Linguistics 220
Phonology: rules, features, and syllables

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Foundations in phonology

- Outline
- Intuitions about phonological structure
- Contrastive vs predictable distributions
- The phoneme and conditional allophones
- A formal model: two levels

- > Natural classes captured by features
- Rule formulations
- Rule interaction
- The syllable
Natural classes, some examples

**Allomorphy: cat[s] vs. dog[z]**
The plural allomorphs [-s] and [-z] are predictable: [-s] occurs after stems that in a *voiceless sound*, [-z] occurs elsewhere.

**Phonetics: bit vs bid** (vowel of *bid* is much longer)
Vowel sounds are shorter before the natural class of voiceless stops, i.e., /p t k/.

**Phonology: *[tlip]*
Two coronal stops in a row are not allowed.

**Goal:** we need a toolbox for capturing natural classes.
Phonological features

**Assumption:** consonant and vowel sounds are not unanalyzed wholes; rather they are units of sound that are composed of a set of feature specifications.

**Illustration:**
“t” (voiceless coronal stop) is really:

\[ [+\text{voice}, \text{CORONAL}, -\text{continuant}, -\text{sonorant} ...] \]

“i” (i.e., a high front tense vowel) is really:

\[ [\text{DORSAL, +high, -low, +tense, -back}] \]

“voiced obstruents” is really:

\[ [+\text{voice}, -\text{sonorant}] \]

**Up-shot:** by representing Cs and Vs as feature specifications, we can elegantly express phonological generalizations that refer to natural classes.
Features, some technical stuff

**Feature values:**

*binary* features: specified either ‘+’ = have an attribute, or ‘-’ = lack the attribute.

Example: [± voice], [+voice] sounds are voiced, [-voice] sounds are voiceless

*monovalent* features: only have one value. These are written with upper case features in the textbook.

Example: [CORONAL] sounds involve the tongue tip or blade; there is no way to refer to sounds that don’t have this property (and that’s a good thing).

**Feature theory:**

It is important to understand that a set of phonological features is a predictive theory of possible and impossible phonological processes. Features capture natural classes, so it’s only possible to state a rule in terms of the groupings of sounds that the features predict. We review here the theory proposed by the textbook.

**Illustration:** the fact that [CORONAL] is monovalent means that no rule of phonological can refer to the set of ‘non-coronal’ consonants, e.g., labials, velars, and glottals.
**Motivation:** pick out the natural classes of consonants (cf. vowels), obstruents (stops, fricatives, and affricates), and sonorants (nasals, liquids, glides, and vowels).

[± consonantal]: [+consonant] sounds are produced with a major obstruction in the vocal tract; [-consonant] sounds lack this obstruction, i.e., glides, vowels and glottals (obstruction not in vocal tract).

[± syllabic]: [+syllabic] sounds can act as syllable peaks; all other sounds are [-syllabic]

[± sonorant]: [+sonorant] sounds are ‘singable’, i.e., vowels, glides, liquids, nasals; [-sonorants] or ‘obstruents’ include stops, fricatives, and affricates.
Exercise: Russian devoicing

Some facts
sled-a  slet  'track (gen./nom.sg.)'  
knig-a  knik  'book (nom.sg./gen.pl.)'
raz-a  ras  'occasion (gen./nom.sg.)'
gub-a  gup  'lip (nom.sg./gen.pl.)'

Observation: a subset of Russian consonants are devoiced word-finally.

Task: place all the consonants in the words above in a consonant chart (next slide). Then circle the consonants that are devoiced.

Questions: what is the natural class of sounds that are devoiced? Which manner feature to you need to predict these sounds?
Consonant chart
Manner features

**Motivation:** characterize natural classes involving manner of articulation

[± **continuant**]: [+continuant] sounds have (nearly) free airflow through the center of the oral cavity; [-continuant] sounds, i.e., nasal and oral stops, lack this airflow.

[± **delayed release**]: [+delayed release] is for affricates because they have a slower release of the stop closure than other stops.

