Language Understanding λ(μ) Laboratory

Draw Your Own Vowel Chart

(11th Seminar for Intern-3)

Ye Kyaw Thu
Lab Leader, LU Lab., Myanmar

10 Aug 2025 (SUN)

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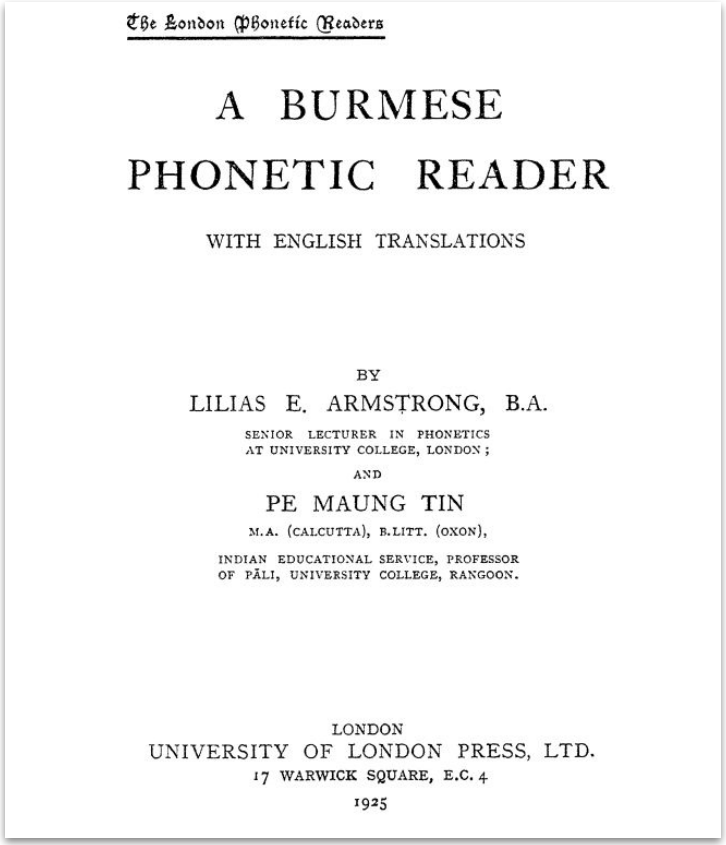
Introduction to Phonetics (Burmese)



The London Phonetic Readers

A BURMESE
PHONETIC READER

WITH ENGLISH TRANSLATIONS

BY
LILIAS E. ARMSTRONG, B.A.
SENIOR LECTURER IN PHONETICS
AT UNIVERSITY COLLEGE, LONDON;
AND
PE MAUNG TIN
M.A. (CALCUTTA), B.LITT. (OXON),
INDIAN EDUCATIONAL SERVICE, PROFESSOR
OF PĀLI, UNIVERSITY COLLEGE, RANGOON.

LONDON
UNIVERSITY OF LONDON PRESS, LTD.
17 WARWICK SQUARE, E.C. 4
1925

- ပါမောက္ခ ကော့တနေး၏ ဖိုနင်းသီအိုရီကျမ်းထွက်ပေါ်လာပြီးနောက် မြန်မာဘာသာစကားကို ဖိုနင်း ဟူသော သဘောတရားနှင့်လေ့လာတင်ပြသည့် ပထမဦးဆုံးသော သုတေသနလုပ်ငန်းအဖြစ် မှတ်ယူနိုင်ပါသည်။
- ၎င်းစာအုပ်ကို ဆရာဦးရွှေသွင် (၁၉၆၉) မြန်မာပြန်သည်။

ဆရာဦးသိန်းထွန်း လေလှိုင်းသဒ္ဒဗေဒနှင့် မြန်မာစကားသံပြောင်းလဲမှုစနစ် စာအုပ်တွင် အထက်ပါအတိုင်း ဖော်ပြထားသည်။

Introduction to Phonetics (Burmese)

THE TYPE OF PRONUNCIATION

The pronunciation represented is that of Mr. Pe Maung Tin (_phe: _maũ _tĩ:), who has prepared the texts and the translations. His speech is typical of that spoken by the educated classes of Lower Burma.

A double-sided gramophone record (No. C 1181) of texts 5, 8, 9, 12, 13, and 14, spoken by Mr. Tin, may be obtained from the Gramophone Company, 363 Oxford Street, London, W.1, and from their agents.

Page 1, A Burmese Phonetic Reader

Introduction to Phonetics (Burmese)

- 363 Oxford Street, London
- Gramophone Company
- His Master's Voice Symbol

Introduction to Phonetics (Burmese)

I. *Oral Vowels*

(a) *Pure Vowels.* These are represented by the following symbols :—

1. i as in ˈsi: (*to ride*)
   ɪ (chief subsidiary member of the i-phoneme) as in ˀsɪˀ (*war, battle*).
2. e as in ˈpe: (*to give*).
   eɪ (chief subsidiary member of the e-phoneme) as in ˀpeɪˀ (*to shut*).
3. ɛ as in ˌlɛ: (*field*).
4. ɑ as in ˌbɑ: (*please*).
   a (chief subsidiary member of the ɑ-phoneme) as in ˀlaˀ (*fresh*).
   ə is used in unstressed positions in the place of ɑ, ɛ, ɪ, u, etc. Further research may prove that ə is a separate phoneme. For the present it may be considered as attached to the ɑ-phoneme.
5. ɔ as in ˈsɔ: (*early*).
6. o as in ˈpo: (*silk*).
   ou (chief subsidiary member of the o-phoneme) as in ˀpouˀ (*putrid*).
7. u as in ˌku: (*to help*).
   ʊ (chief subsidiary member of the u-phoneme) as in ˀkʊˀ (*to kill*).

(b) *Diphthongs.* Represented thus :—

8. aɪ as in ˀmaɪˀ (*stupid*).
9. ɑʊ as in ˀlɑʊˀ (*enough*).

Four other diphthongs which have a nasal element are given under Nasalized Vowels.

II. *Nasalized Vowels*

Represented thus :—

10. ĩ as in ˌwĩ: (*to enter*).
11. eĩ „ ˌseĩ (*diamond*).
12. aĩ „ ˈpaĩ (*to divide*).
13. ɑ̃ „ ˈpɑ̃: (*a flower*).
14. ṹ „ ˀsṹˈ (*to risk*).
15. ɑṹ „ ˀsɑṹˈ (*to wait*).
16. oṹ „ ˈpoṹ (*to hide*).

Page 3 and 4, A Burmese Phonetic Reader

Introduction to Phonetics (Burmese)

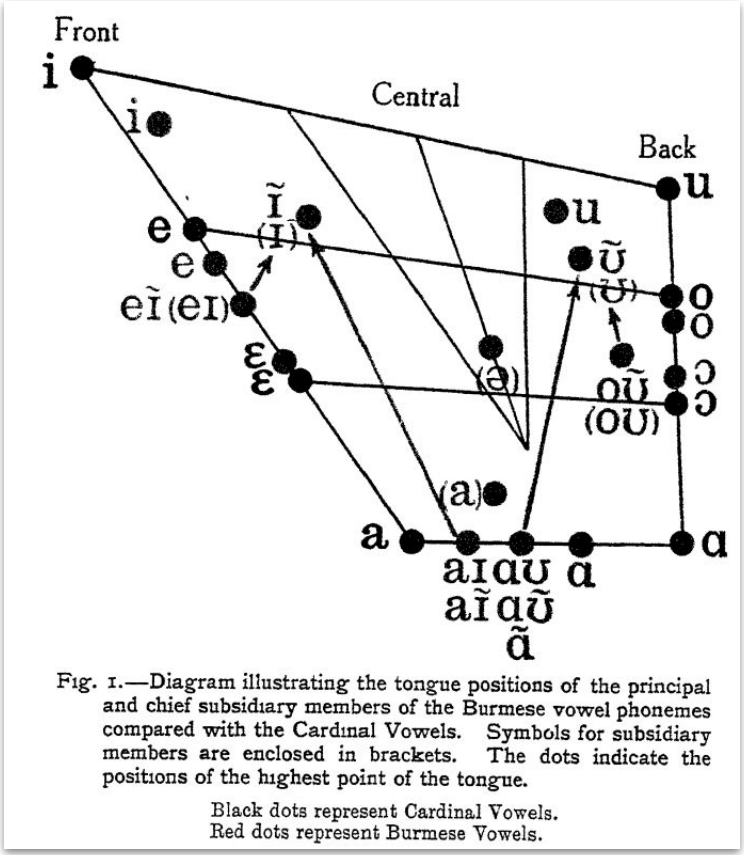


Fig. 1.—Diagram illustrating the tongue positions of the principal and chief subsidiary members of the Burmese vowel phonemes compared with the Cardinal Vowels. Symbols for subsidiary members are enclosed in brackets. The dots indicate the positions of the highest point of the tongue.

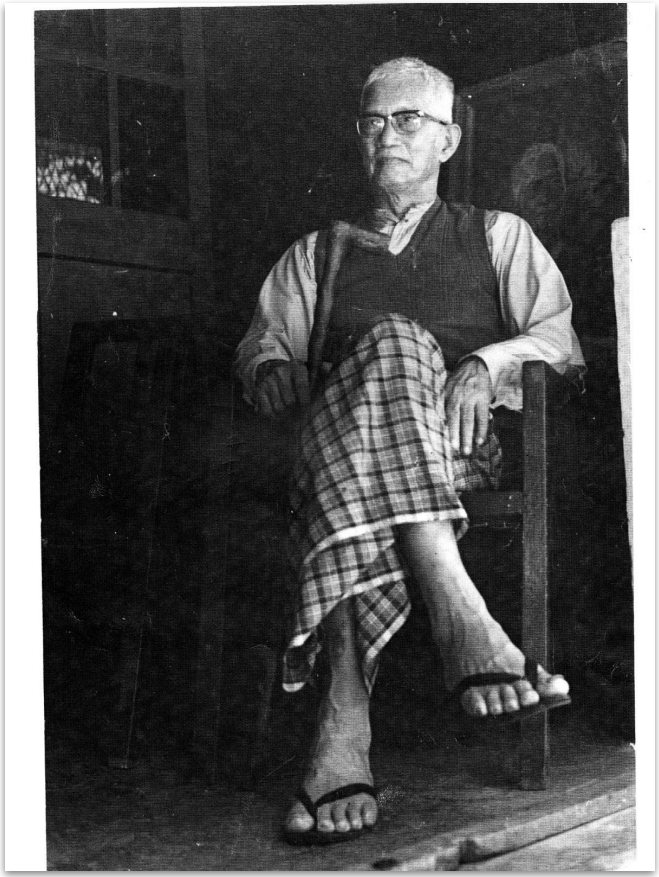
Black dots represent Cardinal Vowels.
Red dots represent Burmese Vowels.

- ဒီ vowel chart က လေ့လာရသလောက် မြန်မာစာအတွက် ပထမဆုံးလို့ ယူဆ
- ဆရာမကြီး Lilias Eveline Armstrong နဲ့ ဆရာကြီး ဦးဖေမောင်တင်တို့ရဲ့ သုတေသန အလုပ်ပါ
- ဒီနေ့ ဆရာ့ lecture ကိုနားထောင်ပြီးရင် ဒီ vowel chart ပုံကို ပြန်ဆွဲကြည့်ကြရအောင်

Introduction to Phonetics (Burmese)

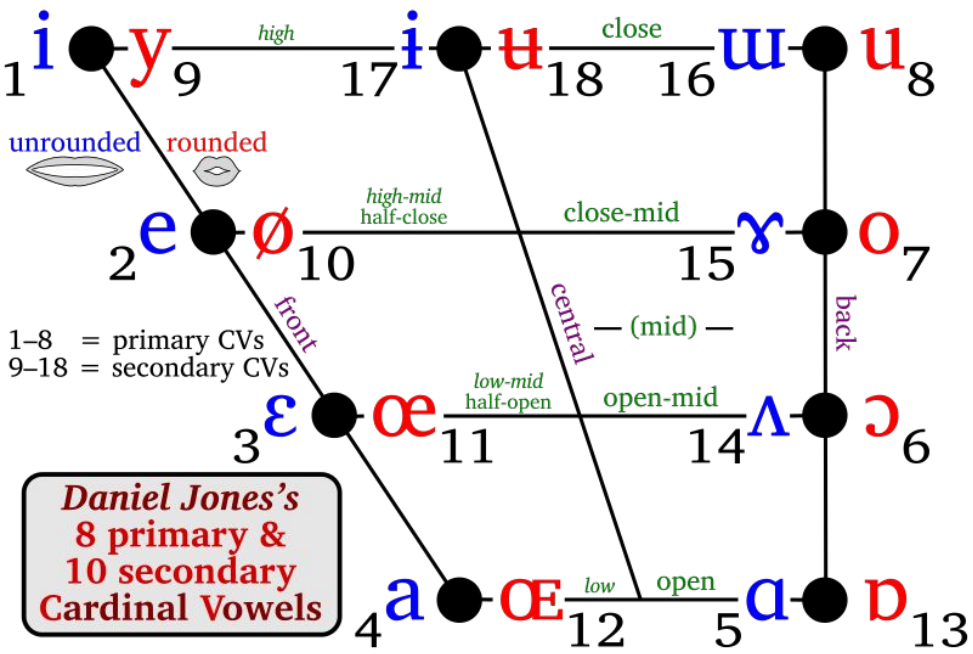
- English Phonetician Lilias Eveline Armstrong (29 September 1882 – 9 December 1937)
- She worked at University College London, where she attained the rank of reader.
- Armstrong is most known for her work on English intonation as well as the phonetics and tone of Somali and Kikuyu.
- Her book on English intonation, written with Ida C. Ward, was in print for 50 years.
- https://en.wikipedia.org/wiki/Lilias_Armstrong

Introduction to Phonetics (Burmese)



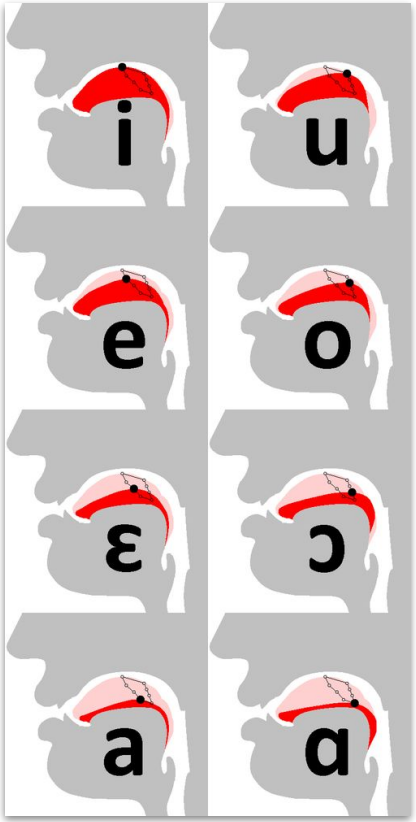
- ဦးဖေမောင်တင် သည် မြန်မာနိုင်ငံသား မြန်မာဘာသာနှင့် ပါဠိဘာသာ ပညာရှင်၊ စာရေးဆရာ၊ တက္ကသိုလ်ပါမောက္ခတစ်ဦး ဖြစ်သည်။
- မြန်မာ့သမိုင်း၊ ရာဇဝင်များ, ဗုဒ္ဓဘာသာကျမ်းစာအချို့ကို အင်္ဂလိပ်ဘာသာသို့ပြန်ဆိုခဲ့သောသူ
- မြန်မာစာပေကို တက္ကသိုလ်တွင် အဆင့်မီမီ သင်ကြားနိုင်သည့် အခြေအနေသို့ရောက်အောင် အားထုတ်ကြိုးပမ်းခဲ့သော ဆရာကြီးတစ်ဦး
- မြန်မာနိုင်ငံ၏ ပထမဆုံးတက္ကသိုလ်ဖြစ်သော ရန်ကုန်တက္ကသိုလ်၌ မြန်မာအဖျိုးသားထဲမှ ပထမဆုံး ခန့်အပ်ခံရသော ပါမောက္ခ
- http://bios.myanmar-institut.org/2019/01/31/pe-maung-tin-1888-1973/

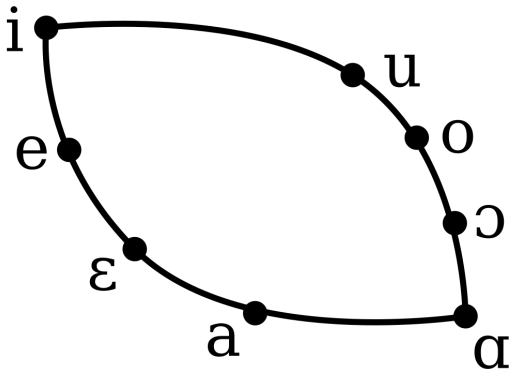
Introduction to Phonetics (Vowels)

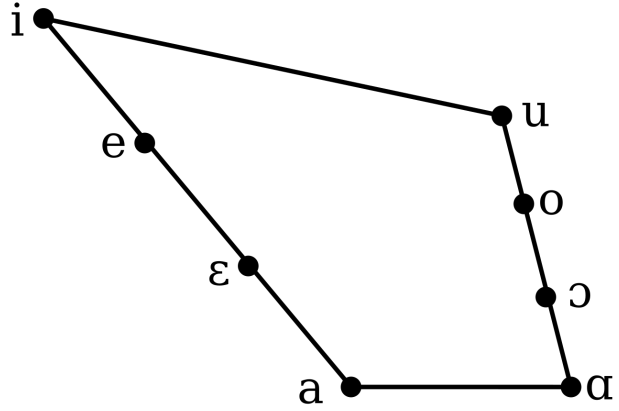


- A cardinal vowel is a vowel sound produced when the tongue is in an extreme position, either front or back, high or low.
- The current system was formulated by Daniel Jones in the early 20th century,[1] though the idea goes back to earlier phoneticians, notably Ellis and Bell.

