ALLOPHONES AND PHONEMES:
MINIMAL PAIRS AND COMPLEMENTARY DISTRIBUTION
Stuff coming up

- Assignment #4 is due **Monday Feb 24**
- On the horizon... Midterm #1
  - The IPA
  - Syllabification
  - Phonotactic constraints
  - Phonemes, Rules, and Phonology
Features and natural classes
Each list below contains sounds that are members of a natural class and one sound that does not belong to that natural class. Find one phonological feature that all the phones of the natural class share and name the phone that is left out. (We are only considering the sounds that are on your features chart. There may be more than one solution — you need give only one.) So, for example, if the sounds are [t, d, g, b, m], one answer would be: the natural class is made up of phones that are [+voice] and the phone that doesn’t belong is [t].

1. [s, z, l, d, n, t, f, k, 3, tʃ, dʒ, ɹ, θ, ɹ]
2. [i, e, u, ə, i]
3. [e, i, ɪ, i, u]
4. [s, ʃ, ʒ, θ, z, tʃ, dʒ]
5. [p, t, f, b, v, m, w, ɹ]
Features

- **Features**: the properties which can define a sound
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- We write them as [+Feature] or [-Feature]
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- We write them as [+Feature] or [-Feature]
- That notation helps us be very precise, so we know what our theories actually predict.
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Features

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  - i.e. by changing [+Voice] feature to [-Voice]
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Changing whether you burp when making a speech sound can’t make it into a different speech sound.
Features

- **Example:** You can turn one sound into another by changing whether your vocal cords vibrate.
  - i.e. by changing [+Voice] feature to [-Voice]
- Changing whether you burp when making a speech sound can’t make it into a different speech sound.
  - i.e. there’s no [+Burp] or [-Burp] feature
You will have to memorize the features.

There’s a nice chart on Moodle:

| Consonants | p | b | t | d | k | g | f | v | s | z | θ | ð | f | ʒ | th | m | n | ŋ | l | r | j | w | m | h | ? |
| consonant  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| vowel      | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| sonorant   | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| voice      | - | + | - | + | - | + | - | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| labial     | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| coronal    | - | - | + | + | - | - | - | - | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| anterior   | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| strident   | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| nasal      | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| stop       | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| back       | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| lateral    | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| p b t d k g f v s z θ ð f ʒ th m n ŋ l r j w m h ? |

| Vowels   | i | e | ë | æ | æ | i | ë | λ | å | ø | u | ø | u |
|----------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| consonant| - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| vowel    | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| voice    | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| round    | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| high     | + | + | - | - | - | - | - | - | - | - | - | - | - | - |
| back     | - | - | - | - | - | + | + | + | + | + | + | + | + | + |
| front    | + | + | + | + | - | - | - | - | - | - | - | - | - | - |
| low      | - | - | - | - | + | - | - | - | - | - | - | - | - | - |
| tense    | + | - | + | - | - | - | - | - | - | - | + | + | + | - |

| p b t d k g f v s z θ ð f ʒ th m n ŋ l r j w m h ? |
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- For instance, [w] and [h] are [-consonant]
  - but also [-vowel]
- So you really gotta memorize them!
- Memorize them in “chunks”, e.g. make a flashcard with [+consonant] on one side and “all the things I think of as consonants except [W], [h], [j], [ʍ], [ʔ]
Warning!

Features don’t always mean what you’d expect!

For instance, [w] and [h] are [-consonant]
  but also [-vowel]

So you really gotta memorize them!

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quizlet.com
Natural classes

- **Natural class**: a group of sounds that can be defined by some feature(s)
- What natural class is this: [b], [d], [g], [m], [n]?
Natural classes

- Our list: [b], [d], [g], [m], [n]
Natural classes

- Our list: [b], [d], [g], [m], [n]
- If you’re stuck, try some hypotheses.
Natural classes

- Our list: [b], [d], [g], [m], [n]
- If you’re stuck, try some hypotheses.
  - Maybe [+Stop]?
Natural classes

- Our list: [b], [d], [g], [m], [n]
- If you’re stuck, try some hypotheses.
  - Maybe [+Stop]?
  - Nope! We’re missing [p], [t], [k]
Natural classes

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- If you’re stuck, try some hypotheses.
  - Maybe [+Stop]?
  - Nope! We’re missing [p], [t], [k]
  - Oh, so maybe [+Voiced]
Natural classes

