Phonological analysis

(1) Three goals of phonological analysis

- What sounds does a language use to build morphemes?
  - Japanese uses both short and long vowels; words can differ just in the length of one of their vowels; English does not have long vowels in this sense
    toro 'take' vs. *tooro* 'pass'
    kado 'corner' vs. *kaado* 'card'
    obasan 'aunt' vs. *obaasan* 'grandmother'
  - English uses the sound [h] (*hat, ahead,* etc.); French and Italian do not.
- What are the allowable combinations of sounds?
  - English uses the sound [h], but not at the ends of words; Farsi has [h] even word-finally: [rah] 'road'
  - English: *blick* is a possible (but non-occurring) word; *bnick* would not be possible (words may not start with [bn])
- How do sounds change depending on what is around them?
  - In American English, the sounds [t] and [d] become a flap [ɾ] in certain contexts
    seat [sit] ∼ *seater* [siɾər] (someone who seats)
    seed [sid] ∼ *seeder* [siɾər] (someone who seeds)

1 What are the sounds of a language?

(2) Review from last week: identifying phonemes by the minimal pairs test

- [kɪl] vs. [gɪl]: changing the voicing of the initial stop changes the meaning of the word
  - Voicing is *contrastive*: changing the voicing of a sound can yield a different sound, used in different words
  - Different sounds = different *phonemes*
- Compare [skɪl] vs. [sk^{h}ɪl]: adding aspiration results in slightly odd pronunciation, but does not change meaning of word
  - More precisely: English could not have a word [sk^{h}ɪl] that requires aspiration
  - Aspiration is *non-contrastive*: changing it yields a different version of the same sound
  - It is, however, systematic: occurs fairly consistently before stressed vowels (unless preceded by [s])

(3) Applying the minimal pairs test

- Among the many, many sounds that English speakers produce at one time or another, how many of these reflect meaningful(contrastive) differences?
- Testing by minimal pairs

Aspiration	[bæk] ∼ [bæk^{h}]	not contrastive
Ejective	[bæk] ∼ [bæk']	not contrastive
Length	[bæk] ∼ [bæk:] (long [k]	not contrastive
Voicing	[bæk] ∼ [bæg]	contrastive

- [k] and [g] are distinct sounds in English; the others may occur in natural speech, but they are not contrastive/distinct

(4) An important point

- In the previous example, the fact that voicing is contrastive was made obvious by the fact that changing [bæk] to [bæg] yielded a different word, with a different meaning
- More often, changing a contrastive feature results in something that *would be a different word, if it existed*—for example, *kick* [kɪk] → [kɪg]
- *Contrastive* is an abstract/virtual notion

(5) Using minimal pairs to determine the inventory of the language

By checking whether a distinction is *contrastive* or *noncontrastive*, we can tell which of the many distinctions we actually hear people saying are "linguistically meaningful"

- This is what lets us pick out a small number of contrastive sounds from amidst a huge variety of surface forms

	Bilabial	Labiodental	Interdental	Alveolar	Palatal	Velar	Glottal
Stops	p/p^h			t/t^h		k/k^h	
	b			d		g	
Nasals	m			n		ŋ	
Fricatives		f	θ	s	š		
		v	ð	z	ž		
Affricates					č		
					ǰ		
Liquids				l, r			
Glides					j	w, ʍ	h

- Same logic for vowels: changing length, breathiness, creakiness, pitch, loudness, etc., does not make a difference (no minimal pairs); but changing height and backness/rounding does change what vowel you hear

(6) Generalizations about the inventory of English sounds

- Some types of sounds never occur (at least, not contrastively): ejectives, implosives, etc.
- Many combinations don't occur: velar fricatives, palatal stops and nasals, bilabial fricatives, nonalveolar liquids, etc.
- Stops and nasals occur at the same places of articulation (bilabial, alveolar, and velar)
- Fricatives, affricates, and glides are the only sounds that are palatal (etc. . .)

2 What are the possible combinations of sounds?

(7) English has [h], but not at the end of a word

hop	[hap]	but not	**pah*	[pah]
ahead	[əhɛd]	but not	**adeah*	[ədɛh]
reheat	[rihit]	but not	**reteah*	[ritih]

- German, Scottish, Hebrew [x]: usually pronounced by English speakers as [h] (*Hanukkah*), but pronounced as [k] at the ends of words (*Bach*, *Loch*, etc.)

Contextual restriction: no [h] word-finally

- No *h* / ___ #
  - ➢ / = in the environment of (introduces the context)
  - ➢ ___ = location of sound in question
  - ➢ # = a word boundary

    "No *h* when it occurs before a word boundary" (= at the end of a word)

(8) English has velar nasal [ŋ], but not at the beginning of a word

ring	[rɪŋ]	but not	**ngir*	[ŋɪr]
lung	[lʌŋ]	but not	**ngul*	[ŋʌl]

- How would you write the contextual restriction on [ŋ]?

