Regularity and exceptions in paradigmatic systems

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Introduction

The topic of this paper is the regular and irregular patterns in morphology and their diachronic aspects: how these patterns evolve from simple phonologically motivated patterns. The literature on morphological exceptions is diverse and encompasses many approaches, see also WBCDL094 and WBCDL097. Rule/constraint-based theories usually make an artificial distinction between productive (regular) and irregular language patterns, see Wolf (2011) for a summary and see also WBCDL012. Depending on the chosen theoretical framework, irregular forms can be marked in different ways as in lexical phonology (Kiparsky 1982, 1985), morphology (Aronoff 2013, Baerman 2015) and Optimality Theory (Prince – Smolensky 1993). The main technical solutions are the following: marking the stems in the dictionary with diacritic marks (see Pater 2007) or phonologically (underspecification), or separating the grammar of irregular and regular forms, for example by listing exceptional forms (listedness) or placing them in another grammatical layer (e.g. strata or co-phonologies). Some of the paradigm-based theories (see e.g. Albright 2011) also use similar solutions (e.g. paradigmatic layers, see Parker – Sims 2020), see also WBCDL092. A significant number of these theories is not morpheme-based as theories applying rules/constraints, but word-based, e.g. the Word and Paradigm model (on the distinction see Blevins 2016). Word-based theories explain the high frequency of irregular forms by assuming that speakers memorize complete words (see e.g. Bybee 2010, Haspelmath – Sims 2002). Irregularities in paradigmatic patterns are usually not discrete (regular vs. exceptional), but show gradual behaviour, and word-based theories can connect this paradigmatic graduality with similarities between entire word forms (an example of such an approach based on analogy is Blevins – Blevins 2009, Hay – Baayen 2005), see also WBCDL081.

An important difference between the rule-based and analogy-based grammatical approaches is how they treat “exceptionality” and ”productivity”. Rule/constraint-based approaches concentrate mainly on patterns that they consider “productive”, that involve general (ideally universal) rules/constraints, and select others as “exceptional” and outside the scope of the grammar. This view raises theoretical and empirical/methodological problems. On the one hand, the usual definitions of productivity are too tight: there are relevant broad generalizations on large closed word-classes that cannot be productively expanded (e.g., monomorphemic verbal roots in many languages), and there are lower-level generalizations on closed subclasses of open classes that play a crucial role in grammar. On the other hand, productive vs. exceptional behaviour is gradual, their border is not clear cut: some lower-level generalizations can be used productively. Rule/constraint-based theories often misuse the notion of exceptionality when they define the scope of the theory: if the theory works in the relevant “nonproductive” data then they analyse them, if it does not then they label

"exceptional" phenomena as extragrammatical, often irrespectively of their (type) frequency. Whole-word theories, however, recognize the fact that linguistic patterns are at different levels of the exceptionality/productivity spectrum, ranging from totally idiosyncratic behaviour through different generalizations of (variously) limited scope to the almost exceptionless linguistic patterns. In this view, (type) frequency plays a crucial role (Bybee 2007): productive language behaviour can be predicted by analogical attraction, whose strength depends on the frequency and similarity of the relevant sets of linguistic expressions.

Our aim is to examine the basic principles of paradigmatic organization and explain the emerging patterns synchronically and diachronically. In order to achieve these we scrutinize the complexity of the paradigmatic patterns in morphophonology. We will show that sites of variation, which are prerequisite to diachronic change, can be predicted from the proximity relations in the paradigmatic system. The basic concepts and their relationships are exemplified by Hungarian data that are complex enough and fairly elaborated for such a purpose. The consequences of this approach are meant to be general and universal.

1. Macro-level and micro-level description

In science, we commonly employ two levels of description and analysis: (a) macro-level description and (b) micro-level description. In this paper we utilize this distinction for morphophonology.

I. Macro-level: This approach involves the abstraction of linguistic components like morphemes, stems, affixes, and patterns that define their shape; this essentially means the conditioning factors of allomorphies that lead to paradigmatic patterns. It mirrors the macroscopic analysis found in fields like thermodynamics, where we scrutinize global attributes such as temperature, pressure, and mass.

II. Micro-level: In contrast, the micro-level approach investigates the interactions among specific linguistic elements, their specific interactions and the statistical characteristics of the subsystem. These interactions manifest themselves as connections between surface forms (like output–output correlations in Optimality Theory), technically, analogical connections (mainly the attraction between two (sets of) forms). This parallels the microscopic examination in thermodynamics, where we delve into particle interactions, their energy states and emerging statistical parameters like entropy.

Although our main focus typically rests on macro-level properties within morphophonology, it is worth noting that several relevant subsystems exist. Moreover, macro-level descriptions are not uniform; they encompass sublevels that enable us to explore the system in progressively finer detail, with a bottom-up method. By contrast, a micro-level model works top-down, it infers from the statistical properties of the numerous interactions between (word-)forms to observed patterns. In section 2 we will present the macro-level description of a specific morphophonological pattern, and in section 3 we will give an outline of the elements of a micro-level description and show how this kind of account can be used in

explaining the diachronic change of paradigmatic patterns and the emergence of irregular forms.

2 Macro-levels of morphophonology

In this section we present a description of morpho-phonological patterns from a paradigmatic point of view. We will describe several types of paradigmatic systems from the simplest homogeneous patterns to the most complex gradual patterns. We will examine the definitive properties of these types, and define the concept of monotonicity that can be considered a universal property of morphological patterns that have at least partial phonological motivation. We will show that the logical definition of the complex patterns can be multi-layered since several arbitrary stem and suffix classes have to be stipulated for the exact description. The site of variation in a paradigmatic system is not arbitrary: they occur at the border of patterns. The provided description and analysis will be demonstrated with a concrete allomorphy (vowel–zero alternation at the border of the stem and suffix) and exemplified by Hungarian data.

2.1 Homogeneous pattern

We will first look at homogeneous paradigmatic patterns. When we observe the morphophonological pattern of a language, the very first and rough approximation is the following: there are no differences between patterns, all linguistic forms behave in basically the same way. In this case – in Hungarian and in several other languages – this ubiquitous pattern is plain agglutination that can be expressed by the simple concatenative scheme: stem+suffix. In a language that is essentially agglutinative, such as Hungarian, the stem is a free form, i.e. it occurs by itself when the unmarked morphosyntactic values associate with it (in the case of nominals it is often the singular (SG) nominative (NOM) non-possessive form). In contrast, the other morphosyntactic values require an overt suffix after the free stem.

This is exemplified by the Hungarian data in (1). The pairs of Hungarian nouns in (1a) show this pattern which is schematized in (1b). This simple paradigmatic system is shown in (1c) where the rows represent the lexemes (stems) and the columns show the morphosyntactic values (inflected forms) or derivational meanings (derivational forms) – here we use the concept of *extended paradigm* that includes both types of suffixed forms (see Steriade 1999). The members of the paradigmatic system are the word-forms that obey the general pattern of suffixation, i.e. their structure is the concatenation of the stem-form and the suffix-form according to the relevant row and column of the paradigmatic table, respectively. It is important to note that at this highly general level of description, the system can be treated as completely homogeneous: only one pattern (the plain concatenation of the stem and the suffix) applies, which is abbreviated as **A**.

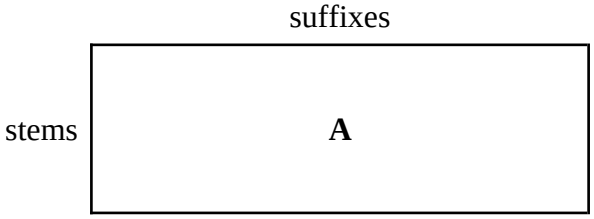
(1) Homogeneous pattern with plain agglutination

a.

buli	'party.SG'	*buli-k*	'-PL'
hajó	'ship.NOM'	*hajó-n*	'-SUP'
kapu	'gate'	*kapu-tok*	'-POSS.2PL'

b. SCHEME: STEM + SUFFIX (pattern **A**: plain concatenation of morphs)

c. paradigmatic system with one pattern **A**:



2.2 Alternation

Plain concatenation is usually not the only pattern that occurs in a language. Several kinds of morpheme alternations can occur that alter the simple pattern mentioned above. These alternations can be general (productive) and/or phonological/phonologically motivated. These are determined by the phonological shape of the morphemes or in other cases they can be at various levels of exceptionality, i.e. regularities may occur with a lexically given subset of stems and suffixes. If an alternation applies, the concept of the uniform pattern is not tenable anymore: more than one pattern arises partitioning the paradigmatic structure.

This situation is exemplified in (2) below by a productive vowel-zero alternation that applies between the stem and the suffix in Hungarian. A vowel occurs at the morpheme-boundary after consonant-final stems (2a), whereas vowel-final stems take the vowelless alternant of the suffix (cf. 1a above). In this paper, we do not deal with the morphemic status and the quality of this alternating vowel (on this controversial topic, see Siptár–Törkenczy 2000, Rebrus et al. to appear). What is important here is the syllabic structure (i.e. consonant+vowel sequences) at the relevant site of the forms. Thus the schemes include the two relevant patterns: the plain concatenation **A** mentioned in (1) that creates ...V-C... sequences at the morpheme boundary (cf. 1a), and the vowel insertion pattern **B**, that creates ...C-**V**C... sequences (cf. 2a) – this is shown in (2b). (It is worth noting that vowel insertion is not entirely determined by the (monomorphemic) phonotactics of the language, either in word-final position or word-internally, hence it is a genuine morphophonological process.)

Thus the paradigmatic system here is not homogeneous as in (1c), it is split into two patterns induced by the two relevant stem-classes. This is shown in (2c) where stem-class **1** contains the V-final stems (creating forms with pattern **A**), while stem-class **2** covers the C-final stems (creating forms with pattern **B**). This kind of patterning can be called *categorical* because the split between the two patterns is strict (uniquely defined by the phonological properties of the stems) and *one-dimensional* because it depends solely on the stems: all the suffixes mentioned behave the same way.

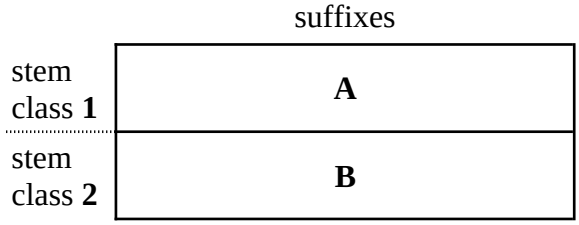
(2) Categorical 1-dimensional patterns determined by stem-classes

a.	*dal*	'song.SG'	*dal-**o**k*	'song-PL'
	baj	'trouble.NOM'	*baj-**o**n*	'trouble-SUP'
	nap	'day'	*nap-**o**tok*	'day-POSS.2SG'

b. SCHEMES:

- pattern **A** (plain concatenation): stem-class **1** (V-final stems, cf. 1a)
- pattern **B** (vowel insertion): stem-class **2** (C-final stems, cf. 2a)

c. paradigmatic system with two patterns **A** and **B** induced by stem classes



2.3 Conjunctive pattern

The description of patterns shown above should be changed if the suffixes do not behave uniformly. This situation frequently occurs: a set of suffixes may be resistant to certain or most allomorphies. This means that more than one class of suffix type has to be distinguished: alternating and non-alternating types. In this case the condition of the allomorphy is *conjunctive*: the stem of the relevant form has to belong to a designated stem class *and* the suffix has to be a member of a designated suffix class. This *conjunctive two-dimensional* pattern is exemplified in (3a) with Hungarian data where the suffixes do not undergo vowel-insertion independently of the class of the stem, thus create ...V-C... or ...C-C... sequences at the morpheme-boundary. The relevant schemes are in (3b), where suffix class **b** denotes these non-alternating suffixes, while suffix class **a** denotes alternating suffixes in the relevant sense. The distinction of the two suffix classes is lexical, it is impossible to uniquely define them by their phonological or morphological properties (though some correlations exist, these correlations are not definitive). Thus the condition of the allomorphy can be expressed by a logical conjunction: vowel insertion (pattern **B**) takes place if and only if the suffixed form is associated with stem class **2** *and* with suffix class **a**.