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  - Maybe [+Stop]?
  - Nope! We’re missing [p], [t], [k]
  - Oh, so maybe [+Voiced]
  - Nope, since vowels are [+Voice] too.
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  - Nope! We’re missing [p], [t], [k]
  - Oh, so maybe [+Voiced]
  - Nope, since vowels are [+Voice] too.
  - Aha, so maybe [+Stop, +Voiced]?
  - Yep!
On the homework, you have to identify what natural class all-but-one sound is from.
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- Let’s practice:
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  - [m], [n], [b]
  - [k], [s], [u], [t], [f], [h]
Natural classes

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- Let’s practice:
  - [m], [n], [b]
  - [k], [s], [u], [t], [f], [h]
  - [v], [w], [i], [o], [j], [h], [a]
Natural classes

- On the homework, you have to identify what natural class all-but-one sound is from.
- Let’s practice:
  - [m], [n], [b]
    - All but [b] are [+Nasal]
  - [k], [s], [u], [t], [f], [h]
    - All but [u] are [+Consonant]
  - [v], [w], [i], [o], [j], [h], [a]
    - All but [v] are [-Consonant]
    - Also all but [h] are [+Voice]
What about with this data?
What about with this data?

- The answer isn’t what you think!
What about with this data?

- The answer isn’t what you think!
- There’s no [+Cat] feature in our system.
What about with this data?

- The answer isn’t what you think!
- There’s no [+Cat] feature in our system.
- And even if we did have features that applied here...
What about with this data?
Allophones and phonemes
Are [n] and [r] allophones or phonemes in English? Give the evidence for your choice.
The cast of characters

- **Phonemes**: sounds that can distinguish words
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- **Allophones**: different ways that a phoneme can be pronounced depending on context
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- **Minimal pairs**: a way of demonstrating that two sounds are separate phonemes
Definitions

- **Phonemes**: sounds that can distinguish words
- **Allophones**: different ways that a phoneme can be pronounced depending on context
- **Minimal pairs**: a way of demonstrating that two sounds are separate phonemes
- **Complementary distribution**: a way of demonstrating that two sounds are allophones of a single phoneme
Allophones and Phonemes

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    - Remember: for phonemes, we use slashes instead of brackets
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    - ban
    - bæm
Allophones and Phonemes

- **Phonemes**: sounds that can distinguish words
- Examples in English: /n/ and /m/ are phonemes
  - Remember: for phonemes, we use slashes instead of brackets
- We know this because “ban” and “bam” are different words, and they differ only in whether they have an /n/ or an /m/
  - bæn
  - bæm
- A pair of words like this is called a **minimal pair**.
Minimal Pairs

- Important:
  - Minimal pair forms are distinct by only a single sound
  - If there is more than one difference, then it is not a minimal pair
Minimal Pair Practice

- What are the distinct phonemes given this data?
- English data:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>/sɛt/</td>
<td>/mɛloʊ/</td>
<td>/wɛd/</td>
<td>/kʰɡ/</td>
</tr>
<tr>
<td>/wɛt/</td>
<td>/sʌb/</td>
<td>/sɛd/</td>
<td>/dʰɡ/</td>
</tr>
<tr>
<td>/dʌb/</td>
<td>/sæt/</td>
<td>/mɛdoʊ/</td>
<td>/kæt/</td>
</tr>
<tr>
<td>/dæb/</td>
<td>/ræŋ/</td>
<td>/klæŋ/</td>
<td>/sʌtɛl/</td>
</tr>
</tbody>
</table>
Minimal Pair Practice: Answers

- What are the distinct phonemes given this data?

  - English data:

    | [sɛt]       | [mɛloʊ] | [wɛd]       | [kɔɡ] |
    |-------------|---------|-------------|-------|
    | [wɛt]       | [sʌb]   | [sɛd]       | [dɔɡ] |
    | [dʌb]       | [sæt]   | [mɛdoʊ]     | [kæt] |
    | [dəɛb]      | [ræŋ]   | [klæŋ]      | [sʌtəl] |

- /s/ vs. /w/ - set vs. wet
- /d/ vs. /t/ - wed vs. wet
- /d/ vs. /s/ - dub vs. sub
- /s/ vs. /k/ - cat vs. sat
- /d/ vs. /k/ - dog vs. cog
- /d/ vs. /l/ - mellow vs. meadow
Complementary distribution

- Recall that English has two sounds: [t] and [tʰ]
Complementary distribution

- Recall that English has two sounds: [t] and [th]
- But you can’t have a word [thav] that means “a snake that’s a sweetie” and a separate word [tav] that means “a cat that’s not a sweetie”.

Recall that English has two sounds: [t] and [tʰ]

But you can’t have a word [tʰæv] that means “a snake that’s a sweetie” and a separate word [tav] that means “a cat that’s not a sweetie”.

