Paradigms in Morphology

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Abstract During the 20th century, morphology has long been described in terms of rules and processes. In recent decades, the focus of inflectional morphology has shifted from the structure of units to the structures they form together. These structures are paradigms containing lexemes that vary in the same way. With the aim of unifying inflectional and derivational morphology, several proposals have been made to transfer inflectional paradigms to derivation, taking advantage of the many similarities between the two subfields of morphology.

Keywords: Alignment, Derivational paradigms, Inflectional paradigms, Indirect relations, Interpredictability, Lexeme, Transpositional paradigms, Word Family, Word Form.

Key points

- Paradigms are morphological structures composed of lexemes in inflection and word families in derivation.
- Paradigms define the morphological organization of the lexicon and are used to predict new word forms of lexemes and new lexemes in word families.
- Paradigms were first used to describe inflection. The paradigmatic structuring of derivation is part of an effort to unify morphology.
- Inflectional paradigms are organized in terms of combinations of morphosyntactic features. They are complete and maximally predictive.
- Derivational paradigms are smaller, partial systems, structured by a variety of semantic relations that are more difficult to grasp.

1 Introduction

During the 20th century, morphological theories focused on describing the structure of lexical units, generally in terms of morphemes and the rules for composing them. In recent decades, the description of inflectional systems has shifted from the structure of units to the structures they form together, that is, paradigms containing lexemes that inflect in identical ways (Section 2). More recently, morphologists have asked how this organization into paradigms can be applied to derivation (Section 3). Their answers have led to three types of paradigmatic models (Section 4).

2 Paradigms and inflection

The term paradigm is usually used to describe a system in which "everything fits together", i.e., whose elements vary systematically. This is the case in inflectional morphology. For example, Latin nouns are all declined for the same numbers and cases. Inflectional features such as gender, number and case are called morphosyntactic features. Table 1 shows the declension of the nouns *rosa* 'rose', *cura* 'cure', *arbor* 'tree', and

Nom.Sg	Voc.Sg	Acc.Sg	Gen.Sg	Dat.Sg	Abl.Sg	Nom.Pl	Voc.Pl	Acc.Pl	Gen.Pl	Dat.Pl	Abl.Pl
rosa	rosa	rosam	rosae	rosae	rosa	rosae	rosae	rosas	rosarum	rosis	rosis
cura	cura	curam	curae	curae	cura	curae	curae	curas	curarum	curis	curis
arbor	arbor	arborem	arboris	arbori	arbore	arbores	arbores	arbores	arborum	arboribus	arboribus
dolor	dolor	dolorem	doloris	dolori	dolore	dolores	dolores	dolores	dolorum	doloribus	doloribus

Table 1: Paradigm of Latin nouns (excerpt)

dolor 'pain'. The header lists all the feature combinations by which these nouns vary. The cells contain the inflected forms of these nouns.

Nouns whose forms realize the same combinations of morphosyntactic features and can therefore fill the same table, form a paradigm. Their combinations of features are interpredictable. Once the inflectional properties of one form are known, the combinations of all other forms can be predicted. More generally, this is true of all lexemes. A Latin noun that has a form for the nominative singular will also have a form for the accusative plural (Table 1).

Two nouns may belong to the same paradigm even if their forms do not display the same contrast, as in the case of *rosa* and *arbor*. The form of *rosa* in Gen.Sg is obtained (orthographically) from that in Nom.Sg by substituting *-ae* for *-a* whereas for *arbor*, this form is obtained by adding *-is*. Within paradigms, subsets of lexemes characterized by identical formal variations are usually called inflectional classes: *rosa* and *cura* belong to the same inflectional class while *arbor* and *dolor* belong to a different one.

