

# Automatic Stress Marking on Urdu Speech Corpus Using Acoustic Cues

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# Overview

- What is “Stress”?
- Significance of Stress in Speech
- Stress in Urdu Speech
- Significance of Stress in Unit Selection Text to Speech System
- Need for Automated System
- Methodology
- Results
- Future Work

# What is Stress?

- Relative emphasis that may be given to certain syllables in a word.
- Display of prominence on a certain syllable [1]

## Syllable

A Unit of Pronunciation having one Vowel Sound, with or without surrounding Consonants, forming the Whole or a Part of the Word.

# Urdu Syllable Examples

1. S A\_A . H I L      ساحل      (Coast)  
CVV . CVC
2. N I G . R A\_A N      نگران      (Supervisor)  
CVC . CVVC
3. S A X T      سخت      (Hard)  
CVCC
4. T\_D I . D\_Z A\_A . R A T\_D      تجارت      (Trade)  
CV . CVV . CVC

# Urdu Syllable Templates

1. CV
2. V
3. CVC
4. CVV
5. VC
6. VV
7. CVCC
8. CVVC
9. CVVCC
10. VCC
11. VVC

# Urdu Syllable Templates

1.  $CV \rightarrow 0 + 1 = 1$
2.  $V \rightarrow 1 = 1$
3.  $CVC \rightarrow 0 + 1 + 1 = 2$
4.  $CVV \rightarrow 0 + 2 = 2$
5.  $VC \rightarrow 1 + 1 = 2$
6.  $VV \rightarrow 2 = 2$
7.  $CVCC \rightarrow 0 + 1 + 1 + 1 = 3$
8.  $CVVC \rightarrow 0 + 2 + 1 = 3$
9.  $CVVCC \rightarrow 0 + 2 + 1 + 1 = 4$
10.  $VCC \rightarrow 1 + 1 + 1 = 3$
11.  $VVC \rightarrow 2 + 1 = 3$

Light Syllables

Heavy Syllables

Super Heavy  
Syllables

SA\_A.HIL ساحل (Coast)  
CVV . CVC

\*Weight at final position = Weight – 1

# Significance of Stress in Speech

- Syllable prominence can change the meaning of a word in some languages. E.g. in Greek language **poli** means “city” and **poli** means “much”.
- Stress placement can change the class of word, as in English. E.g.  
**project** (Noun), **project**(Verb)  
**present** (Noun), **present**(Verb)

# Stress in Urdu Speech

- Fixed Stress Language
- Defined rules to mark stress on a word
  - Only one syllable of a word is stressed
  - Last heavy syllable is stressed
  - If all syllables are light, the penultimate syllable is stressed[1]



# Stress in Urdu Speech

- Changes the meaning of word

SAS . T\_DA\_A

(Cheap)

