Transactions of the
Bayesian Society

Simulated Feature Evolution using the TKF91 Model

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Abstract

It all started in a little town called Madrid...

Introduction

In this paper, we attempt to do the impossible!

Methods

We used any and all means necessary.

Conclusion

Vene Vidi Vici

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2) Words in each language by meaning
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4) Character file
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6) Segment Groups
7) Diacritics
8) Euler Feature Diagram
9) International Phonetic Alphabet
10) Feature Tree
11) SAMPAConversion
12) Word Lists by Language
13) Language Tree File
14) Nytril Source Code

References

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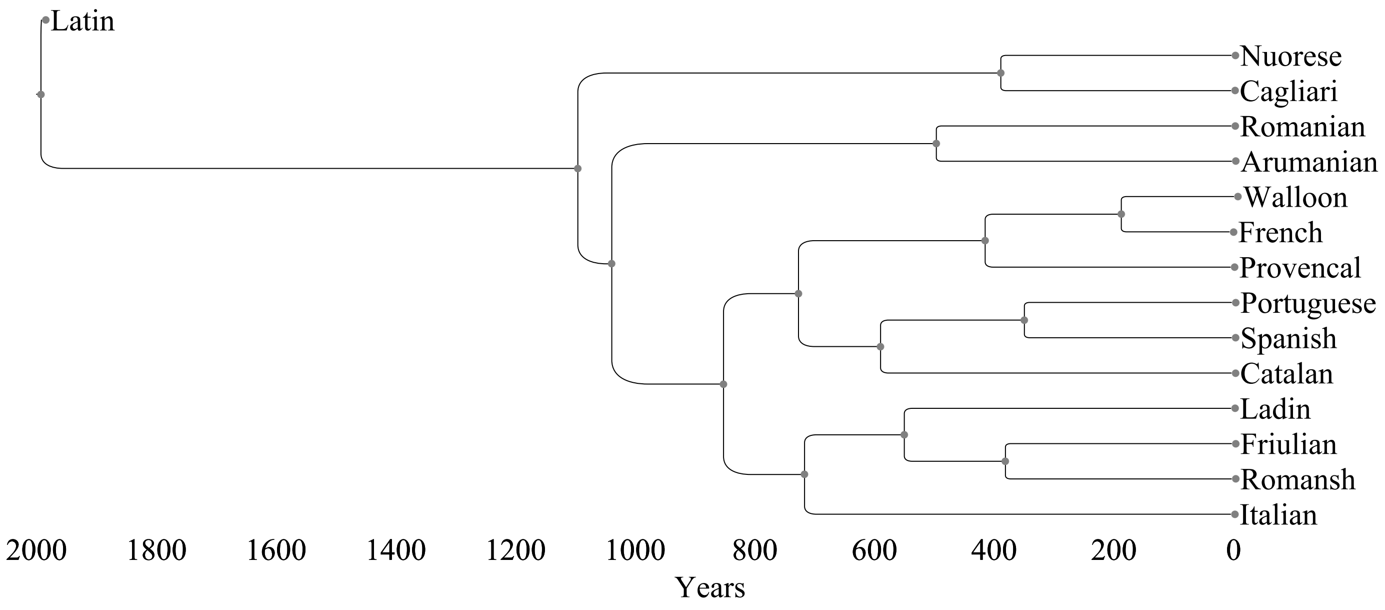
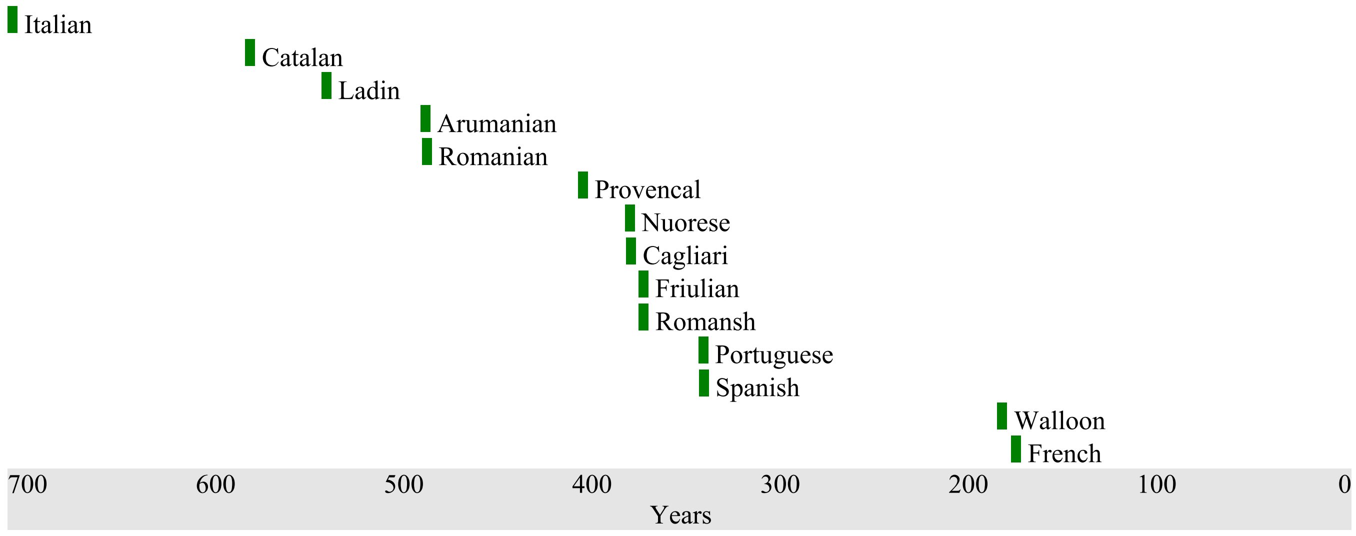
Appendix 1 - Language Tree



Last Branch



Appendix 2 - Words in each language by meaning

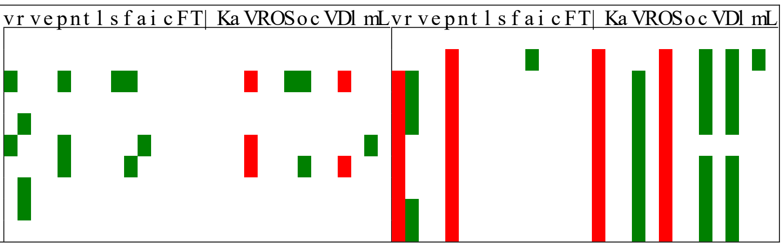
	I	You	We	One	Person	Dog	Skin	Ear
Latin	egoː	tuː	noːs	uːnus	persoːna	kanis	kutis	auris
Romanian	ew	tu	noy	unu	om	kaine	pyele	ureke
Catalan	ʒo	tu	nuzaltrɜs	un	pɜrsonɜ	kɜ	peʎ	urɛʎɜ
Portuguese	eu	tu	noʃ	ũ	pɛrzon	kɐ̃ũ	pɛlɜ	oraʎa
Spanish	yo	tu	nosotros	uno	persona	pero	piel	oreha
French	jɜ	ti	nu	œ̃	om	ʃiɐ̃	po	ore
Walloon	çe	te	nos	ɛ̃	ɔ̃m	çẽ	pow	oreye
Romansh	yaw	ti	nus	en	kɜrʃθawn	θawn	pel	ureʎɜ
Friulian	yo	tu	nou	uŋ	pɛrsoŋ	kỹaŋ	pỹel	oreli
Italian	io	tu	noi	uno	persona	kane	pɛlle	orekkyo

	Eye	Drink	Hear	Die	Come	Star	Water	Fire
Latin	okulus	bibere	audiːre	moriː	veniːre	steːla	akʷa	iŋnis
Romanian	oky	bea	auzy	mury	veny	stea	apɜ	fok
Catalan	uʎ	bɛurɜ	sɜnti	muri	bɜni	ɜstreʎɜ	aixw̃ɜ	fok
Portuguese	oʎu	bɜb	ov	mur	vir	ɜʃtrela	ɛgw̃a	fogu
Spanish	oho	bebe	oir	mori	veni	estreya	agw̃a	fuego
French	ɜy	bw̃a	ɔ̃tɐ̃dr	muri	vɜni	etw̃ol	o	fe
Walloon	ui	bwɛr	ʃute	murrir	vnir	twɛl	ɛwɜ	fɛ
Romansh	eʎ	bayvɜr	udir	murir	vɜłir	ʃtaylɜ	awɜ	fyew
Friulian	voli	bevi	sintei	murei	viłei	stelɛ	agɛ	fuk
Italian	okkyo	bere	ud	mor	vɛn	stella	akwa	fwoko

	Path	Full	New
Latin	wɪa	pleːnus	nowus
Romanian	cale	plin	now
Catalan	kɜmi	plɛ	nou
Portuguese	sẽda	ʃeyu	novu
Spanish	senda	yeno	nuevo
French	rut	plɜ̃	nuvo
Walloon	vwɐ̃y	plĩ	novɛl
Romansh	viɜ	playn	nof
Friulian	stradɛ	plen	łuf
Italian	sentyaro	pyɛno	nwovo

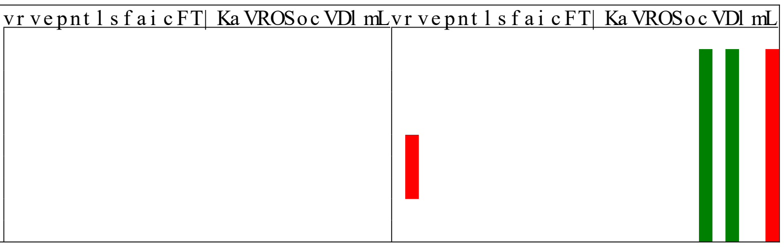
Meaning: **I**

ego:
ew
ʒo
eu
yo
jɜ
çe
yaw
yo
io



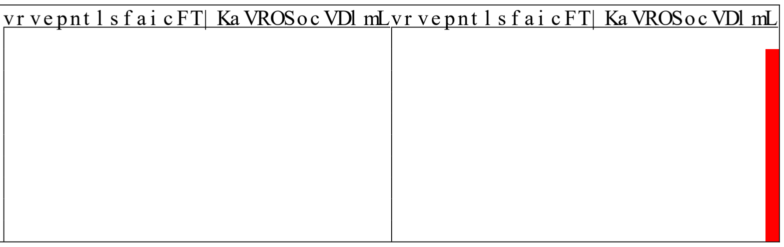
Meaning: **You**

tu:
tu
tu
tu
tu
ti
te
ti
tu
tu



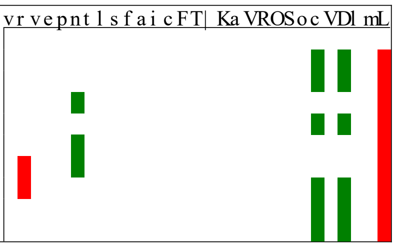
Meaning: **We**

no:s
noy
nuzaltrɜs
noʃ
nosotros
nu
nos
nus
nou
noi



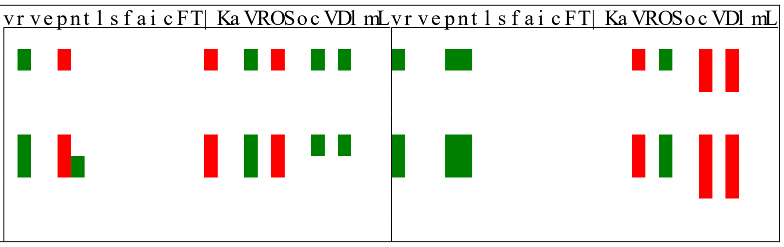
Meaning: **One**

u:nus
unu
un
ũ
uno
œ̃
ɛ̃
en
uŋ
uno



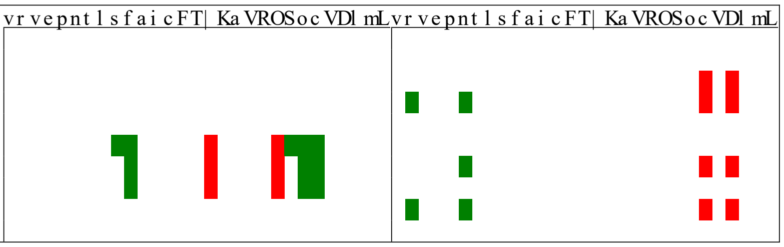
Meaning: **Person**

perso:na
om
pɜrsonɜ
pɛrzon
persona
om
ɔ̃m
kɜrʃθawn
pɛrsoŋ
persona

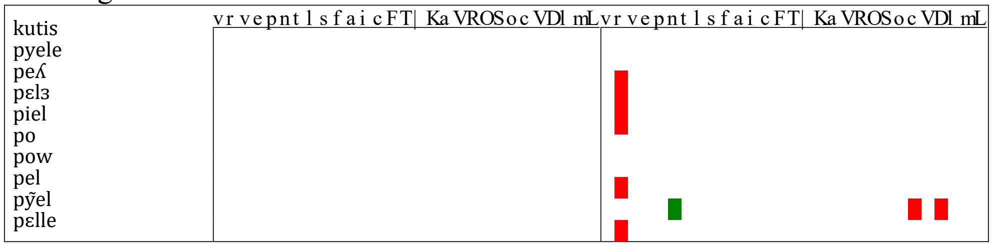


Meaning: **Dog**

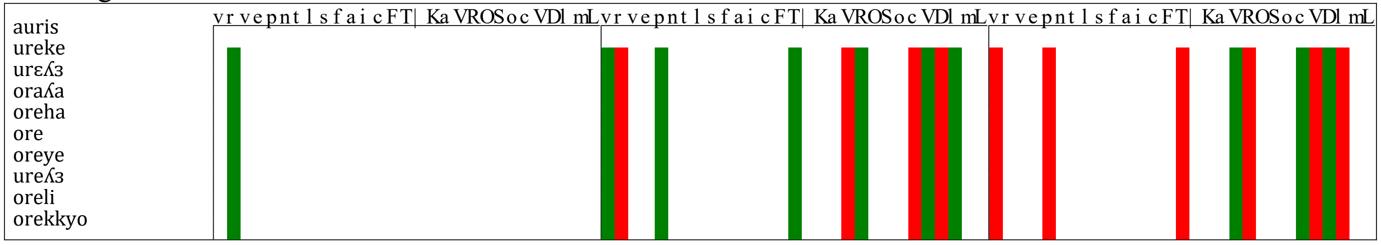
kanis
kaine
kɜ
kẽũ
pero
ʃiẽ
çẽ
θawn
kỹaŋ
kane