Introduction to Phonetics (Vowels)





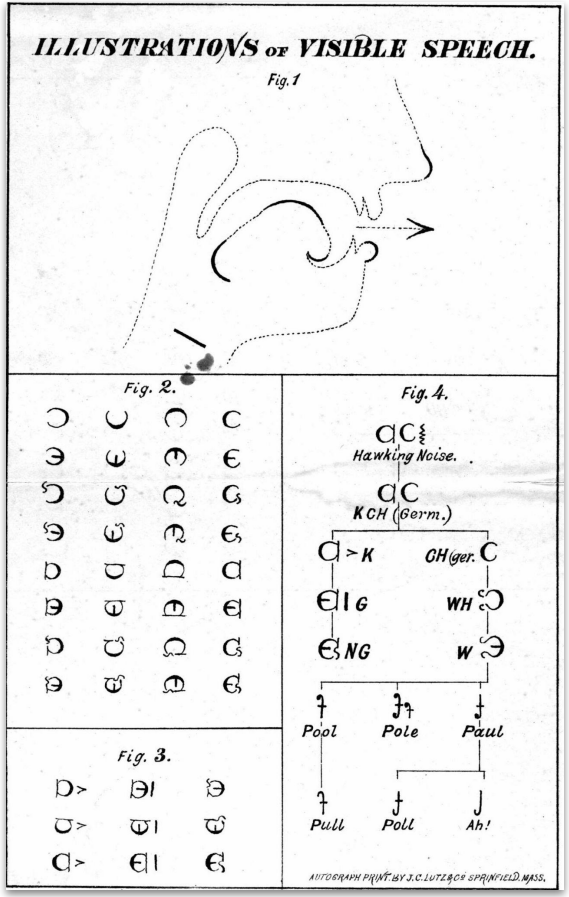


- အသံထုတ်တဲ့အခါ၊ စကားပြောတဲ့အခါမှာ လျှာရဲ့အမြင့်ဆုံး ပိုင့်တွေကို ချိတ်ပြီး ဆွဲပြထားတဲ့ သဘောပါ

- အများစု ပုံဆွဲကြတဲ့အခါမှာ အောက်ပါ ပုံစံမျိုးပိုမြင်ရလိမ့်မယ်

Introduction to Phonetics (Vowels)

- **Iconic notation**: Character shapes visually represent vocal tract articulator positions.
- **Alphabetic notation**: No visual link between shapes and articulation.
- **Advantage**: More flexible in showing pronunciation nuances (MacMahon 1996).
- **Example**: Alexander Melville Bell's Visible Speech (Ellis 1869).
- https://en.wikipedia.org/wiki/Phonetic_transcription



Introduction to Phonetics (IPA)

International Phonetic Association

ɪntəˈnæʃənəl fəˈnɛtɪk əsoʊsiˈeɪʃn

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The International Phonetic Alphabet and the IPA Chart

The official International Phonetic Alphabet, and its organization in a chart, is maintained by the Association. As noted in our 1999 Handbook (Appendix 4), modifications have always been the result of "members making proposals for changes, which were published in the journal and voted on by the Association's Council" (p. 196). Only changes to the alphabet or chart that have been approved by the Council can be considered part of the official IPA. For further information, please consult the Secretary.

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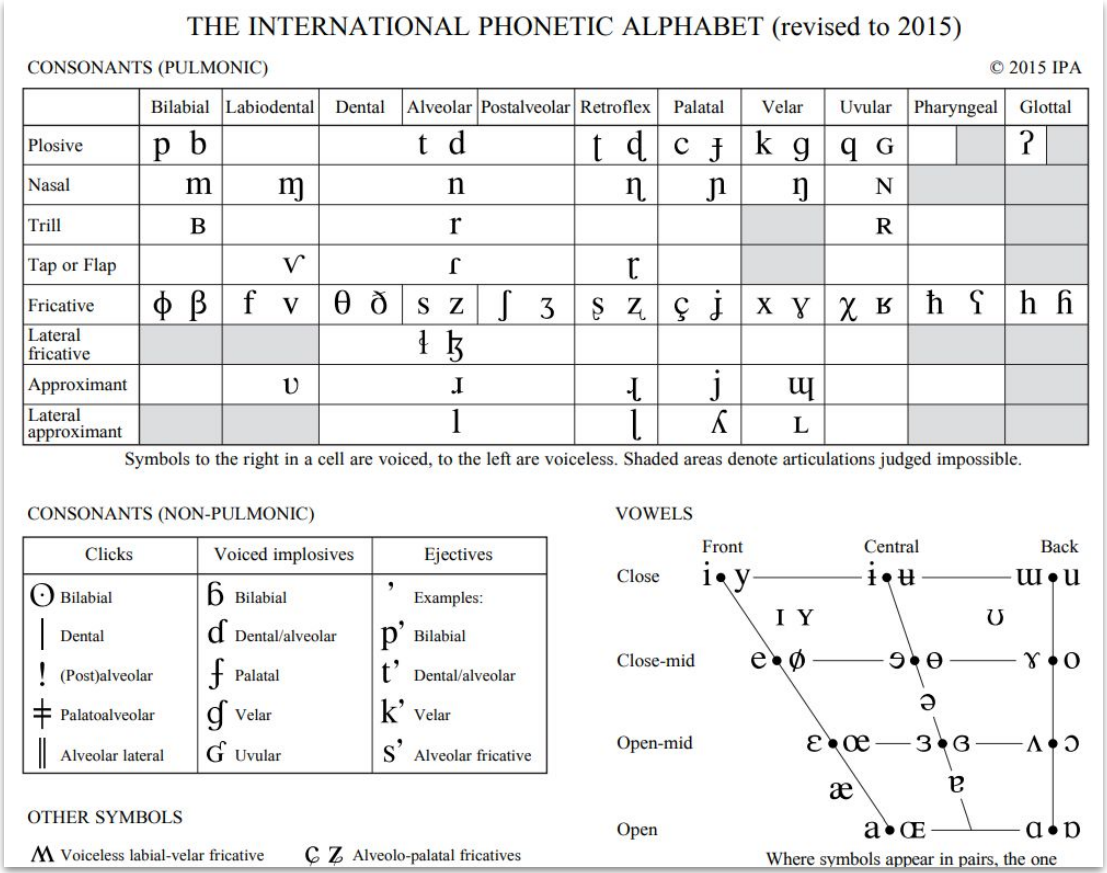
Introduction to Phonetics (IPA)



THE INTERNATIONAL PHONETIC ALPHABET (revised to 2015)

CONSONANTS (PULMONIC)

© 2015 IPA

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap		ⱱ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

Clicks	Voiced implosives	Ejectives
ʘ Bilabial	ɓ Bilabial	’ Examples:
| Dental	ɗ Dental/alveolar	pʼ Bilabial
! (Post)alveolar	ʄ Palatal	tʼ Dental/alveolar
ǂ Palatoalveolar	ɠ Velar	kʼ Velar
ǁ Alveolar lateral	ʛ Uvular	sʼ Alveolar fricative

OTHER SYMBOLS

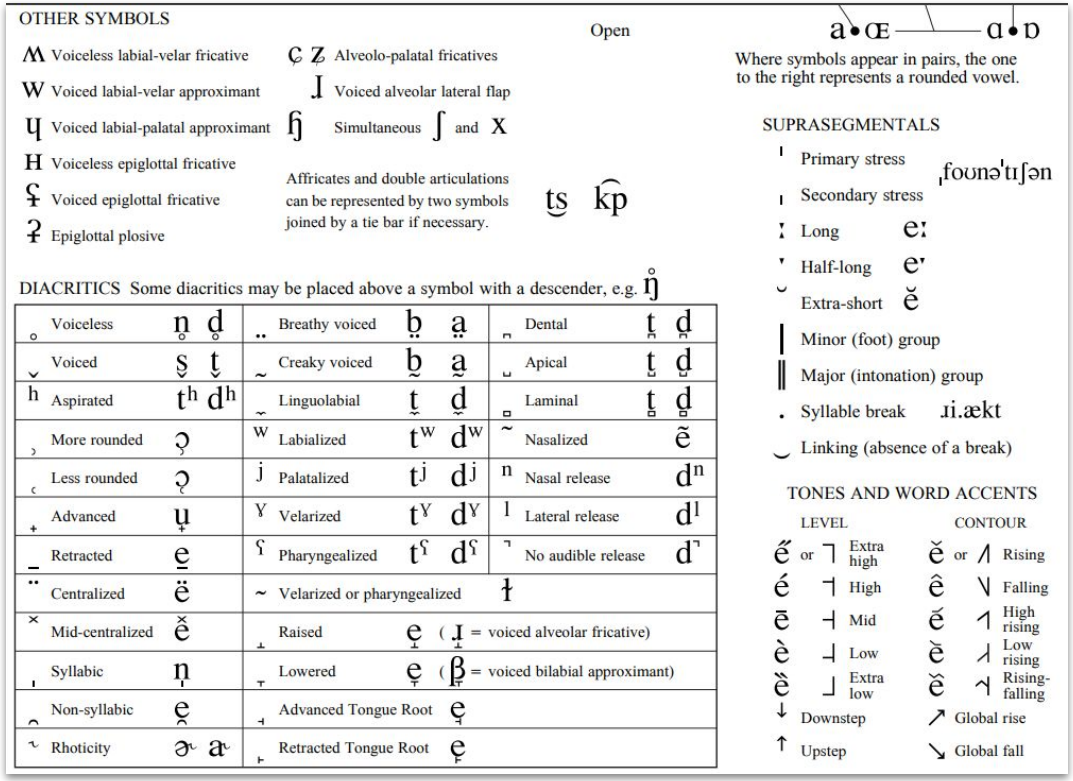
ʍ Voiceless labial-velar fricative ɕ ʑ Alveolo-palatal fricatives

VOWELS

Where symbols appear in pairs, the one

- **The IPA**: The oldest and leading organization for phoneticians.
- **Founded**: 1886 in Paris (130 years in 2016).
- **Milestone**: 2018 marked 130 years since the IPA alphabet’s first publication.

Introduction to Phonetics (IPA)



OTHER SYMBOLS

ʍ Voiceless labial-velar fricative
w Voiced labial-velar approximant
ɥ Voiced labial-palatal approximant
ʜ Voiceless epiglottal fricative
ʢ Voiced epiglottal fricative
ʡ Epiglottal plosive

ɕ ʑ Alveolo-palatal fricatives
ɺ Voiced alveolar lateral flap
ʃ͡ɧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary. t͡s k͡p

Open
a • œ — ɑ • ɒ
Where symbols appear in pairs, the one to the right represents a rounded vowel.

DIACRITICS Some diacritics may be placed above a symbol with a descender, e.g. ŋ̊

◌̥	Voiceless	n̥ d̥	◌̤	Breathy voiced	b̤ a̤
◌̬	Voiced	s̬ t̬	◌̰	Creaky voiced	b̰ a̰
◌ʰ	Aspirated	tʰ dʰ	◌̼	Linguolabial	t̼ d̼
◌̹	More rounded	ɔ̹	◌ʷ	Labialized	tʷ dʷ
◌̜	Less rounded	ɔ̜	◌ʲ	Palatalized	tʲ dʲ
◌̟	Advanced	u̟	◌ˠ	Velarized	tˠ dˠ
◌̠	Retracted	e̠	◌ˤ	Pharyngealized	tˤ dˤ
◌̈	Centralized	ë	◌̴	Velarized or pharyngealized	ɫ
◌̽	Mid-centralized	e̽	◌̝	Raised	e̝ (ɪ̝ = voiced alveolar fricative)
◌̩	Syllabic	n̩	◌̞	Lowered	e̞ (β̞ = voiced bilabial approximant)
◌̯	Non-syllabic	e̯	◌̘	Advanced Tongue Root	e̘
◌˞	Rhoticity	ɚ a˞	◌̙	Retracted Tongue Root	e̙

◌̃	Nasalized	ẽ	
◌ⁿ	Nasal release	dⁿ	
◌ˡ	Lateral release	dˡ	
◌̚	No audible release	d̚	

SUPRASEGMENTALS

ˈ Primary stress ˌfoʊnəˈtɪʃən
ˌ Secondary stress
ː Long eː
ˑ Half-long eˑ
◌̆ Extra-short ĕ
| Minor (foot) group
‖ Major (intonation) group
. Syllable break ɹi.ækt
‿ Linking (absence of a break)

TONES AND WORD ACCENTS

LEVEL		CONTOUR	
e̋ or e᷄	Extra high	ě or e᷅	Rising
é e᷅	High	ê e᷄	Falling
ē e᷆	Mid	e᷈	High rising
è e᷇	Low	e᷉	Low rising
ȅ e᷈	Extra low	e᷊	Rising-falling
↓	Downstep	↗	Global rise
↑	Upstep	↘	Global fall

- The IPA is a universal, precise system for transcribing speech sounds.
- It's not a writing system, but a tool to accurately represent pronunciation in any language.

Introduction to Phonetics (IPA)

The chart is divided into:

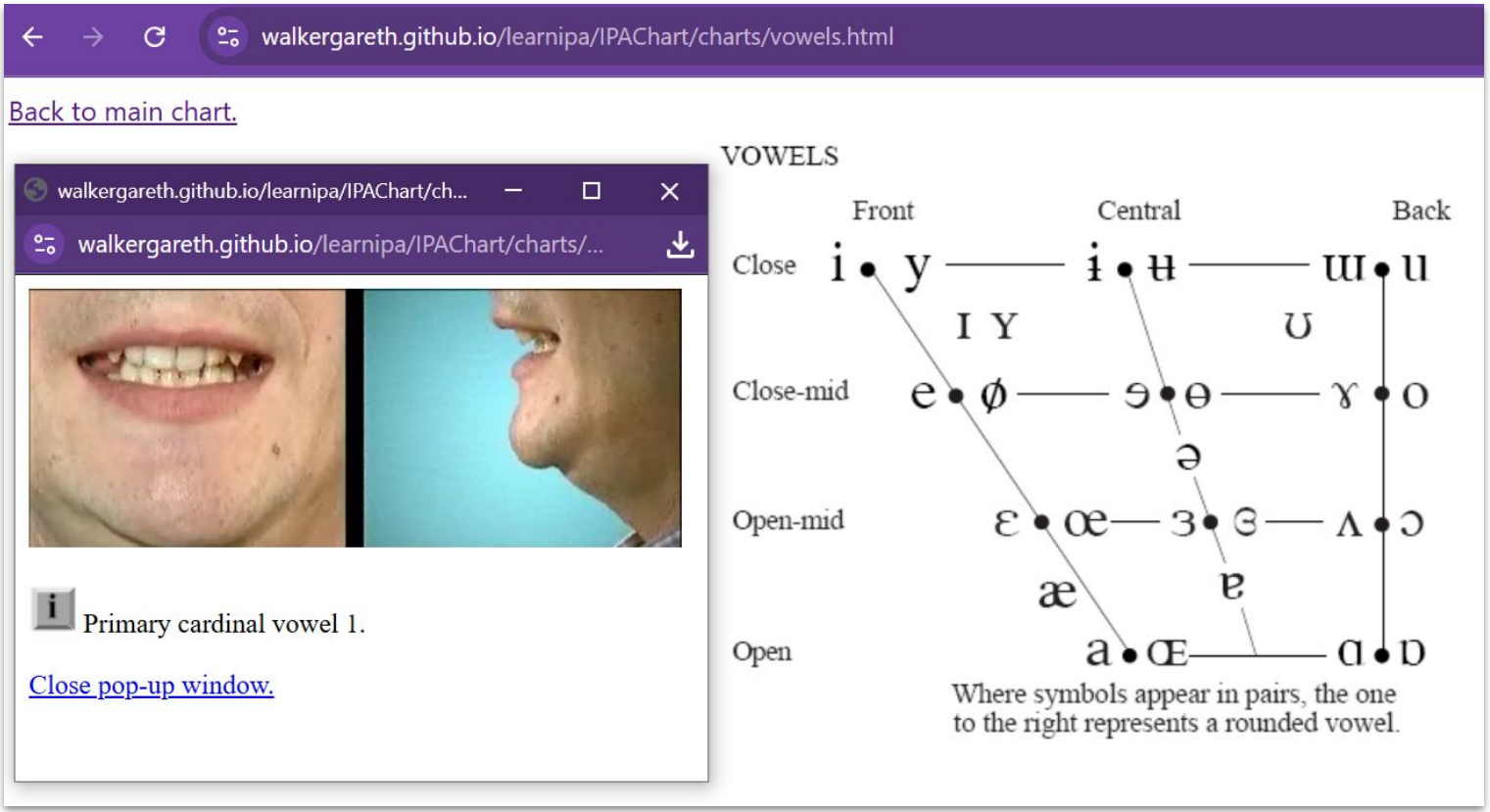
- Consonants (pulmonic), အဆုပ်ကတွန်းထုတ်လိုက်တဲ့လေနဲ့ပြောတဲ့ ဗျည်း
- Consonants (non-pulmonic), အဆုပ်ကလေကိုမသုံးတဲ့ ဗျည်းသံ
- Other symbols (rare/complex consonants)
- Vowels
  - Height: Close (top), Open (bottom)
  - Backness: Front → Central → Back
  - Roundedness: Left symbol unrounded, right symbol rounded
- Diacritics (Voiceless, Aspirated, Nasalized vowel, More rounded vowel, Raised/lowered)
- Suprasegmentals (stress, tone, length, etc.)

Introduction to Phonetics (IPA)

Applications of IPA

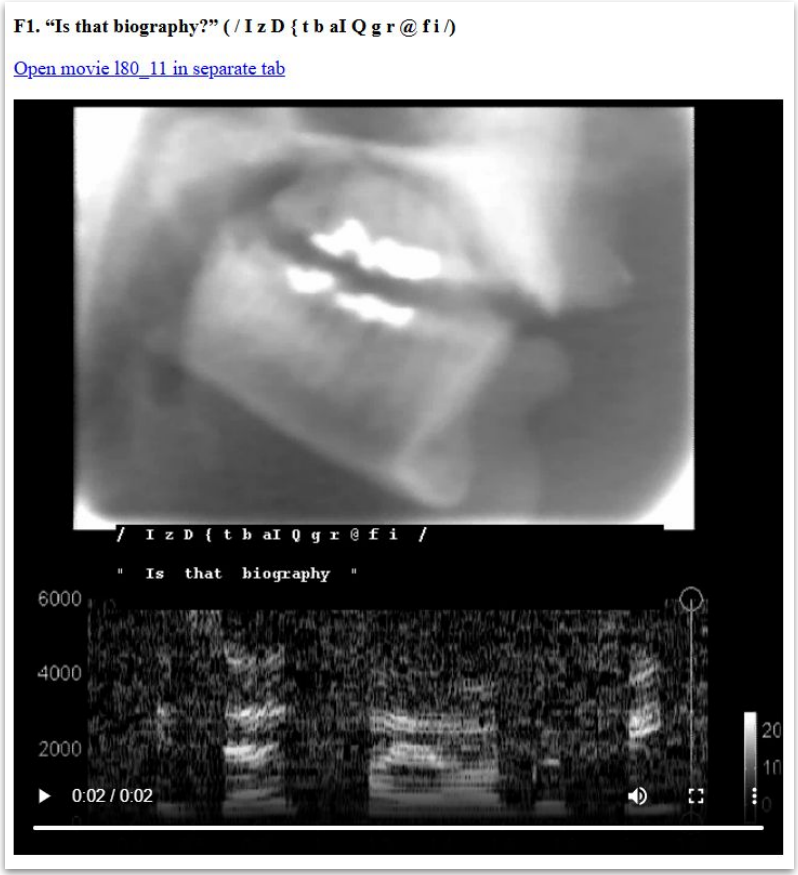
- Linguistics research – precisely describing sounds of any language
- Language teaching – showing learners exact pronunciation
- Dictionaries – e.g., /fəˈnɛtɪks/
- Speech therapy – documenting speech disorders
- Computational linguistics – G2P, TTS, ASR
- Fieldwork – recording endangered languages

Introduction to Phonetics (IPA)