The sound [tʰ] is just what happens to [t] when you pronounce it in a particular context.
Complementary distribution

- Recall that English has two sounds: [t] and [tʰ]
- But you can’t have a word [tʰav] that means “a snake that’s a sweetie” and a separate word [tav] that means “a cat that’s not a sweetie”.
- The sound [tʰ] is just what happens to [t] when you pronounce it in a particular context.
- Allophones: the different sounds that correspond to a single phoneme
Complementary Distribution

- **Complementary distribution**: when two sounds never appear in the same contexts
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- When two sounds are in complementary distribution, that tells you that they’re allophones.
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- What would happen if we tried to put unaspirated [t] in a context where [th] appears?
Complementary Distribution

- **Complementary distribution**: when two sounds never appear in the same contexts.
- When two sounds are in complementary distribution, that tells you that they’re allophones.
- It’s a Batman/Bruce Wayne sort of thing.
- What would happen if we tried to put unaspirated [t] in a context where [tʰ] appears?
- This would trigger the rule which turns [t] into [tʰ]!
Phonemes

/tap/

[tʰap]
Here, your rule mechanism sees the phonemic context and says “hey, my aspiration rule needs to apply”
Complementary Distribution

- English has non-nasal [æ] and nasal [ã].
Complementary Distribution

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- Let’s figure out if they’re allophones.
Complementary Distribution

- English has non-nasal [æ] and nasal [ã].
- Let’s figure out if they’re allophones.
  - [hænd] [træm] [hæŋ] [væŋ] [ãm]
  - [hæt] [pæt] [væt] [kæt] [æt] [ræt] [bæʃ] [bæg] [kætʃ]
English has non-nasal [æ] and nasal [ã̃].

Let’s figure out if they’re allophones.

- [hænd] [træm] [hæŋ] [væŋ] [ã̃m]
- [hæt] [pæt] [væt] [kæt] [æt] [ræt] [bæʃ] [bæg] [kæʃ]

Yep, they’re allophones— [ã̃] **always** appears before a nasal consonant, and [æ] **never** appears before one.
Complementary Distribution: Tips

- Always start by making a list of contexts!
  - [æ]: h_n, t_m, h_ŋ, v_n, #_m
  - [ã]: h_t, f_d, p_t, v_t, k_t, … (for all the data)
- Now look at your list and see if you notice any natural classes.
- I recommend using your feature chart a lot—some natural classes will be subtle and non-obvious.
- On rare occasion, the solution will jump out at you. More commonly you’ll have to consider and test some hypotheses (i.e. guess and check):
  - Eyeballing your list, you might notice that [æ] often precedes [t], [sound], and that [ã] never does.
  - So here’s a hypothesis: [æ] only occurs before something [-Voice, +Stop] and [ã] occurs otherwise.
  - If you check the data, you’ll see that this hypothesis is wrong—[æ] can occur before [+Voice] sounds like [d] and [-Stop] sounds like [ʃ].
  - But it’s not completely off, since [ã] indeed never appears before [-Voice, +Stop] sounds.
  - So we can revise our hypothesis and try again.
- In this example, the pattern is pretty intuitive. You get a nasal vowel before a nasal consonant and a non-nasal vowel before a non-nasal consonant. Not all examples are like this—for instance, the [j] deletion rule feels kind of arbitrary. However, examples like this are common enough that it can be a good idea to consider intuitive hypotheses if nothing else is springing to mind.

How to read this:
- “h_n” means that the data includes an example where the sound you’re examining between [h] and [n]
- # marks a word boundary
Languages treat different sounds as phonemes.
Minimal Pairs: Crosslinguistic variation

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- Example: /t/ and /tʰ/ are phonemes in Hindi.
Minimal Pairs: Crosslinguistic variation

- Languages treat different sounds as phonemes.
- Example: /t/ and /tʰ/ are phonemes in Hindi.
- We know this because of minimal pairs like this:
  - [tar] - “postpone”
  - [tʰar] - “woodshop”
Rules with features
Rules with features

Now let's look at a few words from Old English, a language spoken between 450 and 1150 (and from which modern English historically descends):

1. [brīgan] 'to bring'
2. [brinjan] 'to drink'
3. [blæyan] 'to laugh'
4. [blōgen] 'full grown'
5. [nīxt] 'night'
6. [fōnt] 'font'
7. [hrævn] 'raven'
8. [manna] 'man's'
9. [mōna] 'moon'
10. [niōsta] 'next'
11. [noon] 'noon'
12. [lēgjān] 'to lengthen'
13. [ōvnas] 'ovens'

Based on these words, can you tell if [n] and [ŋ] were allophones or phonemes in Old English. If phonemes, tell me what shows this; if allophones, give the rule that describes their distribution. This rule should be in terms of phonological features.