[± **nasal**]: [+nasal] sounds have a lowered velum, and so have nasal airflow; [-nasal] features have a raised velum.

[± **lateral**]: [+lateral] sounds have lateral airflow, so it picks out the class of [l] sounds.
**Exercise: Turkish devoicing**

**Observation:** in Turkish, certain consonants are devoiced in syllable final position (before the ‘.’ in plural), and others are not.

**Task:** put all the consonants of the words below in a consonant chart (next slide), and circle ones that are devoiced. What phonological feature is needed to predict this natural class?

<table>
<thead>
<tr>
<th>Lexical form</th>
<th>Objective</th>
<th>Plural</th>
</tr>
</thead>
</table>
| ip           | ipi       | ip.ler  | ‘rope’  
| dib          | dibi      | dip.ler | ‘bottom’ 
| at           | atɯ       | at.lar  | ‘horse’  
| ad           | adɯ       | at.lar  | ‘name’   
| gög          | gögi      | gök.ler | ‘sky’    
| dif          | difi      | dif.ler | ‘tooth’  
| kɯz          | kɯzɯ     | kɯz.lar | ‘daughter’ 
| deniz        | denizi    | deniz.ler | ‘sea’     
| aːdʒ          | aːdʒɯ     | aːtʃ.lar | ‘tree’     


Consonant chart
Laryngeal features

**Motivation**: characterize natural classes involving laryngeal activity.

[±voice]: [+voice] sounds are voiced, [-voice] sounds lack voicing.

[±spread glottis]: [+spread glottis] sounds are all aspirated consonants; [-s.g.] are the complement set of sounds.

[±constricted glottis]: [+constricted glottis] sounds involve a closed glottis, like the glottal stop.
Exercise: preglottalized stops

**Observation:** voiceless stops are ‘preglottalized’ syllable-finally; there is a quick glottal closure before the closure in the vocal tract for the stop. In some cases, like the variant form for *knick knacks*, the stop actually becomes a glottal stop.

• pɪʔktə or pɪʔʃə ‘picture’
• nɪʔk naʔks or nɪʔ naʔks ‘knick knacks’
• kɪʔp ‘Kip’

• **Questions:** which of the laryngeal features best characterizes the output of this process? And what features can pin-point the input to the process?
Place features

**Motivation**: characterize natural classes having to do with place of articulation

**[LABIAL]**: [LABIAL] sounds involve one or both of the lips.

**Dependent features**: features that are dependent on other monovalent features, i.e., features that are only specified if another feature is present. Dependent features are only relevant for Place features, and they further refine the action of a particular articulator.

**Example**: [±round] is dependent on [LABIAL], [+round] sounds have protruded lips.
Place, cont’d

[CORONAL]: any sound with a raised tongue tip or blade (first 4 cm of tongue).

Features dependent on [CORONAL]:

[± anterior]: [+anterior] are in the front of the alveopalatal region, i.e., interdentals, alveolars; [-anterior] are at or behind the alveopalatal region, i.e., palatals and alveopalatal.

[± strident]: [+strident] coronal fricatives that have a high-pitched noisy sound, including /s z ʒ ʃ dʒ/, other coronals are [-strident]
Exercise: Bengali assimilation

**Task:** /r/ assimilates to the follow consonant by becoming a copy of it if that consonant is in a particular natural class. What is that natural class and what phonological feature captures it? (/t/ is a retroflex coronal.)

