עיבוד שפות טבעיות

שולי וינטנר

Morphology

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Why look at many languages?

Example

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- דברו is third person, plural, past form of the verb לדבר
- this form is obtained by concatenating the suffix ו [u] to the base דיבר [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.

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  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

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- Inflection and derivation

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

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gǒu	bú	ài	chī	qīngcài
dog	*not*	*like*	*eat*	*vegetable*

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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

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"?המשבפחינו"

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"The grammar is in the morphology"

Inflectional languages

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am ó
love 1p/Sg/Pres/Indicative/Active

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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*.

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הפגנה	–	הפגנות		הפגנה	–	*הפגני

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Example: passivization (Latin)

puer Cicerōnem laudat
*boy Cicero praise/3/Sg/Pres/Ind/**Act***
"the boy praises Cicero"

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*Cicero praise/3/Sg/Pres/Ind/**Pass***
"Cicero is praised"

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Example: causativization נפל ← הפיל; נסע ← הסיע

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vir Cicerōnem laudābō
*man Cicero praise/3/Sg/**Future**/Ind*
"the man will praise Cicero"

vir Cicerōnem laudāvit
*man Cicero praise/3/Sg/**Perf**/Ind*
"the man has praised Cicero"

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∗הם דברה כל הלילה

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

Nominal morphology

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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.

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**

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

Adjectival morphology

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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

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Negation: able → unable; חוטי ← אלחוטי

Compounding

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In German, the concatenation is expressed in the orthography:

lebensversicherungsgesellschaftsangestellter

leben	s versicherung	s gesellschaft	s angestellter
life	*insurance*	*company*	*employee*

What are morphemes?

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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**.

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

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Example: Bontoc (Philippines)

fikas	$\longrightarrow$	f-**um**+ikas
strong		*be strong*

kilad	$\longrightarrow$	k-**um**+ilad
red		*be red*

fusul	$\longrightarrow$	f-**um**+usul
enemy		*be an enemy*

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Example: Ulwa (Nicaragua)

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

What are morphemes?

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

Example: German participles

säuseln	**ge**+säusel+**t**
brüsten	**ge**+brüst+**et**
täuschen	**ge**+täusch+**t**

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?

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orang $\rightarrow$ orang+orang
man *men*

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

mulari $\rightarrow$ mula+mulari
man *men*

gindalba $\rightarrow$ gindal+gindalba
lizard *lizards*

So, what are morphemes?

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

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Example:

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

$\langle (root \rightarrow V, causative), (\_i\_\_e\_) \rangle$ ג.ד.ל ← גידל

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.

What information should a morphological analyzer produce?

The answer depends on the application:

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

Morphotactics

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Various kinds of such constraints are known.

Example:

טבע ← טבעי ← טבעיות ← על-טבעיות

but

*טבעיות-על; *על-טבעותי

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Types of constraints:

- Constraints on the type of the affix: על is a prefix, ות is a suffix
- Syntactic constraints: [i] 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

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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.

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

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

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

city+s $\longrightarrow$ cities (and not $*$citys)

bake+ing $\longrightarrow$ baking (and not $*$bakeing)

Phonology

A phonological rule (changing [a^{j}] to [i]) is not reflected in the orthography:

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grammátical $\longrightarrow$ grammaticálity

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Examples of phonological rules

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impossible; **im**pose; **im**mortal

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Finnish: vowel harmony

NOM	PART	gloss
taivas	taivas+**ta**	sky
puhelin	puheli+**ta**	telephone
lakeus	lakeus+**ta**	plain
syy	syy+**tä**	reason
lyhyt	lyhyt+**tä**	short
ystävällinen	ystävällinen+**tä**	friendly