2. How humans speak

The Monster Text to Speech & Voice Cloning Course

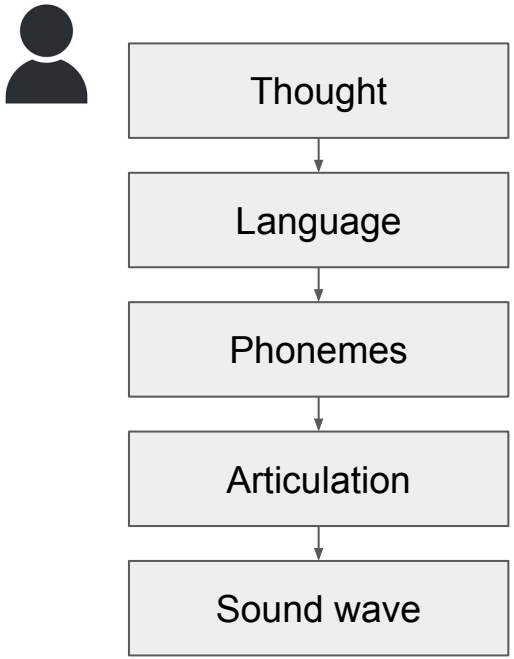
THE SOUND OF AI

Before we can make machines talk, we need to understand what talking is.

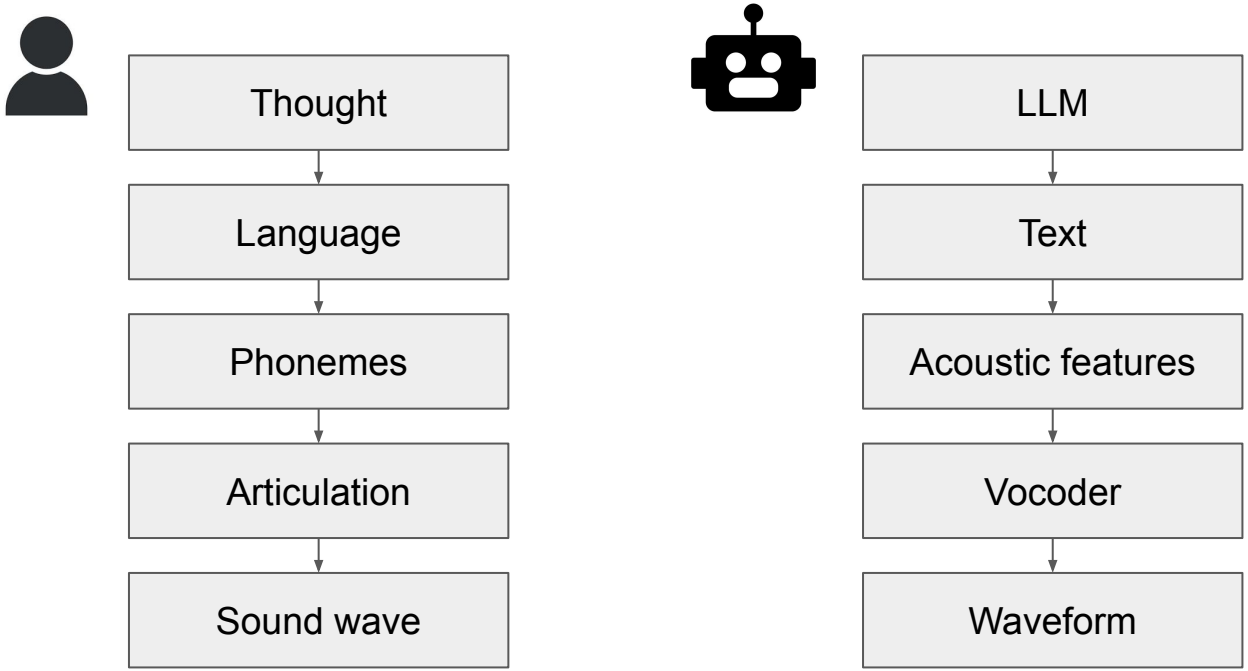
What makes speech special

- Information-dense
- Multidimensional: meaning, language, sound, emotion, and identity