SAS . T\_DA\_A

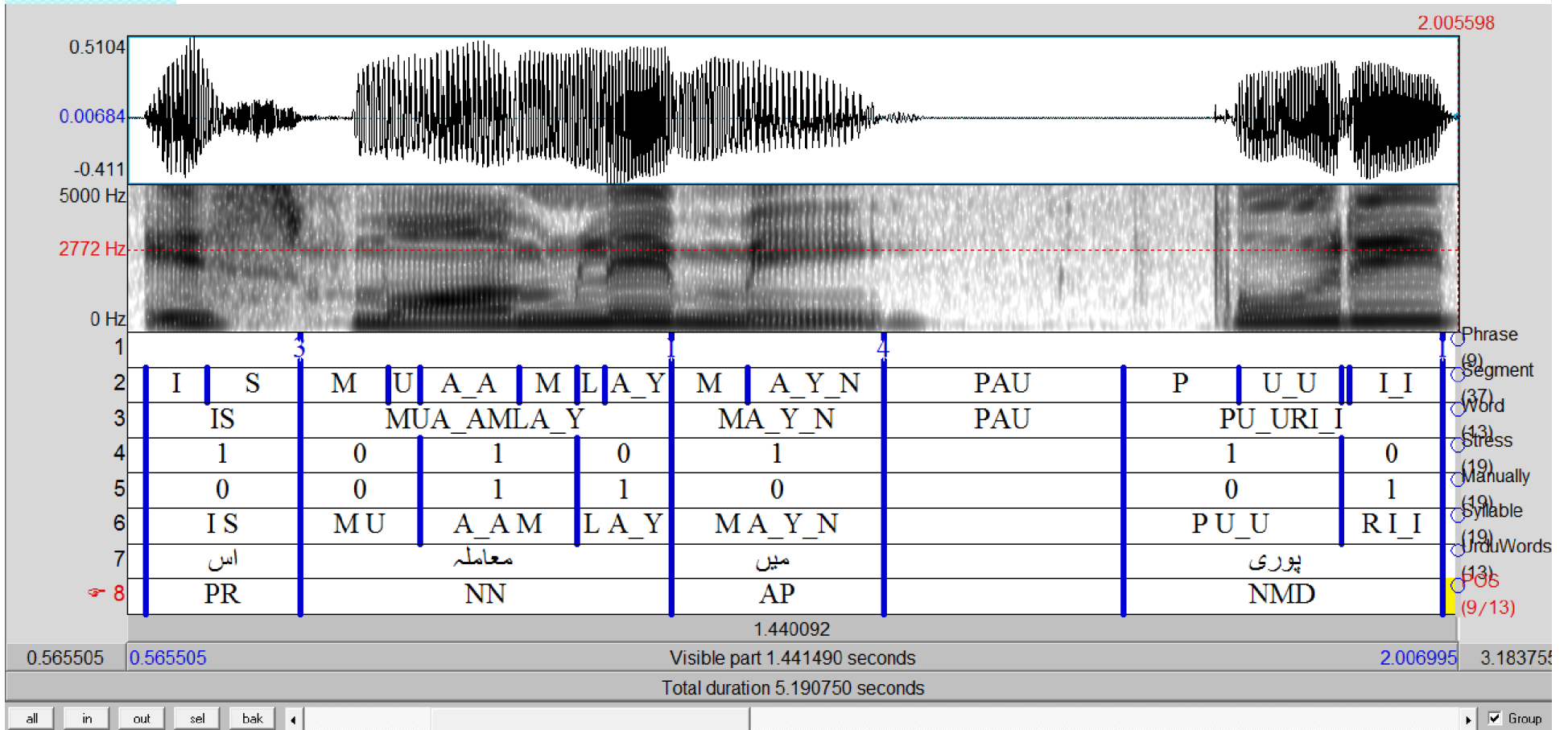
(Take rest)

