Text-to-Speech Synthesis of Irish

Project Overview

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Outline

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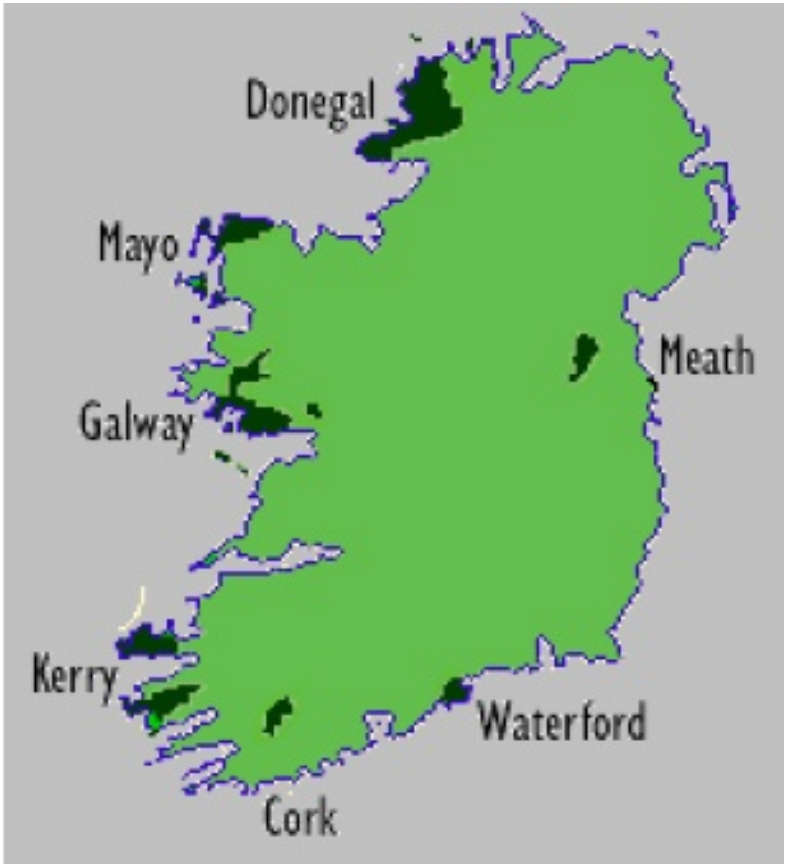
The Irish Language in Ireland



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- Ireland's first language and an official language of the EU
- Spoken natively in only a few areas of the country
- Compulsory school subject

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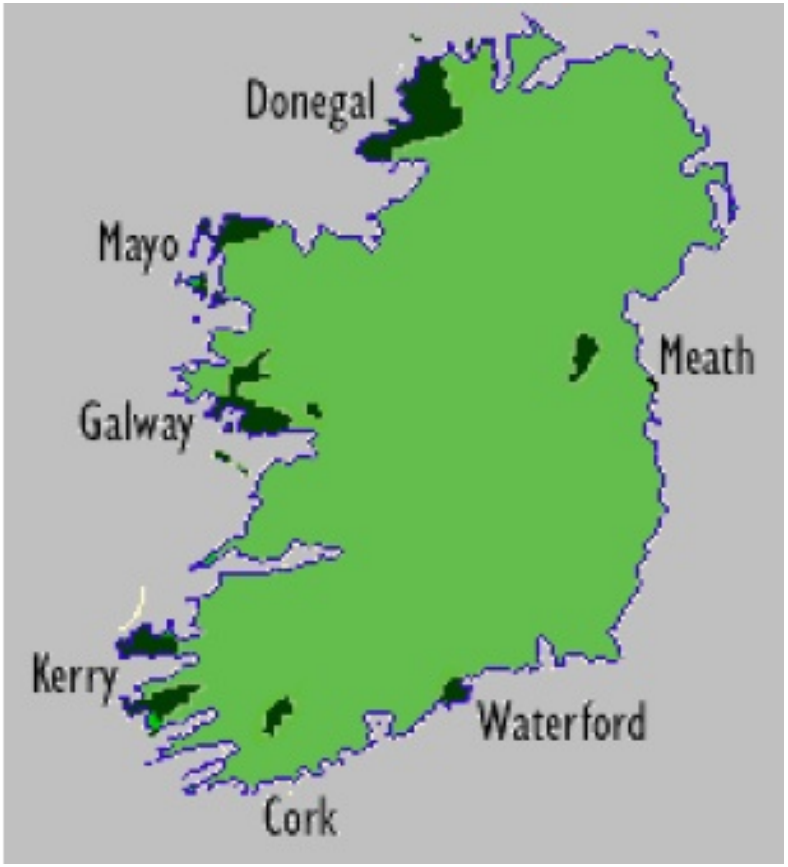

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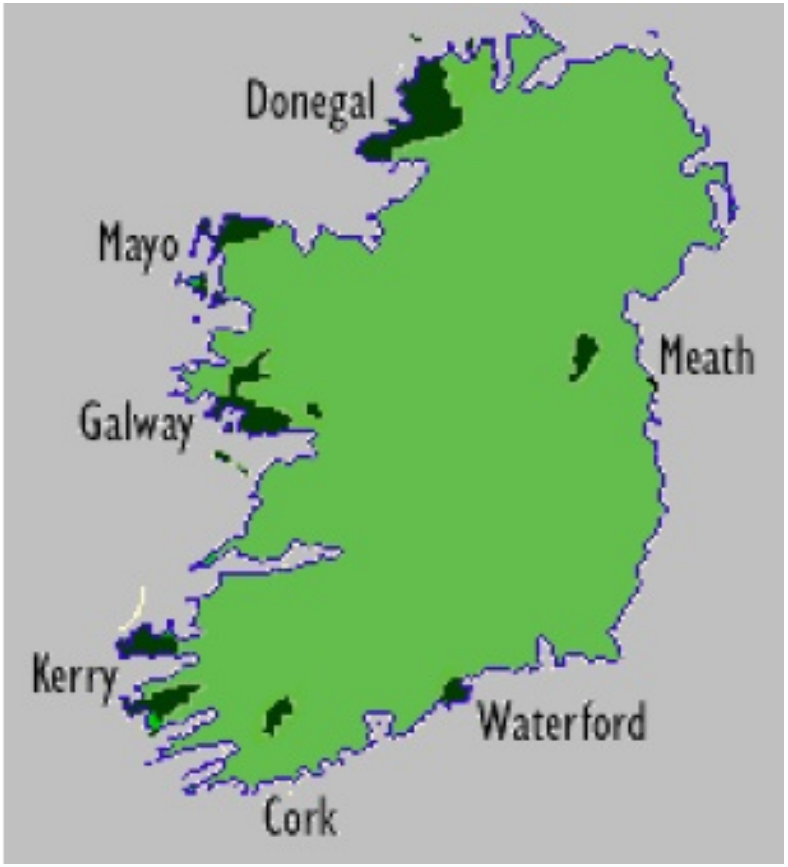

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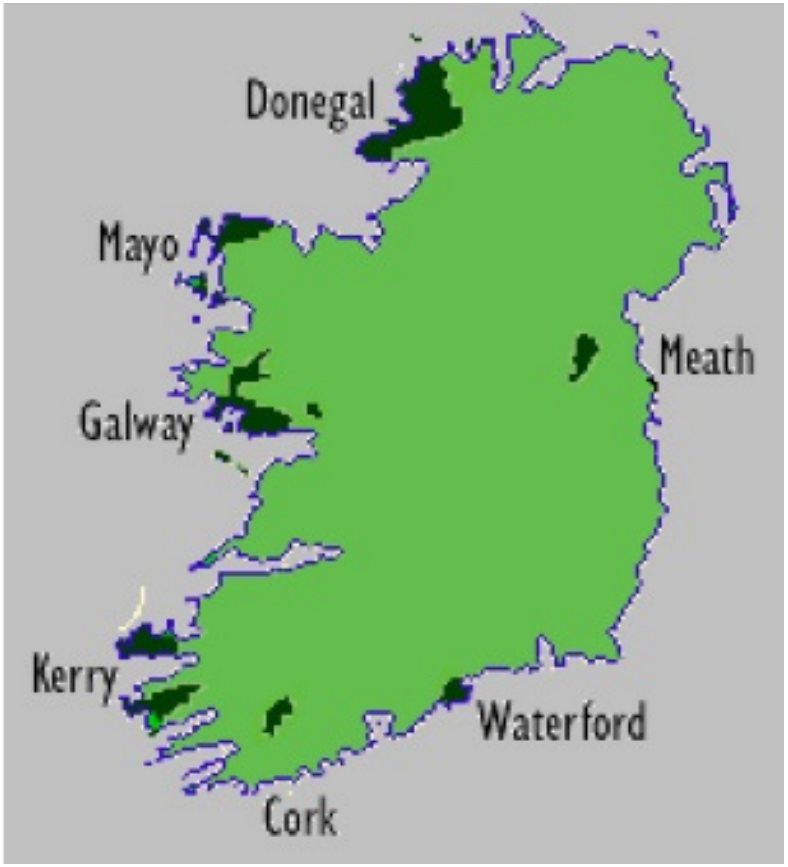

