

# Phonemic Inventory as a Phylogenetic Characteristic

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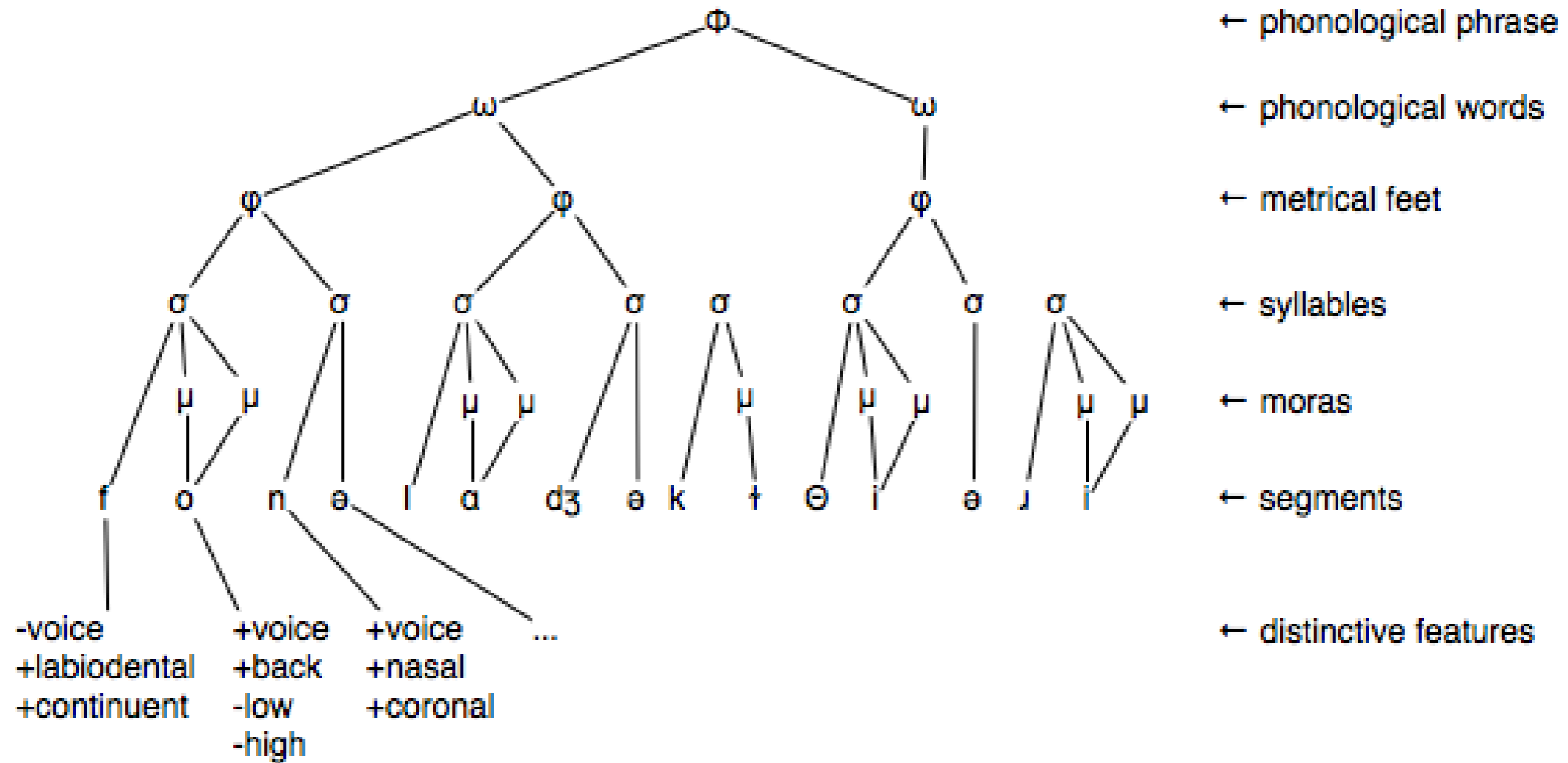
# Reconstruction without lexicon?

- Underlying model of historical linguistics:
  - ▶ Soundchange
  - ▶ Changes in phoneme system ?
- Can we use the structure of phoneme systems for reconstruction ?

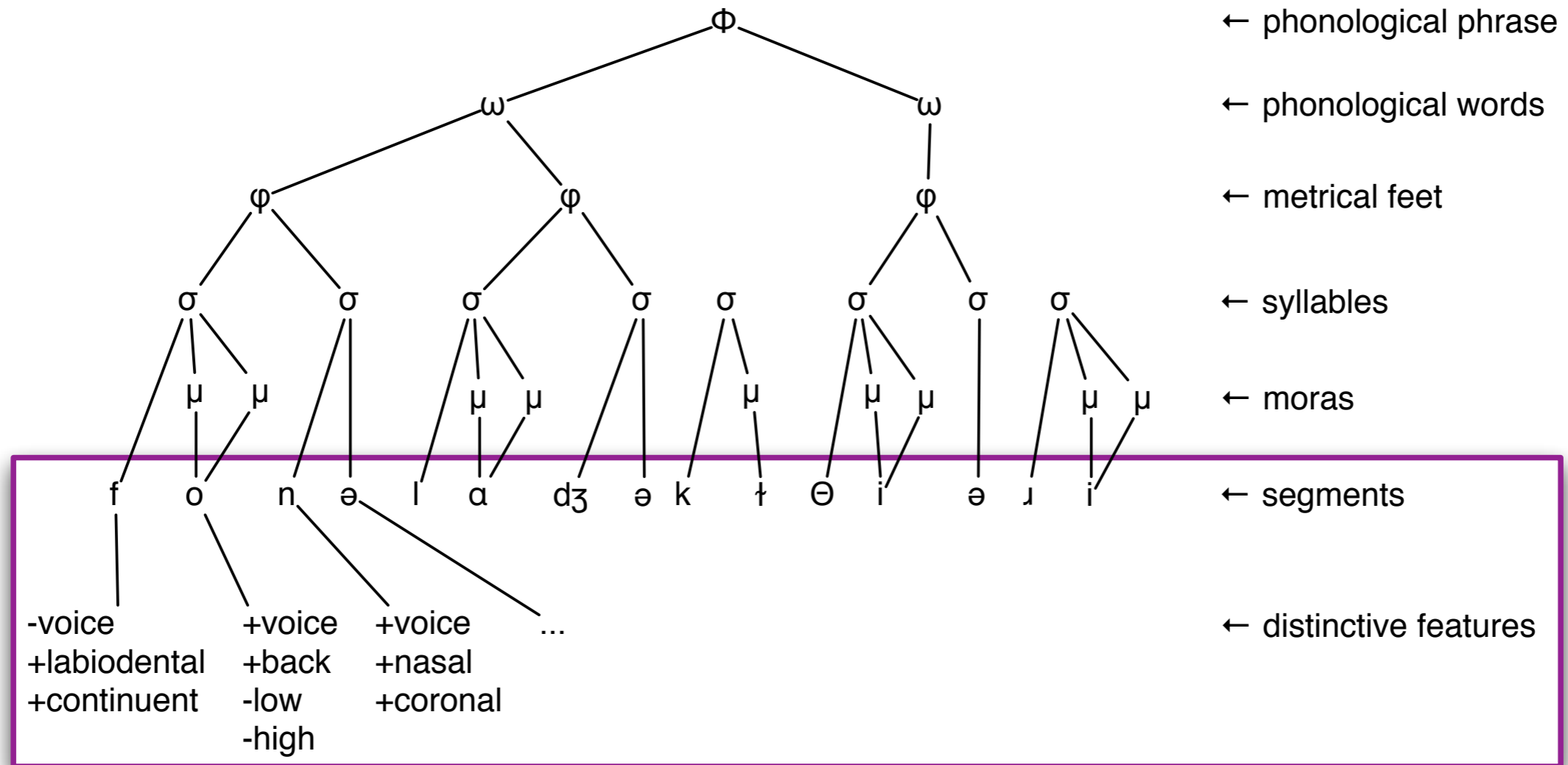
# Phoible

Phoneme Inventory Database

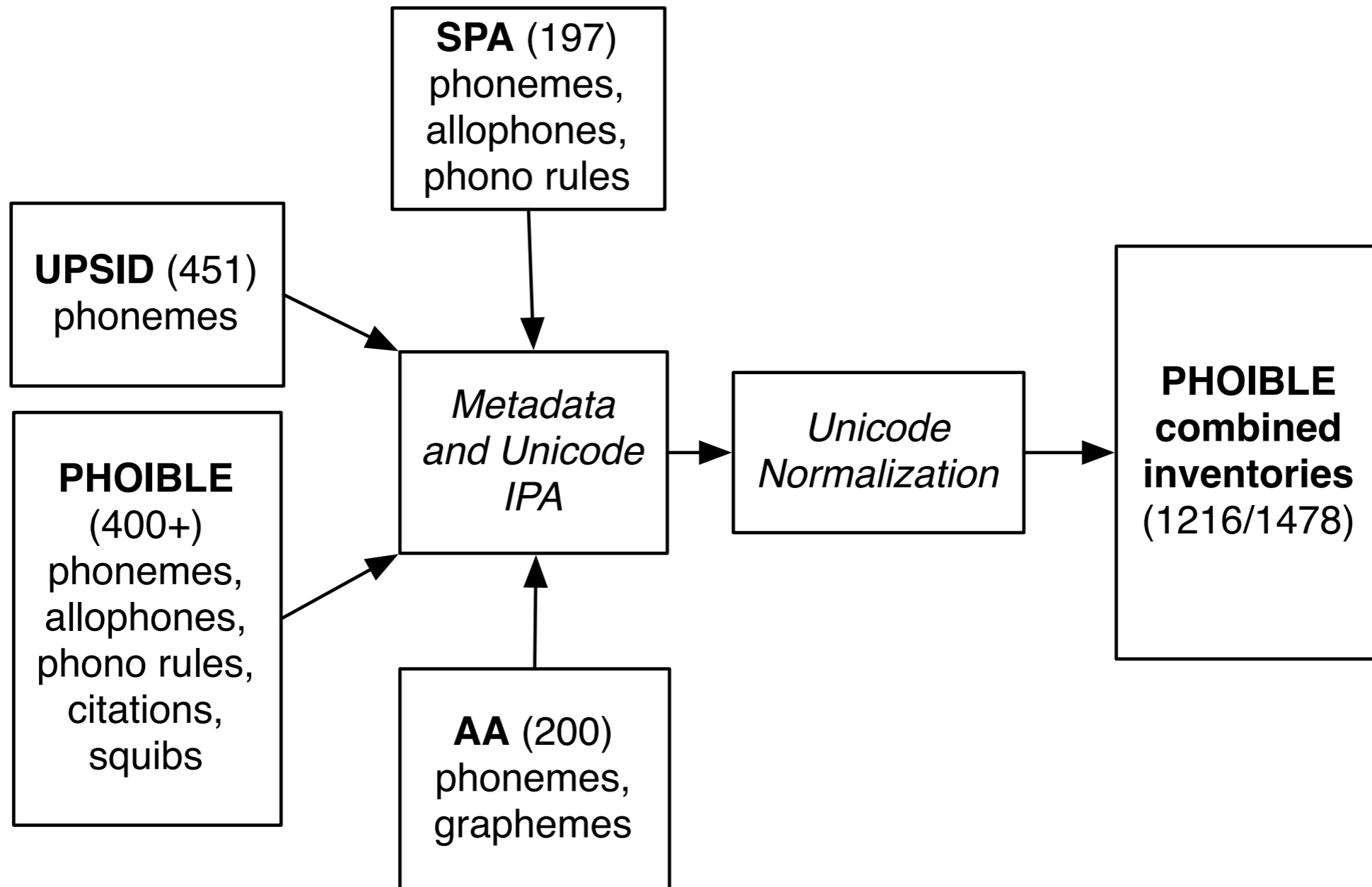
# Where are we ?



