spencer.

[2] An early precursor is (Stump, 1981), which proposes an inflectional analysis of clitics but without much empirical justification. Note that adopting an inflectional analysis for FPCs does not commit one to saying that all traditional clitics should receive this type of treatment, as Miller emphasizes. Even for Romance weak pronominal forms, it is not clear that a uniform treatment is called for (see e.g. Crysmann, 2002, on Portuguese).

morphotactic restrictions on clitic combinations that escape a syntactic explanation (§1.3).[3]

1.1. Position Class Effects

The order of realization of FPCs does not correlate with the morphosyntactic properties they express; for instance dative clitics may precede (1) or follow (2) accusatives depending on person and reflexive status.[4]

(1) a. Paul me la présentera.
Paul DAT.1S ACC.3FS present-FUT.3S
'Paul will present her to me.'

b. *Paul la me présentera.
Paul ACC.3FS DAT.1S present-FUT.3S

(2) a. Paul la lui présentera.
Paul ACC.3FS DAT.3S present-FUT.3S
'Paul will present her to him.'

b. *Paul lui la présentera.
Paul DAT.3S ACC.3FS present-FUT.3S

In addition, some FPCs are in complementary distribution, despite the fact that they express compatible syntactic information. For instance, *se* and *te* cannot co-occur (4a) despite the fact that they can express different arguments of a single verb (3). In such a situation, the only solution is to express the dative argument as a full pronoun, an option which is normally blocked by the possibility of using an FPC.

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[3] Note that all the data discussed in this section is well-known from traditional descriptions, although no precise analysis accounts for all of it, as far as we know. We do not discuss here possible counter-arguments to a morphological treatment of FPCs, but see e.g. Delais-Roussarie (2001).

[4] The data is trickier for enclitics in imperatives, where alternate orders are possible, at least in some varieties. For instance the realizations in (i) and (ii) are both possible in at least some varieties. The sociolinguistic and geographical determinants of the variation between (i) and (ii) are ill understood, but both possibilities are available in the speech of the authors. By contrast, (iv) is completely excluded.

(i) Donne le moi !
give.imp acc.3ms dat.1s
'Give it to me!'

(ii) %Donne moi le !
give.imp dat.1s acc.3ms

(iii) Donne le lui !
give.imp acc.3ms dat.3s
'Give it to him!'

(iv) *Donne lui le !
give.imp dat.3s acc.3ms

Note that robust data on enclitic complement FPCs is generally lacking, since (i) these only occur in imperatives, and are thus quite rare in existing (oral and written) corpora, and (ii) intuitions are not very reliable because of strong sociolinguistic effects associated with some attested combinations such as (ii).

(3) a. Paul te présentera Jean.
Paul DAT.2S present-FUT.3S Jean
'Paul will present Jean to you.'

b. Paul se présentera à Marie.
Paul REFL.3 present-FUT.3S to Marie
'Paul will present himself to Marie.'

(4) a. *Paul se te présentera.
Paul REFL.3 DAT.2S present-FUT.3S

b. *Paul te se présentera.
Paul DAT.2S REFL.3 present-FUT.3S

c. Paul se présentera à toi.
Paul REFL.3 present-FUT.3S to PRO.2S
'Paul will present himself to you.'

These properties are easily captured by treating the FPC system as an instance of position class morphology, where (more or less arbitrary) collections of items compete for realization in a single position. Concretely, it is usually assumed that the proclitic system can be captured using a series of seven position classes, as indicated in table 1.

In this table, the morphosyntactic information expressed by the clitic is shown between brackets. Note that the negative marker *ne* is the only non-pronominal element of the template. [5]

1	2	3	4	5	6	7
[*1s,nom*]	*negation*:	[*1s,acc/dat*]:	[*3ms,acc,nonrefl*]:	[*3s,dat,nonrefl*]:	[*loc*]:	[*de*]:
je	**ne**	**me**	**le**	**lui**	**y**	**en**
[*2s,nom*]		[*2s,acc/dat*]:	[*predicative*]:	[*3p,dat,nonrefl*]:		
tu		**te**	**le**	**leur**		
[*3ms,nom*]		[*3,acc/dat,refl*]:	[*3fs,acc,nonrefl*]:			
il		**se**	**la**			
[*3fs,nom*]		[*1p,acc/dat*]:	[*3p,acc,nonrefl*]:			
elle		**nous**	**les**			
...		[*2p,acc/dat*]:				
		vous				

Table 1: The traditional description of the proclitic system

1.2. Morphophonological Idiosyncrasies

There are a number of phonological reduction phenomena involving FPCs that cannot be accounted by regular phonology, since they are sensitive to properties inaccessible to

[5] For present purposes we ignore 'ethical' datives, but see note 21 below.

phonology. On the other hand these properties resemble the morphophonological idiosyncrasies typical of affix-host combinations.

First, there are cases of clitic-host fusion. For instance, the nominative 1s clitic *je* has a special realization when followed by the form *suis* of the lexeme ÊTRE 'be' (5a). Notice that such a realization is excluded with the otherwise homophonous form of the lexeme *suivre* 'follow' (5b), barring any hope of a phonological conditioning of the reduction.

(5) a. ʒə sɥi yn fij
je suis une fille
'I am a girl.'/'I follow a girl.'

b. ʃɥiynfij
'I am a girl.' / *'I follow a girl.'

Second, we also find cases of clitic-clitic fusion. The most well established of these concerns the clitic sequence *je lui*, which gives rise to various reductions that are not available in phonologically similar contexts. So for instance the reduced realizations found in (6a) are not possible with the present 1s form of the lexeme *luire* 'glow', despite its being homophonous with the clitic *lui* (6b).

(6) a. Je lui dirai.
NOM.1S DAT.3S tell-FUT.1S
'I will tell him.'
[ʒlɥidiʁɛ]/[ʒɥidiʁɛ]/[ʒidiʁɛ]

b. Je luis dans le noir.
NOM.1S glow-PRST.1S in DEF black
'I glow in the dark.'
[ʒlɥidɑ̃lnwaʁ]/*[ʒɥidɑ̃lnwaʁ]/*[ʒidɑ̃lnwaʁ]

Third, FPCs are among the items giving rise to 'elision' in French, the non-realization of a word-final vowel before a vowel-initial word. Note that despite a long tradition of treating elision as a general, phonological phenomenon, it concerns exactly four items in French: the definite article *la*, the complementizer *si*, and two FPCs, the nominative 2s *tu* and the accusative 3fs *la*. Moreover there are really three different behaviours at hand : *si* elides optionally, and only before the subject clitic *il(s)*, the socially preferred realization being elision. *Tu* also elides optionally, but before any vowel, and the socially preferred realization is non-elision, elision being somewhat informal. Both the article and the FPC *la* give rise to obligatory elision in all varieties.

(7) a. % si il vient
if he comes

b. s'il vient

c. si Isabelle vient
if Isabelle comes

d. * s'Isabelle vient

(8) a. Tu iras à Paris.
NOM.2S go-FUT.2S at Paris
'You will go to Paris.'

b. %T'iras à Paris.

(9) a. l' épouse
def. wife

b. *la épouse

(10) a. Je l' épouse.
NOM.1S ACC.3FS marry-PRST.3S
'I marry her.'

b. *Je la épouse.

This data points to the observation that elision is not at all a general, homogeneous phenomenon in French, but is best treated as a case of local, lexically specified, phonologically-conditioned allomorphy. Although we do not want to prejudge the analysis of the article *la* and the complementizer *si*, it is notable that this type of allomorphy is very common in morphological combinations, but is quite rare in syntactic combinations.

1.3. Morphotactics

Finally, there are a number of strange restrictions on the cooccurrence of FPCs. First, there are a number of arbitrary gaps : some clitic pairs can never be realized, such as pairs consisting of a clitic from the series *me*, *te*, *se*, *nous*, *vous* followed by a clitic in the series *lui*, *leur* (8a). Once again, this opens up the possibility of using a full pronoun for the dative (8b).

(8) a. *Paul se lui présentera.
Paul REFL.3 DAT.3S present-FUT.3S

b. Paul se présentera à elle.
Paul REFL.3 present-FUT.3S to PRO.3FS
'Paul will present himself to her.'

Second, there is at least one well documented case of clitic drop:[6] in informal varieties, FPCs from the series *le*, *la*, *les* can be dropped before FPCs in the series *lui*, *leur* (10a). That this is a robust observation is shown by the contrast in (9)-(10) : the lexeme *apporter* 'bring' is one of the few verbs which take an obligatory direct object, as illustrated in (10)b. Thus (10)a cannot be treated as a simple case of direct object drop : the possibility of not realizing the accusative complement is correlated with the presence of the clitic *lui*. This is accounted for if we assume that *lui* counts as a realization of both the accusative and the dative in this context, i.e (10)a is an alternate realization of the morphosyntactic information expressed by(9)a.[7]

(9) a. Paul la lui apportera.
Paul ACC.3FS DAT.3S bring-FUT.3S
'Paul will bring it to her.'

b. Paul l' apportera à Marie.
Paul ACC.3FS bring-FUT.3S to Marie
'Paul will bring it to Marie.'