Speech pipeline



Speech pipeline



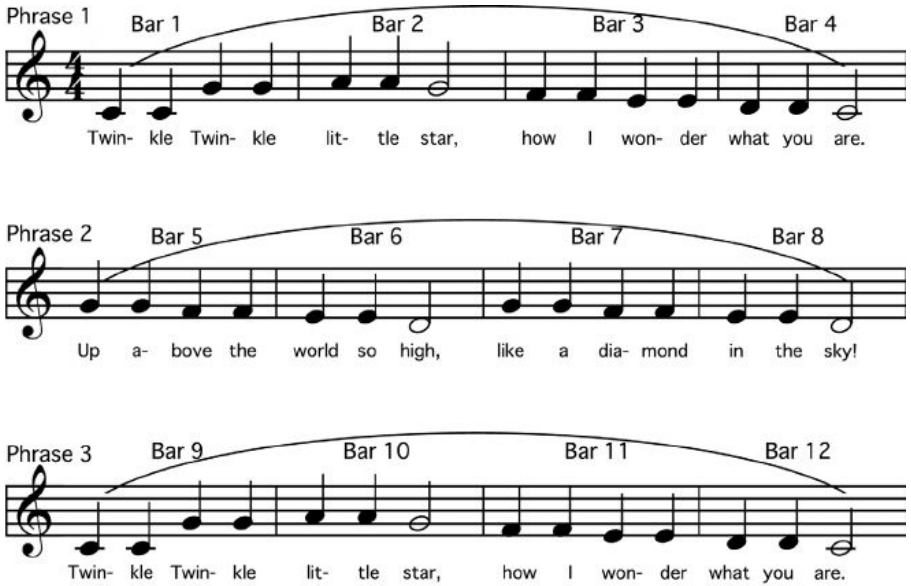
Thoughts to words (language)

- Speech is planned before it’s spoken
- Encode semantics + syntax
  - Semantic layer: what we want to say
  - Syntactic layer: how to say it
- Corresponds to text in TTS

Words to sounds (phonemes)

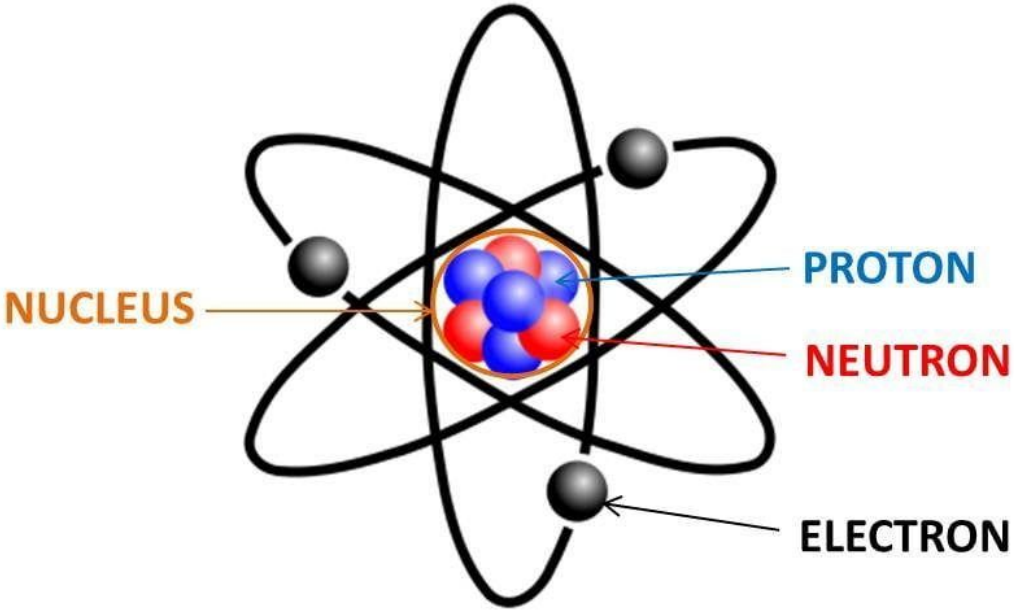
- Phoneme = atom of speech
- Vowels + consonants

Understanding phonemes

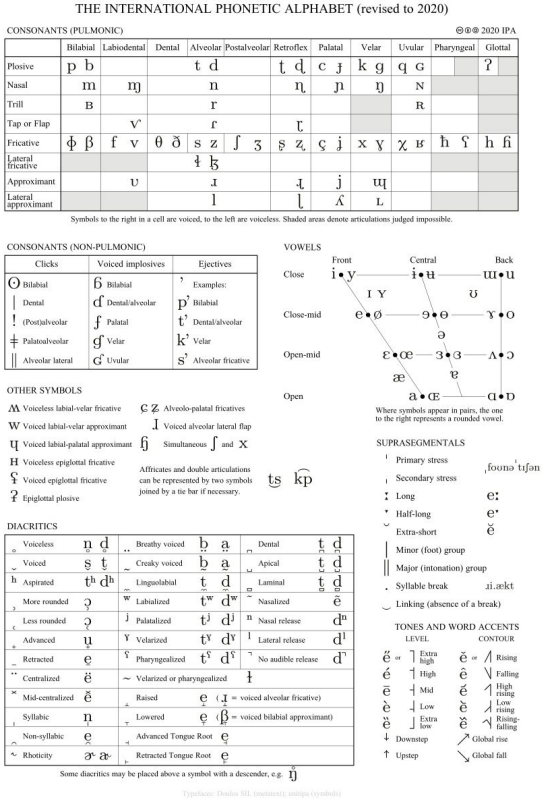


- Word = musical phrase
- Phoneme = note

Understanding phonemes



International Phonetic Alphabet



- Collection of all possible sounds
- 100-150 distinct base symbols
- Modifiers (diacritics)
- Hundreds of distinct sounds