An important property of conjunctive patterns is that their complement set cannot be defined conjunctively and uniquely like the complement sets of natural classes in phonology (see Chomsky–Halle 1968). That is, if we want to express the set of forms that do not undergo vowel insertion (pattern **A**) then we have to use logical disjunction, and this definition can be done in more than one way. The figure in (3c) shows that the conjunctive pattern **B** is located in the "corner" of the paradigmatic space (i.e. *monotonic* in both dimensions) – it does not matter which corner it is, because this depends on the direction of the ordering of stem classes and suffix classes. What matters is that pattern **B** maintains monotonicity (see later for more complex patterns), and so does pattern **A**.

(3) Conjunctive 2-dimensional pattern determined by stem-classes and suffix-classes

a. no vowel–zero alternation (resistant suffixes) – cf. (1a), (2a)

V-final stems	C-final stems	
buli-nak	*dal-nak*	'-DAT'
hajó-hoz	*baj-hoz*	'-ALL'
kapu-tól	*nap-tól*	'-ABL'

b. SCHEMES:

- conjunctive pattern **B** (vowel-insertion): stem-class **2** *and* suffix class **a** (cf. 2a)
- disjunctive pattern **A** (concatenation): stem-class **1** *or* suffix class **b** (cf. 1a, 3a)
  – overlapping definition

c. paradigmatic system with two patterns **A** (non-shaded) and **B** (shaded) induced by two stem and two suffix classes

	suffix class **a**		suffix class **b**	
stem class **1**	hajó-n	hajó-tok	hajó-tól	hajó-nak
stem class **2**	dal-**o**n	dal-**o**tok	dal-tól	dal-nak

2.4 Gradual pattern

It is cross-linguistically frequent that the morphophonological system does not follow the binary opposition examined above and further type(s) of suffixation have to be taken into account (for the insufficiency of the binary distinction of synthetic–analytic or level 1–level 2 suffixations, see Halle–Mohanan 1985, Fabb 1988 for English and Rebrus et al. 1996 for Hungarian). In this case a more complex paradigmatic pattern occurs. This is exemplified by the accusative suffix in (4a') and (4b') below. The class of consonant-final stems is split in two: some consonant-final stems take the ACC suffix without a vowel, others undergo vowel insertion. (This alternation is mainly conditioned by the quality of the last consonant of the stem, but numerous further lexical, morphophonological and morphological factors blur the picture, see Siptár–Törkenczy 2000, Trón–Rebrus 2001.) Therefore, in order to account for this new alternation type, we have to stipulate a third suffix type (**aii**) and another stem type (**2i**) – cf. (4a'). The rest of the types will be referred to as **ai** and **2ii** – cf. (4a,b) and (4b'), respectively.

Positing the third type of suffixation has serious theory-relevant consequences. Most importantly neither of the patterns can be defined conjunctively and uniquely: both patterns **A** and **B** are cannot be captured without logical disjunction in the way they could in (3b), and both patterns have several different definitions (in the case of pattern **B** in (4c), three distinct definitions exist: one overlapping and two non-overlapping ones, just as for pattern **A** in 3b). However, both patterns observe the monotonicity property that we have seen in the conjunctive pattern in (3).

The border of the two patterns forms a stepped line, as can be seen in (4d), which we will call gradual. As we have mentioned, gradual patterns cannot be defined easily by means

of stem and suffix classes. The more grades there are, the more complex definition is needed and the more alternative definitions exist in a macro-level description (see later). Usually, there is no theoretical argument for deciding which description of these patterns of the numerous possibilities is the most appropriate.

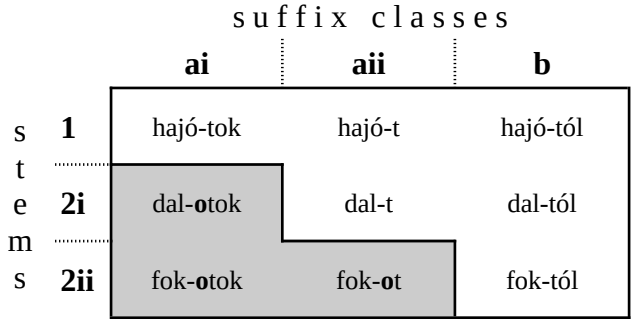
(4) Disjunctive (gradual) patterns determined by three stem-classes and three suffix-classes

a.	*dal-**o**k*	a'.	*dal-t*	'song-PL/ACC'
	*baj-**o**n*		*baj-t*	'trouble-SUP/ACC'
	*hús-**o**d*		*hús-t*	'flesh-POSS.2SG/ACC'
b.	*fok-**o**s*	b'.	*fok-**o**t*	'degree-ADJZ/ACC'
	*szám-**o**l*		*szám-**o**t*	'number-VRBZ/ACC'
	*ráf-**o**m*		*ráf-**o**t*	'headband-POSS.1SG/ACC'

c. SCHEMES (both are disjunctive):

- pattern **B** (vowel-insertion): (**2** *and* **ai**) *or* (**2ii** *and* **a**) – overlapping definition, examples in (4a,b), (4b')
- pattern **A** (concatenation): all other cases – examples in (1a), (3a), (4a')

d. paradigmatic system with two patterns **A** (non-shaded) and **B** (shaded) induced by three stem and suffix classes



We have seen that the phonologically motivated vowel-zero alternation in suffix class **a** (the first two columns in 4b) can be overridden by the class **aii** suffix (ACC: the 2nd column in 4b). This can be treated as an example of the *underapplication* of the vowel-insertion rule (requiring a vowel after consonant-final stems), because not all consonant-final stems take a vowel before ACC. Beside this non-application, the *overapplication* of the vowel-insertion rule can also happen (on their function in the phonological grammar, see Benua 1997). Certain vowel-final stems take a vowel before certain suffixes. This is shown in (5a) below, where plural and adjective-forming suffixes (indicated by **a0**) show this behaviour after certain noun and adjective stems (**1ii**), while after others (**1i**) they do not. These phenomena, however, do not extend to all suffixes that show regular vowel-zero alternation; this class is referred to as **ai** in (5a).

This non-phonological allomorphy makes the paradigmatic system more complex, as the length of the definition scheme and the number of grades of the pattern boundary shows

(see 5b and 5c, respectively). It is shown in (5c) that the thick gradual borderline between the two patterns (**A** and **B**) does not coincide with the border of the two phonologically determined stem classes (**1** and **2**), which is indicated by a horizontal dotted line. Overapplication occurs where the gradual line is above the horizontal dotted line (row **1ii** & column **a0**) and underapplication occurs where the former is under the latter (row **2i** & column **aii**).

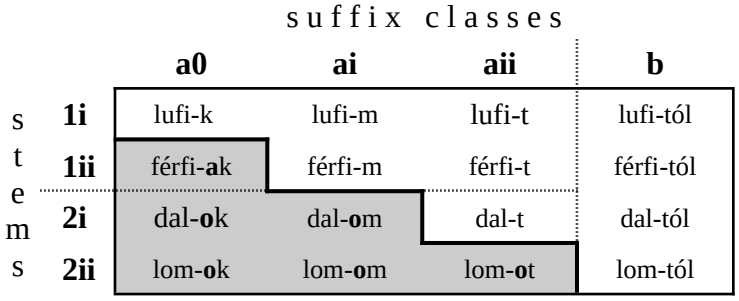
(5) Gradual patterns determined by four stem-classes and four suffix-classes

a.	**a0** -PL	**a0** -ADJZ	**ai** -POSS.1SG	**ai** -SUP	**aii** -ACC	
1i	*lufi-k*	*lufi-s*	*lufi-m*	*lufi-n*	*lufi-t*	‘balloon’
	dagi-k	*dagi-s*	*dagi-m*	*dagi-n*	*dagi-t*	‘fatty (Adj)’
	háború-k	*háború-s*	*háború-m*	*háború-n*	*háború-t*	‘war’
	bordó-k	*bordó-s*	*bordó-m*	*bordó-n*	*bordó-t*	‘claret (Adj)’
1ii	*férfi-**a**k*	*férfi-**a**s*	*férfi-m*	*férfi-n*	*férfi-t*	‘man’
	*város-i-**a**k*	*város-i-**a**s*	*város-i-m*	*város-i-n*	*város-i-t*	‘urban (Adj)’
	*lassú-**a**k*	–	*lassú-m*	*lassú-n*	*lassú-t*	‘slow (Adj)’
	*rang-ú-**a**k*	–	*rang-ú-m*	*rang-ú-n*	*rang-ú-t*	‘ranked (Adj)’

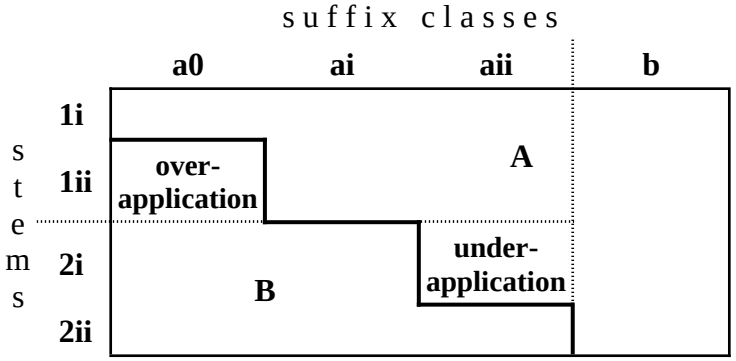
b. SCHEMES:

- gradual pattern **B** (vowel-insertion): (**2** and (**a0** or **ai**)) *or* (**1ii** and **a0**) *or* (**2ii** and **aii**)
- gradual pattern **A** (concatenation): in all other cases

c. the two gradual patterns **A** (non-shaded) and **B** (shaded)



d. the two patterns **A** and **B** do not coincide with phonologically defined stem classes



2.5. Properties of patterns

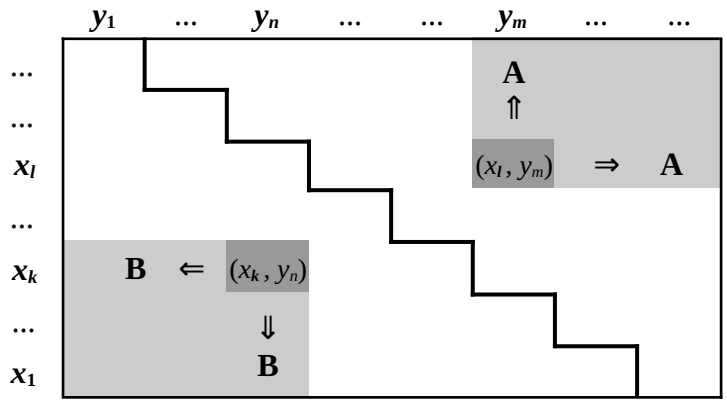
The following list in (6) below summarizes the properties of the four types of patterns mentioned so far. The two relevant properties are whether pattern **B** and its counterpart (i.e. complement) **A** can be defined by logical conjunction, and whether they satisfy monotonicity. It is shown in (3b) that the complement of a conjunctive two-dimensional pattern cannot be conjunctively defined (6c), and neither a gradual pattern, nor its complement admits a conjunctive definition (see 4c above and 6d below). Fortunately, all patterns mentioned here are *monotonic* in both dimensions (more precisely, gradual patterns can always be made monotonic by (re)arranging the order of suffix and/or stem classes – see the next section on the calculation of their appropriate order).