Inflectional paradigms can be typeset in the form of tables whose rows correspond to lexemes and whose columns contain their inflected forms for a given combination of morphosyntactic features. This type of representation is called *form-driven* in the sense that the cell values of the paradigm are forms. Other representations are possible (Boyé & Schalchli 2016):

- In Paradigm Function Morphology or PFM (Stump 2001), paradigms are *content-driven*, i.e., their cells contain sets of lexical and morphosyntactic features. Functions generate the form of lexemes from these features.
- For Carstairs-McCarthy (1994), a paradigm is an *association* between a content-driven paradigm, called Paradigm_1, and a form-driven paradigm, called Paradigm_2.
- Natural Morphology (Dressler et al. 1987) uses paradigm structure conditions (PSC) to organize inflectional classes into a *network of hierarchies* that describes how morphosyntactic and formal properties of inflected forms are inherited.
- In the context of implicative morphology, Ackerman et al. (2009) pose the Paradigm Cell Filling Problem ("What licenses reliable inferences about the inflected (and derived) surface forms of a lexical item?"). The answer relies on *principal parts*, i.e.,, the subsets of lexeme forms that are fully interpredictable (Bonami & Boyé 2003). It is also based on *entropy*, which measures the predictability of a target form from one or more source forms with respect to the information available (Ackerman et al. 2009).

Constructive approaches that generate inflected forms from a root by adding morphemes or by rules (Hockett 1954) are contrasted with abstractive approaches that starts from the existing forms of lexemes to discover how they organize themselves into paradigms (Blevins 2006); mixed approaches also exist, such as PFM (Stump 2001), which combines paradigmatic organization and morpheme concatenation.

Paradigms are particularly well suited for describing inflection because (*i*) they take into account the fact that the inflected forms of a lexeme are determined by the morphosyntactic features of the language they belong to and the values they can take, the

so-called feature geometry; (*ii*) they make it possible to provide a systematic way to describe, classify and predict non-canonical phenomena (Corbett 2007):

- **syncretism**: several cells share the same exponent, e.g., Dat.Pl and Abl.Pl in Table 1.
- **defectiveness**: some cells are unfilled. The French verb *falloir*.v 'must' does not have 1Sg, 2Sg, 1Pl and 2Pl forms in any tenses and modes.
- **overabundance**: some cells are filled with two or more values. The Italian verb *dovere* 'must' has two forms in Ind.Prs.1Sg, *devo* and *debbo*.
- **deponency**: exponents usually associated to certain features are reused to realize different features; e.g., the Latin verb *sequor* 'follow' is conjugated in the active voice using passive exponents.
- **suppletion**: inflected forms of the same lexeme have different stems: *went* and *go* are suppletive forms of the verb *go*.

3 Transposing inflectional paradigms to derivational morphology

To what extent is derivation also paradigmatic in nature? A positive answer is a precondition for inflection and derivation to be handled by the same linguistic module (Bauer 1997).

Most studies of derivational paradigms see them as an adaptation of inflectional paradigms. This view stems from the fact that inflectional paradigms are considered prototypical and fully fulfill their main functions: they are perfectly delimited; their cells are determined by combinations of morphosyntactic features of their part-of-speech; they are generally complete, maximally predictive (in the sense that speakers are theoretically able to produce the inflected forms of any lexeme in the lexicon); they contain all the inflected forms in the lexicon. They have also been the subject of typological (Corbett 2007) and experimental (Hay & Baayen 2005) studies. Consequently, many studies on derivational paradigms tend to take the paradigmatic organization of inflectional morphology as a starting point, although exceptions exist (Section 3).

The main argument for transposing inflectional paradigms to derivational morphology is based on the similarities between these two subfields.
(*i*) In inflection, lexemes can be seen as inflectional families: lexemes represent sets of forms that share the same meaning and the same part-of-speech. By analogy, families of derivationally related words such as (1) and (2) in French fulfill the same role: they are composed of lexemes that share part of their semantic content.

(1)	*parachute*.n	*parachuter*.v	*parachutage*.n	*parachuteur*.n
	'parachute'	'parachute'	'parachuting'	'he who parachutes'

(2)	*parachute*.n	*parachutiste*.v	*parachutisme*.n
	'parachute'	'skydiver'	'skydiving'

Notice that paradigms (1) and (2) cannot be merged into one, because (cargo) parachuting scenarios do not normally involve skydiving, and vice versa.
(*ii*) Both inflectional and derivational paradigms are superpositions of aligned families whose members are related by the same meaning contrasts (Bonami & Strnadová 2019). For example, families (1) and (3) can be aligned.