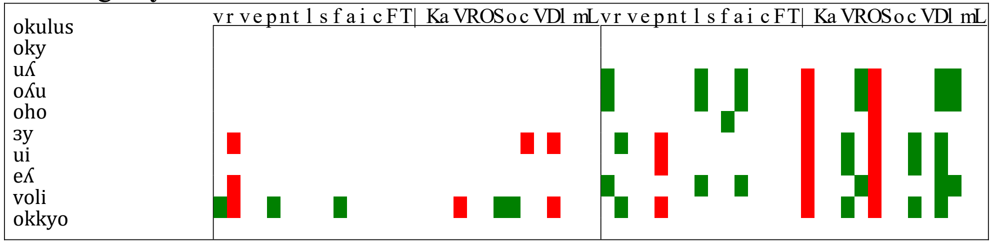
Meaning: **Skin**



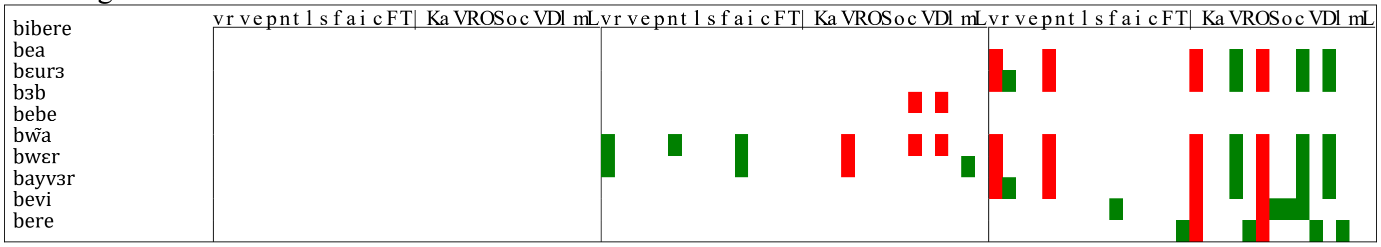
Meaning: **Ear**



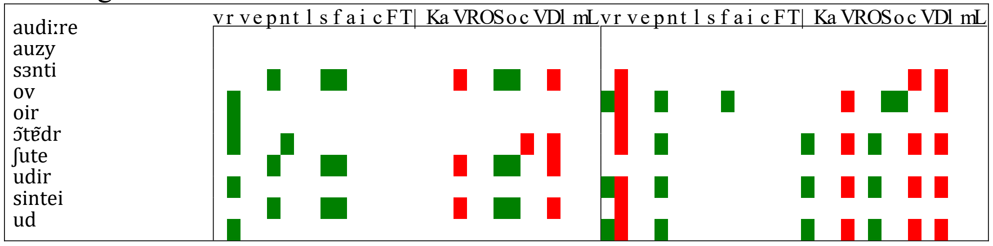
Meaning: **Eye**



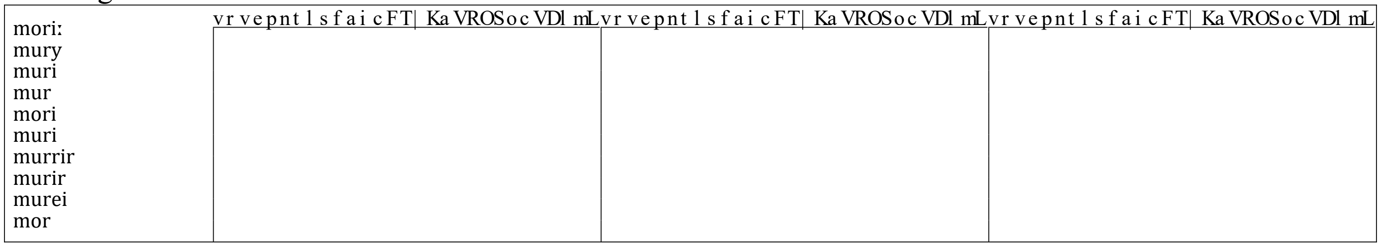
Meaning: **Drink**



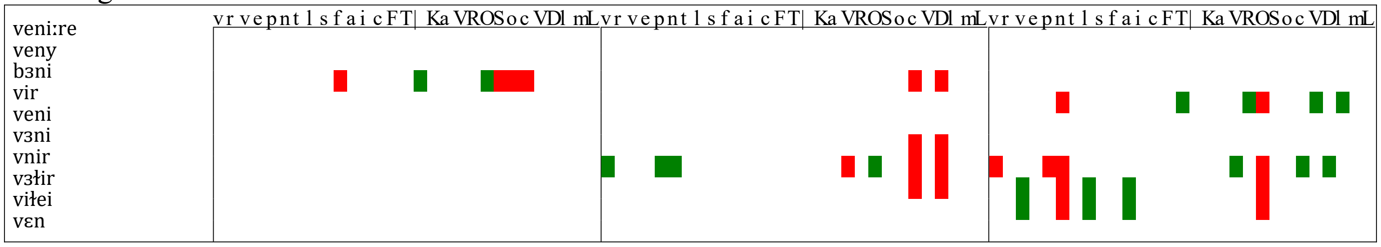
Meaning: **Hear**



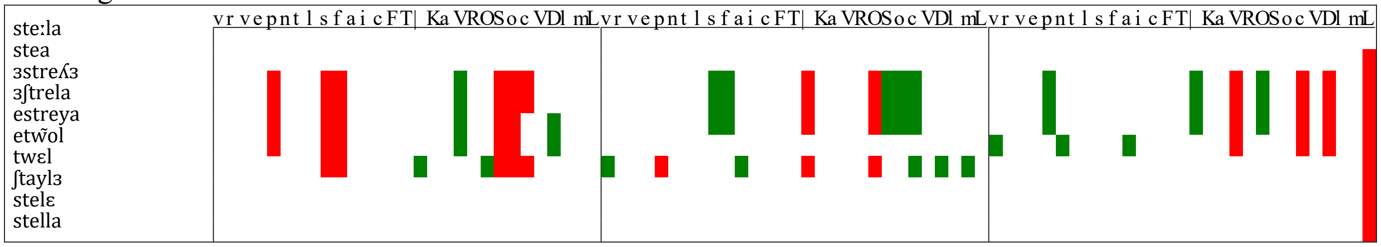
Meaning: **Die**



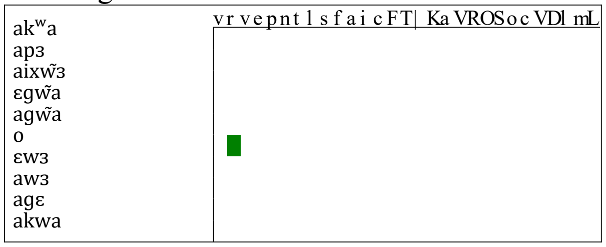
Meaning: **Come**



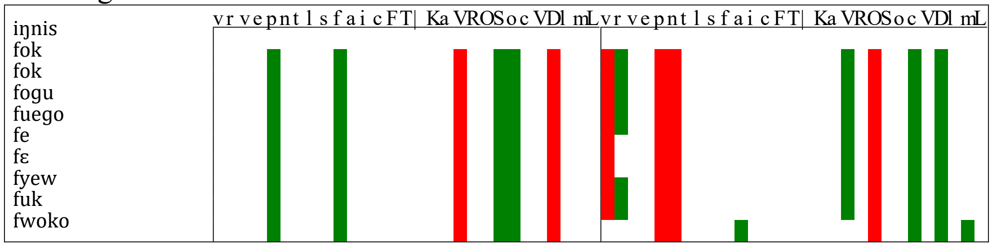
Meaning: **Star**



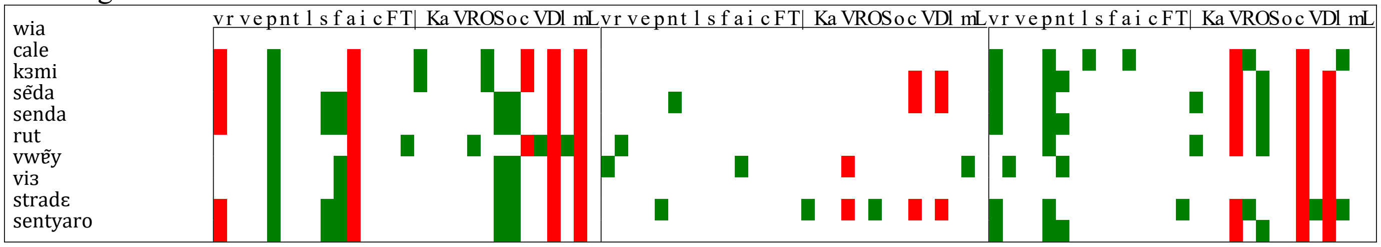
Meaning: **Water**



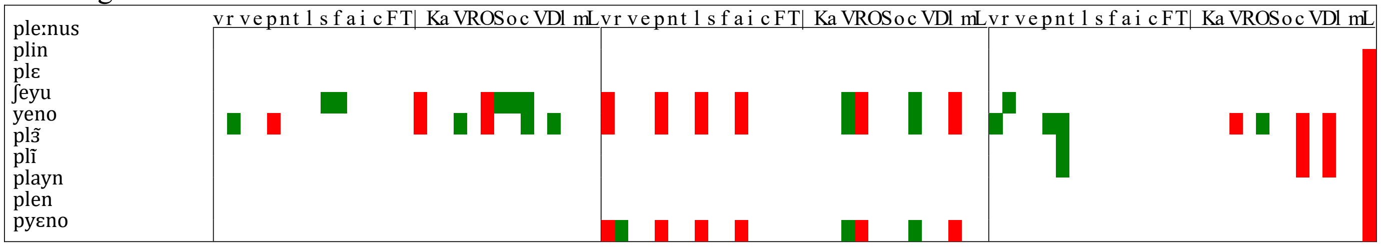
Meaning: **Fire**



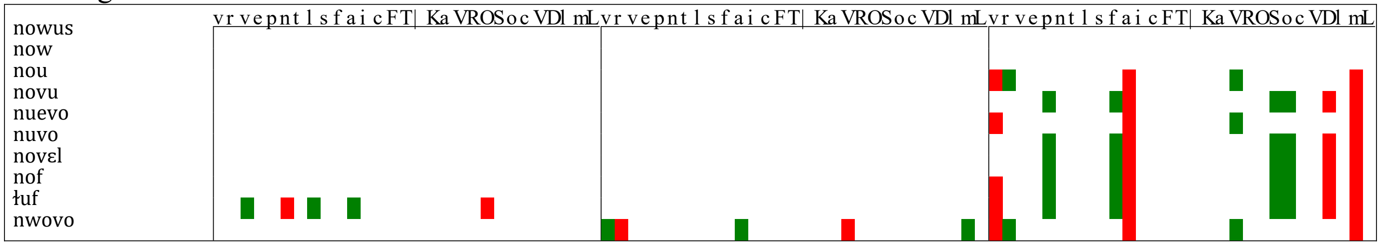
Meaning: **Path**



Meaning: **Full**



Meaning: **New**



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  Romanian   (AX-)(DH)(FNY------)(HFH-)(NS------)(LKMFA)(IYAOA)(HJALA--)
  Catalan    (dN-)(DH)(FHZKODJaG)(HF--)(IaJGNFa-)(La---)(IAe--)(HJfea--)
  Portuguese (AH-)(DH)(FNi------)(j---)(IfJZNF--)(Lkj--)(IfOa-)(NJKeK--)
  Spanish    (YN-)(DH)(FNGNDJNG-)(HFN-)(IAJGNFK-)(IAJN-)(IMAO-)(NJAmK--)
  French     (na-)(DM)(FH-------)(o---)(NS------)(iMk--)(IN---)(NJA----)
  Walloon    (rA-)(DA)(FNG------)(s---)(pS------)(rl---)(INX--)(NJAYA--)
  Romansh    (YKX)(DM)(FHG------)(AF--)(LaJiuKXF)(uKXF-)(IAO--)(HJAea--)
  Friulian   (YN-)(DH)(FNH------)(HW--)(IfJGNW--)(LwKW-)(IwAO-)(NJAOM--)
  Italian    (MN-)(DH)(FNM------)(HFN-)(IAJGNFK-)(LKFA-)(IfOOA)(NJALLYN)

  Latin      (NLHOHG)(PMPAJA)(KHQRJA)(SNJR--)(TAFRJA)(GDUOK--)(KVK--)(MW
  Romanian   (NLY---)(PAK---)(KHZY--)(SHJY--)(TAFY--)(GDAK---)(KIa--)(bN
  Catalan    (He----)(PfHJa-)(GaFDM-)(SHJM--)(PaFM--)(aGDJAea)(KMgha)(bN
  Portuguese (NeH---)(PaP---)(NT----)(SHJ---)(TMJ---)(aiDJAOK)(fBhK-)(bN
  Spanish    (NmN---)(PAPA--)(NMJ---)(SNJM--)(TAFM--)(AGDJAYK)(KBhK-)(bH
  French     (aY----)(PhK---)(pDkQJ-)(SHJM--)(TaFM--)(ADhNO--)(N----)(bA
  Walloon    (HM----)(PXfJ--)(iHDA--)(SHJJMJ)(TFMJ--)(DXfO---)(fXa--)(bf
  Romansh    (Ae----)(PKYTaJ)(HQMJ--)(SHJMJ-)(TavMJ-)(iDKYOa-)(KXa--)(bY
  Friulian   (TNOM--)(PATM--)(GMFDAM)(SHJAM-)(TMvAM-)(GDAOf--)(KBf--)(bH
  Italian    (NLLYN-)(PAJA--)(HQ----)(SNJ---)(TfF---)(GDAOOK-)(KLXK-)(bX

  Latin      FMG)(XMK-----)(IOUFHG)(FNXHG)
  Romanian   L--)(cKOA----)(IOMF--)(FNX--)
  Catalan    L--)(LaSM----)(IOf---)(FNH--)
  Portuguese BH-)(GlQK----)(iAYH--)(FNTH-)
  Spanish    ABN)(GAFQK---)(YAFN--)(FHATN)
  French     ---)(JHD-----)(IOq---)(FHTN-)
  Walloon    ---)(TXkY----)(IOt---)(FNTfO)
  Romansh    AX-)(TMa-----)(IOKYF-)(FNb--)
  Friulian   L--)(GDJKQf--)(IOAF--)(vHb--)
  Italian    NLN)(GAFDYKJN)(IYfFN-)(FXNTN)