(6) Properties of the patterns discussed

pattern types:	**conjunctive**	**monotonic**
a. homogeneous pattern **A**:	yes (trivially)	yes (trivially)
b. 1-dim. pattern **B**; its complement **A**:	**yes**; **yes**	**yes**; **yes**
c. 2-dim. conjunctive **B**; its complement **A**:	**yes**; no	**yes**; **yes**
d. gradual **B**; its complement **A**:	no; no	**yes**; **yes**

The monotonic property of patterns (especially the gradual pattern) has an important consequence for the *implicative* structure of the paradigmatic system studied here. Let us suppose that a form is part of a monotonic pattern, then there are directions in both dimensions such that if we move in those directions in the paradigmatic space, then *all the other forms* in those directions will *share the same pattern*. This is shown in (7) below and can be formalized in the following way: take an arbitrary form from pattern **B** that is in *k*th stem class ($\boldsymbol{x}_k$) and *n*th suffix class ($\boldsymbol{y}_n$) indicated as ($\boldsymbol{x}_k$, $\boldsymbol{y}_n$). In this case, for all indices $i \leq k$ and for all $j \leq n$, all forms ($\boldsymbol{x}_i$, $\boldsymbol{y}_j$) will have the pattern **B**. This is demonstrated in (7) below at the bottom left region of the table. The relevant form in the dark shaded cell within pattern **B** enforces that all forms on its left or below (the shaded cells horizontally and vertically) belong to the same pattern. Similarly, if a form ($\boldsymbol{x}_l$, $\boldsymbol{y}_m$) is within pattern **A** then for all indices $i \geq l$ and for all $j \geq m$, all forms ($\boldsymbol{x}_i$, $\boldsymbol{y}_j$) are also within pattern **A** (see the right upper part of the table in 7). These implications within a monotonic pattern considerably increase the predictability of the paradigmatic system, see Ackerman et al. (2009, 2016), P. Blevins et al. (2017) on this topic for a slightly different approach.

(7) Implications due to monotonicity within gradual paradigmatic patterns



2.6. Uncertainty

The data in (8a) below show that the forms which display postvocalic vowel-insertion do not behave uniformly. There are certain suffix and stem combinations that show overapplication while other combinations do not and these two kinds of behaviour do not coincide for all stem and suffix classes. This phenomenon occurs with adjective and numeral stems, cf. (8a): *szigorú-**a**k* vs. *millió-k*, but *szigorú-**a**n* and *millió-**a**n*), while other adjective stems do not show vowel-insertion with the same suffixes at all (cf. *bordó-n, bordó-k*). Therefore, a new suffix class (**a0'**) and a new stem class (**1ii'**) are needed (see 8a below). Thus the definition scheme (8b) and the paradigmatic system (8c) become more complex: the five stem and suffix classes induce a five-step borderline between patterns **A** and **B**, and the disjunctive definition must contain at least five parts. Figure (8c) contains some examples at the relevant points of the paradigmatic system for ease of reference.

The area of the paradigmatic space where overapplication and underapplication take place are "weak" regions of the paradigmatic system in the sense that there is no phonological motivation for the behavior of the forms (as opposed to the case of consonant or vowel-final stems or non-alternating suffixes). In this case only lexical information (the arbitrary stem and suffix classes) can provide enough information for creating the grammatical forms. To put it the other way, there are regions in the paradigmatic space where a phonological motivation supports one or the other pattern, the patterns of forms belonging to these regions are phonologically motivated and exceptionless (these can be called "islands of certainty"). In our case three such regions exist (shaded in 8d). The first island of certainty covers the forms that contain a suffix belonging to suffix class **b** (see the last column in 8d). In this class there is no vowel-zero alternation at all (resistant suffixes), thus the whole region belongs to pattern **A**. The second island is located at the intersection of stem class **1** and suffix classes **ai** or **aii**. In this site of the paradigm vowel insertion is always forbidden, thus a ...V-C... sequence occurs at morpheme boundary, so the area belongs to pattern **A** with *maximal certainty* (see on the top center shaded area in 8d). The third island is where stem class **1** and suffix classes **a0'**, **a0** and **ai** intersect (see bottom left shaded area in 8d). These forms compulsorily undergo vowel-insertion creating a C-**V**C sequence at the morpheme boundary, so they belong to pattern **B** with maximal certainty. Other forms of the

paradigmatic space occur with *lower certainty*, i.e. the forms that belong to non-shaded areas are weak forms. In these areas of weak forms, the boundary between the two patterns does not coincide with other phonologically determined borderlines, so the potentially gradual boundary can be unstable (indicated by dash line in 8d).

(8) Gradual patterns determining five stem-classes and suffix-classes

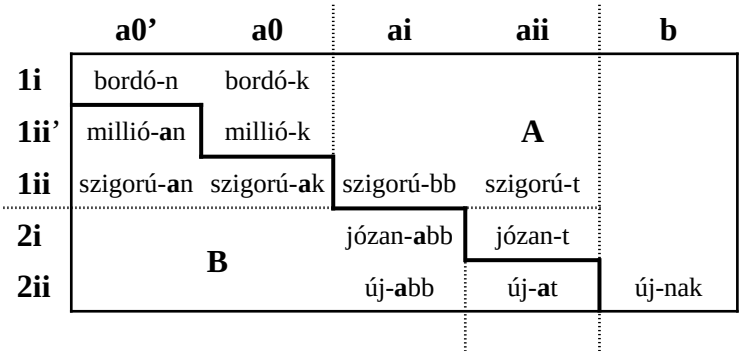
a.

	a0' -ADVZ	**a0** -PL	**ai** -CMPR	**aii** -ACC	
1i	*bordó-n* *keki-n*	*bordó-k* *keki-k*	*bordó-bb* *keki-bb*	*bordó-t* *keki-t*	'claret (Adj)' 'khaki (Adj)
1ii'	*millió-**a**n* *ká-**a**n*	*millió-k* *ká-k*	*millió-bb* –	*millió-t* *ká-t*	'million (Num)' 'letter k (Num)'
1ii	*szigorú-**a**n* *hajú-**a**n*	*szigorú-**a**k* *hajú-**a**k*	*szigorú-bb* *%hajú-bb*	*szigorú-t* *hajú-t*	'strict (Adj)' '-haired (Adj)'

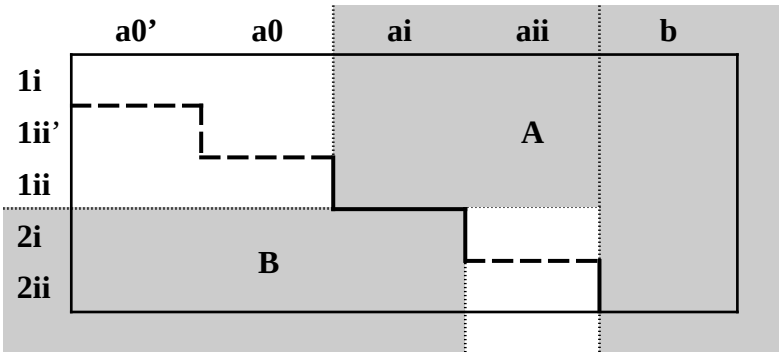
b. SCHEMES:

- pattern **B**: (**2** & (**a0'** or **a0** or **ai**)) *or* (**1ii** & (**a0'** or **a0**)) *or* (**1ii'** & **a0'**) *or* (**2ii** & **aii**)
- pattern **A**: in all other cases

c. gradual patterns with several grades



d. islands of certainty (shaded) and vague borders within weak regions (non-shaded)



2.7 Vacillation

It is not surprising that variation (if it exists) can occur in weak regions of the paradigmatic space (on this hypothesis, see Kálmán et al. 2021 for Hungarian, and on zones of variation in vowel harmony see Hayes et al. 2009). This is true for the vowel-zero alternation examined so far. If we look at the forms in (9a) below, it can be seen that vacillation takes place before suffixes of type **a0** only, or before suffixes of both type **a0'** or **a0** depending on the stem (on this phenomena, see Nádasdy 2019). These stems can be considered mixtures of the two stem classes mentioned in (8a,c) above: **1ii' – 1ii** and **1i – 1ii**, respectively.

The other weak region in (8c) is connected to the accusative (suffix class **bii**). These forms also vacillate; this is shown in (9b) below. Vacillation before the ACC suffix usually occurs after compounds whose last consonant permits the vowelless ACC alternant (see Ittzés–Lagos 2022), but is sometimes also possible after monomorphemic roots. The systematic or occasional variation of these forms further complicates the paradigmatic patterns, because the exact description of these patterns requires the stipulation of new distinct (mixed) stem-classes for stems which show vacillating behaviour (**1ii'~1ii, 1i~1ii** and **2i~ii**). This is demonstrated in (9c), where the cells where vacillation occurs are shaded. These areas can be viewed as the overlapping regions of pattern **A** and **B**: vacillation takes place in areas covered by both patterns.

(9) Vacillating forms of gradual patterns

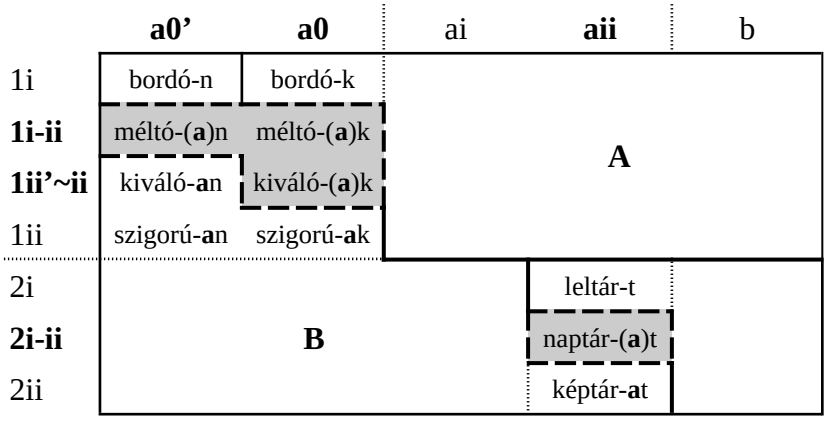
a.

	a0' -ADVZ	**a0** -PL	**ai** -CMPR	**aii** -ACC	
1ii'~1ii	*kiváló-**a**n*	*kiváló-(**a**)k*	*kiváló-bb*	*kiváló-t*	'outstanding'
	*hű-**e**n*	*hű-(**e**)k*	*hű-bb*	*hű-t*	'faithful'
1i~ii	*méltó-(**a**)n*	*méltó-(**a**)k*	*méltó-bb*	*méltó-t*	'worthy'
	*zsugori-(**a**)n*	*zsugori-(**a**)k*	*zsugori-bb*	*zsugori-t*	'stingy'

b.