The following are words from one of the dialects of the Portuguese spoken in Brazil.

[tenu] 'I have'
[tal] 'such'
[natu] 'born'
[kua]<sub>ru</sub> 'four'
[uta]<sub>l</sub> 'to anoint'
[ifivi] 'I had'
[ifiu] 'uncle'
[paijinnar] 'to skate'
[partfii] 'party'
[pejif] 'comb'
[dadu] 'given'
[madzina] 'godmother'
[modemnui] 'modern'
[unidu] 'united'
[guada] 'guard'
[̃gieneizu] 'money'
[œjshu] 'hatred'
[vecadigit] 'green'
[vejadaŋji] 'truth'
[giŋgi] 'big'

Compare [tʃ]/[ð] (that is: [+constr +stop +nasal +resident]) to [ʃ]/[ŋ] (that is: [+constr +stop +nasal +resident]).

Are these phonemes? (That is: is [t] a different phoneme from [ʃ] and [ð] a different phoneme from [ŋ]?) Or are they allophones? (That is: is [t] an allophone of [ʃ] (or vice versa) and [ð] an allophone of [ŋ] (or vice versa)?) If allophones, give the rule, in terms of phonological features, that controls their distribution.
How to approach these questions

- For both of these questions, you have to check for minimal pairs and for complementary distribution.
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  - ...you’re done! They’re separate phonemes!
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- For both of these questions, you have to check for minimal pairs and for complementary distribution.
- If you find minimal pairs, that means...
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- If you instead find complementary distribution...
How to approach these questions

For both of these questions, you have to check for minimal pairs and for complementary distribution.

If you find minimal pairs, that means...
  ...you’re done! They’re separate phonemes!

If you instead find complementary distribution...
  ...you have to write a rule
We saw earlier that [æ] becomes [æː] before a [+Nasal] consonant.
We saw earlier that [æ] becomes [æ̝] before a [+Nasal] consonant.

We could write a rule like this:

\[ /æ/ \rightarrow [æ̝] \] when a [+Nasal] consonant follows
Rules with features

- We saw earlier that \([æ] \) becomes \([æ̆] \) before a \([+\text{Nasal}] \) consonant.
- We could write a rule like this:
  - \(/æ/ \rightarrow [æ̆] \) when a \([+\text{Nasal}] \) consonant follows
- But if we look at more data, we find…
  - bõn, tũn, dĩm, zĩŋu…
  - dot, kup, tik, zĩltʃ…
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But if we look at more data, we find...

- bõn, tũn, dĩm, zĩŋ...
- dot, kup, tik, zilltʃ...

So it’s every vowel, not just [æ]!
We could explain this using a bunch of rules like this:

- /o/ → [õ] when a [+nasal] consonant follows
- /u/ → [ũ] when a [+nasal] consonant follows
- ...
We could explain this using a bunch of rules like this:

- /o/ → [Õ] when a [+nasal] consonant follows
- /u/ → [Ũ] when a [+nasal] consonant follows
- ...

But isn’t that a weird coincidence that English has all these rules which do basically the same thing?
Rules with features

- We could explain this using a bunch of rules like this:
  - $/o/ \rightarrow [\tilde{\text{O}}]$ when a $[+\text{nasal}]$ consonant follows
  - $/u/ \rightarrow [\tilde{\text{U}}]$ when a $[+\text{nasal}]$ consonant follows
  - ...

- But isn’t that a weird coincidence that English has all these rules which do basically the same thing?
- Wouldn’t it be better if we could write one rule that does all of this?
Rules with features

- Using features, we can do exactly that:
  - [+Vowel] $\rightarrow$ [+Nasal] when [+Nasal] follows
Rules with features

- Using features, we can do exactly that:
  - $[+\text{Vowel}] \rightarrow [+\text{Nasal}]$ when $[+\text{Nasal}]$ follows

- A tip:
  - Why does our rule nasalize originally non-nasal vowels instead of de-nasalizing nasal vowels?
  - Because the $[+\text{Nasal}]$ ones appear *in* a context defined by a natural class, and the $[-\text{Nasal}]$ ones appear *except* in that context.
  - Keeping that in mind will make your rules way simpler.
Rules with features

- So for the homework:
  - Check for minimal pairs.
  - If you can’t find any, then check for complementary distribution (by making a list and looking for natural classes).
  - If you find a natural class, write a rule that would transform one sound into the other.
  - If you get stuck or run into problems, talk to your fellow students and/or email me!