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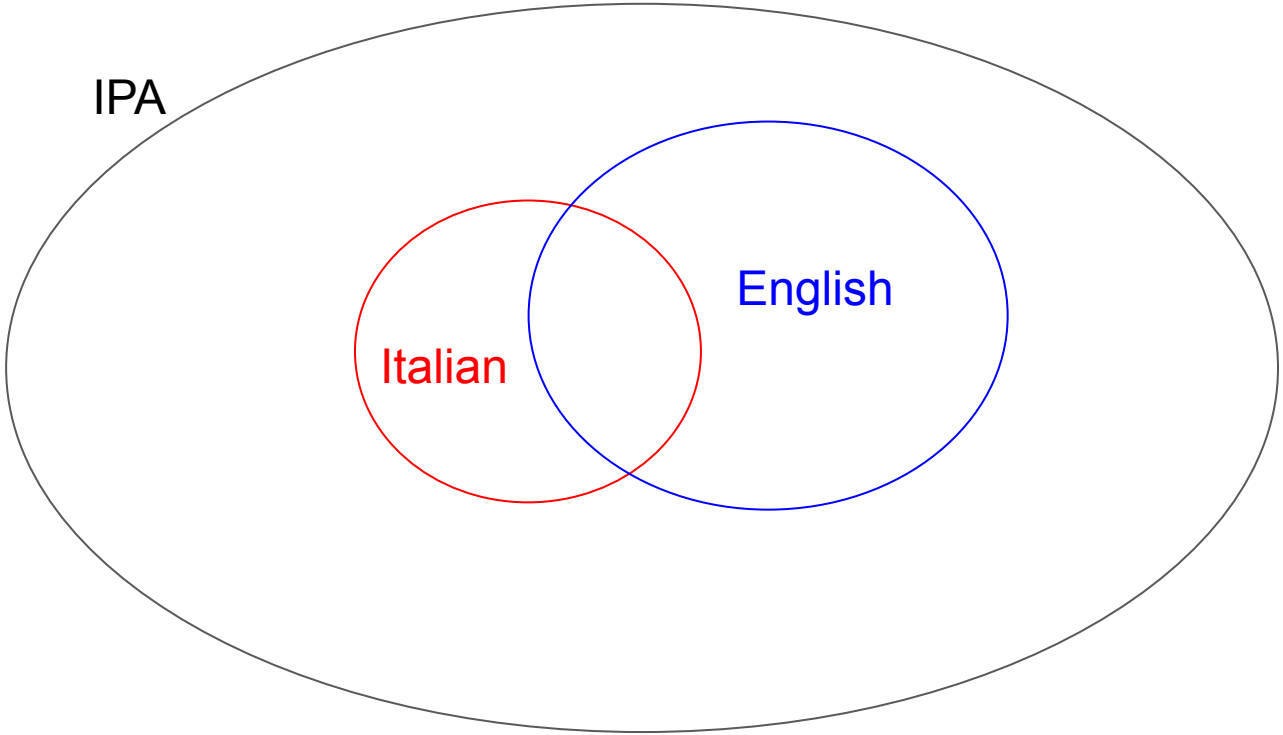
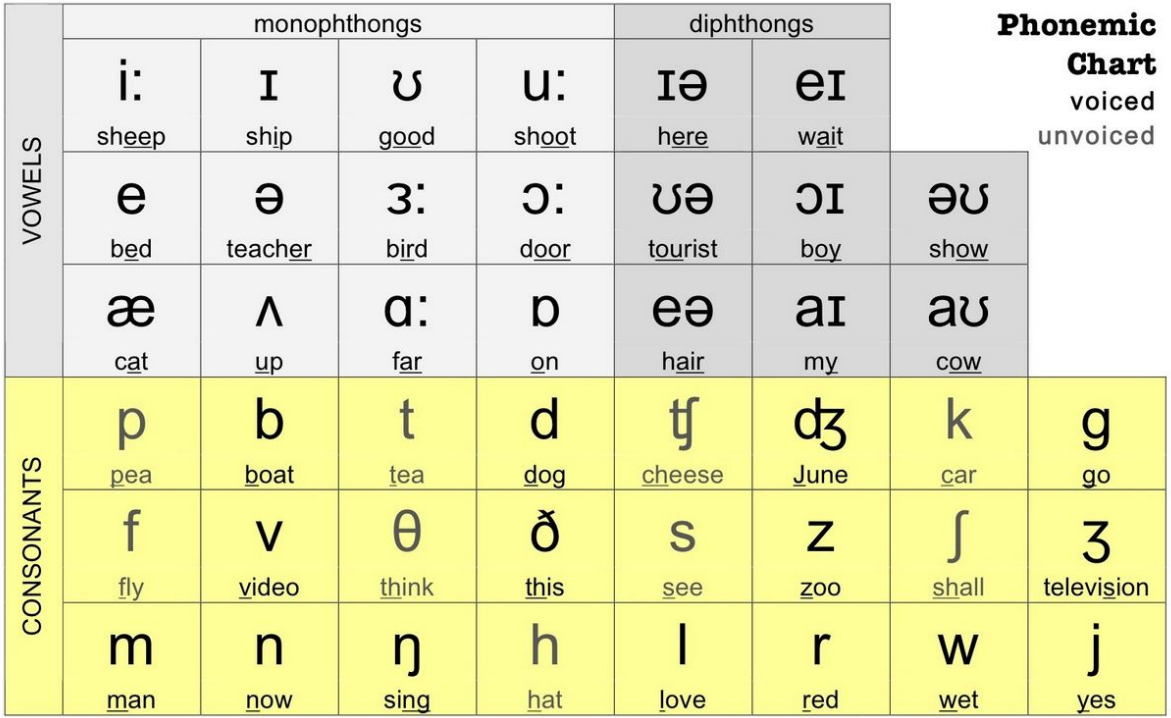
Language phoneme inventories