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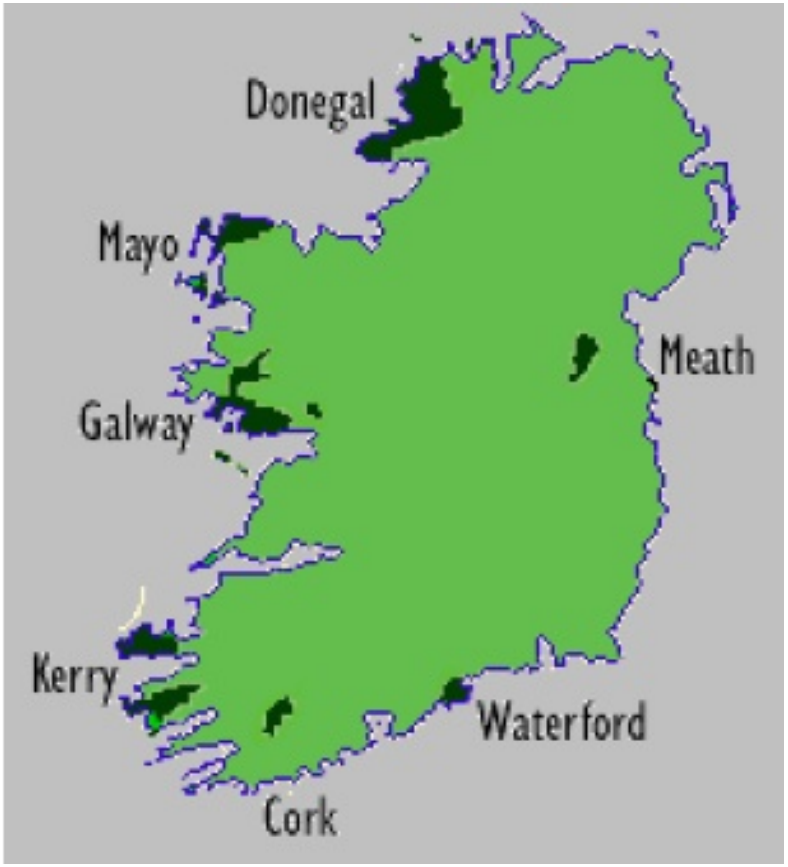

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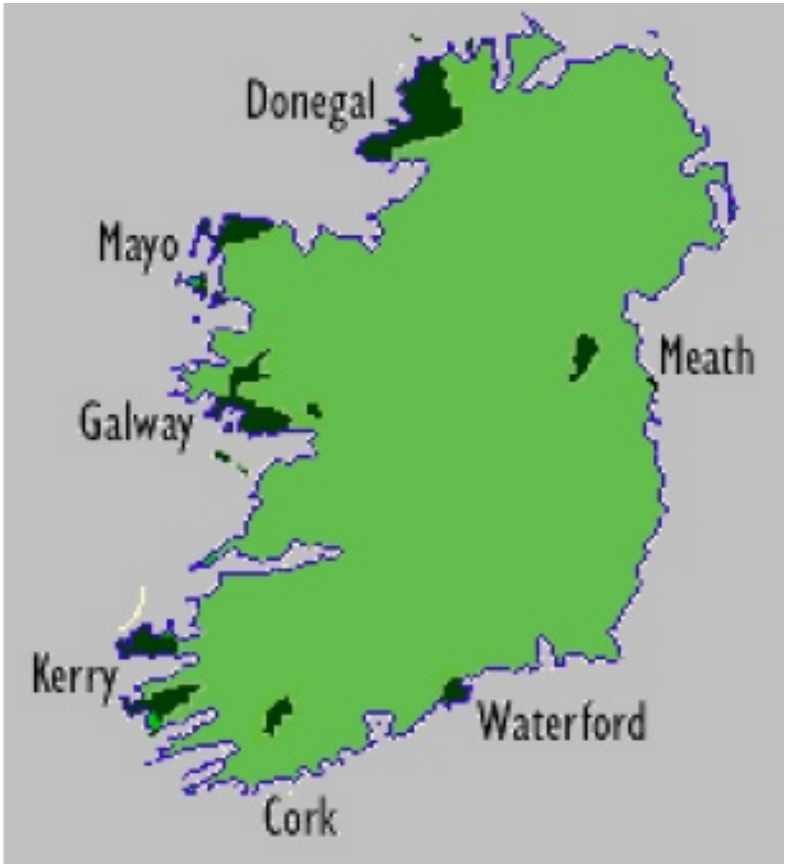

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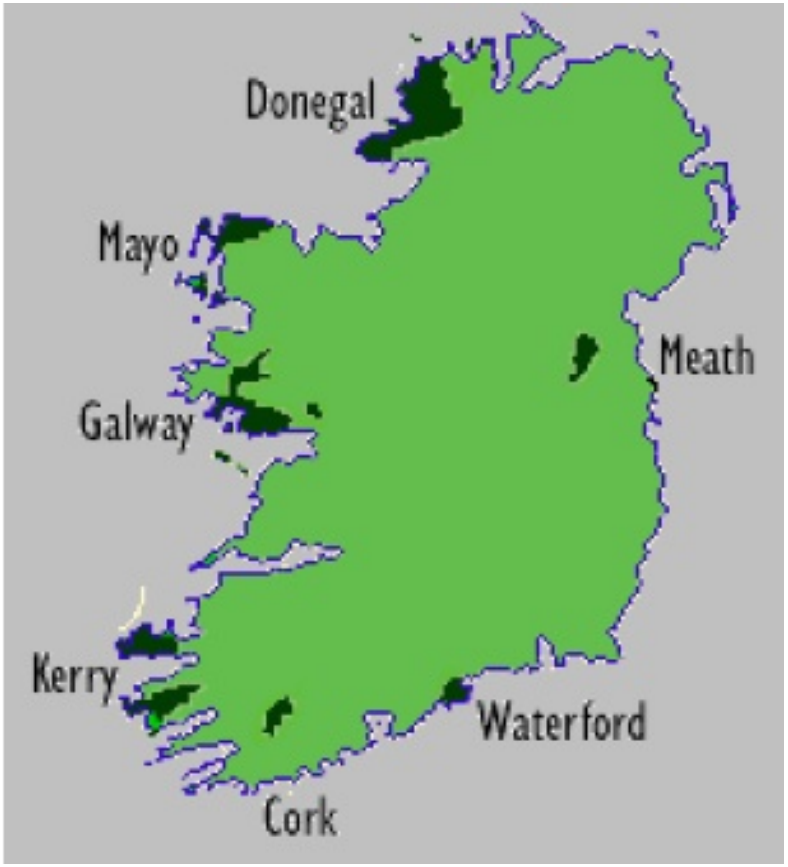

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1. Lack of interaction with native speakers
   - Many teachers are not native or fluent speakers
   - Very few remaining Gaeltacht regions
2. Lack of a standard dialect
   - Dialect differs drastically from place to place
   - Difficult to understand a speaker of a different dialect
3. Complex orthographical system
   - *Ní bhfaighigh* is pronounced [nʲiː wiː]
4. Complex sound system
   - palatalised and velarised consonant oppositions
   - *bád* [bád] means *boat*; *báid* [bádʲ] means *boats*

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Irish Consonants

	Labial	Dental	Alveolar	Alveolo-palatal	Palatal	Velar	Glottal
Plosive	pˠ bˠ pʲ bʲ	t̪ˠ d̪ˠ		tʲ dʲ	c ɟ	k g	
Fricative/ Approximant	fˠ w fʲ vʲ		sˠ	ɕ	ç j	x ɣ	h
Nasal	mˠ mʲ	n̪ˠ	n	n̪ʲ	ɲ	ŋ	
Tap			ɾˠ ɾʲ				
Lateral Approximant		l̪ˠ	l	l̪ʲ			

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Some Applications

Language Learning

- Teaching aids and language learning devices

Accessibility

- Screen readers for the visually impaired
- Synthetic voices for the vocally impaired

Other Applications

- Synthetic voices for online gaming avatars
- Historical archives - each voice is a snapshot of an Irish dialect at a particular time

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The Corpus

- Large database of recorded speech, labelled as units
- Many examples of each speech unit in many different contexts
- The bigger the corpus, the higher the quality of the synthesised speech

Example of a Uniphone Corpus

- "A whole joy was reaping."
- "But they've gone south."
- "You should fetch azure Mike."