(3)	*patin*.n	*patiner*.v	*patinage*.n	*patineur*.n
	'skate'	'skate'	'skating'	'skater'

(*iii*) Formally, categorically and semantically uniform derivational paradigms can be considered equivalent to inflectional classes. In inflection, these classes are structured into networks of stems, see Bonami & Boyé (2003) stem spaces; in derivation, they are structured by semantic relations within networks, such as action (1) and activity (2) networks as proposed by e.g., Fradin (2020).
(*iv*) Derivation is considered irregular. However, this is also the case for inflectional paradigms (Section 2). Some French examples of non-canonical phenomena in derivation might be:

- **syncretism**: demonyms and the corresponding idiom names have the same form: *italien* 'italian'; *portuguais* 'portuguese';
- **defectiveness**: no stative noun is derivationally related to the verb *plaire* 'please' that would mean 'the fact that *X* pleases Y': *plaisance*.n is attested, but means 'boating' (on French psych verb-based nominalizations, see e.g., Knittel & Marín (2021)).
- **suppletion**: the -al suffixed adjective *carcéral* 'of prison' related to the noun *prison* 'prison' is formed on the noun Latinate stem (*carcer*) (Bonami & Strnadová 2019);
- **overabundance**: doublets as in *cerisaie* and *ceriseraie*, both meaning 'plantation of cherry trees'.
- **deponency**: affix swapping, as with *bougie* 'candle':*bougeoir* 'candlestick', where the exponent *-oir*, usually used to coin verb-based instrument nouns exclusively, here replaces the expected exponent *-ier*.

(*v*) Some lexemes are predictable within word families. In French, verbs related to an action noun suffixed by -ation usually have a masculine agent noun suffixed with *-ateur* and a feminine agent noun suffixed with *-atrice*.
(*vi*) Furthermore, the inflectional lexicon is expanded by adding new lexemes to existing paradigms. In derivation, the lexicon is expanded by adding the word family hosting the newly coined word to an existing paradigm.

On the other hand, derivational paradigms differ from inflectional paradigms in many ways (*i*)-(*vi*). These differences suggest that derivational paradigms are not direct adaptations of inflectional paradigms.
(*i*) Inflectional paradigms are fully determined by a finite number of morphosyntactic features with fully known values. Derivational paradigms are structured by semantic relations that cannot be formally characterized in a similar way.
(*ii*) Inflectional paradigms are generally complete (i.e., they contain very few empty cells), unlike derivational paradigms. This difference is partly explained by the fact that inflection is obligatory, whereas derivation is not.
(*iii*) Inflectional families may contain dozens of forms (e.g., French verbs typically have 51 forms), whereas derivational paradigms are smaller because semantic predictability is very local, unlike morphosyntactic predictability.
(*iv*) Affix competition is a massive phenomenon in derivation with no equivalent in inflection, where rival affixes belong to different inflectional classes.
(*v*) In inflectional paradigms, all forms have the same degree of complexity. For instance, verb forms *parle* 'talk.Ind.Prs.3Sg' and *parlera* 'talk.Ind.Fut.3Sg' are directly related to one another and to all the other forms of the paradigm of the verb *parler*. They only differ by the value of the tense feature and therefore have the same complexity. Derivational paradigms contain lexemes of different complexity, as in (1), where *parachuteur* is more complex than *parachuter*. Among others, the noun is semantically more complex than the verb because its meaning contains an additional agentive component.

(*vi*) Inflectional paradigms are disjoint (a word form usually belongs to a single lexeme), whereas derivational paradigms may overlap as (1) and (2) via the shared lexeme parachute.

Inflectional paradigms group together forms that all have the same meaning and part-of-speech and differ only in their morphosyntactic features. Anything that does not fall into the inflectional domain is often considered derivational. However, a number of studies have shown that certain relations considered to be derivational have some of the properties of inflection, such as the relation between adjectives to their *-ly* adverbs (*light*:*lightly*). These relations, sometimes called transpositions (Spencer 1999; 2013) include verb-based action nouns (*parachuter*:*parachutage*), noun-based relational adjectives (*nation*:*national*), adjective-based quality nouns (*rich*:*richness*), and relations between feminine and masculine human nouns, as (*skieur* 'male skier':*skieuse* 'female skier') in French. In transpositional paradigms lexemes have the same core meaning but different parts-of-speech. These paradigms have a high degree of predictability and differ in this respect from derivational paradigms.