English phonetic chart



The 44 phonemes of Received Pronunciation based on the popular Adrian Underhill layout

adapted by EnglishClub.com

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Phonetic transcription

She bought two red apples

/ʃi bɔːt tuː red ˈæplz/

Coarticulation

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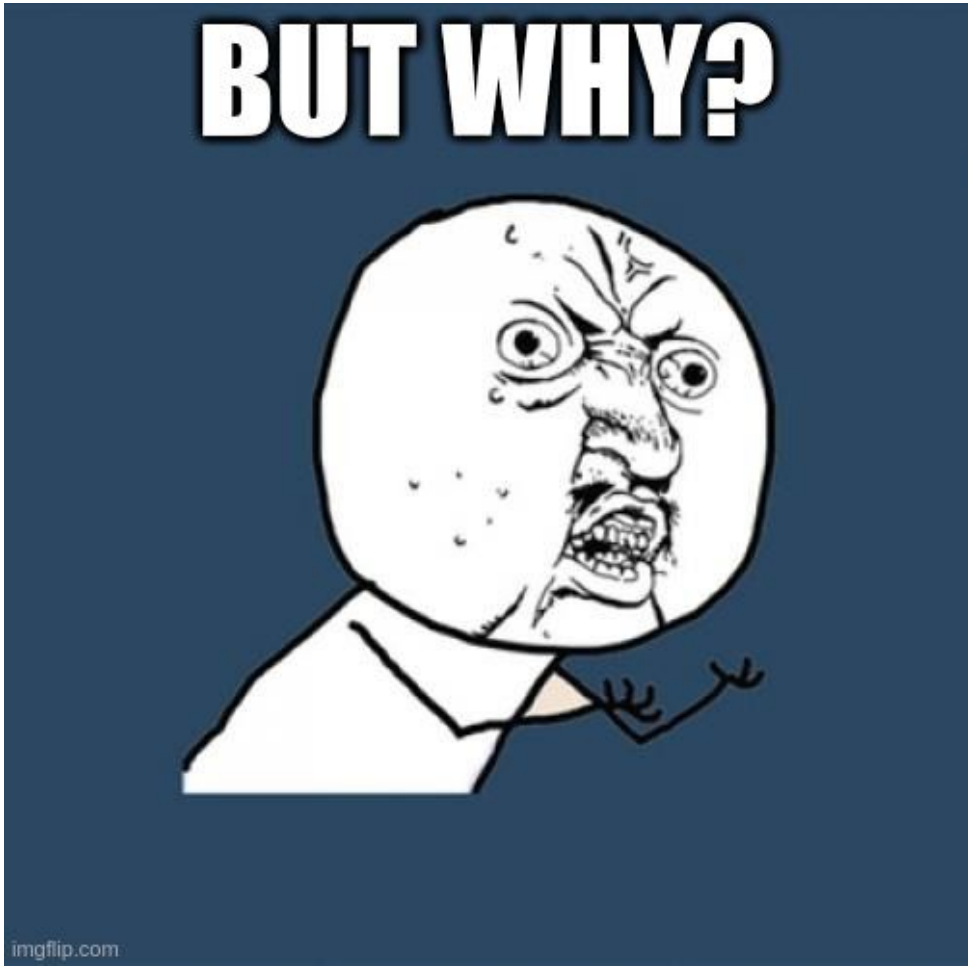
- Idea: concatenate pre-recorded phonemes to generate speech
- Problem: sounds robotic


BUT WHY?
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Speech sound changes based on context

Prosody

- Rhythm + pitch + stress + intonation
- Encodes both linguistic structure and emotion
- Prosody = music of speech

Spot the difference in prosody

“We’re going.”