- Changes the class of word

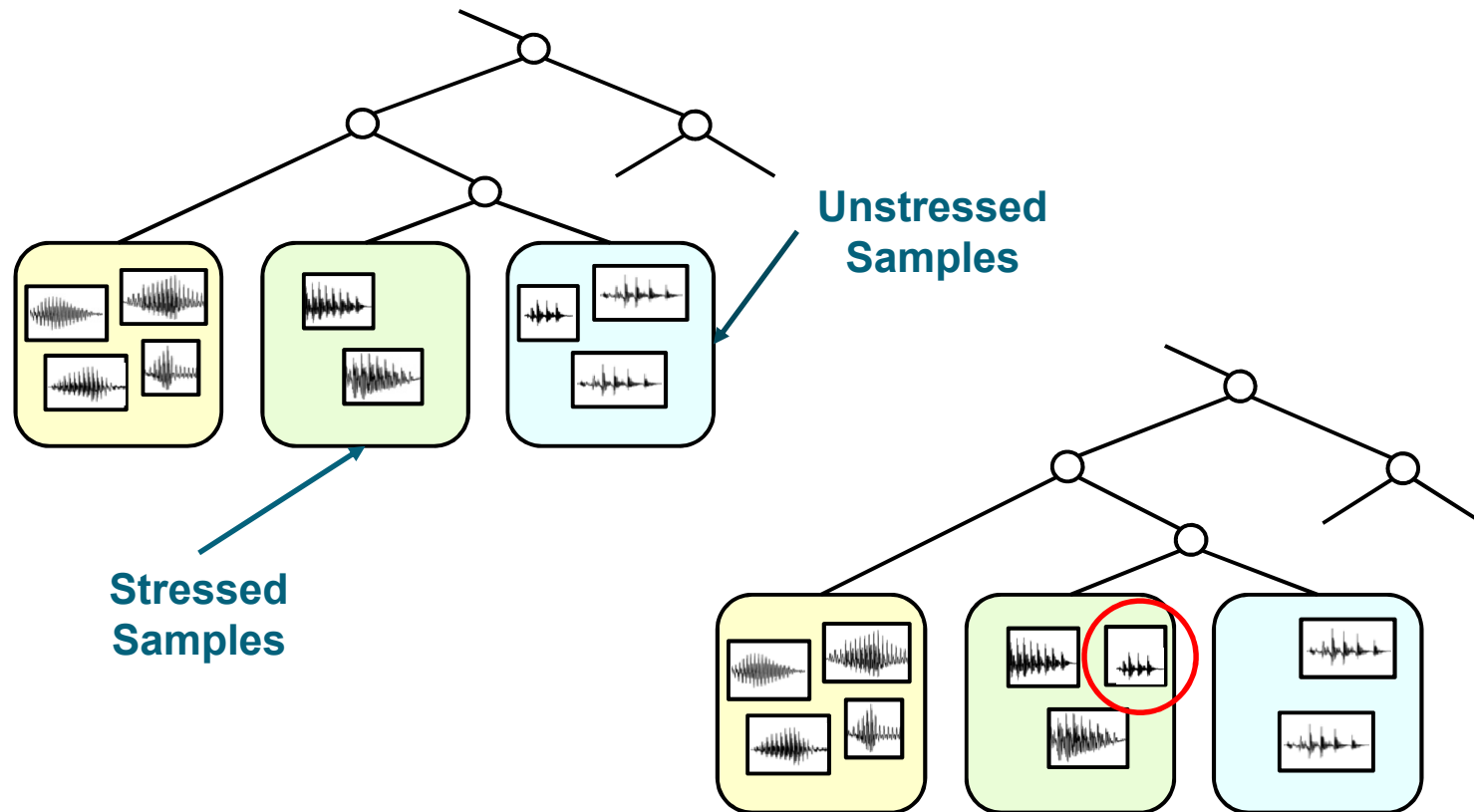
Past	Imperative
UL . TA_A	UL . TA_A
T_SA . LA_A	T_SA . LA_A
D_ZA . LA_A	D_ZA . LA_A
BA . T_SA_A	BA . T_SA_A

# Stress in Urdu Speech

- Variable in Speech



# Significance of Stress in Unit Selection Text to Speech System



# Need for Automated System

- 10 hours of speech
- Approx. 20,000 syllables in an hour
- 1300 manually marked syllables per week
- 15 weeks per hour