(10) a. Paul lui apportera.
Paul DAT.3S bring-FUT.3S
'Paul will bring it to her.'

b. *Paul apportera à Marie.
Paul bring-FUT.3S to Marie

Once again, this type of data is familiar from inflectional (and in particular templatic) morphology, but quite alien for syntactic combinations.

[6] Other cases discussed by Miller (1992) include haplology data, such as the possibility of dropping the locative clitic *y* before the future forms of the lexeme *aller* (i). Note that a locative complement is otherwise obligatory with *aller* (ii).

(i) Paul ira.
Paul go-FUT.3S
'Paul will go there.'

(ii) *Paul est allé.
Paul is go.PASTP.MS
'Paul went.'

[7] It is sometimes suggested that (10)a is simply the effect of a phonological reduction of [la] to [l] followed by a degemination from [llɥi] to [lɥi]. However this would be the only case where [la] reduces to [l] before a consonant. Notice in particular that the reduction is not available before the verb *leurre* (i-ii), which is homophonous to the clitic *leur* before which reduction is possible (iii).

(i) Paul la leurre admirablement.
Paul ACC.3FS lure-PRST.3S wonderfully
'Paul wonderfully lures her.'

(ii) #Paul leurre admirablement. (not compatible with a specific interpretation of the object)

(iii) Paul leur apportera.
Paul dat.3p bring-fut.3s
'Paul will bring it to them'

2. Previous Approaches to FPCs

We follow Miller (1992) in concluding from the previous data that FPCs are better treated as an instance of inflectional morphology that as an instance of syntax.[8] In this section we review briefly two existing formal analyses in this tradition.

2.1. Miller and Sag (1997)

Miller and Sag propose an HPSG (Pollard and Sag, 1994) analysis of FPCs. Although most of the paper deals with issues in the syntax of FPCs, it includes a realizational, template-based analysis of the morphology of clitics.

The realization of clitics is governed by a function F_{PRAF}, which taxes as input (i) an inflected form, (ii) the HEAD value of the verb (specifying its morphosyntactic features), and (iii) the verb's ARGUMENT-STRUCTURE list (specifying the list of its arguments). The function outputs a specification of a clitic template, including information as to whether the template is enclitic or proclitic. The template consists of seven slots ; it includes a specification of specific enclitic forms (slot 5) which were not taken into account in table 1. Negative *ne* is not taken into account.

Table 2 summarises the effect of F_{PRAF} in the case of proclitics.[9] The first column corresponds to the HEAD argument of the function. Column 2 indicates the morphosyntactic properties associated with a member of the ARG-ST list which is to be realized as a clitic. Column 3 specifies in which slot it is realized and column 4 under what form.

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[8] As is well known, noninverted subject clitics have some properties that are less affix-like than those of the rest of FPCs (Couquaux, 1986). In particular they may take scope over a coordination of VPs, at least in formal varieties (i)—this is impossible for object clitics in all varieties (ii). This property points to an analysis of subject clitics as syntactic atoms. However treating subject clitics as syntactic atoms makes it hard, if not impossible, to account for the clitic-host and clitic-clitic fusions observed in section 1. There are two possible routes here : either subject clitics should be treated as "true clitics" in the sense of Zwicky (1977), that is, syntactic atoms with the morphophonological properties of word-internal morphs—the problem with such a hypothesis is that we lack a formally precise proposal for accounting for such true clitics. Or we could follow Miller (1992) in assuming that there are really two competing systems for subject clitics in contemporary French, one where they are syntactic atoms, and one where they are affixes. One argument in favor of this second solution is the fact that wide scope over coordination and clitic-host fusion seem to be in complementary distribution (iii).

(i)	Il	lira	ce	livre	et	le	critiquera.
	he	read-FUT.3S	this	book	and	it	criticize-FUT3S
	'He will read this book and criticize it.'						
(ii)	*Il	le lira	aujourd'hui	et	critiquera		demain.
	he	it read-FUT.3S	today	and	criticize-FUT.3S		tomorrow.
	'He will read it today and criticize it tommorrow.'						
(iii)	Je	suis	et	resterai	content.		
	I	be-PRST.1S	and	stay-FUT.1S	happy		
	'I'm happy and will stay that way.'						

[ʒəsɥiɛʁɛstəʁɛkɔ̃tã] / *[ʃɥiɛʁɛstəʁɛkɔ̃tã]

[9] Miller and Sag's analysis also applies to the case of enclitics, but we do not discuss that part of the analysis since (i) it would take us too far afield and (ii) the variety described in Miller and Sag differs strongly from our own as far as enclitics are concerned, making comparisons difficult.

HEAD	ARG-ST element	slot	form
tensed	[*1s*, *nom*]	SL-1	je
tensed	[*2s*, *nom*]	SL-1	tu
tensed	[*3ms*, *nom*]	SL-1	il
tensed	[*3fs*, *nom*]	SL-1	elle
…	…	…	…
	[*1s*, *obj*]	SL-2	me
	[*2s*, *obj*]	SL-2	te
	[*3s*, *obj*, *refl*]	SL-2	se
	[*1p*, *obj*]	SL-2	nous
	[*2p*, *obj*]	SL-2	vous
	[*3ms*, *acc*]	SL-3	le
	[*3ms*, *predicative*]	SL-3	le
	[*3fs*, *acc*]	SL-3	la
	[*3p*, *acc*]	SL-3	les
	[*3s*, *à*$_1$]	SL-4	lui
	[*3p*, *à*$_1$]	SL-4	leur
	[*à*$_2$]	SL-6	y
	[de]	SL-7	en

Table 2—Miller and Sag's (1997) realization function in the enclitic case

Table 2 encodes a number of auxiliary hypotheses on French morphosyntax. The forms *à* and *de* are taken to be case markers rather than prepositions ; two distinct case values can be realized as *à*, corresponding to the clitics *lui*/*leur* and *y* respectively. The value *obj* is an underspecified case value corresponding to a choice between accusative and *à*$_1$.

In addition to the specification of F_{PRAF}, Miller and Sag propose that the template is subject to structural constraints such as the following, which account for some morphotactic idiosyncrasies :

(11) If slot 2 is nonempty, then slot 4 is empty.

This constraint makes sure that clitics in the series *me/te/se/nous/vous* cannot cooccur with clitics in the series *lui/leur*, as observed in §1.3.

Although the syntactic part of Miller and Sag's analysis is impressively detailed, there are problems with the morphological proposal, which is clearly underdeveloped. First, the proposal deals nicely with position class effects, but has nothing to say on morphophonological idiosyncrasies.[10] The treatment of morphotactics based on constraints on the templates is not formalized and not very promising of an elegant formalization. Second and more importantly, the system is set up so that each feature combination may give rise to only one phonological realization. This is highly problematic, since most of the alternative realizations discussed in section 1 are optional : fused forms, *tu* elision and clitic drop are only options which coexist with

[10] Remember from the discussion in section 1 that these idiosyncrasies cannot be attributed to phonology, and should be treated within the morphological component.

other possible realizations in the grammar. Thus the problem is not so much that Miller and Sag's analysis describes a standardized variety, but that their formal setup cannot be adapted to the description of a variety where alternative realizations are allowed.

2.2. Monachesi (1999, 2005)

Monachesi (1999) develops an analysis of Italian pronominal clitics based on data analogous to Miller's, and that may easily be mimicked in an analysis of French. Monachesi (2005) extends the approach to Romance in general with special reference to Rumanian.

Monachesi's proposal is based on the postulation of implicational constraints linking the value of a verb's CLITICS list, representing the arguments of the verb that need to be realized as clitics, and the morphological features STEM and AFFIX. Each constraints states globally a possible morphological realization for a full CLITICS list—the constraints deal directly with clitic sequences rather than individual clitics. Thus (12)a is the constraint realizing a dative 1s and a locative as *mi ci*. This way of dealing with clitic sequences allows Monachesi to accommodate morphophonological idiosyncrasies directly: for instance (12)b states an idiosyncratic realization for the sequence of a dative 1s and an accusative 3ms (the realization is idiosyncratic because *mi lo* would be expected instead of *me lo*). Finally optionality is not an issue, because disjunctions can be included in the constraints. For instance, (12)c states two alternative (elided and non-elided) realizations for a pre-vocalic accusative 3ms.