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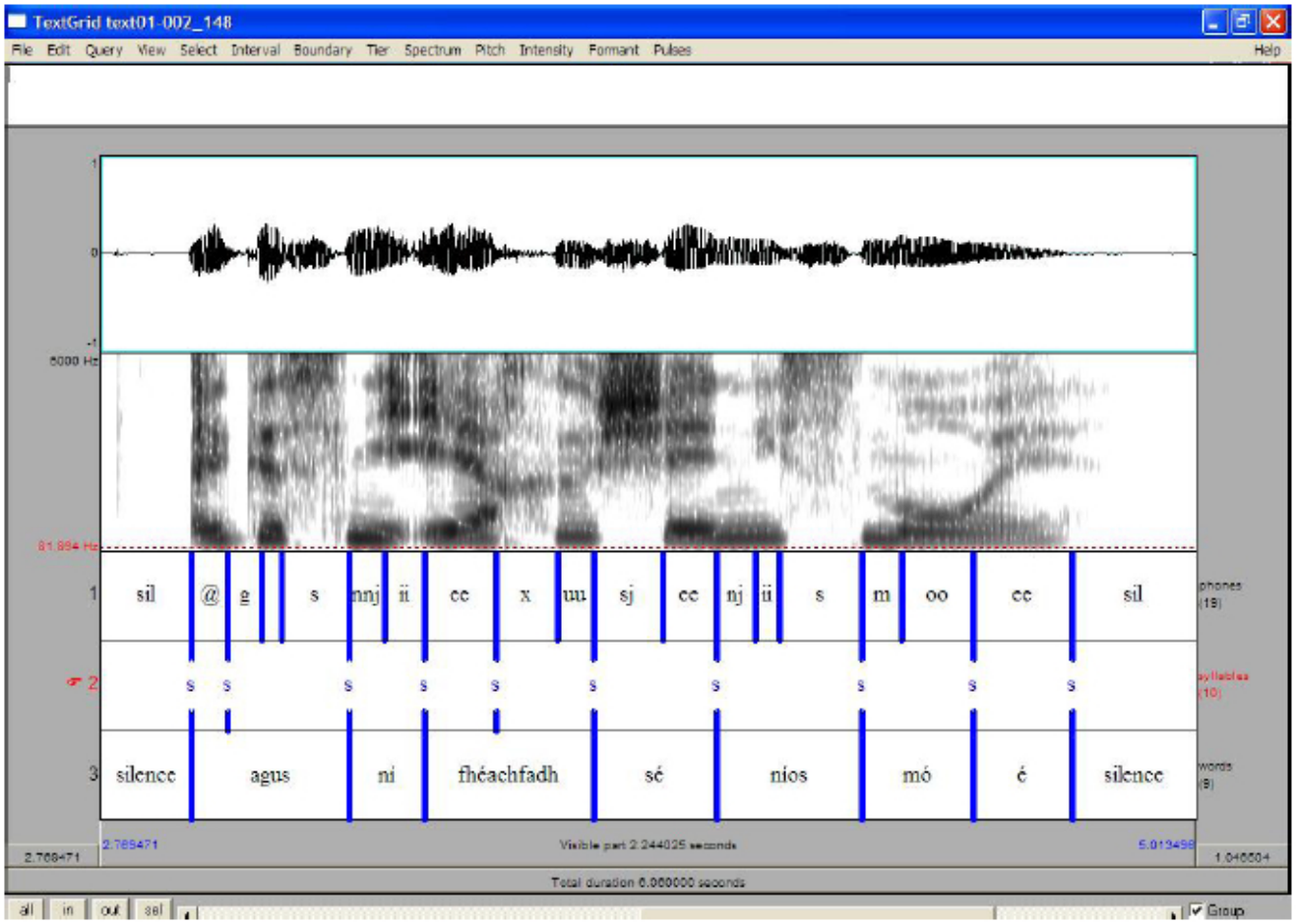

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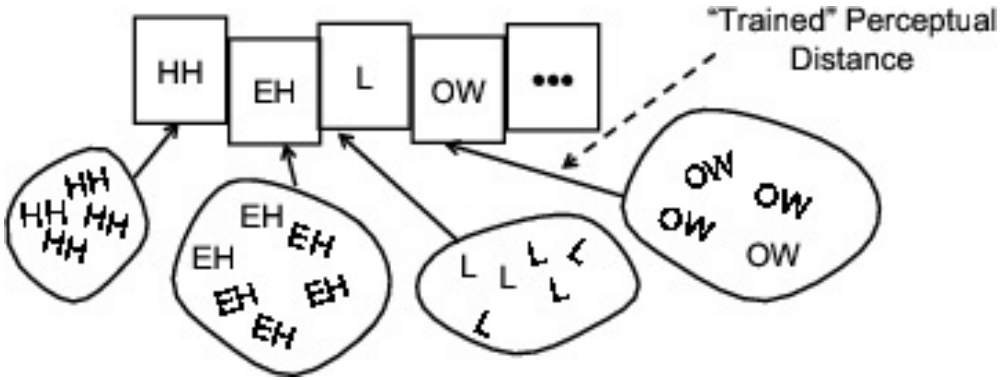
How Unit Selection Synthesis Works



- The **target utterance** is the sequence of units to be synthesised
- A set of candidates are chosen for each unit in the target utterance
- The most appropriate sequence of units is chosen by calculating the **cost function**

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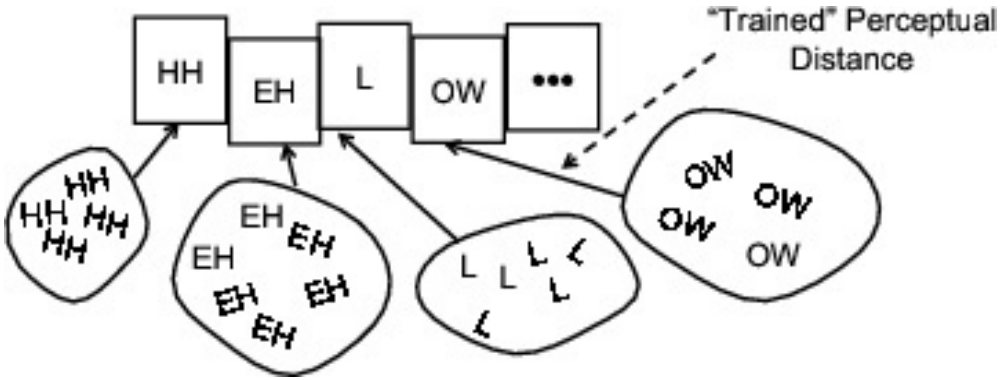

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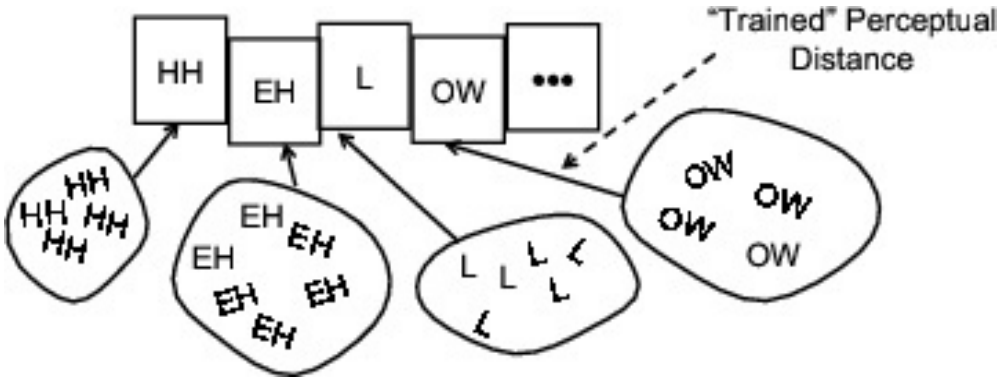

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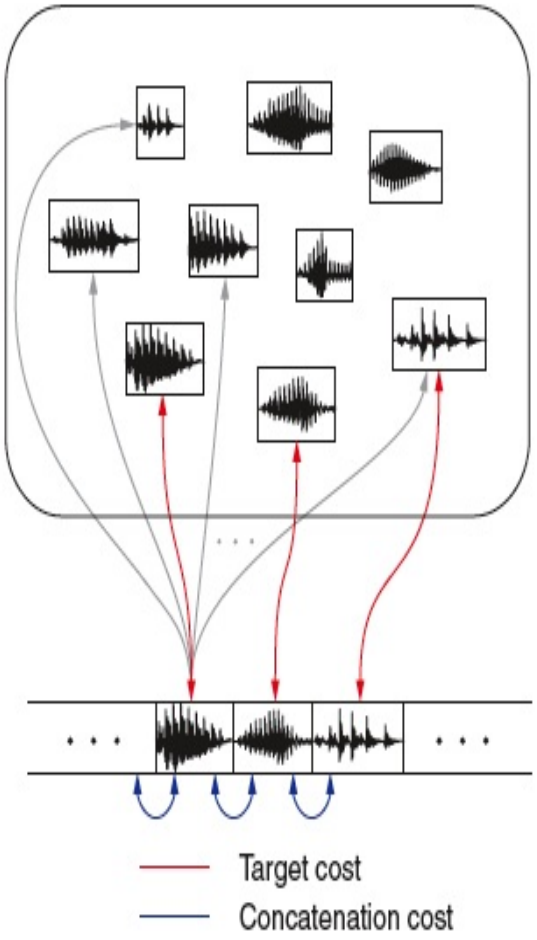

