

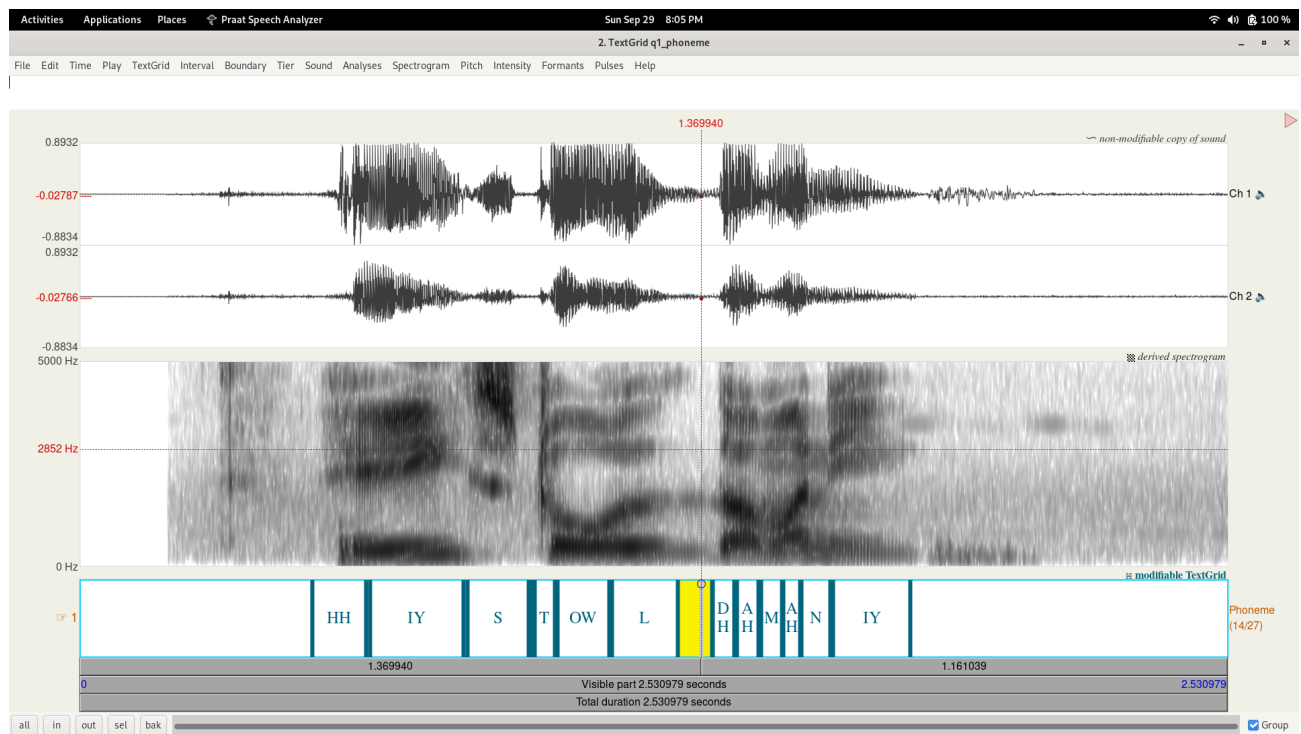
7.

a) The sentence: "HE STOLE THE MONEY"

• **ARPhet:**

- **HE** - HH IY1
- **STOLE** - S T OW1 L
- **THE** - DH AH1
- **MONEY** - M AH1 N IY0

- The phoneme level spectrogram segments in the recording audio by marking the phoneme segment boundaries as follows:



Phoneme segment boundaries:

Phoneme	Start Time	End Time
HH	0.531292517007	0.850566893424
IY1	0.850566893424	0.980272108844
S	0.980272108844	1.04013605442
T	1.04013605442	1.10997732426

OW1	1.10997732426	1.20975056689
L	1.20975056689	1.41927437642
DH	1.41927437642	1.50907029478
AH1	1.50907029478	1.5589569161
M	1.5589569161	1.61882086168
AH1	1.61882086168	1.64875283447
N	1.64875283447	1.85827664399
IY0	1.85827664399	2.53673469388

b) The spectrogram patterns dependency on the articulatory configuration of the respective phonemes. Let's analyze how different manners of articulation affect these patterns, using the phonemes in my audio ("HE STOLE THE MONEY"). I'll break down them on the types of phonemes based on the manner of articulation:-

i) Fricatives

- **Examples:** [hh] (in "he"), [s] (in "stole")
 - **Pattern:** Fricatives show noise and a high-energy pattern spread across frequencies due to turbulence created by airflow through a narrow constriction.
 - **Spectrogram:** In "he," the fricative [hh] shows scattered energy across a broad frequency range, especially in the higher frequencies. The [s] in "stole" produces a high-frequency energy pattern, visible as a dense region of dark bands above 4 kHz, indicating turbulence.
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ii) Vowels

