Phonology...

- The set of sounds that occur in a given language.
- The permissible arrangements of these sounds in words.
- The process of adding, deleting, or changing sounds.

**Phonology**: Study of speech sounds and sound patterns.
There are a few sounds in our language that we are mentally aware of.

In physical reality, these sounds are produced using different physical gestures.

Mental reality and physical reality are quite different.
The example of the ‘t’ sound in English

- In the speaker’s mind, these are members of the same category
- In physical reality, they are all different:
  - ‘tap’ \[t^hæp\]
  - ‘stop’ \[stæp\]
  - ‘let’ \[lɛʔ\]
  - ‘seating’ \[siˈrɪŋ\]
Phonemic vs. phonetic levels

[t]  [ʔ]  [ɾ]  [θ]

/t/
In phonology we will concentrate on the nature of sounds in the head and their relationship with the sounds that we physically produce.

- Sounds in the head are called **phonemes**, and are always written with slanted brackets “/…”
- Physically produced sounds are called **phones**, and are always written with angled brackets “[...]”

**Underlying (phonemic) Representation:** /hæt/
**Surface (phonetic) Representation:** [hæt]
The first step in analyzing a language’s phonology is to locate all of its basic sounds (phonemes).
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How do we determine whether a sound is phonemic in a given language or not?
Minimal pairs

- Two words of a language that differ in only one sound.
Minimal pairs

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- Some examples of minimal pairs in English:

  [pin]  [tin]  -> Only the first sounds differ
  [bæt]  [bIt]  -> Only the second sound differ
  [hæd]  [hæt]  -> Only the last sound differ
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- This tells us that sounds /p/, /t/, /d/, /æ/, /I/ are phonemes of English.
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- Some examples of minimal pairs in English:

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  [hæd]  [hæt] -> Only the last sound differ

- This tells us that sounds /p/, /t/, /d/, /æ/, /I/ are phonemes of English.
- The basic idea is that phonemes serve to distinguish words from each other. **Hence, finding minimal pairs is the most effective way to show that two sounds are distinct phonemes.**
# English Phonemes : consonants

<table>
<thead>
<tr>
<th></th>
<th>Bilabial</th>
<th>Labiodental</th>
<th>Dental</th>
<th>Alveolar</th>
<th>Palatoalveolar</th>
<th>Palatal</th>
<th>Velar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stops</strong></td>
<td>voiceless</td>
<td>/p/</td>
<td></td>
<td>/t/</td>
<td></td>
<td>/k/</td>
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<td>pin</td>
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<td>kin</td>
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<td>din</td>
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<tr>
<td><strong>Affricates</strong></td>
<td>voiceless</td>
<td></td>
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<td>/tʃ/</td>
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<tr>
<td><strong>Fricatives</strong></td>
<td>voiceless</td>
<td>/f/</td>
<td>/θ/</td>
<td>/s/</td>
<td>/ʃ/</td>
<td>/h/</td>
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<td>thin</td>
<td>sin</td>
<td>shin</td>
<td>hymn</td>
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<tr>
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<td>/v/</td>
<td>/ð/</td>
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<td></td>
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<td>vin</td>
<td>this</td>
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<td>Lynn</td>
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<td>/ɹ/</td>
<td>/j/</td>
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The IPA chart (Consonants)

<table>
<thead>
<tr>
<th></th>
<th>bilabial</th>
<th>labiodental</th>
<th>interdental</th>
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</table>
# English phonemes: vowels

<table>
<thead>
<tr>
<th></th>
<th>Front Unrounded</th>
<th>Central Unrounded</th>
<th>Back Unrounded</th>
<th>Back Rounded</th>
<th>Diphthongs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper high</td>
<td>/i/</td>
<td></td>
<td>/u/ boot</td>
<td></td>
<td>/ai/, /au/, /oɪ/ bite, bout, Coɪ</td>
</tr>
<tr>
<td>Lower high</td>
<td>/ɪ/ bit</td>
<td></td>
<td>/ʊ/ foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper mid</td>
<td>/eɪ/ bait</td>
<td>/ə/ abbot</td>
<td>/ɒ/ boat</td>
<td></td>
<td>Rhotacized upper mid central</td>
</tr>
<tr>
<td>Lower mid</td>
<td>/ɛ/ bet</td>
<td></td>
<td>/ʊ/ bought</td>
<td></td>
<td>unrounded</td>
</tr>
<tr>
<td>Low</td>
<td>/æ/ bat</td>
<td></td>
<td>/ɑ/ father</td>
<td></td>
<td>/ɜː/ Bert</td>
</tr>
</tbody>
</table>
3 dimensional classification of English Vowels

The diagram illustrates the classification of English vowels based on three dimensions:

- **Front**: The front position of vowels.
- **Central**: The central position of vowels.
- **Back**: The back position of vowels.