(9) English also allows limited set of vowels at the ends of words

happy [hæpi]	*array* [əre]
anew [ənu]	*hello* [həlo]
awry [əraj]	*allow* [əlaw]
alloy [ælɔj]	

…but no words like *[hæpɪ], *[əlɛ], *[əlʊ], *[həlæ]

- No lax vowels / ___ #[1]

(10) Describing restrictions with features

- As the previous example shows, restrictions are often on entire groups of sounds (lax vowels, voiceless sounds, affricates, etc.)
- Groups of sounds that behave alike in some respect = NATURAL CLASSES
- If a group of sounds forms a natural class, we assume it is because those sounds have some crucial set of properties in common
- Properties are described with *features*
  - Lax vowels = [−tense]
  - Voiceless sounds = [−voice]

> ☞ A complete list of feature values is found in your textbook, on pp. 299-300

- Restating the restriction in features: No [−tense] / ___ #

(11) Looking in more detail at distinctive features

- Same general idea as describing sounds phonetically:
  - Consonants: voicing, manner of articulation, place of articulation
  - Vowels: height, backness, rounding

  However, the feature names are not always identical to the phonetic terms
- Example: bilabials and labiodentals

	Bilabial	Labiodental
Stop	p, b	
Nasal	m	
Fric.		f, v

  - Bilabial vs. labiodental place is not contrastive in English: [fɪd] vs. [ɸɪd] (similar to [f], but with both lips instead of lower lip + upper teeth) would not be different words
  - So, no feature given for bilabial vs. labiodental; a single distinctive feature: [+labial]
- Another big discrepancy between phonetic terms & phonological features: manner features

p. 299

	Stops	Fricatives	Affricates	Nasals	Liquids	Glides	Vowels
[consonantal]	+	+	+	+	+	−	−
[sonorant]	−	−	−	+	+	+	+
[syllabic]	−	−	−	−	−	−	+
[nasal]	−	−	−	+	−	−	−
[continuant]	−	+	−	−	+	+	+
[sibilant]	−	+/−	+	−	−	−	−

[1] Actually, this is not quite complete: schwa is lax, and is allowed word-finally

- Vowels: [−syllabic] (NOT [−consonantal])
- Obstruents (=stops, fricatives, affricates): [−sonorant]
- Consonants: [−syllabic]
- Consonants except for glides: [−consonantal]
- Fricatives: $\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \end{bmatrix}$
- Affricates: $\begin{bmatrix} -\text{continuant} \\ +\text{sibilant} \end{bmatrix}$
- Stops and nasals: $\begin{bmatrix} -\text{continuant} \\ -\text{sibilant} \end{bmatrix}$

(12) Practice using natural classes to pick out sets of sounds

What is the set of features needed to describe the following:

- i, ɪ, e, ɛ, æ
- i, e, o, u
- i, e
- e, ɛ, o, ɔ, æ, a, ʌ
- ɪ, ɛ, æ, ʌ

Consonants are more complicated. I suggest starting with the chart above, to try to find the right subset of features that uniques picks out the manner of articulation that you want to describe; then add the appropriate voicing and place features, as necessary

- Suppose we're trying to describe [f, θ, s, š] = voiceless fricatives
- Fricatives = $\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \end{bmatrix}$

  [+consonantal] is redundant, since all [−sonorant] sounds are [+consonantal]); similar arguments for [−syllabic], [−nasal], etc.
- Voiceless fricatives = $\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \\ -\text{voice} \end{bmatrix}$

☞ Although the goal is to describe the natural class with the smallest number of features possible, it does not really hurt to include extra features. Try your best, and make sure that you include also a prose description of the class of sounds you are trying to describe

More practice: how about

- s, š, z, ž
- m, n, ŋ
- t, d, n, s, z, l, r

(13) Another example: possible consonant combinations at the beginning of a word in English

pray	[pre]	play	[ple]	*pnay	[pne]
crime	[krajm]	climb	[klajm]	*knime	[knajm]
brew	[bru]	blue	[blu]	*bnue	[bnu]
grass	[græs]	glass	[glæs]	*gnass	[gnæs]
*srow	[sro]	slow	[slo]	snow	[sno]

- Extends to novel words: *brick* is a word, *blick* *could be* a word, but **bnick* could not be a word; *snick* would be fine, though

- Nasals cannot come after any initial consonant other than [s]
- No [+nasal] / # $\begin{bmatrix} -\text{syllabic} \\ -\text{sibilant} \end{bmatrix}$ ___

☞ Descriptions of phonological generalizations should include both a prose statement and a formal statement in features