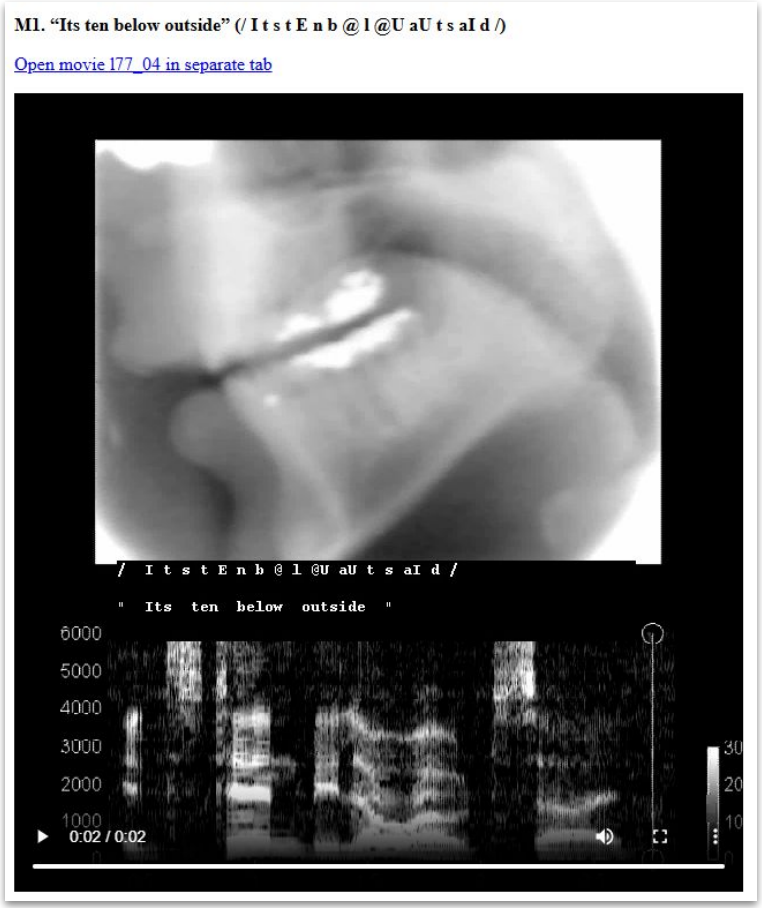
https://walkergareth.github.io/learnipa/IPAChart/charts/vowels.html

Introduction to Phonetics (xray demo)



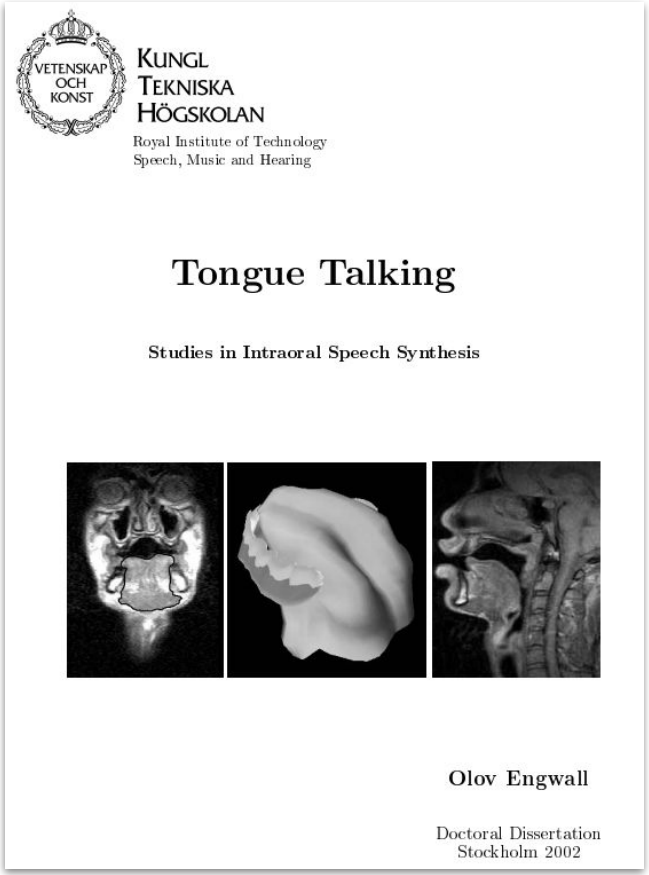
- https://www.phonetik.uni-muenchen.de/~hoole/kurse/movies/xray/xray_demo.html
- F1. “Is that biography?” (/ I z D { t b aI Q g r @ f i /)

Introduction to Phonetics (xray demo)



- https://www.phonetik.uni-muenchen.de/~hoole/kurse/movies/xray/xray_demo.html
- M1. “Its ten below outside” (/ I t s t E n b @ l @U aU t s aI d /)

Introduction to Phonetics (3D simulation)



- Tongue Talking, doctoral thesis, Olov Engwall, 2002

Introduction to Phonetics (3D simulation)

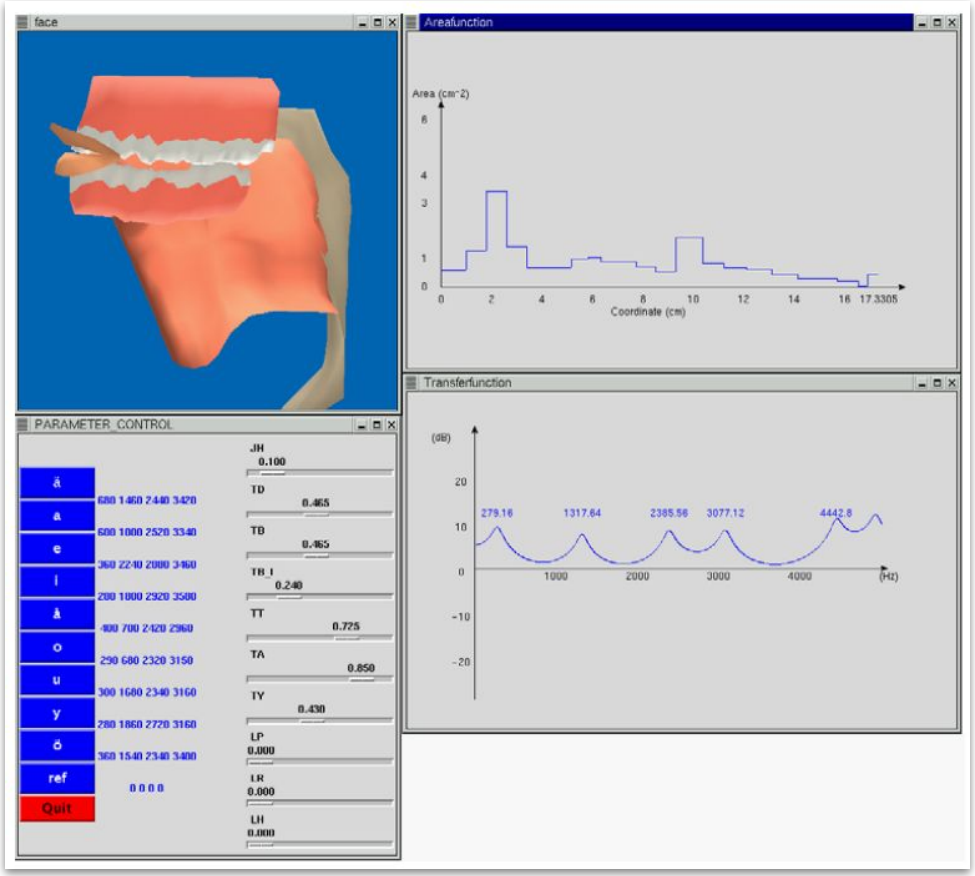
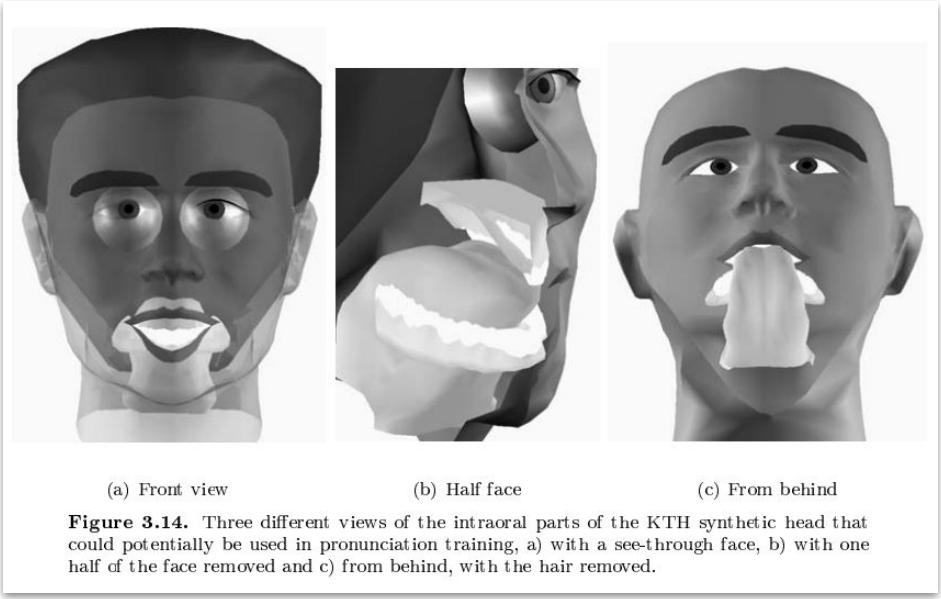


Fig. The graphical interface for the interactie articulatory synthesis, consisting of one window for the vocal tract model, one for the parameter and phoneme control, one for the area function and one for the transfer function.

Introduction to Phonetics (3D simulation)



(a) Front view (b) Half face (c) From behind

Figure 3.14. Three different views of the intraoral parts of the KTH synthetic head that could potentially be used in pronunciation training, a) with a see-through face, b) with one half of the face removed and c) from behind, with the hair removed.

- Tongue Talkin, doctoral dissertation, Olov Engwall
- https://www.diva-portal.org/smash/get/diva2:9174/FULLTEXT01.pdf

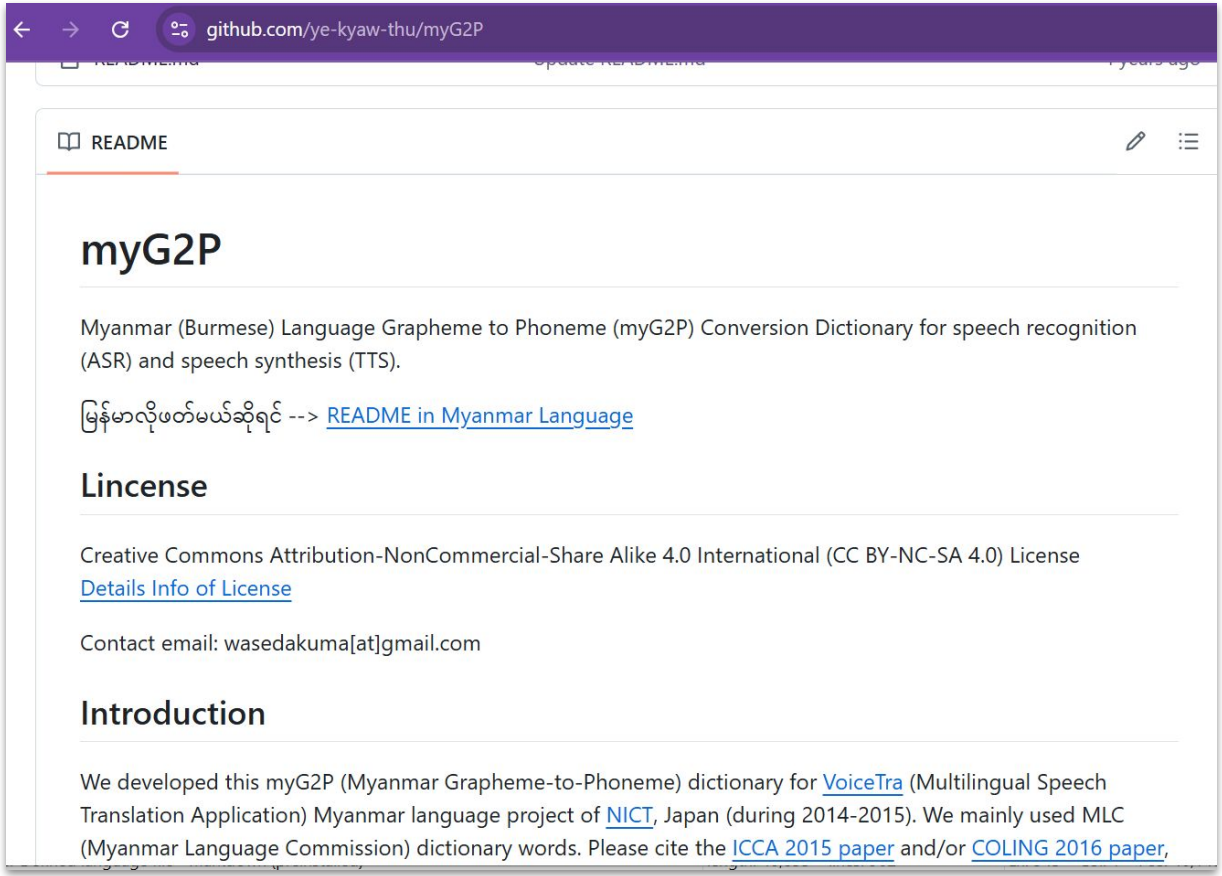
Fig. Three different views of the intraoral parts of the KTH synthetic head that could potentially be used in pronunciation training, a) with a see-through face, b) with one half of the face removed and c) from behind, with the hair removed

Introduction to Phonetics (3D simulation)

Fig. The difference between naive and expert listeners in the confusion matrix for the model's vowels. Stimuli horizontally and response vertically.

	iː	eː	æː	ɑː	ɔː	uː	ʉ̟ː	yː	øː	*Total*
iː	**6**							3	1	*10*
eː	1	**-2**								*-1*
æː			**-3**							*-3*
ɑː		1		**-1**						*0*
ɔː				1	**0**					*1*
uː						**0**	1			*1*
ʉ̟ː							**-2**	8	4	*10*
yː	-7							**-11**		*-18*
øː		1	3				1		**-5**	*0*

Introduction to Phonetics (Example Demo Application)



- Version 2 ကျမှ IPA symbol ကို ထပ်ဖြည့်တယ်
- အဓိက ကူညီပေးခဲ့တာက YTU, Yangon က ဆရာ့ကျောင်းသူတွေပါ (မနီထွေးအောင်၊ ဝင့်သိဂီ၊ ရွှေစင်မိုး …)

Introduction to Phonetics (Example Demo Application)

- စက်ရုပ်သံ TTS ဒီမို လုပ်ပြမယ်
- Linux မှာ ရှိတဲ့ espeak နဲ့ myG2P ကိုပဲ သုံးပြီး လုပ်လို့ ရတယ်
- myG2P က IPA ကို ယူမယ်
- တခုရှိတာက myG2P ရဲ့ IPA က တချို့ကို ဆရာတို့ modify လုပ်တာ၊ ထပ်ဖြည့်တာမျိုး လုပ်ထားတာမို့
- အဲဒါကြောင့် Mapping တချို့ ဖြည့်လုပ်ဖို့ လိုအပ်တယ်
- Python နဲ့ coding လုပ်လိုက်ရင် ဒီမို TTS ရပြီ
- လက်ရှိ လုပ်ထားတာက espeak ရဲ့ English အသံ ဥပဒေတွေကိုပဲ အခြေခံပြီး လုပ်ပြထားတာ ဖြစ်တယ်

Introduction to Phonetics (Example Demo Application)

```
IPA_TO_ESPEAK = {
    # Standard IPA consonants
    'p': 'p', 'b': 'b', 't': 't', 'd': 'd', 'k': 'k', 'g': 'g',
    'm': 'm', 'n': 'n', 'ŋ': 'N', 'f': 'f', 'v': 'v', 'θ': 'T',
    'ð': 'D', 's': 's', 'z': 'z', 'ʃ': 'S', 'ʒ': 'Z', 'h': 'h',
    'tʃ': 'tS', 'dʒ': 'dZ', 'l': 'l', 'r': 'r', 'j': 'j', 'w': 'w',
    'ɕ': 's', 'ʑ': 'z', 'ɲ': 'J', 'ɬ': 'K', 'ɮ': 'H', 'ʍ': 'W',

    # Myanmar-specific consonants
    'ɴ': 'n',  # Myanmar final nasal
    'ɹ': 'r',  # Alternative rhotic
    'ʈ': 't', 'ɖ': 'd',  # Retroflex
    'ɽ': 'r',  # Retroflex flap
    'ɸ': 'f', 'β': 'v',  # Bilabial fricatives
    'ʂ': 'S', 'ʐ': 'Z',  # Retroflex fricatives
    'ʔ': '?', 'ħ': 'h',  # Pharyngeal
    'ʘ': 'p', 'ǀ': 't', 'ǃ': '!', 'ǂ': 'c', 'ǁ': 'l',  # Clicks

    # Vowels
    'i': 'i', 'ɪ': 'I', 'e': 'e', 'ɛ': 'E', 'æ': '&',
    'a': 'a', 'ɑ': 'A', 'ɔ': 'O', 'o': 'o', 'ʊ': 'U', 'u': 'u',
    'ʌ': 'V', 'ə': '@', 'ɚ': '@`', 'ɝ': '3', 'ɜ': '3',
```

- IPA2espeak
- Run လုပ်လိုက်
- Wav ဖိုင် ထုတ်လိုက်
- နားထောင် လိုက်
- Mapping ကို ပြင်လိုက်

Introduction to Phonetics (Example Demo Application)

```
    # Myanmar-specific vowels
    'ɯ': 'M', 'ɤ': '7', 'ɨ': '1', 'ʉ': '2',

    # Tone markers (Myanmar uses these as diacritics)
    '̀': '_L',  # Low tone
    '́': '_H',  # High tone
    '̂': '_R',  # Rising tone
    '̌': '_F',  # Falling tone
    '̄': '_M',  # Mid tone
    '̋': '_HH', # Extra high
    '̏': '_LL', # Extra low

    # Diacritics
    'ʰ': '_h',  # Aspirated
    'ʲ': '_j',  # Palatalized
    'ʷ': '_w',  # Labialized
    'ˠ': '_G',  # Velarized
    'ˤ': '_?',  # Pharyngealized
    '̃': '~',   # Nasalized
    '̥': '_0',  # Voiceless
    '̤': '_t',  # Breathy voice
    '̪': 'd',   # Dental
```

- တကယ်တမ်းခေါင်းစားတာက myG2P မှာထပ်ဖြည့်ထားတဲ့အပိုင်းတွေကို mapping လုပ်ရတဲ့အပိုင်းပါ

Introduction to Phonetics (Example Demo Application)

```
ye@lst-hpc3090:~/exp/vs/ipa2speech$ python ./ipa_my2speech.py --help
usage: ipa_my2speech.py [-h] [--input INPUT] [--output OUTPUT] [--voice VOICE] [--speed SPEED]

Convert IPA (International Phonetic Alphabet) to speech using espeak

options:
  -h, --help       show this help message and exit
  --input INPUT    Input file containing IPA text (one per line) (default: None)
  --output OUTPUT  Output WAV file (if not specified, returns audio data) (default: None)
  --voice VOICE    Voice to use for speech synthesis (default: en-us)
  --speed SPEED    Speech speed in words per minute (default: 120)
ye@lst-hpc3090:~/exp/vs/ipa2speech$
```

Introduction to Phonetics (Example Demo Application)

```
ye@lst-hpc3090:~/exp/vs/ipa2speech$ cat ./test1.ipa.txt
kə tɕʰɪˋɴ
kə já
kə jɪˋɴ
tɕʰɪˊɴ
mʊˋɴ
bə mà
jə kʰàɪɴ
ʃáɴ
ye@lst-hpc3090:~/exp/vs/ipa2speech$
```

- ဆရာ ဘာတွေ ရိုက်ထည့်ထားတာလဲ ဖတ်နိုင်တဲ့သူက ဖတ်ပေးကြပါဦး

Introduction to Phonetics (Example Demo Application)