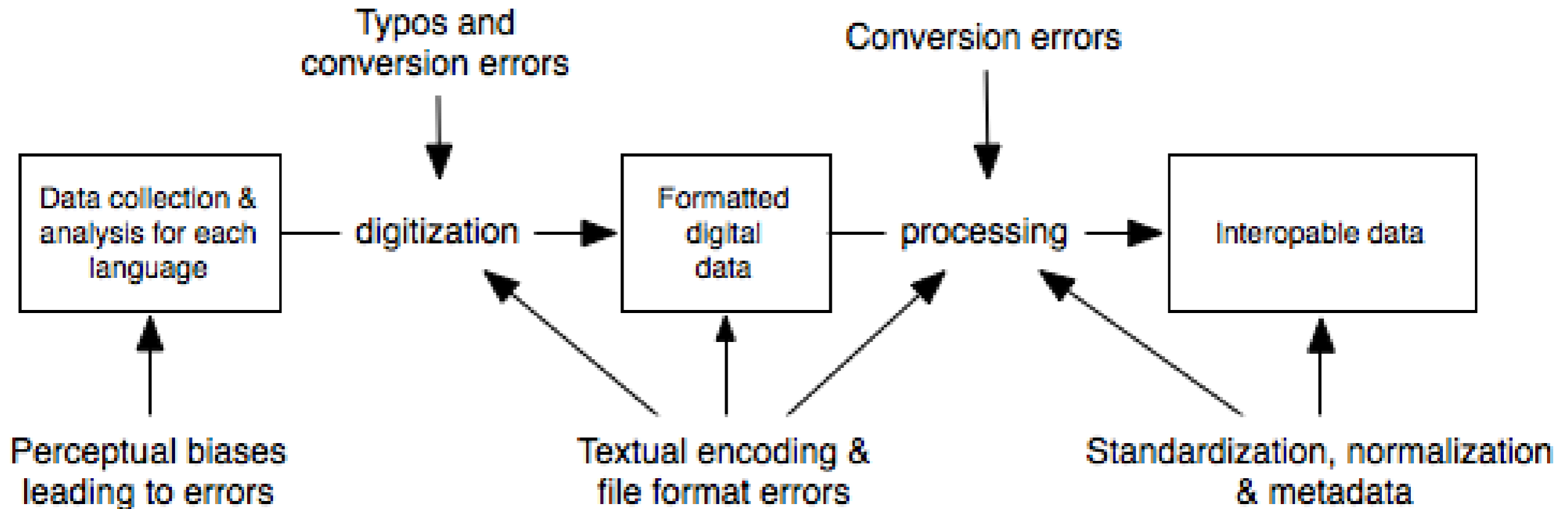
# Where are we ?



# PHOIBLE resources



# Workflow to add segments



# Challenges

- Transcription is an impressionistic analysis
- Language documentation varies in its descriptive adequacy
- Different theoretical models are used in writing language descriptions
- The comparative linguist should not typologize on the descriptive linguists' analytical preferences (Hyman 2008)



# Different analyses, same language

Table 2.1: Analyses of vertical vowel system of Kabardian (Hyman 2008:99)

Ladefoged & Maddieson 1996	/i ə a/
Halle 1970	/ə a/
Anderson 1978	/a/
Kuipers 1960	No vowels

# Deciphering descriptions

- Linguistic analyses must be extracted from language descriptions
- Poor descriptions ?
- Phonemes in loanwords and other marginal phonemes ?
- Unusual/rare descriptions ?
  - ▶ ‘half voice’
  - ▶ ‘p-tense’

# Keep as close as possible to the sources

- Result: PHOIBLE now contains
- **1500 Inventories**  
 (“doculects”, 1235 distinct ISO 639-3 codes)
- **1953 Segment Types**  
 (“claimed focal phonetic value of phoneme”)

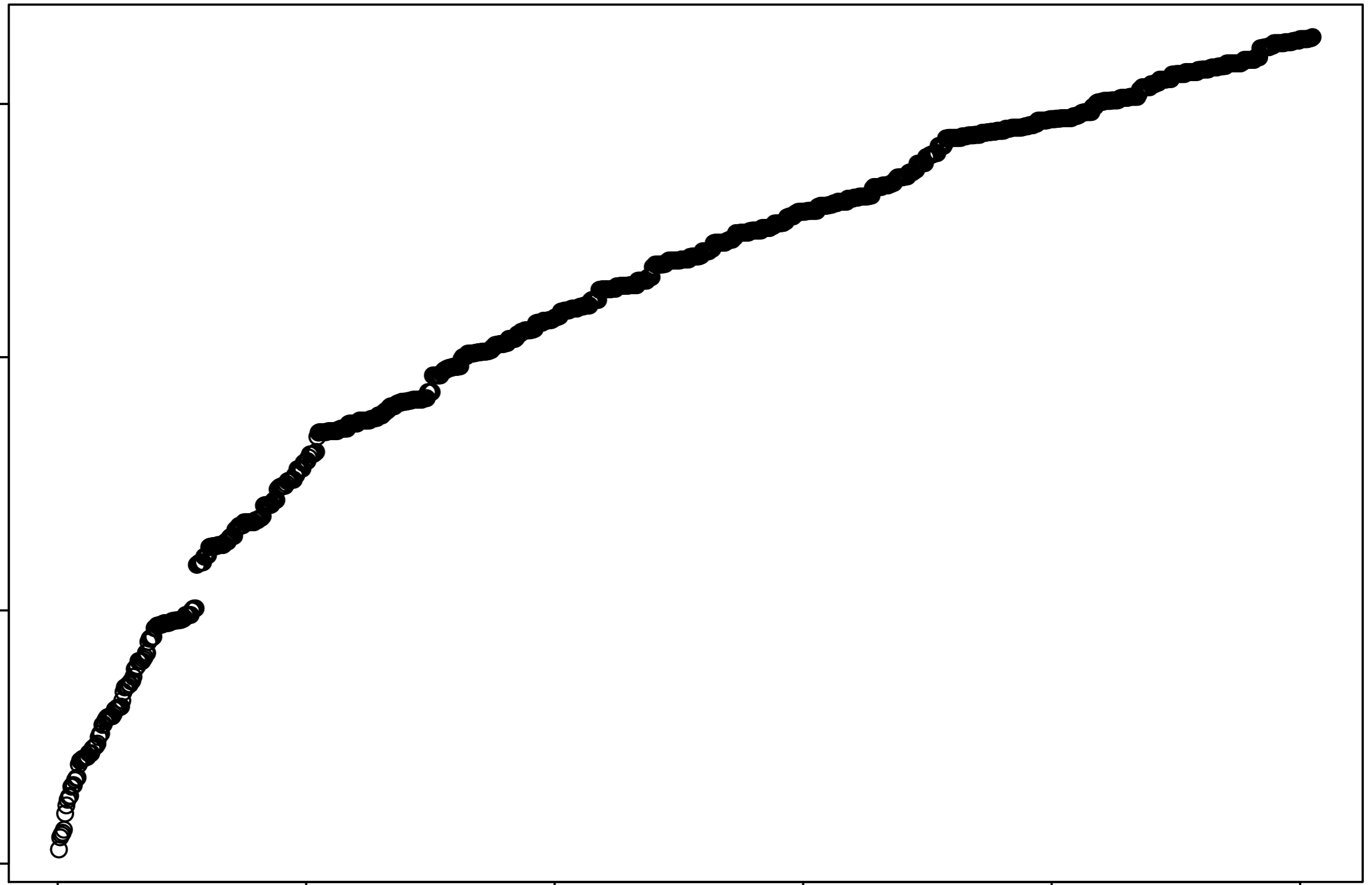


cumulative number of phones

0  
500  
1000  
1500

0 200 400 600 800 1000

languages in random order



# Mapping distinctive features to segment types

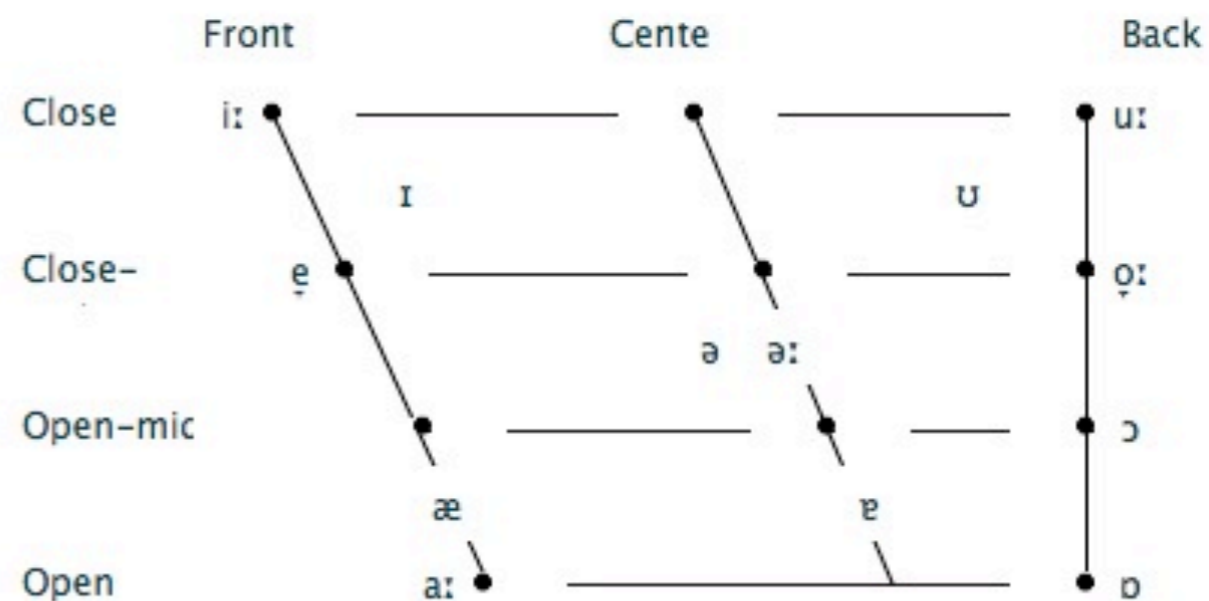
- Features are the atoms that combine compositionally to form a segment
- /i/ is { -labial, -round, +high, ... }
- Available distinctive feature systems lack typological representation
- There are way more segments than expected!