(14) One last example from English: sibilants + consonant combinations

stow	[stow]	snow	[sno]	slow	[slo]	*srow	[sro]
*shtow	[što]	*shnow	[šno]	*shlow	[šlo]	shred	[šrɛd]

- Word-initial s + C combinations are usually OK, but not #sr
- Word-initial š + C combinations are mostly not possible, exception #šr
- COMPLEMENTARY DISTRIBUTION: one sound occurs where the other sound does not
- No *s* / ___ $\begin{bmatrix} -\text{syllabic} \\ +\text{sonorant} \\ -\text{nasal} \\ -\text{lateral} \end{bmatrix}$, and no *š* / ___ [+consonantal] except [r]

(15) A German example:

Buch	[buːx]	'book'
riech	[riːç]	'smell' (imperative)
mich	[mɪç]	'me'
hoch	[hoːx]	'high'
Pech	[pɛç]	'bad luck'
Loch	[lɔx]	'hole'
Dach	[dax]	'roof'

- [x] = voiceless velar fricative, [ç] = voiceless palatal fricative
- Can you see any pattern to the distribution of [x] and [ç]?
- How would you state the restrictions on where [x] does not occur? (or where [ç] does not occur...)

(16) Summary so far:

- Possible sounds in a language: using minimal pairs to determine the phonemes of a language, figure out which features are contrastive
- Generalizations about possible sounds and combinations of sounds, formalized using distinctive features
- Last step: use these devices to explain why sounds sometimes change in different contexts

3 How do sounds change depending on the context?

(17) Some more German data

Buch	[buːx]	'book'	Bücher	[byçər]	'books'
Dach	[dax]	'roof'	Dächer	[dɛçər]	'roofs'
Loch	[lɔx]	'hole'	Löcher	[lœçər]	'holes'

- The distribution of [x] and [ç] seen in (15) is not just a static fact about German
- It is actively forced: when the vowel changes, the fricative must change too

(18) ALTERNATIONS: changes in sounds depending on the context

- In the singular, these nouns have back vowel + [x]
- In the plural, the vowel changes; this triggers a change to [ç]
- These nouns have two *allomorphs*: one with [x], and one with [ç]

(19) Expressing alternations with phonological rules

- Change *x* (a voiceless velar fricative) to *ç* (voiceless palatal fricative) after a front vowel
- Describing with features:
  - Fricatives = $\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \end{bmatrix}$
  - Voiceless fricatives = $\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \\ -\text{voice} \end{bmatrix}$

Voiceless velar fricative:	Voiceless palatal fricative:
$\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \\ -\text{voice} \\ +\text{velar} \\ -\text{palatal} \end{bmatrix}$	$\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \\ -\text{voice} \\ -\text{velar} \\ +\text{palatal} \end{bmatrix}$

- Formalizing the change:

$$\begin{bmatrix} -\text{sonorant} \\ +\text{continuant} \\ -\text{voice} \\ +\text{velar} \\ -\text{palatal} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{velar} \\ +\text{palatal} \end{bmatrix} / \begin{bmatrix} +\text{syllabic} \\ -\text{back} \end{bmatrix} \text{—}$$

  - Format: A → B / C ___ D = change A to B after a C, and before a D
  - When C or D is not specified, it doesn't matter (here, change cares only about the *preceding* front vowel
  - Change A → B: velar and palatal fricatives have almost all the same features, except the place features; in B, we only need to state the ones that change (it's assumed that any feature that isn't mentioned stays the same)
  - Always accompany with a prose description: a voiceless velar fricative becomes palatal when it comes after a front vowel

(20) Proving that the rule works: sample derivations

Analysis of the *Buch* ∼ *Bücher* alternation:

- Word is really [buːx], but when plural suffix *-er* is added, vowel changes to front rounded [y]
- The vowel change triggers the velar → palatal rule; end result is the observed phonetic form

Showing this in a "sample derivation"

Basic form:	buːx + ər
Vowel change:	byxər
Palatalization:	byçər
Phonetic form:	byçər

(21) Another example: English past tenses

Present	Past	Phonetic past	Final segment	Suffix
droop	drooped			
jump	jumped			
kick	kicked			
latch	latched			
miss	missed			
brush	brushed			
rate	rated			
plant	planted			
sort	sorted			
trade	traded			
land	landed			
rub	rubbed			
nag	nagged			
save	saved			
bathe	bathed			
budge	budged			
harm	harmed			
train	trained			
plan	planned			
soar	soared			
call	called			
play	played			
ski	skied			
row	rowed			

- Step 1: figure out what is alternating (here: are the final segments changing? the suffix? both?) What are the allomorphs?
- Step 2a: look at the neighboring sounds to see what they have in common
  - Are the allomorphs in *complementary distribution*? (one allomorph after one set of sounds, the other after the complement set)
  - What combinations of sounds are being avoided?

  What are the environments for the three allomorphs of the past suffix?