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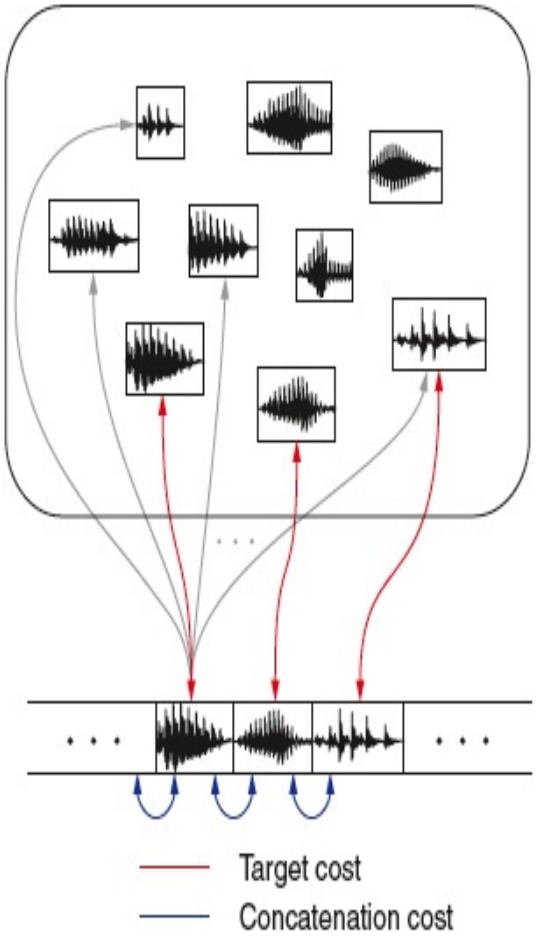

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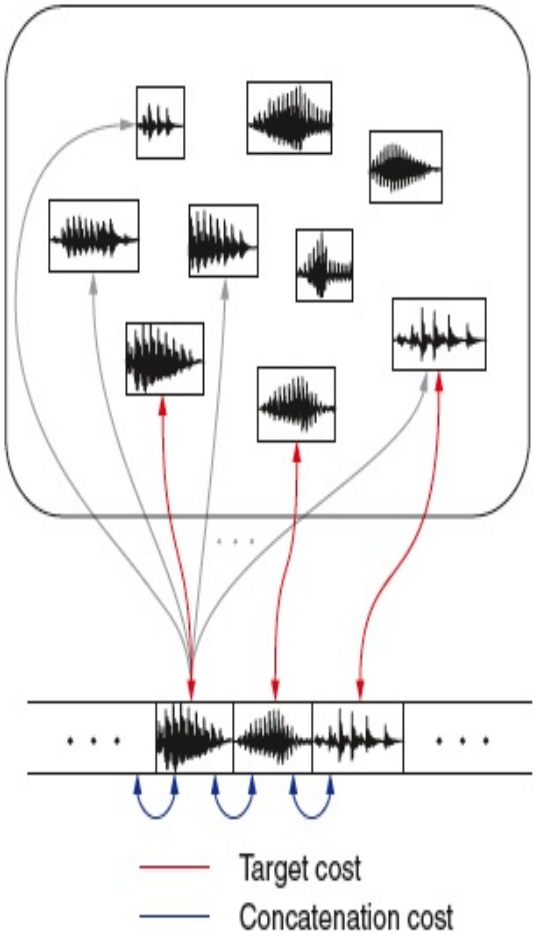

- Target Cost
  - Similarity between the target unit and the candidate unit

$$C^t(t_i, u_i) = \sum_{j=1}^{p} w_j^t C_j^t(t_i, u_i)$$

- Concatenation Cost
  - Perceptual similarity between one chosen unit and the next

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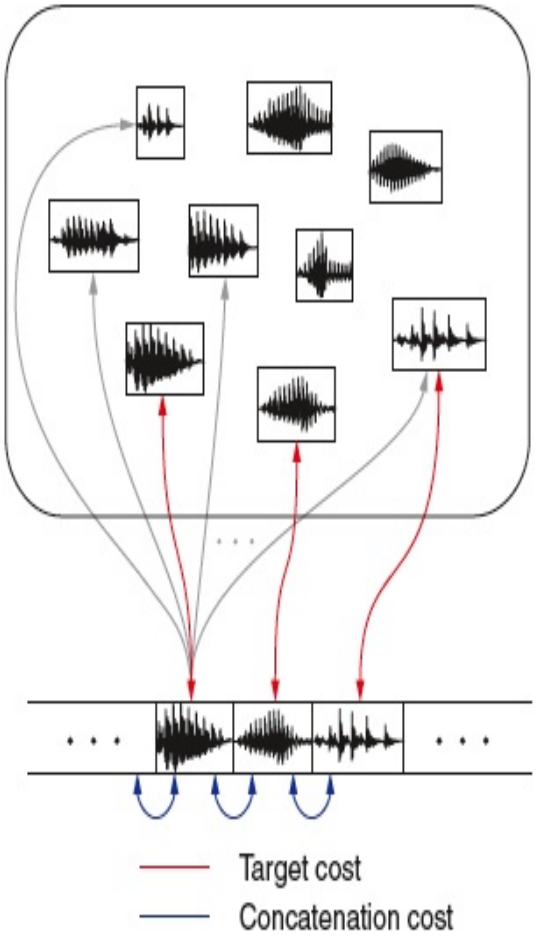

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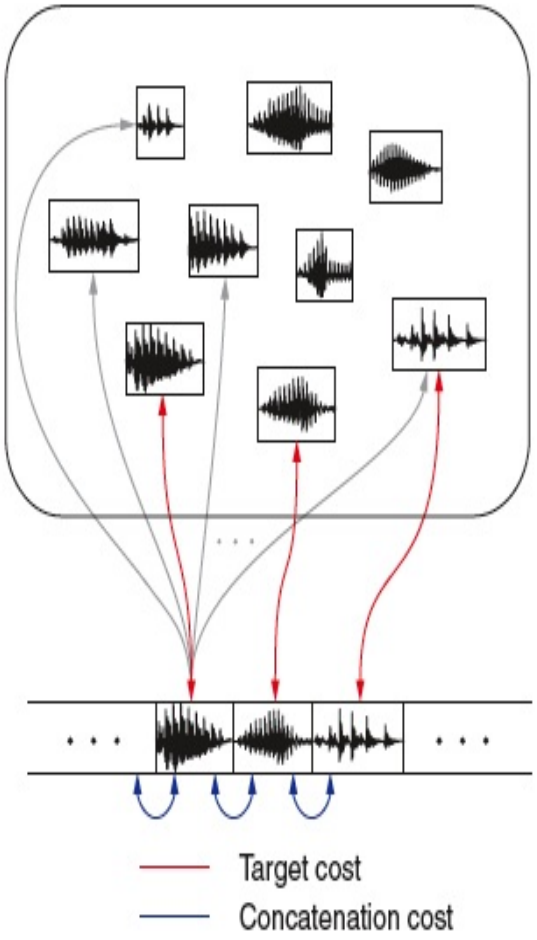

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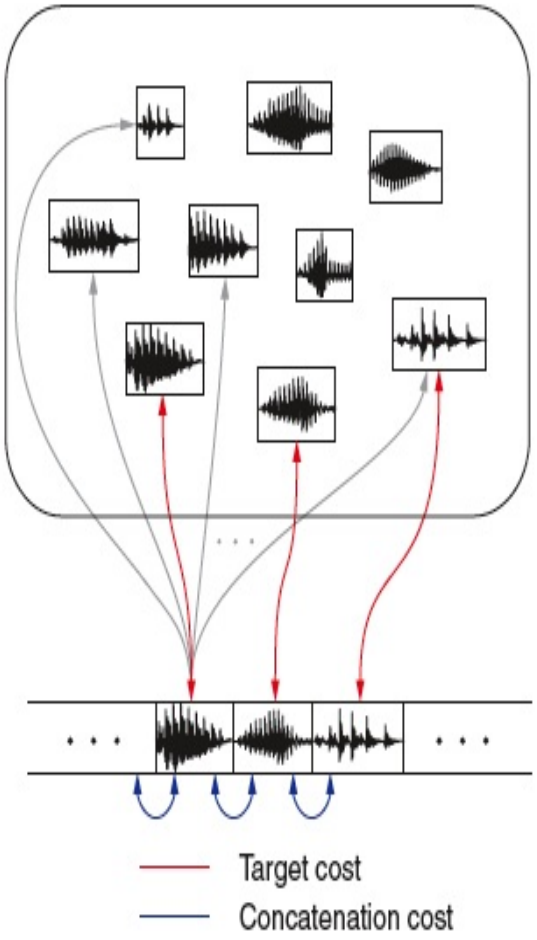