- ရှေ့က IPA input ဖိုင်ကနေ wave ဖိုင် (i.e. အသံဖိုင်) အဖြစ် ပြောင်းပြမယ်

```
ye@lst-hpc3090:~/exp/vs/ipa2speech$ time python ipa_my2speech.py --input ./test1.ipa.txt --output ./8_ethnics.wav
Using espeak version: eSpeak NG text-to-speech: 1.52.0  Data at: /usr/local/share/espeak-ng-data
Processing IPA text: kə tɕʰɪˋɴ kə já  kə jɪˋɴ tɕʰɪˊɴ mʊˋɴ bə mà  jə kʰàɪɴʃáɴ
Converted IPA to eSpeak: kə tɕʰɪˋɴ kə já  kə jɪˋɴ tɕʰɪˊɴ mʊˋɴ bə mà  jə kʰàɪɴʃáɴ -> k@ ts_hI_Ln k@ ja_H k@ jI_Ln ts_hI_Hn m
U_Ln b@ ma_L j@ k_ha_LIn Sa_Hn
Successfully generated speech and saved to ./8_ethnics.wav

real    0m0.096s
user    0m1.478s
sys     0m0.023s
```

```
ye@lst-hpc3090:~/exp/vs/ipa2speech$ soxi ./8_ethnics.wav

Input File     : './8_ethnics.wav'
Channels       : 1
Sample Rate    : 22050
Precision      : 16-bit
Duration       : 00:00:04.91 = 108191 samples ~ 367.997 CDDA sectors
File Size      : 216k
Bit Rate       : 353k
Sample Encoding: 16-bit Signed Integer PCM

ye@lst-hpc3090:~/exp/vs/ipa2speech$
```

- Soxi command နဲ့ wavefile information ကို ကြည့်လို့ ရတယ်။

Introduction to Phonetics (Example Demo Application)

- Conversion လုပ်ပြီး ရလာတဲ့ wavefile ကို နားထောင်ကြည့်ကြရအောင်
- 8_ethnics.wav

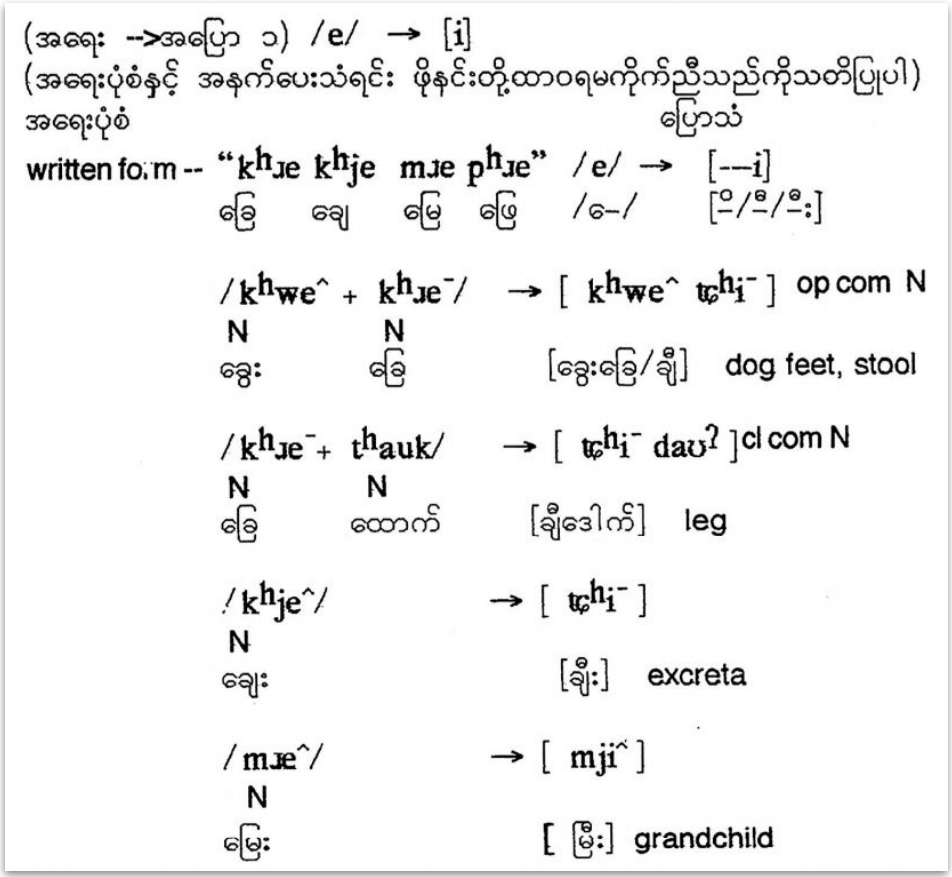
Introduction to Phonetics (Burmese)

- တကယ်တမ်း မြန်မာစာနဲ့ ပတ်သက်တဲ့ phonetic, speech တွေကို လုပ်မယ်ဆိုရင် ဖတ်ကို ဖတ်ကြရလိမ့်မယ်
- သံပြင်း/သံညှင်း ပြောင်းတဲ့ ကိစ္စတွေ
- တနည်းအားဖြင့် G2P ကိစ္စတွေ နဲ့ ပတ်သက်ပြီး အသေးစိတ် study လုပ်ထားတယ်
- စာအုပ် အနေနဲ့ရော၊ PDF ဖိုင်အနေနဲ့ပါ သိမ်းထားတယ်
- လိုအပ်တဲ့အခါမှာ အသုံးဝင်လို့

Introduction to Phonetics (Burmese)

/lã^ + pauʔ/ N V	→	[lʌ̃ m^ bauʔ]cl N ph	
လမ်း ပေါက်		[လမ်းပေါက်]	doorway
/hle¯ + tɕouʊ̃¯/ N V	→	[hle¯ ʤouʊ̃¯]cl N ph	
လှေ ကူး		[လှေကူး]	boat that can be hailed for a free ride
/wuʊ̃¯ + tɕi^/ N V	→	[wʊ̃ɲ¯ ʤi^]cl N ph	
ဝန် ကြီး		[ဝန်ကြီး]	(carrier of heavy duty, heavy burden) minister
/əpjo¯ + tɕʰɔ^/ N V	→	[əpjo¯ ʤɔ^]cl N ph	
အပျို ချော		[အပျိုချော]	beautiful maiden

Introduction to Phonetics (Burmese)


(အရေး -->အပြော ၁) /e/ → [i]
(အရေးပုံစံနှင့် အနက်ပေးသံရင်း ဖိုနင်းတို့ထာဝရမကိုက်ညီသည်ကိုသတိပြုပါ)
အရေးပုံစံ ပြောသံ
written form -- "$k^hɹe$ k^hje mɹe $p^hɹe$" /e/ → [--i]
ခြေ ချေ မြေ ဖြေ /e-/ [ိ/ီ/ီး]

/$k^hwe^$ + $k^hɹe^-$/ → [$k^hwe^$ $tɕ^hi^-$] op com N
N N
ခွေး ခြေ [ခွေးခြေ/ချီ] dog feet, stool

/$k^hɹe^-$+ t^hauk/ → [$tɕ^hi^-$ $dauʔ$] cl com N
N N
ခြေ ထောက် [ချီဒေါက်] leg

/$k^hje^$/ → [$tɕ^hi^-$]
N
ချေး [ချီး] excreta

/mɹe^/ → [mji^]
N
မြေး [မြီး] grandchild

- မြန်မာစာမှာက ရေးတဲ့အတိုင်း မဖတ်တာတွေ အများကြီးပဲ
- ရေးတော့အမှန် ဖတ်တော့ အသံ
- Rule နဲ့ လုပ်ကြည့်ခဲ့တယ်
- Exceptional rule တွေ အများကြီးပါပဲ
- ဆရာ့ G2P paper မှာ ဖော်ပြထားပါတယ်

Introduction to Phonetics (Phonetic vs Phonology)

Phonetic

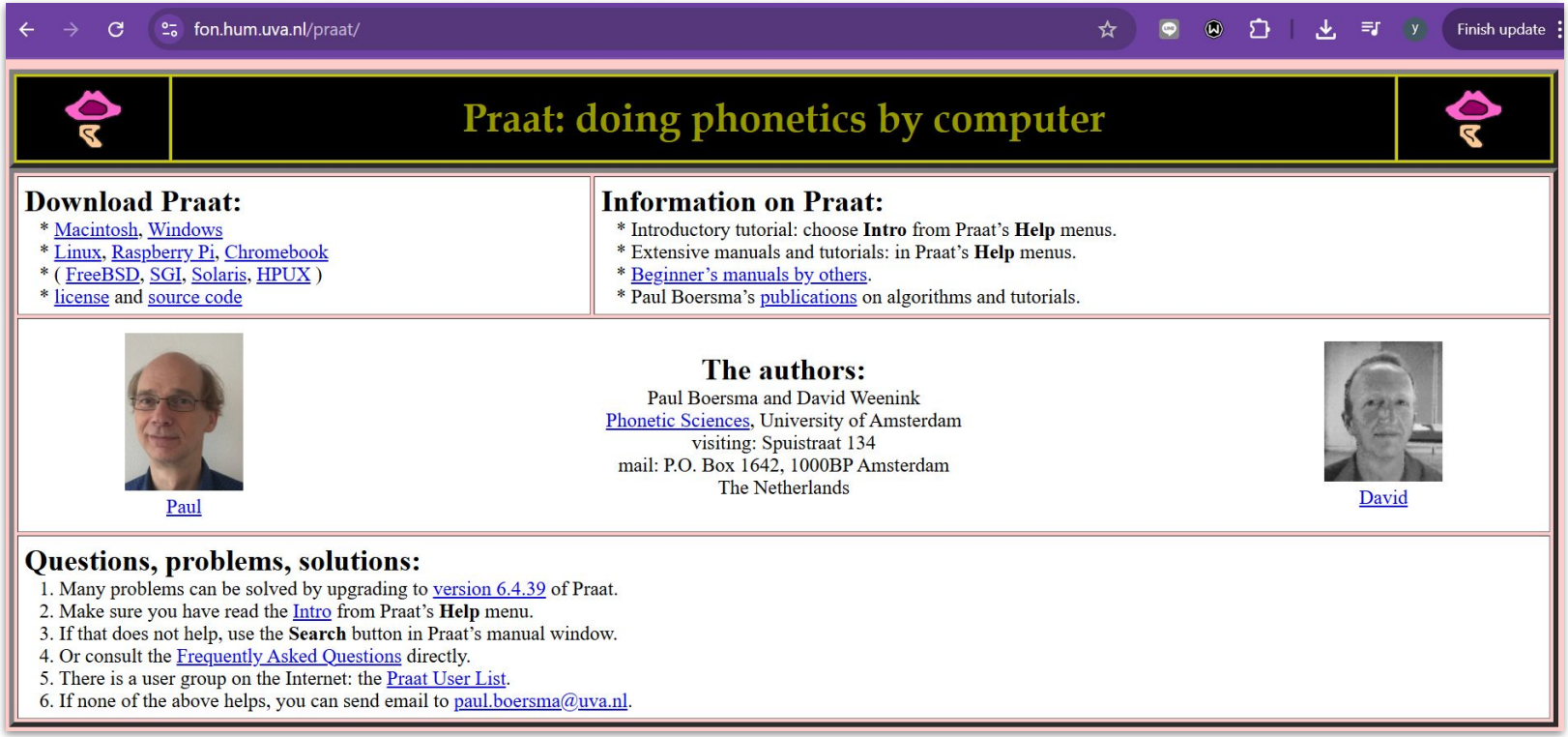
- Studies the physical aspects of speech sounds: how they’re produced (articulation), transmitted (acoustics), and perceived (hearing).
- Focuses on all possible sounds humans can make, regardless of language.
- Example: Analyzing how the tongue moves for the "t" sound in "tea" vs. "tree."

Introduction to Phonetics (Phonetic vs Phonology)

Phonology

- Studies how sounds function systematically in a particular language.
- Focuses on meaningful sound patterns (e.g., why "pat" and "bat" are distinct words in English).
- Example: The rule that English plural "-s" sounds like /s/ (cats) or /z/ (dogs).
- **TL;DR**: Phonetics = raw sounds; Phonology = sound rules in a language.

Praat



Praat Homepage: https://www.fon.hum.uva.nl/praat/

Praat (Useful Shortcuts)

Windows	Mac	Function
`Tab`	`Tab`	Play from cursor/selected portion
`Ctrl+I`	`Command+I`	Zoom in
`Ctrl+O`	`Command+O`	Zoom out
`Ctrl+N`	`Command+N`	Zoom to selected portion
`Ctrl+A`	`Command+A`	Show all (zoom full range)
`Ctrl+B`	`Command+B`	Zoom back (previous zoom level)
`Enter`	`Return`	Add boundary at cursor
`Alt+Backspace`	`Option+Delete`	Delete selected boundary
`Ctrl+R`	`Command+R`	Run a script
`Ctrl+T`	`Command+T`	Run selected portion of a script

- Praat ကို စသုံးစမှာ ခက်လိမ့်မယ်
- Shortcut key တွေကို သိထားမှ အလုပ်လုပ်ရတာ အဆင်ပြေလိမ့်မယ်
- Alt+Backspace (Windows) or Option+Delete (Mac) for boundary delection

Preparing Myanmar Language Vowels

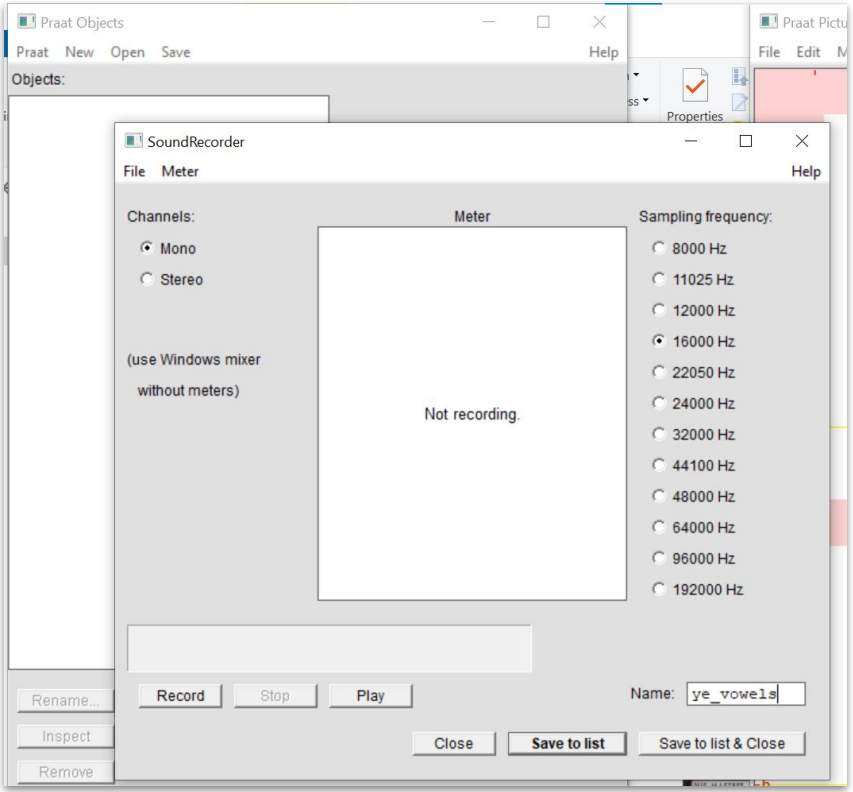
- အ၊ အာ၊ အိ၊ အီ၊ အု၊ အူ၊ အေ၊ အဲ၊ အော
- လေ့လာမိသလောက်၊ တကယ်တမ်းက (အ အာ အိ အု အေ အဲ အော) နဲ့တင် လုံလောက်ပါတယ်
- Coding လုပ်ဖို့အတွက်က Unicode နံပါတ်တွေပါ သိထားသင့်တယ်
- a (\u0061), ɑ (\u0069), i (\u0069), u (\u0075), e (\u0065), ɛ (\u025B), o (\u0075)

Preparing Myanmar Language Vowels

Myanmar Vowel	IPA	Explanation
အ	/a/	Central low vowel
အာ	/ɑ/	Low back vowel
အိ / အီ	/i/	High front vowel
အု (ဥ) / အူ (ဦ)	/u/	High back vowel
အေ / ဧ	/e/	Mid front vowel
အဲ	/ɛ/	Open-mid front vowel
အော / ဩ	/o/	Close-mid back vowel

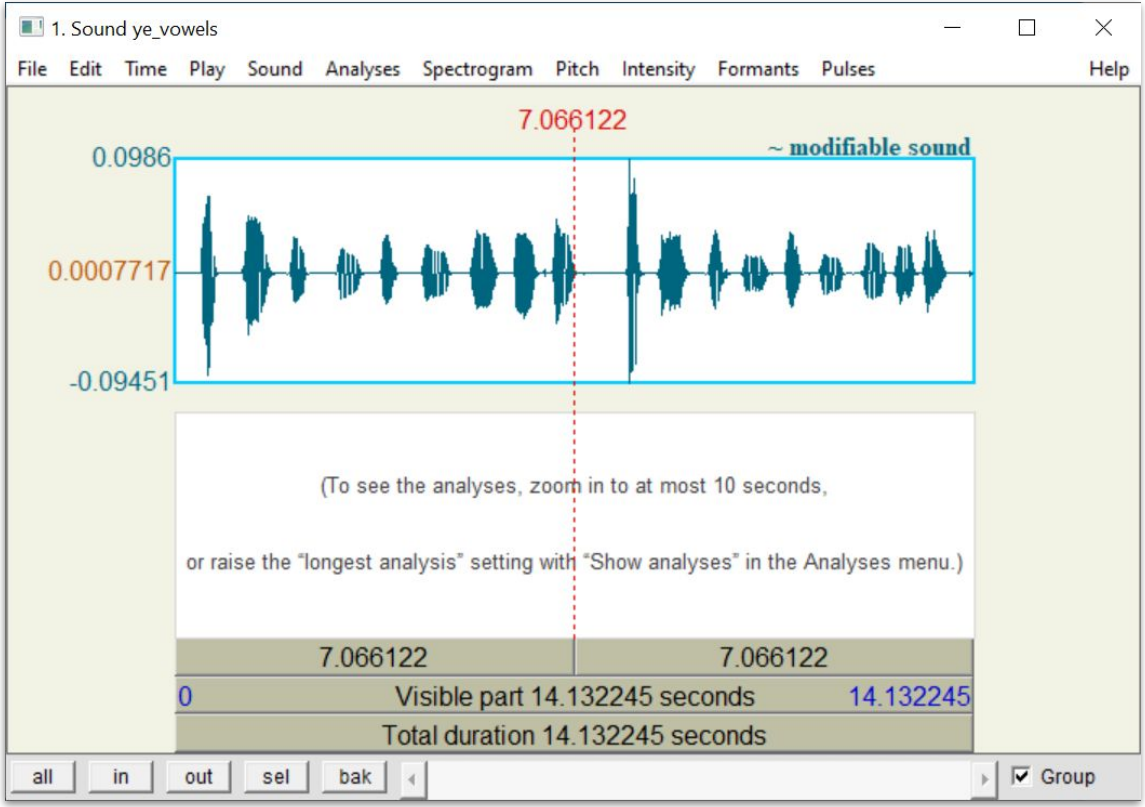
- အားလုံး ညီအောင်ညှိပြီး recording လုပ်ကြပါ
- လက်ရှိအတိုင်း အ၊ အာ၊ အိ၊ အု၊ အေ၊ အဲ၊ အော ဆိုပြီး အသံသွင်းလည်း အဆင်ပြေပါတယ်
- သို့မဟုတ် အ၊ အာ၊ အိ၊ အီ၊ အု၊ အူ၊ အေ၊ အဲ၊ အော၊ အော်၊ အံ၊ အား ဆိုပြီး အသံသွင်းကြမယ် ဆိုရင်လည်း အားလုံးညှိပြီး လုပ်ကြပါ

