

## Morphology

Morphology is the area of linguistics which studies the structure of words.

Almost all natural language applications require some processing of words: lexicon lookup, morphological analysis and generation, part-of-speech determination etc.

In order to implement such function, it is necessary to understand which morphological process take place in a variety of languages.

Why look at many languages?

## עניבורד שפוחט טבעיות

שולף וינטונר

### Example

הם **דברו** כל הלילה

Observations:

- **לדבר** is third person, plural, past form of the verb **דבר**
- this form is obtained by concatenating the suffix **ו** [u] to the base **דבר** [dibber]
- in the inflected form **דברו**, the vowel [e] of the base [dibber] is reduced to a schwa. This reduction is mandatory, as [dibberu] is ungrammatical.

### Example

These simple observations shed light on a variety of issues:

- What information is encoded by morphology?  
In the example, morphology encodes details such as person, number and tense.
- How morphology encodes information?  
In the example, the final form is obtained by concatenating an affix (which is not a word) to the end of a base (which might be a word).
- Interaction of morphology and phonology  
In the example, the vowel [e] is shortened to a schwa.

## Structure of this part of the course

- Typology of languages
- Inflection and derivation
- What information is encoded by morphology
- How morphology encodes information
  - concatenation, infixation, circumfixation, root and pattern, reduplication
- Interaction of morphology and phonology

## Isolating languages

No bound forms. Example: Mandarin Chinese

gǒu bú ài chī qīngcài

*dog not like eat vegetable*

Can mean any of the following (inter alia):

- the dog doesn't like to eat vegetables
- the dog didn't like to eat vegetables
- the dogs don't like to eat vegetables
- the dogs didn't like to eat vegetables
- dogs don't like to eat vegetables

## Typology of languages

**Isolating** : no bound forms. Example: Mandarin Chinese

**Agglutinative** : bound forms occur and are arranged in the word like beads on a string

Example: Turkish

**Polysynthetic** : elements that often occur as separate words in other languages (such as arguments of the verb) are expressed morphologically. Example: Yupik (central Alaska)

**Inflectional** : distinct features are merged into a single bound form. Example: Latin

## Agglutinative languages

Beads on a string. Example: Turkish

çöplüklerimizdekiledenmiydi

çöp lük ler imiz de ki ler den mi y di

*garbage Aff Pl Ip/Pl Loc Rel Pl Abl Int Aux Past*

"was it from those that were in our garbage cans?"

“המשפחה שלנו?”

## Polysynthetic languages

Morphology encodes units that are usually considered syntactic (as in noun incorporation). Example: Yupik

qayá:liy'u:i'u:n'i

qayá: li y'u: i'u: n'i

kayaks make excellent he Past

"he was excellent at making kayaks"

"The grammar is in the morphology"

## Inflections and derivations

*Inflectional* morphology takes as input a word and outputs a form of the same word appropriate to a particular context.

Example: [dibber] ⇒ [dibbru]

The output is appropriate to a context in which the subject is third person plural and the tense is past.

Hence: words have *paradigms*, defining all possible inflected forms of a word. Words which belong to the same paradigm are all *inflected forms* of a single *morpheme*.

## Inflectional languages

Portmanteau morphemes: a single morpheme can encode various bits of information. Example: Latin

amó

am ó

love 1p/Sg/Pres/Indicative/Active

## Inflections and derivations

*Derivational* morphology takes as input a word and outputs a different word that is derived from the input. This is also called *word formation*.

Example: establish+ment+ary+an+ism

Example: התלמיט → התלטה → התלטי → התלטינות

## Inflections and derivations - distinctive criteria

- Inflection does not change the part-of-speech, derivation might.

התלטה – התלעות; התלטה – התלטי

- Inflection is sometimes required by the syntax, derivation never is.

- If a language marks an inflectional category, it marks it on all appropriate words. In other words, the relation denoted by inflectional morphology is *productive*.

התלטי	–	התלטה	התלעות	–	התלטה
התלטי*	–	התלטה	התלעות	–	התלטה

## Verbal morphology

Verbs are commonly marked with indications of the time at which the situations denoted by them occurred, or the state of completion of the situation. Such markers encode *tense* and *aspect*, respectively.

Example: Latin

vir Cicerōnem laudābō

man Cicero praise/3/Sg/Future/Ind

“the man will praise Cicero”

vir Cicerōnem laudāvīt

man Cicero praise/3/Sg/Perf/Ind

“the man has praised Cicero”

## Verbal morphology

Verbs specify the number (and type) of arguments they may take. In many languages, morphological devices modify these lexically specified markings.

