עייבוד שפוח תביעה
ﺵוליך ריינ ['#
Morphology
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Why look at many languages?
Example

הוא דיבור כל הלילה
Example

הוא דבר כל הלילה

Observations:

• דבר is third person, plural, past form of the verb דבר.
Example

הס דיבור סל הלייה

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• דיבור is third person, plural, past form of the verb דיבור

• this form is obtained by concatenating the suffix ל [u] to the base דיבור [dibber]
Example

הס דיבור כלילה

Observations:

• דיבור is third person, plural, past form of the verb דיבר

• this form is obtained by concatenating the suffix [u] to the base [dibber]

• in the inflected form דיבור, 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:
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- What information is encoded by morphology?

  In the example, morphology encodes details such as person, number and tense.
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• 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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• Typology of languages
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- Typology of languages
- Inflection and derivation
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Isolating: no bound forms. Example: Mandarin Chinese
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**Agglutinative**: bound forms occur and are arranged in the word like beads on a string

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

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gǒu bú ài chī qīngcài

*dog* not *like* *eat* *vegetable*
**Isolating languages**

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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
Agglutinative languages

Beads on a string. Example: Turkish
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çöplüklerimizdekiLEDENMIYDİ
Agglutinative languages

Beads on a string. Example: Turkish

çöplüklerimizdeki ledenmiydi

cöp lük ler imiz de ki ler den mi y di
garbage Aff Pl 1p/Pl Loc Rel Pl Abl Int Aux Past
“was it from those that were in our garbage cans?”
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“המשובחון?”
Polysynthetic languages

Morphology encodes units that are usually considered syntactic (as in noun incorporation). Example: Yupik
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qayá:liy’u:l’u:n’i
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kayaks make excellent he Past

“he was excellent at making kayaks”
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“The grammar is in the morphology”
Inflectional languages

Portmanteau morphemes: a single morpheme can encode various bits of information. Example: Latin
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love 1p/Sg/Pres/Indicative/Active
Inflections and derivations

*Inflectional* morphology takes as input a word and outputs a form of the same word appropriate to a particular context.
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Example: [dibber] ⇒ [dibbru]

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

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Example: \([\text{dibber}] \Rightarrow [\text{dibbru}]\)

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*. 
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*Derivational* morphology takes as input a word and outputs a different word that is derived from the input. This is also called *word formation*.
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Example: establish
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Example: establish + ment
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Example: התלטטל → התלטט
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Example: התכלית → התכלית → התכלית → התכלית
Inflections and derivations - distinctive criteria
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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”
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Example: causativization

נפל ← הפיול; נסע ← הטרע
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.
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Example: Latin

vir Cicerōnem laudābō
\textit{man Cicero praise/3/Sg/Future/Ind}
“the man will praise Cicero”

vir Cicerōnem laudāvit
\textit{man Cicero praise/3/Sg/Perf/Ind}
“the man has praised Cicero”
Verbal morphology

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

The princess kisses the frog

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Verbal morphology

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Example:

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In some languages (e.g., Georgian and Chichewâ) verbs agree not only with their subjects but also with their objects.
Nominal morphology
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.
# The inflection paradigm of Latin *magnus*

<table>
<thead>
<tr>
<th></th>
<th>masculine</th>
<th>feminine</th>
<th>neuter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>sing.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nom</td>
<td>magn+<strong>us</strong></td>
<td>magn+<strong>a</strong></td>
<td>magn+<strong>um</strong></td>
</tr>
<tr>
<td>gen</td>
<td>magn+<strong>ī</strong></td>
<td>magn+ae</td>
<td>magn+<strong>ī</strong></td>
</tr>
<tr>
<td>dat</td>
<td>magn+<strong>ō</strong></td>
<td>magn+ae</td>
<td>magn+<strong>ō</strong></td>
</tr>
<tr>
<td>acc</td>
<td>magn+<strong>um</strong></td>
<td>magn+<strong>am</strong></td>
<td>magn+<strong>um</strong></td>
</tr>
<tr>
<td>abl</td>
<td>magn+<strong>ō</strong></td>
<td>magn+<strong>ā</strong></td>
<td>magn+<strong>ō</strong></td>
</tr>
<tr>
<td><strong>plur.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nom</td>
<td>magn+<strong>ī</strong></td>
<td>magn+ae</td>
<td>magn+<strong>a</strong></td>
</tr>
<tr>
<td>gen</td>
<td>magn+<strong>ōrum</strong></td>
<td>magn+<strong>ārum</strong></td>
<td>magn+<strong>ōrum</strong></td>
</tr>
<tr>
<td>dat</td>
<td>magn+<strong>īs</strong></td>
<td>magn+<strong>īs</strong></td>
<td>magn+<strong>īs</strong></td>
</tr>
<tr>
<td>acc</td>
<td>magn+<strong>ōs</strong></td>
<td>magn+<strong>ās</strong></td>
<td>magn+<strong>a</strong></td>
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<td>magn+<strong>īs</strong></td>
<td>magn+<strong>īs</strong></td>
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Many languages distinguish between two or three grammatical genders: feminine, masculine and neuter.