# English

	Bilabia	Labio Dental	Dental	Alveolar	Post Alveolar	Retrofle	Palatal	Velar	Uvular	Pha-ryngeal	Epig-lottal	Glottal
Plosive	p <sup>h</sup> b		t <sup>h</sup> d					k <sup>h</sup> g				ʔ
Nasal	m			n				ŋ				
Trill												
Tap/Flap												
Fricative		f v	θ ð	s z	ʃ ʒ			x				h
Affricate												
Lateral Fricative												
Lateral Affricate						tʃ dʒ						
Approximant							ɹ j					
Lateral Approximan				l								

Clicks	Voiced Implosives	Ejectives(')
Bilabial	Bilabial	Bilabial
Dental	Dental/alveo	Dental/alveo
(Post)alveola	Palatal	Palatal
Palatoalveoli	Velar	Velar
Alveolar later	Uvular	

Other Symbo m w



	l	m	n	ɲ	i:	ə	ɔ̃	ɛ	ɔ	s	a:	ʊ	ɱ	k <sup>h</sup>	v	ɔ:	ŋ	dʒ	t <sup>h</sup>	w	b	g	tʃ	x	u:	d	z	θ	p <sup>h</sup>	ɒ	f	ʒ	æ	ɐ	ɹ	h	j	ʔ	ɛ:				
atr	0	0	0	0	-	-	0	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	-	0	0	0	0	-	0	0	-	-	0	0	0	0	-				
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strident	-	0	-	+	0	0	-	0	0	+	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	+	-	0	0	0	+	0	0	-	0	0	0	-	0	0	0	0
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low	0	0	0	0	-	-	0	-	-	0	+	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	+	0	0	+	+	0	0	+	+	0	0	-	0	-
front	0	0	0	0	+	-	0	+	-	0	-	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	-	0	0	+	-	0	0	+	0	0	+	0	-	
back	0	0	0	0	-	-	0	-	+	0	-	+	+	-	0	+	-	0	0	+	0	-	0	-	+	0	0	0	0	+	0	0	-	-	0	0	-	-	0	0	-	0	-



# Feature specifications for natural classes of sounds

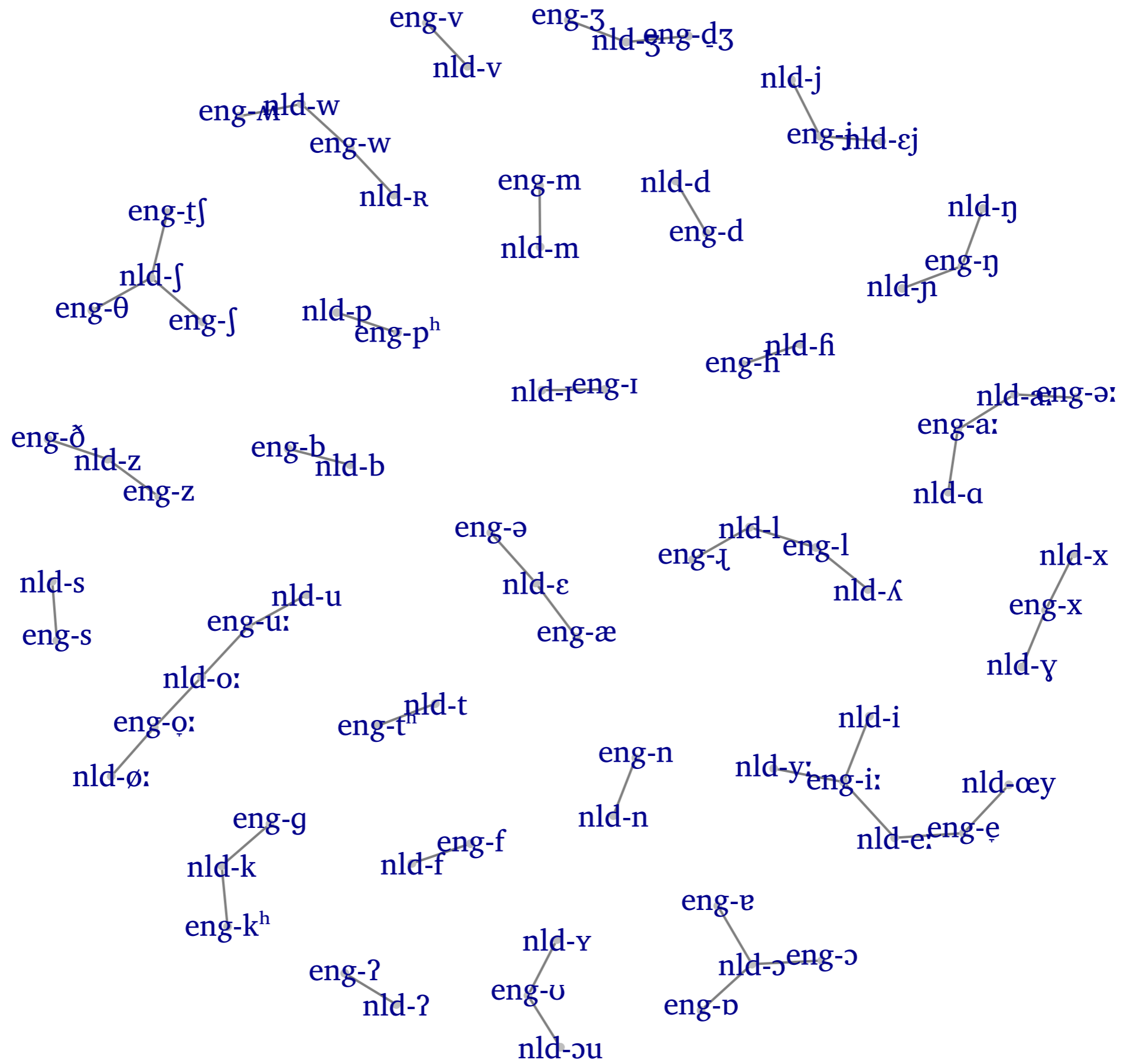
Class of sounds	Feature specification
Vowels	[+syllabic]
Glides	[-syllabic] [-consonantal]
Liquids	[+consonantal] [+approximant]
Nasals	[+sonorant] [-approximant]
Fricatives	[-sonorant] [+continuant]
Affricates	[-continuant] [+delayed release]
Stops	[-delayed release]
Stops & Affricates	[-continuant]
Liquids & Glides	[-syllabic] [+approximant]
Liquids, Glides, & Nasals	[-syllabic] [+sonorant]

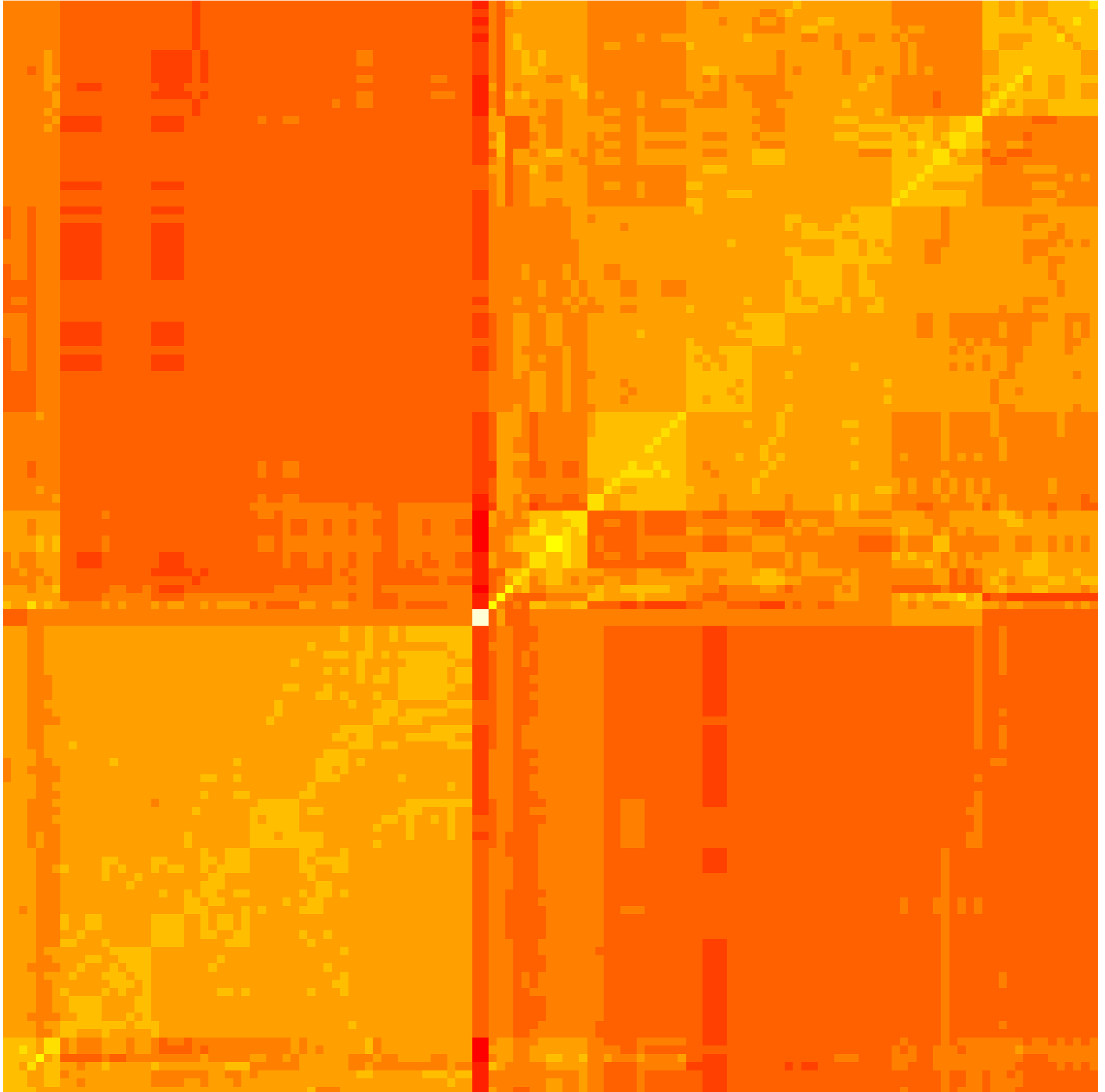
# Using inventories for reconstruction

- The test:
- Can we (algorithmically) at least distinguish North Germanic from West Germanic
- ...
- nope, didn't work (until now)