“We’re going?”

Spot the difference in prosody

“We’re going.”

“We’re going?”

Timbre and voice identity

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  - Resonance of the nasal and oral cavities
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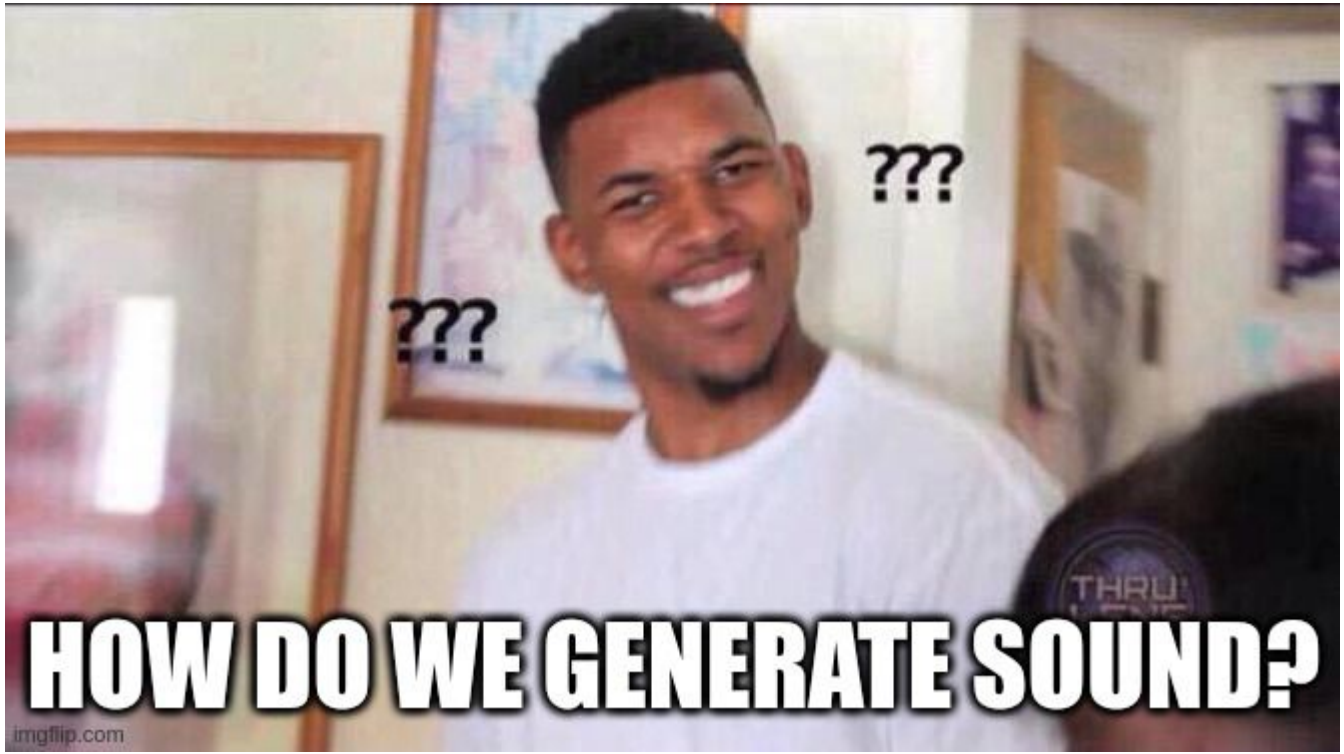
- Voice cloning models try to capture timbre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HOW DO WE GENERATE SOUND?
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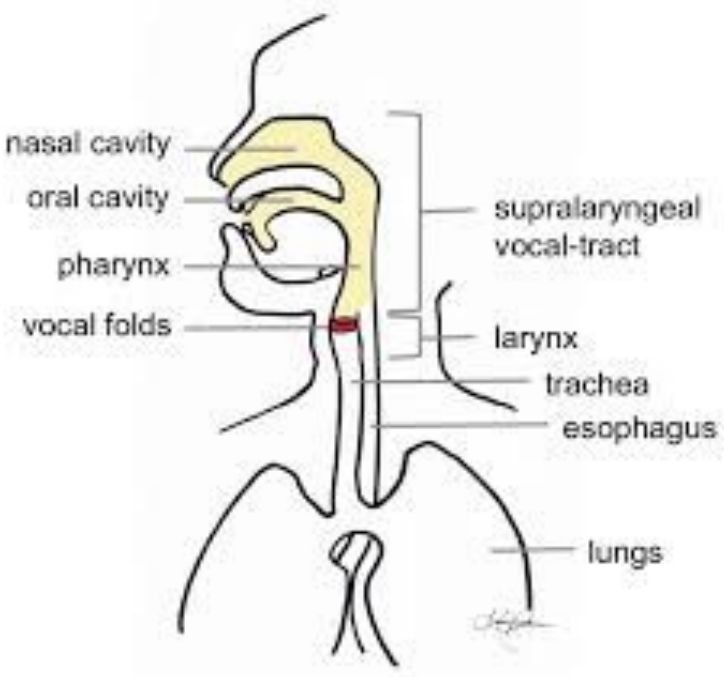
Source-filter model