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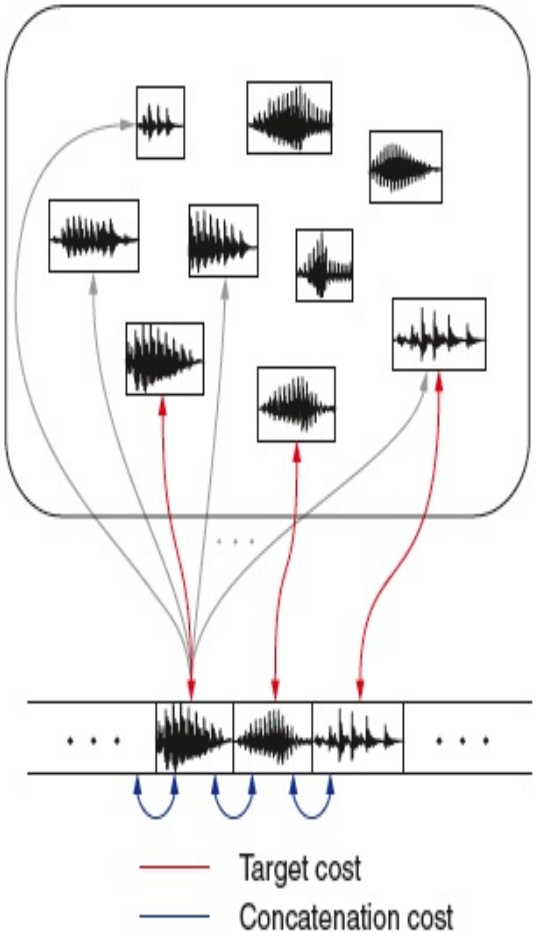

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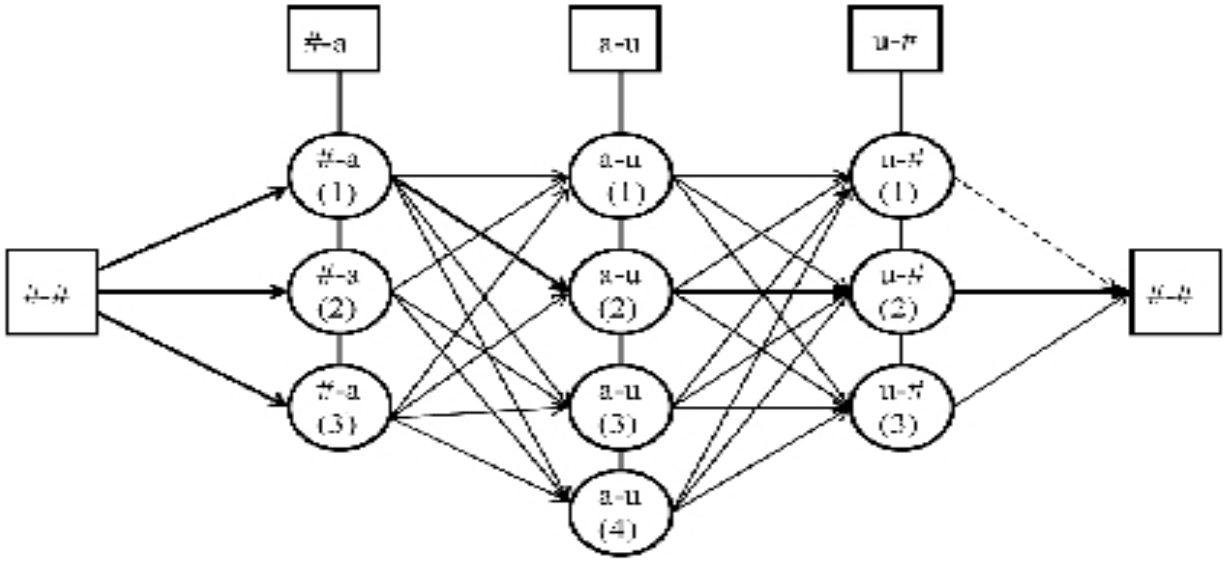

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- Calculates a cost for every possible combination of units
- The units selected are those which combine to give the sentence with the lowest cost

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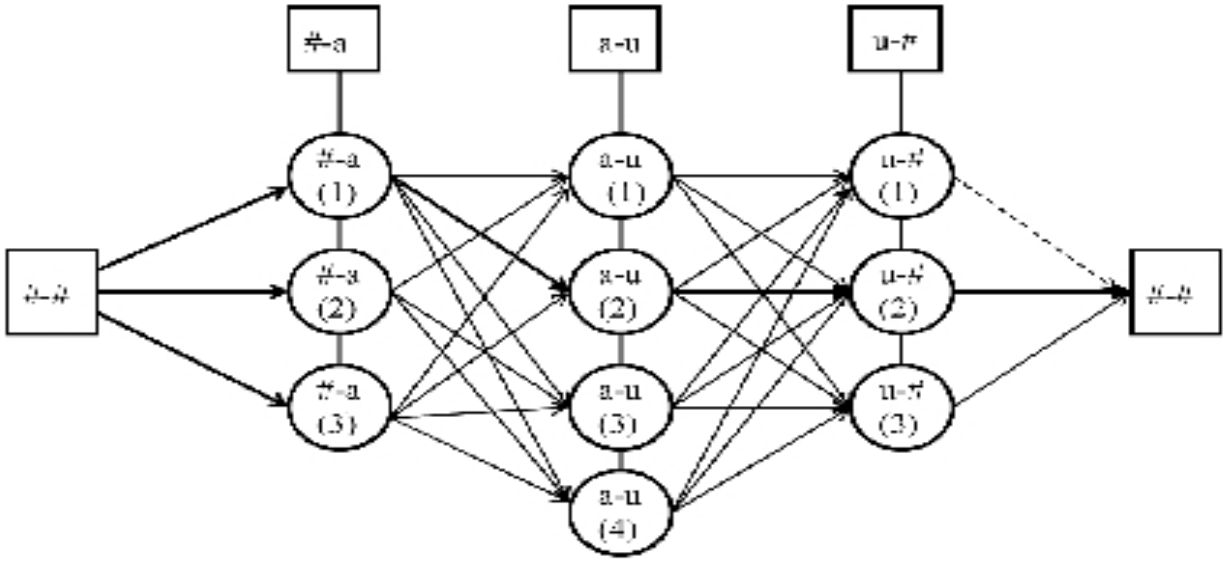

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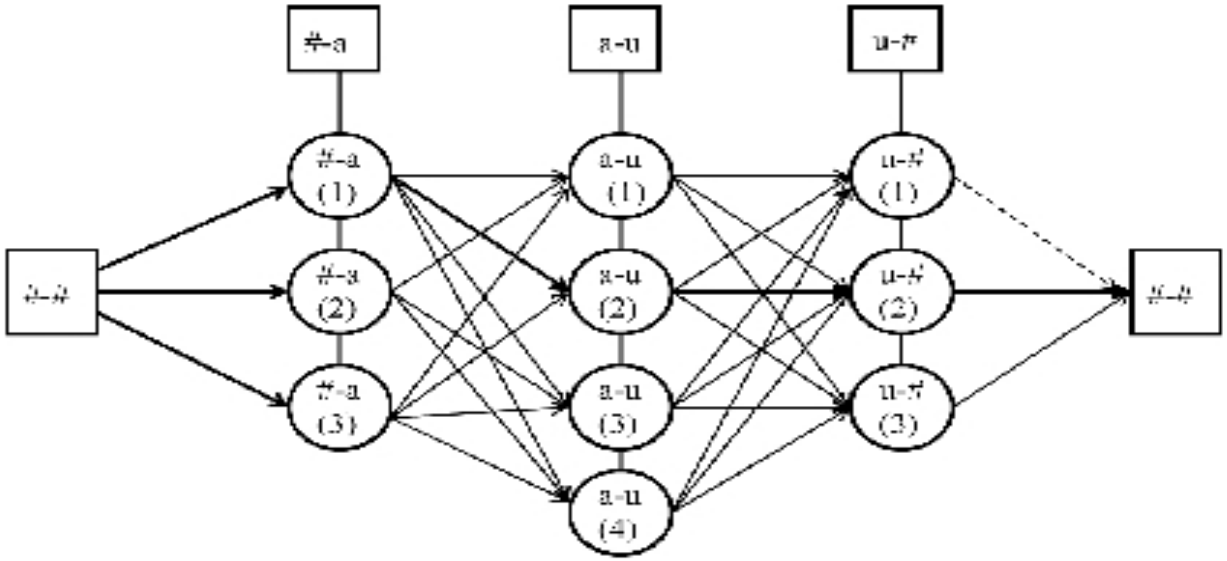

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Pros and cons of Unit Selection Synthesis

Pros

- High quality, natural sounding speech
- Prosody and intonation are preserved
- Minimum signal processing required