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

Many languages express comparison of adjectives morphologically.
Adjectival morphology

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Example: Welsh

<table>
<thead>
<tr>
<th>gwyn</th>
<th>gwynn+ed</th>
<th>gwynn+ach</th>
<th>gwynn+af</th>
</tr>
</thead>
<tbody>
<tr>
<td>white</td>
<td>as white</td>
<td>whiter</td>
<td>whitest</td>
</tr>
<tr>
<td>teg</td>
<td>tec+ed</td>
<td>tec+ach</td>
<td>tec+af</td>
</tr>
<tr>
<td>fair</td>
<td>as fair</td>
<td>fairer</td>
<td>fairest</td>
</tr>
</tbody>
</table>
Derivational morphology
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In general, derivational morphology is not as productive as inflectional morphology.
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Nominalization: destroy → destruction;

שמד ← שמידה; פדה ← פדה; הסיס ← הסיס
Derivational morphology

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Nominalization: destroy $\rightarrow$ destruction;

עומר ← שמייה; פייה ← פיהות; הסיס ← הסיס

Deverbal adjectives: drink $\rightarrow$ drinkable; וול ← וניל
Derivational morphology

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Nominalization: destroy → destruction;

Nominalization:

Deverbal adjectives: drink → drinkable;

Denominalized adjectives:
Derivational morphology

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שמד ← שמידה; פידה ← פידה;つの ← のの

Deverbal adjectives: drink → drinkable;

נמל ← נמי

Denominalized adjectives: שלחתי← שלחתי

Adjective nominalization: grammatical → grammaticality

נדיר ← נדירים
Derivational morphology

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

Nominalization: destroy → destruction;

שמד ← שמוד; פיהת ← פיהת; הסים ← הסים

Deverbal adjectives: drink → drinkable;

נל ← ניל

Denominalized adjectives: שולח ← שולחני

Adjective nominalization: grammatical → grammaticality

נדיר ← נדירות

Negation: able → unable;

 possui ← possuiי
Compounding
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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.
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Example: policeman; newspaper; יִפְט עַינָיו

Both lexemes might undergo modification in the process.
Compounding

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Example: policeman; newspaper; יומת עיתון

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?
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.
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

cöp  lük  ler  imiz  de  ki  ler  den  mi  y  di
garbage Aff  Pl  1p/Pl  Loc  Rel  Pl  Abl  Int  Aux  Past
What are morphemes?

Linear concatenation is not the only way in which languages put morphemes together. Affixes may also attach as *infixes* inside words.
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Example: Bontoc (Philippines)

- *fikas* → *f-um+i kas*
  - 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.
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In general, the placement of infixes is governed by prosodic principles.

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?

Another nonsegmental process is *reduplication*.

Example: Indonesian

orang → orang+orang

*man*       *men*
What are morphemes?

Another non-segmental process is *reduplication*.

Example: Indonesian

orang → orang+orang

*man* → *men*

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

mulari → mula+mulari

*man* → *men*

gindalba → gindal+gindalba

*lizard* → *lizards*
So, what are morphemes?

In its most general definition, a morpheme is an ordered pair \((\text{CAT}, \text{PHON})\), 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.
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Example:

\[
\langle (\text{Adj} \rightarrow \text{N}, \text{“state of”}), ([\text{ut}], \text{suffix}) \rangle \\
\langle (\text{root} \rightarrow \text{V}, \text{causative}), (\_\text{i}\_\text{e}\_\text{e}_\_\text{)} \rangle
\]
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 דבר is an inflected form of לדבר; sometimes morphological information is needed, either as a list of features (דבר 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

Morphotactics investigates the constraints imposed on the order in which morphemes are combined.
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Various kinds of such constraints are known.

Example:

טבוע ← טבעי ← טבוועות ← על-טבוועות

but

*טבועות-על; *על-טבוועי
Morphotactics

Types of constraints:
Morphotactics

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• Constraints on the type of the affix: על is a prefix, ו is a suffix
Morphotactics

Types of constraints:

- **Constraints on the type of the affix:** ֻל is a prefix, ָות is a suffix

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Morphotactics

Types of constraints:

- **Constraints on the type of the affix:** על is a prefix, وت 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
Phonology
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Phonology

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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.
Phonology

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

Orthographic rules often do not correspond to phonological rules.

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

A phonological rule (changing $a^j$ to $i$) is not reflected in the orthography:

divine+ity $\rightarrow$ divinity
Phonology

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

divine+ity → divinity

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

grammátical → grammaticálity
Phonology

Examples of phonological rules
Phonology

Examples of phonological rules

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

impossible; impose; immortal
**Phonology**

Examples of phonological rules

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

impossible; impose; immortal

**Finnish:** vowel harmony

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