2i~ii	*szó-tár-(**a**)t*	*nap-tár-(**a**)t ...*	'dictionary/calendar-ACC'
	*cip-zár-(**a**)t*	*veszteg-zár-(**a**)t ...*	'zipper/quarantine-ACC
	*sál-(**a**)t, gáz-(%**a**)t*		'scarf/gas-ACC'

c. Variation in a gradual paradigm structure



2.8. An excursion to conjugation

The paradigmatic system of Hungarian verbs also shows gradual patterns, weak regions and variable forms we analyzed in the previous sections. The overall patterns are very similar despite the apparent morphophonological differences between declension and conjugation. Verbs also show vowel–zero alternation at the morpheme boundary between the stem and the suffix, and there are non-alternating (resistant) suffixes as well (see the examples in 10a and 10b, respectively). However, there are significant differences: verbal roots are rarely vowel-final and in these few cases they always have consonant-final root alternants (that is why the examples in 10a do not contain monomorphemic roots, but stems that have a vowel-final suffix). Furthermore, there is no overapplied vowel insertion after stem-final vowels (as opposed to the declension patterns, see 5a, 8a). Another difference is that certain verbal suffixes are sensitive to the number of stem-final consonants (thus VC-stem and CC-stem classes have to be distinguished). This is shown in (10e) below, where the first column contains the suffix class **aii** with the regular vowel–zero alternation (see 8a), and the last column shows the resistant suffixes (suffix class **bii**, see 10b).

The two intermediate columns in (10e) show suffix classes comprising those suffixes that show vowel–zero alternation, but its conditions are different from suffixes of class **ai** (and from each other). In suffix class **aii** the vowel of the past tense suffix is generally sensitive to the *quality* of the stem-final consonant: in the case of coronal/palatal sonorants (*r, l, n, j, ɲ*) vowel insertion does not apply (see 10c below), but there are systematic deviations from this pattern (see Trón–Rebrus 2005). The other intermediate suffix class comprises several suffixes that are generally sensitive to the *quantity* of the stem-final consonants (suffix class **bi** in 10e). Vowels typically occur after CC-final stems but do not after V-final or VC-final ones (see 10d). This pattern is also subject to several morphological and phonological constraints, thus the pattern is not entirely phonologically motivated (see Siptár–Törkency 2000, Rebrus–Törkenczy 2009, Rácz et al. 2021).

The vowel-insertion pattern in (10e) that emerges from the behaviour of individual suffixes requires four suffix and four stem classes and shows a gradual borderline (for a similar pattern of declination, see 8c above). From the viewpoint of the vowel-insertion process the pattern can be viewed as a further example of *underapplication* (where **aii**-suffixes do not undergo vowel-insertion after **2i**-stems) and *overapplication* (where **bi**-suffixes do show vowel insertion after **2iii**-stems) as can be seen in (10f) according to the (morpho)phonologically strict differences between stem types (V-final or C-final) and suffix types (suffix types **a** or **b**).

(10) Stem and suffix classes in the verbal paradigm

a. vowel-insertion: alternating suffixes

V-final stems:	C-final stems
ad-ná-d ‘give-COND-DEF.2SG’	*ad-**o**d* ‘give-DEF.2SG’
mos-ná-l ‘wash-COND-INDF.2SG’	*mos-**o**l* ‘wash-INDF.2SG’
dob-ná-nk ‘throw-COND-INDF.1PL’	*dob-**u**nk* ‘throw-INDF.1PL’
vár-t-á-k ‘wait-PST-DEF-3PL’	*vár-t-**a**k* ‘wait-PST-3PL’
kér-i-tek ‘ask-DEF-2PL’	*kér-j-**e**tek* ‘ask-SBJV-2PL’

b. no vowel insertion (resistant suffixes)

V-final stems:	C-final stems
sző-j(j) ‘weave-SBJV.INDF.2SG’	*döng-j* ‘bang-SBJV.INDF.2SG’
lő-dd ‘shoot-SBJV.DEF.2SG’	*dob-d* ‘throw-SBJV.DEF.2SG’
ró-juk ‘notch-DEF.1PL’	*fog-juk* ‘hold-DEF.1PL’
e-het ‘eat-POT’	*ért-het* ‘understand-POT’
nő-ve ‘grow-ADV.PTCP’	*önt-ve* ‘pour-ADV.PTCP’

c. basic vowel insertion patterns in past non-definite 3rd singular (suffix **aii**)

V-final or VR-final stems:	other stems:
ró-tt ‘notch-PST’	*nyom-**o**tt* ‘push-PST’
ve-tt ‘take-PST’	*döf-**ö**tt* ‘stab-PST’
vár-t ‘wait-PST’	*mos-**o**tt* ‘wash-PST’
fúj-t ‘blow-PST’	*fog-**o**tt* ‘hold-PST’
tol-t ‘push-PST’	*ajánl-**o**tt* ‘suggest-PST’

d. basic vowel insertion patterns with suffix class **bi**

V-final or VC-final stems:	CC-final stems:
ró-nak ‘notch-INDF.3PL’	*mond-**a**nak* ‘say-INDF.3PL’
ráz-tok ‘jolt-INDF.2PL’	*vonz-**o**tok* ‘attract-INDF.2PL’
fog-[s] ‘hold-INDF.2SG’	*fing-**a***[s(:)] ‘fart-INDF.2SG’
hat-na ‘affect-COND’	*tart-**a**na* ‘hold-COND’
ad-ni ‘give-INF’	*kezd-**e**ni* ‘start-INF’

e. gradual patterns in the verbal paradigmatic system

		ai DEF.2SG	**aii** PST	**bi** INDF.2SG	**bii** SBJV.DEF.2SG
1	V-final	(ad-ná-d)	ró-tt	ró-sz	ró-dd
2i	VR-final	vár-**o**d	vár-t	vár-sz	vár-d
2ii	other VC	fog-**o**d	fog-**o**tt	fog-sz	fog-d
2iii	CC-final	fing-**o**d	fing-**o**tt	fing-**a**sz	fing-d

f. underapplication and overapplication of vowel insertion

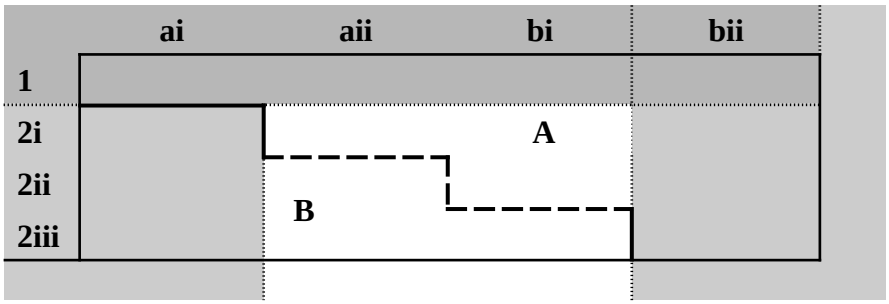
		ai DEF.2SG	**aii** PST	**bi** INDF.2SG	**bii** SBJV.DEF.2SG
1	V-final				
2i	VR-final		**under-application**	**A**	
2ii	other VC	**B**			
2iii	CC-final			**over-application**	

The paradigmatic system of verbs contains regions where the forms undoubtedly belong to either pattern **B** (vowel insertion) or **A** (simple concatenation) similarly to the system of declension (see 8d above). These regions generally constitute a conjunctive 2-dimensional pattern, i.e. they are defined easily by logical conjunction of suffix class(es) and stem class(es) as we pointed out in (3). For verbs, these islands of certainty are the following: **ai**-suffixed forms of consonant-final stems (stem classes **2**) must belong to pattern **B** (bottom left shaded area in 11a below). Pattern **A**, on the other hand, comprises all forms with vowel-final stems independently of the suffix (stem class **1**, dark shaded first row of the table in 11a), and all forms with resistant suffixes independently of the stem (suffix class **bii**, shaded last column of the table).

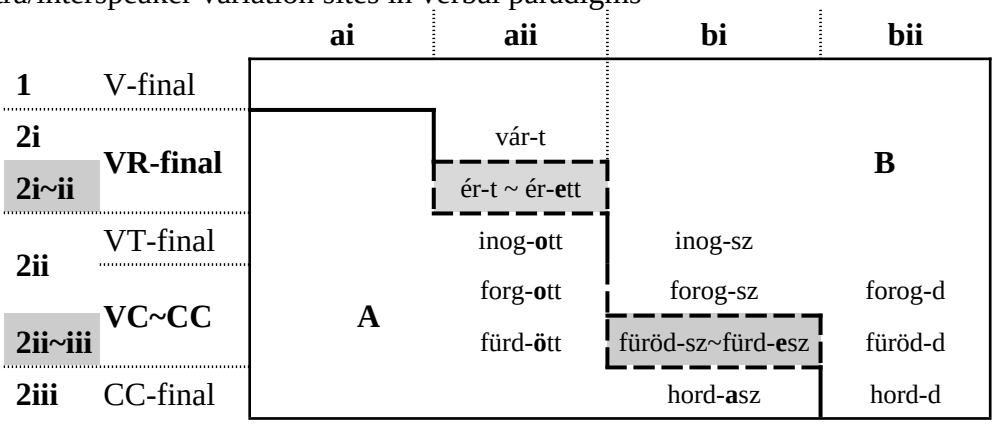
The residual non-shaded areas are weak areas in the sense that there is no firm phonological support for the behaviour of these forms. The result is that the borderline of the two patterns in this area is vague (indicated by a dashed line in 11a). Hence forms near this uncertain border are potential sites of variation, which can manifest themselves in (i) lexical variation, (ii) intraspeaker variation (vacillation) or (iii) interspeaker (dialectal, sociolectal etc.) variation. This means that new lexical stem and suffix classes may have to be stipulated for the exact description of the variation. Such vacillating forms are illustrated in (11b) below for the relevant suffix classes. Past tense forms (suffix class **aii**) show diverse types of variation: (i) lexical, (ii) intraspeaker or (iii) interspeaker variation: (i) V*d*-final and *Vll*-final verbs can be lexically different in whether they undergo vowel-insertion (e.g. *tagad-**o**tt* ‘deny-PST’ vs. *ragad-t* ‘stick_to-PST’, *máll-**o**tt* ‘peel-PST’ vs. *áll-t* ‘stand-PST’); (ii) verbs with a final single or geminate sonorant can show vacillation (*hull-**o**tt ~ hull-t* ‘fall_out-PST’, *ér-**e**tt ~ ér-t* ‘ripen-PST’) or (iii) sociolectal, dialectal or register variation (*áll-**o**tt ~ áll-t*, *szól-**o**tt ~ szól-t* ‘speak-PST’) – see Trón–Rebrus 2005. The same holds for the suffix class **bi** containing numerous verbal inflectional suffixes, especially after stems that have two stem alternants, a VC-final and a CC-final one (epenthetic stems, see Siptár–Törkenczy 2001). The unstable status of these forms is shown by considerable variation falling into several types: (i) lexical conditioning within this stem class: a **bi**-suffix can either occur with a VC-final stem alternant without a vowel or a CC-final stem with a vowel (e.g. *hiányoz-ni ~ hiányz-**a**ni* ‘be_absent-INF’, but *dohányoz-ni ~ *dohányz-**a**ni* ‘smoke-INF’); This may be accompanied by (ii) intraspeaker and (iii) interspeaker variation as well: *füröd-nek ~ fürd-**e**nek* ‘bathe-INDF.3PL’ and sometimes there is regional dialectal variation *söpör-nek ~ %söpr-**e**nek* ‘sweep-INDF.3PL’ (see Kálmán et al. 2012, Rebrus–Törkenczy 2009, 2011, Rácz et al. 2021 for more details on the extremely complex behaviour of these forms). These variation phenomena require the introduction of new vacillating stem class(es); in (11b) below we simply refer to them as **2i~ii** and **2ii~iii**. It has to be noted that the exact description of the variation phenomena requires new *suffix* class(es) as well: for a certain class of stems there is a systematic difference in variation between suffixes within class **bi**: e.g. *mosakod-nak ~ mosaksz-**a**nak* ‘*wash*(intr.)-INDF.3SG’, but *mosakod-ni ~ *mosaksz-ani* ‘id.-INF’.