- Vocal folds = vibration source
- Vocal tract = resonant filter

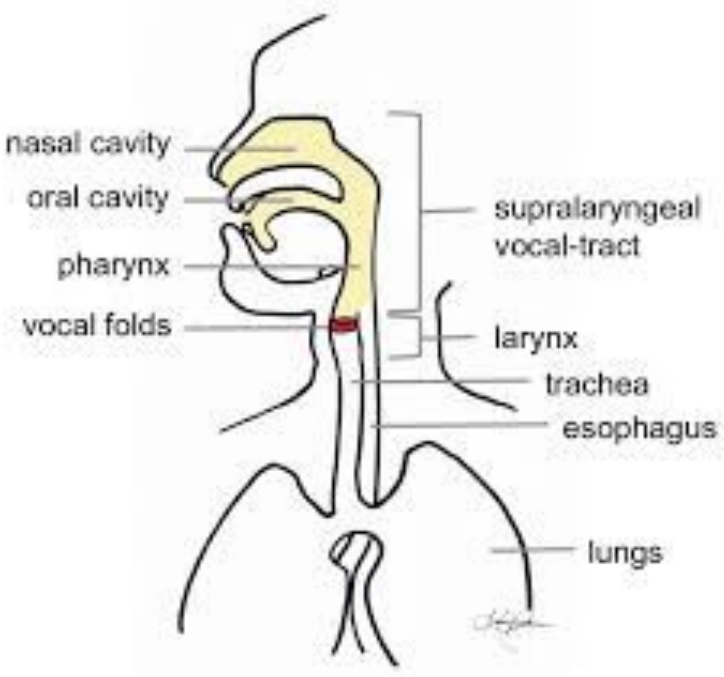
Source-filter: Subtractive synth

Source-filter model: Revisited



1. Lungs = energy source

Source-filter model: Revisited



1. Lungs = energy source
2. Vocal folds = oscillator (i.e., glottal sound)

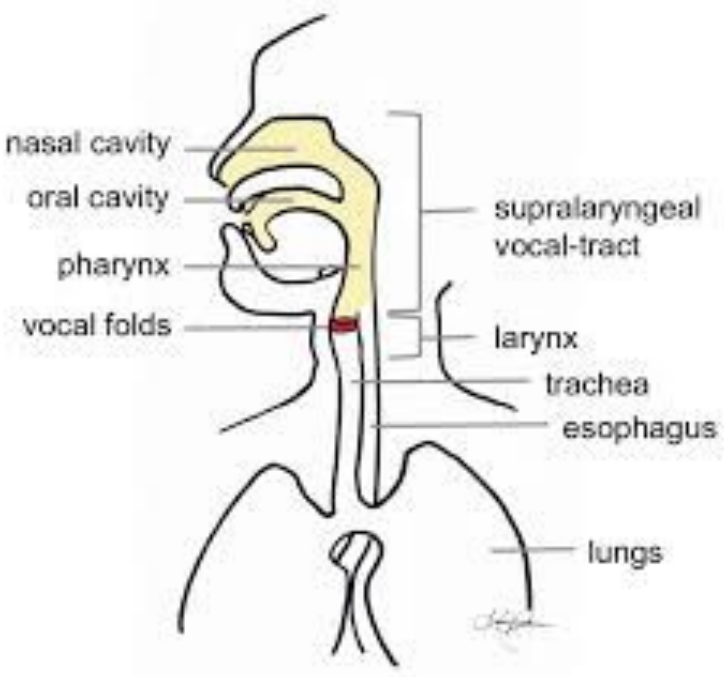
Glottal sound

- Vocal folds opening-closing cycle
- Quasi-periodic waveform
- The vibration frequency = fundamental frequency (f_0)
- The spectrum contains harmonics

Types of glottal sounds

- Voiced sounds: vocal folds vibrate
  → /a/, /b/, /d/
- Voiceless sounds: folds open →
  noise-like → /s/, /f/, /t/