Example: passivization (Latin)

puer Cicerōnem laudat

boy Cicero praise/3/Sg/Pres/Ind/Act

“the boy praises Cicero”

Cicerōnem laudātur

Cicero praise/3/Sg/Pres/Ind/Pass

“Cicero is praised”

Example: causativization

נפל ← הפיל; נסע ← הסיע

## Verbal morphology

In many languages the verb must *agree* on person, number, gender or other features with one or more of its arguments.

Example:

The princess kisses the frog

\*The princess kiss the frog

הם דברו כל הלילה

\*הם דברו כל הלילה

In some languages (e.g., Georgian and Chichewâ) verbs agree not only with their subjects but also with their objects.

## Nominal morphology

Inflectional categories for nouns (and adjectives) include

- number (singular, plural, dual)
- case (marking various kinds of semantic function)
- gender (feminine, masculine, neuter)

Latin has five cases: nominative, genitive, dative, accusative, ablative.

Finnish has fourteen different cases!

Example: the inflection paradigm of the noun *magnus* (big) in Latin.

## Nominal morphology

Many languages distinguish between two or three grammatical genders: feminine, masculine and neuter.

In some languages, such as the Bantu languages, more detailed gender classes exist.

Example: Swahili has inflection affixes for humans, thin objects, paired things, instruments and extended body parts, inter alia.

## The inflection paradigm of Latin *magnus*

	masculine	feminine	neuter
sing.	nom magn+us	magn+a	magn+um
	gen magn+ī	magn+ae	magn+ī
	dat magn+ō	magn+ae	magn+ō
	acc magn+um	magn+am	magn+um
	abl magn+ō	magn+ā	magn+ō
plur.	nom magn+ī	magn+ae	magn+a
	gen magn+ōrum	magn+ārum	magn+ōrum
	dat magn+īs	magn+īs	magn+īs
	acc magn+ōs	magn+ās	magn+a
	abl magn+īs	magn+īs	magn+īs

## Adjectival morphology

Many languages express comparison of adjectives morphologically.

Example: Welsh

gwyn	gwynn+ed	gwynn+ach	gwynn+af
white	as white	whiter	whitest
teg	tec+ed	tec+ach	tec+af
fair	as fair	fairer	fairest

## Derivational morphology

In general, derivational morphology is not as productive as inflectional morphology.

Nominalization: destroy → destruction;

שמר ← שמונה; פירתה ← פירות; הסכים ← הסכם

Deverbal adjectives: drink → drinkable; נול ← נולד

Denominalized adjectives: שולחני ← שולחן

Adjective nominalization: grammatical → grammaticality

נדיר ← נדירות

Negation: able → unable; אלתוטי ← תוטי

## What are morphemes?

In order to know what morphemes are, it is useful to check in what ways they are expressed.

The simplest model of morphology is the situation where a morphologically complex word can be analyzed as a series of morphemes concatenated together.

An example: Turkish. Not only is Turkish morphology exclusively concatenative; in addition, all affixes are suffixes. Turkish words are of the form *stem suffix\**.

çöplüklerimizdekiledenmiydi

çöp lük ler imiz de ki ler den mi y di  
garbage Aff Pl 1p/Pl Loc Rel Pl Abl Int Aux Past

## Compounding

In contrast to derivations and inflections, where affixes are attached to a stem, in compounding two or more lexemes' stems are joint together, forming another lexeme.

Example: policeman; newspaper; בית ספר; יפת עינים

Both lexemes might undergo modification in the process.

In German, the concatenation is expressed in the orthography:

Lebensversicherungsgesellschaftsangestellter

leben s versicherung s gesellschaft s angestellter

life insurance company employee

## What are morphemes?

Linear concatenation is not the only way in which languages put morphemes together. Affixes may also attach as *infixes* inside words.

Example: Bontoc (Philippines)

fikas → f-um+ikas

strong be strong

kilad → k-um+ilad

red be red

fusul → f-um+usul

enemy be an enemy

## What are morphemes?

In the Bontoc case the infix must be placed after the first consonant of the word to which it attaches.

In general, the placement of infixes is governed by prosodic principles.

Example: Ulwa (Nicaragua)

suu+ <b>ki</b> -lu	my dog
suu+ <b>ma</b> -lu	your (Sg) dog
suu+ <b>ka</b> -lu	his/her/its dog
suu+ <b>ni</b> -lu	our (inclusive) dog
suu+ <b>ki+na</b> -lu	our (exclusive) dog
suu+ <b>ma+na</b> -lu	your (Pl) dog
suu+ <b>ka+na</b> -lu	their dog

## What are morphemes?

In contrast to processes of attaching an affix to a stem, there exist also nonsegmental morphological processes. A typical example is the Semitic *root and pattern* morphology.