(12) a. $\left[\begin{array}{l} complex-word \\ \text{CLITICS } \langle \text{NP}[dat,1sg],\text{NP}[loc] \rangle \end{array}\right] \rightarrow \left[\text{AFFIX } \langle mici \rangle\right]$

b. $\left[\begin{array}{l} complex-word \\ \text{CLITICS } \langle \text{NP}[dat,1sg],\text{NP}[acc,3ms] \rangle \end{array}\right] \rightarrow \left[\text{AFFIX } \langle melo \rangle\right]$

c. $\left[\begin{array}{l} complex-word \\ \text{CLITICS } \langle \text{NP}[acc,3ms] \rangle \end{array}\right] \rightarrow \left[\begin{array}{ll} \text{STEM} & \langle vowel,\ldots \rangle \\ \text{AFFIX} & \langle l \rangle \vee \langle lo \rangle \end{array}\right]$

Although Monachesi's setup can deal with the very issues that were problematic for Miller and Sag, it seems to miss important generalizations, at least for French. As we just saw, Monachesi states a different constraint for each clitic sequence that has to be generated. This might be a reasonable move for Italian, where the number of possible clitic clusters is low (56 according to Monachesi's 1999 data), and thus the proportion of idiosyncratic clusters is quite high. But this will not do for French, where we have to deal with subject clitics, subject clitic inversion, and the fact that enclitic clusters differ from proclitic clusters. A simple (but fastidious) calculation shows that even in conservative varieties such as that described by Miller and Sag, there are 1909 different cases to consider. It is clearly not satisfying to need nearly 2000 rules to deal just with the standard variety.

2.3. Discussion

The two analyses we just discussed have complementary advantages and complementary drawbacks: Miller and Sag's analysis is elegantly simple and general, at the price of coverage—ironically, this analysis gives no account for the very data Miller (1992) collected to argue in favour of a morphological view of PFCs. Monachesi's analysis can deal with the full set of data, but at the price of denying any structure to the clitic sequence, which gives rise to an explosion of the number of rules. Clearly, what is needed is a way of treating the idiosyncrasies without denying that in simple cases the clitic sequence is analyzable.

Paradigm Function Morphology (PFM; Stump 2001) seems like a good candidate for this task: PFM has been applied in detail to cases of position class morphology, and is known to be able to deal with cases where the position class system seems to collapse, because of affix fusions, position reversals, etc.

3. A PFM Analysis of French Pronominal Clitics

3.1. A Sketch of Paradigm Function Morphology

In this section we provide a sketch of Paradigm Function Morphology. The presentation is based on a PFM analysis of French conjugation that is detailed in appendix A.

Paradigm Function Morphology is an explicit theory of inflectional morphology that is both inferential and realizational: First, affixes are not treated as signs, but as the result of the application of a rule relating morphosyntactic features to a phonological function modifying a base. Second, inflectional rules do not consume features, but merely express (realize) them. Thus there is no requirement that a feature must be expressed exactly once.

In PFM, the inflectional system of a language is modelled by a *paradigm function*. Paradigm functions take as input a root and a feature set, and return a phonological form.

Although many approaches to morphology can be defined within this setup, PFM assumes that paradigm functions are further characterized by using a system of *realization rule blocks*. Each rule is assigned a block index, and the paradigm function defines the order in which the blocks must be traversed.

Realization rules come in two varieties. *Rules of exponence* simply associate a phonological modification to the expression of a given feature set. For instance, (13) is the rule used for regular first person plural inflection on verbs in French:[11] the rule states that to express the feature set σ on a base X of category V, if the feature set contains the specification that the person is 1 and the number is plural, then /ɔ̃/ is suffixed to the base.

(13) X_{V},σ: {PER *1*, NB *pl*} → X⊕ɔ̃

[11] Note that we use the notation proposed by Ackerman and Stump (2004) rather than that of (Stump, 2001). We also adopt the HPSG practice of typesetting attribute names in SMALL CAPITALS and atomic values in *italics*.

Rules of referral do not express an exponent directly but refer the realization of a feature set in a given block to that of a possibly different feature set in a possibly different block. For example, in French conjugation, the forms used in first person plural and second person plural are always identical, in all tenses, except for the different person endings (*-ons*/*-mes* and *-ez*/*-tes*).[12] This can be captured by the rule in (14). This rule presupposes an analysis of French conjugation with four rule blocks, where the last block 4 contains rules such as (13) introducing the person endings. Rule (14) belongs to the preceding block 3. The notation $\langle X,\sigma\rangle : \beta$ denotes the result of submitting the form X with feature set σ to the rules of block β. So in words, (14) states that the expression of second person plural on form X is identical to the expression of first person plural on the same form X in block 3.

(14) X_V,σ: {PER *2*, NB *pl*} → ⟨X, σ / {PER *1*}⟩ : 3

Finally the system accommodates the notion of a *portmanteau rule*, a rule corresponding to the traversal of a block sequence instead of a single block. This provides a simple way of accommodating both affix fusion and full form suppletion. In affix fusion, a single rule of realization is used instead of a succession of rules in consecutive blocks. In full form suppletion, a single rule specifies directly the full form associated with some feature bundle for a given lexeme, bypassing the whole block system. An example from appendix A is rule (16) accounting for the use of the suppletive form *sommes* for the first person plural present form of *être*, instead of the expected *étons*.

(15) a. Sample block 1 rule:[13]
X_V,σ: {TENSE *prst*} → Y, where Y is X's basic stem.

b. Sample block 4 rule:
X_V,σ: {PER *1*, NB *pl*} → X⊕õ

(16) Portmanteau 1-4 rule:
$X_{être},\sigma$: {TREL *eq*, TREF *deictic*, PER *1*, NB *pl*} → sɔm

Note that despite the fact that the inflectional system as a whole is postulated to be a function, nothing precludes multiple rules to be appropriate for the expression of the same feature set in the same block. Thus special care must be taken to make sure that a single result always prevails. In PFM this is done by assuming a specificity ordering on the rules. First, no system can contain two rules in the same block such that both rules may apply to the same input feature set and neither of the two rules is more specific than the other. Second, when facing a choice between two rules within a block, the more specific rule always prevails: this is what Stump calls Panini's principle.[14] These two

[12] The only exceptions to this generalization are the two verbs with a suppletive 2P form in the present indicative, *faire* and *dire*. These are best treated as special cases (see Bonami and Boyé 2002 for discussion) and can be dealt with in PFM using portmanteau rules specific to a single lexeme.

[13] The notation from appendix A has been simplified for ease of exposition.

[14] A special case must be made for portmanteau rules, because these cannot be compared directly to ordinary rules. Stump's assumption, embedded in the Function Composition Default (Stump, 2001: 142)

assumption are sufficient to make sure that the block system indeed produces at most one output for any given input.

3.2. *The Standardized Subsystem*

We start by providing a simple PFM analysis of what we call the "standardized subsystem" of proclitics, that is, the part of the Standard French system modelled by (Miller and Sag, 1997). For simplicity, we follow Monachesi and assume that verbs carry a list-valued CLTS feature expressing what clitics must be realized in a given syntactic context; we leave out the specification of the syntactic constraints determining what ends up on the CLTS list, to avoid the issue of integrating PFM with an explicit syntactic framework.[15]

For the standardized subsystem we rely on a sequence of seven blocks, corresponding to the position classes in table 1. The block system is depicted informally in figure 1, where each block is represented as a transition between two states and each rule as an arrow relating these two states.[16]

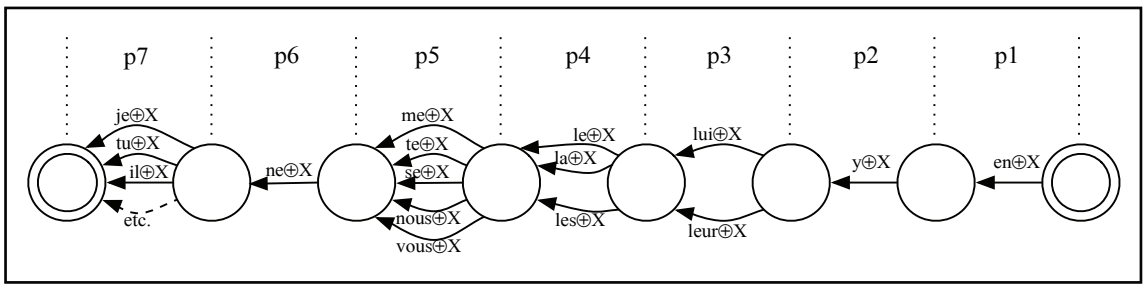

Figure 1: The standardized subsystem

To express the rules, we assume a case/marking system identifying different types of arguments of verbs. The basic cases are *nominative*, *accusative*, *dative* for *à*-marked phrases alternating with the clitics *lui*/*leur*, *locative* for static locative expressions in the sense of (Bonami, 1999), and *de* for phrases marked with *de* in general, be they NPs, PPs or VPs (see Abeillé et al. 2004, 2005 for relevant data and analysis on *de* phrases).[17] We also adopt Miller and Sag's (1998) underspecified *obj* case/marking value which generalizes over *accusative* and *dative*; this is the case value assigned to FPCs in slot p3.