Source-filter model: Revisited



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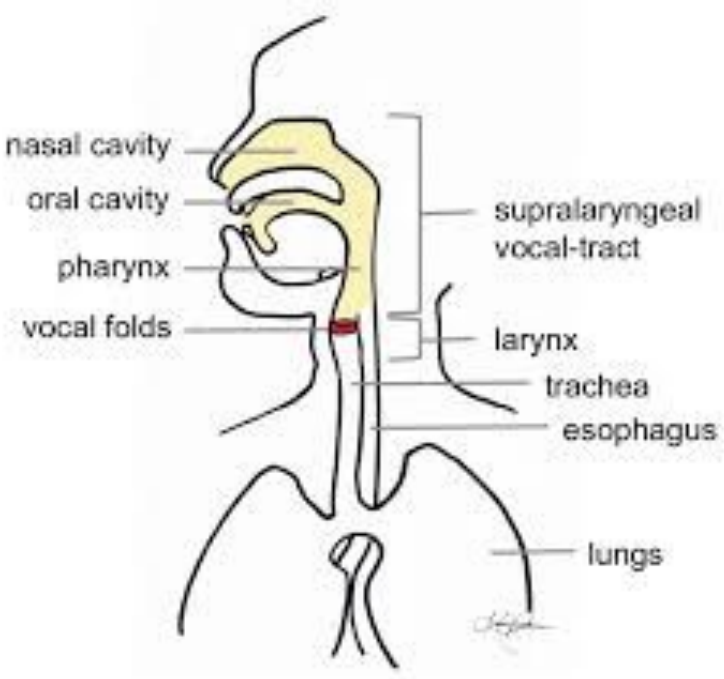
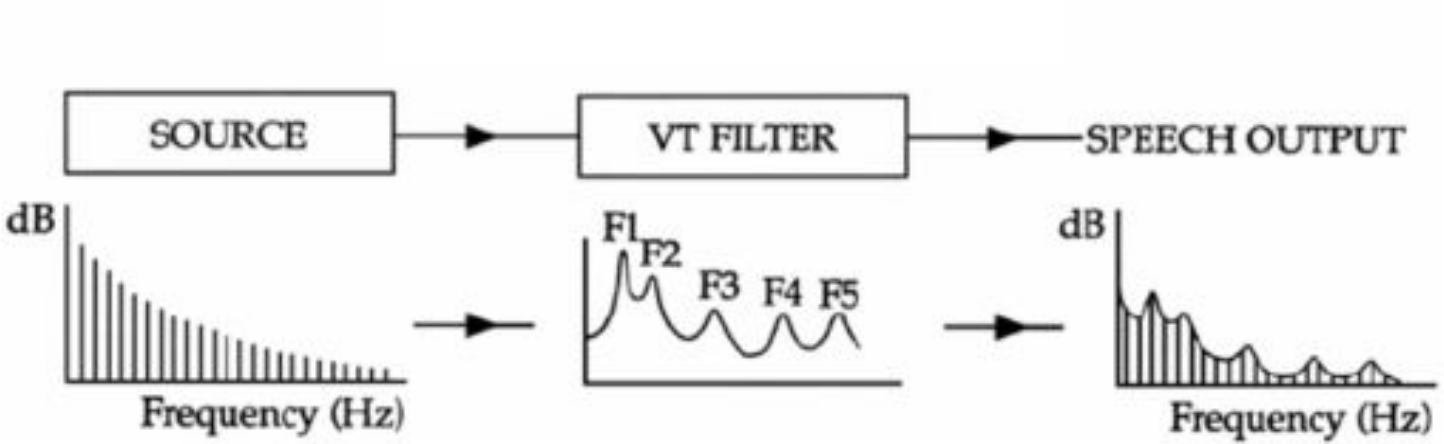
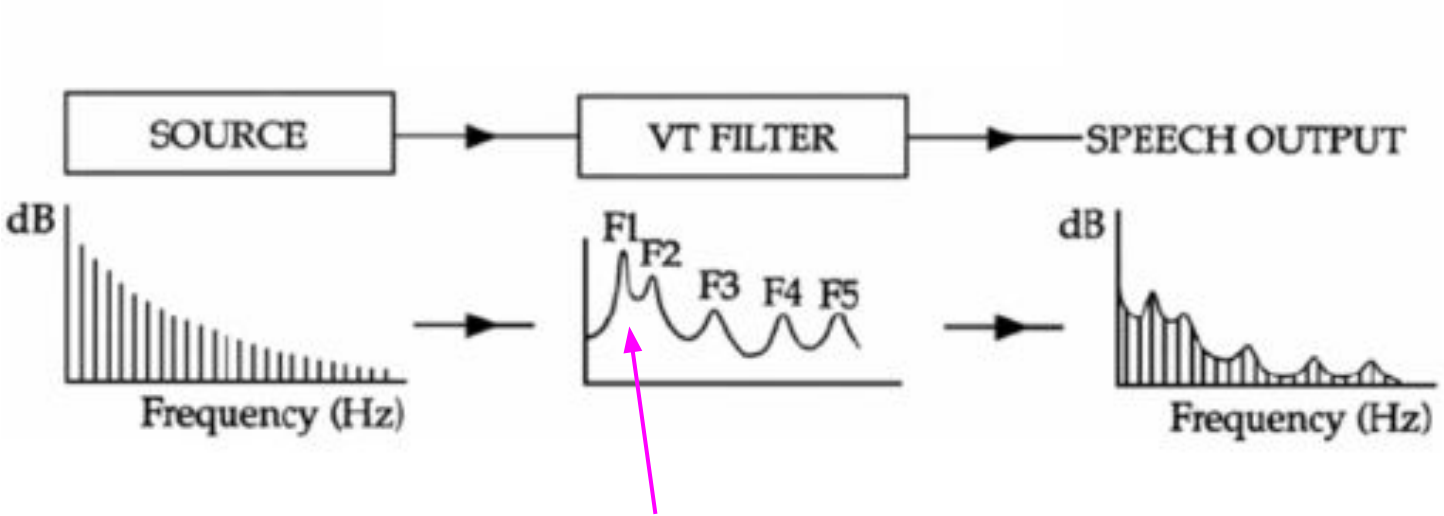