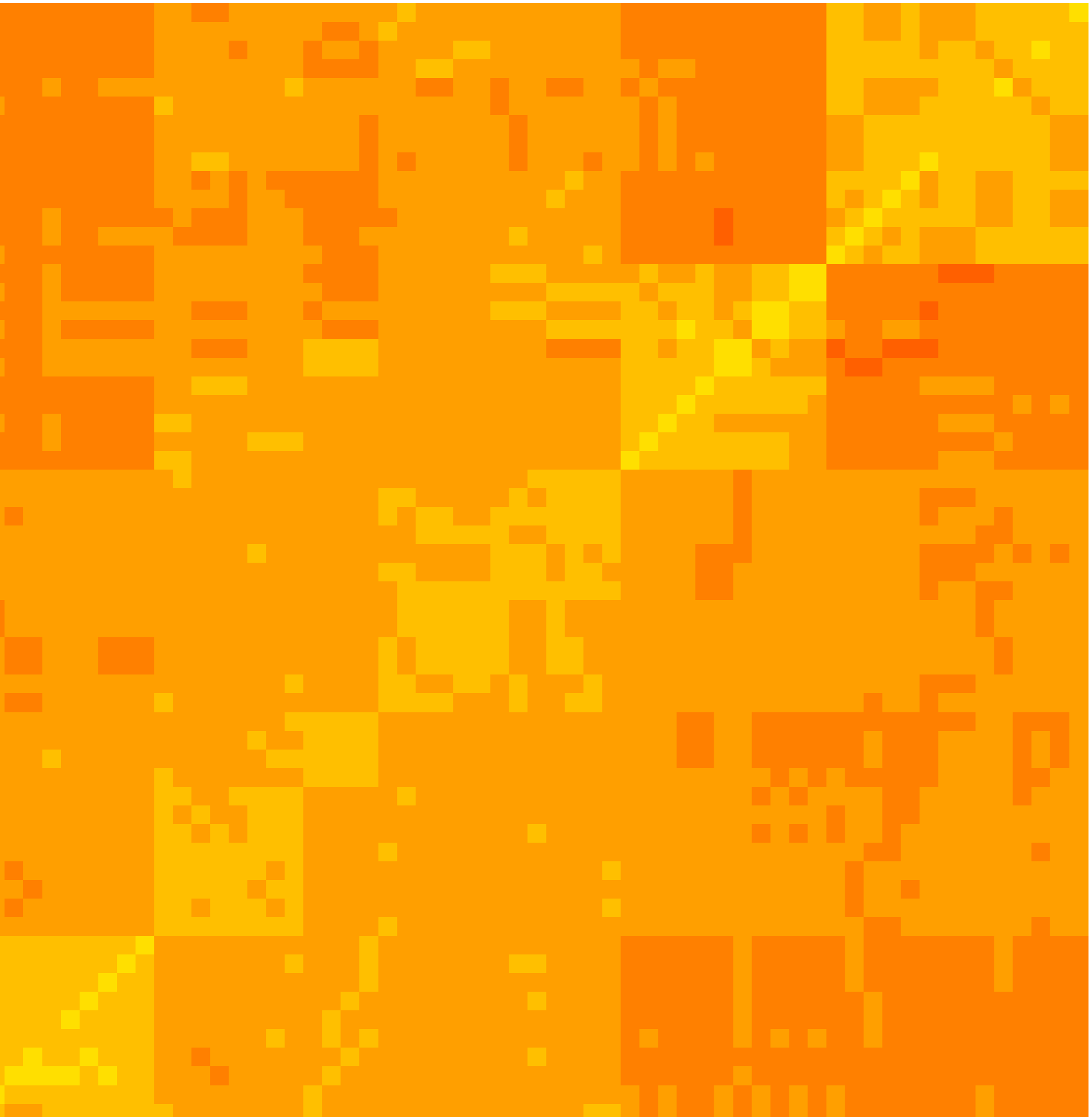
# The Problem

- Reconstruction assumes comparable characteristics (“aligned characters”)
- How to “align” phoneme systems across languages?