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is that portmanteau rules always win competition against non-portmanteau rules, whatever the specificity of these.

[15] However it is a simple exercise in typed feature structure modelling to embed a version of PFM in an HPSG grammar; this allows one to use directly Miller and Sag's syntactic analysis in combination with the current morphological analysis.

[16] The similarity to the standard depiction of finite-state automata is not completely fortuitous—see Karttunen (2003) and Malouf (2005) for tentative formulations of PFM as an instance of finite state morphology.

[17] Note that *dative* corresponds to Miller and Sag's $\grave{a}_1$, and *locative* corresponds to Miller and Sag's $\grave{a}_2$.

Rule (17) simply states that a clitic corresponding to a *de*-marked phrase can be realized by prefixing ɑ̃(n) to a verb form in block p1.[18] Parentheses in the phonological representations note a *latent* segment, that is, a segment that is only realized if followed by a segment of the opposite category : latent consonants surface only before vowels, and latent vowels realize only before consonants.[19] Rule (18) indicates that a clitic corresponding to a locative phrase is realized by prefixing [i] in block p2. Rule (19) allows two realizations for a clitic corresponding to a dative nonreflexive in block p3 (dative reflexives can only be realized in block p5).

(17) Block p1
X_V,σ : {CLTS ⟨…,{*de*},…⟩} → ɑ̃(n) ⊕ X

(18) Block p2
X_V,σ : {CLTS ⟨…,{*loc*},…⟩} → i ⊕ X

(19) Block p3
a. X_V,σ : {CLTS ⟨…,{*dat*,*3s*,*nonrefl*},…⟩} → lɥi ⊕ X

b. X_V,σ : {CLTS ⟨…,{*dat*,*3p*,*nonrefl*},…⟩} → lœʁ ⊕ X

Block p4 includes the expected rules realizing a clitic corresponding to an accusative nonreflexive argument. Notice that final [ə]s are not treated as latent vowels, since [ə]s are generally subject to deletion rules in French. A further rule is used to realize clitics corresponding to predicative arguments (adjectival or nominal complements of the copula), whose form is not dependent on gender.

(20) Block p4
a. X_V,σ : {CLTS ⟨…,{*acc*,*3ms*,*nonrefl*},…⟩} → lə ⊕ X

b. X_V,σ : {CLTS ⟨…,{*acc*,*3fs*,*nonrefl*},…⟩} → l(a) ⊕ X

c. X_V,σ : {CLTS ⟨…,{*acc*,*3p*,*nonrefl*},…⟩} → le(z) ⊕ X

d. X_V,σ : {CLTS ⟨…,{PRED +},…⟩} → lə ⊕ X

Block p5 realizes clitics corresponding to reflexive and/or fist/second person accusative or dative arguments.

[18] In the interest of readability we abbreviate feature descriptions where possible. Thus *acc* stands for {CASE *accusative*}, 3ms for {PERSON *3,* GENDER *masculine*, NUMBER *singular*}, etc.

[19] The use of latent segments is more or less standard in descriptions of French phonology. Although they can certainly be dispensed with, their inclusion simplifies greatly the description of morphophonology. See Bonami, Boyé and Tseng (2004) for an explicit formalization of the notion of latent segment in an HPSG grammar of French.

(21) Block p5

a. X_V,σ: {CLTS ⟨…,{*obj*,*1s*},…⟩} → mə ⊕ X

b. X_V,σ: {CLTS ⟨…,{*obj*,*2s*},…⟩} → tə ⊕ X

c. X_V,σ: {CLTS ⟨…,{*obj*,*3*,*refl*},…⟩} → sə ⊕ X

d. X_V,σ: {CLTS ⟨…,{*obj*,*1p*},…⟩} → nu(z) ⊕ X

e. X_V,σ: {CLTS ⟨…,{*obj*,*2p*},…⟩} → vu(z) ⊕ X

The sole rule in block p6 allows for the realization of negative *ne*. In Contemporary French *ne* does not express negation by itself, but acts as a scope-marker indicating where negative words (adverbs such as *pas* 'not', quantifiers such as *personne* 'nobody', adverbs of quantification such as *jamais* 'never') take scope (Kayne, 1984). Following Godard (2004) we assume that the relation between the scope of negation and the realization of the form *ne* is mediated by a morphosyntactic feature ±NE ; thus *ne* is the realization of a {NE +} specification.

(22) Block p6

a. X_V,σ: {NE +} → nə ⊕ X

Block p7 accounts for the realization of nominative pronominal arguments as proclitics. The rules are sensitive to a feature INV which serves as a trigger for subject clitic inversion : contexts licensing a clitic inversion,[20] such as root interrogatives, introduce an {INV +} specification. Here since we are dealing with proclitic realizations the rule is sensitive to an {INV –} specification.

(23) Block p7

a. X_V,σ: {INV –, CLTS ⟨…,{*nom*,*1s*},…⟩} → ʒə ⊕ X

b. X_V,σ: {INV –, CLTS ⟨…,{*nom*,*2s*},…⟩} → ty ⊕ X

c. X_V,σ: {INV –, CLTS ⟨…,{*nom*,*3ms*},…⟩} → il ⊕ X

d. etc.

Finally, note that the rule system above does not block the realization of sequences such as *se lui* (8). We propose to treat this restriction not as part of the rule block system, but as a feature cooccurrence restriction indicating that a reflexive or nonthird person object and a dative cannot co-occur on the CLTS list. A direct advantage of this move is that it accounts directly for the fact that the data in (8) has direct

[20] As is known since Kayne (1972), *clitic subject inversion* should not be confused with *stylistic inversion* of full NPs, which is triggered in a different set of contexts (mostly, extraction contexts) and has different formal properties.

parallels in the enclitic system, despite the fact that different clitics (and thus different position classes) are used (25). Thus we capture a generalization that cannot be captured if the restriction is treated as a restriction on the block system.

(24) Feature cooccurrence restriction
$\{\text{CLTS}\ \langle \ldots, x : \{obj\}, \ldots, \{dat\}, \ldots \rangle\} \Rightarrow x : \{3, nonrefl\}$

(25) a. *Présente lui moi !
present-IMP.2S DAT.S OBJ.1S

b. Présente moi à elle !
present-IMP.2S OBJ.1S to PRO.3FS
'Present me to her!'

3.3. Some Common Variants

In this section we show how the account of the standardized subsystem can be extended to account for the data discussed in section 1. Our basic strategy is to add more rules, many of which are portmanteau rules. The overall layout of the system is as depicted in figure 2.[21]

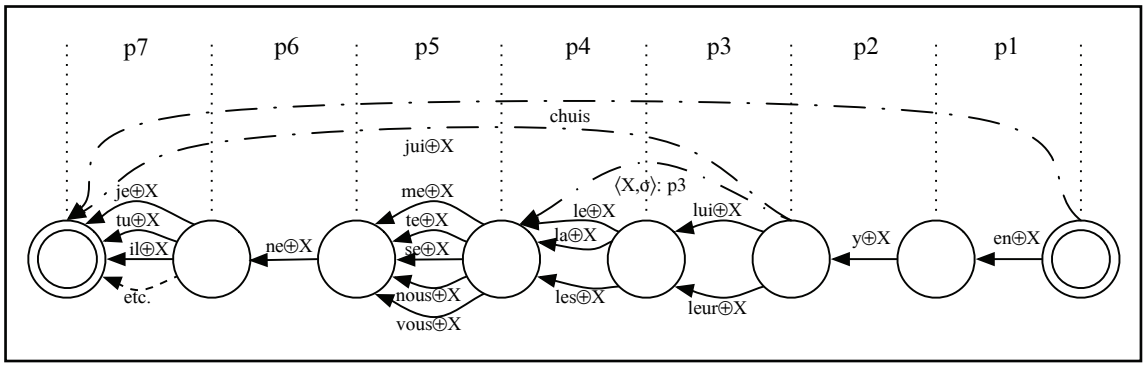

Figure 2: Some common variants

[21] A further complication that should be taken into account is the distribution of so-called 'ethical dative' clitics, which are forms in the series *me*/*te*/*nous*/*vous* which are used in colloquial spoken French to mark emphatically the surprise of the speaker at the reported state of affairs (see Leclère, 1976, for extended discussion). As (i–ii) shows, ethical datives can cooccur with a clitic belonging to block p5; thus they should be treated by adding a further block p5' between p5 and p6. Rule (iii) could be used to this effect, assuming that {SURPRISE +} is a placeholder for whatever is the correct characterization of the pragmatic effect of the ethical dative.