4 Paradigmatic theories and frameworks of morphology

Paradigmatic morphology frameworks can be distinguished based on two main criteria. The first concerns the structure of families and paradigms. Bauer (1997) considers derivational families as star-shaped graphs with the ancestor of the family at the center, to which the other lexemes are directly connected. Other authors, such as Dokulil (1962) consider derivational families (called word-formation families by Dokulil) to have tree-like structures that combine two types of paradigmatic structures (see Štekauer (2014) for an overview):

- relations between a lexeme and all its immediate derivatives (word-formation bundles), and
- series of derivational relations that connect a complex lexeme it to its base, up to the root of the tree (word-formation series) (Ševčíková 2020).

Families can also be represented as non-oriented graphs (Melloni & Dal Maso 2022; Hathout & Namer 2022). These graphs contain indirect relations between siblings, also called second-order schemas by Booij & Masini (2015) and sister schemas by Jackendoff & Audring (2020).

The second criterion is the degree of unification of inflection and derivation. In the remainder of this section, we discuss three types of models:

(*i*) those in which derivational paradigms inherit the principles and mechanisms of inflectional paradigms,
(*ii*) those in which inflectional paradigms reuse the principles and mechanisms of derivational paradigms, and
(*iii*) those in which inflectional and derivational paradigms are treated uniformly.

Inflectional paradigm frameworks are adapted to derivation

In frameworks that adapt inflectional paradigms to derivation, such as PFM (Stump 2001)), inflectional and derivational relations are described separately. This is also the case in the onomasiological approach proposed by Antoniova & Štekauer (2015) for which derivational paradigms are relatively faithful copies of inflectional paradigms.

> "[...] the inflectional paradigm is based on expression by affixes of certain (grammatical) categories, for example, CASE, NUMBER and GENDER in nouns. Analogically, to this, derivational paradigms are also based on expressing certain (derivational semantic) categories, for example, the category of AGENT, PATIENT, INSTRUMENT, LOCATION, ABSTRACTNESS, ACTION, RESULT OF ACTION, etc." (Antoniova & Štekauer 2015: 62-63)

PFM is a paradigmatic model of inflection. Its paradigms are indexed by combinations of morphosyntactic properties (the set of which is called feature geometry). Feature combinations are denoted by σ. PFM has paradigm functions (PF) that associate a stem S with each pair $<L, \sigma>$, where L is a lexeme. Realization rules then produce the corresponding form. These rules are organized in blocks and applied to the pair $<S, \sigma>$ in a cascade fashion. The rule application is determined by conditions on the part-of-speech and on the combinations of morphosyntactic features. For example, in French a paradigmatic function associates the stem S = /pɛɲ/ of the verb *peindre* 'paint' with σ:{mood:ind, agr:{per:1, num:pl}}, then the appropriate realization function produces the phonological form /pɛɲɔ̃/. PFM being an incremental model, the size of the lexicon, and thus the set of lexemes that can be inflected, can be increased without the need to modify blocks and rules.

Stump (2001: 257) proposes to adapt PFM to derivational morphology by introducing paradigmatic functions in which morphosyntactic feature combinations are replaced by semantic categories such as "privative adjective" for the formation of *friendless* from *friend*.

Derivational paradigm frameworks adapted to inflection

Conversely, some models such as Construction Morphology or CxM (Booij 2010; 2017), Relational Morphology (Jackendoff & Audring 2020) and ParaDis (Hathout & Namer 2022) use mechanisms designed for derivational morphology, but can be adapted to inflectional morphology in a second step. Again, inflectional and derivational relations are treated separately. This distinction is particularly relevant in view of the differences of complexity and diversity between the two types of paradigms (Boyé & Schalchli 2016). Knowing that "he who can do more can do less", adapting a model designed for derivational morphology to inflectional morphology is relatively easy.