  ;
end;
```

Appendix 5 - Segments in the target word list

Char.	Segment	Words containing this segment
A	e	egoː, persoːna, bibere, audiːre, veniːre, ew, kaine, pyele, ureke, bea, veny, stea, cale, peʎ, ɜstreʎɜ, eu, ɜʃtrela, ʃeyu, persona, pero, piel, oreha, bebe, veni, estreya, fuego, senda, yeno, nuevo, ore, etw̃ol, fe, çe, te, oreye, ʃute, en, pel, ureʎɜ, eʎ, fyew, pỹel, oreli, bevi, sintei, murei, viłei, stelɛ, plen, kane, pɛlle, orekkyo, bere, stella, sentyaro
B	g	egoː, ɛgw̃a, fogu, agw̃a, fuego, agɛ
C	oː	egoː, noːs, persoːna
D	t	tuː, kutis, steːla, tu, stea, nuzaltrɜs, sɜnti, ɜstreʎɜ, ɜʃtrela, nosotros, estreya, ti, ɔ̃tẽdr, etw̃ol, rut, te, ʃute, twɛl, ʃtaylɜ, sintei, stelɛ, stradɛ, stella, sentyaro
E	uː	tuː, uːnus
F	n	noːs, uːnus, persoːna, kanis, veniːre, iŋnis, pleːnus, nowus, noy, unu, kaine, veny, plin, now, nuzaltrɜs, un, pɜrsonɜ, sɜnti, bɜni, nou, noʃ, pɛrzon, novu, nosotros, uno, persona, veni, senda, yeno, nuevo, nu, vɜni, nuvo, nos, vnir, novɛl, nus, en, kɜrʃθawn, θawn, playn, nof, sintei, plen, noi, kane, vɛn, sentyaro, pyɛno, nwovo
G	s	noːs, uːnus, persoːna, kanis, kutis, auris, okulus, steːla, iŋnis, pleːnus, nowus, stea, nuzaltrɜs, pɜrsonɜ, sɜnti, ɜstreʎɜ, sẽda, nosotros, persona, estreya, senda, nos, nus, pɛrsoŋ, sintei, stelɛ, stradɛ, stella, sentyaro
H	u	uːnus, kutis, auris, okulus, audiːre, pleːnus, nowus, tu, unu, ureke, auzy, mury, nuzaltrɜs, un, urɛʎɜ, uʎ, bɛurɜ, muri, nou, eu, oʎu, mur, fogu, ʃeyu, novu, uno, fuego, nuevo, nu, rut, nuvo, ui, ʃute, murrir, nus, ureʎɜ, udir, murir, uŋ, murei, fuk, łuf, ud
I	p	persoːna, pleːnus, pyele, apɜ, plin, pɜrsonɜ, peʎ, plɛ, pɛrzon, pɛlɜ, persona, pero, piel, po, plɜ̃, pow, plĩ, pel, playn, pɛrsoŋ, pỹel, plen, pɛlle, pyɛno
J	r	persoːna, auris, bibere, audiːre, moriː, veniːre, ureke, mury, nuzaltrɜs, pɜrsonɜ, urɛʎɜ, bɛurɜ, muri, ɜstreʎɜ, pɛrzon, oraʎa, mur, vir, ɜʃtrela, nosotros, persona, pero, oreha, oir, mori, estreya, ore, ɔ̃tẽdr, rut, oreye, bwɛr, murrir, vnir, kɜrʃθawn, ureʎɜ, bayvɜr, udir, murir, vɜłir, pɛrsoŋ, oreli, murei, stradɛ, orekkyo, bere, mor, sentyaro
K	a	persoːna, kanis, auris, audiːre, steːla, ak^wa, wia, kaine, bea, auzy, stea, apɜ, cale, nuzaltrɜs, aixw̃ɜ, oraʎa, ɜʃtrela, ɛgw̃a, sẽda, persona, oreha, estreya, agw̃a, senda, bw̃a, yaw, kɜrʃθawn, θawn, bayvɜr, ʃtaylɜ, awɜ, playn, kỹaŋ, agɛ, stradɛ, kane, stella, akwa, sentyaro
L	k	kanis, kutis, okulus, kaine, ureke, oky, fok, kɜ, kɜmi, kẽũ, kɜrʃθawn, kỹaŋ, fuk, kane, orekkyo, okkyo, akwa, fwoko
M	i	kanis, kutis, auris, bibere, iŋnis, wia, kaine, plin, sɜnti, muri, bɜni, aixw̃ɜ, kɜmi, vir, piel, oir, mori, veni, ti, ʃiẽ, vɜni, ui, murrir, vnir, udir, murir, vɜłir, viɜ, oreli, voli, bevi, sintei, murei, viłei, io, noi
N	o	okulus, moriː, nowus, noy, om, oky, fok, now, ʒo, pɜrsonɜ, nou, noʃ, pɛrzon, oraʎa, oʎu, ov, fogu, novu, yo, nosotros, uno, persona, pero, oreha, oho, oir, mori, fuego, yeno, nuevo, po, ore, etw̃ol, o, nuvo, nos, pow, oreye, novɛl, nof, pɛrsoŋ, oreli, voli, io, noi, orekkyo, okkyo, mor, fwoko, sentyaro, pyɛno, nwovo
O	l	okulus, steːla, pleːnus, pyele, cale, plin, nuzaltrɜs, plɛ, pɛlɜ, ɜʃtrela, piel, etw̃ol, plɜ̃, twɛl, plĩ, novɛl, pel, ʃtaylɜ, playn, pỹel, oreli, voli, stelɛ, plen, pɛlle, stella
P	b	bibere, bea, bɛurɜ, bɜni, bɜb, bebe, bw̃a, bwɛr, bayvɜr, bevi, bere
Q	d	audiːre, sẽda, senda, ɔ̃tẽdr, udir, stradɛ, ud
R	iː	audiːre, moriː, veniːre
S	m	moriː, om, mury, muri, kɜmi, mur, mori, ɔ̃m, murrir, murir, murei, mor
T	v	veniːre, veny, ov, vir, novu, veni, nuevo, vɜni, nuvo, vnir, vwẽy, novɛl, bayvɜr, vɜłir, viɜ, voli, bevi, viłei, vɛn, nwovo
U	eː	steːla, pleːnus
V	k^w	ak^wa
W	ŋ	iŋnis, uŋ, pɛrsoŋ, kỹaŋ

X	w	wia, nowus, ew, now, pow, bwɛr, twɛl, ɛwɜ, vwe͂y, yaw, kɜrʃθawn, θawn, awɜ, fyew, akwa, fwoko, nwovo
Y	y	noy, pyele, oky, auzy, mury, veny, ʃeyu, yo, estreya, yeno, ɜy, oreye, vwe͂y, yaw, bayvɜr, ʃtaylɜ, fyew, playn, orekkyo, okkyo, sentyaro, pyɛno
Z	z	auzy, nuzaltrɜs, pɛrzon
a	ɜ	apɜ, nuzaltrɜs, pɜrsonɜ, kɜ, urɛʎɜ, bɛurɜ, sɜnti, bɜni, ɜstreʎɜ, aixw̃ɜ, kɜmi, pɛlɜ, bɜb, ɜʃtrela, jɜ, ɜy, vɜni, ɛwɜ, kɜrʃθawn, ureʎɜ, bayvɜr, vɜłir, ʃtaylɜ, awɜ, viɜ
b	f	fok, fogu, fuego, fe, fɛ, fyew, nof, fuk, łuf, fwoko
c	c	cale
d	ʒ	ʒo
e	ʎ	peʎ, urɛʎɜ, uʎ, ɜstreʎɜ, oraʎa, oʎu, ureʎɜ, eʎ
f	ɛ	urɛʎɜ, bɛurɜ, plɛ, pɛrzon, pɛlɜ, ɛgw̃a, bwɛr, twɛl, ɛwɜ, fɛ, novɛl, pɛrsoŋ, stelɛ, agɛ, stradɛ, pɛlle, vɛn, pyɛno
g	x	aixw̃ɜ
h	w̃	aixw̃ɜ, ɛgw̃a, agw̃a, bw̃a, etw̃ol
i	ʃ	noʃ, ɜʃtrela, ʃeyu, ʃie͂, ʃute, kɜrʃθawn, ʃtaylɜ
j	ũ	ũ, ke͂ũ
k	e͂	ke͂ũ, ʃie͂, ɔ̃te͂dr, vwe͂y
l	ẽ	sẽda, çẽ
m	h	oreha, oho
n	j	jɜ
o	œ̃	œ̃
p	ɔ̃	ɔ̃te͂dr, ɔ̃m
q	ɜ̃	plɜ̃
r	ç	çe, çẽ
s	ɛ̃	ɛ̃
t	ĩ	plĩ
u	θ	kɜrʃθawn, θawn
v	ł	vɜłir, viłei, łuf
w	ỹ	kỹaŋ, pỹel

Pulmonic Consonants

Manner	Bilabial	Labial	Labio-Dental	Linguo-Labial	Dental	Alveolar	Post-Alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal-Epiglottal	Glottal
Nasal	m̥ m		ɱ	n̼		n̥ n		ɳ̊ ɳ	ɲ̊ ɲ	ŋ̊ ŋ	ɴ		
Stop	p b	kʷgʷ	p̪ b̪	t̼ d̼		t d		ʈ ɖ	c ɟ	k g	q ɢ	ʡ	ʔ
Sibilant, Fricative						s z	ʃ ʒ	ʂ ʐ	ɕ ʑ				
Fricative	ɸ β		f v	θ̼ ð̼	θ ð	θ̠ ð̠	ɹ̠̊˔ ɹ̠˔	ɻ˔	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Approximant			ʋ̥ ʋ			ɹ̥ ɹ		ɻ̊ ɻ	j̊ j	ɰ̊ ɰ			ʔ̞
Tap/Flap	ⱱ̟		ⱱ	ɾ̼		ɾ̥ ɾ		ɽ̊ ɽ			ɢ̆	ʡ̆	
Trill	ʙ̥ ʙ					r̥ r		ɽ̊r̥ ɽr			ʀ	ʜ ʢ	
Lateral, Fricative						ɬ ɮ		ɭ̊˔ ɭ˔	ʎ̝̊ ʎ̝	ʟ̝̊ ʟ̝			
Lateral, Approximant						l̥ l		ɭ̊ ɭ	ʎ̥ ʎ	ʟ̥ ʟ	ʟ̠		
Lateral, Tap/Flap						ɺ		ɭ̆	ʎ̆	ʟ̆			

Shaded areas denote articulations judged to be impossible. Where symbols appear in pairs, the one to the right represents a modally voiced consonant.

Non-Pulmonic Consonants

Manner	Bilabial	Labio-Dental	Dental	Alveolar	Post-Alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal-Epiglottal
Ejective, Stop				t’		ʈ’	c’	k’	q’	ʡ’
Ejective, Fricative	ɸ’	f’	θ’	s’	ʃ’	ʂ’	ɕ’	x’	χ’	
Ejective, Lateral, Fricative				ɬ’						
Tenuis, Click	ʘ ʘ̬		ǀ ǀ̬	ǃ ǃ̬			ǂ ǂ̬			
Nasal, Click	ʘ̃		ǀ̃	ǃ̃			ǂ̃			
Tenuis, Lateral, Click				ǁ ǁ̬						
Implosive	ɓ̥ ɓ			ɗ̥ ɗ		ᶑ̊ ᶑ	ʄ̊ ʄ	ɠ̊ ɠ	ʛ̥ ʛ	

Shaded areas denote articulations judged to be impossible. Where symbols appear in pairs, the one to the right represents a modally voiced consonant.

Vowels

	Front	Near-Front	Central	Near-Back	Back
Close	i • y		ɨ • ʉ		ɯ • u
Near-close		ɪ • ʏ	ᵻ • ᵿ	ʊ	
Close-mid	e • ø		ɘ • ɵ		ɤ • o
Mid	ø̞		ə		o̞
Open-mid		ɛ • œ	ɞ • ɜ		ʌ • ɔ
Near-open		æ • ɶ	ɐ		
Open		a • ɶ	ä		ɑ • ɒ

Where symbols appear in pairs, the one to the right represents a rounded vowel.

Long Vowels

	Front	Near-Front	Central	Near-Back	Back
Close	iː				uː
Mid	eː				oː
Open			aː		

Pulmonic Affricates

Manner	Bilabial	Labio-Dental	Dental	Alveolar	Alveolo-Palatal	Retroflex	Palatal	Palato-Alveolar	Velar	Uvular	Pharyngeal-Epiglottal	Glottal
Sibilant	▨	▨		ts dz	tɕ dʑ	ʈʂ ɖʐ		t̠ʃ d̠ʒ	▨	▨	▨	▨
Non-Sibilant	pɸ bβ	p̪f b̪v	t̪θ d̪ð	tɹ̝̊ dɹ̝			cç ɟʝ	t̠ɹ̠̊˔ d̠ɹ̠˔	kx ɡɣ	qχ	ʡʢ	ʔh
Lateral	▨	▨		tɬ dɮ		ʈɭ̊˔	cʎ̝̊		kʟ̝̊ ɡʟ̝		▨	▨

Shaded areas denote articulations judged to be impossible.

Ejective Affricates

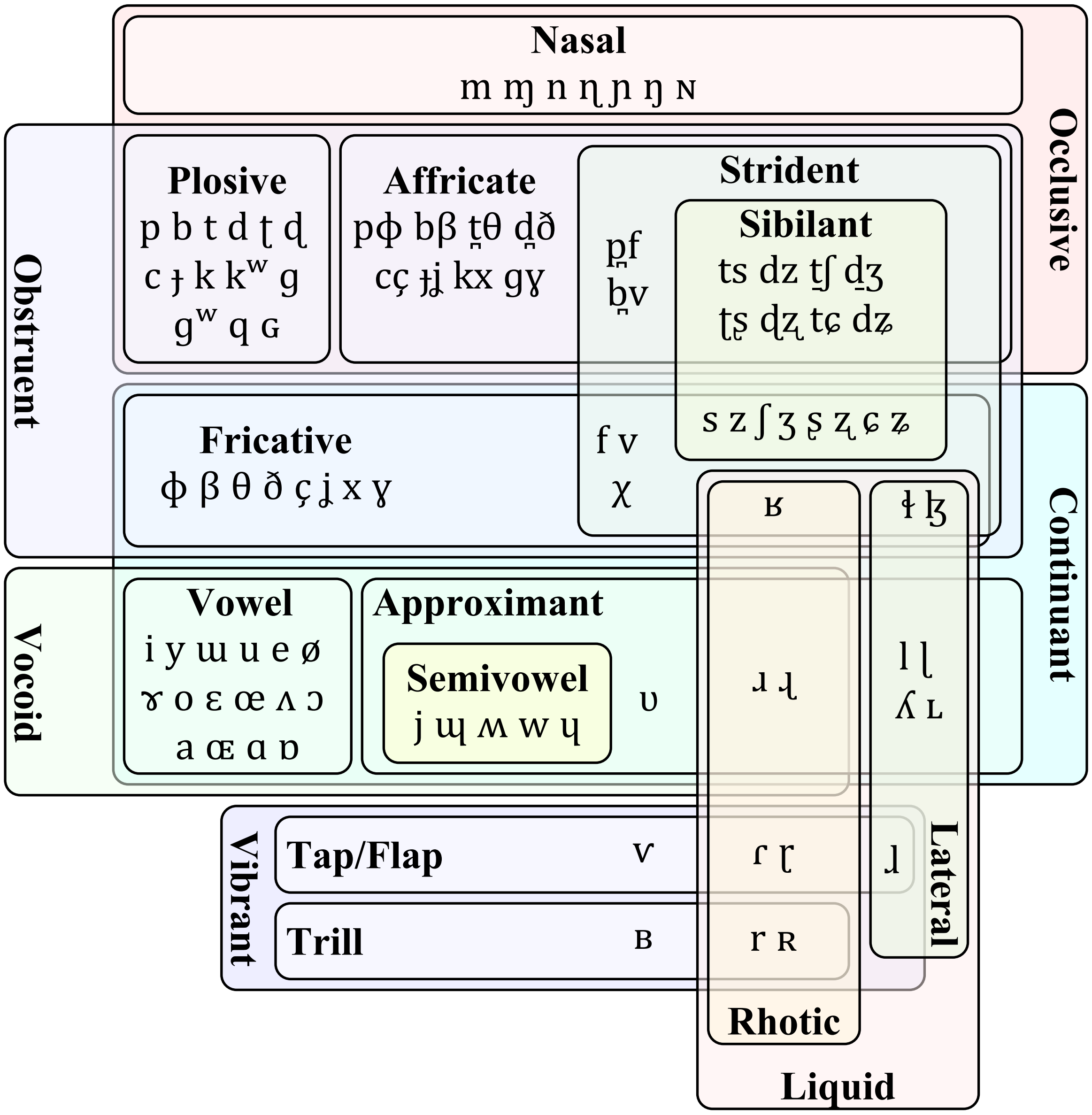
Manner	Bilabial	Labio-Dental	Alveolar	Retroflex	Palatal	Palato-Alveolar	Velar	Uvular	Pharyngeal-Epiglottal	Glottal
Central			ts’	ʈʂ’		t̠ʃ’	kx’	qχ’		▨
Lateral	▨	▨	tɬ’		cʎ̝̊’		kʟ̝̊’		▨	▨

Shaded areas denote articulations judged to be impossible.

Other Segments

r̃	Uvular Voiced Pulmonic Nasal Fricative	ɫ	Alveolar Voiced Velarized Pulmonic Lateral Approximant
ʍ	Labial-Velar Approximant Continuant Vocoid Semivowel	w̃	Labial-Velar Voiced Nasal Approximant
w	Labial-Velar Voiced Approximant Continuant Vocoid Semivowel	ɥ	Labial-Palatal Voiced Approximant Continuant Vocoid Semivowel
ɧ	Post-Alveolar Sibilant Fricative	ʢ	Pharyngeal-Epiglottal Voiced Fricative
ʡ	Pharyngeal-Epiglottal Ejective	p’	Bilabial Ejective Pulmonic Stop
œ̃	Open-mid Near-Front Rounded Nasal Vowel	ỹ	Close Front Rounded Nasal Vowel
ã	Open Near-Front Nasal Vowel	ɐ̃	Near-open Central Rounded Nasal Vowel
ɔ̃	Open-mid Back Rounded Nasal Vowel	ɜ̃	Open-mid Near-Front Nasal Vowel
ɛ̃	Open-mid Near-Front Nasal Vowel	ũ	Close Back Rounded Nasal Vowel
ẽ	Close-mid Front Nasal Vowel	ĩ	Close Front Nasal Vowel

Diacritics					
	Undefined escape character	̃	Nasalized	̈	Centralized
̟	Advanced	̠	Retracted	̌	RisingTone
̥	Voiceless		Implosive	̩	Syllabic
ʼ	Ejective	ˤ	Pharyngealized	̂	Falling tone
̯	Non-syllabic	̚	No audible release	˞	Rhotic hook
̘	Advanced tongue root	̺	Apical	̏	Extra low tone
᷅	Low rising tone	̜	Less rounded	̪	Dental
̴	Velarized or Pharyngealized	↘	Global fall	ˠ	Velarized
́	High tone	᷄	High rising tone	ʰ	Aspirated
ʲ	Palatalized	̰	Creaky voiced	̀	Low tone
ˡ	Lateral release	̄	Mid tone	̻	Laminal
̼	Linguo-Labial	ⁿ	Nasal release	̹	More rounded
̞	Lowered	̙	Retracted tongue root	↗	Global rise
᷈	Rising falling tone	̝	Raised	̋	Extra high tone
̤	Breathy voiced	̬	Voiced	ʷ	Labialized
̆	Extra short	̽	Mid-centralized	ꜜ	Down-step
ꜛ	Up-step	.	Sylable break	ˈ	Primary stress
ˌ	Secondary stress	ː	Long	ˑ	Half-long
	Indeterminacy in french vowels		Begin Non-segmental notation		End non-segmental notation
ʢ	Voiced epiglottal fricative	ǃ	Post-alveolar click	|	Minor group
ǀ	Dental click	‖	Major group	ǁ	Alveolar lateral click
ǂ	Palatal click	̊	Voiceless descender	̱	Combining macron
͜	Tie-bar below	͡	Tie-bar above	ɬ	Ready made combination
→	Becomes		Separator		


Nasal
m ɱ n ɳ ɲ ŋ ɴ
Occlusive
Obstruent
Plosive
p b t d ʈ ɖ
c ɟ k kʷ g
gʷ q ɢ
Affricate
pɸ bβ t̪θ d̪ð
cç ɟʝ kx gɣ
Strident
p̪f
b̪v
Sibilant
ts dz t̠ʃ d̠ʒ
ʈʂ ɖʐ tɕ dʑ
s z ʃ ʒ ʂ ʐ ɕ ʑ
Fricative
ɸ β θ ð ç ʝ x ɣ
f v
χ
ʁ
ɬ ɮ
Continuant
Vocoid
Vowel
i y ɯ u e ø
ɤ o ɛ œ ʌ ɔ
a ɶ ɑ ɒ
Approximant
Semivowel
j ɰ ʍ w ɥ
ʋ
ɹ ɻ
l ɭ
ʎ ʟ
Vibrant
Tap/Flap
ⱱ
ɾ ɽ
ɺ
Lateral
Trill
ʙ
r ʀ
Rhotic
Liquid

IPA Segments

a Open Near-Front Vowel Continuant Vocoid 0061 a	b Bilabial Voiced Pulmonic Stop Occlusive 0062 b	c Palatal Pulmonic Stop Occlusive 0063 c	d Alveolar Voiced Pulmonic Stop Occlusive 0064 d
e Close-mid Front Vowel Continuant Vocoid 0065 e	f Labio-Dental Pulmonic Fricative Strident Obstruent Continuant 0066 f	h Glottal Pulmonic Fricative 0068 h	i Close Front Vowel Continuant Vocoid 0069 i
j Palatal Voiced Pulmonic Approximant Continuant Vocoid Semivowel 006A j	k Velar Pulmonic Stop Occlusive 006B k	l Alveolar Voiced Pulmonic Lateral Approximant Rhotic Vocoid Liquid 006C l	m Bilabial Voiced Pulmonic Nasal Occlusive 006D m
n Alveolar Voiced Pulmonic Nasal Occlusive 006E n	o Close-mid Back Rounded Vowel Continuant Vocoid 006F o	p Bilabial Pulmonic Stop Occlusive 0070 p	q Uvular Pulmonic Stop Occlusive 0071 q
r Alveolar Voiced Pulmonic Trill Rhotic Vibrant Liquid 0072 r	s Alveolar Pulmonic Sibilant Fricative Strident Obstruent Continuant 0073 s	t Alveolar Pulmonic Stop Occlusive 0074 t	u Close Back Rounded Vowel Continuant Vocoid 0075 u

v	w	x	y
Labio-Dental Voiced Pulmonic Fricative Strident Obstruent Continuant	Labial-Velar Voiced Approximant Continuant Vocoid Semivowel	Velar Pulmonic Fricative Obstruent Continuant	Close Front Rounded Vowel Continuant Vocoid
0076	0077	0078	0079
v	w	x	y
z	ä	æ	ç
Alveolar Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant	Open Central Vowel	Near-open Near-Front Vowel	Palatal Pulmonic Fricative Obstruent Continuant
007A	00E4	00E6	00E7
z	a_"	{	C
ð	ø	ħ	ŋ
Dental Voiced Pulmonic Fricative Obstruent Continuant	Close-mid Front Rounded Vowel Continuant Vocoid	Pharyngeal-Epiglottal Pulmonic Fricative	Velar Voiced Pulmonic Nasal Occlusive
00F0	00F8	0127	014B
D	2	X\	N
œ	ǀ	ǁ	ǂ
Open-mid Near-Front Rounded Vowel Continuant Vocoid	Dental Ejective Tenuis Click Affricate	Alveolar Ejective Tenuis Lateral Click Affricate	Palatal Ejective Tenuis Click Affricate
0153	01C0	01C1	01C2
9	|	| \ | \	=\
ǃ	ɐ	ɑ	ɒ
Alveolar Ejective Tenuis Click Affricate	Near-open Central Rounded Vowel	Open Back Vowel Continuant Vocoid	Open Back Rounded Vowel Continuant Vocoid
01C3	0250	0251	0252
!\	6	A	Q

ɓ	ɔ	ɕ	ɖ
Bilabial Voiced Ejective Implosive Click Affricate	Open-mid Back Rounded Vowel Continuant Vocoid	Palatal Pulmonic Sibilant Fricative Strident Obstruent Continuant	Retroflex Voiced Pulmonic Stop Occlusive
0253	0254	0255	0256
b_<	O	s\	d`
ɗ	ɘ	ə	ɛ
Alveolar Voiced Ejective Implosive Click Affricate	Mid Central Vowel	Close-mid Central Vowel	Open-mid Near-Front Vowel Continuant Vocoid
0257	0258	0259	025B
d_<	@\	@	E
ɜ	ɞ	ɟ	ɠ
Open-mid Central Vowel	Open-mid Central Rounded Vowel	Palatal Voiced Pulmonic Stop Occlusive	Velar Voiced Ejective Implosive Click Affricate
025C	025E	025F	0260
3	3\	J\	g_<
ɡ	ɢ	ɣ	ɤ
Velar Voiced Pulmonic Stop Occlusive	Uvular Voiced Pulmonic Stop Occlusive	Velar Voiced Pulmonic Fricative Obstruent Continuant	Close-mid Back Vowel Continuant Vocoid
0261	0262	0263	0264
g	G\	G	7
ɥ	ɦ	ɧ	ɨ
Labial-Palatal Voiced Approximant Continuant Vocoid Semivowel	Glottal Voiced Pulmonic Fricative	Post-Alveolar Sibilant Fricative	Close Central Vowel
0265	0266	0267	0268
H	h\	x\	1
ɪ	ɫ	ɬ	ɭ
Near-close Near-Front Vowel	Alveolar Voiced Velarized Pulmonic Lateral Approximant	Alveolar Pulmonic Lateral Fricative Strident Obstruent Continuant Liquid	Retroflex Voiced Pulmonic Lateral Approximant Rhotic Vocoid Liquid
026A	026B	026C	026D
I	5	K	n`

ɮ	Alveolar Voiced Pulmonic Lateral Fricative Strident Obstruent Continuant Liquid	026E	K\
ɯ	Close Back Vowel Continuant Vocoid	026F	M
ɰ	Velar Voiced Pulmonic Approximant Continuant Vocoid Semivowel	0270	M\
ɱ	Labio-Dental Voiced Pulmonic Nasal Occlusive	0271	F
ɲ	Palatal Voiced Pulmonic Nasal Occlusive	0272	J
ɳ	Retroflex Voiced Pulmonic Nasal Occlusive	0273	n`
ɴ	Uvular Voiced Pulmonic Nasal Occlusive	0274	N\
ɵ	Close-mid Central Rounded Vowel	0275	8
ɶ	Near-open Near-Front Rounded Vowel	0276	&
ɶ	Open Near-Front Rounded Vowel Continuant Vocoid	0276	&
ɸ	Bilabial Pulmonic Fricative Obstruent Continuant	0278	p\
ɹ	Alveolar Voiced Pulmonic Approximant Rhotic Vocoid Liquid	0279	r\
ɺ	Alveolar Voiced Pulmonic Lateral Tap/Flap Rhotic Vibrant Liquid	027A	l\
ɻ	Retroflex Voiced Pulmonic Approximant Rhotic Vocoid Liquid	027B	r\`
ɽ	Retroflex Voiced Pulmonic Tap/Flap Rhotic Vibrant Liquid	027D	r`
ɾ	Alveolar Voiced Pulmonic Tap/Flap Rhotic Vibrant Liquid	027E	4
ʀ	Uvular Pulmonic Trill Rhotic Vibrant Liquid	0280	R\
ʁ	Uvular Voiced Pulmonic Fricative Rhotic Strident Obstruent Continuant Liquid	0281	R
ʂ	Retroflex Pulmonic Sibilant Fricative Strident Obstruent Continuant	0282	s`
ʃ	Post-Alveolar Pulmonic Sibilant Fricative Strident Obstruent Continuant	0283	S
ʄ	Palatal Voiced Ejective Implosive Click Affricate	0284	J_<
ʈ	Retroflex Pulmonic Stop Occlusive	0288	t`
ʉ	Close Central Rounded Vowel	0289	}
ʊ	Near-close Near-Back Rounded Vowel	028A	U

ʋ Labio-Dental Voiced Pulmonic Approximant Vocoid 028B v\	ʌ Open-mid Back Vowel Continuant Vocoid 028C V	ʍ Labial-Velar Approximant Continuant Vocoid Semivowel 028D W	ʎ Palatal Voiced Pulmonic Lateral Approximant Rhotic Vocoid Liquid 028E L
ʏ Near-close Near-Front Rounded Vowel 028F Y	ʐ Retroflex Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant 0290 z`	ʑ Palatal Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant 0291 z\	ʒ Post-Alveolar Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant 0292 Z
ʔ Glottal Pulmonic Stop 0294 ?	ʕ Pharyngeal-Epiglottal Voiced Pulmonic Fricative 0295 ?\	ʘ Bilabial Ejective Tenuis Click Affricate 0298 O\	ʙ Bilabial Voiced Pulmonic Trill Vibrant 0299 B\
ʛ Uvular Voiced Ejective Implosive Click Affricate 029B G_<	ʜ Pharyngeal-Epiglottal Pulmonic Trill 029C H\	ʝ Palatal Voiced Pulmonic Fricative Obstruent Continuant 029D j\	ʟ Velar Voiced Pulmonic Lateral Approximant Rhotic Vocoid Liquid 029F L\
ʡ Pharyngeal-Epiglottal Ejective 02A1 <\	ʡ Pharyngeal-Epiglottal Pulmonic Stop 02A1 >\	ʢ Pharyngeal-Epiglottal Voiced Pulmonic Trill 02A2 <\	ʢ Pharyngeal-Epiglottal Voiced Fricative 02A2 ?\
β Bilabial Voiced Pulmonic Fricative Obstruent Continuant 03B2 B	θ Dental Pulmonic Fricative Obstruent Continuant 03B8 T	χ Uvular Pulmonic Fricative Strident Obstruent Continuant 03C7 X	ᵻ Near-close Central NonIPA Vowel 1D7B I\

ᵿ	ᶑ	ⱱ	L̆
Near-close Central NonIPA Rounded Vowel	Retroflex Voiced Ejective Implosive Click Affricate	Labio-Dental Voiced Pulmonic Tap/Flap Vibrant	Velar Voiced Pulmonic Lateral Tap/Flap
1D7F	1D91	2C71	004C, 0306
U\	🟥	🟥	🟥
aː	ã	b̪	bβ
Open Central Vowel Continuant Vocoid Long	Open Near-Front Nasal Vowel	Labio-Dental Voiced Pulmonic Stop	Bilabial Voiced Pulmonic Affricate Occlusive
0061, 02D0	0061, 0303	0062, 032A	0062, 03B2
a:	~a	b_d	🟥
cç	cʼ	dz	dɮ
Palatal Pulmonic Affricate Occlusive	Palatal Ejective Stop	Alveolar Voiced Pulmonic Sibilant Affricate Occlusive Strident	Alveolar Voiced Pulmonic Lateral Affricate
0063, 00E7	0063, 02BC	0064, 007A	0064, 026E
🟥	c_>	🟥	🟥
dʑ	d̼	eː	ẽ
Alveolo-Palatal Voiced Pulmonic Sibilant Affricate Occlusive Strident	Linguo-Labial Voiced Pulmonic Stop	Mid Front Vowel Continuant Vocoid Long	Close-mid Front Nasal Vowel
0064, 0291	0064, 033C	0065, 02D0	0065, 0303
🟥	🟥	e:	e*
fʼ	iː	ĩ	j̊
Labio-Dental Ejective Fricative	Close Front Vowel Continuant Vocoid Long	Close Front Nasal Vowel	Palatal Pulmonic Approximant
0066, 02BC	0069, 02D0	0069, 0303	006A, 030A
f_>	i:	i*	🟥
kx	kʷ	kʼ	l̥
Velar Pulmonic Affricate Occlusive	Labial Pulmonic Stop Occlusive	Velar Ejective Stop	Alveolar Pulmonic Lateral Approximant
006B, 0078	006B, 02B7	006B, 02BC	006C, 0325
🟥	k_W	k_>	🟥

m̥ Bilabial Pulmonic Nasal 006D, 0325 m_0	n̥ Alveolar Pulmonic Nasal 006E, 0325 n_0	n̼ Linguo-Labial Voiced Pulmonic Nasal 006E, 033C m_d	oː Mid Back Rounded Vowel Continuant Vocoid Long 006F, 02D0 o:
o̞ Mid Back Vowel 006F, 031E 🟥	pɸ Bilabial Pulmonic Affricate Occlusive 0070, 0278 🟥	pʼ Bilabial Ejective Pulmonic Stop 0070, 02BC p_>	p̪ Labio-Dental Pulmonic Stop 0070, 032A p_d
qʼ Uvular Ejective Stop 0071, 02BC q_>	qχ Uvular Pulmonic Affricate 0071, 03C7 🟥	r̃ Uvular Voiced Pulmonic Nasal Fricative 0072, 0303 r~	r̥ Alveolar Pulmonic Trill 0072, 0325 🟥
sʼ Alveolar Ejective Fricative 0073, 02BC s_>	ts Alveolar Pulmonic Sibilant Affricate Occlusive Strident 0074, 0073 🟥	tɕ Alveolo-Palatal Pulmonic Sibilant Affricate Occlusive Strident 0074, 0255 🟥	tʼ Alveolar Ejective Stop 0074, 02BC t_>
t̼ Linguo-Labial Pulmonic Stop 0074, 033C 🟥	uː Close Back Rounded Vowel Long 0075, 02D0 u:	ũ Close Back Rounded Nasal Vowel 0075, 0303 u*	w̃ Labial-Velar Voiced Nasal Approximant 0077, 0303 w~
xʼ Velar Ejective Fricative 0078, 02BC x_>	ỹ Close Front Rounded Nasal Vowel 0079, 0303 y~	ð̠ Alveolar Voiced Pulmonic Fricative 00F0, 0320 🟥	ð̼ Linguo-Labial Voiced Pulmonic Fricative 00F0, 033C 🟥

ø̞	Mid Front Vowel	00F8, 031E	🟥
ŋ̊	Velar Pulmonic Nasal	014B, 030A	N_0
œ̃	Open-mid Near-Front Rounded Nasal Vowel	0153, 0303	oe*
ǀ̃	Dental Ejective Nasal Click Affricate	01C0, 0303	🟥
ǀ̬	Dental Voiced Ejective Tenuis Click Affricate	01C0, 032C	🟥
ǁ̬	Alveolar Voiced Ejective Tenuis Lateral Click Affricate	01C1, 032C	🟥
ǂ̃	Palatal Ejective Nasal Click Affricate	01C2, 0303	🟥
ǂ̬	Palatal Voiced Ejective Tenuis Click Affricate	01C2, 032C	🟥
ǃ̃	Alveolar Ejective Nasal Click Affricate	01C3, 0303	🟥
ǃ̬	Alveolar Voiced Ejective Tenuis Click Affricate	01C3, 032C	🟥
ɐ̃	Near-open Central Rounded Nasal Vowel	0250, 0303	a*
ɓ̥	Bilabial Ejective Implosive Click Affricate	0253, 0325	🟥
ɔ̃	Open-mid Back Rounded Nasal Vowel	0254, 0303	o*
ɕʼ	Palatal Ejective Fricative	0255, 02BC	s_>
ɖʐ	Retroflex Voiced Pulmonic Sibilant Affricate Occlusive Strident	0256, 0290	🟥
ɗ̥	Alveolar Ejective Implosive Click Affricate	0257, 0325	🟥
ɛ̃	Open-mid Near-Front Nasal Vowel	025B, 0303	E*
ɜ̃	Open-mid Near-Front Nasal Vowel	025C, 0303	3*
ɟʝ	Palatal Voiced Pulmonic Affricate Occlusive	025F, 029D	🟥
ɠ̊	Velar Ejective Implosive Click Affricate	0260, 030A	🟥
ɡɣ	Velar Voiced Pulmonic Affricate Occlusive	0261, 0263	🟥
ɡʷ	Labial Voiced Pulmonic Stop Occlusive	0261, 02B7	g_W
ɢ̆	Uvular Voiced Pulmonic Tap/Flap	0262, 0306	🟥
ɬʼ	Alveolar Ejective Lateral Fricative	026C, 02BC	K_>

ɭ˔	Retroflex Voiced Pulmonic Lateral Fricative	026D, 02D4	🟥
ɭ̆	Retroflex Voiced Pulmonic Lateral Tap/Flap	026D, 0306	🟥
ɭ̊	Retroflex Pulmonic Lateral Approximant	026D, 030A	🟥
ɰ̊	Velar Pulmonic Approximant	0270, 030A	🟥
ɲ̊	Palatal Pulmonic Nasal	0272, 030A	J_0
ɳ̊	Retroflex Pulmonic Nasal	0273, 030A	n`_0
ɸʼ	Bilabial Ejective Fricative	0278, 02BC	p_>
ɹ̥	Alveolar Pulmonic Approximant	0279, 0325	🟥
ɻ˔	Retroflex Voiced Pulmonic Fricative	027B, 02D4	🟥
ɻ̊	Retroflex Pulmonic Approximant	027B, 030A	🟥
ɽr	Retroflex Voiced Pulmonic Trill	027D, 0072	🟥
ɽ̊	Retroflex Pulmonic Tap/Flap	027D, 030A	🟥
ɾ̥	Alveolar Pulmonic Tap/Flap	027E, 0325	🟥
ɾ̼	Linguo-Labial Voiced Pulmonic Tap/Flap	027E, 033C	🟥
ʂʼ	Retroflex Ejective Fricative	0282, 02BC	s`_>
ʃʼ	Post-Alveolar Ejective Fricative	0283, 02BC	S_>
ʄ̊	Palatal Ejective Implosive Click Affricate	0284, 030A	🟥
ʈʂ	Retroflex Pulmonic Sibilant Affricate Occlusive Strident	0288, 0282	🟥
ʈʼ	Retroflex Ejective Stop	0288, 02BC	t`_>
ʋ̥	Labio-Dental Pulmonic Approximant	028B, 0325	🟥
ʎ̆	Palatal Voiced Pulmonic Lateral Tap/Flap	028E, 0306	🟥
ʎ̝	Palatal Voiced Pulmonic Lateral Fricative	028E, 031D	🟥
ʎ̥	Palatal Pulmonic Lateral Approximant	028E, 0325	🟥
ʔh	Glottal Pulmonic Affricate	0294, 0068	🟥

ʔ̞ Glottal Voiced Pulmonic Approximant `0294, 031E` 🟥	ʘ̃ Bilabial Ejective Nasal Click Affricate `0298, 0303` 🟥	ʘ̬ Bilabial Voiced Ejective Tenuis Click Affricate `0298, 032C` 🟥	ʙ̥ Bilabial Pulmonic Trill `0299, 0325` 🟥
ʛ̥ Uvular Ejective Implosive Click Affricate `029B, 0325` 🟥	ʟ̝ Velar Voiced Pulmonic Lateral Fricative `029F, 031D` 🟥	ʟ̠ Uvular Voiced Pulmonic Lateral Approximant `029F, 0320` 🟥	ʟ̥ Velar Pulmonic Lateral Approximant `029F, 0325` 🟥

ʡʢ
Pharyngeal-Epiglottal Voiced Pulmonic Affricate
`02A1, 02A2`
🟥
	ʡʼ