  1.

  2.

  3.

- Step 3: try to figure out which allomorph is the "basic" one, and which allomorphs are the result of changes
  - Premise: we want to unite all of the allomorphs into a single lexical entry
  - For each allomorph, look at the environments for the competing allomorphs. Try swapping each allophone into the environments for its competitors. Can you find any illegal combinations that are being avoided?
  - Often, doing this reveals that one allomorph would be illegal in the other contexts; provides a motivation for the change
- Write rules that change the basic allomorph into the other allomorphs, in the appropriate contexts

(22) Confirmation that this analysis is right: the *Bach* test

- Experiment: find an English speaker who can reliably pronounce [x] in words from German (such as *Bach*)
- Have this speaker say a sentence like: "Handel out-Bached Bach"
- Voiceless [t] allomorph is chosen automatically and reliably, even though the speaker may never have produced the past tense of a [x]-final verb before
- Reason this works: speaker knows that [x] is [−voice], and this is all the information that is needed to select the past tense allomorph correctly

(23) Another example from German: word-final obstruents

Dieb	[diːp]	'thief'	Diebe	[diːbə]	'thieves'
Lob	[loːp]	'praise'	Lobe	[loːbə]	'praises'
Mord	[mort]	'murder'	Morde	[mordə]	'murders'
Eid	[ajt]	'oath'	Eide	[ajdə]	'oaths'
Berg	[bɛrk]	'mountain'	Berge	[bɛrgə]	'mountains'
Krieg	[kriːk]	'war'	Kriege	[kriːgə]	'wars'

- As before, collect allomorphs/allophones and their contexts
- Are they in complementary distribution? If yes, then possibility that they're really the same thing, but one has changed in some context
- Try out each allophone in the opposite contexts; anything obviously wrong?
  - In many cases, we can't guess the direction of the change simply by seeing how things would look if we chose one or the other as the "basic" form

Some more German data

Piep	[piːp]	'peep'	Piepe	[piːpə]	'peeps'
Wort	[vort]	'word'	Worte	[vortə]	'words'
Grat	[graːt]	'ridge'	Grate	[graːtə]	'ridges'
Werk	[vɛrk]	'work'	Werke	[vɛrkə]	'works'
Aspik	[aspiːk]	'aspic'	Aspike	[aspiːkə]	'aspics'

- How does this affect your list of allophones and contexts?
  - Voiced stops: only when there's a vowel after
  - Voiceless stops: everywhere

Or, stated another way:

	/ ___ #	/ ___ V
'murder'	t	d
'word'		t

- Contrast between voiced and voiceless stops is *neutralized* / ___ # (to voiceless)
- Voiced stops occur in a restricted set of environments (namely, / ___ V), while voiceless stops occur everywhere
- If we choose voiceless as basic, there's no way to predict that some words should have [d] in plural, and other words have [t] (since both sounds would be fine there)
- If we choose voiced as basic, then it's easy to write a rule devoicing / ___ # (no ambiguity)

☞ Predictability: when there is a contrast in some contexts but not others, look to the more contrastive context for the basic form

(24) Another neutralization example, from American English

eat	[it]	eating	[iɾɪŋ]
wait	[wet]	waiting	[weɾɪŋ]
loot	[lut]	looting	[luɾɪŋ]
cart	[kart]	carting	[karɾɪŋ]
lead	[lid]	leading	[liɾɪŋ]
elude	[ilud]	eluding	[iluɾɪŋ]
card	[kard]	carding	[karɾɪŋ]

- Here, neutralization to flap [ɾ] occurs when there's a following vowel
- Following predictability principle above, non-neutralizing [t], [d] should be chosen as the more basic forms

Change an alveolar stop to [ɾ] before a stressless vowel

- $\begin{bmatrix} -\text{continuant} \\ -\text{nasal} \\ +\text{alveolar} \end{bmatrix} \rightarrow$ [+flap] / ___ stressless vowel

(Using ad hoc [+flap] feature, and we won't try to formalize "stressless vowel" here)

(25) Back to German [x] vs [ç] in (15):

- Here, the two sounds are in complementary distribution
- No neutralization (predictability principle doesn't say which to choose as basic)
- Neither direction seems to fix a more obvious problem (change eliminates [x] after front vowels, or [ç] after back vowels)
- Phonetic naturalness: front after front vowels is extremely common in the world's languages; backing after back vowels is a lot less common. Armed with this knowledge, we can choose [x] as more basic, since [x] → [ç] is a more common/natural rule

☞ However, choice is very subtle, and requires knowledge of a wider range of cases; it is important to understand the basic principles of choosing one allomorph/allophone as basic, but there will be hard cases that you won't be in a position to decide about. In such cases, you should simply list the two alternatives (rule goes A → B or B → A), and explain why they both seem equally plausible.