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>barʃa</td>
<td>baʃʃa</td>
<td>‘rainy season’</td>
</tr>
<tr>
<td>miʈʰur ʃari</td>
<td>miʈʰuʃ ʃari</td>
<td>‘Mithu’s sari’</td>
</tr>
<tr>
<td>ramer bari</td>
<td>ramer bari</td>
<td>‘Ram’s house’</td>
</tr>
<tr>
<td>ramer ṭaka</td>
<td>rameṭ ṭaka</td>
<td>‘Ram’s money’</td>
</tr>
<tr>
<td>fonkorbo</td>
<td>fonkorbo</td>
<td>‘will telephone’</td>
</tr>
<tr>
<td>ʃundor dɔrdʒa</td>
<td>ʃundod dɔddʒa</td>
<td>‘beautiful door’</td>
</tr>
<tr>
<td>bɔrdi</td>
<td>bɔddi</td>
<td>‘elder sister’</td>
</tr>
<tr>
<td>bʱorti</td>
<td>bʱotti</td>
<td>‘full’</td>
</tr>
<tr>
<td>korlo</td>
<td>kollo</td>
<td>‘do-3rd future’</td>
</tr>
<tr>
<td>matʃʰer naːk</td>
<td>matʃʰen naːk</td>
<td>‘fish’s nose’</td>
</tr>
<tr>
<td>matʃʰer matʰa</td>
<td>matʃʰer matʰa</td>
<td>‘fish’s head’</td>
</tr>
</tbody>
</table>
Consonant chart
[**DORSAL**]: all sounds using the tongue dorsum or back of the tongue.

**Features dependent on [DORSAL]**

[±**high**]: [+high] sounds are consonants and vowels with the tongue body raised from a central position in the oral cavity.

[±**low**]: [+low] sounds are vowel sounds lowered from a central position in the oral cavity.

[±**back**]: [+back] sounds are consonants and vowels with the tongue body behind the palatal region of the oral tract; [-back] for front vowels.

[±**tense**]: [+tense] is for tense (peripheral, more constricted) vowels, [-tense] for lax vowels.

[±**reduced**]: [+reduced] vowels have undergone vowel reduced and are shorter in duration, e.g., schwa.
Exercise: Corsican vowels

Task: only some vowels are nasalized (shown in capitals) before a nasal segment in the same syllable. What is the natural class of vowels that gets nasalized, and what feature pin-points it.

<table>
<thead>
<tr>
<th>Word</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>printʃipe</td>
<td>‘prince’</td>
</tr>
<tr>
<td>Aŋku</td>
<td>‘also’</td>
</tr>
<tr>
<td>pOnte</td>
<td>‘bridge’</td>
</tr>
<tr>
<td>fuŋgu</td>
<td>‘mushroom’</td>
</tr>
<tr>
<td>kOntu</td>
<td>‘account’</td>
</tr>
<tr>
<td>fundamEntu</td>
<td>‘foundation’</td>
</tr>
</tbody>
</table>
Vowel chart
Feature charts

No memorization
The goal of this class isn’t to make you memorize a bunch of feature specifications. Rather, to provide a toolbox for doing linguistic analysis.

Feature charts, p. 89, 90
You can use the charts on p. 89 (consonants) and p. 90 (vowels) in all your exercises and the final exam. You will be given a copy of this chart in the exam. The key is learning how to use it productively.
Putting features in rules

Standard format for phonological rules:

\[ A \rightarrow B / X___Y \]  ‘A goes to B when in X___Y’

A, B, X and Y can be either nothing (Ø) or a bundle of features.
Deletion: \[ A \rightarrow \emptyset / X___Y \], ‘A gets deleted in environment X___Y’
Insertion: \[ \emptyset \rightarrow B \ldots \]

‘#’ = the word boundary, e.g., __# reads ‘word-final’

Tips:
-try to use as few features as possible (more general)
-don’t repeat features from A in B.
Exercise

Rewrite the rules below using this rule format.

**Russian devoicing**: word-final obstruents are devoiced.

**Turkish devoicing**: syllable final stops are devoiced.

**English preglottalization**: syllable final voiceless stops are preglottalized (assume this is just glottalized, and the phonetics will work out the timing details).

**Corsican nasalization**: non-high vowels become nasalized when right before a nasal in the same syllable.
Extended exercise: two rules in Polish

Task: isolate the alternation in the allomorphs below, state the apparent generalization, and propose a rule to account for it. Finally, is the opposite rule possible?

