

Allomorphy

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Morphemes Can Have More than One Realization

In English, there is a morpheme `HOP`, meaning, roughly, ‘jump like a rabbit’. There are two ways of spelling hop:

- (1) a. Peter was afraid to **hop** past Mr. McGregor’s gate.
- b. Peter **hops** past Mr. MacGregor’s gate.
- c. Peter **hopped** past Mr. MacGregor’s gate.
- d. Peter is **hopping** past Mr. MacGregor’s gate.

When `HOP` occurs before the past tense suffix *-ed* or the present participle suffix *-ing* it is realized as *hopp*, but it is realized as *hop* elsewhere.

This is an example of what is called allomorphy—the state of affairs when a single morpheme has more than one realization. The realization can be in terms of spelling. It can also be in terms of pronunciation or (in a sign language) in the motor or visual representation of the morpheme.

The basic definition of allomorphy:

- (2) a. The signified remains constant
- b. The signifier varies
- c. The distribution of the various signifiers is predictable

The various signifiers are called `ALLOMORPHS`. The *hopp* allomorph occurs before a suffix that starts with a vowel. The *hop* allomorph occurs in all other situations (elsewhere).

Phonologically-Conditioned Allomorphy

The best studied type of allomorphy is that in which the `ENVIRONMENTS`¹ that determine which allomorph will surface are based on sound. Since we have not dealt with phonology yet, we will use spelling as a proxy for pronunciation (even though these two things—phonology and orthography—are rather different beasts).

Examples from English

A classic example of allomorphy is presented by the English plural suffix:

Sometimes the plural is written as *-s*. More rarely, it is written as *-es*. Whether one writes *-s* or *-es* is perfectly predictable: When the plural suffix follows *ch*, *sh*, *s*, or *z*, one writes *-es*. Otherwise, one writes *-s*, as seen in Table 1.

One can express this pattern of allomorphy as a rule:

This is true of spelling (orthography) but not pronunciation. *hopped* is pronounced /hapt/, with no vowel before the suffix.

This is an application of a principle, first known from the Sanskrit grammarian Pāṇini, which is sometimes called the `ELSEWHERE PRINCIPLE`. It holds that grammatical rules act like case statements in programming languages, with the most specific cases given priority, more general cases following, and a fallback case (the elsewhere case) applying when none of the other cases do.

¹ Linguists call general contexts `ENVIRONMENTS`.

| | | | |
|------|-------|-------|--------|
| kit | kits | kiss | kisses |
| kid | kids | buzz | buzzes |
| pick | picks | pitch | itches |
| bud | buds | bus | buses |
| puff | puffs | | |
| fin | fins | | |
| jam | jams | | |
| path | paths | | |
| pill | pills | | |
| fear | fears | | |

Table 1: Orthographic allomorphs of the English plural suffix.

1. Start by adding the suffix *s*. We'll call *s* the **UNDERLYING FORM** of the morpheme.
2. Apply a rule that adds an *e* between any sequence of *s*, *z*, *sh*, or *ch* and an *s* (at the end of a word).

For those who are familiar with Python regular expression syntax, the rewrite rule could be expressed with the following function:

```
import re

def e_insertion(form: str) -> str:
    return re.sub("(ch|sh|s|z|)(s)$", "\1e\2", form)
```

Figure 1: A Python implementation of the English *e*-insertion rule.

Applying this to the underlying form of the word (the concatenation of the underlying forms of both morphemes) sometimes results in a change and sometimes does not. When there is a change, our plural morpheme looks like *-es* (or, at least, we have an *e* before the final *s*).

The same function can be applied to all words. It will only insert *e* in cases where the *-es* allomorph is expected. Or almost.

What about words like *pass*? If we pass *pass* to our `e_insertion` function, we get *pases*, which is not what we want. We need some way of saying that our rule only applies at morpheme boundaries (not in the middle of morphemes like *pass*). Let us say that rather than concatenating the underlying forms of morphemes to get the underlying form of the word that we join them with `^`, indicating a morpheme boundary, and that we delete all of the `^` symbols when we are done with them. We can then revise our function to be:

This rule will apply to *pass^s* (yielding *pass^es*), but will not apply to *pass*. It raises an important point: some rules of allomorphy are sensitive to morphological structure. Indeed, some apply only to certain morphemes.

```
import re

def e_insertion(form: str) -> str:
    return re.sub("(ch|sh|s|z|)[^](s)$", "\\1^e\\2", form)
```

Figure 2: A revised Python implementation of the English e-insertion rule.