Example: Hebrew *binyanim*

*\_\_a\_\_a\_\_, ni\_\_a\_\_, i\_\_el\_\_, u\_\_a\_\_, hi\_\_i\_\_, hu\_\_a\_\_, hit\_\_a\_\_e\_\_.*

## What are morphemes?

Some languages exhibit *circumfixes*, affixes which attach discontinuously around a stem.

Example: German participles

säuseln	<b>ge</b> +säusel+ <b>t</b>
brüsten	<b>ge</b> +brüst+ <b>et</b>
täuschen	<b>ge</b> +täusch+ <b>t</b>

## What are morphemes?

Another nonsegmental process is *reduplication*.

Example: Indonesian

orang	→	orang+orang
<i>man</i>		<i>men</i>

Sometimes only part of the word is duplicated, as in Yidin (Australia) plural:

mulari	→	mula+mulari
<i>man</i>		<i>men</i>

gindalba	→	gindal+gindalba
<i>lizard</i>		<i>lizards</i>

## So, what are morphemes?

In its most general definition, a morpheme is an ordered pair  $\langle \text{CAT}, \text{PHON} \rangle$ , where  $\text{CAT}$  is the morphological category expressed by the morpheme (for example, its syntactic and semantic features), and  $\text{PHON}$  represents its phonological form, including the ways in which it is attached to its stem.

Example:

$\langle (\text{Adj} \rightarrow N, \text{"state of"}), ([ut], \text{suffix}) \rangle$       נדיר  $\leftarrow$  נדירות

$\langle (\text{root} \rightarrow V, \text{causative}), (-i\_e) \rangle$       גידל  $\leftarrow$  גידול

## What information should a morphological analyzer produce?

The answer depends on the application:

Sometimes it is sufficient to know that  $\text{דברר}$  is an inflected form of  $\text{לדבר}$ ; sometimes morphological information is needed, either as a list of features ( $\text{דברר}$  is third person, plural, past form of the verb  $\text{לדבר}$ ) or as a structure tree; sometimes it is better to produce a list of phonemes without determining word boundaries.

## What are words, then?

A morpheme is a pairing of syntactic/semantic information with phonological information. In the same way, it is useful to assume that words have dual structures: phonological and morphological. The two structures are not always isomorphic.

It is a fairly traditional observation in morphology that there are really two kinds of words from a structural point of view: phonological words and syntactic words. These two notions specify overlapping but not identical sets of entities. Furthermore, the orthographic word might not correspond to any of these.

## Morphotactics

Morphotactics investigates the constraints imposed on the order in which morphemes are combined.

Various kinds of such constraints are known.

Example:

$\text{טבע} \leftarrow \text{טבעי} \leftarrow \text{טבעיות} \leftarrow \text{על-טבעיות}$

but

$\text{*טבעיות-על; *על-טבעיות}$



## Morphotactics

Types of constraints:

- Constraints on the type of the affix: לַע is a prefix, תּוּ is a suffix
- Syntactic constraints: [l] converts a noun to an adjective; [ut] converts an adjective to a noun
- Other constraints: in English, “Latin” affixes are attached before “native” ones:
 

non+im+partial	non+il+legible
*in+non+partial	*in+non+legible

## Phonology

Orthographic rules often do not correspond to phonological rules.

An orthographic rule that does not correspond to any phonological rule:

city+s → cities (and not \*citys)

bake+ing → baking (and not \*bakeing)

## Phonology

Ideally, the task of a morphological analysis system would be to break the word down to its component morphemes and determine the meaning of the resulting decomposition.

Things are not that simple because of the often quite drastic effects of phonological rules. A great deal of the effort in constructing computational models of morphology is spent on developing techniques for dealing with phonological rules.

Since most computational analyses of morphology assume *written* input, phonological rules are often confused with orthographic ones.

## Phonology

A phonological rule (changing [aʲ] to [i]) is not reflected in the orthography:

divine+ity → divinity

A phonological rule (stress shift) is not reflected in the orthography:

grammátical → grammaticáilty

## Phonology

Examples of phonological rules

English: [n] changes to [m] before a labial consonant:

**impossible; impose; immortal**

Finnish: vowel harmony

NOM	PART	gloss
taivas	taivas+ <b>ta</b>	sky
puhelin	puheli+ <b>ta</b>	telephone
lakeus	lakeus+ <b>ta</b>	plain
syy	syy+ <b>tä</b>	reason
lyhyt	lyhyt+ <b>tä</b>	short
ystävällinen	ystävällinen+ <b>tä</b>	friendly