Cons

- Large database needed containing hours of recorded speech
- Synthesis can be very slow
- Voice cannot be changed without sacrificing quality

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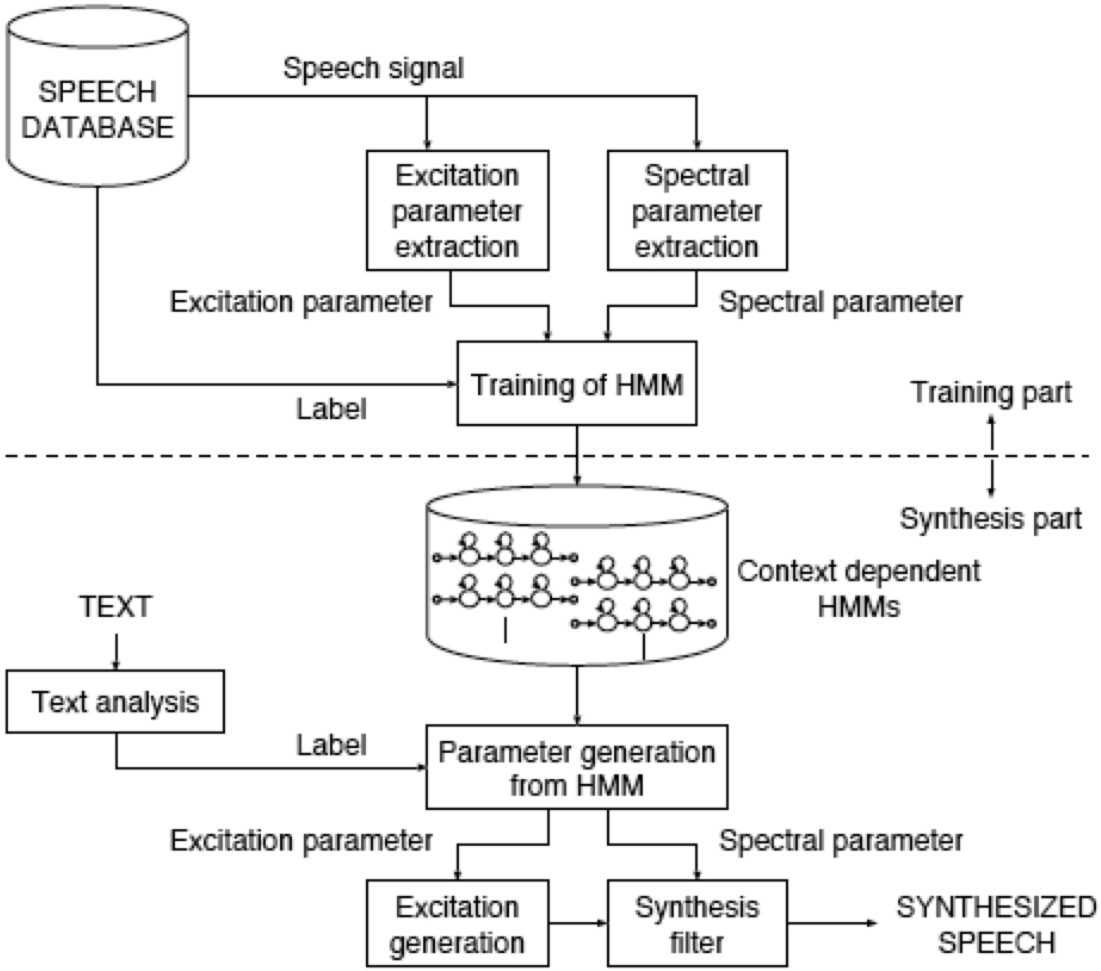
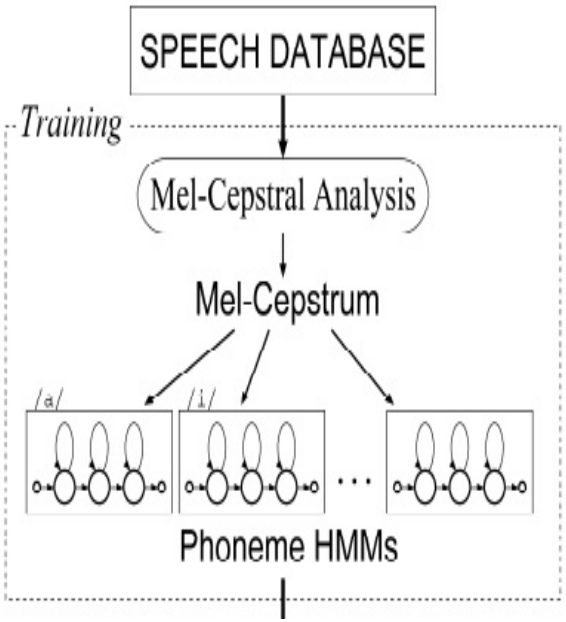
How HMM Synthesis Works



Training HMMs



- Duration, f0 and spectral information is extracted from the recorded speech
- This information is stored as excitation and spectral parameters
- The parameters are modelled using Hidden Markov Models (HMM)

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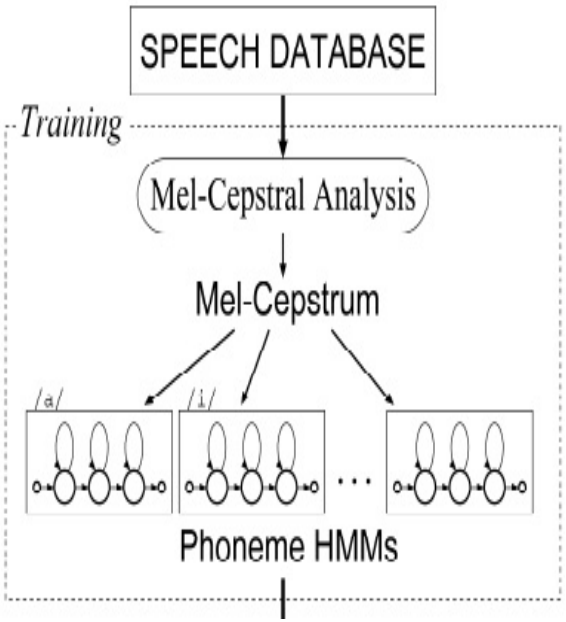

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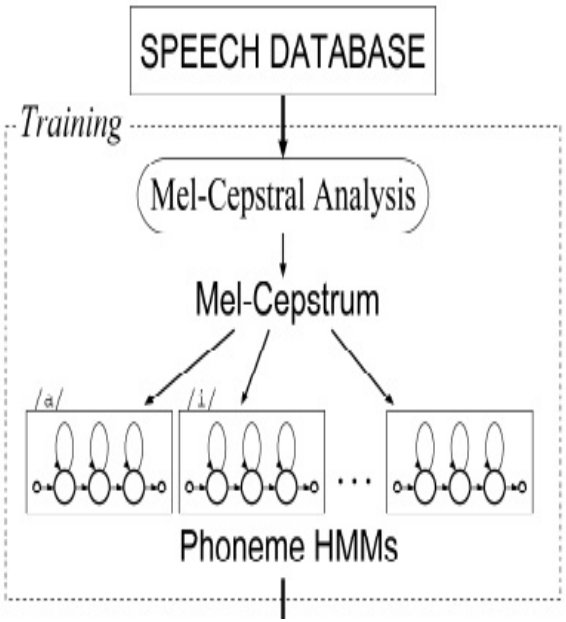

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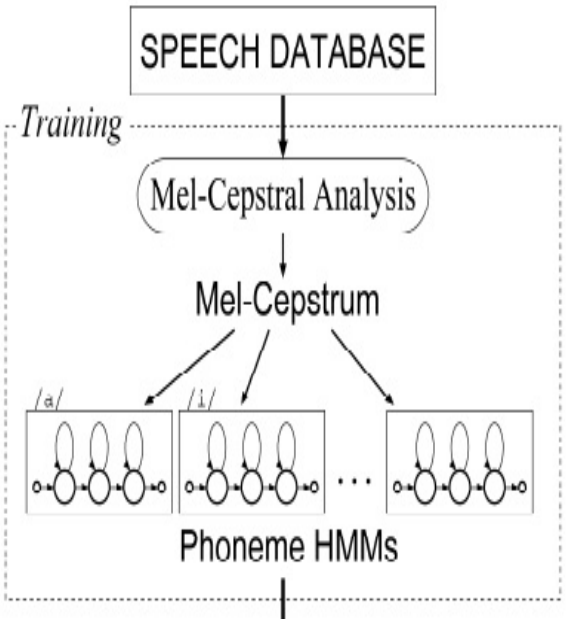