- **Examples:** |iy| (in "he"), |ow| (in "stole"), |ah| (in "money")
 - **Pattern:** Vowels are voiced sounds with clear formants, visible as horizontal bands. The spacing between the formants depends on the tongue and lip configuration.
 - **Spectrogram:**
 - The vowel |iy| in "he" displays clear formants, with the first formant (F1) being low and the second formant (F2) being high due to the fronted, high tongue position.
 - The |ow| in "stole" has lower F2, as it is a back vowel, and formant transitions are visible as the lips round.
 - The vowel |ah| in "money" shows prominent formants in the lower frequencies, with more energy concentrated in F1.
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iii) Nasals

- **Example:** |m| (in "money"), |n| (in "money")
 - **Pattern:** Nasals are characterized by low-frequency energy due to the nasal airflow. They have a reduced overall energy in higher frequencies compared to vowels and fricatives.
 - **Spectrogram:**
 - The nasal |m| in "money" shows a strong low-frequency band (below 500 Hz) with minimal higher-frequency energy.
 - Similarly, the |n| in "money" is characterized by the nasal formant, with diminished energy in higher frequencies and a voiced bar indicating the vocal fold vibration.
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iv) Stops

- **Examples:** |t| (in "stole"), |d| (in "the")

- **Pattern:** Stops are produced by completely blocking airflow and then releasing it, which creates a distinct pattern of silence followed by a burst of energy.
 - **Spectrogram:**
 - The [t] in "stole" shows a brief silence (closure) followed by a vertical burst of energy after the release.
 - Similarly, the [d] in "the" has a noticeable burst after the stop closure, with the energy concentrated in higher frequencies for voiceless stops like [t].
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v) Glides

- **Examples:** [ɪ] (in "stole"), [w] (in "money")
 - **Pattern:** Glides like [ɪ] and [w] are semi-vowels with articulatory configurations similar to vowels but with faster transitions. They show formant transitions that are smoother than stops but faster than full vowels.
 - **Spectrogram:**
 - The [ɪ] in "stole" shows smooth transitions in the formants, particularly in F2 and F3, indicating the tongue's movement.
 - The [w] in "money" has a rapid glide transition, where formants shift quickly, resembling the formant patterns of vowels.
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c) The spectrogram patterns dependency on the articulatory configuration of the respective phonemes considering at least three different types of vowels (back, central, and front) and one diphthong:

i) Front Vowels:

- **Articulatory Configuration:** Front vowels are produced with the tongue positioned near the front of the mouth. They are typically pronounced with spread lips.
 - **Example:** In the spectrogram of the vowel [iy] in "he," the spectrogram shows a relatively low F1 (indicating the tongue is high in the mouth) and a very high F2 (indicating the front tongue position). This large gap between F1 and F2 is characteristic of front vowels, as the tongue is advanced towards the front.
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ii) Central Vowels:

- **Articulatory Configuration:** Central vowels involve the tongue positioned in the middle of the mouth, typically with neutral or relaxed lip rounding.
 - **Example:** In the spectrogram of the central vowel [ah] in "money," the formants are more closely spaced, particularly between F1 and F2, reflecting the neutral tongue position. Central vowels do not show as large a formant gap as front vowels, indicating the mid-position of the tongue.
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iii) Back Vowels:

- **Articulatory Configuration:** Back vowels are produced with the tongue retracted towards the back of the mouth, often with rounded lips.
 - **Example:** In the spectrogram of the back vowel [ow] in "stole," a low F1 (indicating the high tongue position) and a low F2 (indicating the back tongue position) are visible. This reduced F2 value is characteristic of back vowels, showing the retracted tongue position.
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iv) Diphthongs:

- **Articulatory Configuration:** Diphthongs are complex vowel sounds where the tongue moves from one vowel position to another within the same syllable, creating a transition between two vowel qualities.
 - **Example:** The diphthong [ay] in "money" starts with a front vowel-like quality and transitions into a higher tongue position, as reflected in the formant movement on the spectrogram. There is a visible shift in both F1 and F2, marking the tongue's dynamic movement through the vowel.
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In the spectrogram, these articulatory configurations of vowels (front, central, back, and diphthongs) directly affect the position and transition of formants (especially F1 and F2), which indicate tongue height and front-back placement.