	Pharyngeal-Epiglottal Ejective Stop
	`02A1, 02BC`
	`>\_>`
		ʡ̆
		Pharyngeal-Epiglottal Voiced Pulmonic Tap/Flap
		`02A1, 0306`
		🟥
			θʼ
			Dental Ejective Fricative
			`03B8, 02BC`
			`T_>`

θ̠
Alveolar Pulmonic Fricative
`03B8, 0320`
🟥
	θ̼
	Linguo-Labial Pulmonic Fricative
	`03B8, 033C`
	🟥
		χʼ
		Uvular Ejective Fricative
		`03C7, 02BC`
		`X_>`
			ᶑ̊
			Retroflex Ejective Implosive Click Affricate
			`1D91, 030A`
			🟥

ⱱ̟ Bilabial Voiced Pulmonic Tap/Flap `2C71, 031F` 🟥	b̪v Labio-Dental Voiced Pulmonic Affricate Occlusive Strident `0062, 032A, 0076` 🟥	dɹ̝ Alveolar Voiced Pulmonic Affricate `0064, 0279, 031D` 🟥	d̠ʒ Palato-Alveolar Voiced Pulmonic Sibilant Affricate Occlusive Strident `0064, 0320, 0292` 🟥
d̪ð Dental Voiced Pulmonic Affricate Occlusive `0064, 032A, 00F0` 🟥	kxʼ Velar Ejective Central Affricate `006B, 0078, 02BC` 🟥	p̪f Labio-Dental Pulmonic Affricate Occlusive Strident `0070, 032A, 0066` 🟥	qχʼ Uvular Ejective Central Affricate `0071, 03C7, 02BC` 🟥

tsʼ Alveolar Ejective Central Affricate 0074, 0073, 02BC	tɬʼ Alveolar Ejective Lateral Affricate 0074, 026C, 02BC	t̠ʃ Palato-Alveolar Pulmonic Sibilant Affricate Occlusive Strident 0074, 0320, 0283	t̪θ Dental Pulmonic Affricate Occlusive 0074, 032A, 03B8
ɡʟ̝ Velar Voiced Pulmonic Lateral Affricate 0261, 029F, 031D	ɭ̊˔ Retroflex Pulmonic Lateral Fricative 026D, 030A, 02D4	ɹ̝̊ Post-Alveolar Voiced Pulmonic Fricative 0279, 031D, 030A	ɹ̠̊ Post-Alveolar Pulmonic Fricative 0279, 0320, 030A
ʈʂʼ Retroflex Ejective Central Affricate 0288, 0282, 02BC	ʎ̝̊ Palatal Pulmonic Lateral Fricative 028E, 031D, 030A	ʟ̝̊ Velar Pulmonic Lateral Fricative 029F, 031D, 030A	cʎ̝̊ Palatal Voiced Pulmonic Lateral Affricate 0063, 028E, 031D, 030A
kʟ̝̊ Velar Pulmonic Lateral Affricate 006B, 029F, 031D, 030A	tɬ̝̊ Alveolar Pulmonic Lateral Affricate 0074, 026C, 031D, 030A	tɹ̝̊ Alveolar Pulmonic Affricate 0074, 0279, 031D, 030A	t̠ʃʼ Palato-Alveolar Ejective Central Affricate 0074, 0320, 0283, 02BC
ɽ̊r̥ Retroflex Pulmonic Trill 027D, 030A, 0072, 0325	ʈɭ̊˔ Retroflex Pulmonic Lateral Affricate 0288, 026D, 030A, 02D4	cʎ̝̊ʼ Palatal Ejective Lateral Affricate 0063, 028E, 031D, 030A, 02BC	d̠ɹ̠˔ Palato-Alveolar Voiced Pulmonic Affricate 0064, 0320, 0279, 0320, 02D4
kʟ̝̊ʼ Velar Ejective Lateral Affricate 006B, 029F, 031D, 030A, 02BC	t̠ɹ̠̊˔ Palato-Alveolar Pulmonic Affricate 0074, 0320, 0279, 0320, 030A, 02D4		

Appendix 10 - Feature Tree

- Vowels
  - Front: i iː y e ø ø̞ eː ỹ ẽ ĩ
  - Near-Front: ɪ ʏ ɛ œ æ ɶ a ɶ ɶ̃ ã ɜ̃ ɛ̃
  - Central: ɨ ʉ ᵻ ᵿ ɘ ə ɵ ɞ ɜ ɐ ä aː ɐ̃
  - Near-Back: ʊ
  - Back: ɯ u uː ɤ o o̞ ʌ ɔ oː ɑ ɒ ɔ̃ ũ
- Affricates
  - Non-Pulmonic
    - Voiced
      - Tenuis: ʘ̬ ǀ̬ ǃ̬ ǂ̬ ǁ̬
      - Click: ɓ ɗ ᶑ ʄ ɠ ʛ
    - Voiceless
      - Tenuis: ʘ ǀ ǃ ǂ ǁ
      - Click: ʘ̃ ǀ̃ ǃ̃ ǂ̃ ɓ̥ ɗ̥ ᶑ̊ ʄ̊ ɠ̊ ʛ̥
      - Ejective: ts’ t̠ʃ’ ʈʂ’ kx’ qχ’ tɬ’ cʎ̝̊’ kʟ̝̊’
  - Pulmonic
    - Voiced
      - Sibilant: dz d̠ʒ ɖʐ dʑ
      - Lateral: dɮ cʎ̝̊ gʟ̝
      - No Features: bβ b̪v d̪ð dɹ̝ d̠ɹ̠˔ ɟʝ ɡɣ ʡʢ
    - Voiceless
      - Sibilant: ts t̠ʃ ʈʂ tɕ
      - Lateral: tɬ̝̊ ʈɭ̊˔ kʟ̝̊
      - No Features: pɸ p̪f t̪θ tɹ̝̊ t̠ɹ̠̊˔ cç kx qχ ʔh
- Consonants
  - Pulmonic
    - Voiced
      - Nasal: r̃ m ɱ n̼ n ɳ ɲ ŋ ɴ
      - Fricative: z ʒ ʐ ʑ β v ð̼ ð ð̠ ɹ̝̊ ɻ˔ ʝ ɣ ʁ ʕ ɦ ɮ ɭ˔ ʎ̝ ʟ̝
      - Lateral: l ɫ ɭ ʎ ʟ ʟ̠ ɺ ɭ̆ ʎ̆ ʟ̆
      - Stop: b b̪ d̼ d ɖ ɟ ɡ ɡʷ ɢ
      - Approximant: ʋ ɹ ɻ j ɰ ʔ̞
      - Tap/Flap: ⱱ̟ ⱱ ɾ̼ ɾ ɽ ɢ̆ ʡ̆
      - Trill: ʙ r ɽr ʢ
    - Voiceless
      - Nasal: m̥ n̥ ɳ̊ ɲ̊ ŋ̊
      - Ejective: p’
      - Fricative: s ʃ ʂ ɕ ɸ f θ̼ θ θ̠ ɹ̠̊ ç x χ ħ h ɬ ɭ̊˔ ʎ̝̊ ʟ̝̊
      - Lateral: l̥ ɭ̊ ʎ̥ ʟ̥
      - Stop: p p̪ t̼ t ʈ c k kʷ q ʡ ʔ
      - Approximant: ʋ̥ ɹ̥ ɻ̊ j̊ ɰ̊
      - Tap/Flap: ɾ̥ ɽ̊
      - Trill: ʙ̥ r̥ ɽ̊r̥ ʀ ʜ
  - Non-Pulmonic
    - Voiced
      - Nasal: w̃
      - Fricative: ʢ
      - Approximant: w ɥ
    - Voiceless
      - Ejective: ʡ t’ ʈ’ c’ k’ q’ ʡ’ ɸ’ f’ θ’ s’ ʃ’ ʂ’ ɕ’ x’ χ’ ɬ’
      - Fricative: ɧ
      - Approximant: ʍ

Appendix 11 - SAMPAConversion

SAMPA	IPA	Segment
		SpaceSegment
&	ɶ	FrontOpenRounded
1	ɨ	CloseCentralUnrounded
2	ø	CloseMidFrontRounded
3	ɜ	aeh
4	ɾ	VdAlveolarTap
5	ɫ	ssha
6	ɐ	OpenMidSchwa
7	ɤ	CloseMidBackUnrounded
8	ɵ	ooh
9	œ	OpenMidNearFrontRounded
?	ʔ	GlottalStop
@	ə	Schwa
A	ɑ	OpenBackUnrounded
B	β	VdBilabialFricative
C	ç	sh
D	ð	VdDentalFricative
E	ɛ	eh
F	ɱ	VdLabioDentalNasal
G	ɣ	VdVelarFricative
H	ɥ	VdLabialPalatalApproximant
I	ɪ	NearCloseFrontUnrounded
J	ɲ	VdPalatalNasal
K	ɬ	VlAlveolarLateralFricative
L	ʎ	yuh
M	ɯ	CloseBackUnrounded
N	ŋ	nya
O	ɔ	OpenMidBackRounded
Q	ɒ	OpenBackRounded
R	ʁ	VdUvularFricative
S	ʃ	shh
T	θ	th
U	ʊ	NearCloseBackRounded
V	ʌ	OpenMidBackUnrounded
W	ʍ	VlLabialVelarApproximant
X	χ	VlUvularFricative
Y	ʏ	NearCloseFrontRounded
Z	ʒ	gzah
a	a	ah
b	b	b
c	c	tya
d	d	d
e	e	ay
f	f	f
g	ɡ	g
h	h	h
i	i	e
j	j	jg
k	k	k

l	l	l
m	m	m
n	n	n
o	o	oh
p	p	p
q	q	VlUvularStop
r	r	r
s	s	s
t	t	t
u	u	u
v	v	v
w	w	w
x	x	xha
y	y	eeh
z	z	zz
{	æ	NearFrontUnrounded
|	ǀ	VlDentalTenuisClick
}	ʉ	CloseCentralRounded
!\	!	VlAlveolarTenuisClick
3*	ɜ̃	aehn
3\	ɞ	OpenMidCentralRounded
<\	ʢ	VdPharyngealTrill
=\	ǂ	VlPalatalTenuisClick
>\	ʡ	VdEpiglottalStop
?\	ʕ	VdPharyngealFricative
@\	ɘ	MidCentralUnrounded
B\	ʙ	VdBilabialTrill
E*	ɛ̃	ehnn
G\	ɢ	VdUvularStop
H\	ʜ	VlPharyngealTrill
I\	ᵻ	NearCloseCentralUnrounded
J\	ɟ	VdPalatalStop
K\	ɮ	VdAlveolarLateralFricative
L\	ʟ	VdVelarLateral
M\	ɰ	VdVelarApproximant
N\	ɴ	VdUvularNasal
O\	ʘ	VlBilabialTenuisClick
R\	ʀ	VlUvularTrill
U\	ᵿ	NearCloseCentralRounded
X\	ħ	VlPharyngealFricative
a*	ɐ̃	ahn
a:	aː	aye
d`	ɖ	VdRetroflexStop
e*	ẽ	en
e:	eː	ai
h\	ɦ	VdGlottalFricative
i*	ĩ	een
i:	iː	ee
j\	ʝ	VdPalatalFricative
l\	ɺ	VdAlveolarLateralFlap
n`	ɳ	VdRetroFlexNasal
o*	ɔ̃	oon

o:	oː	LongO
p\	ɸ	VlBilabialFricative
r\	ɹ	VdPostalveolarApproximant
r`	ɽ	VdRetroflexFlap
r~	r̃	rn
s\	ɕ	VlPalatalSibFricative
s`	ʂ	VlRetroflexSibFricative
t`	ʈ	VlRetroflexStop
u*	ũ	uh
u:	uː	uu
v\	ʋ	VdLabioDentalApproximant
w~	w̃	wh
x\	ɧ	SimultaneousSx
y~	ỹ	ey
z\	ʑ	VdPalatalSibFricative
z`	ʐ	VdRetroflexSibFricative
~a	ã	aa
J_0	ɲ̊	VlPalatalNasal
K_>	ɬ’	VlPostalveolarLatFricEjective
N_0	ŋ̊	VlVelarNasal
S_>	ʃ’	VlPostalveolarFricativeEjective
T_>	θ’	VlDentalFricativeEjective
X_>	χ’	VlUvularFricativeEjective
a_"	ä	OpenCentralUnrounded
b_<	ɓ	VdBilabialImplosiveClick
b_d	b̪	VdLabioDentalStop
c_>	c’	VlPalatalStopEjective
d_<	ɗ	VdAlveolarImplosiveClick
f_>	f’	VlLabiodentalFricativeEjective
g_<	ɠ	VdVelarImplosiveClick
g_W	g^w	gw
k_>	k’	VlVelarStopEjective
k_W	k^w	kw
m_0	m̥	VlBilabialNasal
m_d	n̼	VdLinguoLabioNasal
n_0	n̥	VlAlveolarNasal
oe*	œ̃	uuh
p_>	p’	VlBilabialStopEjective
p_d	p̪	VlLabioDentalStop
q_>	q’	VlUvularStopEjective
r\`	ɻ	VdRetroflexApproximant
s_>	s’	VlAlveolarFricativeEjective
t_>	t’	VlAveolarStopEjective
x_>	x’	VlVelarFricativeEjective
>_>	ʡ’	VlEpiglottalStopEjective
G_<	ʛ	VdUvularImplosiveClick
J_<	ʄ	VdPalatalImplosiveClick
n`_0	ɳ̊	VlRetroFlexNasal
p_>	ɸ’	VlBilabialFricativeEjective
s_>	ɕ’	VlPalatalFricativeEjective
s`_>	ʂ’	VlRetroflexFricativeEjective
t`_>	ʈ’	VlRetroflexStopEjective

| \ | \ ǁ	VlAlveolarTenuisLateralClick

Latin

Meaning	SAMPA	IPA	Sounds
I	ego:	egoː	ay-g-LongO
You	tu:	tuː	t-uu
We	no:s	noːs	n-LongO-s
One	u:nus	uːnus	uu-n-u-s
Two	duo	duo	d-u-oh
Person	perso:na	persoːna	p-ay-r-s-LongO-n-ah
Fish	piskis	piskis	p-e-s-k-e-s
Dog	kanis	kanis	k-ah-n-e-s
Louse	pedikulus	pedikulus	p-ay-d-e-k-u-l-u-s
Tree	arbor	arbor	ah-r-b-oh-r
Leaf	foly~u*	folỹũ	f-oh-l-ey-uh
Skin	kutis	kutis	k-u-t-e-s
Blood	sang_Wis	sangʷis	s-ah-n-gw-e-s
Bone	o:s	oːs	LongO-s
Horn	kornu:	kornuː	k-oh-r-n-uu
Ear	auris	auris	ah-u-r-e-s
Eye	okulus	okulus	oh-k-u-l-u-s
Nose	na:sus	naːsus	n-aye-s-u-s
Tooth	de:ns	deːns	d-ai-n-s
Tongue	liNgw~E	liŋgw̃ɛ	l-e-nya-g-wh-eh
Knee	genu:	genuː	g-ay-n-uu
Hand	manus	manus	m-ah-n-u-s
Breast	pektus	pektus	p-ay-k-t-u-s
Breast	mama	mama	m-ah-m-ah
Liver	jekur	jekur	jg-ay-k-u-r
Drink	bibere	bibere	b-e-b-ay-r-ay
See	wide:re	wideːre	w-e-d-ai-r-ay
Hear	audi:re	audiːre	ah-u-d-ee-r-ay
Die	mori:	moriː	m-oh-r-ee
Come	veni:re	veniːre	v-ay-n-ee-r-ay
Sun	so:5	soːɫ	s-LongO-ssha
Star	ste:la	steːla	s-t-ai-l-ah
Water	ak_Wa	akʷa	ah-kw-ah
Stone	lapis	lapis	l-ah-p-e-s
Fire	iNnis	iŋnis	e-nya-n-e-s
Path	wia	wia	w-e-ah
Mountain	mo:ns	moːns	m-LongO-n-s
Night	noks	noks	n-oh-k-s
Full	ple:nus	pleːnus	p-l-ai-n-u-s
New	nowus	nowus	n-oh-w-u-s
Name	no:men	noːmen	n-LongO-m-ay-n

Romanian

Meaning	SAMPA	IPA	Sounds
I	ew	ew	ay-w
You	tu	tu	t-u
We	noy	noy	n-oh-eeh
One	unu	unu	u-n-u
Two	doy	doy	d-oh-eeh
Person	om	om	oh-m
Fish	peSte	peʃte	p-ay-shh-t-ay
Dog	kaine	kaine	k-ah-e-n-ay
Louse	paduke	paduke	p-ah-d-u-k-ay
Tree	arbore	arbore	ah-r-b-oh-r-ay
Tree	pom	pom	p-oh-m
Leaf	frunz3	frunzɜ	f-r-u-n-zz-aeh
Skin	pyele	pyele	p-eeh-ay-l-ay
Blood	s3nje	sɜnje	s-aeh-n-jg-ay
Bone	os	os	oh-s
Horn	korn	korn	k-oh-r-n
Ear	ureke	ureke	u-r-ay-k-ay
Eye	oky	oky	oh-k-eeh
Nose	nas	nas	n-ah-s
Tooth	dinte	dinte	d-e-n-t-ay
Tongue	limb3	limbɜ	l-e-m-b-aeh
Knee	jenuNky	jenuŋky	jg-ay-n-u-nya-k-eeh
Hand	m3n3	mɜnɜ	m-aeh-n-aeh
Breast	s3n	sɜn	s-aeh-n
Liver	fikat	fikat	f-e-k-ah-t
Drink	bea	bea	b-ay-ah
See	vedea	vedea	v-ay-d-ay-ah
Hear	auzy	auzy	ah-u-zz-eeh
Die	mury	mury	m-u-r-eeh
Come	veny	veny	v-ay-n-eeh
Sun	soare	soare	s-oh-ah-r-ay
Star	stea	stea	s-t-ay-ah
Water	ap3	apɜ	ah-p-aeh
Stone	pyatr3	pyatrɜ	p-eeh-ah-t-r-aeh
Fire	fok	fok	f-oh-k
Path	cale	cale	tya-ah-l-ay
Mountain	munte	munte	m-u-n-t-ay
Night	noapte	noapte	n-oh-ah-p-t-ay
Full	plin	plin	p-l-e-n
New	now	now	n-oh-w
Name	nume	nume	n-u-m-ay

Catalan

Meaning	SAMPA	IPA	Sounds
I	Zo	ʒo	gzah-oh
You	tu	tu	t-u

We	nuzaltr3s	nuzaltrɜs	n-u-zz-ah-l-t-r-aeh-s
One	un	un	u-n
Two	dos	dos	d-oh-s
Person	p3rson3	pɜrsonɜ	p-aeh-r-s-oh-n-aeh
Fish	peS	peʃ	p-ay-shh
Dog	k3	kɜ	k-aeh
Louse	poL	poʎ	p-oh-yuh
Tree	abr3	abrɜ	ah-b-r-aeh
Leaf	fuL3	fuʎɜ	f-u-yuh-aeh
Skin	peL	peʎ	p-ay-yuh
Blood	saN	saŋ	s-ah-nya
Bone	os	os	oh-s
Horn	korn	korn	k-oh-r-n
Horn	ba53	bałɜ	b-ah-ssha-aeh
Ear	urEL3	urɛʎɜ	u-r-eh-yuh-aeh
Eye	uL	uʎ	u-yuh
Nose	nas	nas	n-ah-s
Tooth	den	den	d-ay-n
Tongue	LeNgw~3	ʎeŋgw̃ɜ	yuh-ay-nya-g-wh-aeh
Knee	j3noL	jɜnoʎ	jg-aeh-n-oh-yuh
Hand	ma	ma	m-ah
Breast	pit	pit	p-e-t
Liver	fej3	fejɜ	f-ay-jg-aeh
Drink	bEur3	bɛurɜ	b-eh-u-r-aeh
See	bEur3	bɛurɜ	b-eh-u-r-aeh
Hear	s3nti	sɜnti	s-aeh-n-t-e
Die	muri	muri	m-u-r-e
Come	b3ni	bɜni	b-aeh-n-e
Sun	sol	sol	s-oh-l
Star	3streL3	ɜstreʎɜ	aeh-s-t-r-ay-yuh-aeh
Water	aixw~3	aixw̃ɜ	ah-e-xha-wh-aeh
Stone	pe8r3	peɵrɜ	p-ay-ooh-r-aeh
Fire	fok	fok	f-oh-k
Path	k3mi	kɜmi	k-aeh-m-e
Mountain	mon	mon	m-oh-n
Night	nit	nit	n-e-t
Full	plE	plɛ	p-l-eh
New	nou	nou	n-oh-u
Name	nom	nom	n-oh-m

Portuguese

Meaning	SAMPA	IPA	Sounds
I	eu	eu	ay-u
You	tu	tu	t-u
We	noS	noʃ	n-oh-shh
One	u*	ũ	uh
Two	doiS	doiʃ	d-oh-e-shh

Person	pErzon	pɛrzon	p-eh-r-zz-oh-n
Fish	paiS3	paiʃɜ	p-ah-e-shh-aeh
Dog	ka*u*	kɐ̃ũ	k-ahn-uh
Louse	pioLu	pioʎu	p-e-oh-yuh-u
Tree	Ervur3	ɛrvurɜ	eh-r-v-u-r-aeh
Leaf	foLa	foʎa	f-oh-yuh-ah
Skin	pEl3	pɛlɜ	p-eh-l-aeh
Blood	sa*x3	sɐ̃xɜ	s-ahn-xha-aeh
Bone	osu	osu	oh-s-u
Horn	Sifr3	ʃifrɜ	shh-e-f-r-aeh
Ear	oraLa	oraʎa	oh-r-ah-yuh-ah
Eye	oLu	oʎu	oh-yuh-u
Nose	nariS	nariʃ	n-ah-r-e-shh
Tooth	de*t3	dẽtɜ	d-en-t-aeh
Tongue	li*gua	lĩgua	l-een-g-u-ah
Knee	ZuaLu	ʒuaʎu	gzah-u-ah-yuh-u
Hand	ma*u	mɐ̃u	m-ahn-u
Breast	saiuS	saiuʃ	s-ah-e-u-shh
Liver	fixa8u	fixaɵu	f-e-xha-ah-ooh-u
Drink	b3b	bɜb	b-aeh-b
See	ver	ver	v-ay-r
Hear	ov	ov	oh-v
Die	mur	mur	m-u-r
Come	vir	vir	v-e-r
Sun	sol	sol	s-oh-l
Star	3Strela	ɜʃtrela	aeh-shh-t-r-ay-l-ah
Water	Egw~a	ɛgw̃a	eh-g-wh-ah
Stone	pEdra	pɛdra	p-eh-d-r-ah
Fire	fogu	fogu	f-oh-g-u
Path	se*da	sẽda	s-en-d-ah
Mountain	mo*ta5a	mɔ̃tała	m-oon-t-ah-ssha-ah
Night	noyt3	noytɜ	n-oh-eeh-t-aeh
Full	Seyu	ʃeyu	shh-ay-eeh-u
New	novu	novu	n-oh-v-u
Name	nom3	nomɜ	n-oh-m-aeh

Spanish

Meaning	SAMPA	IPA	Sounds
I	yo	yo	eeh-oh
You	tu	tu	t-u
We	nosotros	nosotros	n-oh-s-oh-t-r-oh-s
This	este	este	ay-s-t-ay
That	ese	ese	ay-s-ay
That	akely~a	akelỹa	ah-k-ay-l-ey-ah
Who	kien	kien	k-e-ay-n
What	ke	ke	k-ay
Not	no	no	n-oh

All	todos	todos	t-oh-d-oh-s
Many	muCos	muços	m-u-sh-oh-s
One	uno	uno	u-n-oh
Two	dos	dos	d-oh-s
Big	grande	grande	g-r-ah-n-d-ay
Long	largo	largo	l-ah-r-g-oh
Small	peke5o	pekeło	p-ay-k-ay-ssha-oh
Small	Ciko	çiko	sh-e-k-oh
Woman	muher	muher	m-u-h-ay-r
Man	ombre	ombre	oh-m-b-r-ay
Person	persona	persona	p-ay-r-s-oh-n-ah
Fish	peskado	peskado	p-ay-s-k-ah-d-oh
Fish	pes	pes	p-ay-s
Bird	ave	ave	ah-v-ay
Bird	paharo	paharo	p-ah-h-ah-r-oh
Dog	pero	pero	p-ay-r-oh
Louse	pioho	pioho	p-e-oh-h-oh
Tree	arbol	arbol	ah-r-b-oh-l
Tree	palo	palo	p-ah-l-oh
Seed	semiya	semiya	s-ay-m-e-eeh-ah
Leaf	oha	oha	oh-h-ah
Root	rais	rais	r-ah-e-s
Bark	kortesa	kortesa	k-oh-r-t-ay-s-ah
Bark	kaskara	kaskara	k-ah-s-k-ah-r-ah
Skin	piel	piel	p-e-ay-l
Flesh	karne	karne	k-ah-r-n-ay
Blood	sangre	sangre	s-ah-n-g-r-ay
Bone	weso	weso	w-ay-s-oh
Grease	grasa	grasa	g-r-ah-s-ah
Egg	wevo	wevo	w-ay-v-oh
Horn	kw~erno	kw̃erno	k-wh-ay-r-n-oh
Tail	kola	kola	k-oh-l-ah
Tail	rabo	rabo	r-ah-b-oh
Feather	pluma	pluma	p-l-u-m-ah
Hair	pelo	pelo	p-ay-l-oh
Hair	cabeyo	cabeyo	tya-ah-b-ay-eeh-oh
Head	kabesa	kabesa	k-ah-b-ay-s-ah
Ear	oreha	oreha	oh-r-ay-h-ah
Eye	oho	oho	oh-h-oh
Nose	naris	naris	n-ah-r-e-s
Mouth	boka	boka	b-oh-k-ah
Tooth	diente	diente	d-e-ay-n-t-ay
Tongue	lengw~a	lengw̃a	l-ay-n-g-wh-ah
Claw	gara	gara	g-ah-r-ah
Foot	pie	pie	p-e-ay
Foot	pata	pata	p-ah-t-ah
Knee	rodiya	rodiya	r-oh-d-e-eeh-ah
Hand	mano	mano	m-ah-n-oh
Belly	bariga	bariga	b-ah-r-e-g-ah
Neck	kw~eyo	kw̃eyo	k-wh-ay-eeh-oh

Neck	peskw~eso	peskw̃eso	p-ay-s-k-wh-ay-s-oh
Breast	peCo	peço	p-ay-sh-oh
Breast	seno	seno	s-ay-n-oh
Heart	korason	korason	k-oh-r-ah-s-oh-n
Liver	igado	igado	e-g-ah-d-oh
Drink	bebe	bebe	b-ay-b-ay
Eat	kome	kome	k-oh-m-ay
Bite	morde	morde	m-oh-r-d-ay
See	ve	ve	v-ay
Hear	oir	oir	oh-e-r
Know	sabe	sabe	s-ah-b-ay
Know	konose	konose	k-oh-n-oh-s-ay
Sleep	dormi	dormi	d-oh-r-m-e
Die	mori	mori	m-oh-r-e
Kill	mata	mata	m-ah-t-ah
Swim	nada	nada	n-ah-d-ah
Fly	vola	vola	v-oh-l-ah
Walk	anda	anda	ah-n-d-ah
Walk	kamina	kamina	k-ah-m-e-n-ah
Come	veni	veni	v-ay-n-e
Lie	akosta	akosta	ah-k-oh-s-t-ah
Lie	eCa	eça	ay-sh-ah
Sit	senta	senta	s-ay-n-t-ah
Stand	esta de pie	esta de pie	ay-s-t-ah- -d-ay- -p-e-ay
Give	da	da	d-ah
Say	desi	desi	d-ay-s-e
Sun	sol	sol	s-oh-l
Moon	luna	luna	l-u-n-ah
Star	estreya	estreya	ay-s-t-r-ay-eeh-ah
Water	agw~a	agw̃a	ah-g-wh-ah
Rain	yuvia	yuvia	eeh-u-v-e-ah
Stone	piedra	piedra	p-e-ay-d-r-ah
Sand	arena	arena	ah-r-ay-n-ah
Earth	tiera	tiera	t-e-ay-r-ah
Cloud	nube	nube	n-u-b-ay
Smoke	humo	humo	h-u-m-oh
Fire	fuego	fuego	f-u-ay-g-oh
Ash	senisa	senisa	s-ay-n-e-s-ah
Burn	kema	kema	k-ay-m-ah
Burn	arde	arde	ah-r-d-ay
Path	senda	senda	s-ay-n-d-ah
Mountain	sero	sero	s-ay-r-oh
Mountain	monta5a	montała	m-oh-n-t-ah-ssha-ah
Red	roho	roho	r-oh-h-oh
Red	kolorado	kolorado	k-oh-l-oh-r-ah-d-oh
Green	verde	verde	v-ay-r-d-ay
Yellow	amariyo	amariyo	ah-m-ah-r-e-eeh-oh
White	blanko	blanko	b-l-ah-n-k-oh
Black	negro	negro	n-ay-g-r-oh
Night	noCe	noçe	n-oh-sh-ay

Hot	kaliente	kaliente	k-ah-l-e-ay-n-t-ay
Cold	frio	frio	f-r-e-oh
Full	yeno	yeno	eeh-ay-n-oh
New	nuevo	nuevo	n-u-ay-v-oh
Good	bw~eno	bw̃eno	b-wh-ay-n-oh
Round	redondo	redondo	r-ay-d-oh-n-d-oh
Dry	seko	seko	s-ay-k-oh
Name	nombre	nombre	n-oh-m-b-r-ay

French

Meaning	SAMPA	IPA	Sounds
I	j3	jɜ	jg-aeh
You	ti	ti	t-e
We	nu	nu	n-u
This	s3si	sɜsi	s-aeh-s-e
That	s3la	sɜla	s-aeh-l-ah
Who	ki	ki	k-e
What	kwa	kwa	k-w-ah
Not	n3 pa	nɜ pa	n-aeh- -p-ah
All	tu	tu	t-u
Many	boku	boku	b-oh-k-u
One	oe*	œ̃	uuh
Two	de	de	d-ay
Big	gra*	grẽ	g-r-ahn
Long	lo*	lɔ̃	l-oon
Small	p3ti	pɜti	p-aeh-t-e
Woman	fam	fam	f-ah-m
Man	om	om	oh-m
Person	om	om	oh-m
Fish	pw~aso*	pw̃asɔ̃	p-wh-ah-s-oon
Bird	wazo	wazo	w-ah-zz-oh
Dog	Sia*	ʃiẽ	shh-e-ahn
Louse	pu	pu	p-u
Tree	arbr3	arbrɜ	ah-r-b-r-aeh
Seed	gran	gran	g-r-ah-n
Leaf	f3y	fɜy	f-aeh-eeh
Root	rasin	rasin	r-ah-s-e-n
Bark	ekors	ekors	ay-k-oh-r-s
Skin	po	po	p-oh
Flesh	vy~a*d	vỹẽd	v-ey-ahn-d
Blood	sa*	sẽ	s-ahn
Bone	os	os	oh-s
Grease	grais	grais	g-r-ah-e-s
Egg	3f	ɜf	aeh-f
Horn	korn	korn	k-oh-r-n
Tail	ke	ke	k-ay
Feather	ply~m	plỹm	p-l-ey-m

Hair	S3ve	ʃɜve	shh-aeh-v-ay
Head	t3t	tɜt	t-aeh-t
Ear	ore	ore	oh-r-ay
Eye	3y	ɜy	aeh-eeh
Nose	ne	ne	n-ay
Mouth	buS	buʃ	b-u-shh
Tooth	da*	dɛ̃	d-ahn
Tongue	la*g	lɛ̃g	l-ahn-g
Claw	o*gl	ɔ̃gl	oon-g-l
Foot	py~e	pỹe	p-ey-ay
Knee	j3nu	jɜnu	jg-aeh-n-u
Hand	ma*	mɛ̃	m-ahn
Belly	va*tr	vɛ̃tr	v-ahn-t-r
Neck	ku	ku	k-u
Breast	pw~atrin	pw̃atrin	p-wh-ah-t-r-e-n
Heart	k3r	kɜr	k-aeh-r
Liver	fw~a	fw̃a	f-wh-ah
Drink	bw~a	bw̃a	b-wh-ah
Eat	ma*g	mɛ̃g	m-ahn-g
Bite	mord	mord	m-oh-r-d
See	vw~a	vw̃a	v-wh-ah
Hear	o*ta*dr	ɔ̃tɛ̃dr	oon-t-ahn-d-r
Know	savw~a	savw̃a	s-ah-v-wh-ah
Sleep	dormi	dormi	d-oh-r-m-e
Die	muri	muri	m-u-r-e
Kill	tue	tue	t-u-ay
Swim	naje	naje	n-ah-jg-ay
Fly	vw~ale	vw̃ale	v-wh-ah-l-ay
Walk	marSe	marʃe	m-ah-r-shh-ay
Come	v3ni	vɜni	v-aeh-n-e
Lie	seta*dr	setɛ̃dr	s-ay-t-ahn-d-r
Lie	etra*da*dE	etrɛ̃dɛ̃dɛ	ay-t-r-ahn-d-ahn-d-eh
Sit	sasw~a	sasw̃a	s-ah-s-wh-ah
Sit	etrasi	etrasi	ay-t-r-ah-s-e
Stand	s3l3ve	sɜlɜve	s-aeh-l-aeh-v-ay
Stand	s3t3nird3vu	sɜtɜnirdɜvu	s-aeh-t-aeh-n-e-r-d-aeh-v-u
Give	done	done	d-oh-n-ay
Say	di	di	d-e
Sun	sole	sole	s-oh-l-ay
Moon	len	len	l-ay-n
Star	etw~ol	etw̃ol	ay-t-wh-oh-l
Water	o	o	oh
Rain	plui	plui	p-l-u-e
Stone	py~er	pỹer	p-ey-ay-r
Sand	sabl	sabl	s-ah-b-l
Earth	ter	ter	t-ay-r
Cloud	nuaj	nuaj	n-u-ah-jg
Smoke	fEme	fɛme	f-eh-m-ay
Fire	fe	fe	f-ay
Ash	sa*dr	sɛ̃dr	s-ahn-d-r

Burn	brule	brule	b-r-u-l-ay
Path	rut	rut	r-u-t
Mountain	mo*taj	mɔ̃taj	m-oon-t-ah-jg
Red	ruj	ruj	r-u-jg
Green	ver	ver	v-ay-r
Yellow	jon	jon	jg-oh-n
White	bla*	blɛ̃	b-l-ahn
Black	nw~ar	nw̃ar	n-wh-ah-r
Night	nui	nui	n-u-e
Hot	So	ʃo	shh-oh
Cold	fr~wa	fr̃wa	f-rn-w-ah
Full	pl3*	plɜ̃	p-l-aehn
New	nuvo	nuvo	n-u-v-oh
Good	bo*	bɔ̃	b-oon
Round	ro*	rɔ̃	r-oon
Dry	s3k	sɜk	s-aeh-k
Name	no*	nɔ̃	n-oon

Walloon

Meaning	SAMPA	IPA	Sounds
I	Ce	çe	sh-ay
You	te	te	t-ay
We	nos	nos	n-oh-s
One	E*	ɛ̃	ehnn
Person	o*m	ɔ̃m	oon-m
Dog	Ce*	çẽ	sh-en
Skin	pow	pow	p-oh-w
Ear	oreye	oreye	oh-r-ay-eeh-ay
Eye	ui	ui	u-e
Drink	bwEr	bwɛr	b-w-eh-r
Hear	Sute	ʃute	shh-u-t-ay
Die	murrir	murrir	m-u-r-r-e-r
Come	vnir	vnir	v-n-e-r
Star	twEl	twɛl	t-w-eh-l
Water	Ew3	ɛwɜ	eh-w-aeh
Fire	fE	fɛ	f-eh
Path	vwa*y	vwɛ̃y	v-w-ahn-eeh
Full	pli*	plĩ	p-l-een
New	novEl	novɛl	n-oh-v-eh-l

Romansh

Meaning	SAMPA	IPA	Sounds
I	yaw	yaw	eeh-ah-w
You	ti	ti	t-e
We	nus	nus	n-u-s

One	en	en	ay-n
Two	dus	dus	d-u-s
Person	k3rSTawn	kɜrʃθawn	k-aeh-r-shh-th-ah-w-n
Fish	peS	peʃ	p-ay-shh
Dog	Tawn	θawn	th-ah-w-n
Louse	pluL	pluʎ	p-l-u-yuh
Tree	plant3	plantɜ	p-l-ah-n-t-aeh
Leaf	feL	feʎ	f-ay-yuh
Skin	pel	pel	p-ay-l
Blood	saNk	saŋk	s-ah-nya-k
Bone	os	os	oh-s
Horn	korn3	kornɜ	k-oh-r-n-aeh
Ear	ureL3	ureʎɜ	u-r-ay-yuh-aeh
Eye	eL	eʎ	ay-yuh
Nose	nas	nas	n-ah-s
Tooth	dEnt	dɛnt	d-eh-n-t
Tongue	lyewNg3	lyewŋgɜ	l-eeh-ay-w-nya-g-aeh
Knee	Z3neye	ʒɜneye	gzah-aeh-n-ay-eeh-ay
Hand	mawn	mawn	m-ah-w-n
Breast	pET	pɛθ	p-eh-th
Liver	5irom	ɫirom	ssha-e-r-oh-m
Drink	bayv3r	bayvɜr	b-ah-eeh-v-aeh-r
See	v3zayr	vɜzayr	v-aeh-zz-ah-eeh-r
Hear	udir	udir	u-d-e-r
Die	murir	murir	m-u-r-e-r
Come	v35ir	vɜɫir	v-aeh-ssha-e-r
Sun	suleL	suleʎ	s-u-l-ay-yuh
Star	Stayl3	ʃtaylɜ	shh-t-ah-eeh-l-aeh
Water	aw3	awɜ	ah-w-aeh
Stone	krap	krap	k-r-ah-p
Fire	fyew	fyew	f-eeh-ay-w
Path	vi3	viɜ	v-e-aeh
Mountain	munto53	muntoɫɜ	m-u-n-t-oh-ssha-aeh
Night	noT	noθ	n-oh-th
Full	playn	playn	p-l-ah-eeh-n
New	nof	nof	n-oh-f
Name	num	num	n-u-m

Friulian

Meaning	SAMPA	IPA	Sounds
I	yo	yo	eeh-oh
You	tu	tu	t-u
We	nou	nou	n-oh-u
One	uN	uŋ	u-nya
Two	doi	doi	d-oh-e
Person	pErsoN	pɛrsoŋ	p-eh-r-s-oh-nya
Fish	pes	pes	p-ay-s

Dog	ky~aN	kỹaŋ	k-ey-ah-nya
Louse	pEdoli	pɛdoli	p-eh-d-oh-l-e
Tree	arbul	arbul	ah-r-b-u-l
Leaf	fw~eE	fw̃eɛ	f-wh-ay-eh
Skin	py~el	pỹel	p-ey-ay-l
Blood	saNk	saŋk	s-ah-nya-k
Bone	vw~es	vw̃es	v-wh-ay-s
Horn	kw~ar	kw̃ar	k-wh-ah-r
Ear	oreli	oreli	oh-r-ay-l-e
Eye	voli	voli	v-oh-l-e
Nose	nas	nas	n-ah-s
Tooth	dint	dint	d-e-n-t
Tongue	leNgE	leŋgɛ	l-ay-nya-g-eh
Knee	zEnoli	zɛnoli	zz-eh-n-oh-l-e
Knee	jEnoli	jɛnoli	jg-eh-n-oh-l-e
Hand	man	man	m-ah-n
Breast	pet	pet	p-ay-t
Liver	fiat	fiat	f-e-ah-t
Liver	fy~at	fỹat	f-ey-ah-t
Drink	bevi	bevi	b-ay-v-e
See	viodi	viodi	v-e-oh-d-e
See	vy~odi	vỹodi	v-ey-oh-d-e
Hear	sintei	sintei	s-e-n-t-ay-e
Die	murei	murei	m-u-r-ay-e
Come	vi5ei	viłei	v-e-ssha-ay-e
Sun	soreli	soreli	s-oh-r-ay-l-e
Star	stelE	stelɛ	s-t-ay-l-eh
Water	agE	agɛ	ah-g-eh
Stone	py~erE	pỹerɛ	p-ey-ay-r-eh
Fire	fuk	fuk	f-u-k
Path	stradE	stradɛ	s-t-r-ah-d-eh
Mountain	mont	mont	m-oh-n-t
Mountain	monta5E	montałɛ	m-oh-n-t-ah-ssha-eh
Night	5ot	łot	ssha-oh-t
Full	plen	plen	p-l-ay-n
New	5uf	łuf	ssha-u-f
Name	non	non	n-oh-n

Italian

Meaning	SAMPA	IPA	Sounds
I	io	io	e-oh
You	tu	tu	t-u
We	noi	noi	n-oh-e
One	uno	uno	u-n-oh
Two	due	due	d-u-ay
Person	persona	persona	p-ay-r-s-oh-n-ah
Fish	peSe	peʃe	p-ay-shh-ay

Dog	kane	kane	k-ah-n-ay
Louse	pidokky~o	pidokkỹo	p-e-d-oh-k-k-ey-oh
Tree	albero	albero	ah-l-b-ay-r-oh
Leaf	foLa	foʎa	f-oh-yuh-ah
Skin	pElle	pɛlle	p-eh-l-l-ay
Blood	saNgwe	saŋgwe	s-ah-nya-g-w-ay
Bone	osso	osso	oh-s-s-oh
Horn	korno	korno	k-oh-r-n-oh
Ear	orekkyo	orekkyo	oh-r-ay-k-k-eeh-oh
Eye	okkyo	okkyo	oh-k-k-eeh-oh
Nose	naso	naso	n-ah-s-oh
Tooth	dante	dante	d-ah-n-t-ay
Tongue	liNgwa	liŋgwa	l-e-nya-g-w-ah
Knee	jinokkyo	jinokkyo	jg-e-n-oh-k-k-eeh-oh
Hand	mano	mano	m-ah-n-oh
Breast	pEtto	pɛtto	p-eh-t-t-oh
Liver	fegato	fegato	f-ay-g-ah-t-oh
Drink	bere	bere	b-ay-r-ay
See	ved	ved	v-ay-d
Hear	ud	ud	u-d
Die	mor	mor	m-oh-r
Come	vEn	vɛn	v-eh-n
Sun	sole	sole	s-oh-l-ay
Star	stella	stella	s-t-ay-l-l-ah
Water	akwa	akwa	ah-k-w-ah
Stone	pyEtra	pyɛtra	p-eeh-eh-t-r-ah
Fire	fwoko	fwoko	f-w-oh-k-oh
Path	sentyaro	sentyaro	s-ay-n-t-eeh-ah-r-oh
Mountain	monta5a	montała	m-oh-n-t-ah-ssha-ah
Night	notte	notte	n-oh-t-t-ay
Full	pyEno	pyɛno	p-eeh-eh-n-oh
New	nwovo	nwovo	n-w-oh-v-oh
Name	nome	nome	n-oh-m-ay