(11) Variation sites in conjugation

a. islands of certainty (shaded) and uncertain borders within weak regions (non-shaded)



b. intra/interspeaker variation sites in verbal paradigms



Summarizing the observations so far, we have shown that non-phonological allomorphies can result in extremely complex patterns in the paradigmatic system. The macro-level description of these patterns utilizes numerous stem and suffix classes and intermediate (mixed) classes, as well. Thus the logical definition of a specific pattern can be highly complex (often implausibly overcomplicated), because of the highly gradual character of the patterns and their potentially uncertain borders which can only be defined by stipulating these lexically specified stem and suffix classes. Such uncertain borders manifest themselves in several types of variation phenomena: lexical, intraspeaker or interspeaker variation. Moreover, the exact triggering factors for the vacillating behaviour are often not completely described; there are probably tendencies rather than clear-cut regularities, and beside phonological and morphological factors, semantic, usage-based and sociolinguistic considerations can be relevant within the region of uncertainty. In the next section we present an outline of the elements of a micro-level description and show how this kind of account can be used in explaining the diachronic change of paradigmatic patterns.

3 Micro-level description and diachronic change

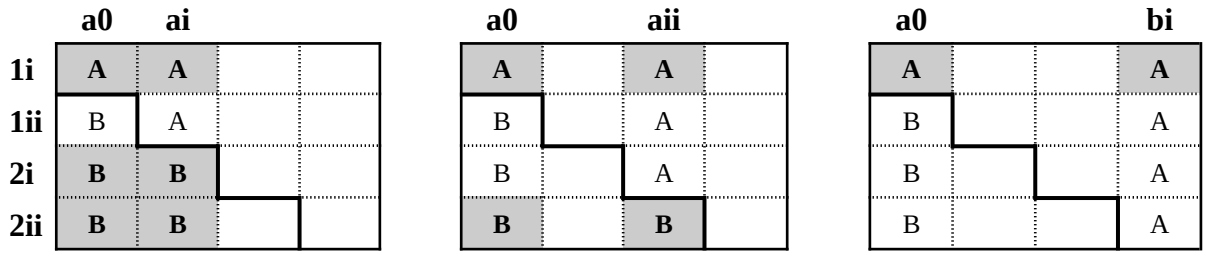
3.1 Analogy and similarity

The micro-level description is based on the concept of direct connection between forms. This is a kind of *output–output correspondence* relation which plays an important role in constraint-based grammars, such as Optimality Theory (Benua 1997), and also in diverse forms of analogy-based grammars (see Bybee 2010, J. Blevins–J. P. Blevins 2009). From an analogical point of view, correspondences between forms manifest themselves in *similarity-based behaviour* (see Pierrehumbert 2006, Hay–Baayen 2005, Lindsay et al. 2024 in general and Rácz et al. 2021 for Hungarian): if two linguistic entities are similar in one or more respects, then they tend to be more similar in other respect(s). The strength of attraction is proportional to the similarity of the two relevant forms and the frequency of the source form(s), where similarity means their joint attributes with respect to their form and/or function. For practical reasons we do not associate two individual entities with each other, but *sets* of entities. In morphophonology, where we examine mainly the formal behaviour of entities, this means that if the formal and/or functional similarity is great enough between two sets of word-forms, then their morphophonological behaviour will be similar. The crucial problem now is how we quantify similarity, i.e. what numbers are to be assigned to pairs of (sets of) forms when measuring the quantity of their similarity.

In this paper we do not define a concrete similarity function (on this very complex task, see Skousen 1989, Frisch–Pierrehumbert–Broe (2004), Krott–Baayen–Schreuder (2001), but only define the *difference* of similarities that can be inferred from the paradigmatic organization (from the shape of patterns in a paradigmatic system). If we consider two suffix classes, we can observe how many stems or more simply how many different stem classes show the same pattern. In this case, the more shared the pattern is that is assigned to the two stem classes, the more similar they are. This is shown in (12a) below, where the suffix class **a0** is compared to the three other suffix classes (**ai**, **aii** and **bii**, respectively) in the paradigmatic system with the gradual pattern **B** or its complementary pattern **A**. We will show that similarity is proportional to the "proximity" of suffix classes if their order is given as in (12) below and throughout this paper, i.e., the closer the two suffix classes are, the greater the similarity is between them. In other words, similarity sets up a linear ordering relation on suffix classes: **a0** ⋘ **ai** ⋘ **aii** ⋘ **bi** (the direction of the relation ⋘ does not matter, we can obtain the same information with the opposite order). It is important to note that in this approach certain similarities between suffix classes are not compared: if the proximity of two pairs of suffix classes is the same by the calculation mentioned above based on the paradigmatic system, then it does not follow that the similarity between the members of each pair is identical. This is exemplified in (12b) below where the designated suffix classes have the same proximity to each other in the two tables (here they are adjacent in both tables). This does not mean that the similarity between the two relevant suffix classes is equal (i.e. *sim*(**ai**, **a0**) = *sim*(**ai**, **aii**)); it may (and usually does) depend on other extraparadigmatic factors such as type frequency of the given classes or other kinds of resemblance (e.g. similar form or function of the suffixes of these classes).

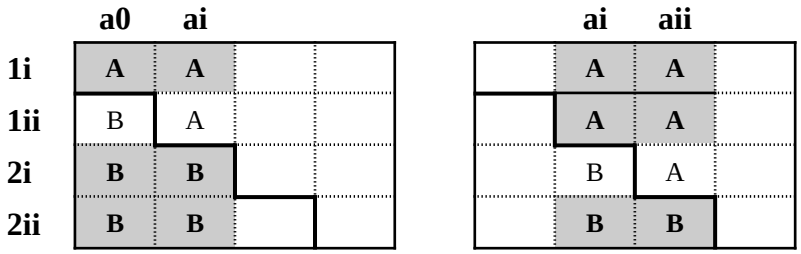
(12) Similarities between suffix classes induced by the gradual pattern

a. similarity difference is defined by proximity (linear ordering)



consequence: *sim*(**a0**, **ai**) > *sim*(**a0**, **aii**) > *sim*(**a0**, **bi**)

b. similarity difference is not defined by linear ordering (it depends on other factors)



consequence: the relation between *sim*(**a0**, **ai**) and *sim*(**ai**, **aii**) is not defined

It has been shown above that a pattern in the paradigmatic system induces a proximity (similarity) relation between suffix classes that manifests itself in a linear ordering of these classes. The analogue of this view also holds for *stem* classes: the gradual pattern in (12) induces a proximity relation between stem classes which is easily explained by the following linear ordering of stem classes: **1i ⋘ 1ii ⋘ 2i ⋘ 2ii** (which is used throughout the paper). Hence we have two kinds of proximity in the two dimensions: one between suffix classes within a row, i.e. a (stem-)paradigm defined by the same stem (in the "horizontal" dimension) and one between stem classes within a suffix paradigm that is defined by the same suffix (in the "vertical" dimension).

Here the following question arises: What proximity relations hold for an individual suffixed form in a paradigmatic system? As it was mentioned, an individual form is affected by several analogical forces of attraction by other forms within the paradigmatic space. These forces have different strengths defined by the proximity to (i.e. similarity with) other forms in two dimensions: (i) forms that have the same stem (within the stem paradigm, i.e. in horizontal dimension) and (ii) forms that have the same suffix (within the suffix paradigm, i.e. in vertical dimension). We claim that the "diagonal" analogical effects from individual forms that are not in the same row or not in the same column are so weak that they are negligible – this is because functional and phonological similarity is very low between forms that have different stems and different suffixes. The analogical attraction depends on proximity: the greatest effect comes from the form itself because identity means maximal

similarity; the second greatest one is between *adjacent* paradigm cells horizontally or vertically; and the other non-adjacent cells horizontally or vertically in the descending order of their distance from the form in question. This is illustrated in (14a) later where the designated paradigm cell that is located in the joint part of individual stem ***x*** and individual suffix ***y*** is solid black, and the darkness of other relevant cells indicate the strength of their analogical effect upon the designated cell (dark grey: greater effect, light grey: smaller effect).

It is not easy to calculate all the analogical connections between all individual forms because of the potentially high number of existing forms and thus the high number of all potential connections between the forms in a paradigmatic system. Instead, we take advantage of the generalization used so far: we calculate the analogical attraction between *sets* of forms rather than individual ones. These sets of forms can be any collections of suffixed forms that are in a local close similarity relation with each other (e.g. they are similar enough in form and/or in function). Typically, these sets of forms are subsets of the sets defined by stem and suffix classes such that all members of a subset have a stem from the *same* stem class defined by the paradigmatic pattern and have a suffix from the *same* suffix class (i.e. it is a refinement of the cell defined by the stem and suffix classes). In this case, the basic units of the analogical connections will be those designated generalized cells that are the intersections of the subset of the relevant suffix class and the subset of the relevant stem class. For instance, if we consider the verbal paradigm in (10e), we can make a generalized cell consisting of sets of forms such that we take a subset from any stem class (e.g. coronal-final stems or intransitive verbal stems within the stem class **2ii** (VC-final stems)) and a subset from any suffix class (e.g. suffixes with a stable vowel or person/number markers within suffix class **bi**) – this will be a subpart of the greater cell that is defined by the stem class **2ii** and the suffix class **bi**. The following potential analogical sources can take effect on such a set of forms in a designated generalized cell: (a) the strongest analogical connections hold between the forms within the designated cell; (b) smaller but considerable analogical connections hold between forms in this designated cell and forms in the *adjacent* cells; (c) the strength of analogy is even smaller with sources in those *non-adjacent* cells whose stems belong to the same stem class as the designated cell belongs to or whose suffixes belong to the same suffix class (the closer the proximity, the greater the analogical effect); and (d) the effects of other forms in "diagonal" cells are so weak that they are negligible. These four types of analogical sources are summarized in (13abcd) below, and illustrated in (14a), where the designated form is associated with stem class ***x*** and suffix class ***y***, i.e. it is within the generalized cell defined by classes ***x*** and **y**.