1. Lungs = energy source
2. Vocal folds = oscillator (i.e., glottal sound)
3. Vocal tract = resonant filter
4. Lips, tongue, jaw = articulators

Source-filter model: Revisited

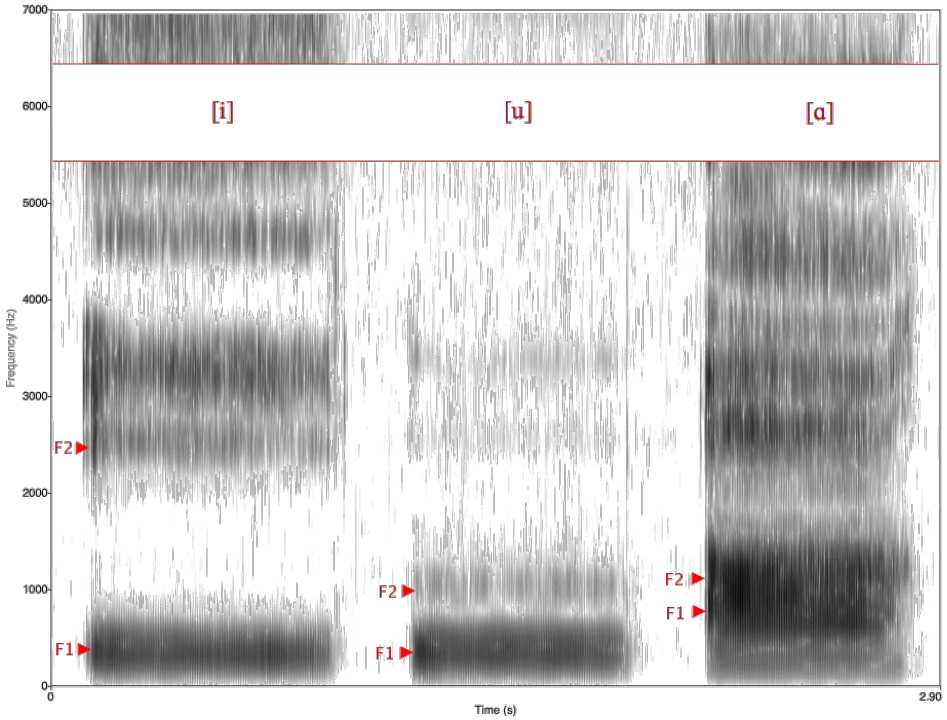


Source-filter model: Revisited



Amplified frequency regions = Formants

Formants



- Resonances
- Different vowels, different formants
- Changing tongue and lip position shifts formant frequencies → changes vowel
- Formants make you sound like you


WHY SHOULD WE
CARE ABOUT
SOURCE-FILTER AND FORMANTS?
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Many TTS systems use source-filter and formants

Emotion and expressivity

- Speech is deeply emotional and context-driven
- Emotion changes prosody, pitch, energy, tempo
- Example: “I’m fine”

Speech is multilayered

Layer	What It Encodes	AI Analogy
Thought	Meaning	Text input
Language	Words, grammar	Text-to-phoneme
Prosody	Rhythm, melody	Acoustic model
Timbre	Identity	Speaker embedding
Waveform	Air vibration	Vocoder output

In this course, we'll learn how AI replicates each of these layers

Why is TTS/voice cloning hard?

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- Speech combines structure (phonemes) + fluidity (prosody) + individuality (timbre) + dynamics (emotion)

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- Speech combines structure (phonemes) + fluidity (prosody) + individuality (timbre) + dynamics (emotion)
- Humans learn it effortlessly; machines have to model each layer