```
#NEXUS
begin taxa;
  dimensions ntax=15;
  taxlabels Latin Nuorese Cagliari Romanian Arumanian Walloon French Provencal
Portuguese Spanish Catalan Ladin Friulian Romansh Italian;
end;

begin trees;
  tree LanguageTree = (Latin:0.81,((Nuorese:411.2,Cagliari:410.52):755.27,((
Romanian:526.1,Arumanian:526.97):579.53,((((Walloon:200.55,French:192.63):
243.09,Provencal:437.74):333.32,((Portuguese:369.61,Spanish:369.4):256.8,
Catalan:626.07):146.55):133.85,((Ladin:582.91,(Friulian:403.47,Romansh:403.37):
180.58):178.13,Italian:760.59):144.66):199.54):60.6):958.67):1324.32;
end;
```

English.nytril

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    with Lang
      let Separator           = ", "
      let Abstract            = "Abstract"
      let Affricate           = "Affricate"
      let Affricates          = "Affricates"
      let Alveolar            = "Alveolar"
      let AlveoloPalatal      = "Alveolo-Palatal"
      let And                 = "and"
      let Appendices          = "Appendices"
      let Appendix            = "Appendix"
      let Approximant         = "Approximant"
      let Approximants        = "Approximants"
      let Authors             = "Authors"
      let AvailableAt         = "Available at"
      let Back                = "Back"
      let Bilabial            = "Bilabial"
      let Category            = "Category"
      let Categories          = "Categories"
      let Central             = "Central"
      let Click               = "Click"
      let Close               = "Close"
      let CloseMid            = "Close-mid"
      let Conclusion          = "Conclusion"
      let Consonant           = "Consonant"
      let Consonants          = "Consonants"
      let Continuant          = "Continuant"
      let Continuants         = "Continuants"
      let Coronal             = "Coronal"
      let Dental              = "Dental"
      let Dorsal              = "Dorsal"
      let Diacritic           = "Diacritic"
      let Diacritics          = "Diacritics"
      let Ejective            = "Ejective"
      let EMail               = "E-mail"
      let EjectiveAffricates = "Ejective Affricates"
      let Feature             = "Feature"
      let Features            = "Features"
      let Fricative           = "Fricative"
      let Fricatives          = "Fricatives"
      let Front               = "Front"
      let Glottal             = "Glottal"
      let Implosive           = "Implosive"
      let Impossible          = "Impossible"
      let ImpossibleShaded    = "Shaded areas denote articulations judged to be impossible."
      let Introduction        = "Introduction"
      let IPA                 = "IPA"
      let IPAListing          = "IPA Segments"
      let IPAFullName         = "International Phonetic Alphabet"
      let Labial              = "Labial"
      let LabioDental         = "Labio-Dental"
      let LabialPalatal       = "Labial-Palatal"
      let LabialVelar         = "Labial-Velar"
      let LinguoLabial        = "Linguo-Labial"
      let Laryngeal           = "Laryngeal"
      let Language            = "Language"
      let LanguagePhylogeny   = "Language Tree"
      let LanguageList        = "List of Languages"
      let Lateral             = "Lateral"
      let Laterals            = "Laterals"
      let Liquid              = "Liquid"
      let Liquids             = "Liquids"
      let LongVowel           = "Long"
      let LongVowels          = "Long Vowels"
      let Manner              = "Manner"
      let Manners             = "Manners"
      let Meaning             = "Meaning"
      let Meanings            = "Meanings"
      let Methods             = "Methods"
      let Mid                 = "Mid"
```

```
  let Name                 = "Name"
  let Nasal                = "Nasal"
  let Nasals               = "Nasals"
  let NearBack             = "Near-Back"
  let NearClose            = "Near-close"
  let NearFront            = "Near-Front"
  let NearOpen             = "Near-open"
  let NoFeatures           = "No Features"
  let NonIPA               = "NonIPA"
  let NonSibilant          = "Non-Sibilant"
  let NonPulmonic          = "Non-Pulmonic"
  let NPConsonants         = "Non-Pulmonic Consonants"
  let NytrilSourceCode     = "Nytril Source Code"
  let Obstruent            = "Obstruent"
  let Obstruents           = "Obstruents"
  let Occlusive            = "Occlusive"
  let Occlusives           = "Occlusives"
  let Open                 = "Open"
  let OpenMid              = "Open-mid"
  let Or                   = "or"
  let OtherSegments        = "Other Segments"
  let Pharyngeal           = "Pharyngeal-Epiglottal"
  let Pulmonic             = "Pulmonic"
  let PConsonants          = "Pulmonic Consonants"
  let Palatal              = "Palatal"
  let PalatoAlveolar       = "Palato-Alveolar"
  let Place                = "Place"
  let Places               = "Places"
  let Plosive              = "Plosive"
  let Plosives             = "Plosives"
  let Property             = "Property"
  let PostAlveolar         = "Post-Alveolar"
  let PulmonicAffricates = "Pulmonic Affricates"
  let Puncuation           = "Puncuation"
  let References           = "References"
  let Retroflex            = "Retroflex"
  let Rhotic               = "Rhotic"
  let Rhotics              = "Rhotics"
  let Rounded              = "Rounded"
  let Sampa                = "SAMPA"
  let Segment              = "Segment"
  let Segments             = "Segments"
  let SemiVowel            = "Semivowel"
  let SemiVowels           = "Semivowels"
  let Sibilant             = "Sibilant"
  let Sibilants            = "Sibilants"
  let Sounds               = "Sounds"
  let Stop                 = "Stop"
  let Strident             = "Strident"
  let Stridents            = "Stridents"
  let SymbolPairVoiced     = "Where symbols appear in pairs, the one to the right represents a modally voiced
consonant."
  let SymbolPairRounded    = "Where symbols appear in pairs, the one to the right represents a rounded vowel."
  let TapFlap              = "Tap/Flap"
  let TapFlaps             = "Tap/Flaps"
  let Tenuis               = "Tenuis"
  let Text                 = "Text"
  let Trill                = "Trill"
  let Trills               = "Trills"
  let Unrounded            = "Unrounded"
  let Uvular               = "Uvular"
  let Velar                = "Velar"
  let Velarized            = "Velarized"
  let Vocoid               = "Vocoid"
  let Vibrant              = "Vibrant"
  let Vibrants             = "Vibrants"
  let Vocoids              = "Vocoids"
  let Voiced               = "Voiced"
  let Voiceless            = "Voiceless"
  let Vowel                = "Vowel"
  let Vowels               = "Vowels"
  let Word                 = "Word"
  let Years                = "Years"
end
```