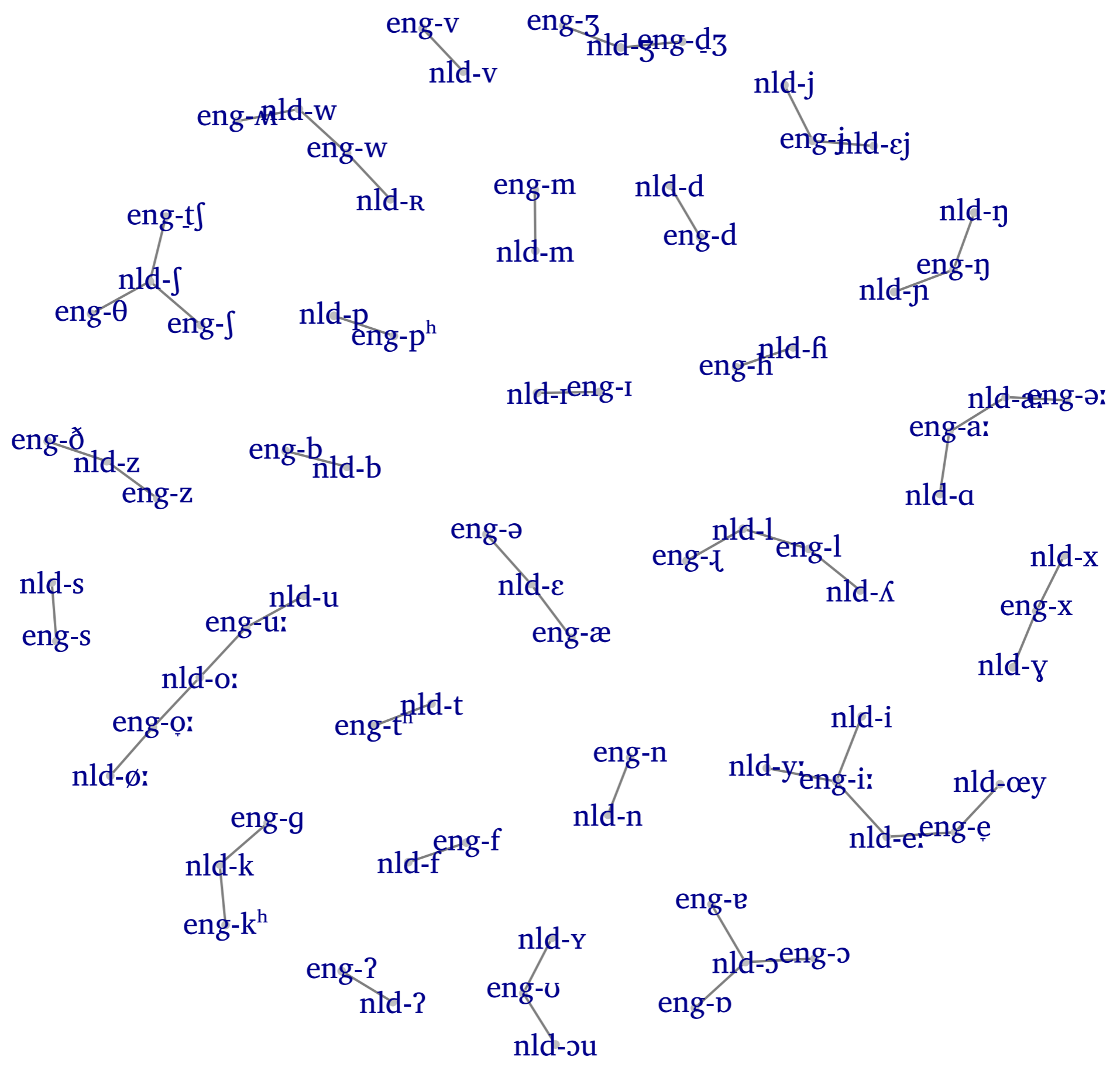




ॐ नमो भगवते वासुदेवाय ॥ नमो भगवते वासुदेवाय ॥ नमो भगवते वासुदेवाय ॥



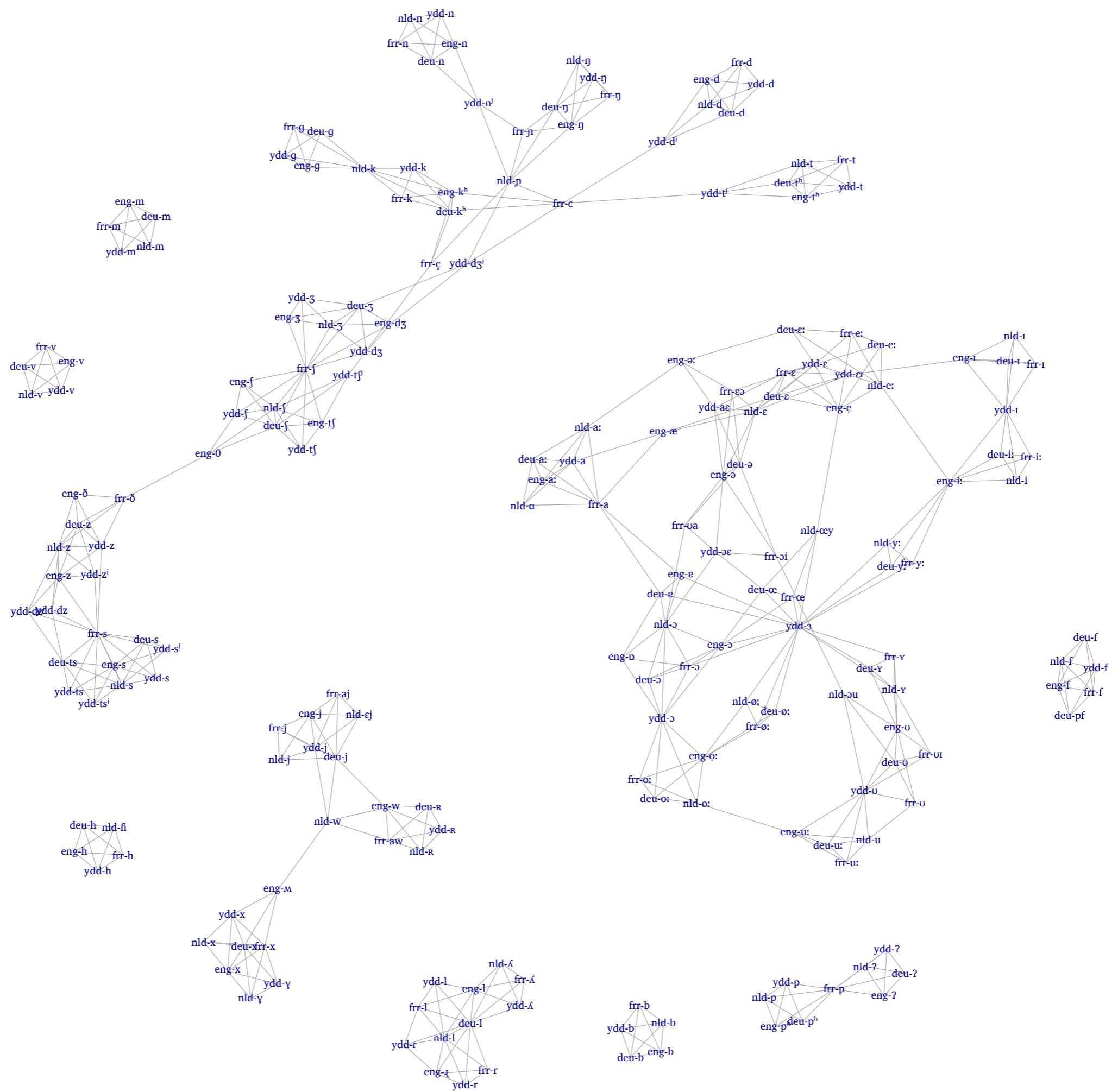


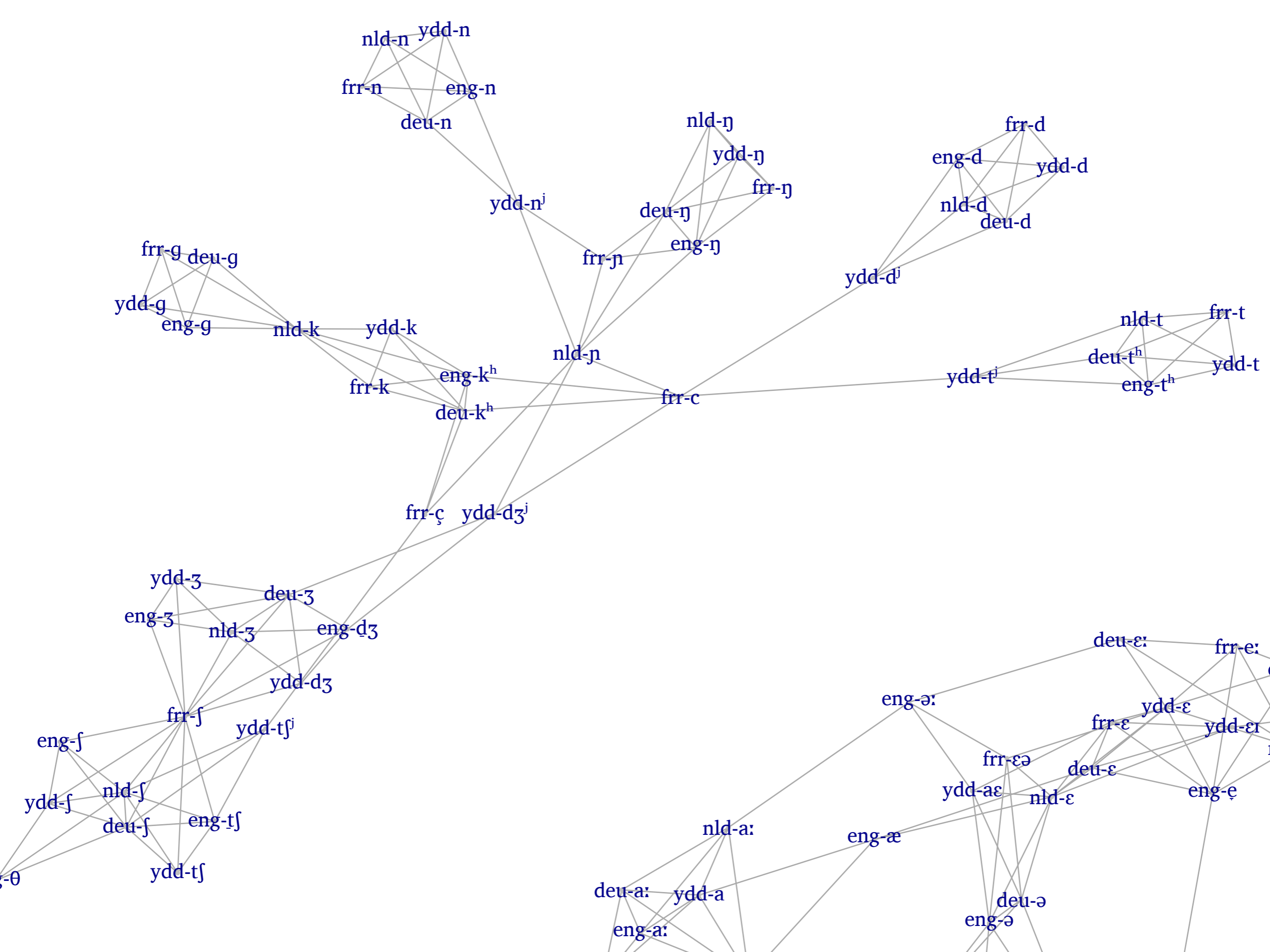


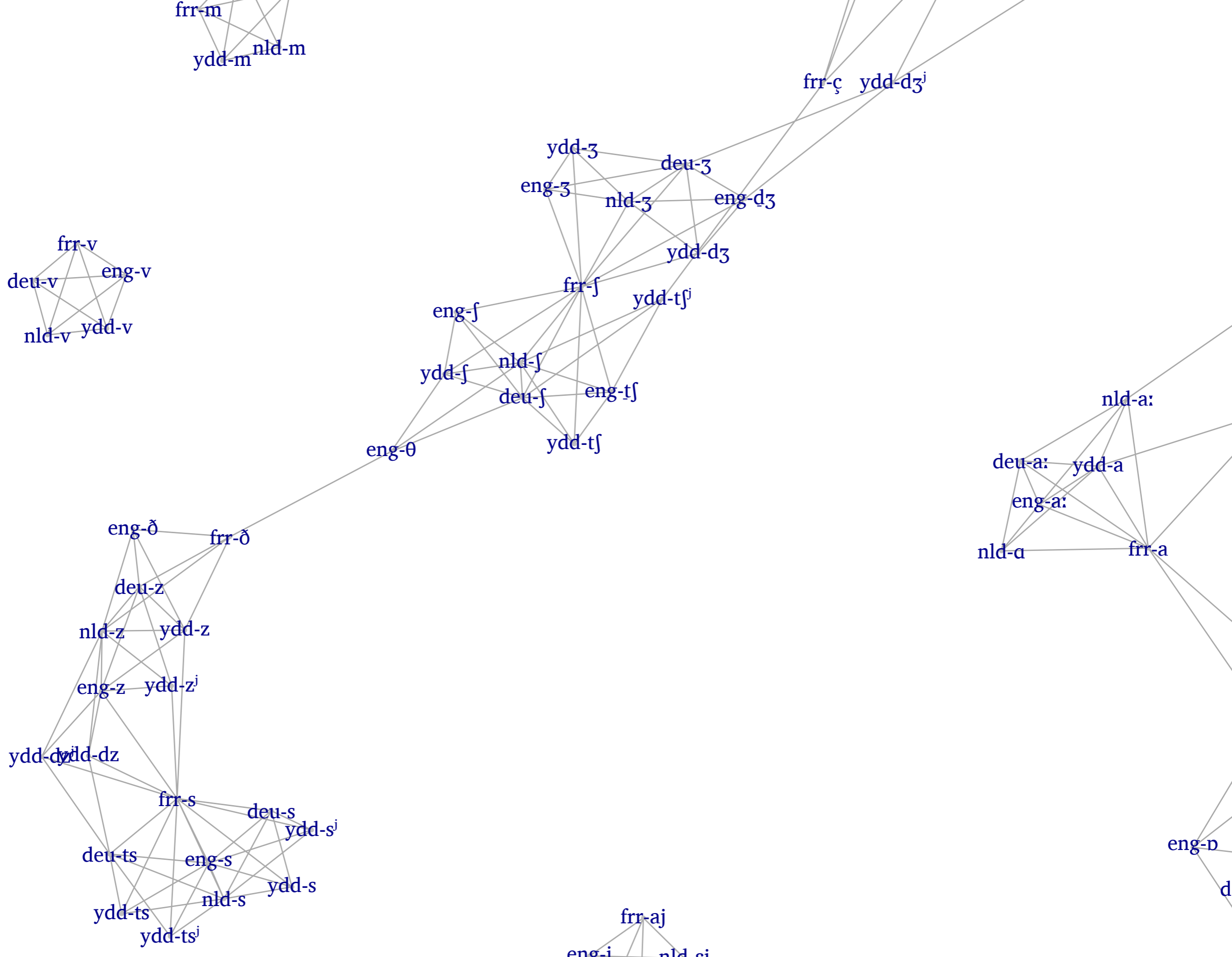


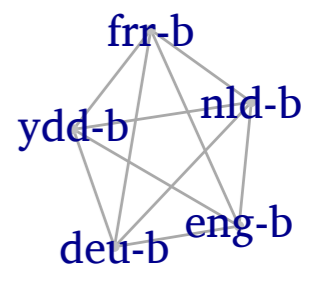
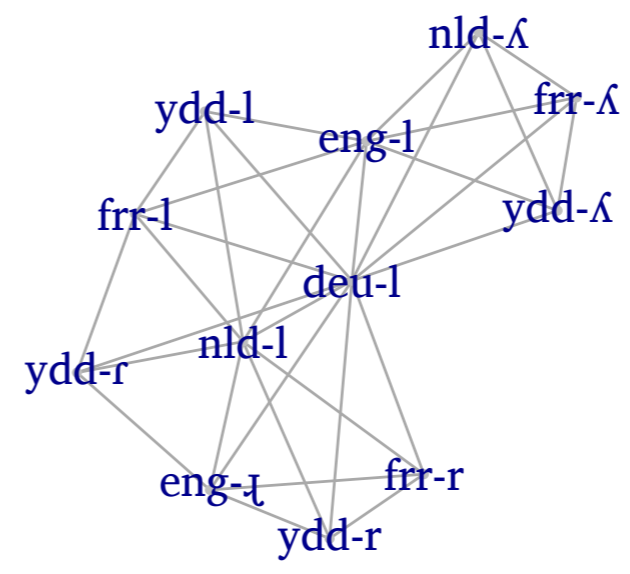
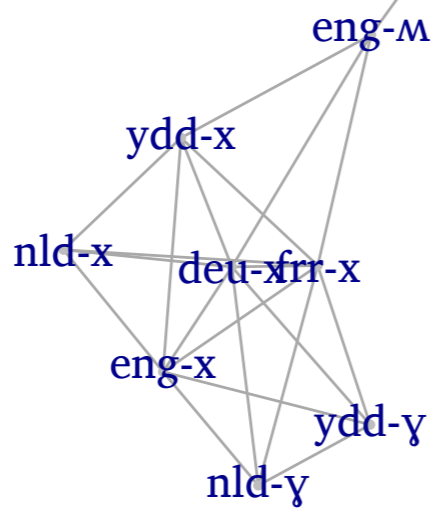