Recording



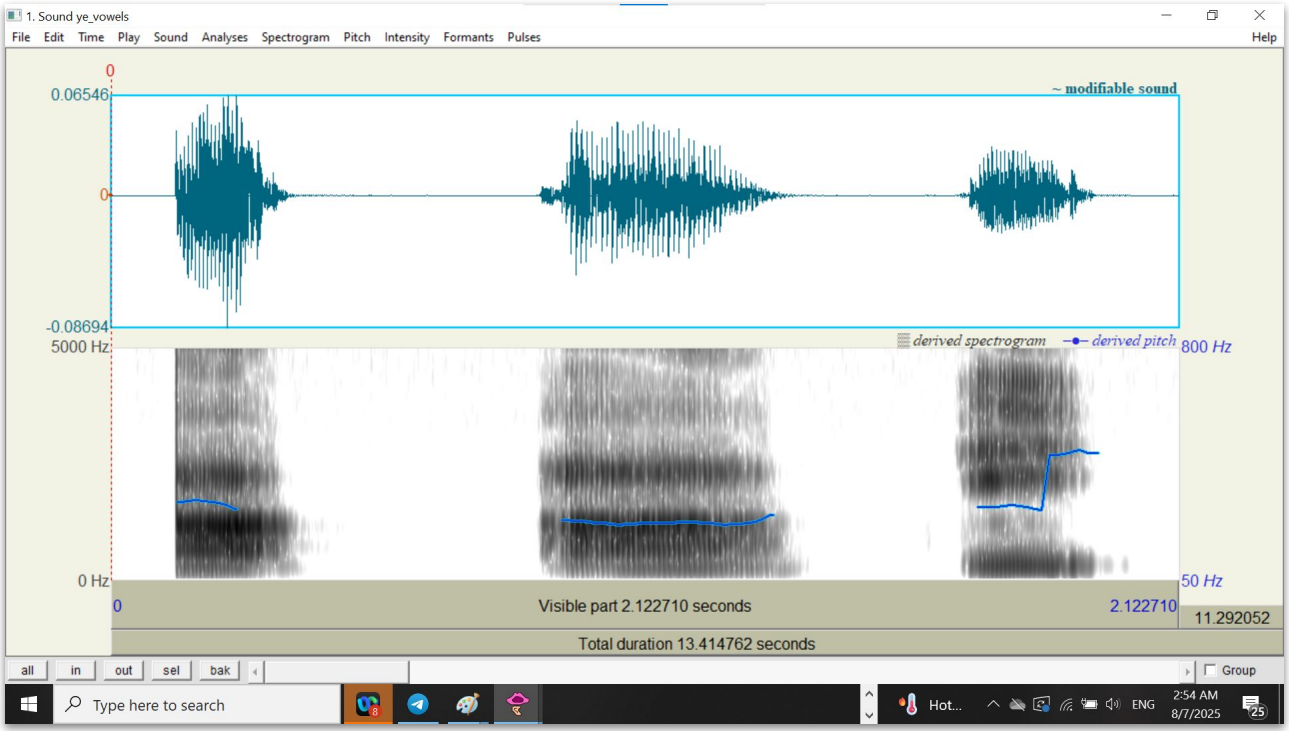
- အဆင်ပြေတဲ့ recorder နဲ့ recording လုပ်လို့ ရတယ်
- Praat ကို သုံးပြီး လုပ်တာက ပိုကောင်းတယ်
- Noise မများတဲ့ နေရာမှာ အသံသွင်းပါ

Formant Tracking



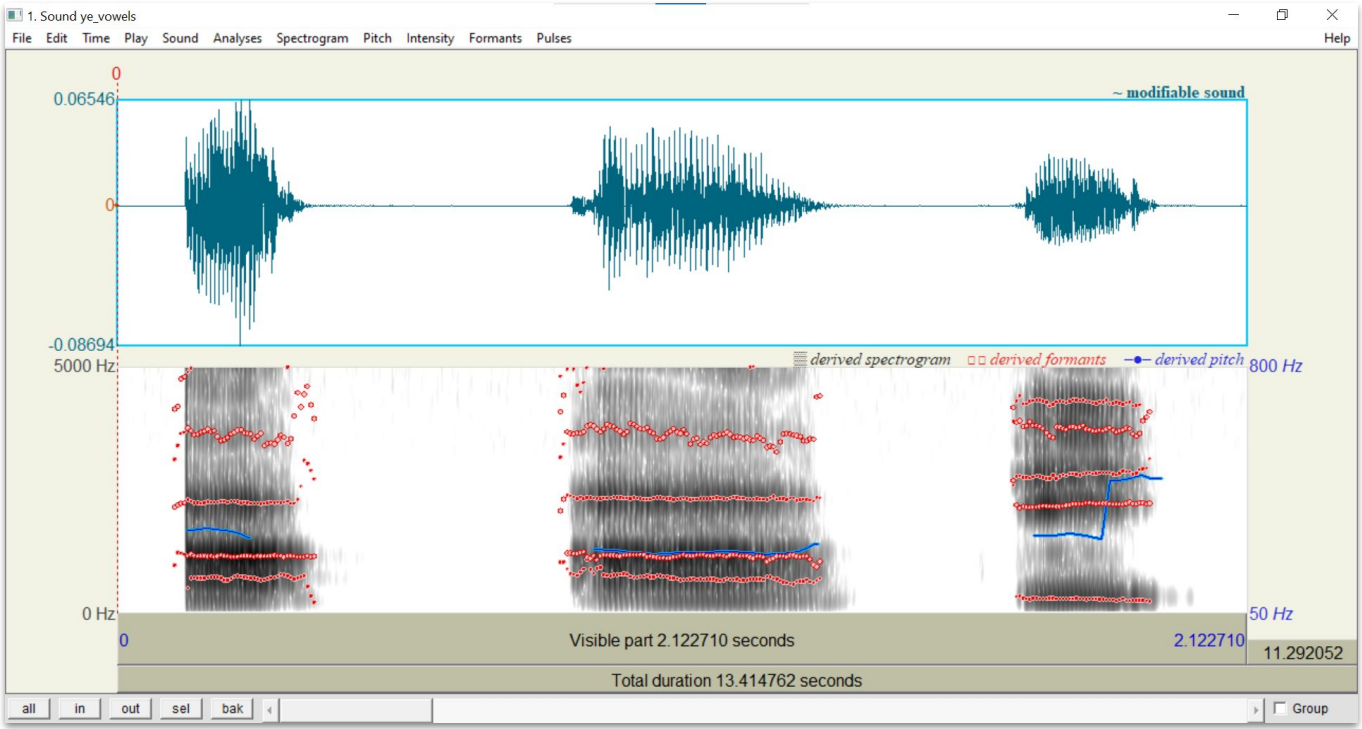
- အ၊ အာ၊ အီ၊ အီ၊ အူ၊ အူ၊ အေ၊ အဲ၊ အော
- နှစ်ခါ အသံသွင်းခဲ့တယ်

Formant Tracking



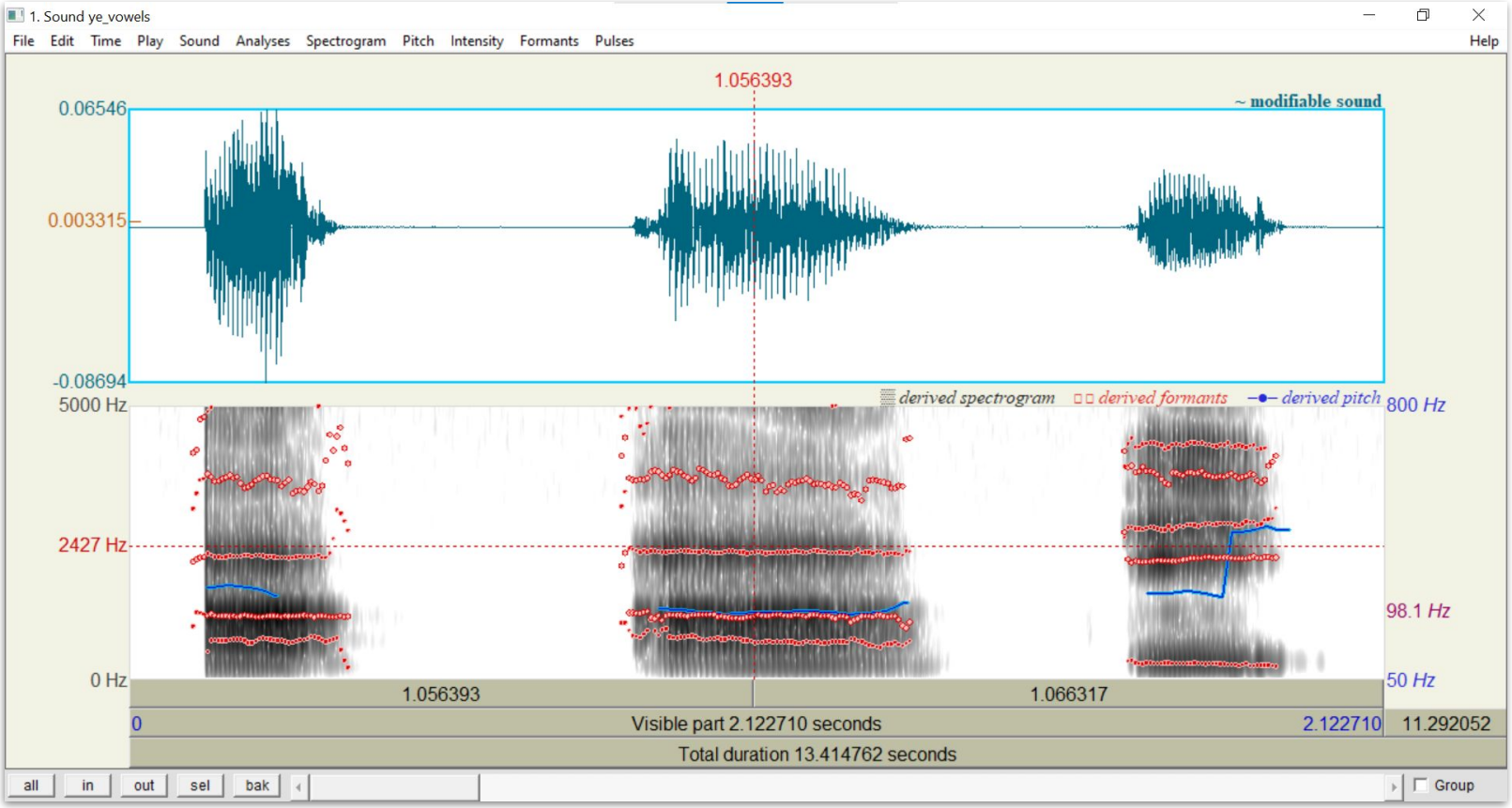
- Selection မှတ်ထားတဲ့ အပိုင်းကို Ctrl+N နဲ့ Zoom in လုပ်ကြည့်ပြီး Vowel sound တွေကို လေ့လာပါ

Formant Tracking

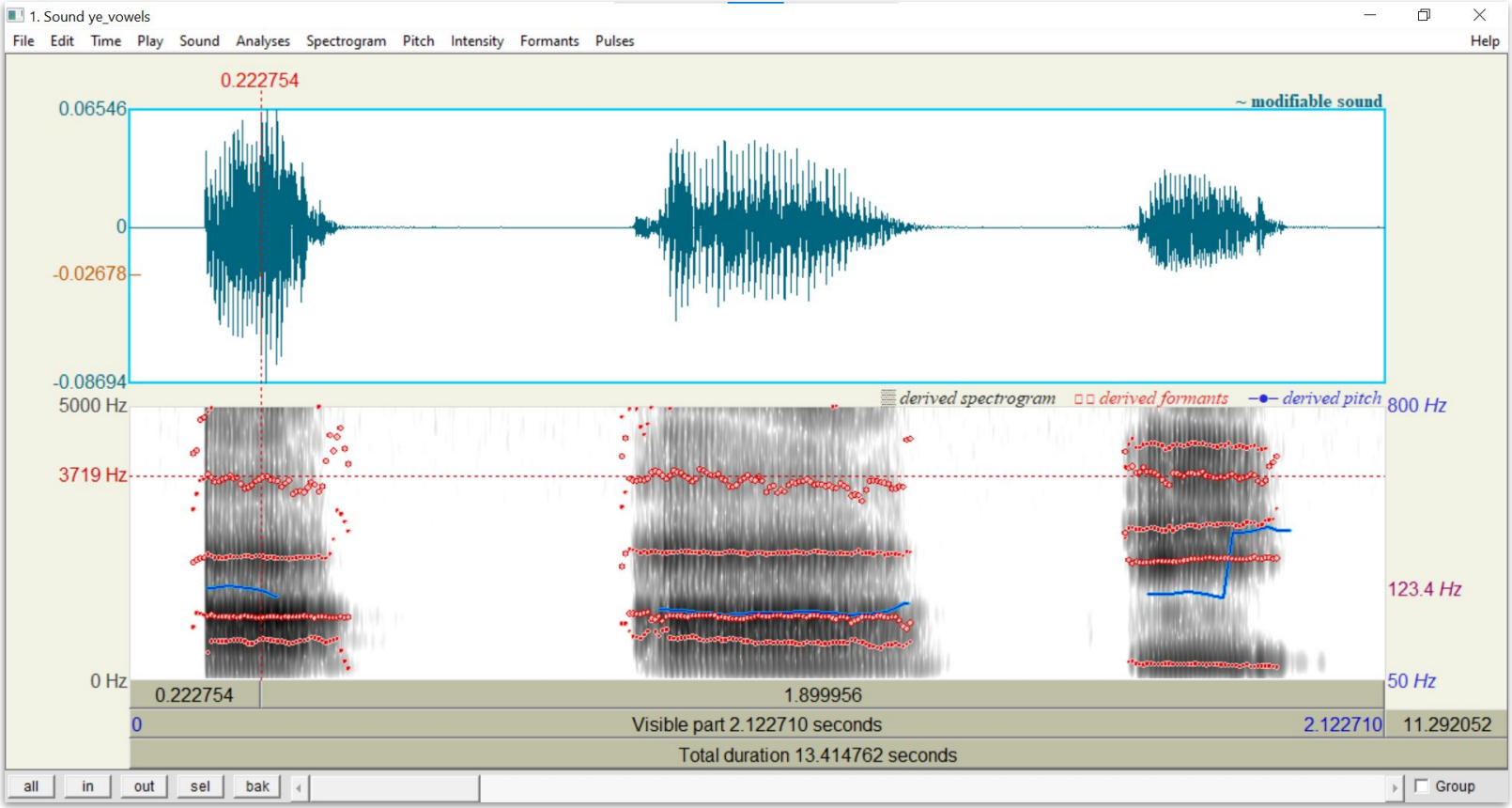


- Formants menu အောက်က Show formants ကို နှိပ်လိုက်ရင် formant line တွေကို အနီရောင်နဲ့ ပြပေးမယ်