# Cues for Stress Marking

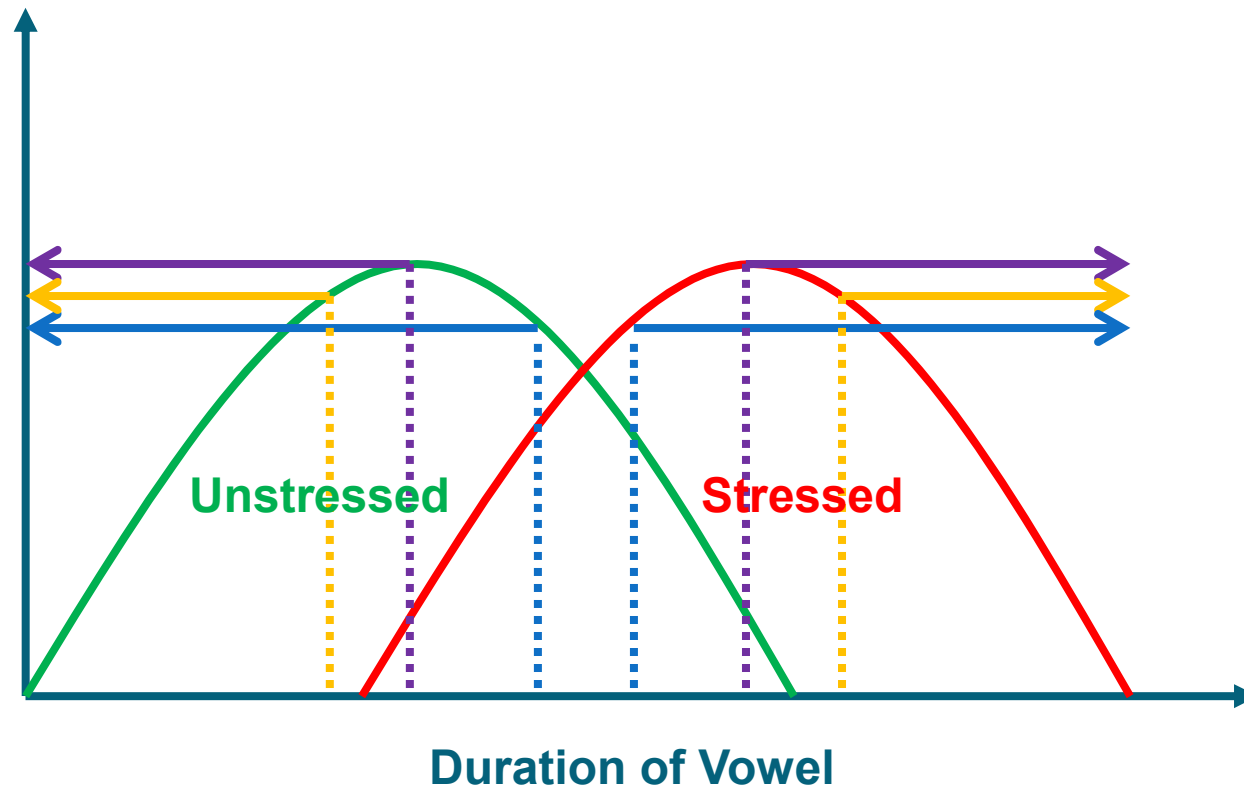
- Heavy Coda (VCC)
- Duration
- Fundamental Frequency (f0)
- Glottalization
- Intensity

# Duration

Duration of Unstressed Vowel < Duration of Stressed Vowel  
 Duration at Non Final Position < Duration at Final Position < Duration at  
 Final Position with Pause

Vowel	Non Final 0	Non Final 1	Final 0	Final 1	Final with Pau 0	Final with Pau 1
A	57	78	60	84	75	100
A_Y	62	112	76	134	139	180
I_I	70	116	85	117	148	191