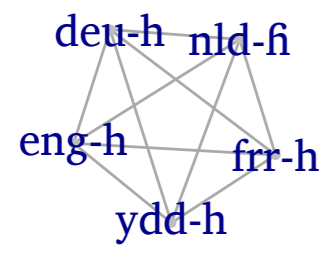
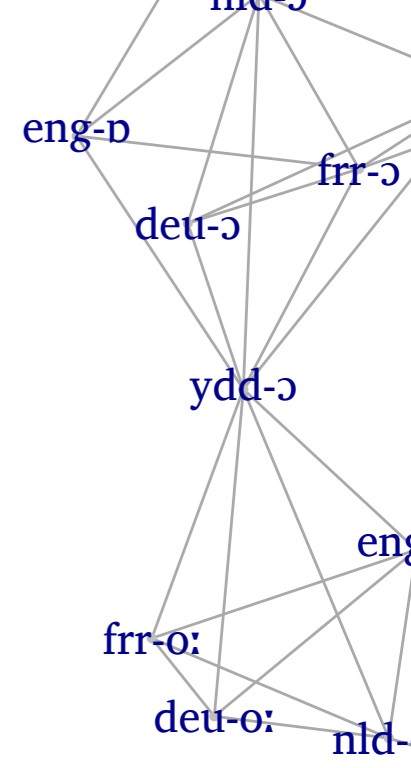
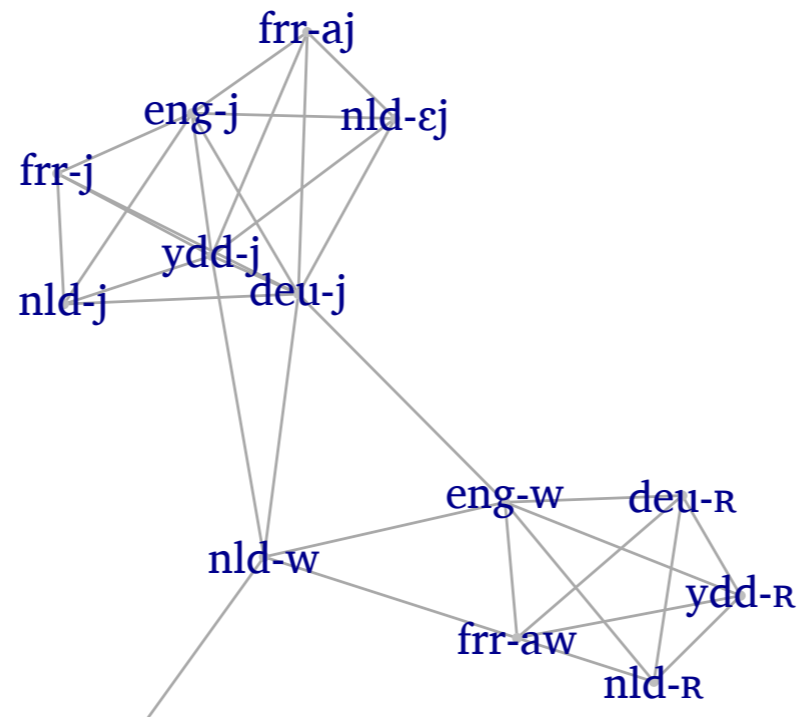
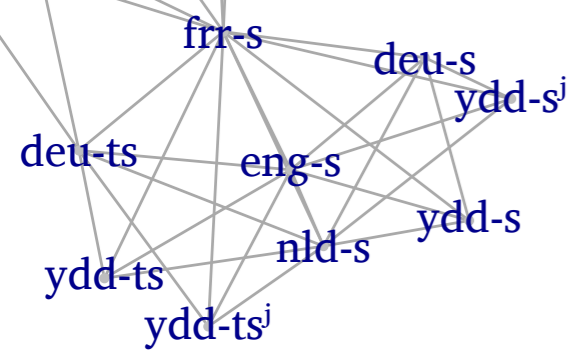


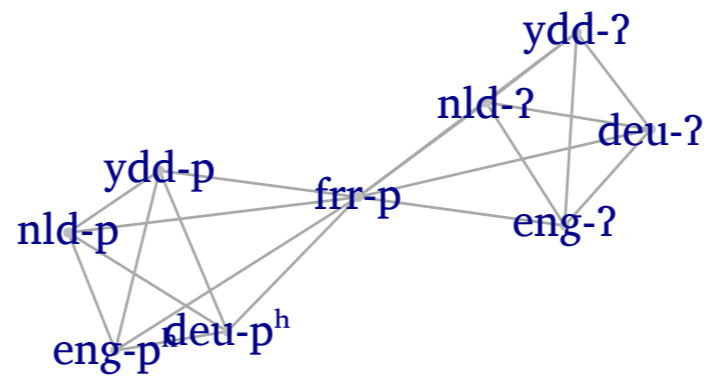
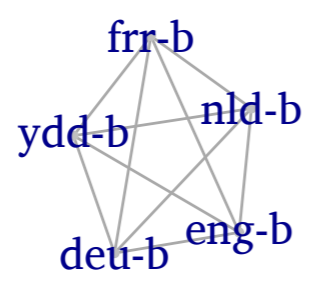
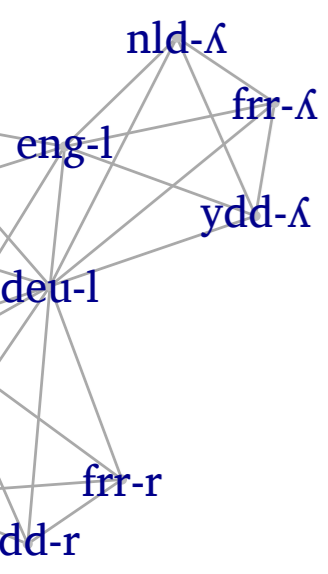
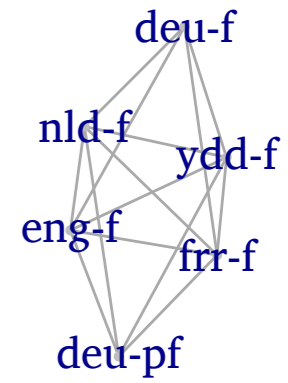
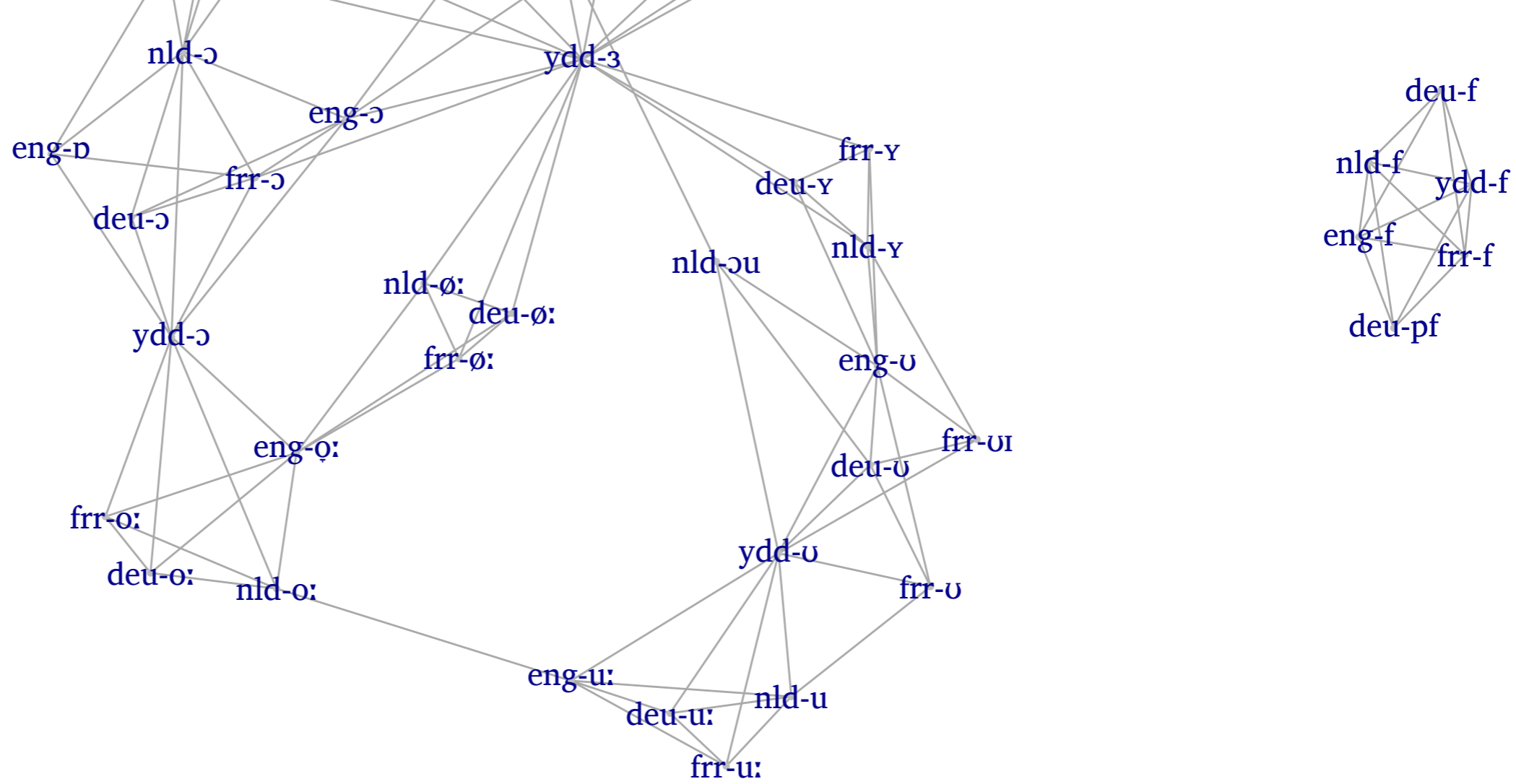