(13) Analogical sources that can affect a form in a generalized cell (***x***, ***y***)
– in order of decreasing strength

a. **within the cell**: a subset ***x*** of any stem class and a subset ***y*** of any suffix class:
forms ***x***+***y***

b. **adjacent cells**:
- horizontally: same subset of stem class and a "proximal" suffix class:
forms ***x***+***y'*** where *y* and *y*' are in the same or adjacent suffix classes
- vertically: same subset of suffix class and an adjacent suffix class:
forms ***x'***+***y*** where *x* and *x*' are in the same or adjacent stem classes

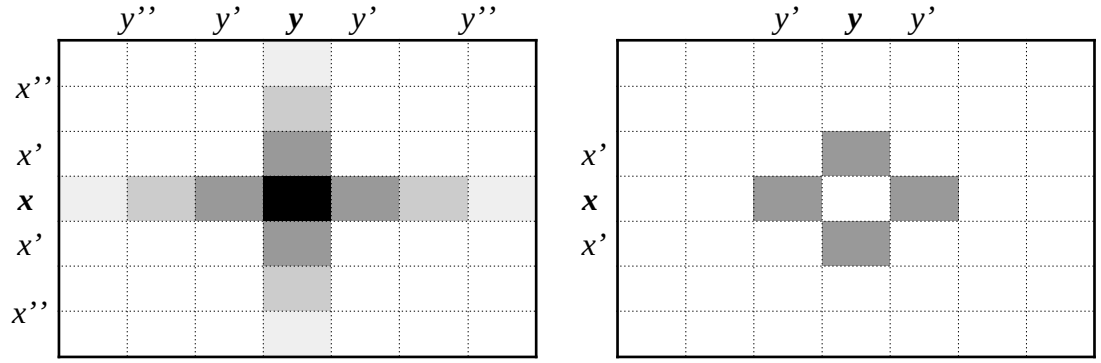
c. **non-adjacent cells**: strength depends on their proximity
- horizontally: same stem class and a non-adjacent suffix class:
forms ***x***+***y''*** where *y* and *y*'' are non-adjacent
- vertically: same suffix class and a non-adjacent suffix class:
forms ***x''***+***y*** where *x* and *x*'' are non-adjacent

d. other potential sources are negligible

For the sake of simplicity we will make further plausible simplifications in the rest of the paper. This is because the present analysis does not require a quantified comparison of different analogical strengths; the local adjacency relations defined by the positions of the relevant (generalized) cells alone will suffice for our purposes. On the one hand, we will ignore the effects within the designated cell itself (13a) and also the effects of non-adjacent cells (13c). That is, we will only consider the *adjacent* cells as being effective analogical sources as mentioned above in (13b). This situation is illustrated in (14b) below, where only the grey cells can take effect (in this case the cells are generalized cells). The reasons for these simplifications are the following: the effects within the designated cell (13a) can be considered as the inertia of these forms and not a proper external effect, i.e. the effects within the cell are independent of and uninfluenced by the distinct effects from outside the designated cell. And also, the effects of non-adjacent cells (13c) can be negligible if an appropriate decreasing series of strengths is chosen (in this case the cumulative effect of the adjacent and non-adjacent cells is considered to be identical to the effect of the adjacent cells). On the other hand, we will not define different strengths of effects from the four (or fewer) adjacent cells shown in (14b), because in the general case we do not know their modifying factors (they depend on the different frequencies of the forms belonging to the relevant cells, the greater or smaller similarity of forms etc. and are not defined by the paradigmatic organization). This, however, permits that in special cases the effects of the adjacent cells can differ considerably. This will be relevant later.

(14) similarity connections of a designated cell (***x***, ***y***) that are defined by proximity

a. gradually decreasing similarity b. simplified discrete similarity: only adjacency



3.2 Stable and unstable positions

Suppose that in the paradigmatic space the generalized cells mentioned above are in a linear ordering relation by two dimensions (by the suffixes and by stems). In this case the proximity of cells defines the strength of analogy and the four adjacent cells affect each cell, see (14b) above (at the edges of the paradigmatic space the number of adjacent cells is smaller, here we ignore this complication). Suppose that there are two complementary patterns in the paradigmatic system (**A** and **B**) whose border is aligned with certain cell borders. In this situation a designated (generalized) cell can be in three kinds of positions with regard to the patterns and this position is defined by the adjacency of the cell to the border of the pattern: (i) inside the pattern (the cell is non-adjacent to the border), (ii) at the edge of the pattern (only one edge of the cell is aligned with the pattern border) and (iii) in the corner of the pattern (two edges of the cell are aligned with the pattern border). More than two cell edges cannot be aligned to pattern borders in a monotonic pattern.

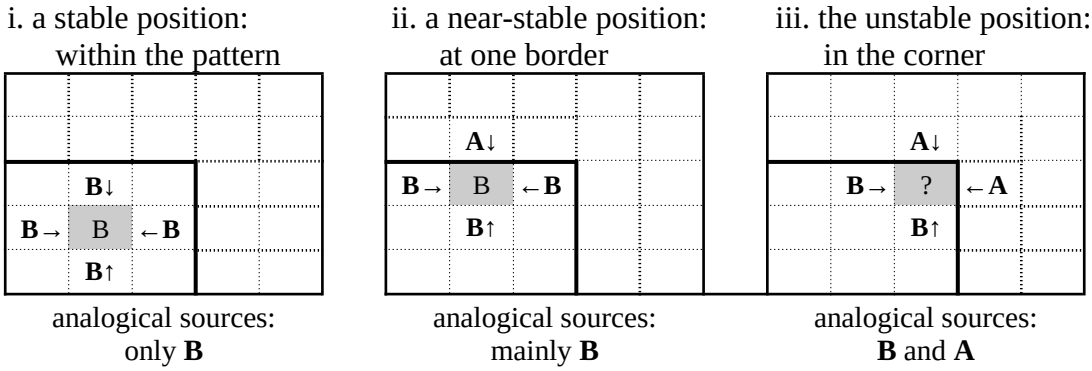
The number of cells in positions (ii) and (iii) mentioned above depends on the type of the given pattern. If the number of cells within the two patterns is not very small then all types of patterns contain internal cells in position (i): homogeneous patterns (1) contain only this position. One-dimensional patterns defined in (2) contain positions (i) and (ii) only, there is no "corner". Conjunctive patterns defined in (3) contain all three positions, the number of positions in type (iii) is one since there is only one corner. This is shown in (15a) below, where the designated cells are shaded grey. Gradual patterns contain as many cells in position (iii) as there are stem/suffix classes defining the gradual pattern. This is exemplified in (15biii) where the gradual pattern contains three stem/suffix classes, thus the number of corners (i.e. the cells in position iii) is also three (shaded grey).

Positions (i-iii) defined above have direct consequences for the relevant analogical attractions that affect a given cell. Cells in pattern-internal position (i) are affected by identical analogical effects since the four adjacent cells have the same pattern, in (15ai) a conjunctive pattern, and in (15bi) a gradual pattern. In this case the cells are *stable* with regard to their pattern. Those cells that are at one pattern border (position ii) are predominantly affected by their own pattern (see 15aii and 15bii below) since their 3 adjacent cells belong to their own pattern – this means a *near-stable* status. By contrast, the tables in (15aiii) and (15biii) show that cells in the corner (position iii) are *unstable* since the

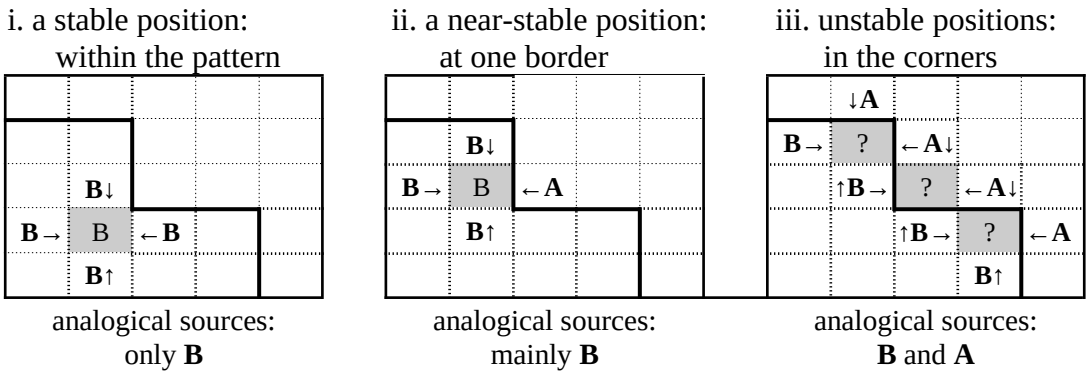
analogical effects from their adjacent cells are contradictory: 2 of the 4 adjacent cells belong to the same pattern (**B**), and the other 2 to the complementary pattern **A**.

(15) Stable and unstable regions

a. in a conjunctive pattern



b. in a gradual pattern



It is important to note that the *actual* effects of analogy depend on additional factors of similarity and frequency of the cells. The calculation in (15) shows only those effects that are defined by the proximity relations and the relative position of the cell and the pattern borders that have been defined in the paradigmatic system. Thus, it is possible that a near-the-border position (ii) is actually unstable and not near-stable as defined by its paradigmatic status, if the analogical effect of pattern **A** from the only adjacent cell in pattern **A** approximately equals the effect of pattern **B** from the three adjacent cells in pattern **B**. Likewise, corner positions can be stable instead of unstable if the cumulative external effects from the cells in the same pattern are predominantly larger than from ones in the complementary pattern. The latter situation occurs in the corner cells of the islands of certainty (see 8d, 11a) where the high phonological similarity between the cells in the same pattern result in the predominant effect from the same pattern overriding the effect of the complement pattern. We abstract away from these external modifying factors in this discussion. From the paradigmatic point of view they are reasonably considered as *arbitrary*: they depend on larger or smaller similarities between sets of forms, and their frequency. In this general approach we disregard these factors; the lack of precise information about their strength motivates the simplification that the adjacent analogical effects are essentially *uniform* and the assumption that it is

predicted from the paradigmatic organization which positions are most likely to be stable and unstable ones.

3.3 A model for paradigmatic change

Now, the following question arises: why are synchronic *gradual* patterns cross-linguistically so frequent? Our answer can involve another question that is inherently diachronic (on the diachronic evolution of synchronic phonological patterns, see J. Blevins 2009): why and how do patterns evolve from very simple clear-cut pattern(s) into highly complex gradual patterns involving uncertainty regions (zones of variation)? The literature on Hungarian suggests that the answer will be based on the potential and most probable trajectories of paradigmatic systems changing from one type into another or others. The sub-problems are involved depending on the type of the source and the target patterns: change (i) from a homogeneous pattern into a one-dimensional alternational pattern, (ii) from an alternational pattern into a two-dimensional conjunctive pattern and (iii) from a conjunctive pattern into gradual pattern(s). Since the elements that can be considered irregular/exceptional typically appear in the multi-step gradual pattern, therefore our main focus here is the last type of trajectory (iii), which can be explained by the paradigmatic organisation of the language.

(i) The difference between a homogeneous pattern and a one-dimensional pattern is that the latter involves allomorphy. From a morphophonological point of view such allomorphies are typically phonologically motivated alternations. These alternations usually occur for phonotactic reasons, as in the case of the vowel–zero alternation mentioned in (2) above: the vowel that appears after consonant-final stems avoids complex codas (stem-final consonant clusters (CC#) or in certain cases triconsonantal clusters (CC.C)) and the vowelless suffix alternant after vowel-final stems avoids hiatus (V.V) – both configurations are universally marked. The initiating factor of such alternations is usually a diachronic phonological change, for instance the reduction and deletion of stem-final vowels in word-final position followed by the restructuring of the stem-final vowel before suffixes (e.g. *hala-k* > *hal-ak* ‘fish-PL’). In certain cases the actual phonotactic constraints of the language allow certain marked configurations mentioned above (e.g. certain types of final clusters or hiatus) which originated in diachronic change (e.g. altering phonotactics in time) and can be treated in a model in which several phonotactic layers (co-phonologies) are supposed within a language (see Ito–Mester 2003 for Japanese stems, Trón–Rebrus 2001 for Hungarian morphophonology).