(i) Il t' a fait un de ces boucans !
he ETH.DAT has done one of these noises
'He did so much noise!'

(ii) Il te nous a passé un de ces savons !
he ETH.DAT us has passed one of these soaps
'He gave us an incredible telling-off!

(iii) Block p5′
X_V, σ: {SURPRISE +} → ⟨X, {CLTS ⟨…,{*dat* ,*nonrefl*},…⟩}⟩ : p3

To account for elided realizations of *tu*, we include an extra rule in block p7 stating that *tu* can be generated with a final 'latent' vowel, which surfaces only if followed by a consonant. Note that since the original *tu* rule is not suppressed, we end up with optional rather than obligatory elision.

(26) Block p7
$X_{V,\sigma}$: {INV –, CLTS ⟨…,{*nom*,*2s*},…⟩} → t(y) ⊕ X

We account for the possibility of realizing *je suis* as [ʃɥi] by stating a portmanteau rule covering the whole block system. This rule states that if we are dealing with a first person singular present indicative form of the lexeme *être*, and that a subject clitic must be realized, then [ʃɥi] is a possible realization. Note that the rule states that the subject clitic must be the sole member of the CLTS list, thus correctly barring [ʃɥi] from being a realization of e.g. *je le suis*. On the other hand, [ʃɥi] can be used in negative contexts, as a variant of *je ne suis*, since the rule does not exclude the possibility of a {NE +}) specification.

(27) Portmanteau p1–p7 rule
$X_{\text{être},\sigma}$: {INV –, CLTS ⟨{*nom*,*1s*}⟩,MODE *indic*, TENSE *prst*} → ʃɥi

A similar, but different rule is used to account for reduced realizations of *je lui* sequences. We posit a portmanteau rule covering blocks p3 to p7 and stating that both nominative 1s and a dative 3s clitics can be realized by the single sequence [ʒɥi]. Note that the rule completely bypasses the expression of features that could be realized by blocks p4, p5, p6. As a matter of fact this desirable: (i) realization of *ne* in p6 is optional in standard French, so that the [ʒɥi] reduction is possible even in negative (NE +) contexts; (ii) the restriction in (24) excludes the possibility that an input to rule (28) also asks for a clitic to be realized in p5; and finally the realization of block p5 clitics is optional before block p4 clitics, as already noted above and accounted for directly below in the general case, so that [ʒɥi] is indeed a possible realization for a nominative-accusative-dative clitic sequence. Finally, the rule correctly authorizes the realization of clitics from blocks p1 and p2, accounting for examples such as *je lui en donnerai* [ʒɥiɑ̃dɔnʁɛ].

(28) Portmanteau p3–p7 rule
$X_{V,\sigma}$: {INV –, CLTS ⟨…,{*nom*,*1s*},…,{*dat*,*3s*,*nonrefl*},…⟩} → ʒɥi ⊕ X

To account for clitic drop we use a portmanteau rule which is also a rule of referral. This rule basically states that when realizing both a nonreflexive third person accusative and a nonreflexive third person dative, one option is to refer to the realization of the same feature set in block p3 while ignoring block p4. As the reader can check this captures our generalization correctly.

(29) Portmanteau p3–p4 rule
X_V,σ : {CLTS ⟨…,{*acc*,*3s*,*nonrefl*},{*dat*,*3s*,*nonrefl*},…⟩} → ⟨X, σ⟩ : p3

4. A Relational Version of PFM

4.1. The Issue

The rule system defined in section 3 seems to account adequately for all the properties of FPCs discussed in section 1, with one big caveat. In Paradigm Function Morphology, as the name indicates, inflectional morphology takes the form of a function—for each possible input the system provides no more than one output. To make sure that the rule block system indeed provides a single output for each input, PFM relies on Panini's principle: for every possible input there must be a most specific rule in each block compatible with the feature set to be expressed, which is chosen as the output of that block.

As it stands, the rule system defined above both violates Panini's principle and produces inadequate results. First, block p7 contains two rules applicable to the exact same feature set, for elided and non-elided *tu*. Second, many rules turn out to be applied obligatorily because they are specific enough, blocking the application of another possible rule. For instance rule (27) is very specific, and blocks the possibility of realizing *je suis* as [ʒəsɥi], which is empirically incorrect. The same holds for the two other portmanteau rules in (28) and (29).

Thus it seems that PFM has one design property that is at odds with the empirical characteristics of the FPC system: the FPC system is not functional, but relational. On the other hand, the rule formats authorized by PFM have been shown to provide adequate means of modelling some of the peculiar properties of FPCs. Thus an adequate analysis can be provided by modifying PFM so that the functional requirement is dropped.

Formulating a relational version of PFM is a somewhat tedious task ; a proposal can be found in appendix B. Intuitively, what needs to be done is to define traversing a block of rules as a process which may give rise to different outputs, according to the rules that have been chosen. Likewise, the notation ⟨*X*,σ⟩ : β should be interpreted not as denoting the result of applying the narrowest rule in block β to ⟨X,σ⟩, but as describing nondeterministically any of the different ways for block β to provide an output for the input ⟨X,σ⟩.[22] One small complication is the status of the Identity Default condition, the condition that when no rule in a block can apply, then the block produces an output identical to its input. In standard PFM, this is dealt with by assuming that each block contains a special, identity rule of exponence. In the relational version, this won't work, because it would amount to making all realization rules optional (since every rule can now apply irrespective of specificity). The solution is to embed the Identity Default condition in the definition of rule blocks, and to state that a block may be traversed with no modification if and only if no rule within that block may be applied to the input.

[22] Note that this means that realization rules themselves are relations and not functions, since rules of referral must now be able to refer to any of the possible realizations of a form/feature set pair within a given block.

4.2. Are Inflectional Systems Functional?

We have shown that it is possible to define a relational version of PFM that can accommodate the type of inflectional behaviour exhibited by FPCs. What remains to be addressed is an empirical issue: typical inflectional systems seem to be functional in Stump's sense. Thus what is it about FPCs that triggers the use of a relational system?

We think that this question cannot be answered directly, and that a broad empirical overview is needed: it might well be the case that relational inflectional systems are more common than (Stump, 2001) seems to assume. Here are a few examples collected at random:

(30) In Spanish, every verb has two sets of forms for the subjunctive imperfective, a set in *-ra* and a set in *-se* (Alcoba, 1999). Each set provides one form for each of the six persons. For example, with the verb *amar* 'love', the following forms of the subjunctive imperfective alternate freely: *amara/amase, amaras/amases, amara/amase, amáramos/amásemos, amarais/amaseis, amaran/amasen*.

(31) In Nepali, negative polarity is morphologically marked in the conjugation (Adhikari 1993). For the present tense, there are two inflectional forms for each person of the negative paradigm: a long form and a short form (except for verb stems ending in -VC which only have long forms). These negative forms are in free variation: *birsanna*/*birsãdinã* 'I don't forget', *birsannas/birsãdejnas* 'you don't forget', etc.

(32) In Finnish, there are two inflectional forms for the genitive plural: a weak form and a strong form (Anttila 1997). For words of one or two syllables, the two forms are in complementary distribution based on phonological criteria. For longer words, free variation arises : *fyysikko* 'physicist', for example, has two genitive plural forms *fyysikkojen* (weak) and *fyysikoiden* (strong).

This list is definitely far from exhaustive, and might not be representative either. However it is sufficient to show that we should not presuppose as self-evident the idea that inflectional systems are functional; whether they are or not seems to be an open research question. Be that as it may, it remains that the nonfunctionality exemplified here is a lot more limited than what we have found in the FPC system. In the three cases mentioned, we could account for the data by assuming a supplementary morphosyntactic feature encoding a distinction between two subparadigms. Although such a feature would be spurious from a morphosyntactic point of view, such local inefficiencies are not unexpected in natural language grammars. By contrast, our observations suggest that the relational character of the FPC system cannot be reduced by using a simple feature distinction, since alternate realizations are distributed throughout the system. We conjecture that nonfunctionality is the gist of the difference between argument realization systems such as the FPC system and true inflection.

Appendix A: A PFM Analysis of French Conjugation

In this appendix we present succinctly a PFM analysis of French conjugation. This analysis serves as an illustration of the workings of PFM, and provides the bases for the PFM analysis of French clitics : the clitic systems takes inflected verb forms as its input.