In CxM, descriptions are realized by schemas that combine the formal and semantic properties of complex lexemes in derivation (Booij 2010) and the formal and morphosyntactic properties of form words in inflection (Booij 2017).

CxM is a hierarchical system. For example, the derivational pattern in (4) describes the association ($\leftrightarrow$) between a suffixed noun N_j with an unspecified exponent (-SUF) and the meaning "user of SEM_i"; the base of N_j, is a noun N_i with a form x and a meaning SEM. In French, rival patterns (5), (6), (7) (see Table 2) inherit from (4) by specifying the exponent value: *-ier*, *-eur*, *-iste*.

(4) $< [_{\mathrm{N}}[_{\mathrm{N}}\ x]_i$ -SUF$]_j \leftrightarrow$ [user of [SEM]$_i]_j >$

(5) $< [_{\mathrm{N}}[_{\mathrm{N}}\ x]_i$ *-ier*$]_j \leftrightarrow$ [user of [SEM]$_i]_j >$

(6) $< [_{\mathrm{N}}[_{\mathrm{N}}\ x]_i$ *-eur*$]_j \leftrightarrow$ [user of [SEM]$_i]_j >$

(7) $< [_{\mathrm{N}}[_{\mathrm{N}}\ x]_i$ *-iste*$]_j \leftrightarrow$ [user of [SEM]$_i]_j >$

User.Masc.Sg	User.Fem.Sg	Used.Sg	User.Masc.Pl	User.Fem.Pl	Used.Pl
violoniste 'violinist'	violoniste	violon 'violin'	violonistes	violonistes	violons
métallier 'metalworker'	métallière	métal 'metal'	métalliers	métallières	métaux
skieur 'skier'	skieuse	ski 'ski'	skieurs	skieuses	skis

Table 2: Paradigmatic system that both includes inflectional (sg *vs* pl) and derivational relations (user of X / something used by Y; female Z / male T)

CxM second-order schemas describe indirect relations (≈) between lexemes of the same level of morphological complexity, whether they share a common base or not. For example (8) relates masculine human nouns in *-eur* and their feminine equivalents in *-euse* (such as *skieur*:*skieuse*).

(8) $< [_{\text{N}}\ x\ \textit{-eur}]_i \leftrightarrow [$ male person corresponding to $\text{SEM}_j]_i > \approx < [_{\text{N}}\ x\ \textit{-euse}]_i \leftrightarrow$ [female person corresponding to $\text{SEM}_i]_j >$

Frameworks designed for both inflectional and derivational paradigms

There is a third group of models in which there is basically no difference between inflection and derivation, and where the same structures contain both inflected and derived forms. Bochner's (1993) cumulative sets and patterns are one of the first in this direction.

Also in his line are Bonami & Strnadová's (2019) paradigmatic systems, where all morphological relations, whether between forms of the same lexeme or between forms of different lexemes, are treated and represented in the same way (Table 2). Paradigmatic systems are based on the notion of family, which is defined as a complete graph in Bonami & Strnadová (2019: 170). The core of the system is the key notion of alignment, which determines the arrangement of families in six paradigms. Following Štekauer (2014), alignment relations are structured by systematic meaning-based contrasts. Paradigmatic systems are therefore sets of fully aligned families. One consequence of alignment is that all families in a paradigm have the same number of members.

The noun pairs in each family in Table 2 are linked by a combination of derivational (User *vs* Used) and (Masc *vs* Fem) and inflectional (Sg *vs* Pl) contrast relations. Alignment does not consider differences between exponents (*violoniste*, *métallier*, and *skieur* are aligned; so are *métaux* and *skis*). Syncretism is illustrated in the *violon* family, where the cells User.Masc.Sg and User.Fem.Sg have the same value (*violiniste*).

5 Conclusion

The ability to predict the value and content of an item from those of other members of its family motivates the paradigmatic organization of morphology. In addition, this organization leads us to review the similarities and differences between morphological areas: it builds on the similarities between inflection and derivation, but at the same time establishes a boundary between derivation and compounding, the latter being rather analogical than paradigmatic in nature (Bagasheva 2020).

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