The diagram uses symbols to represent different vowels, with specific marks indicating the distinctions between high, mid, and low positions as well as the distinctions between tense and lax vowels.
Distinctiveness and Contrast

- Phonemically *distinct* sounds are said to be in *Contrast*.
- These are just the ways of saying that two sounds are separate phonemes.
Examine the pairs of sounds [t] & [d] and [s] & [z]. Are [t] and [d] in contrastive distribution in Finnish? What about [s] and [z]?

| [ratas] | ‘wheel’    | [ku:si] | ‘six’     |         |            |
Examine the pairs of sounds [t] & [d] and [s] & [z]. Are [t] and [d] in contrastive distribution in Finish? What about [s] and [z]?

- [ku:zi] ‘six’
- [li:sa] ‘Lisa’
- [kadot] ‘failures’
- [madon] ‘of a worm’
- [kate] ‘cover’
- [li:za] ‘Lisa’
- [maton] ‘of a rug’
- [katot] ‘roofs’
- [li:za] ‘Lisa’
- [radan] ‘of a track’
- [ratus] ‘wheel’
- [ku:si] ‘six’

What does this tell us about these sounds in Finnish?
Examine the sounds [d] and [ð]. Determine whether they are in contrastive distribution? If they are separate phonemes, give minimal pairs.

[drama] ‘drama’  [komiða] ‘food’  [dolor] ‘pain’
[anda] ‘beat it’  [dime] ‘tell me’  [laðo] ‘side’
[kaða] ‘each’  [durar] ‘to last’  [falda] ‘skirt’
Examine the sounds [d] and [ð]. Determine whether they are in contrastive distribution? If they are separate phonemes, give minimal pairs.

| [drama] ‘drama’ | [komiða] ‘food’ | [dolor] ‘pain’ |
| [anda] ‘beat it’ | [dime] ‘tell me’ | [laðo] ‘side’ |
| [kaða] ‘each’ | [durar] ‘to last’ | [falda] ‘skirt’ |

- What does this tell us about this sound in Spanish?
Sounds that do not contrast

- There are sounds such that the difference between the two could never be the (sole) distinction between words. There are *no minimal pairs.*
- They cannot occur in the same environment.
There are sounds such that the difference between the two could never be the (sole) distinction between words. There are no minimal pairs.

They cannot occur in the same environment.

vs.

[katot] ‘roofs’
[kadot] ‘failures’
Sounds that do not contrast

- There are sounds such that the difference between the two could never be the (sole) distinction between words. There are no minimal pairs.
- They cannot occur in the same environment.

\[\text{vs.}\]

\[
\begin{align*}
\text{[katot]} & \quad \text{‘roofs’} \\
\text{[kadot]} & \quad \text{‘failures’}
\end{align*}
\]

- Can we predict the environment for non-contrastive sounds?
Predicting environments - Aspiration

Are [t] and [tʰ] contrastive in English? If not, can you predict the environment in which [tʰ] appears?

[ˈtʰæp] ‘tap’
[ˈtʰin] ‘tin’
[ˈtʰwajn] ‘twine’
[ˈtʰruθ] ‘truth’

[ˈstap] ‘stop’
[ˈstul] ‘stool’
Predicting environments - Aspiration

- Are [t] and [tʰ] contrastive in English? If not, can you predict the environment in which [tʰ] appears?

\[
\begin{align*}
[tʰæp] & \quad \text{'tap'} \\
[tʰin] & \quad \text{'tin'} \\
[tʰwajn] & \quad \text{'twine'} \\
[tʰruθ] & \quad \text{'truth'}
\end{align*}
\]

\[
\begin{align*}
[stap] & \quad \text{'stop'} \\
[stul] & \quad \text{'stool'}
\end{align*}
\]

\[/t/ \text{ is always aspirated when it occurs in the beginning of stressed syllables}\]
Are [t] and [ɾ] contrastive in English? If not, can you predict the environment in which [ɾ] occurs?

[sɪrɪŋ] ‘sitting’
[ˈærm] ‘atom’
[ˈhɪrɪŋ] ‘hitting’

[ˈstɑp] ‘stop’
[ˈsæt] ‘sat’
[ˈstul] ‘stool’
Predicting environments - Flapping

- Are [t] and [ɾ] contrastive in English? If not, can you predict the environment in which [ɾ] occurs?

['sɪɾɪŋ] ‘sitting’
['æɾm] ‘atom’
['hɪɾɪŋ] ‘hitting’

['stap] ‘stop’
['sæt] ‘sat’
['stul] ‘stool’

○ /t/ is realized as a flap when it is preceded by a stressed vowel and followed by an unstressed vowel
Predicting environments - Glottalization

- Are [t] and [ʔ] contrastive in English? If not, can you predict the environment in which [ʔ] occurs?

[letal'] 'let'
[fæʔ] ‘fat’

- /t/ is realized as glottal stop when it occurs at the end of a word
Can we predict the environments?

- /t/ is always aspirated when it occurs in the beginning of stressed syllables
- /t/ is realized as glottal stop when it occurs at the end of a word
- /t/ is realized as a flap when it is preceded by a stressed vowel and followed by an unstressed vowel
- /t/ is realized as an voiceless alveolar stop when it occurs in any other environment
Can we predict the environments?