Library.nytril

```
using Format, Units, Math, IO
//======================================================================

with TreeLib
  let GetNodeLabel(node) = node.Data?.SymbolName

  let VisitNodeTaxa(set, node) begin
    set.AddReference(node.Data);
    VisitNodeTaxa(set, each node);
  end

  let GetTaxaLabels(tree) begin
    var set = Type.Dictionary(256);
    VisitNodeTaxa(set, tree);
    return (each set.ValueList).SymbolName;
  end
end
//======================================================================

with Nexus
  let CharacterList = ('A'..'Z' step 1) + ('a'..'z' step 1) + ('0'..'9' step 1)
  let EndMarker     = ";"
  let Missing       = "?"
  let Quote         = "\""

  let Keyword(name) = Span {
    TextColor: Colors.Blue,
    name
  }

  let Comment(text) = Span {
    TextColor: Colors.Green,
    "#"
    text
  }

  let AddLine(name) = Span {
    Keyword(name),
    End: EndMarker,
  }

  let AddValue(name, value) = Span {
    Space,
    Keyword(name),
    "=",
    value,
  }

  let Scope(name) = TextBlock {
    IndentSpace: 2,
    Begin: Span {
      Keyword("begin"),
      Space,
      name,
      EndMarker,
    },
    End: Span {
      Keyword("end"),
      EndMarker,
    },
  }

  let NexusFile = TextBlock {
    Comment("NEXUS"),
  }

  let Newick(node) = Span {
    if (node.Length > 0)
      "(",
      Span {
        Separator: ",",
        Newick(each node)
      },
      ")",
    end,
    TreeLib.GetNodeLabel(node),
    ":",
    node.Branch
  }

  let ShowTreeLine(ref tree) = Span {
    "tree ",
    tree.SymbolName,
    " = ",
    Newick(tree),
    EndMarker
  }

  let TreeFormat(taxa) = NexusFile {
    Scope("taxa") {
      AddLine("dimensions") {
        AddValue("ntax", taxa.Length),
      },
      AddLine("taxlabels") {
        Space,
        Span {
          Separator: Space,
          taxa,
        },
      },
    }
  }

  let TreeFile(ref tree) = TreeFormat(TreeLib.GetTaxaLabels(tree)) {
    Scope("trees") {
      ShowTreeLine(ref tree),
    }
  }

  let ShowTaxon(maxlength, taxon, range) = Span {
    taxon.Name,
    Space * (maxlength - taxon.Name.Length),
    IPA.ShowCharacter(each taxon.Characters[range])
  }

  let ShowTaxonSet(maxlength, taxa, range) = {
    ShowTaxon(maxlength, each taxa, range),
    Empty,
  }

  let CharacterFile(taxa) begin
    var maxlength = Math.Max((each taxa).Name.Length)+1;
    var total     = taxa[0].Characters.Length;
    return NexusFile {
      Scope("DATA") {
        AddLine("dimensions") {
          AddValue("ntax", taxa.Length),
          AddValue("nchar", total),
        },
        AddLine("format") {
          AddValue("datatype", "STANDARD"),
          AddValue("gap", IPA.GapSegment.Text),
          AddValue("missing", Missing),
          AddValue("symbols", Span {Quote, CharacterList[Results.UniqueSegments.IndexRange], Quote}),
        },
        Empty,
        Keyword("matrix"),
        ShowTaxonSet(maxlength, taxa, each ((0..<total) / (70 - maxlength))),
        EndMarker,
      }
    }
  end
end
//========================================================================
```