Examples from Turkish

| | | | |
|--------|--------|---------|------------|
| inek | ‘cow’ | ineği | ‘his cow’ |
| kuyruk | ‘tail’ | kuyruğu | ‘its tail’ |
| köpük | ‘foam’ | köpüğü | ‘its foam’ |
| yatak | ‘bed’ | yatağı | ‘its bed’ |

Table 2: Turkish k/ğ alternation

| | ‘hand’ | ‘köy’ | ‘oda’ | ‘korku’ |
|------------|--------|--------|--------|----------|
| unmarked | el | köy | oda | korku |
| accusative | eli | köyü | odayı | korkuyu |
| genitive | elin | köyün | odanın | korkunun |
| dative | ele | köye | odaya | korkuya |
| locative | elde | köyde | odada | korkuda |
| ablative | elden | köyden | odadan | korkudan |

Table 3: Turkish vowel harmony

Examples from Zongozotla Totonac

Consider the forms of the verb *taftúh* ‘leave’ listed in Table 4. The roots are shown in violet. There are three different forms:

- taftúh
- taftí
- tafta

The /h/ is only present when the root is at the end of the word. The allomorph with /i/ occurs before prefixes beginning in /y/. The allomorph /tafta/ occurs before prefixes beginning with /q/. As will become more clear when we talk about phonetics and phonology, this makes a lot of sense. These probably are an example of phonologically conditioned allomorphy. A less-clear case is the past tense prefix */ja/*. *ja* occurs in first person exclusive (1SG and 1PL.EXCL) forms. This could be phonologically conditioned (an /a/ is inserted to prevent a sequence of three consonants in a row from surfacing) or it could be morphologically conditioned (it occurs just in [+me, –you] verbs).

| 'leave' | Present | Past | Future |
|----------|---------------|-----------------|------------------|
| 1SG | k-taftúh | fa-k-taftúh | na-k-taftúh |
| 2SG | taftí-ya' | f-taftí-ya' | na-taftí-ya' |
| 3SG | taftúh | f-taftúh | na-taftúh |
| 1PL.EXCL | k-tafti-yá'w | fa-k-tafti-yá'w | na-k-tafti-yá'w |
| 1PL.INCL | tafti-yá'w | f-tafti-yá'w | na-tafti-yá'w |
| 2PL | tafti-yá:'tit | f-tafti-yá:'tit | na-tafti-yá:'tit |
| 3PL | tafta-qó:y | f-tafta-qó:y | na-tafta-qó:y |

Table 4: Some person and number inflections of Totonac *taftúh* 'leave'.

Other Examples

| | | | | |
|------|---|-------|----------|-------------|
| meng | + | urus | mengurus | 'take care' |
| meng | + | tulis | menulis | 'write' |
| meng | + | kirim | mengirim | 'send' |
| meng | + | pakai | memakai | 'use' |
| meng | + | sewa | menyewa | 'rent' |

Table 5: Nasal substitution in Indonesian

Suppletive Allomorphy

Consider the verb *go* in English. Its past form is *went*. There is no plausible phonological rule by which these two word forms can be derived from the same basic form. This is called **SUPPLETION** or **SUPPLETIVE ALLOMORPHY**. Other examples in English include *good*, *better*, and *best*. These are all forms of the same word, but they derive from different basic forms. This is most clear for *good*, but there is also no general rule by which *better* and *best* can be derived from the same basic form.

Morphologically Conditioned Allomorphy

Sometimes, there are different versions of a morpheme depending on the "class" of the word (like what are called declensions of nouns and conjugations of verbs). Other times, there are different versions of a morpheme depending what other morphemes (and what other inflectional or derivational meanings) occur in a word. Consider the forms of the Totonac verb *paf* 'swim' shown in Table 6. The past suffix is *-lh* except in the second person singular, where we have *-t*. To complicate things, in the second person singular, we have *-a'* except in the past, where we have *-t*. It appears that *-t* represents singular and second person and past and that this version of the person morpheme and the tense morpheme surfaces when the word has all three features

| ‘swim’ | Present | Past | Future |
|--------|---------|----------|-----------|
| 1SG | k-paʃ | k-paʃ-lh | na-k-páʃ |
| 2SG | páʃ-aʔ | paʃ-t | na-páʃ-aʔ |
| 3SG | paʃ | paʃ-lh | na-páʃ |

Table 6: Some singular forms of Totonac *paʃ* ‘swim’

(second person, singular number, and past tense) but the other allomorphs of the two morphemes surface elsewhere.

Implications for Tokenization

All widely used tokenization schemes treat different allomorphs of the same morpheme as different vocabulary items. This is suboptimal, especially for less common morphemes, since embeddings of each of the separate types are likely to be less informative than the embedding of a type that subsumes all of them. Take the case of one of the two negative prefixes in English:

- | | |
|-------------------|---------------------|
| (3) a. imbalanced | i. infinite |
| b. impatient | (5) a. illegal |
| c. impenetrable | b. illiberal |
| d. imponderable | c. illogical |
| e. immortal | d. illimitable |
| f. immoral | e. illegible |
| (4) a. inordinate | (6) a. irreversible |
| b. inapplicable | b. irrevocable |
| c. indecipherable | c. irresistible |
| d. indissoluble | d. irreproachable |
| e. intangible | e. irreconcilable |
| f. interminable | f. irreligious |
| g. inseparable | g. irrational |
| h. insecure | h. irregular |

We could learn representations for *im-*, *in-*, *il-*, and *ir-* separately. However, the number of actual examples in our training data will be, in the final analysis, not that large. As a result, the embeddings may, given the vagaries of small numbers, end up being quite different from one another. A tokenization scheme in which allomorphy was factored out would have the advantage of reducing sparsity and increasing generality.

If, on formal grounds, it can be known that two units, *A* and *B* realize one morpheme *M* (in different context), *A* and *B* should be given the same representation.

References