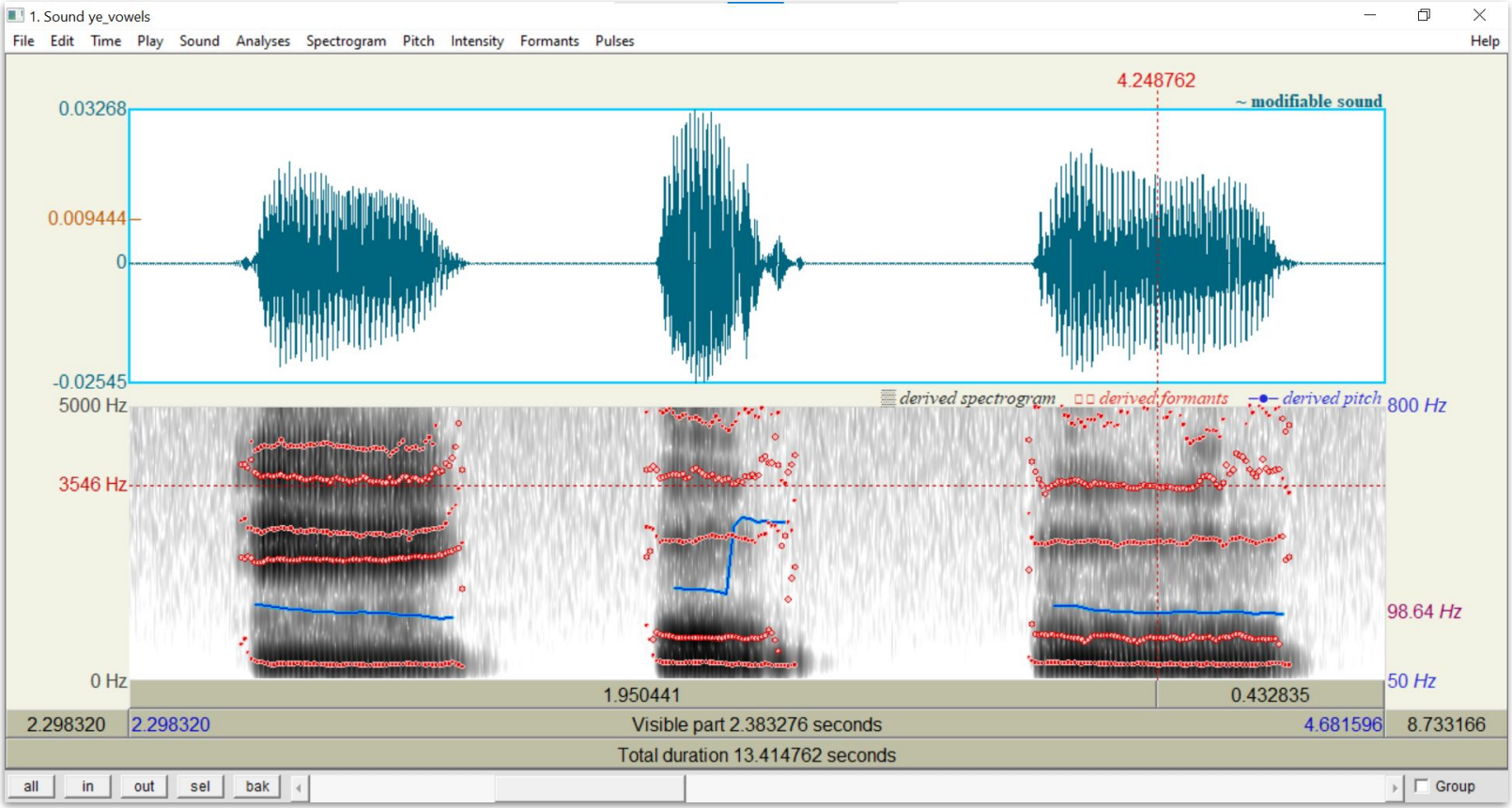
Formant Tracking



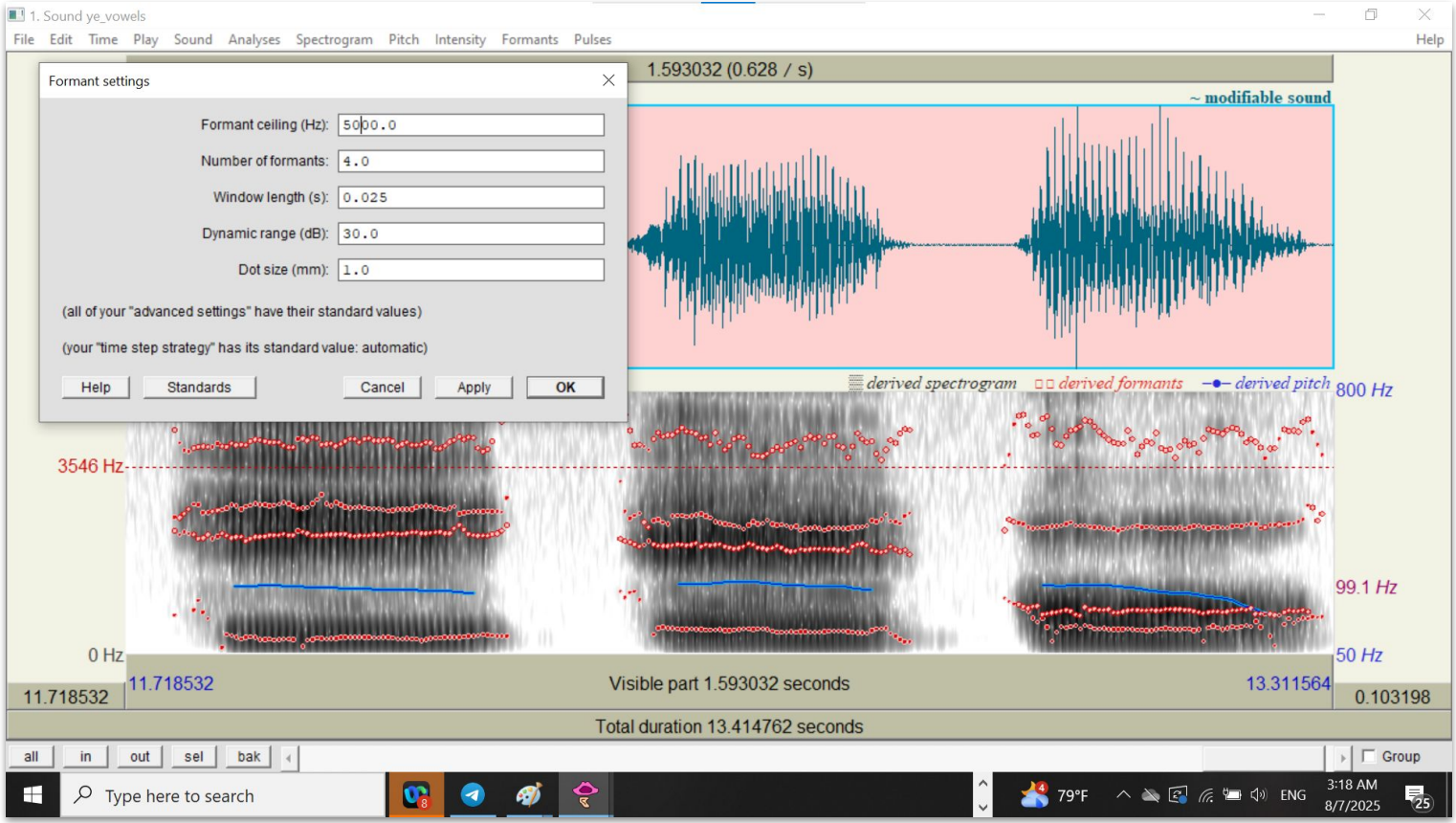
Formant Tracking



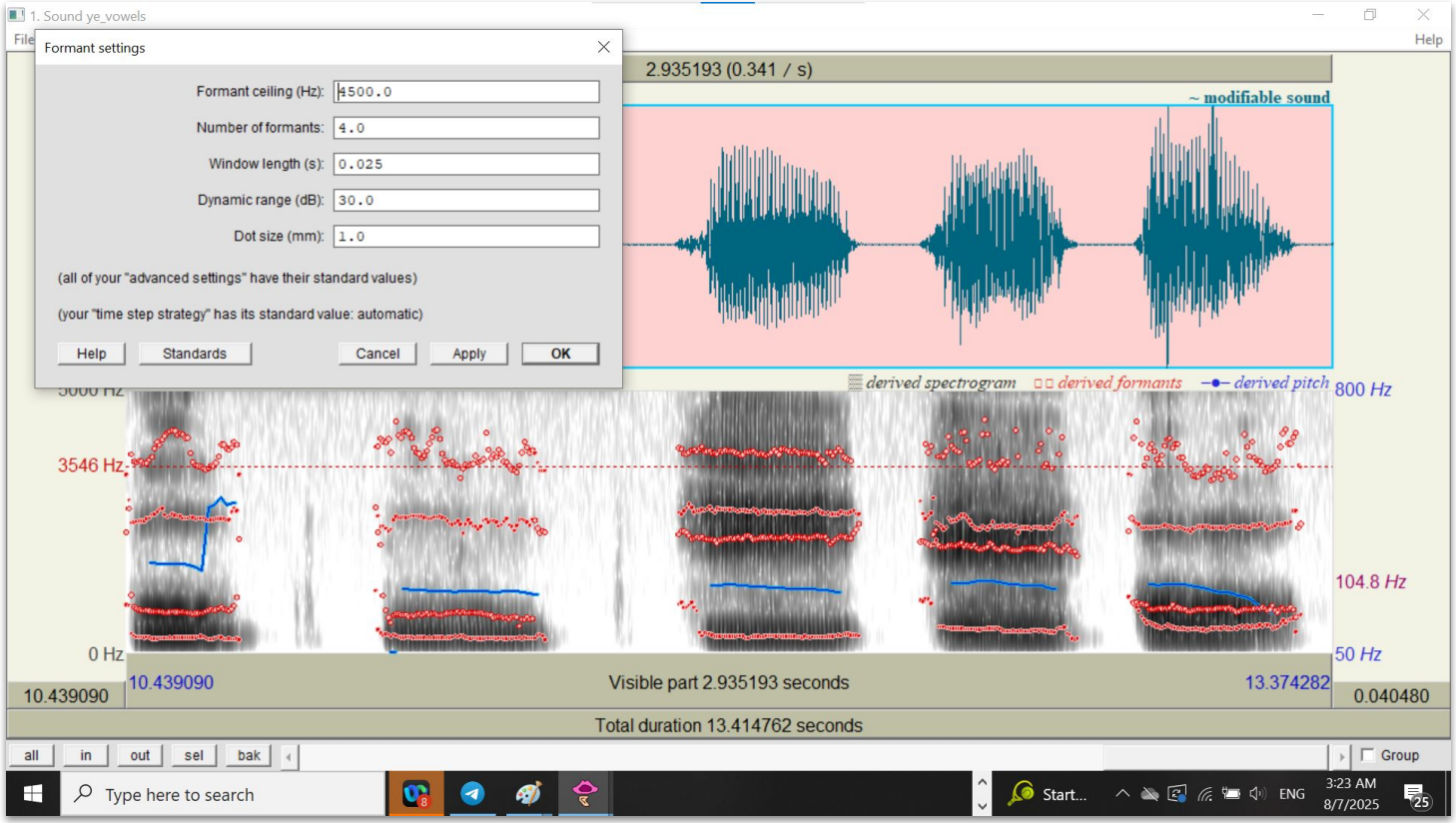
Formant Tracking (Check OK?!)



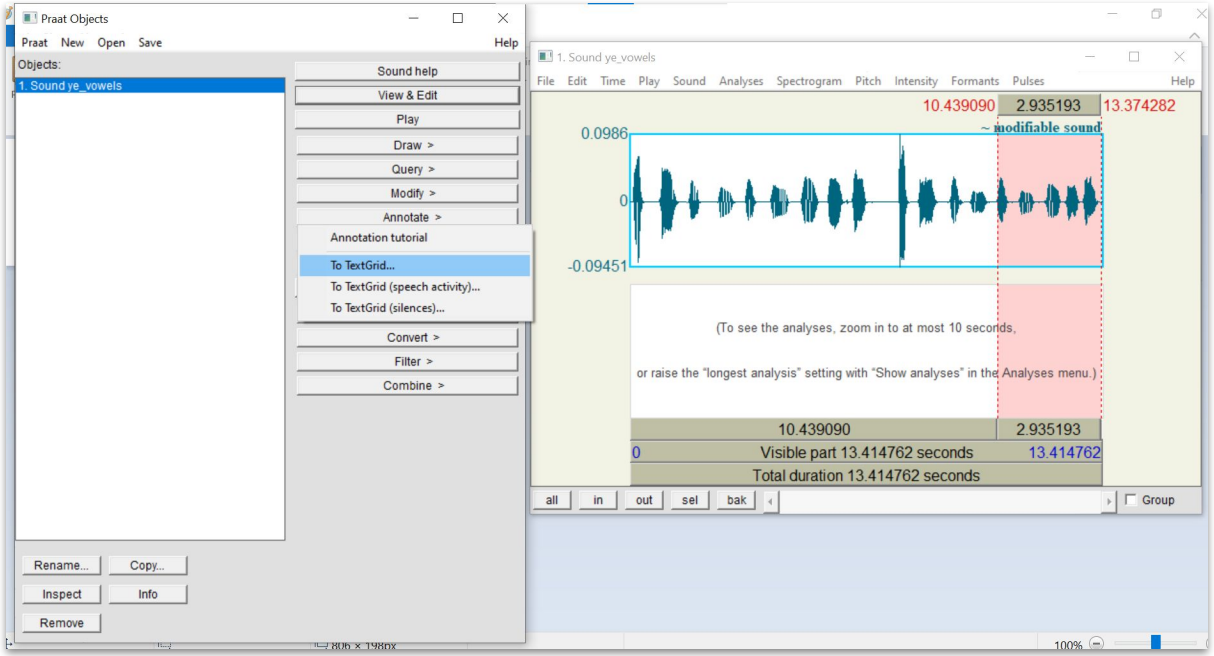
Formant Tracking (setup, 5500 for female, 5000 for male)



Formant Tracking (You have to adjust formant settings)

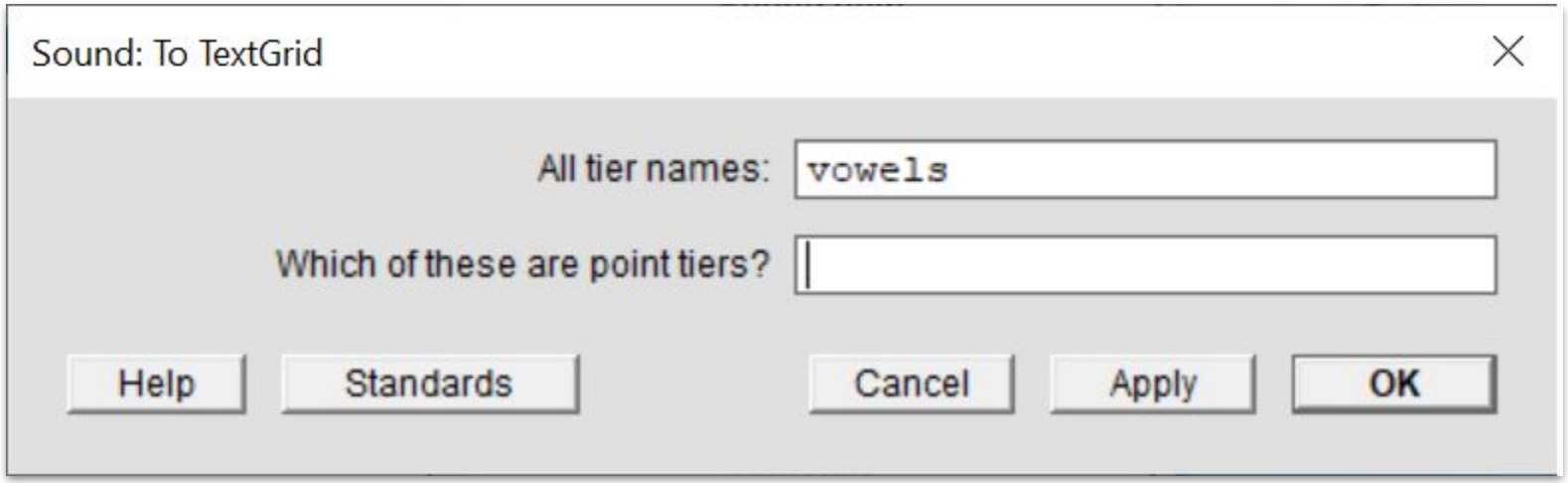


Annotation



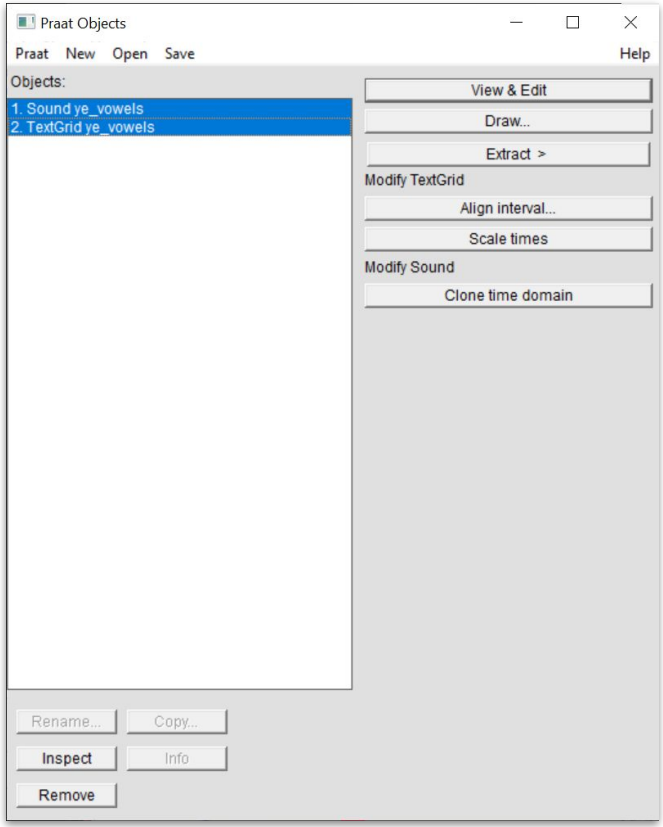
- ဒီနေရာမှာ annotation ဆိုတာက အသံသွင်းထားတဲ့ အ၊ အာ၊ အု စတာတွေကို တစ်ပိုင်းချင်းစီ ဘယ်အသံက ဘာဆိုတာကို လေဘယ်ထိုးတဲ့ အလုပ်ပါ

Annotation (Single tier is OK)



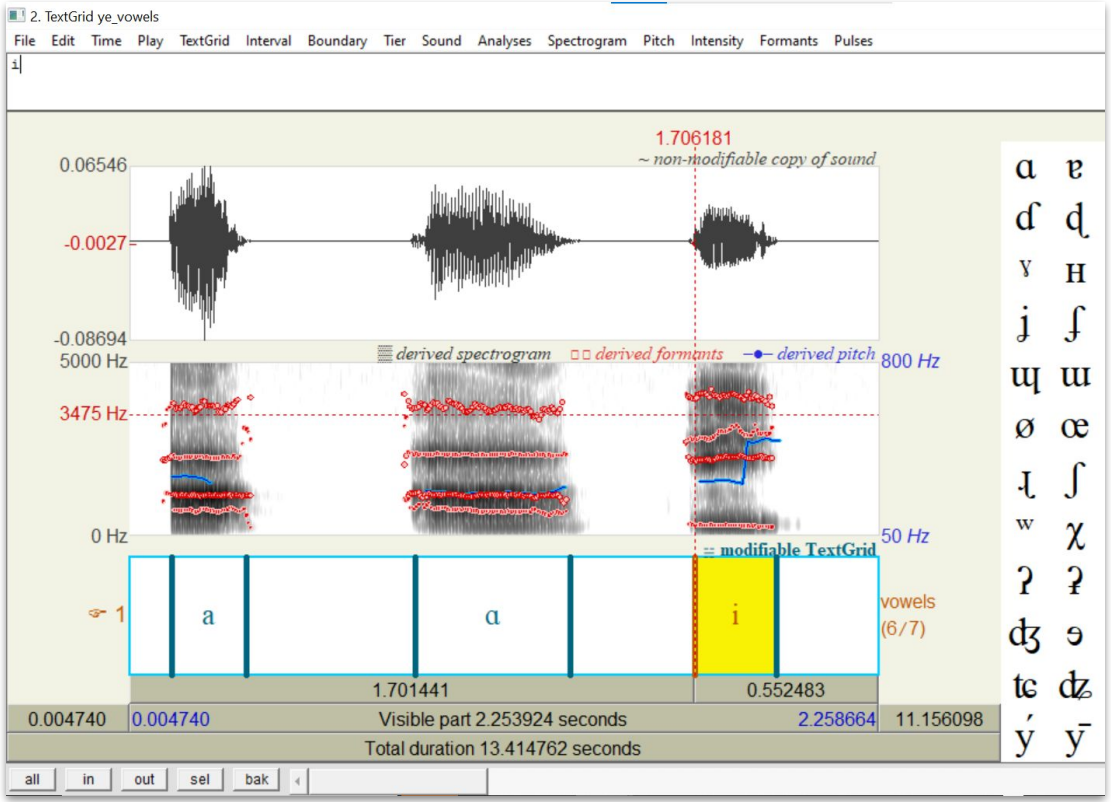
- Tier က တစ်ခုပဲ ထားပါ။ vowels ဆိုပြီး နာမည်ပေးပြီးတော့။
- Which of these are point tiers? ဆိုတဲ့ textbox ကိုတော့ blank လုပ်ပါ။