Languages.nytril

```
let AddLanguage(name, cases=0, words=null) = {
  Name: name,
  Cases: cases,
  Words: words,
}

with Languages
  let Old_Irish          = AddLanguage("Old Irish", 5)
  let Irish              = AddLanguage("Irish", 4)
  let Scots_Gaelic       = AddLanguage("Scots Gaelic", 4)
  let Welsh              = AddLanguage("Welsh")
  let Breton             = AddLanguage("Breton")
  let Cornish            = AddLanguage("Cornish")
  let Latin              = AddLanguage("Latin", 6, WordList.Latin)
  let Nuorese            = AddLanguage("Nuorese")
  let Cagliari           = AddLanguage("Cagliari")
  let Romanian           = AddLanguage("Romanian", 3, WordList.Romanian)
  let Arumanian          = AddLanguage("Arumanian", 3)
  let Catalan            = AddLanguage("Catalan", 0, WordList.Catalan)
  let Portuguese         = AddLanguage("Portuguese", 0, WordList.Portuguese)
  let Spanish            = AddLanguage("Spanish", 0, WordList.Spanish)
  let French             = AddLanguage("French", 0, WordList.French)
  let Provencal          = AddLanguage("Provencal")
  let Walloon            = AddLanguage("Walloon", 0, WordList.Walloon)
  let Ladin              = AddLanguage("Ladin")
  let Romansh            = AddLanguage("Romansh", 0, WordList.Romansh)
  let Friulian           = AddLanguage("Friulian", 0, WordList.Friulian)
  let Italian            = AddLanguage("Italian", 0, WordList.Italian)
  let Gothic             = AddLanguage("Gothic", 5)
  let Old_West_Norse     = AddLanguage("Old West Norse", 4)
  let Icelandic          = AddLanguage("Icelandic", 4)
  let Faroese            = AddLanguage("Faroese", 4)
  let Norwegian          = AddLanguage("Norwegian", 2)
  let Swedish            = AddLanguage("Swedish", 2)
  let Danish             = AddLanguage("Danish", 2)
  let Old_English        = AddLanguage("Old English", 4)
  let English            = AddLanguage("English")
  let Frisian            = AddLanguage("Frisian", 2)
  let Old_High_German    = AddLanguage("Old High German", 5)
  let German             = AddLanguage("German", 4)
  let Luxembourgish      = AddLanguage("Luxembourgish", 3)
  let Swiss_German       = AddLanguage("Swiss German", 3)
  let Dutch              = AddLanguage("Dutch", 2)
  let Flemish            = AddLanguage("Flemish", 2)
  let Afrikaans          = AddLanguage("Afrikaans")
  let Tosk               = AddLanguage("Tosk", 4)
  let Arvanitika         = AddLanguage("Arvanitika", 4)
  let Ancient_Greek      = AddLanguage("Ancient Greek", 5)
  let Modern_Greek       = AddLanguage("Modern Greek", 4)
  let Classical_Armenian = AddLanguage("Classical Armenian", 7)
  let Eastern_Armenian   = AddLanguage("Eastern Armenian", 7)
  let Adapazar           = AddLanguage("Adapazar")
  let Old_Prussian       = AddLanguage("Old Prussian", 5)
  let Lithuanian         = AddLanguage("Lithuanian", 7)
  let Latvian            = AddLanguage("Latvian", 7)
  let Czech              = AddLanguage("Czech", 7)
  let Slovak             = AddLanguage("Slovak", 6)
  let Polish             = AddLanguage("Polish", 7)
  let Lower_Sorbian      = AddLanguage("Lower Sorbian", 6)
  let Upper_Sorbian      = AddLanguage("Upper Sorbian", 6)
  let Ukrainian          = AddLanguage("Ukrainian", 7)
  let Belarusian         = AddLanguage("Belarusian", 6)
  let Russian            = AddLanguage("Russian", 6)
  let Slovenian          = AddLanguage("Slovenian", 6)
  let Macedonian         = AddLanguage("Macedonian")
  let Bulgarian          = AddLanguage("Bulgarian", 2)
  let Serbian            = AddLanguage("Serbian", 7)
  let Old_Church_Slavic  = AddLanguage("Old Church Slavic", 7)
  let Avestan            = AddLanguage("Avestan", 8)
  let Pashto             = AddLanguage("Pashto", 4)
  let Waziri             = AddLanguage("Waziri")
  let Tajik              = AddLanguage("Tajik")
```

```
    let Persian             = AddLanguage("Persian")
    let Sogdian             = AddLanguage("Sogdian", 6)
    let Wakhi               = AddLanguage("Wakhi", 4 /* ? */)
    let Baluchi             = AddLanguage("Baluchi", 3)
    let Kurdish             = AddLanguage("Kurdish", 4)
    let Zazaki              = AddLanguage("Zazaki", 2)
    let Shughni             = AddLanguage("Shughni", 5)
    let Sariqoli            = AddLanguage("Sariqoli", 2)
    let Digor_Ossetic       = AddLanguage("Digor Ossetic", 9)
    let Vedic_Sanskrit      = AddLanguage("Vedic Sanskrit", 8)
    let Nepali              = AddLanguage("Nepali")
    let Assamese            = AddLanguage("Assamese", 6)
    let Oriya               = AddLanguage("Oriya", 3)
    let Bengali             = AddLanguage("Bengali", 4)
    let Bihari              = AddLanguage("Bihari", 5)
    let Marwari             = AddLanguage("Marwari")
    let Hindi               = AddLanguage("Hindi", 3)
    let Urdu                = AddLanguage("Urdu", 3)
    let Sindhi              = AddLanguage("Sindhi", 5)
    let Lahnda              = AddLanguage("Lahnda")
    let Panjabi             = AddLanguage("Panjabi", 5)
    let Gujarati            = AddLanguage("Gujarati", 3)
    let Marathi             = AddLanguage("Marathi", 8)
    let Kashmiri            = AddLanguage("Kashmiri", 5)
    let Singhalese          = AddLanguage("Singhalese", 8)
    let Romani              = AddLanguage("Romani", 3)
    let Tocharian_A         = AddLanguage("Tocharian A", 3)
    let Tocharian_B         = AddLanguage("Tocharian B", 3)
    let Hittite             = AddLanguage("Hittite", 8)
  end
  //======================================================================
```