A.1 Morphosyntactic Features of French Verbs

We follow the tradition in assuming that French verbs inflect for TENSE, MODE, NUMBER, PERSON and GENDER. The only point where we depart from this tradition is in the exact makeup of the TENSE and MODE classification.[23] We adopt Verkuyl *et al.* (2004)'s neo-Reichenbachian (Reichenbach, 1947) analysis allowing one to make sense of the role of the *imparfait* and *conditional* tenses in the French system. Verkuyl et al. propose that the indicative tense system be analyzed along two dimensions: the *temporal relation* between reference time and event time may be either precedence, equality, or succession, giving rise to past, present or future tenses. Independently, the identification of the reference time may be done on a *deictic* basis, i.e. by identifying it with the speech time ; or on an *anaphoric* basis, by identifying it with a previously established time discourse referent. The *imparfait* is the anaphoric version of the present, and the *conditional* is the anaphoric version of the future (there happens to be no anaphoric version of the past). This allows one to make sense e.g. of the distribution of tenses in conditional sentences, or in dependent clauses : in conditionals sentences, antecedents in the *imparfait* associate with consequents in the *conditional* tense, whereas antecedents in the *present* associate with consequents in the *future*. Likewise, when reporting an attitude towards the future, a *present tense* report entails the use of the future in the dependent clause, whereas an *imparfait* report entails the use of the *conditional*.

(33) a. Si Jean vient, il sera furieux.
if Jean come-PRST he be-FUT furious
'If Jean comes he will be furious.'

b. Si Jean venait, il serait furieux.
if Jean come-IMPF he be-COND furious
'If Jean came he would be furious.'

(34) a. Jean pense qu' il viendra.
Jean think-PRST that he come-FUT
'Jean thinks he will come.'

b. Jean pensait qu' il viendrait.
Jean think-IMPF that he come-COND
'Jean thinks he will come.'

[23] Note that we do not model directly periphrastic tenses, which we take to be generated by syntax. See Abeillé and Godard (2002) for a thorough syntactic analysis of French compound tenses.

The feature inventory we propose is given in (35). Table 3 makes explicit the correspondence between tense feature values and the traditional names of French tenses. Note that we treat PERSON, NUMBER and GENDER features as direct features of the verb, rather than using a embedded feature structure specifying what the verb agrees with. This is motivated by the fact that, depending on the syntactic context, French past participles may agree with the subject or the object (36). Yet there is no separate set of exponents for subject and object agreement: rather, the same exponents are used for agreement with whatever target syntax asks for. Thus we assume that the verb carries appropriate PERSON, NUMBER and GENDER features, and that syntax will determine how these features covary with features of an NP in the context.

(35) Features and values

a. MODE : *indicative*, *subjunctive*, *imperative*, *participle*

b. TREF : *anaphoric*, *deictic*

c. TREL : *precedence*, *equality*, *succession*

d. PER : *1*, *2*, *3*

e. GEN : *mas*, *fem*

f. NB : *sg*, *pl*

	{TREL *prec*}	{TREL *eq*}	{TREL *succ*}
{MODE *indic*, TREF *deictic* }	simple past	present	future
{MODE *indic*, TREF *anaphoric* }	—	*imparfait*	conditional
{MODE *subj*}	past subjunctive	present subjunctive	—
{MODE *part*}	past pasticiple	present participle	—

Table 3 – Correspondence between feature values and traditional tenses

(36) a. Auxiliary *avoir*, in-situ object : no agreement
Paul a écrit la lettre.
Paul.MS has write-PASTP.MS.SG the.FS letter.FS
'Paul wrote the letter.'

b. Auxiliary *avoir*, extracted object : object agreement
la lettre que Paul a écrite
the.FS letter.FS that Paul.MS has write-PASTP.FEM.SG
'the letter Paul wrote'

c. Auxiliary *être*: subject agreement
Marie est morte.
Marie.FS is die-PASTP.FEM.SG
'Marie died.'

Finally (37) lists the appropriate feature cooccurrence restrictions : (a) the TREF feature is appropriate only in the indicative, thus there is only one tense series in other moods ; (b) future tenses exist only in the indicative ; (c) there are no tense distinctions in the infinitive and the imperatives ; (d) there is no anaphoric past tense ; (e) only finite moods are compatible with PERSON ; (f) only past participles have GENDER ; (g) infinitives do not inflect for NUMBER ; and finally (h) imperatives have only three forms.

(37) a. $\{\text{TREF } x\} \Rightarrow \{\text{MODE } \textit{indic}\}$

b. $\{\text{TREL } \textit{succ}\} \Rightarrow \{\text{MODE } \textit{indic}\}$

c. $\{\text{TREL } x\} \Rightarrow \neg(\{\text{MODE } \textit{inf}\} \vee \{\text{MODE } \textit{imper}\})$

d. $\neg(\{\text{TREF } \textit{ana}\} \wedge \{\text{TREL } \textit{prec}\})$

e. $\{\text{PER } x\} \Rightarrow \neg(\{\text{MODE } \textit{inf}\} \vee \{\text{MODE } \textit{part}\})$

f. $\{\text{GEN } x\} \Rightarrow (\{\text{MODE } \textit{part}\} \wedge \{\text{TREL } \textit{prec}\})$

g. $\{\text{NB } y\} \Rightarrow \neg(\{\text{MODE } \textit{inf}\})$

h. $\{\text{MODE } \textit{imper}\} \Rightarrow (\{\text{PER } \textit{2}\} \vee (\{\text{PER } \textit{1}\} \wedge \{\text{NB } \textit{pl}\}))$

A.2 The Stem Space

French conjugation is characterized by a complex system of stem allomorphies. Whereas inflectional exponents are uniform for all but a handful of verbs (see table 4), various kinds of stem alternations motivate the traditional clasification of verbs in three groups. Verbs in group I have three distinct stems : basic stem X used by default, a stem Xe in the infinitive and past participle, Xa in the simple past and past subjunctive. Verbs in group II have two stems with a very different distribution : Xi in the present singular, the imperative singular, the infinitive, future, conditional, and past participle, Xis elsewhere. Group III is really a repository for all verbs that pattern neither with group I nor with group II, and a few dozen distinct patterns of stem alternation are attested there. For instance the verb *aller* ‘go’ has six distinct stems : [va] in the present and imperative singular, [ale] in the infinitive and past participle, [ala] in the indicative and subjunctive past, [iʁ] in the future and conditional, [aj] in the present subjunctive singular, [al] elsewhere.

	PER *1*, NB *sg*	PER *2*, NB *sg*	PER *3*, NB *sg*	PER *1*, NB *pl*	PER *2*, NB *pl*	PER *3*, NB *pl*
MODE *indic*, TREF *deictic*, TREL *eq*	id.	id.	id.	⊕ɔ̃	⊕e	id.
MODE *indic*, TREF *ana*, TREL *eq*	⊕ɛ	⊕ɛ	⊕ɛ	⊕jɔ̃	⊕je	⊕ɛ
MODE *indic*, TREF *deictic*, TREL *prec*	raise	id.	id.	⊕m	⊕t	raise ∘ ⊕ʁ
MODE *indic*, TREF *deictic*, TREL *succ*	⊕ʁɛ	⊕ʁa	⊕ʁa	⊕ʁɔ̃	⊕ʁe	⊕ʁɔ̃
MODE *indic*, TREF *ana*, TREL *succ*	⊕ʁɛ	⊕ʁɛ	⊕ʁɛ	⊕ʁjɔ̃	⊕ʁje	⊕ʁɛ
MODE *subj*, TREL *eq*	id.	id.	id.	⊕jɔ̃	⊕je	id.
MODE *subj*, TREL *prec*	⊕s	⊕s	id.	⊕sjɔ̃	⊕sje	⊕s
MODE *imper*	—	id.	—	⊕ɔ̃	⊕e	—

	GEN *mas*, NB *sg*	GEN *fem*, NB *sg*	GEN *mas*, NB *pl*	GEN *fem*, NB *pl*
MODE *part*, TREL *prec*	shorten	id.	shorten	id.

MODE *part*, TREL *eq*	⊕ɑ̃
MODE *inf*	⊕ʁ

Table 4 – Inflectional exponents for verbal feature combinations[24]

From a thorough investigation of the stem alternation data, Bonami and Boyé (2002, 2003) conclude that there is no hope of explaining the choice and distribution of stems on a morphosyntactic or morphophonological basis. French verbal stems are thus *morphomes* in Aronoff's (1994) sense : pure morphological objects which do not express any features and are chosen on an arbitrary basis. To model this explicitly, Bonami and Boyé (2002) propose that each verbal lexeme come equipped with a *stem space*, a data structure with 12 distinct slots that may be filled with identical, related or non-related stems. Individual inflectional rules then refer to a specific slot in the stem space to decide what endings attach to what stem. Table 5 indicates the correspondence between stem slots and inflectional forms.