Data, part I

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>klup</td>
<td>klubi</td>
<td>‘club’</td>
</tr>
<tr>
<td>trup</td>
<td>trupi</td>
<td>‘corpse’</td>
</tr>
<tr>
<td>trut</td>
<td>trudi</td>
<td>‘labor’</td>
</tr>
<tr>
<td>kot</td>
<td>koti</td>
<td>‘cat’</td>
</tr>
</tbody>
</table>
Polish, cont’d

Alternation:

Generalization:

Rule:

Discussion:
**Polish, cont’d**

**Task:** process the following data in the same way, and isolate a new alternation.

**Data, part II**

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>lut</td>
<td>lodi</td>
<td>‘ice’</td>
</tr>
<tr>
<td>trut</td>
<td>trudi</td>
<td>‘labor’</td>
</tr>
<tr>
<td>nos</td>
<td>nosi</td>
<td>‘nose’</td>
</tr>
<tr>
<td>wuk</td>
<td>wugi</td>
<td>‘lye’</td>
</tr>
<tr>
<td>ruk</td>
<td>rogi</td>
<td>‘horn’</td>
</tr>
<tr>
<td>snop</td>
<td>snopi</td>
<td>‘sheaf’</td>
</tr>
</tbody>
</table>
Polish, cont’d

Alternations:

Problem: it’s not possible to predict the distribution of the back vowels from surface forms.

Task: show this by listing the phonetic environments for /o/ \(\rightarrow [u]\) (plural to singular) and /u/ \(\rightarrow [o]\) (singular to plural)
Polish, cont’d

**Assumption:** the input of a rule can refer to phonological structure that is not present at the surface, but nonetheless present at some point in the life of a form.

**Task:** undo the effects of Devoicing in the words below, and look for a generalization.

Before devoicing:

Output:  | lut | trut | wuk | ruk | nos
---|---|---|---|---|---
Plural:  | lodi | trudi | wugi | rogi | nosi
Polish, cont’d

**Generalization:** the mid back vowel raises to its high counterpart before a voiced consonant word-finally.

**Task:** formulate a ‘vowel raising’ rule for the above generalization.
Polish, cont’d

**Task:** illustrate the result of the two rules in the derivations below.

<table>
<thead>
<tr>
<th>Word</th>
<th>‘labor PL’</th>
<th>‘labor SG’</th>
<th>‘ice PL’</th>
<th>‘ice SG’</th>
<th>‘nose SG’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input:</td>
<td>/trud+i/</td>
<td>/trud/</td>
<td>/lod+i/</td>
<td>/lod/</td>
<td>/nos/</td>
</tr>
<tr>
<td><strong>Vowel raising</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Devoicing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Polish, wrap-up**

**Task**: what if devoicing applied before vowel raising? Show this with a different derivation for /lod/.

**Implications**

- Sometimes the description of a phonological system involves considering phonological structures that do not occur in the phonetic representation.
- The adequate analysis of a phonological system sometimes involves considering the interaction of more than one phonological rule.
The stuff of phonology

**Question:** what are the things that constitute phonological representations, and the things referred to by phonological rules?

**Some assumptions**

**Segments:** consonant and vowel structures, the primary undergoers of phonological rules; essential bundles of features

**Features:** segment-internal structure; properties of segments that predict natural classes

**Syllables:** ‘above-segment’ structure that gives the natural groupings of segments.
Evidence for syllables?

**Necessary to characterization of phonological rules:** syllables allow rules to state generalizations more insightfully

**Universal trends:** organizing consonants and vowels into syllables enables linguists to relate generalizations across languages

**Possible words:** the analysis of possible and impossible words can be approached as impossible/possible syllables
The anatomy of a syllable

- Onset (o)
  - INITIAL SYLLABLE
  - Onset (o)
  - Rhyme (R)
  - Nucleus (N)
  - Codas

- Rhyme (R)
  - Rhyme (R)
  - Nucleus (N)
  - Codas

- Nucleus (N)
  - Nucleus (N)
  - Codas

- Codas
  - Codas
Building syllables

Step 1. **Nucleus formation**: a nucleus is the core of a syllable, and it is typically built over vowels and sometimes sonorants. The first step in the algorithm is to build a N(ucleus) over each vowel. Each N node projects an R(ime) and σ node.

```
  σ  σ
  |   |
  R   R
  |   |
  N   N
  |   |
  ᵇ k s t r i m
```
Building syllables, cont’d