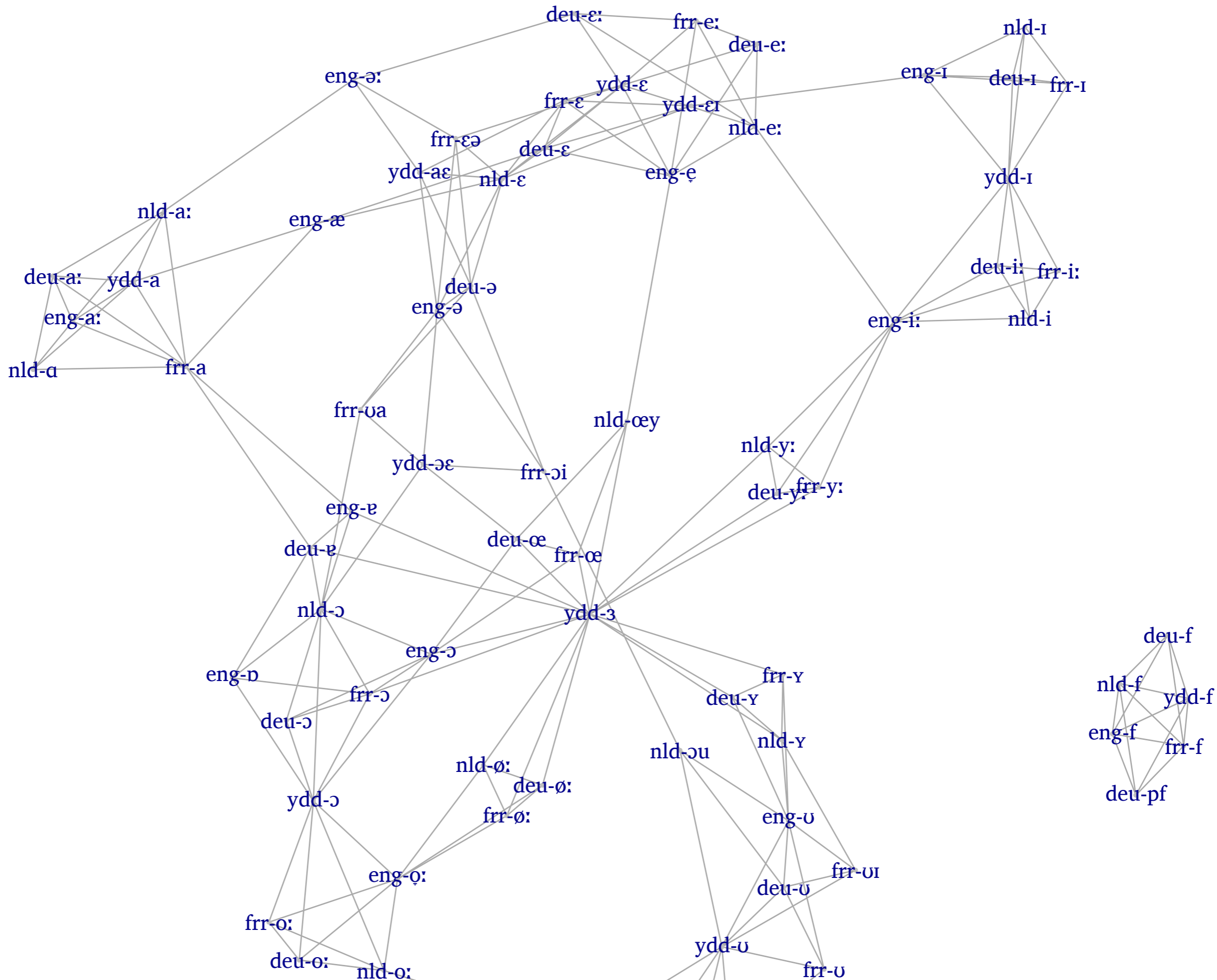




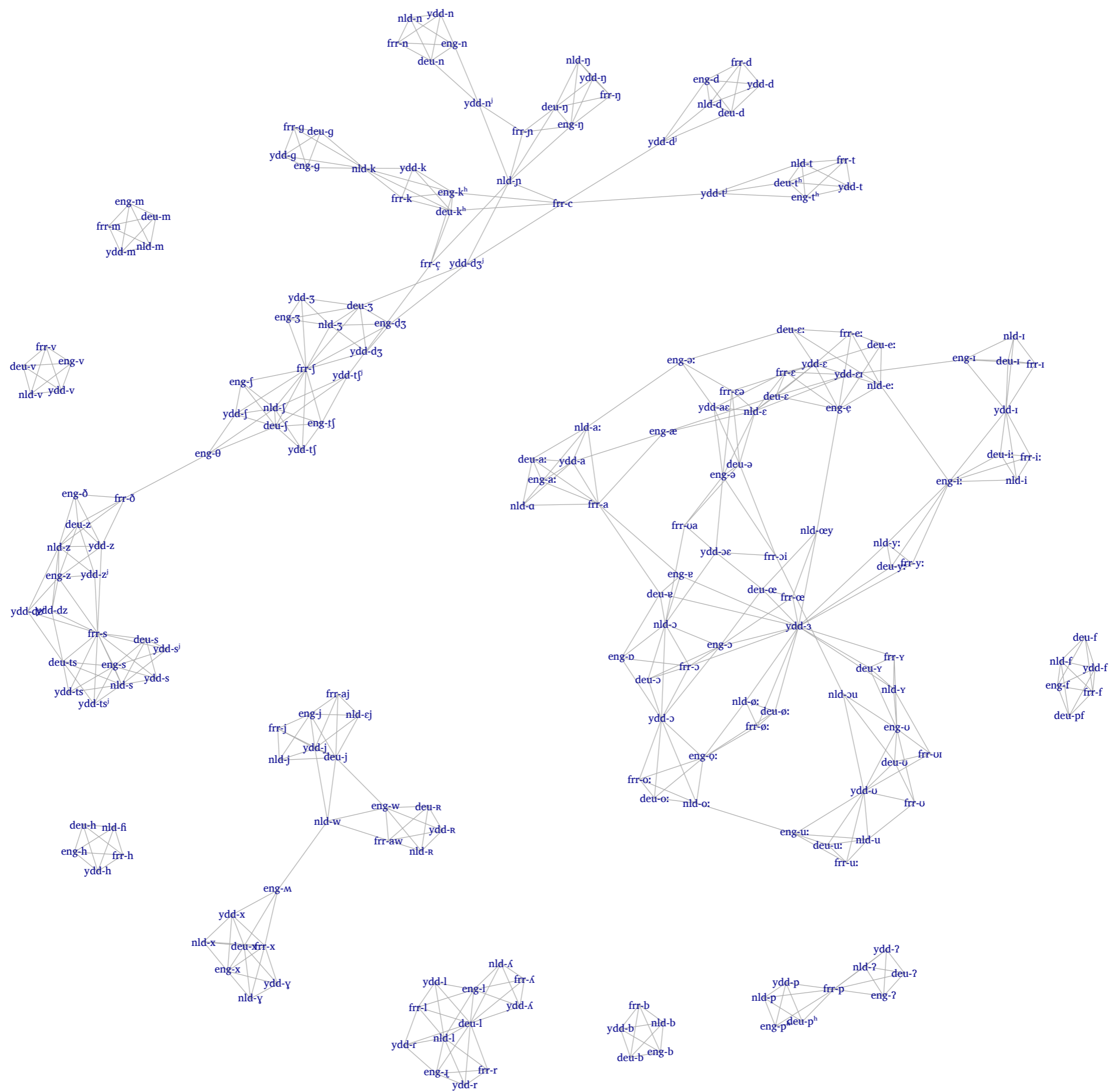


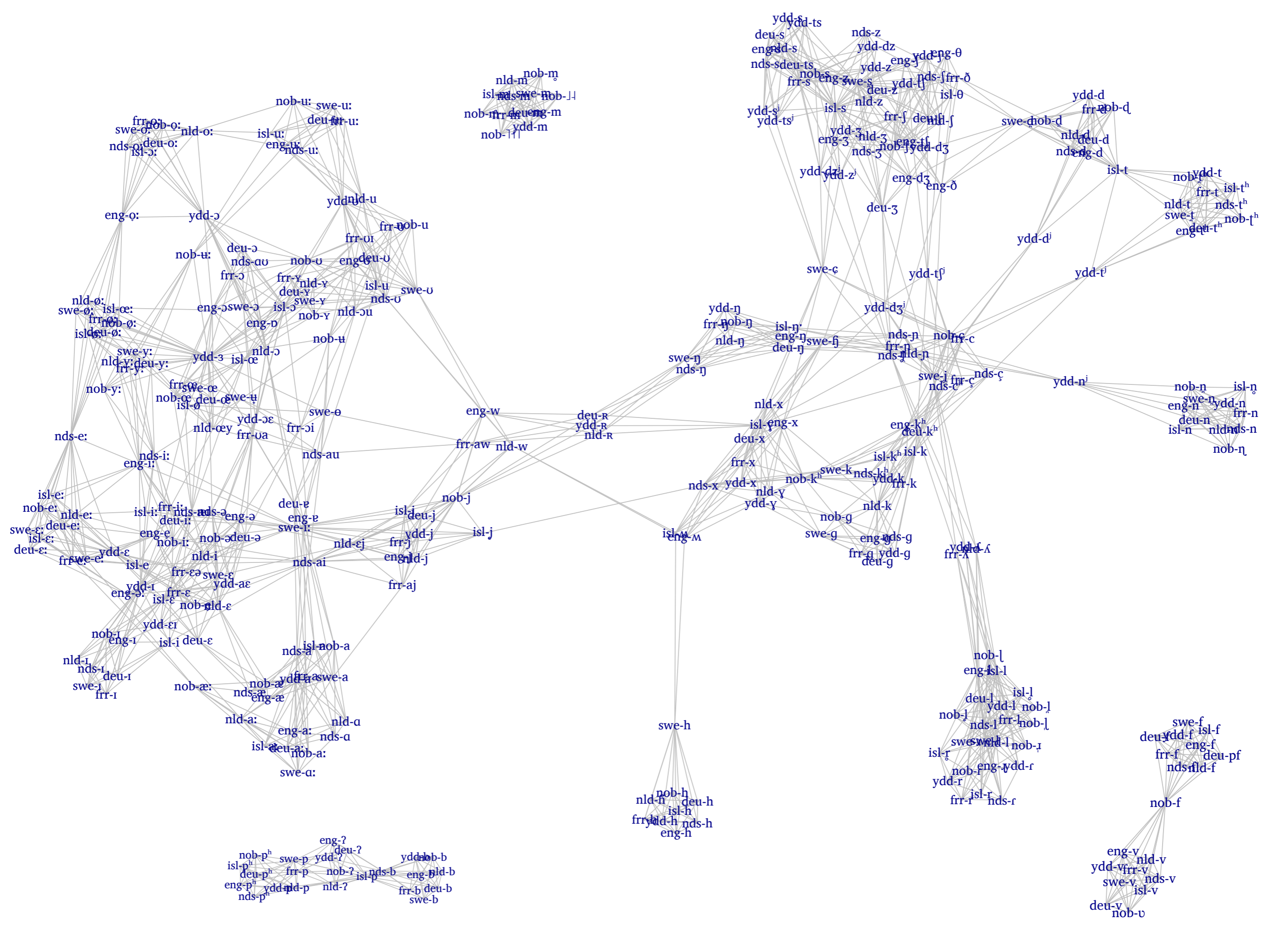












# Characterizing Inventories

- Count identical segments
- Typological characteristics based on features
  - ▶ feature-clusters
  - ▶ feature variation
  - ▶ feature interaction
- Alignment to closest shared phones