[24] Exponents are notated as functions: "id." is the identity function ; for any X, "⊕X" is the function suffixing X to its input; "raise" is a function raising a low final vowel to a mid-open vowel (it has no effect on nonlow vowels), thus turning [lava] into [lave] but [fini] into [fini]; "shorten" is a function suppressing a final consonant, thus turning [ɛ̃klyz] into [ɛ̃kly] but [kɔ̃kly] into [kɔ̃kly]; "∘" is function composition. Note that we ignore the issue of *liaison* consonants throughout. Note further that we assume that first group verbs take a final [ʁ] in the infinitive, which is then suppressed by a general phonological rule deleting [ʁ] after [e] (Boyé, 2000).

slot	inflectional forms	slot	Inflectional forms
1	*imparfait*, present 1pl and 2pl	7	present subjunctive singular and 3pl
2	present 3pl	8	present subjunctive 1pl and 2pl
3	présent sg	9	infinitive
4	present participle	10	future, conditional
5	imperative singular	11	simple past, subjunctive past
6	imperative plural	12	past participle

Table 5 – The French verbal stem space

The crux of Bonami and Boyé (2002, 2003) and later research (e.g. Bonami and Boyé 2005, 2006 ; Bonami, Boyé and Kerleroux, to appear) is to determine how the stem space is structured, and how regular and irregular inflection patterns can be explicated as different ways of filling it. Here we will remain agnostic on the exact formulation of such constraints, which we take to be orthogonal to the realization of inflectional exponents. Thus we will presuppose the existence of the stem space, and use *stem selection rules* (Stump, 2001: chap. 6) in the first rule block to serve as an interface between the stem space and the paradigm function. Concretely, we will assume twelve functions Stem_1, Stem_2, …, Stem_{12}, from roots to phonological forms such that $\text{Stem}_1(X)$ returns the stem occupying slot 1 in the stem space of X, etc.

A.3 The Rules

We propose a system of four rule blocks, whose general structure is outlined in figure 3. Block 1 rules are stem selection rules. Block 2 rules add the [ʁ] realizing {TREL *succ*} in the future and conditional tenses, and the [s] expressing the past subjunctive. Block 3 accounts for the suffixes [j] and [ɛ] realizing {TREF *ana*} in the *imparfait* and conditional (note that this corresponds to the traditional notion that [j] and [ɛ] are allomorphs) and for [j] in the subjunctive. Finally block 3 accounts for the final person/number endings.

Block 1 rules are listed in (38). Since there are 12 different stem slots to choose from, we need at least 12 different rules, one for each slot. The assumption of Panini's principle helps limit the number of rules and eases their formulation by allowing quite a bit of underspecification. For instance, we need not specify overtly that Stem 1 is selected in the *imparfait* and in the present indicative 1pl and 2pl. Rather, (38)a simply specifies that stem 1 realizes {TREL *eq*}, and is overruled by (38)g and (38)h in the relevant cases. The only place where Panini's principle is not sufficient to allow a compact formulation is for stem selection for the subjunctive present: here Stem 7 and Stem 8 are used for two subparts of the paradigm neither of which can be given a nondisjunctive description. Thus we need two separate rules for the selection of stem 8, respectively (38)e and (38)f.[25]

[25] Note that we could equivalently state (38)f as a rule of referral.

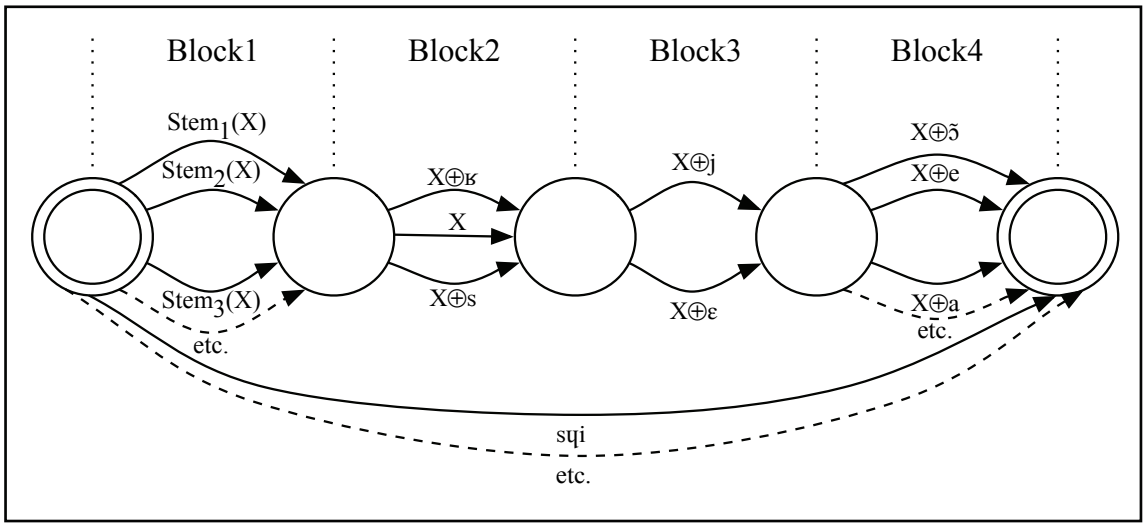

Figure 3 – The French conjugation block system

(38) Block 1 rules

a. X_V,σ: {TREL *eq*} → $Stem_1(X)$

b. X_V,σ: {TREL *prec*} → $Stem_{11}(X)$

c. X_V,σ: {TREL *succ*} → $Stem_{10}(X)$

d. X_V,σ: {TREL *eq*, MODE *subj*} → $Stem_7(X)$

e. X_V,σ: {TREL *eq*, MODE *subj*, PER *1*, NB *pl*} → $Stem_8(X)$

f. X_V,σ: {TREL *eq*, MODE *subj*, PER *2*, NB *pl*} → $Stem_8(X)$

g. X_V,σ: {TREL *eq*, TREF *deictic*, NB *sg*} → $Stem_3(X)$

h. X_V,σ: {TREL *eq*, TREF *deictic*, PER *3*, NB *pl*} → $Stem_2(X)$

i. X_V,σ: {MODE *imper* } → $Stem_6(X)$

j. X_V,σ: {MODE *imper*, NB *sg*} → $Stem_5(X)$

k. X_V,σ: {MODE *inf*} → $Stem_9(X)$

l. X_V,σ: {MODE *part*} → $Stem_4(X)$

m. X_V,σ: { TREL *prec*, MODE *part*} → $Stem_{12}(X)$

Rules in blocks 2 to 4 attempt to account for the realizations noted in table 4 in the most economic fashion possible. Block 2 (39) contains just two rules, for future/conditional [ʁ], and subjunctive past [s]. A third, somewhat unnatural-looking rule is needed to account for the absence of [s] in the subjunctive past 3sg. Note that (to the extent that they use the subjunctive past, which is by far the least used tense in contemporary French) speakers tend to realize an [s] here, suggesting that the relevant rule is indeed unnatural.

(39) Block 2 rules

a. X_V,σ: {TREL *succ*} → X⊕ʁ

b. X_V,σ: {TREL *prec*, MODE *subj*} → X⊕s

c. X_V,σ: {TREL *prec*, MODE *subj*, PER *3*, NB *sg*} → X

Block 3 (40) contains rules realizing [ɛ] in the *imparfait* and conditional, and [j] in the *imparfait*, conditional, subjunctive present and subjunctive past. We do no attempt to account for all occurrences of /j/ with a single rule, since we know of no good morphosyntactic reason to consider the *imparfait*, conditional and subjunctive to form a natural class. However we can account for the general similarity between 1pl and 2pl forms by using a rule of referral that is insensitive to tense and mode.

(40) Block 3 rules

a. X_V,σ: {TREF *ana*} → X⊕ɛ

b. X_V,σ: {TREF *ana*, PER *1*, NB *pl*} → X⊕j

c. X_V,σ: {MODE *subj*, PER *1*, NB *pl*} → X⊕j

d. X_V,σ: {PER *2*, NB *pl*} → ⟨X, σ / {PER *1*}⟩ : 3

Finally block 4 (41) accounts for the final endings.