# Methodology



# Results

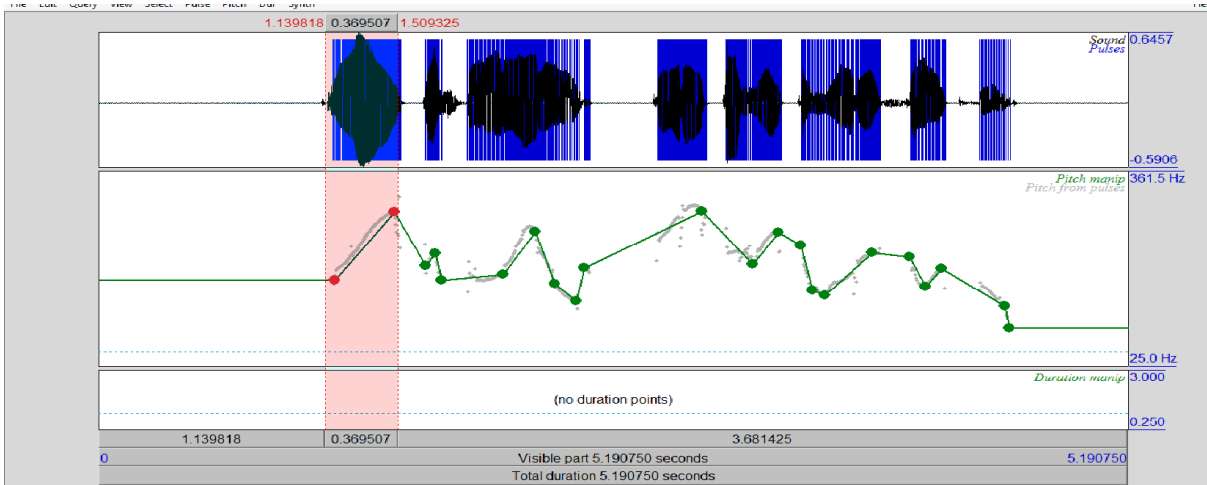
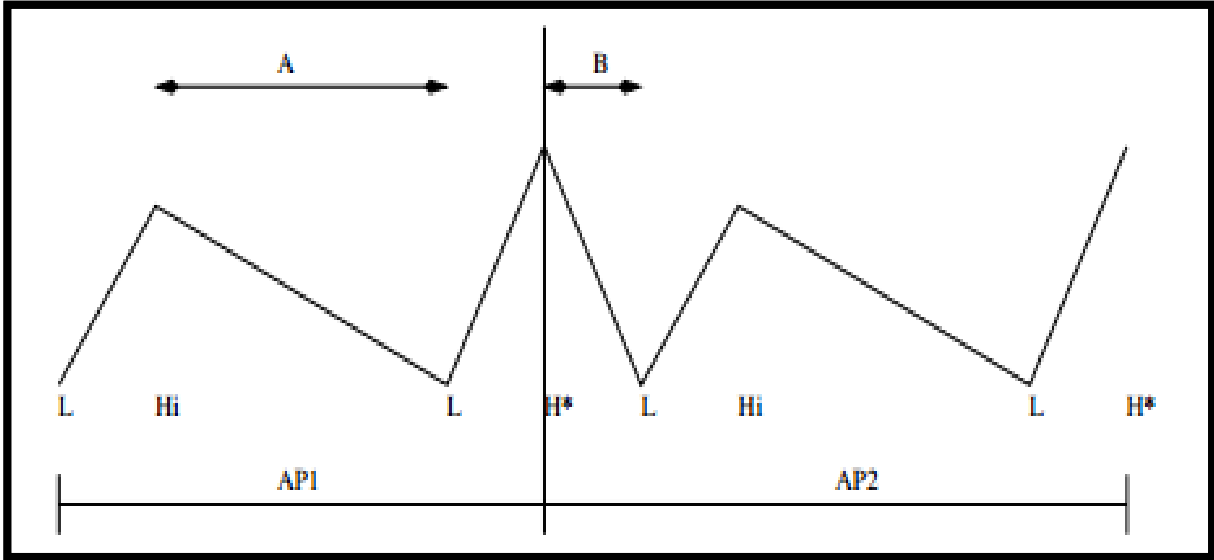
Error Rate %age	Unmarked %age
7.86	20.12
2.98	32.36
2.76	36.23
2.2	49.3
1.3	49.8
1.26	51.7
0.76	62.9