- The fact that the appearance of [t], [ʔ], [ɾ] and [tʰ] is predictable is important.
- These sounds are said to be in *complementary distribution*. 
Can we predict the environments?

- The fact that the appearance of [t], [ʔ], [ɾ] and [tʰ] is predictable is important.
- These sounds are said to be in *complementary distribution*.

- Two sounds are said to be in complementary distribution if one sound never occurs in the environment in which the other occurs.
Complementary Distribution:

Two sounds are in complementary distribution if they occur in different environments.

If two sounds are in complementary distribution, they are allophones of the same phoneme.
Allophones

- We say that /t/ is a ‘phoneme,’ and [t],[ɾ],[ʔ],[tʰ] are its ‘allophones’

  Allophones are phones that are associated with the same phoneme

Phoneme (UR): /t/

Allophones (SR): [t] [ɾ] [ʔ] [tʰ]
Phonemic vs. phonetic levels

[t]  [?]  [th]  [r]  /t/
Consider the words from Thai and English below and answer questions.

<table>
<thead>
<tr>
<th>Thai</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>[paan]</td>
<td>‘like, as’</td>
</tr>
<tr>
<td>[pʰaan]</td>
<td>‘tray with pedestal’</td>
</tr>
<tr>
<td>[baan]</td>
<td>‘classifier’</td>
</tr>
<tr>
<td>[pʰik]</td>
<td>'to peek'</td>
</tr>
<tr>
<td>[spik]</td>
<td>'to speak'</td>
</tr>
<tr>
<td>[bik]</td>
<td>'beak'</td>
</tr>
</tbody>
</table>

1. What is the distribution of [p] and [pʰ] in Thai?
2. What is the distribution of [p] and [pʰ] in English?
3. What is the distribution of [b] and [pʰ] in English?
Consider the words from Thai and English below and answer questions.

<table>
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</table>

1. What is the distribution of [p] and [pʰ] in Thai?
2. What is the distribution of [p] and [pʰ] in English?
3. What is the distribution of [b] and [pʰ] in English?

*The same set of sounds can be in different distributions in different languages*
Phonological Rules

- Generalizations about the patterning of allophones can be stated as phonological rules.
Phonological Rules

- /t/ is always aspirated when it occurs in the beginning of stressed syllables
- /t/ is realized as glottal stop when it occurs at the end of a word
- /t/ is realized as a flap when it is preceded by a stressed vowel and followed by an unstressed vowel
- /t/ is realized as an voiceless alveolar stop when it occurs in any other environment
Formalizing the rules

- Glottalization of /t/: 
  e.g. #lɛt# -&gt; #lɛʔ#
Formalizing the rules

- Glottalization of /t/:
  e.g. #lɛt# -> #lɛʔ#
Formalizing the rules

- Glottalization of /t/: e.g. $t\# \rightarrow ?\#$
Formalizing the rules

- Glottalization of /t/:
  e.g.  \( t\# \to \?\# \)

We describe the change and the environment of the change in two parts. Hence:

\( t \to \?/ \_\# \)
Formalizing the rules

- Glottalization of /t/:
  e.g.  \( t# \rightarrowʔ# \)

We describe the change and the environment of the change in two parts. Hence:

\[ t \rightarrowʔ/ _# \]

The change that is taking place
Formalizing the rules

- Glottalization of /t/:  
  e.g. \( t^\# \rightarrow ?^\# \)

We describe the change and the environment of the change in two parts. Hence:

The change that is taking place

The environment in which the rule applies
Formalizing the rules

- Flapping of /t/:
  
(a) What changes?
(b) In what environment?
Formalizing the rules

- Flapping of /t/:
  
  (a) What changes? $t \rightarrow r$
  
  (b) In what environment?
Formalizing the rules

- Flapping of /t/:
  
  (a) What changes? \( t \rightarrow \emptyset \)

  (b) In what environment? \( V \_\_ V \)
Formalizing the rules

- Flapping of /t/: 

(a) What changes? \( t \rightarrow \mathfrak{r} \) 
(b) In what environment? \( \text{V}_\text{stressed}_\text{V} \)
Formalizing the rules

- Flapping of /t/: 

(a) What changes? \( t \rightarrow r \)

(b) In what environment? \( V \_V \) 

stressed

Rule:
\[
t \Rightarrow r / V \_V \_V
\]

[stress]
The steps of the phonological analysis

1) Minimal pair (phoneme)
2) Before & After Chart
3) Relevant pattern (complementary distribution, allophone)
4) Generalize the environment
5) Decide the basic form (that will give the simpler rule)
6) Form the rule.
Korean: Consider the distribution of [r] and [l] in Korean in the following words. Are they in complementary distribution? If yes, give a rule that describes this change in Korean.

| [rubi] ‘ruby’   | [mul] ‘water’   |
| [kiri] ‘length’ | [pal] ‘leg’     |
| [saram] ‘person’| [sƏul] ‘Seoul’  |
| [irɯm] ‘name’   | [ilgop] ‘seven’ |
| [ratio] ‘radio’ | [ibalsa] ‘barber’ |
| [pʰal] ‘arm’    | [mun] ‘door’    |