(ii) The main difference between a one-dimensional pattern and a two-dimensional (conjunctive) pattern is usually the existence of resistant suffixes (and/or the resistant stems) that do not show (trigger) alternations, e.g. vowel–zero alternation, see (3). The source of such suffixes is usually some originally non-suffixal functional elements (bound forms: postpositions, clitics etc.) or content words (free forms: stems, adverbs etc.), later attaching to stems and admitting specific grammatical functions. This can protect them from certain types of allomorphy – this is the case in Hungarian where there is a group of affixes (mostly case markers and most derivational suffixes) that are resistant to certain alternations (on the graduality of their alternation properties see Rebrus et al. 1996). Their newly attained morphological status, their different phonological shape and/or function can result in their resistance to allomorphy (they usually cannot undergo and cannot trigger alternations). This

kind of analytical status is manifested in two further properties: (i) they can violate (monomorphemic or synthetic) phonotactics at morpheme borders, and (ii) they avoid exceptional or idiosyncratic behaviour – this can be observed in level 2 suffixation in English, too (see Kaye 1995, Kiparsky 1982). *Morphologically regular* (concatenated) past forms may be exceptional phonologically, e.g they can contain long vowel + non-coronal (voiced) consonant clusters in English level 2 suffixation (*heap – heaped* [i:pt], *believe – believed* [i:vd], but *morphologically exceptional* past forms do note violate phonotactics in level 1 suffixation since the vowel shortens (*keep, sleep – kept, slept* cf. *opt, concept,* and *leave – left* cf. *soft, lift*). The conjunctive patterns that have solid phonological support (i.e. are phonologically determined) can frequently serve as regions with a clear-cut border without variation (islands of certainty, see 8d for nominals and 11a for verbs), also after subsequent modifications of the pattern type (in gradual patterns).

(iii) The trajectory from the conjunctive pattern to gradual pattern(s) is motivated by the existence of the unstable positions in the paradigmatic system. It was mentioned in (15) above that the conjunctive pattern has an unstable region that comprises those set(s) of forms that are proximal to both patterns. The site of these unstable patterns is in the corner of the patterns in question (see 15a/biii), other positions inside the patterns are protected from the analogical effects of the complement pattern (see 15a/bi and 15a/bii). In the following part of the paper we provide a schematic description of the potential steps in the trajectory from a simple conjunctive pattern to a complex gradual pattern. It has to be noted that this picture is a framework that describes the *necessary* (but not definitely sufficient) *paradigmatic conditions* of diachronic change: each step is optional in the sense that it happens only in the specific case when the sufficient similarity relations exist. That is, every stage mentioned here has a legitimate *synchronic status*: a diachronic change can stop at any stage. The potential steps are the following: (a) intra/interspeaker variation in an unstable cell, (b) splitting off a suffix and/or stem class and (c) formation of new site(s) of unstable cell(s).

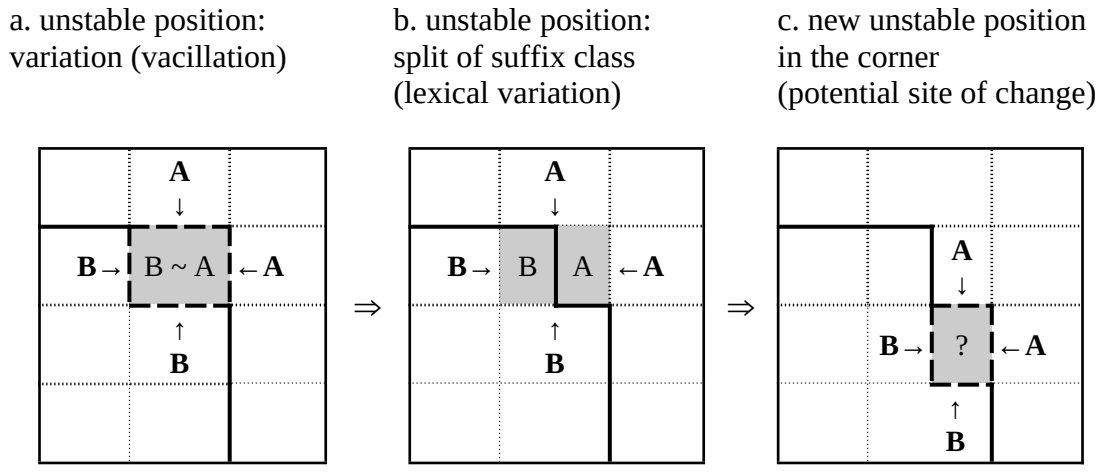
(a) Variation typically occurs if contradictory analogical attractions apply with approximately identical strength (see Kálmán et al. 2012, Rácz–Rebrus 2021 for Hungarian). In the paradigmatic system this means that variable forms have to be in unstable positions. We have shown in (15aiii) that in a conjunctive pattern there is only one unstable region, which is located in the corner of the conjunctive pattern. This means that this is the most probable position where a diachronic process can take place that turns a cell into a site of variation. That is, the invariable forms in this cell can become variable: this usually manifests itself in variation (vacillation). From a macro-level view this means that the paradigm becomes more complex: a new stem class and a new suffix class emerge. The original conjunctive pattern requires two suffix classes and two stem classes while the new pattern will contain new classes for the variable forms. This is shown in (16a) below.

(b) A variable cell is not necessarily homogeneous. It may contain forms that are more similar to forms in one pattern, and others that are more similar to forms in the complementary pattern. In our case this means that forms in an unstable non-homogeneous pattern tend to behave differently, which manifests itself in the variation ratio: some forms have more variants with pattern A than with pattern B, and other forms the other way around. This uneven distribution of variable forms can lead to a situation where two mostly invariable types emerge (for similar behaviour in vowel harmony see Patay et al. 2020). This means that

the variable cell splits into two invariable cells. This split can be realized in the stem dimension (a new stem type) or in the suffix dimension (a new suffix type) depending on the non-paradigmatic similarity and frequency effects. The latter case is shown in (16b) below, where two invariable cells emerge in the place of the one variable cell (it is also possible that one of the cells remains variable and only the other becomes invariable). This change can be viewed as one that "stabilizes" the original cell. If it happens then the new pattern will not be conjunctive anymore, but a gradual one that is shown in (16b) below.

(c) Since the new pattern is gradual, new unstable cells emerge, which implies new potential sites of variation. This is shown in (16c) below for one of the three unstable cells. If the variation and the split happen in the new positions as presented in (16a,b), the gradual pattern becomes more and more complex with more and more stem and suffix classes. This process continues until a state of equilibrium of the paradigm is reached (this balance can later disintegrate if extraparadigmatic factors such as frequency of forms or formal or functional similarity between cells change). The result is a highly complex gradual pattern with several stem and suffix classes. The diachronic process schematized in this way can explain several paradigmatic properties of synchronic grammars: (i) the possibility of a *highly complex* paradigmatic organization with several stem classes and suffix classes, (ii) the fact that the overwhelming majority of morpho-phonological patterns are *monotonic* (conjunctive or gradual) and (iii) the fact that the sites of variation (*regions of uncertainty*) typically are at the border of two gradual patterns.

(16) Possible diachronic trajectory of patterns (conjunctive → gradual)



The above process was simulated on a computer using a stochastic algorithm (Arató–Rebrus 2024). The result was that the change of the unstable cells almost exclusively results in a monotonic (gradual) pattern, where the variable cells are located at the border of the patterns.

What follows is an illustration of the proposed diachronic process outlined in this section. The phenomenon examined here is the past forms of verbs, which shows intriguing patterns synchronically. The main point of these patterns in present-day Hungarian is the following: there are three relevant stem classes and two suffix classes (see Abondolo 1988, Siptár–Törkenczy 2000, Trón–Rebrus 2005). The two suffix classes includes (I) the exponents of the

basic past (PST) forms of verbs bearing a null agreement suffix (past non-definite 3rd singular forms), and (ii) the past exponents of the *suffixed past* (PST+) forms with a vowel-initial exponent after the past suffix (other definite and/or non-3SG forms), For discussions of related issues, see WBCDL090 and WBCDL094. The three relevant stem classes (three "grades" in Abondolo's term) are based on the vowel insertion pattern before the two kinds of the past tense suffixes (PST and PST+). They are the following: 1st grade: no vowel insertion occurs before either of the two past tense classes; 2nd grade: vowel insertion only before PST and not before PST+ and 3rd grade: vowel insertion before both PST and PST+ suffixes. This is shown in (17) below:

(17) The behaviour of past suffixed forms in current Hungarian

	PST (-PST.INDF.3SG)	PST+ (-PST-INDF.3PL)	
1st grade:	*ró-tt* *akad-t*	*ró-tt-ak* *akad-t-ak*	'notch' 'occur'
2nd grade:	*ad-**o**tt* *hord-**o**tt*	*ad-t-ak* *hord-t-ak*	'give' 'carry'
3rd grade:	*old-**o**tt* *tart-**o**tt*	*old-**o**tt-ak* *tart-**o**tt-ak*	'solve' 'hold'

Though the alternation of the vowel before the past suffix is partially phonologically determined, this is not definitive: there are other complex lexical, morphological and phonological factors involved (see Trón–Rebrus 2005). This is demonstrated in (17) with *d*-final verbal stems, which appear in all the three stem classes (e.g. *akad, ad/hord* and *old*, respectively). Moreover, massive variation occurs with certain subclasses of stems (*ér-**e**tt ~ ér-t* 'ripe-PST', *ragad-**o**tt ~ ragad-t* 'adhere-PST', *mond-**o**tt-a ~ mond-t-a* 'say-PST-DEF' etc.).

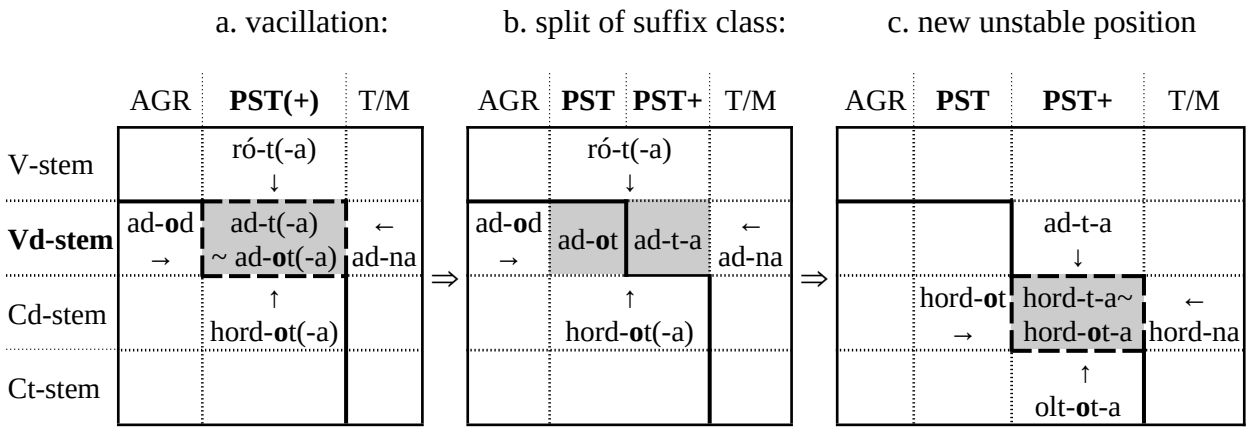
3.4 Evolution of the past

It is known from the history of Hungarian that the vowelless forms after certain consonant-final stems are more recent (see e.g. Benkő et al. 1991). For instance the oldest surviving continuous Hungarian text (Funeral Sermon and Prayer, cca. 1195) contains a vowel between the stem and the suffix *-t* in the form *od**u**tta* and *od**u**t* '(s)he gave it/sg.' (*ad-t-a* and *ad-**o**tt* in modern Hungarian) and later from the begginning of the 13th century: *ſ[c]il**u**t* (*szül-t* 'she bore sy.'), *tacar**u**ta* (*takar-t-a* '(s)he covered it'), see E. Abaffy (1991). The modern form *hord-t-a* '(s)he carried it' still occurred with an inserted vowel (*hord-**o**tt-a*) in the 19th century.