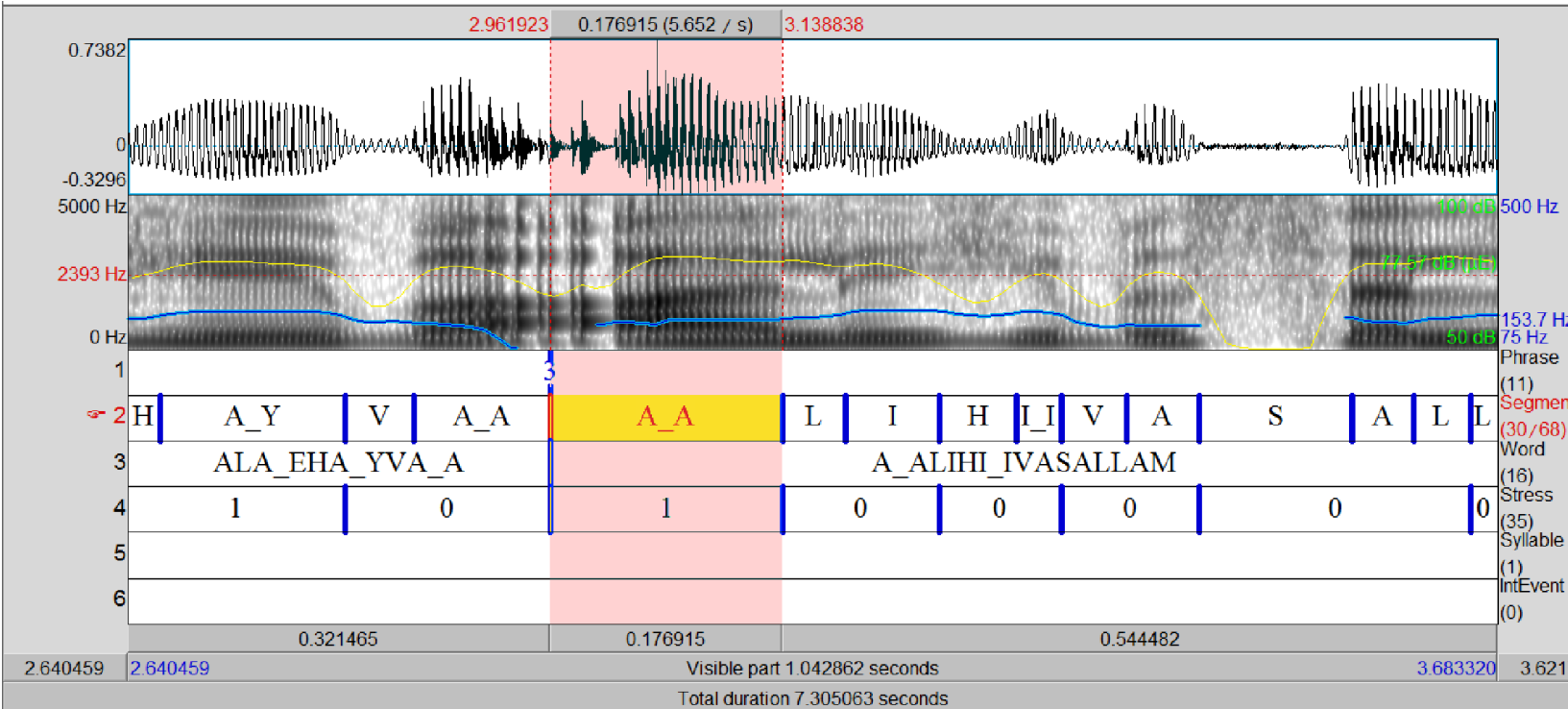
# Future Work

- Fundamental Frequency (f0)
- Glottalization
- Intensity

# F0 Contour



# Glottalization



# Intensity

- Intensity of a stressed syllable will be 3-5dB more than unstressed syllable.

# Thank You



# References

1. Laver, J. Principles of Phonetics. Cambridge: Cambridge University Press. 1994.
2. Ghazali, M. "Urdu Syllable Templates." Annual Report of Center for Research in Urdu Language Processing (CRULP) (2002).