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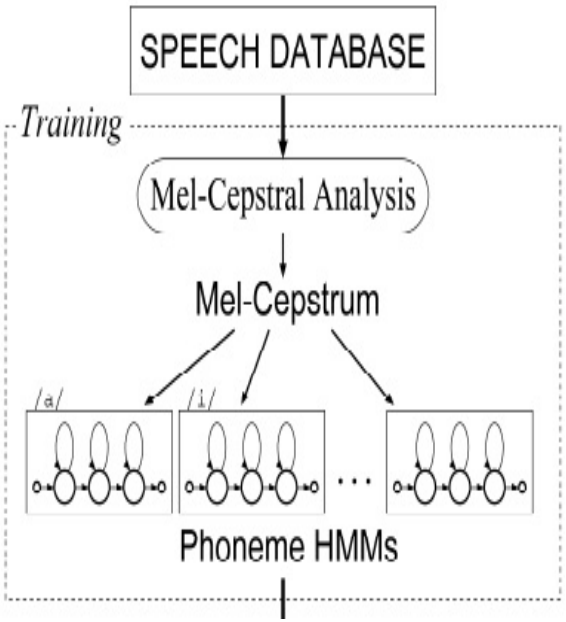

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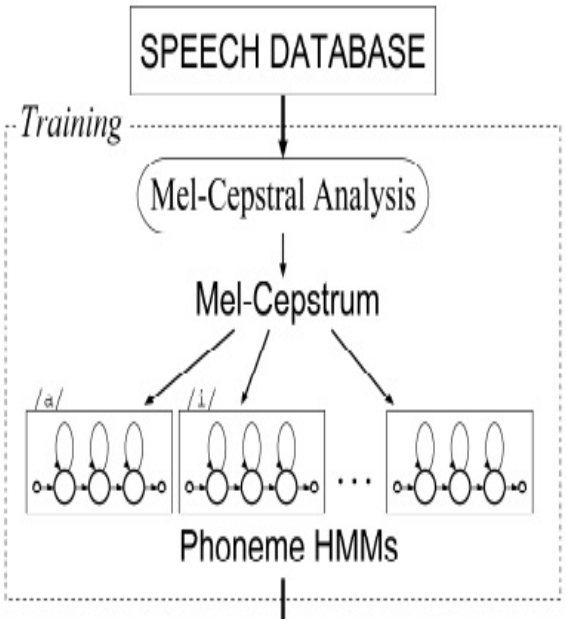

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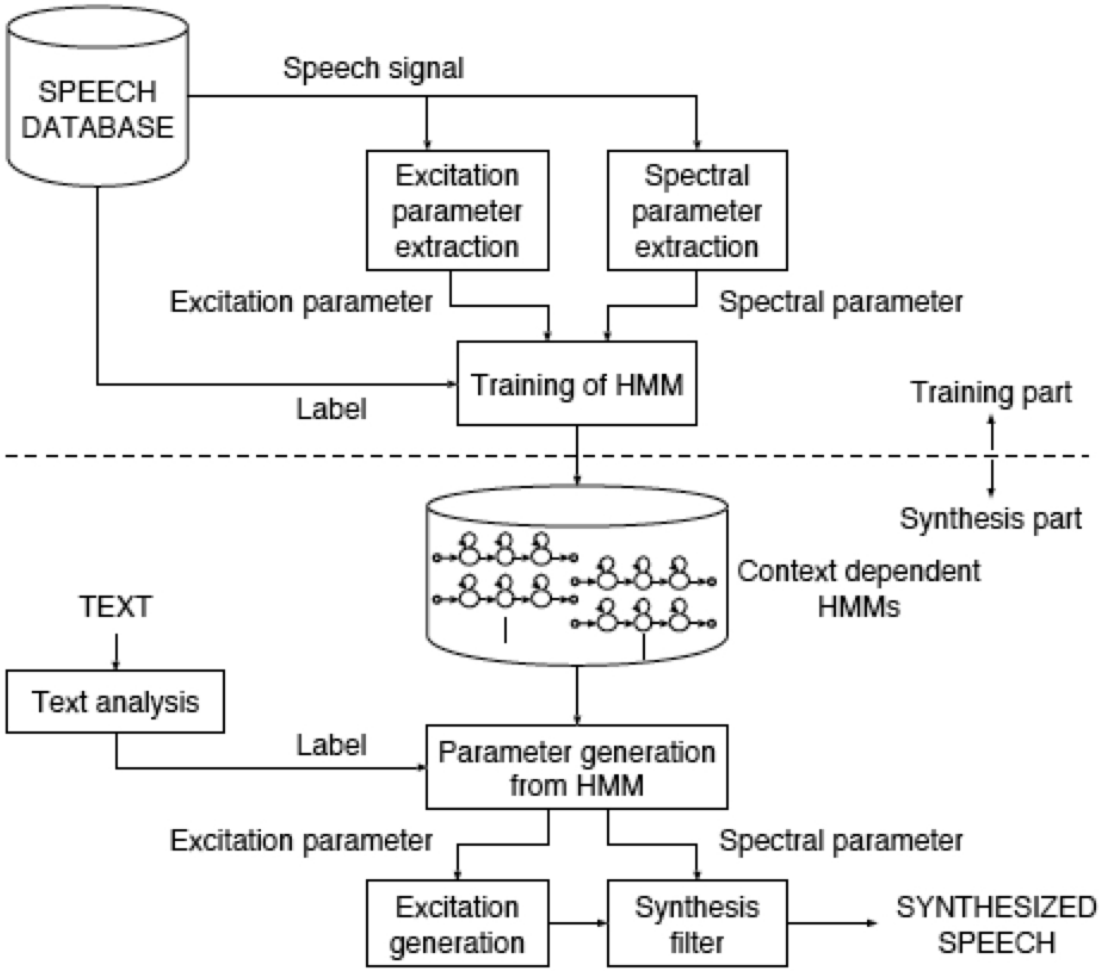
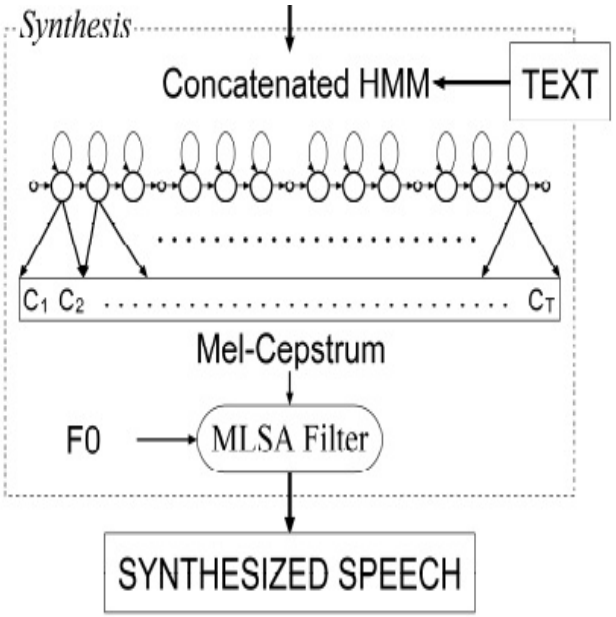


Synthesising HMMs



- The target utterance HMM is constructed as a sequence of unit HMMs
- The excitation and spectral parameters are generated from the HMM
- The speech waveform is generated from the speech parameters using a filter

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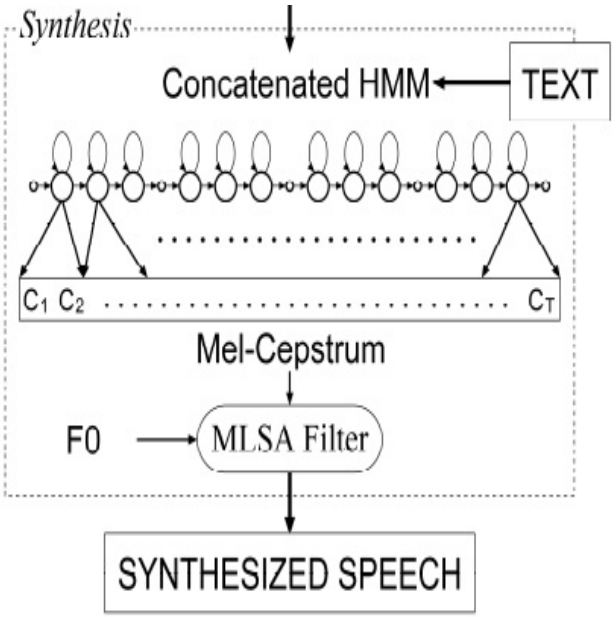

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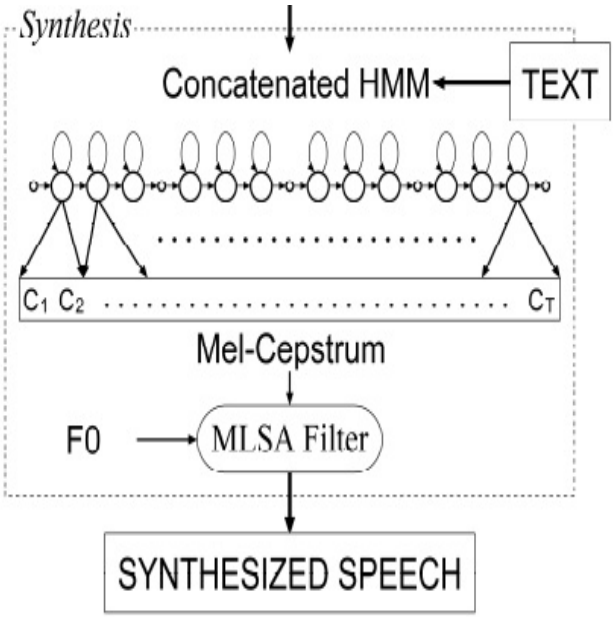