Annotation



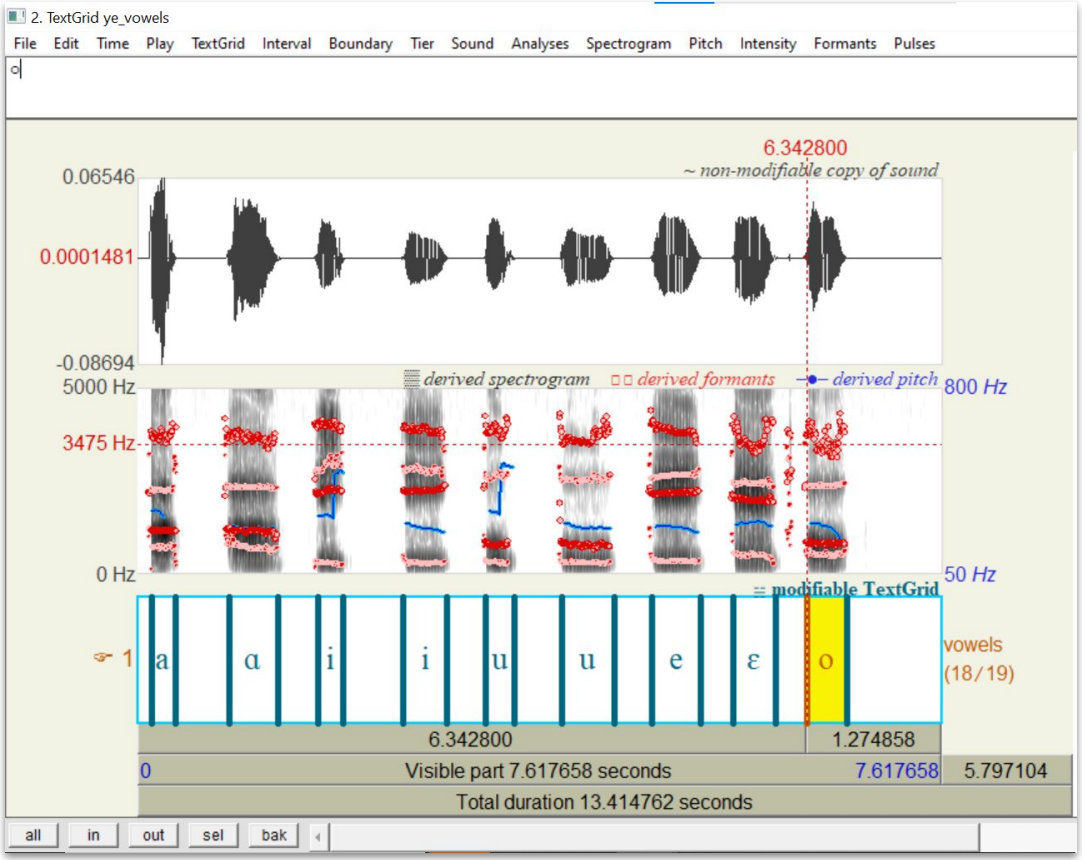
- Sound ရော textGrid ရော နှစ်မျိုးစလုံးကို selection မှတ်ပါ
- ပြီးမှ Annotation လုပ်ပါ

Annotation



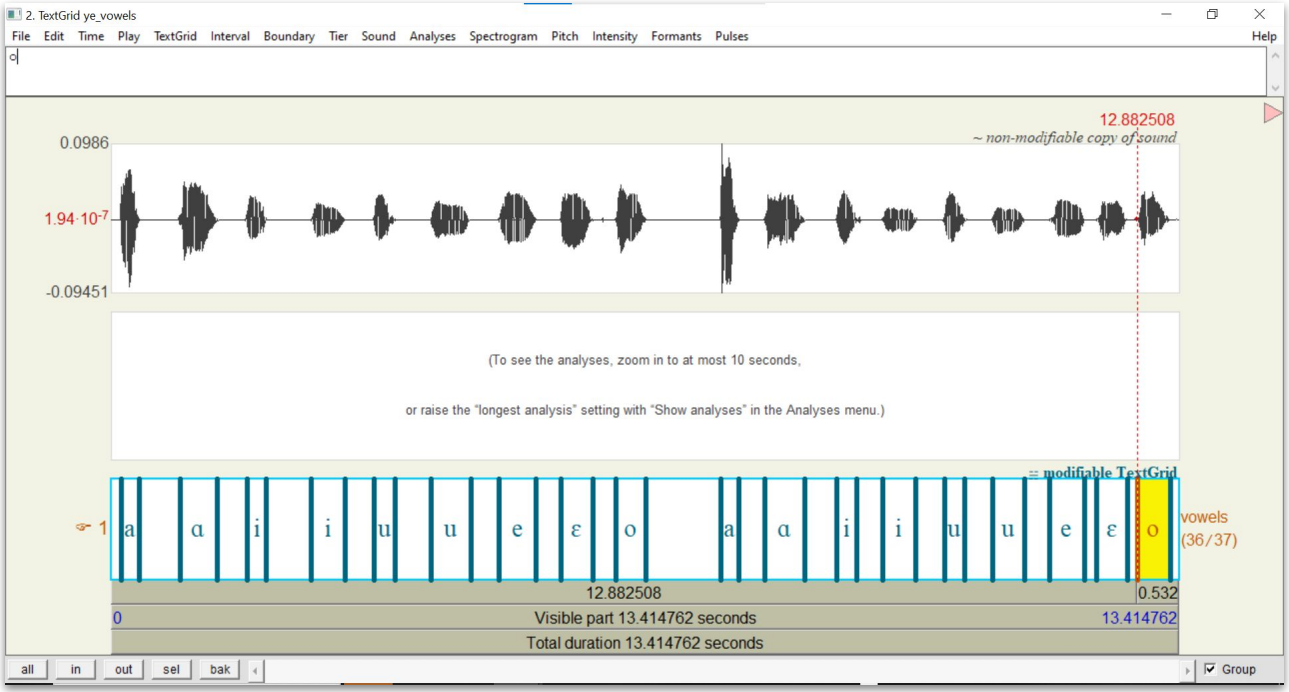
- IPA နဲ့ မထိုးနိုင်ရင်လည်း Roma character နဲ့ ထိုးလည်း ရပါတယ်

Annotation



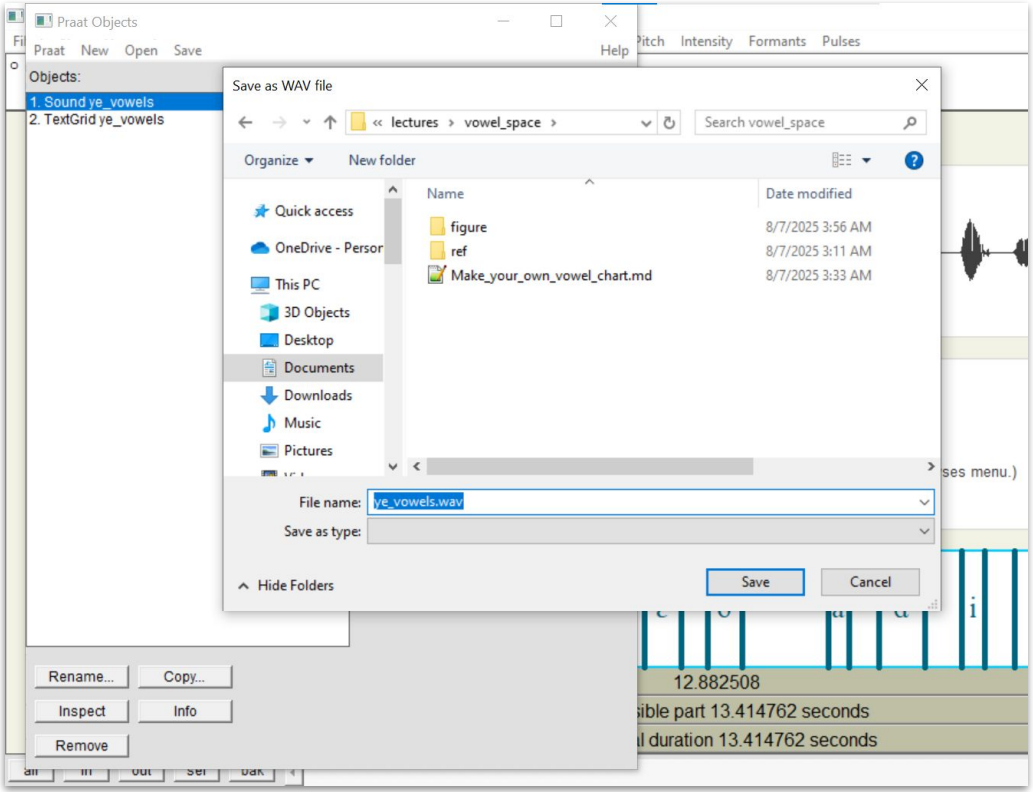
- Annotation လုပ်ထားတာတွေကို ပြန်စစ်ပါ
- Formant တွေကိုလည်း ပြန်စစ်ပါ

Annotation



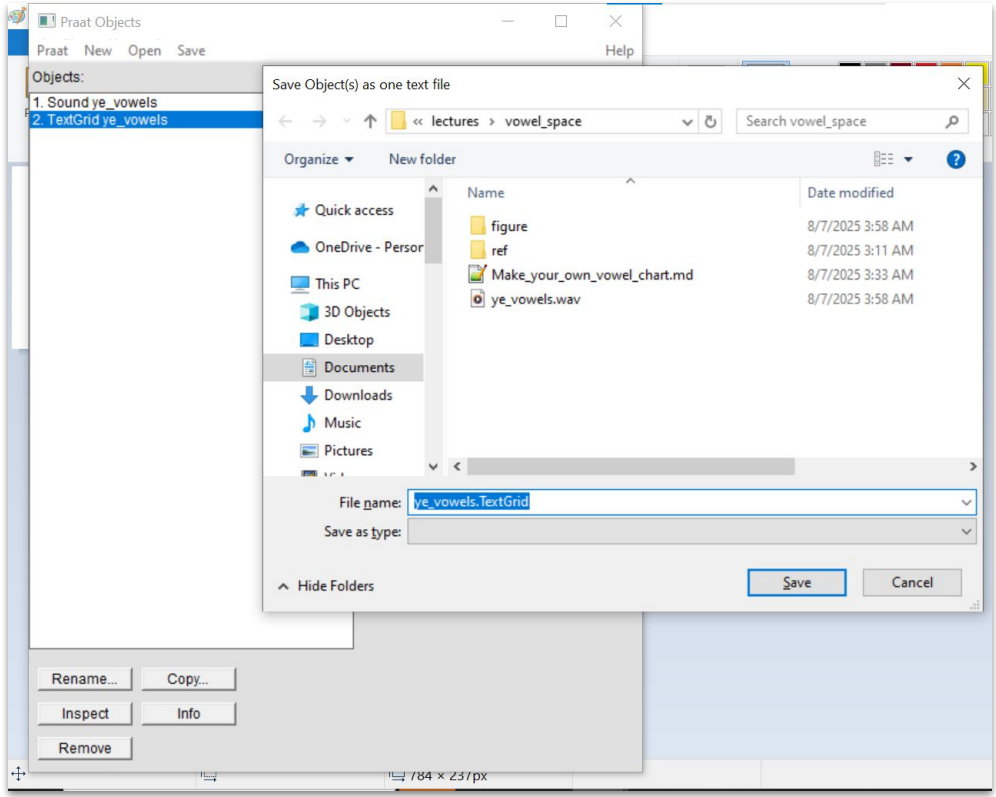
- Vowel အသံအားလုံးကို segmentation လုပ်ပြီး annotation လုပ်ပြီးပြီလား စစ်ပါ

Annotation



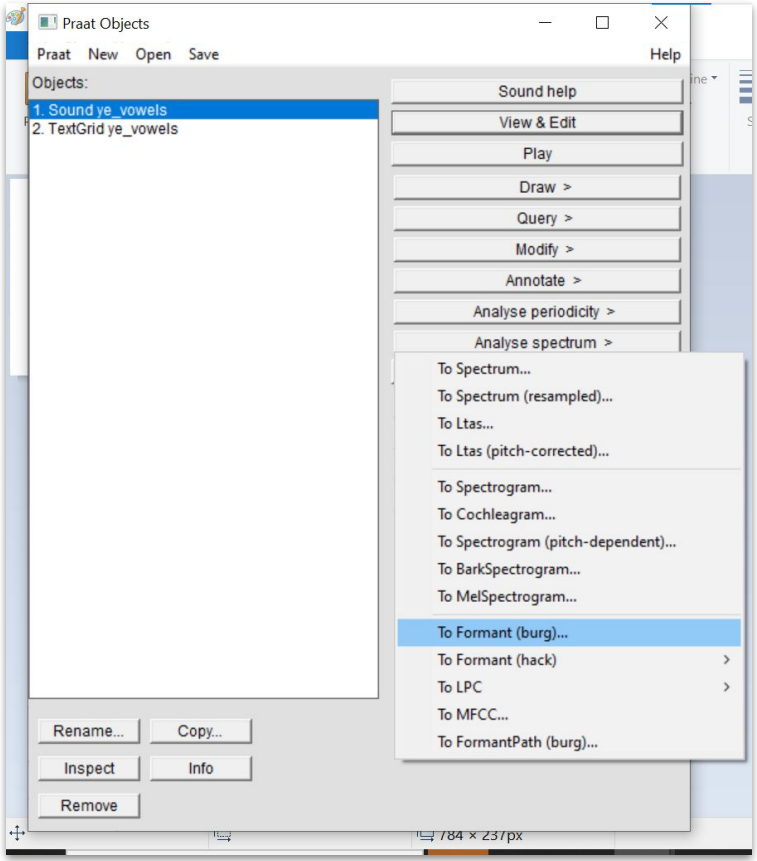
- Wavefile saving

Annotation



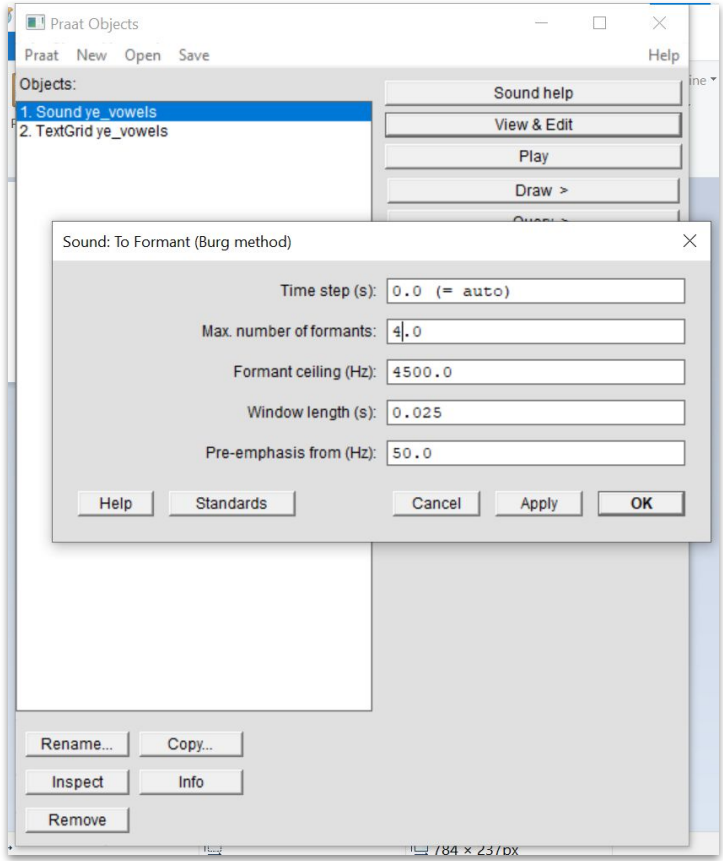
- textGrid file saving

Annotated Spectrum to F1, F2, F3



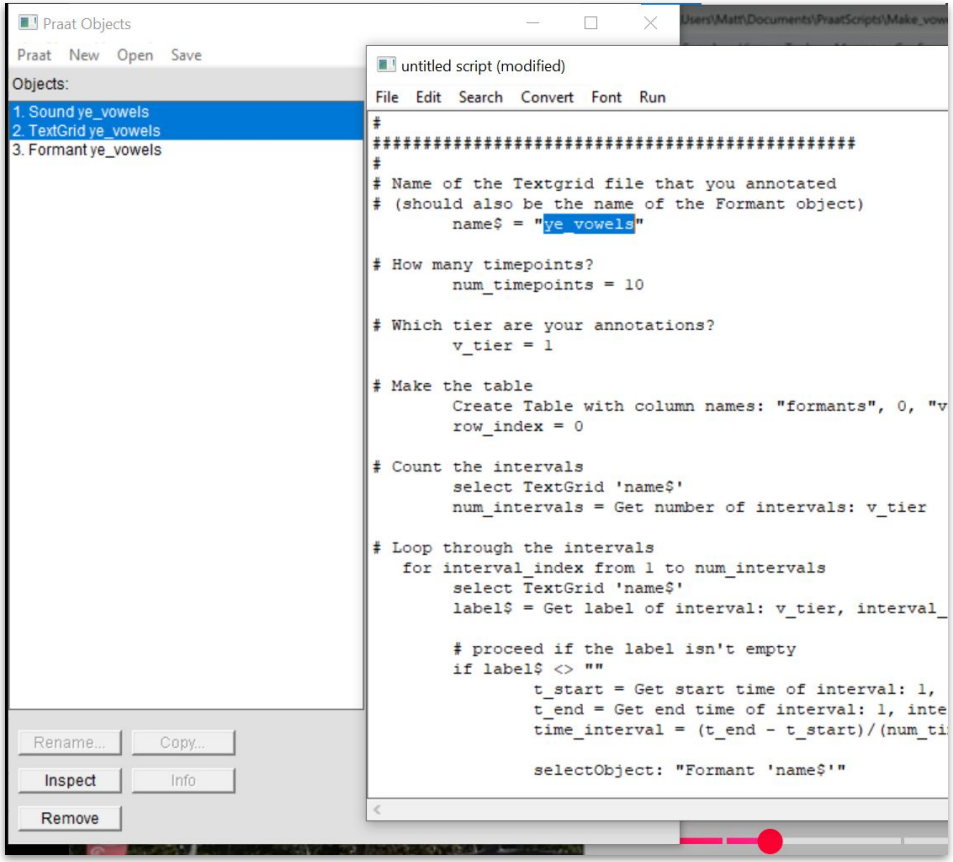
- To Formant (Burg)
- The Burg algorithm is a method used in speech analysis, particularly within software like Praat, to estimate formant frequencies from a sound signal.