**Step 2. Onset formation:** the longest *acceptable* sequence of consonants to the left of the N goes in onset position. A sequence of consonants are acceptable in an onset if it is acceptable word-initially (i.e., they obey the phonotactics).

$$\sigma \quad \sigma$$

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>O</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| ε | k | s | t | r | i | m
Building syllables, cont’d

Step 3. Coda formation: any remaining acceptable consonants that are not part of the syllable are in the coda. A sequence of consonants is acceptable in the coda if it occurs word-finally.

\[
\begin{array}{c}
\sigma & \sigma \\
| & / \\
R & O & R \\
| & \backslash & \backslash \\
NC & NC \\
| & | & | \\
\varepsilon & k & s & t & r & i & m
\end{array}
\]
Referring to syllables in rules I

Generalization
Voiceless stops in English are aspirated *syllable initially*

<table>
<thead>
<tr>
<th>Aspirated stops</th>
<th>Unaspirated stops</th>
</tr>
</thead>
</table>
| Syllable-initially, e.g., [pʰæn] ‘pan’ | Elsewhere, i.e. 
  - second position in onset, e.g., [spɪt] ‘spit’  
  - in a coda, e.g., [sɪp] |
Syllables in rules, cont’d

**Task:** consider how to describe the distribution of aspirated stops without the notion of a syllable. Make sure your generalization accounts for the following words.

*Pan, attack, unkind; span, upset; slap, slot*
Phonotactics: legal combinations

**Assumption**: the legal combinations of sounds in a sequence follows from well-formed syllable structures.

**Example**

*blick* is possible because it has well-formed syllable structure

*bnick* is impossible because it cannot be syllabified into well-formed syllables

**Questions**: what are the phonotactics of English, and how does syllable structure account for them?
Phonotactics of clusters

**Task:** examine the legal combinations of stops /b t k/ and some representative sonorants /n l j/. Produce a grid in which all possible combinations allowed word-initially.

\[
\begin{array}{c|ccccccc}
C_1 \setminus C_2 & b & t & k & n & l & j \\
\hline
b & & & & & & \\
t & & & & & & \\
k & & & & & & \\
n & & & & & & \\
l & & & & & & \\
j & & & & & & \\
\end{array}
\]
Observations

- Word-initial clusters never start with a sonorant
- Two stops are never allowed
- Stop + nasal are not allowed
- Stop + liquids are allowed: bl, kl, cf. *tl
- Stop + glides are allowed: bj, kj, cf. *tj

Objective: account for these observations as restrictions on possible syllables.
Analysis in terms of syllables

Assumptions

- All words are composed of syllables, so the beginnings of words must start with the onset of the first syllable.
- Possible clusters word-initially therefore show possible onsets.
- All clusters must be grouped into syllables; if therefore a sequence does not confirm to the rules of well-formed syllables, it will be classified as ungrammatical.

Task: show how these assumptions account for the possibility of *blick* and the impossibility of *bnick*.
Cross-linguistic trends for syllables

**Sonority sequencing**: syllables tend to raise in sonority from onset to nucleus, and fall from nucleus to coda.

**Sonority scale**

- Vowels > glides > liquids > nasals > stops/fricatives

**English phonotactics**

- **Sharp rise**: bl, tr, kj
- **No rise/not enough**: *pk, *nl,*bn,
Cross-linguistic trends, cont’d

Onset maximization: it is better to syllabify a consonant as an onset (if acceptable) than a coda.

English syllabification

V.CCV: attract, acute
V.CV: attack, alley
VC.CV under duress: upset, abnormal
Syllables: take home messages

Constituency: phonological structure is not unlike syntax—it has internal structure too

Syllable-building algorithms: the construction of syllables are predicted by the grammar, just like the construction of sentence or word trees

Generalizations: syllables make it possible to state generalizations about processes, phonotactics, and cross-linguistic trends that would not be possible without the notion of a syllable