(41) Block 4 rules

a. X_V,σ: {PER *1*, NB *pl*} → X⊕ɔ̃

b. X_V,σ: {PER *2*, NB *pl*} → X⊕e

c. X_V,σ: {TREL *succ*, TREF *deictic*, NB *sg*} → X⊕a

d. X_V,σ: {TREL *succ*, TREF *deictic*, PER *1*, NB *sg*} → X⊕ɛ

e. X_V,σ: {TREL *succ*, TREF *deictic*, PER 3, NB *pl*} → X⊕ɔ̃

f. X_V,σ: {TREL *prec*, TREF *deictic*, PER *1*, NB *sg*} → raise(X)

g. X_V,σ: {TREL *prec*, TREF *deictic*, PER *1*, NB *pl*} → X⊕m

h. X_V,σ: {TREL *prec*, TREF *deictic*, PER 2, NB *pl*} → X⊕t

i. X_V,σ: {TREL *prec*, TREF *deictic*, PER 3, NB *pl*} → raise(X)⊕ʁ

j. X_V,σ: {MODE *inf*} → X⊕ʁ

k. X_V,σ: {MODE *part*, TREL *eq*} → X⊕ɑ̃

l. X_V,σ: {MODE *part*, GEN *mas*} → shorten(X)

A.4 Suppletive Forms

We must account for the existence of a small number of *suppletive inflectional forms* : these are forms whose suppletive character is not limited to the use of a suppletive stem, but are characterized by the absence of normal exponents from block 4. Following Stump (2001) we treat these as the effect of portmanteau rules which are specific to a single lexeme.[26] Note that in a number of cases a more sophisticated analysis is feasible. For instance we could replace (42)e with a rule of referral stating that the form *dites* results from the combination of the verb's stem 3 with the exponent of 2pl normally found only in the simple past (Morin, 1987; Kilani-Schoch and Dressler, 2005). We refrain from writing such rules since (i) there is no empirical way of testing the acuity of a rule whose application is limited to a single lexeme, and (ii) they do not result in a simplification, but in a complexification, of the rule system.

(42) Portmanteau 1–4 rules

a. X_{aller},σ: {TREL *eq*, TREF *deictic*, PER *1*, NB *sg*} → vɛ

b. X_{aller},σ: {TREL *eq*, TREF *deictic*, PER *3*, NB *pl*} → vɔ̃

c. X_{avoir},σ: {TREL *eq*, TREF *deictic*, PER *1*, NB *sg*} → ɛ

d. X_{avoir},σ: {TREL *eq*, TREF *deictic*, PER *3*, NB *pl*} → ɔ̃

e. X_{dire},σ: {TREL *eq*, TREF *deictic*, PER 2, NB *pl*} → dit

[26] Note that technically, we could equivalently put these rules in block 4: since the ouput of each rule is insensitive to the input form X, there is no harm in saying that blocks 1 to 3 have been traversed normally before the suppletive form is selected.

f. $X_{dire,\sigma}$: {MODE *imper*, PER 2, NB *pl*} → dit

g. $X_{être,\sigma}$: {TREL *eq*, TREF *deictic*, PER *1*, NB *sg*} → sɥi

h. $X_{être,\sigma}$: {TREL *eq*, TREF *deictic*, PER *1*, NB *pl*} → sɔm

i. $X_{être,\sigma}$: {TREL *eq*, TREF *deictic*, PER *2*, NB *pl*} → ɛt

j. $X_{être,\sigma}$: {TREL *eq*, TREF *deictic*, PER *3*, NB *pl*} → sɔ̃

k. $X_{faire,\sigma}$: {TREL *eq*, TREF *deictic*, PER 2, NB *pl*} → fɛt

l. $X_{faire,\sigma}$: {MODE *imper*, PER 2, NB *pl*} → fɛt

k. $X_{faire,\sigma}$: {TREL *eq*, TREF *deictic*, PER *3*, NB *pl*} → fɔ̃

Appendix B: A Relational Version of PFM

In this appendix we formulate a relational version of PFM, that is, a system of realizational morphology that is intended to be similar to PFM except for the fact that there may be more than one output for every input. In specifying the system, we attempt to stay as close as possible to the original design of PFM as specified in Stump (2001).

One design decision that we will not follow is the idea that realization rules take as input and output *indexed forms*. Here we simply assume that realization rules are applied to a triplet consisting of a phonological form, a lexeme, and a feature set. Representing lexemes explicitly in the input of rules allows for an easier formalization of stem selection rules.

(43) Let A and V be two sets. The set P of *attribute-value pairs* over A and V and the set S of *feature structures* over A and V are the two smallest sets such that :

a. If $a \in A$ and $v \in V$, then $\langle a,v\rangle \in P$.

b. If $s \subseteq P$ and $\forall a \forall v[\langle a,v\rangle \in s \rightarrow \forall v'[\langle a,v'\rangle \in s \rightarrow v = v']]$, then $s \in S$.

c. If $a \in A$ and $s \in S$, then $\langle a,s\rangle \in P$.

(44) A *feature system* is a triple $\langle A, V, \Lambda\rangle$ where

a. A is a set of atoms, the *attributes*.

b. V is a set of atoms, the *atomic values*.

c. Λ is a subset of S, the set of feature structures over A and V.

Λ corresponds to the set of licit feature structures licensed by the feature system. Such a set is usually characterized by a combination of feature cooccurrence restrictions; here we will remain vague as to the exact formulation of a language for writing such restrictions, and just assume Λ as given.27

(45) Let Φ be the set of phonological sequences. We call any binary relation on Φ a *morphophonological relation*

(46) A *block index system* is a linear order $B=\langle I,<\rangle$ on a finite set I.

(47) A *lexeme system* is a set of object representing lexemes.

The makeup of a lexeme object will depend on the inflectional system to be analyzed. At the very least, each lexeme should specify some phonological sequence which will serve as the base for the application of rules, the lexeme's *root.*

(48) Given a feature system F, a block index system B and a set L of lexemes, a *realization rule* is a 4-tuple $R=\langle i,c,t,\rho\rangle$, where

a. i is a set of adjacent members of B, the block sequence the rule applies in.

b. c is a subset of L, the set of lexemes the rule applies to.

c. t is a feature structure of F, the feature structure realized by the rule.

d. ρ is a morphophonological relation, the change effected by the rule.

(49) Given a lexeme l, a feature set σ, a sequence x, and a rule $r = \langle i,c,t,\rho\rangle$, y is an *output* of rule r for the input triple $\langle\sigma,l,x\rangle$ just in case :

a. $l \in c$;

b. $t \subseteq \sigma$;

c. $\langle x,y\rangle \in \rho$.

(50) A *realization system* is a 4-tuple $\Sigma=\langle B,F,L,R\rangle$, where B is an block index system, F is a feature system, L is a lexeme system, and R is a set of realization rules over B, F, and L.

[27] Using the language of Gazdar *et al.* (1985) is an obvious choice here, since it is the choice Stump (2001) makes. However this language is not sufficient to formulate the FCR in (24). An alternative would be to use a much richer language for feature structure description, such as RSRL (Richter, 2000). This is probably a reasonable choice if one wants to embed the current analysis in a general grammar, but seems overly complex for our current purposes.

(51) Given a sequence of block indices i, a realization system Σ is said to associate x to y through block sequence i for feature set σ and lexeme l if and only if :

a. either R contains a rule $r = \langle i,c,\tau,\rho\rangle$ such that y is an output of rule r for input $\langle\sigma,l,x\rangle$;

b. or there is no such rule, i is a singleton and $x = y$.

(52) A realization system Σ licenses x as a realization of feature set σ for lexeme l if and only if there is a partition of B in block sequences i_1, …, i_n such that

a. Σ associates the root of l to a sequence x_1 through block sequence i_1 ; and

b. Σ associates x_1 to a sequence x_2 through block sequence i_2 ; and

c. …

d. Σ associates x_{n-1} to x through block sequence i_n.

Note that nothing so far constrains the nature of the morphophonological relations embedded in the realization rules : any set of associations between input and output is a possible effect of a rule. This is a design feature, since we do not want to constrain overly the types of rules we authorize (and Stump 2001 itself is less than explicit on an exact inventory). However we can define two familiar rule types :

(53) A realization rule $r = \langle i,c,\tau,\rho\rangle$ is a *rule of exponence* if and only if there is a morphophonologically natural[28] function f: $\Phi \rightarrow \Phi$ such that for any x and y, $\langle x,y\rangle \in \rho$ just in case $f(x)=y$.

In such a case, we write the effect of r as : X_c, σ : $\tau \rightarrow f(X)$

(54) Given a realization system $\Sigma=\langle B,F,L,R\rangle$, a rule $r = \langle i,c,\tau,\rho\rangle$ in Σ is a *rule of referral* if and only if there is a block sequence i' of B and a function $\delta : \Lambda \rightarrow \Lambda$ such that for every lexeme l and feature set σ, y is a realization of $\langle\sigma,l,x\rangle$ by rule r just in case $\Sigma'=\langle B',F,\{l'\},R\rangle$ licenses y as a realization of feature set $\delta(\sigma)$ for lexeme l', where l' is an abstract lexeme with root x and $B'=\langle i',<'\rangle$, where $<'$ is the restriction of $<$ to i'.

In such a case, we write the effect of r as : X_c, σ : $\tau \rightarrow \langle X, \delta(\sigma)\rangle{:}i'$

[28] Of course this definition presupposes a definition of morphophonologically natural functions. We may safely assume that e.g. affixation functions are to be taken as natural.

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