Unified Simplified Grapheme Acoustic Modeling for Medieval Latin LVCSR



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What is the problem with Latin speech recognition?

- Latin is not spoken natively
- There is no available speech database, and it is resource-heavy to create one
- Many variants/dialects exists, and we can only make guesses about the pronunciation
- The pronunciation mainly depends on
- the era of the read text
- the native language of the speaker

Text data

Regions of origin: Kingdom of Bohemia (CZ), Kingdom of Hungary (HU), Kingdom of Poland (PL)

- In-domain data (Monasterium): medieval charters (HU), 480k/35k token/type
- Background data (Latin Library): historical texts, 1.3M/115k token/type

Speech data

Languages: CZ, HU, PL, RO

Table 1: Perplexity/OOV rate

	•	•		
	Te	xt regi	on	
Corpus	CZ	HU	PL	All
Monasterium	551	82	3130	671
Latin Library	3266	3549	2305	4303
Interpolated	924	82	2288	953

Spelling variants

	_	
jam		iam
judex		iudex
gracia		gratia

Test data

- Independent medieval charters
- Region of read text: CZ, HU, PL
- Native language of test speakers: CZ, HU, PL, SK

Perplexity measures on test

	Te			
Corpus	CZ	HU	PL	All
Monasterium			3130	
Latin Library	3266	3549	2305	4303
Interpolated	924		2288	

Baseline Grapheme Model

Languages: Czech (CZ), Hungarian (HU), Polish (PL), Romanian (RO)

- All graphemes are trained
- Only those grapheme models are retained that are part of the Latin alphabet

Table 2: Word Error Rate (WER[%]) results for monolingual grapheme-based acoustic models of Czech, Hungarian, Polish and Romanian (CZ, HU, PL, RO).

	S	Speaker				
AM Language	CZ	HU	PL	SK	\sum	
CZ	53.6	73.8	62.9	45.7	59.0	
HU				29.1		
PL	65.0	67.6	46.4	51.1	57.5	
RO	53.6	69.1	44.7	43.8	52.8	

Knowledge-based grapheme-to-phoneme (G2P) mapping

Languages: CZ, HU

Table 3: Latin digraph context-insensitive rewrite rules.

	-	Digraph				
	ae	oe	ph	q		
CZ	e	oe	f	k		
HU	e	Ø	f	k		

Table 4: Latin context-sensitive rewrite rules. V: vowel, VP: palatal vowel, ^VP: everything but a palatal vowel, C: consonant, *: zero or any, $\hat{}$: beginning of word, $\hat{}$ and $\hat{}$: not s, t or x.

GR	c	c	ch	ch	gu	gu	ti	ti
					_	_	tsi	
rule	cVP	c^VP	VC*ch	^C*ch	guV	guC	$\int \int stx dt$	tiC

Table 5: WER[%] for Czech-Latin sourcetarget G2P model. Acoustic model training set: 76 hours.

	Latin Test Text						
Speaker	CZ	HU	PL	\sum			
CZ			49.1				
HU			58.7				
PL	53.3	18.2	53.2	41.6			
SK	30.3	30.0	44.0	34.8			
\sum	43.9	28.9	50.8	41.2			

Table 6: WER[%] for Hungarian-Latin source-target G2P model. Acoustic model training set: 567 hours.

	Latir	n Test	Text	
Speaker	CZ	HU	PL	\sum
CZ	19.4	6.4	28.0	17.9
HU	25.0	25.4	20.2	23.5
PL		15.4		
SK	20.4	9.1	22.9	17.5
\sum	22.6	12.5	28.1	21.1

Language model

Acoustic model

Unified Simplified Grapheme (USG) Model

Languages: CZ, HU, PL, RO

Table 7: Simplification examples for the unified model.

Language	CZ	HU	PL	RC
Orthographic form	řekl	őz	miś	apa
USG transcription	rekl	ΟZ	mis	apa

Table 8: WER[%] for all the three-language

USG models. Speaker CZ HU PL SK AM Language CZ+HU+PL 28.2 28.2 27.7 22.4 26.6 CZ+HU+RO 23.3 21.4 23.9 19.2 **21.9** 24.6 33.1 25.6 19.8 25.8 CZ+PL+RO HU+PL+RO 24.8 21.5 25.7 20.7 23.2

WER[%] for USG model of Czech, Hungarian, Polish and Romanian (CZ+HU+PL+RO).

	Latin Test Text						
Speaker	CZ	HU	PL	\sum			
CZ			30.7				
HU			25.7				
PL	23.0	10.0	33.0	22.0			
SK	14.5	12.7	24.8	17.3			
$\overline{\sum}$	19.9	12.2	29.0	20.4			

Dimensions of data

Native language of test speakers: CZ, HU, PL, SK

Region of read text: CZ, HU, PL Speech data: CZ, HU, PL, RO

Model type: baseline, knowledge-based, USG

System diagram

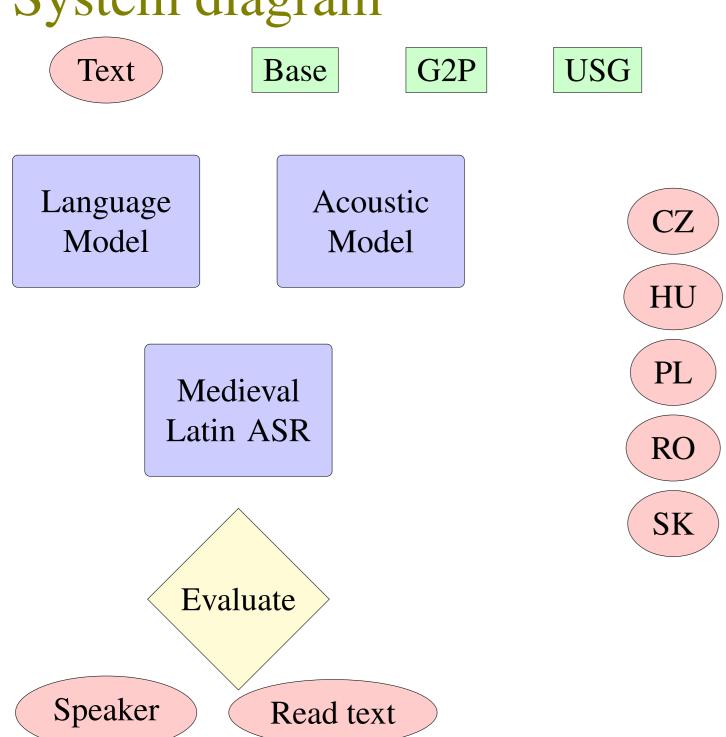


Figure 1: Medieval Latin Speech Recognizer

Conclusions

- Four-language USG is the best
- It is able to generalize over different speaker test sets