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atr	0	0	0	0	-	-	0	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	-	0	0	0	0	-	0	0	-	-	0	0	0	0	-				
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nasal	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
voice	+	+	+	-	+	+	+	+	+	-	+	+	-	-	+	+	+	+	-	+	+	+	-	-	+	+	+	-	-	+	-	+	+	+	+	+	+	+	-	+	-	+	
spreadglottis	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	
constrictedglottis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	
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coronal	+	-	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	+	+	+	-	-	-	-	+	-	-	+	-	-	+	-	-	-	
anterior	+	0	+	-	0	0	+	0	0	+	0	0	0	0	0	0	0	-	+	0	0	0	-	0	0	+	+	+	0	0	0	-	0	0	-	0	0	-	0	0	0	0	
distributed	-	0	-	+	0	0	+	0	0	-	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	-	+	0	0	0	+	0	0	-	0	0	-	0	0	0	0	
strident	-	0	-	+	0	0	-	0	0	+	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	+	-	0	0	0	+	0	0	-	0	0	0	0	0	0	0	
lateral	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
dorsal	-	-	-	-	+	+	-	+	+	-	+	+	+	+	-	+	+	-	-	+	-	+	-	+	+	-	-	-	-	+	-	-	+	+	-	-	+	+	-	-	+	-	+
high	0	0	0	0	+	-	0	-	-	0	-	+	+	+	0	-	+	0	0	+	0	+	0	+	+	0	0	0	0	-	0	0	-	-	0	0	+	0	0	-	0		
low	0	0	0	0	-	-	0	-	-	0	+	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	+	0	0	+	+	0	0	+	+	0	0	-	0	
front	0	0	0	0	+	-	0	+	-	0	-	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	-	0	0	+	-	0	0	+	0	0	-	0		
back	0	0	0	0	-	-	0	-	+	0	-	+	+	-	0	+	-	0	0	+	0	-	0	-	+	0	0	0	0	+	0	0	-	-	0	0	-	-	0	0	-	0	

	l	m	n	ɲ	i:	ə	ɔ̃	ɛ	ɔ	s	a:	ʊ	ɱ	k <sup>h</sup>	v	ɔ:	ŋ	dʒ	t <sup>h</sup>	w	b	g	tʃ	x	u:	d	z	θ	p <sup>h</sup>	ɒ	f	ʒ	æ	ɐ	ɹ	h	j	ʔ	ə:				
atr	0	0	0	0	-	-	0	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	-	0	0	0	0	-	0	0	-	-	0	0	0	0	-				
fortis	-	-	-	-	0	0	-	0	0	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	0	0	-	-	-	-	-	0			
tone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
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implosive	-	-	-	-	0	0	-	0	0	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	0	0	-	-	-	-	-	0			
syllabic	-	-	-	-	+	+	-	+	+	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	+	+	-	-	-	-	-	+			
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consonantal	+	+	+	+	-	-	+	-	-	+	-	-	-	+	+	-	+	+	+	-	+	+	+	+	-	+	+	+	+	-	+	+	-	-	+	-	-	+	-	-	+		
sonorant	+	+	+	-	+	+	-	+	+	-	+	+	-	-	-	+	+	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	+	+	+	+	+	+	-	+	-	+	
continuant	+	-	-	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	+	-	-	-	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+		
delayedrelease	0	0	0	+	0	0	+	0	0	+	0	0	+	-	+	0	0	+	-	0	-	-	+	+	0	-	+	+	-	0	+	+	0	0	0	0	+	0	-	0			
approximant	+	-	-	-	+	+	-	+	+	-	+	+	-	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	+	+	+	+	+	-	+	-	+		
tap	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
trill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
nasal	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
voice	+	+	+	-	+	+	+	+	+	-	+	+	-	-	+	+	+	+	-	+	+	+	-	-	+	+	+	-	-	+	-	+	+	+	+	+	+	+	-	+	-	+	
spreadglottis	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	
constrictedglottis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	
labial	-	+	-	-	-	-	-	-	+	-	-	+	+	-	+	+	-	-	-	+	+	-	-	-	+	-	-	-	+	+	+	-	-	+	-	-	+	-	-	-	-	-	
round	-	-	-	-	-	-	-	-	+	-	-	+	+	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	
labiodental	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
coronal	+	-	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	+	+	+	-	-	-	-	+	-	-	+	-	-	+	-	-	-	
anterior	+	0	+	-	0	0	+	0	0	+	0	0	0	0	0	0	0	-	+	0	0	0	-	0	0	+	+	+	0	0	0	-	0	0	-	0	0	-	0	0	0	0	
distributed	-	0	-	+	0	0	+	0	0	-	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	-	+	0	0	0	+	0	0	-	0	0	-	0	0	0	0	
strident	-	0	-	+	0	0	-	0	0	+	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	+	-	0	0	0	+	0	0	-	0	0	-	0	0	0	0	
lateral	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
dorsal	-	-	-	-	+	+	-	+	+	-	+	+	+	+	-	+	+	-	-	+	-	+	-	+	+	-	-	-	-	+	-	-	+	+	-	-	+	+	-	-	+	-	+
high	0	0	0	0	+	-	0	-	-	0	-	+	+	+	0	-	+	0	0	+	0	+	0	+	+	0	0	0	0	-	0	0	-	-	0	0	-	-	0	0	+	0	-
low	0	0	0	0	-	-	0	-	-	0	+	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	+	0	0	+	+	0	0	+	+	0	0	-	0	-
front	0	0	0	0	+	-	0	+	-	0	-	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	-	0	0	+	-	0	0	+	0	0	+	0	-	
back	0	0	0	0	-	-	0	-	+	0	-	+	+	-	0	+	-	0	0	+	0	-	0	-	+	0	0	0	0	+	0	0	-	-	0	0	-	-	0	0	-	0	-



# Characterizing Inventories

- Count identical segments
- Typological characteristics based on features
  - ▶ feature-clusters
  - ▶ **feature variation**
  - ▶ feature interaction
- Alignment to closest shared phones

	l	m	n	ɲ	i:	ə	ɔ̃	ɛ	ɔ	s	a:	ʊ	ɱ	k <sup>h</sup>	v	ɔ:	ŋ	dʒ	t <sup>h</sup>	w	b	g	tʃ	x	u:	d	z	θ	p <sup>h</sup>	ɒ	f	ʒ	æ	ɐ	ɹ	h	j	ʔ	ə:				
atr	0	0	0	0	-	-	0	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	-	0	0	0	0	-	0	0	-	-	0	0	0	0	-				
fortis	-	-	-	-	0	0	-	0	0	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	0	0	-	-	-	-	-	0			
tone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
click	-	-	-	-	0	0	-	0	0	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	0	0	-	-	-	-	-	0			
implosive	-	-	-	-	0	0	-	0	0	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	0	0	-	-	-	-	-	0			
syllabic	-	-	-	-	+	+	-	+	+	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	+	+	-	-	-	-	-	+			
stress	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
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consonantal	+	+	+	+	-	-	+	-	-	+	-	-	-	+	+	-	+	+	+	-	+	+	+	+	-	+	+	+	+	-	+	+	-	-	+	-	+	-	-	+	-		
sonorant	+	+	+	-	+	+	-	+	+	-	+	+	-	-	-	+	+	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	+	+	+	+	+	+	-	+	-	+	
continuant	+	-	-	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	+	-	-	-	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	-	+		
delayedrelease	0	0	0	+	0	0	+	0	0	+	0	0	+	-	+	0	0	+	-	0	-	-	+	+	0	-	+	+	-	0	+	+	0	0	0	0	+	0	-	0			
approximant	+	-	-	-	+	+	-	+	+	-	+	+	-	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	+	+	+	+	+	-	+	-	+		
tap	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
trill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
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voice	+	+	+	-	+	+	+	+	+	-	+	+	-	-	+	+	+	+	-	+	+	+	-	-	+	+	+	-	-	+	-	+	+	+	+	+	+	+	-	+	-	+	
spreadglottis	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	
constrictedglottis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	
labial	-	+	-	-	-	-	-	-	+	-	-	+	+	-	+	+	-	-	-	+	+	-	-	-	+	-	-	-	+	+	+	-	-	+	-	-	+	-	-	-	-	-	
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coronal	+	-	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	+	+	+	-	-	-	-	+	-	-	+	-	-	+	-	-	-	
anterior	+	0	+	-	0	0	+	0	0	+	0	0	0	0	0	0	0	-	+	0	0	0	-	0	0	+	+	+	0	0	0	-	0	0	-	0	0	-	0	0	0	0	
distributed	-	0	-	+	0	0	+	0	0	-	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	-	+	0	0	0	+	0	0	-	0	0	-	0	0	0	0	
strident	-	0	-	+	0	0	-	0	0	+	0	0	0	0	0	0	0	+	-	0	0	0	+	0	0	-	+	-	0	0	0	+	0	0	-	0	0	0	0	0	0		
lateral	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
dorsal	-	-	-	-	+	+	-	+	+	-	+	+	+	+	-	+	+	-	-	+	-	+	-	+	+	-	-	-	-	+	-	-	+	+	-	-	+	+	-	-	+	-	+
high	0	0	0	0	+	-	0	-	-	0	-	+	+	+	0	-	+	0	0	+	0	+	0	+	+	0	0	0	0	-	0	0	-	-	0	0	+	0	0	-	0		
low	0	0	0	0	-	-	0	-	-	0	+	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	+	0	0	+	+	0	0	+	+	0	0	-	0	
front	0	0	0	0	+	-	0	+	-	0	-	-	-	-	0	-	-	0	0	-	0	-	0	-	-	0	0	0	0	-	0	0	+	-	0	0	+	0	0	-	0		
back	0	0	0	0	-	-	0	-	+	0	-	+	+	-	0	+	-	0	0	+	0	-	0	-	+	0	0	0	0	+	0	0	-	-	0	0	-	-	0	0	-	0	

	l	m	n	ɲ	i:	ə	ɔ̃	ɛ	ɔ	s	a:	ʊ	ɱ	k <sup>h</sup>	v	ɔ:	ŋ	dʒ	t <sup>h</sup>	w	b	g	tʃ	x	u:	d	z	θ	p <sup>h</sup>	ɒ	f	ʒ	æ	ɐ	ɹ	h	j	ʔ	ə:				
atr	0	0	0	0	-	-	0	-	-	0	-	-	0	0	0	-	0	0	0	0	0	0	0	0	-	0	0	0	0	-	0	0	-	-	0	0	0	0	-				
fortis	-	-	-	-	0	0	-	0	0	-	0	0	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	0	0	-	-	-	-	-	0			
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# Characterizing Inventories

- Count identical segments
- Typological characteristics based on features
  - ▶ feature-clusters
  - ▶ feature variation
  - ▶ **feature interaction**
- Alignment to closest shared phones

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- Count identical segments
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# Part of the problem

t - d (Dutch, Yiddish, Frisian)

t<sup>h</sup> - d (English, German, Low German)

t - t<sup>h</sup> (Icelandic)

t - d (Swedish)

t<sup>h</sup> - d (Norwegian)

# Conclusion

- No success yet  
(though only limited testing)
- We have to even deeper analyze historical linguistic argumentation
- Use assumed family-trees to fine-tune the methods (i.e. find out what works best)
- Use even fancier maths ...