Thus we can reconstruct a diachronic trajectory from the simple pattern where all consonant-final forms took an inserted vowel to the recent complex pattern in (17). This reconstruction is a demonstration and surely lacks many details (for finer details see Benkő et al. 1991) but it is suitable for presenting how the complexity of a paradigmatic subsystem increases in terms of the diachronic trajectory presented in (16). Suppose that consonant-final verbal stems had a vowel after the stem (e.g. *ad-**o**tt* and *ad-**o**tt-a*; here we ignore the

gemination of *t* and the quality of the vowels; they are given in the present-day form). In this case the PST and PST+ forms are in a conjunctive vowel insertion pattern mentioned in (3) for nominals. In the case of verbs, the other suffixes in this pattern are mostly (a) person/number/definiteness (AGR) markers without a stable suffix-internal vowel but with a vowel between the stem and the suffix (e.g. *ad-**o**d* 'give-DEF.2SG') and (b) tense/mood (T/M) markers which are resistant suffixes with a stable suffix-internal vowel (e.g. *ad-na* 'give-COND', *ad-j-on* 'give-SBJV-INDF.3SG – the form of the conditional suffix probably changed later). At this stage, the past suffixed forms were within the vowelful pattern but the past suffix was very similar to resistant suffixes in function (tense/mood marker) and partly in form (potentially containing a suffix-internal vowel). In proximity terms this means that the cells of each past form (indicated as PST(+)) are adjacent to the resistant tense/mood markers (T/M) – this is shown in (18a) below. Thus a certain cell will be in the corner of the vowelful pattern and therefore the status of this cell is unstable. The unstable position can easily cause vacillation, which is shown in (18a) in the case of the stem *ad*: *ad-t(-a) ~ ad-**o**t(-a)*. The next potential step is the split of the suffix class as shown in (18b) below: PST+ forms of the V*d*-final (and other VC-final) stems tend to behave like T/M forms (no vowel-insertion: *ad-ta*), but PST forms tend to behave like AGR forms (vowel-insertion: *ad-ot*). This change stabilizes the paradigm of V*d*-final (and most of the VC-final) verbs and makes the overall pattern gradual. (18c) shows that in the new gradual patterns new unstable cells emerge as we pointed out in (16c) above: one of them is the PST+-suffixed forms of C*d*-final stems. This unstable position can show vacillation as we can observe in the obsolete forms *hord-t-a ~ hord-ot-a*. By then the cycle of the trajectory in (16abc) starts again: the cell is later stabilized by means of split of the C*d*-final *stems*: in recent Hungarian one subclass behaves like grade 2 verbs (*mond-t-a, hord-t-a, küld-t-e, kezd-t-e*), while the other subclass as grade 3 verbs (*old-**o**tt-a, küzd-**ö**tt-e, mosd-**o**tt-a*) similarly to C*t*-final verbs (*önt-**ö**tt-e, tart-**o**tt-a, olt-**o**tt-a, fest-**e**tt-e*).

(18) Demonstration of diachronic trajectories: basic past (PST) and suffixed past (PST+)



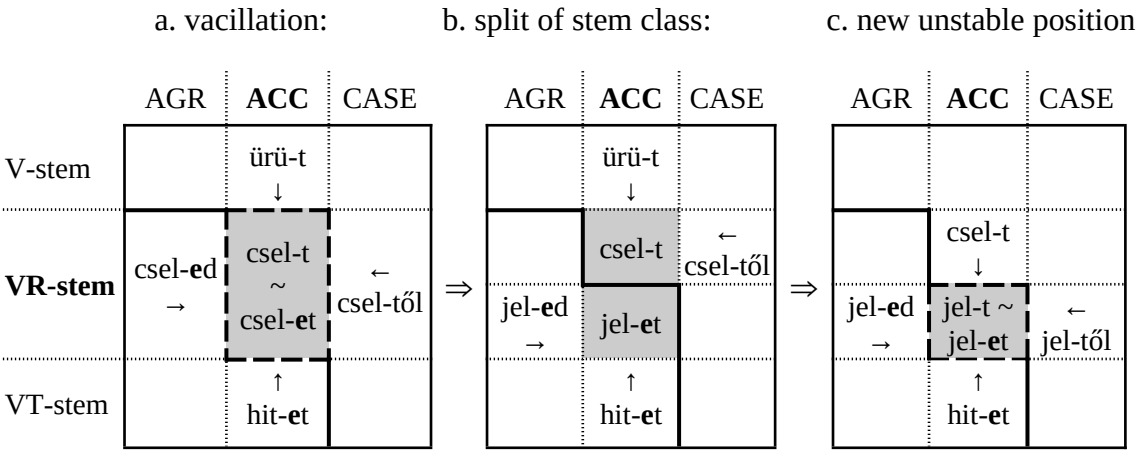
These diachronic changes turn the originally probably conjunctive pattern with few stem and suffix classes into a highly complex gradual pattern involving several stem classes and suffix classes. The change also affects whether the alternation is phonologically or lexically

determined: in the original pattern the allomorphy of the past is defined by the last segment of the stem (vocalic or consonantal), but in the evolution of the complex gradual pattern, more and more morphological and lexical factors take part in addition to others such as homophony avoidance and frequency (see Trón–Rebrus 2005).

3.5 Evolution of the accusative

The development of the accusative can be modeled similarly to the above. In the original state, accusative suffixes were always preceded by a vowel, similarly to the other forms of the suffix class **ai**, which typically contain non-case suffixes (see 4d). Since the formal and functional properties of the accusative are different from suffixes in class **ai** (it contains phonologically unmarked coronal voiceless stop *t* and it functions as a case suffix), it is in an unstable position and shows variation after stem-ending coronal sonorants (VR-stems), see (19a) below. The behavior of the varying forms will then be different: some stems start to show the concatenative pattern, in others the vowel remains (e.g. (e.g. current Hungarian *csel-t* 'feint-ACC' vs. *jel-**e**t* 'sign-ACC'). That is, unlike in the past tense, it is not the suffix class, but the stem class (VR-stems) that splits, see (19b). Henceforth, stems belonging to the *jel-**e**t* stem class can be considered exceptional and often show hesitation due to the pressure of the paradigmatic system (recent: %*jel-t ~ jel-**e**t*). In our view a new unstable cell is created, in which forms with consistent vowel behavior can hesitate (19c).

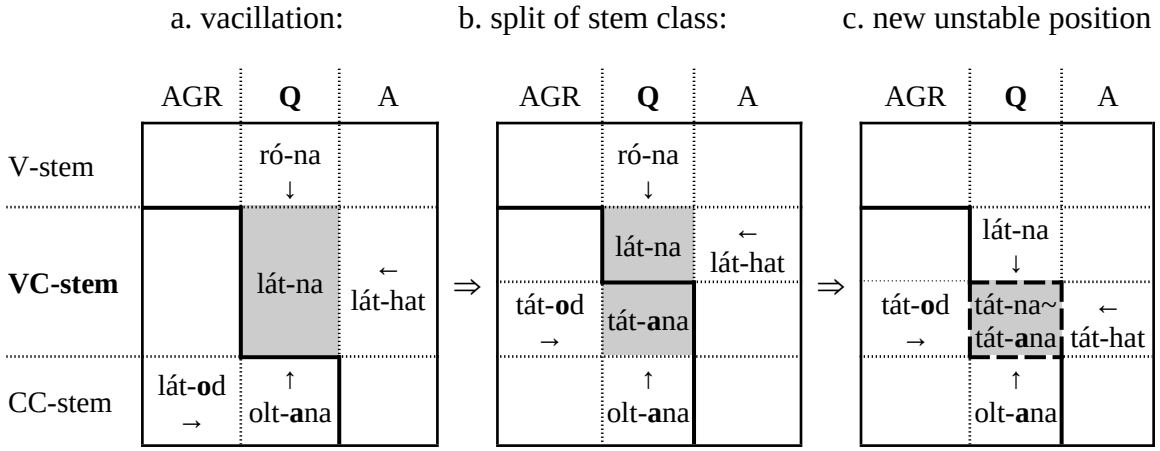
(19) Demonstration of diachronic trajectories: accusative



The interaction of sound changes and the paradigmatic system can produce a whole class of affixes that contains lexical exceptions. This happened in the case of quasianalytic (Q) affixes, where the vowel typically occurs only after CC-final stems (see the stem class **bi** in 10d). In the conjugation system, the completely general syncope rule in Old Hungarian (Horger's law, see Horger 1911) eliminated the vowel before suffixes containing a stable vowel if the stem ended in VC, but not in the case of CC-final stems (e.g. *lát-**a**na* > *lát-na* 'see-COND, but *olt-ana* ⊁ **olt-na* 'extinguish-COND'). That is from the point of view of the paradigmatic pattern, we have to assume two stem classes (VC-final and CC-final stems, numbered as **2i/ii** and **2iii** in table 10e above). We demonstrated this in (20a) below. Later an

independent sound change took place, which in some *t*-ending verb stems changed the final CC to C (*táCt* > *tát*, *szíCt* > *szít*, *bocsáCt* > *bocsát* etc.). These stems thus became exceptional from the point of view of the vowel of quasi-analytic suffixes (e.g. *lát-na* vs. *tát-**a**na* 'open-COND'), i.e. a new class of stems arose within VC-stems, this split is shown in (20b), which may have also contained stems in which originally did not end in final CC (e.g. *vét-**e**ne* 'fault-COND', *véd-**e**ne* 'protect-COND). The unstable paradigmatic position of these exceptional forms is a potential precursor of the later vacillation in the recent form of the language (*tát-(a)nak* '-INDF.3PL', *véd-(e)tek* '-INDF.2PL', *bocsát-(a)lak* 'forgive-2<1SG' etc.), this is shown in (20c).

(20) Demonstration of diachronic trajectories: emerging the quasi-analytic suffixes



4. Conclusion

We have pointed out how the evolution of variation and irregularity can be dealt with in a minimalistic model of the paradigmatic system. The synchronically highly complex paradigmatic patterns cannot or can hardly be explained by a traditional macro-level analysis that utilizes a high number of stem and suffix classes and their triggering factors. The micro-level analysis that invokes direct connections (analogies) between sets of forms is able to explain why and how these complex gradual patterns emerge from simpler phonologically motivated patterns via diachronic trajectories. The key concept is the proximity (adjacency) of sets of forms (generalized paradigm cells) which is defined by their similarity. The adjacency relation between paradigm cells defines the stability status of a particular cell: forms in unstable cells tend to show variation and in this way they are subject to potential diachronic change. This change can result in an intricate pattern of paradigmatic organization.

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List of abbreviations

nominal paradigm:

SG	singular (always zero)
PL	plural
POSS.2PL	possessive (possessor: 2nd plural)
NOM	nominative case (always zero)
SUP	superessive case
DAT	dative case
ALL	allative case
ABL	ablative case
ACC	accusative case
ADJZ	adjectivizer (denominal adjective-forming suffix)
VRBZ	verbalizer (denominal verb-forming suffix)
ADVZ	adverbializer (deadjectival/denumeral adverb-forming suffix)
CMPR	comparative

verbal paradigm:

PST	past tense
COND	conditional mood
SBJV	subjunctive/imperative mood
INDF	indefinite (object is not definite)
DEF	definite (object is definite)
POT	potential
ADV.PTCP	adverbial participle (converb)
INF	infinitive

suffix classes:

PST	basic past
PST+	suffixed past
AGR	agreement suffixes (person/number/definiteness)
T/M	tense/mood suffixes
Q	quasi-analytic suffixes
A	analytic suffixes

stem classes (by the last segment of the stem):

C	consonants
V	vowels
R	coronal sonorants (included palatals): *j r l n ny*
T	alveolar plosives: *t d*