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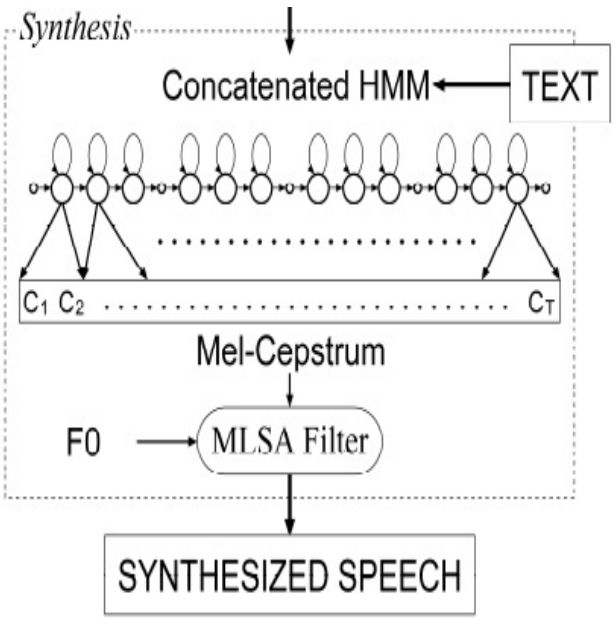

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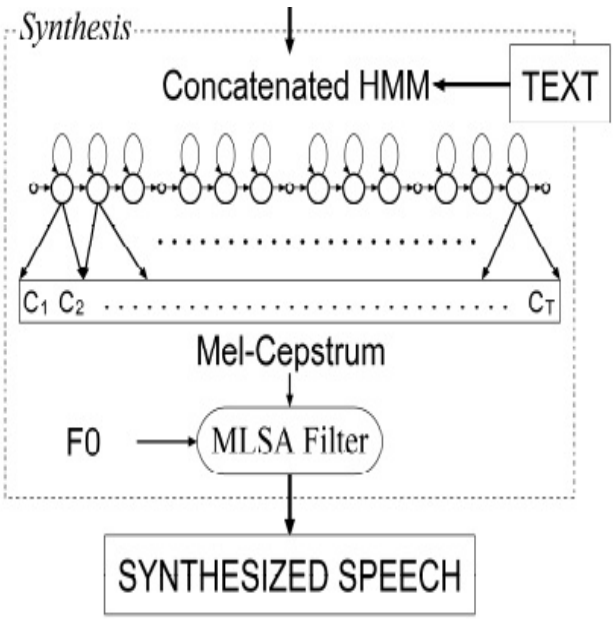

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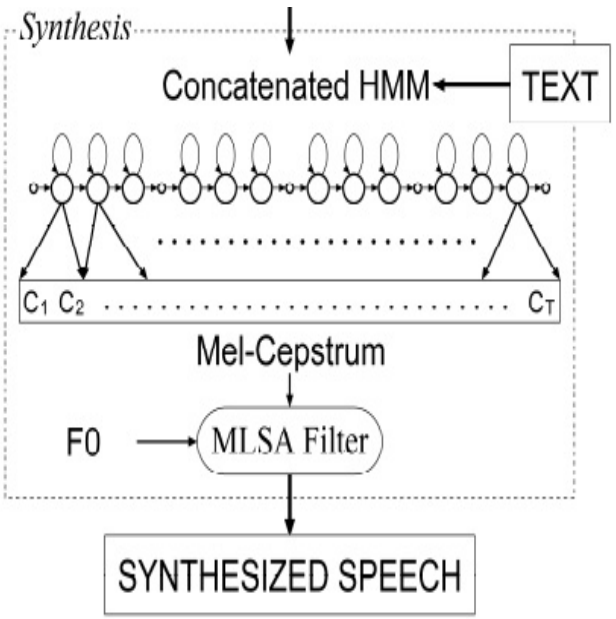

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Pros and Cons of HMM Synthesis

Pros

- Fast, accurate speech synthesis
- Requires only a small amount of memory
- Voices can be manipulated for voice disguise and emotional speech synthesis

Cons

- Heavy signal processing gives the voice a buzzy quality
- This method of synthesis is still being developed

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Building the synthesiser

Building the Corpus

- Gathering out of copyright, dialect specific material for recording
- Recording, aligning and annotating the corpus

The Lexicon

- Creating a dictionary of Irish words and pronunciations

Letter-to-Sound Rules

- Creating a list of grapheme-to-phoneme rules to cater for out-of-lexicon words

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Building the tools

Normalisation Tool

- Changes dates, times and other notation into a string of letters
- Very complex in Irish

Phonetisation Tool

- Changes normal text into a phonetic computer friendly sequence of units
- The corpus is labelled in this way so the units can then be found during synthesis

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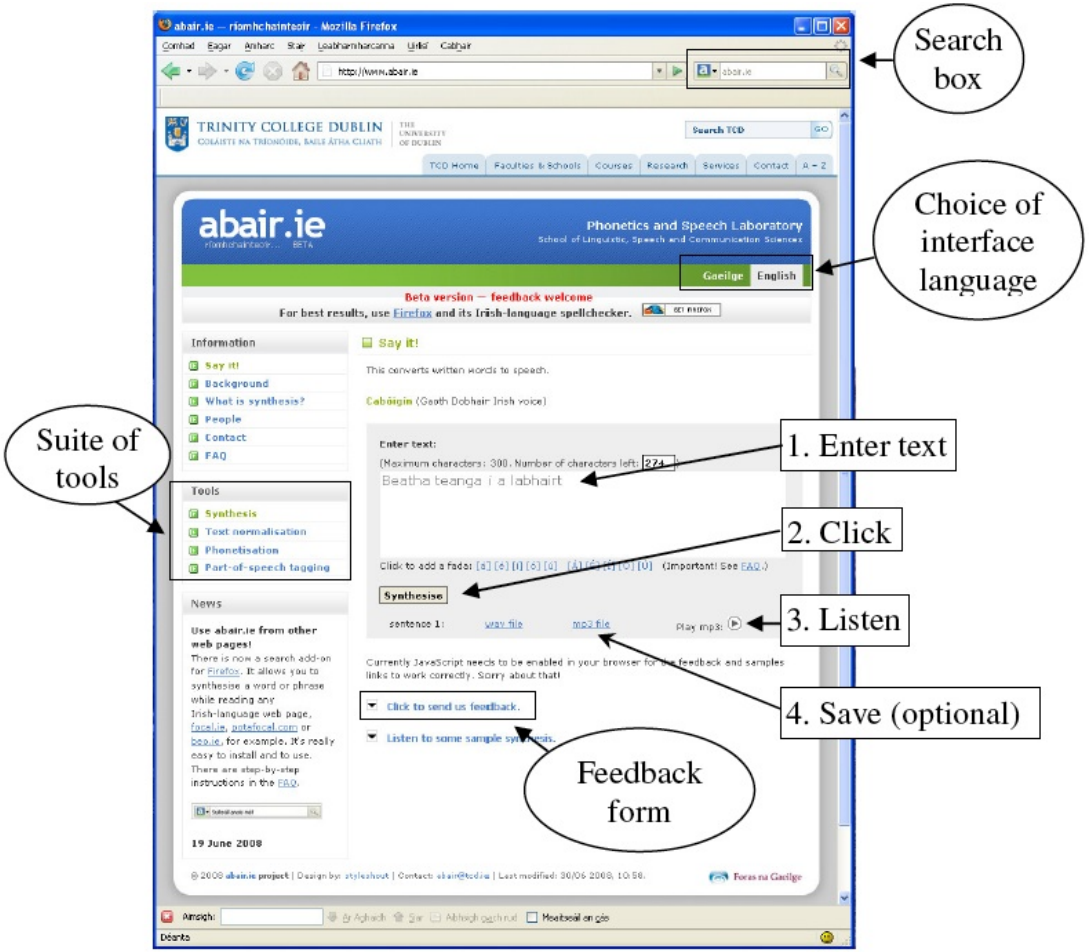
abair.ie Interface



Summary

- Overview of the Irish language, and the importance of synthesising minority languages.
- Explanation of unit selection and Hidden-Markov Model based synthesis.
- The steps taken to create the first Irish language speech synthesiser.
- Outlook
  - Creating HMM-based voices for screen readers
  - Create some unit-selection/HMM hybrid for controllable speech synthesis

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