Annotated Spectrum to F1, F2, F3



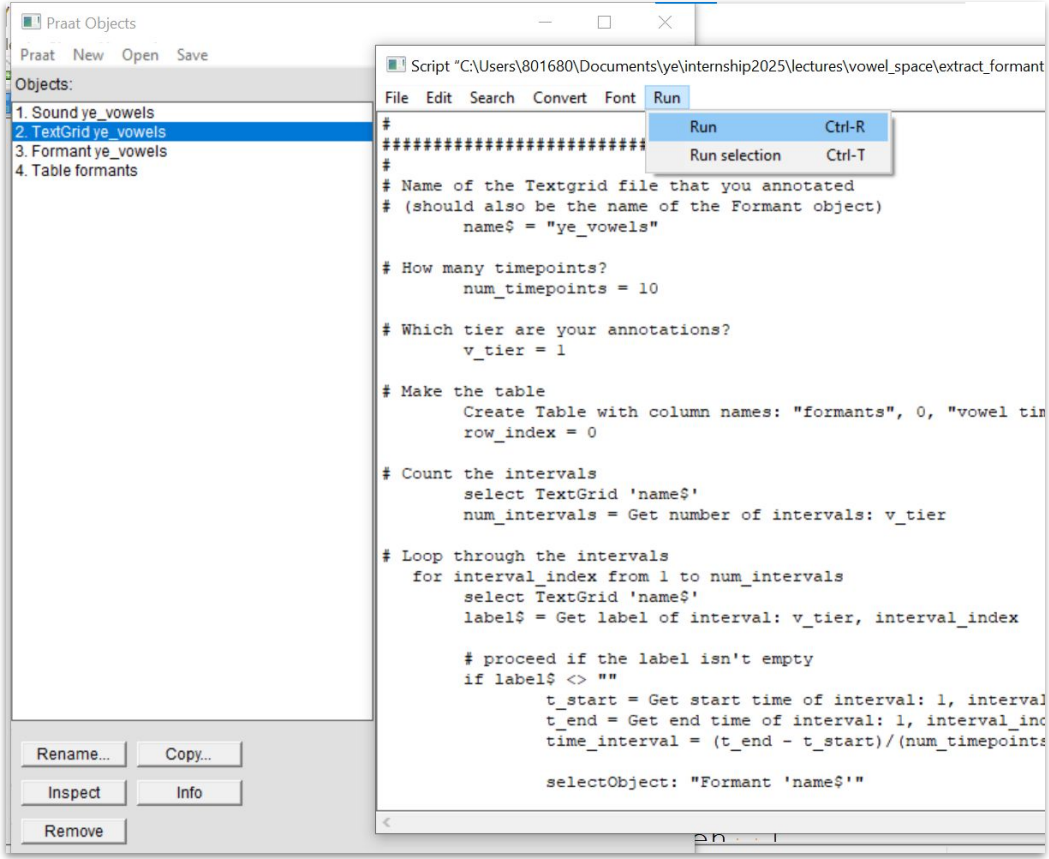
- Annotation လုပ်တုန်းက ထားခဲ့တဲ့ setting နဲ့ တူတူ ထားရမယ်

Annotated Spectrum to F1, F2, F3



- Praat Script ကို သုံးပြီး run မယ်
- https://www.eleanorchodroff.com/tutorial/PraatScripting.pdf

Annotated Spectrum to F1, F2, F3



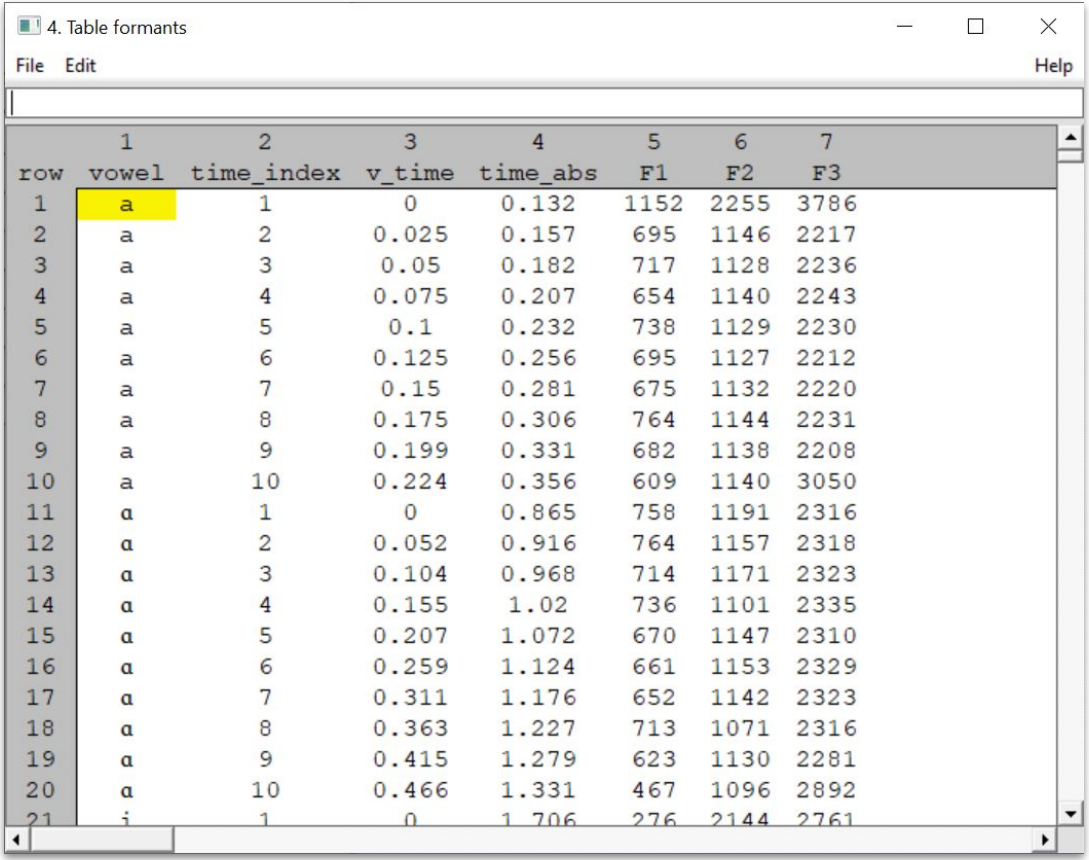
- Selection လုပ်ထားတဲ့ အပိုင်းကိုပဲ ရွေးပြီး run ခိုင်းတာလည်း လုပ်လို့ ရတယ်

Annotated Spectrum to F1, F2, F3

```
#
# Create a formant object for that sound,
# and do it carefully
#  (ensure the formant settings are appropriate
#     for the individual talker's voice)
#
# Mark the intervals that you want to analyze
#    in a Textgrid, like this:
#
#    ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
#    ________________________________
#    |    ah    |      |    ih    |    |    eh    |
#
##################################################
#
# Name of the Textgrid file that you annotated
# (should also be the name of the Formant object)
    name$ = "ye_vowels"

# How many timepoints?
    num_timepoints = 10

# Which tier are your annotations?
```

- ဒီ variable name တူအောင် ထားရမယ်

Annotated Spectrum to F1, F2, F3



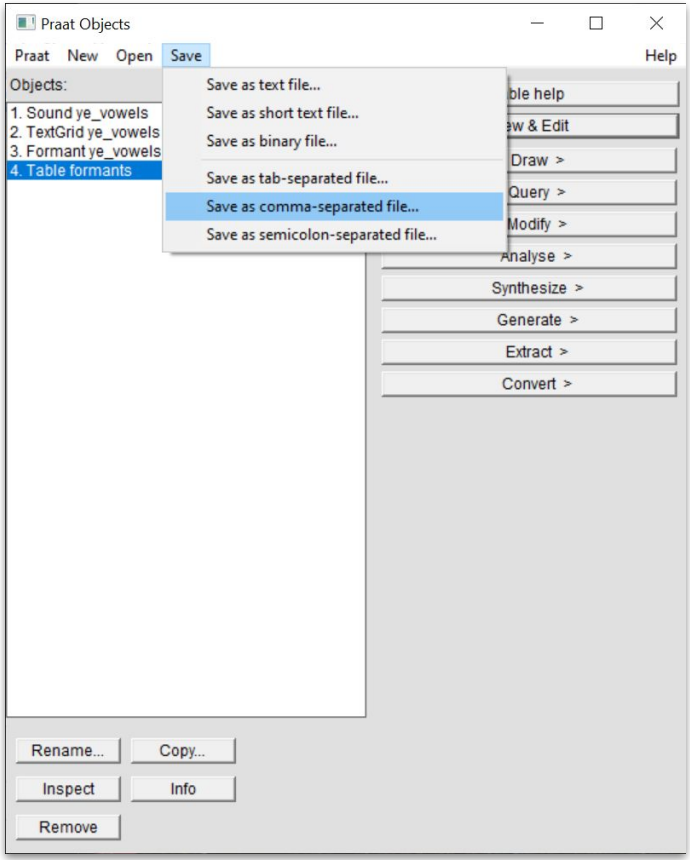
4. Table formants

File Edit Help

row	1 vowel	2 time_index	3 v_time	4 time_abs	5 F1	6 F2	7 F3
1	a	1	0	0.132	1152	2255	3786
2	a	2	0.025	0.157	695	1146	2217
3	a	3	0.05	0.182	717	1128	2236
4	a	4	0.075	0.207	654	1140	2243
5	a	5	0.1	0.232	738	1129	2230
6	a	6	0.125	0.256	695	1127	2212
7	a	7	0.15	0.281	675	1132	2220
8	a	8	0.175	0.306	764	1144	2231
9	a	9	0.199	0.331	682	1138	2208
10	a	10	0.224	0.356	609	1140	3050
11	ɑ	1	0	0.865	758	1191	2316
12	ɑ	2	0.052	0.916	764	1157	2318
13	ɑ	3	0.104	0.968	714	1171	2323
14	ɑ	4	0.155	1.02	736	1101	2335
15	ɑ	5	0.207	1.072	670	1147	2310
16	ɑ	6	0.259	1.124	661	1153	2329
17	ɑ	7	0.311	1.176	652	1142	2323
18	ɑ	8	0.363	1.227	713	1071	2316
19	ɑ	9	0.415	1.279	623	1130	2281
20	ɑ	10	0.466	1.331	467	1096	2892
21	i	1	0	1.706	276	2144	2761

- Extracted F1, F2, F3

Annotated Spectrum to F1, F2, F3

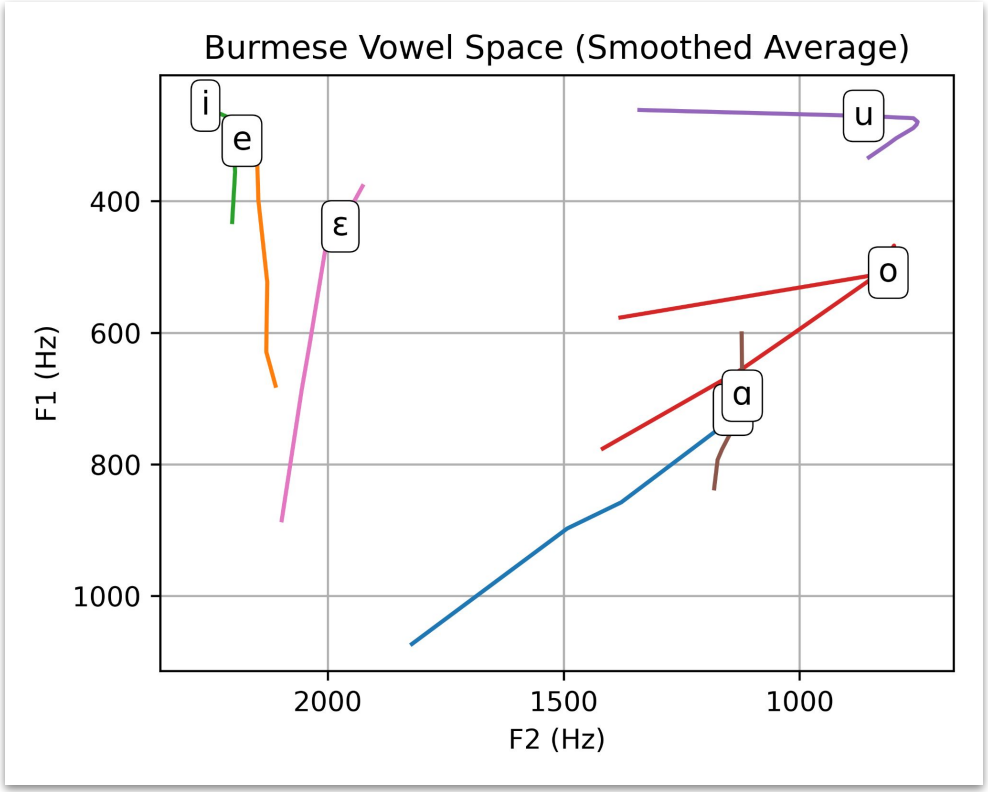


- ဖိုင် ကို သိမ်းပါ

Coding for Drawing Vowel Chart

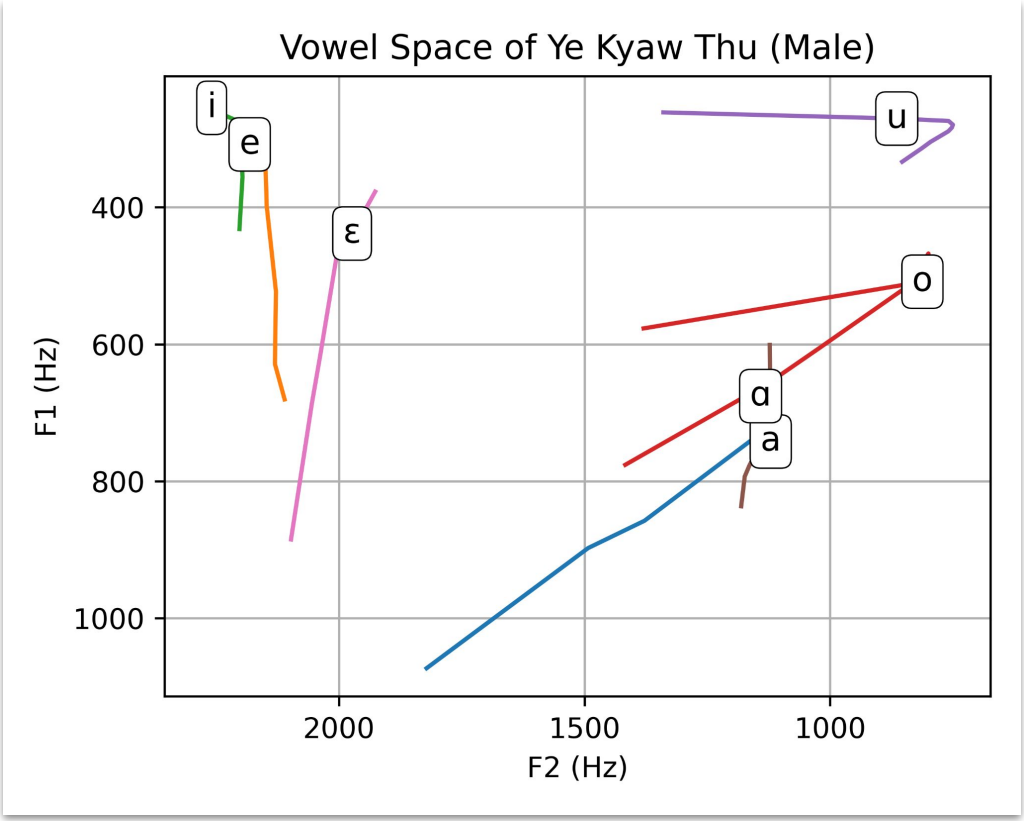
```python
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Plot Burmese Vowel Space (F1 vs F2) using formant table
Written by Ye, LU Lab., Myanmar

- Supports stdin / --input CSV
- Labels vowels using IPA
- Rolling average (window=3) smoothing like the reference R script
- Plots one smoothed path per vowel

Usage:
  python ./plot_vowel_space.py --input ye_formants_utf8.csv --output ./ye_vowel_space.png
"""

import argparse
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.ticker import MultipleLocator

# IPA label map
IPA_MAP = {
    'i': '\u0069',
```

Coding for Drawing Vowel Chart



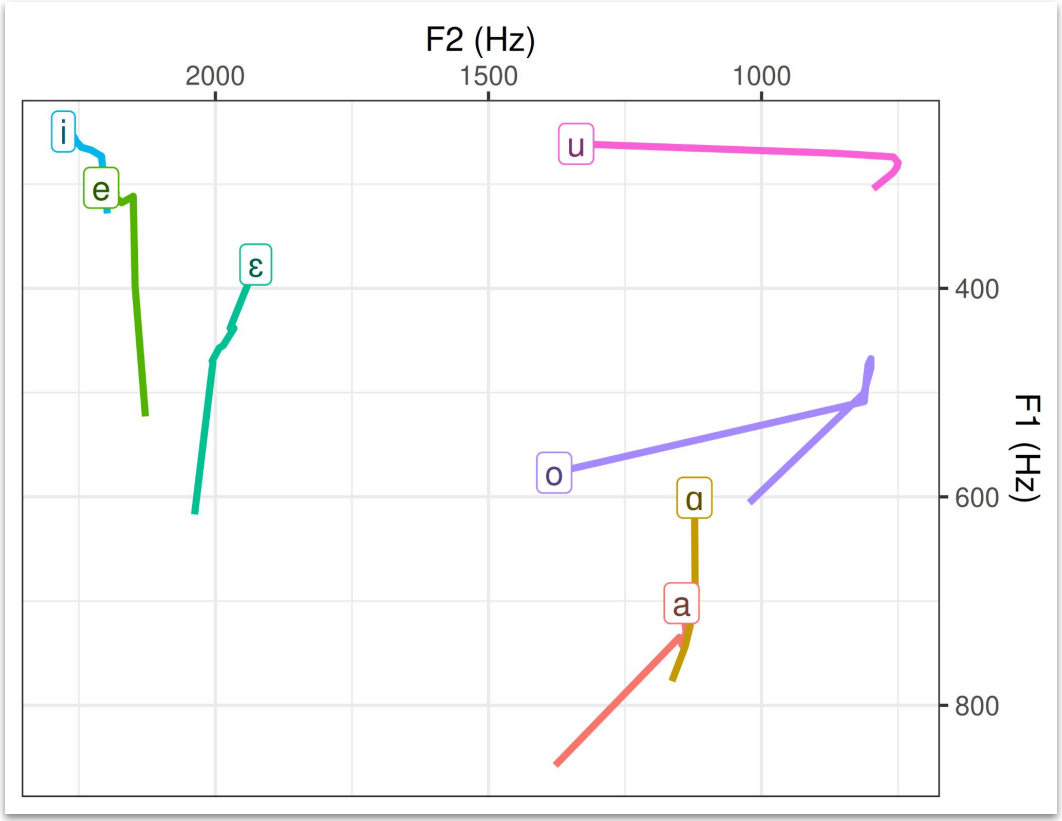
- လက်တွေ့မှာ လေဘယ်ကထပ်နေတာမျိုးလည်း ဖြစ်နိုင်တယ်

Coding for Drawing Vowel Chart



- Coding နဲ့ ဝင်ညှိထားတယ်

Coding for Drawing Vowel Chart (with R)



- R source code နဲ့ ဆွဲထားတာ
- R programming ကို သုံးပြီး ဆွဲရင်တော့ graph က ပုံအဆင်ပြေလိမ့်မယ်
- ကိုယ်စက်ထဲမှာ R programming ထည့်ပြီး ဆွဲချင်တဲ့သူတွေအတွက် R code ကိုလည်း ရှဲပေးထားပါမယ်

Conclusion

vowel	N tokens	F1_mean (Hz)	F2_mean (Hz)	F3_mean (Hz)
a (အ)	20	757	1213	2393
e (ေအ/ဧ)	20	374	2170	2660
i (အိ/အီ)	40	279	2240	2847
o (ေအာ/ ◌ံ)	20	543	1041	2531
u (အု/အူ)	40	282	940	2638
ɑ (အာ)	20	694	1138	2380
ɛ (အဲ)	20	480	1985	2452

- ဆရာ့ရဲ့ vowel space ဇယား
- Average ယူထားတာ

Conclusion

- Phonetic နဲ့ ပတ်သက်ပြီး မိတ်ဆက်ပေးခဲ့တယ်
- မြန်မာစာ Phonetic သမိုင်းကြောင်းလည်း အကျဉ်း မိတ်ဆက်ပေးခဲ့တယ်
- IPA
- IPA to Speech TTS ကို အလွယ် လုပ်ပြခဲ့တယ်
- Praat software ကို မိတ်ဆက်ပေးခဲ့တယ်
- အသံက တကယ်က မြန်မာ vowel အကုန်ကို အသံသွင်းလည်း ရတယ်
- အားလုံးညှိလုပ်ကြဖို့ လိုအပ်တယ်
- တစ်ယောက်ချင်းစီရဲ့ vowel chart ကို assignment အနေနဲ့ လုပ်ကြရအောင်
- Praat ဖိုင်ရော၊ vowel chart ဖိုင်ရော zip ဖိုင်နဲ့ zip လုပ်ပြီး တင်ကြပါ
- Graph မှာ title က ကိုယ့်နာမည်တပ်ပါ
- Zip ဖိုင်ကလည်း ကိုယ့်နာမည် တပ်ပါ

Thank you!
Q&A?
(ykt.nlp.ai@gmail.com)

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