LanguageTree.nytril

```
  using Format, Languages
  //======================================================================

  with LanguageBranches
    let Branch(branch) = Node {
      Branch: branch
    }

    let Leaf(ref language, branch) = Node {
      Data: ref language,
      Branch: branch,
      Label: language.Name
    }

    let Romance = Branch(1324.32) {
      Leaf(Latin, 0.81),
      Branch(958.67) {
        Branch(755.27) {
          Leaf(Nuorese, 411.20),
          Leaf(Cagliari, 410.52),
        },
        Branch(60.60) {
          Branch(579.53) {
            Leaf(Romanian, 526.10),
            Leaf(Arumanian, 526.97),
          },
          Branch(199.54) {
            Branch(133.85) {
              Branch(333.32) {
                Branch(243.09) {
                  Leaf(Walloon, 200.55),
                  Leaf(French, 192.63),
                },
                Leaf(Provencal, 437.74),
              },
              Branch(146.55) {
                Branch(256.80) {
                  Leaf(Portuguese, 369.61),
                  Leaf(Spanish, 369.40),
                },
                Leaf(Catalan, 626.07),
              }
            },
            Branch(144.66) {
              Branch(178.13) {
                Leaf(Ladin, 582.91),
                Branch(180.58) {
                  Leaf(Friulian, 403.47),
                  Leaf(Romansh, 403.37),
                }
              },
              Leaf(Italian, 760.59),
            }
          }
        }
      }
    }

    let Germanic = Branch(443.50) {
      Branch(117.63) {
        Branch(164.08) {
          Branch(870.92) {
            Branch(240.05) {
              Branch(56.52) {
                Leaf(Afrikaans, 220.24),
                Leaf(Flemish, 219.03),
              },
              Leaf(Dutch, 276.86),
            },
            Leaf(Frisian, 517.80),
          },
          Branch(269.41) {
            Leaf(Old_High_German, 0.83),
            Branch(802.11) {
              Branch(89.71) {
                Leaf(Luxembourgish, 228.81),
                Leaf(Swiss_German, 226.19),
              },
              Leaf(German, 314.20),
            }
          }
        },
        Branch(573.40) {
          Leaf(Old_English, 0.81),
          Leaf(English, 1004.03),
        }
      },
      Branch(538.29) {
        Branch(358.92) {
          Leaf(Old_West_Norse, 0.84),
          Branch(383.13) {
            Branch(92.51) {
              Leaf(Faroese, 295.58),
              Leaf(Icelandic, 295.91),
            },
            Leaf(Norwegian, 391.20),
          }
        },
        Branch(633.39) {
          Leaf(Swedish, 497.87),
          Leaf(Danish, 497.35),
        }
      }
    }

    let ChangA3 = Node {
      Branch(665.23) {
        Branch(503.96) {
          Branch(256.63) {
            Branch(129.51) {
              Branch(1949.74) {
                Branch(910.55) {
                  Leaf(Old_Prussian, 1020.97),
                  Branch(629.79) {
                    Leaf(Lithuanian, 917.14),
                    Leaf(Latvian, 917.35),
                  }
                },
                Branch(1229.90) {
                  Branch(499.40) {
                    Branch(81.74) {
                      Leaf(Polish, 646.17),
                      Branch(171.47) {
                        Branch(403.76) {
                          Leaf(Upper_Sorbian, 69.87),
                          Leaf(Lower_Sorbian, 71.70),
                        },
                        Branch(206.18) {
                          Leaf(Czech, 267.53),
                          Leaf(Slovak, 268.56),
                        }
                      }
                    },
                    Branch(129.04) {
                      Branch(144.63) {
                        Leaf(Ukrainian, 454.98),
                        Leaf(Belarusian, 454.65),
                      },
                      Leaf(Russian, 598.99),
                    }
                  },
                  Branch(71.60) {
                    Leaf(Old_Church_Slavic, 194.52),
                    Branch(335.15) {
                      Branch(154.16) {
                        Branch(179.68) {
                          Leaf(Macedonian, 486.21),
                          Leaf(Bulgarian, 486.75),
                        },
                        Leaf(Serbian, 665.73),
                      },
                      Leaf(Slovenian, 820.99),
                    }
                  }
                }
              },
              Branch(320.14) {
                Branch(333.35) {
                  Branch(304.37) {
                    Branch(1276.69) {
                      Branch(990.60) {
                        Leaf(Old_Irish, 0.80),
                        Branch(686.97) {
                          Leaf(Irish, 495.56),
                          Leaf(Scots_Gaelic, 495.92),
                        }
                      },
                      Branch(1041.40) {
                        Branch(363.96) {
                          Leaf(Cornish, 509.95),
                          Leaf(Breton, 767.14),
                        },
                        Leaf(Welsh, 1130.65),
                      }
                    },
                    Romance
                  },
                  Branch(1640.21) {
                    Germanic,
                    Leaf(Gothic, 488.88),
                  }
                },
                Branch(3559.09) {
                  Leaf(Tosk, 527.11),
                  Leaf(Arvanitika, 528.86),
                }
              }
            },
            Branch(792.34) {
              Branch(2217.67) {
                Leaf(Classical_Armenian, 0.79),
                Branch(876.25) {
                  Leaf(Eastern_Armenian, 650.36),
                  Leaf(Adapazar, 650.99),
                }
              },
              Branch(1320.57) {
                Leaf(Ancient_Greek, 0.80),
                Leaf(Modern_Greek, 2423.58),
              }
            }
          },
          Branch(846.08) {
            Branch(1045.43) {
              Leaf(Avestan, 423.76),
              Branch(673.09) {
                Branch(175.08) {
                  Branch(516.83) {
                    Branch(203.00) {
                      Branch(269.81) {
                        Leaf(Wakhi, 1064.02),
                        Branch(435.29) {
                          Leaf(Shughni, 629.37),
                          Leaf(Sariqoli, 629.67),
                        }
                      },
                      Branch(208.53) {
                        Branch(601.98) {
                          Leaf(Tajik, 523.07),
                          Leaf(Persian, 523.46),
                        },
                        Branch(197.46) {
                          Leaf(Baluchi, 928.67),
                          Branch(285.40) {
                            Leaf(Zazaki, 643.65),
                            Leaf(Kurdish, 641.77),
                          }
                        }
                      }
                    },
                    Branch(1108.52) {
                      Leaf(Pashto, 427.66),
                      Leaf(Waziri, 429.56),
                    }
                  },
                  Leaf(Sogdian, 772.55),
                },
                Leaf(Digor_Ossetic, 2229.15),
              }
            },
            Branch(695.61) {
              Leaf(Vedic_Sanskrit, 0.80),
              Branch(1218.19) {
                Branch(323.84) {
                  Leaf(Romani, 1710.04),
                  Leaf(Kashmiri, 1709.37),
                },
                Branch(281.72) {
                  Leaf(Singhalese, 1752.27),
                  Branch(340.38) {
                    Leaf(Nepali, 1410.86),
                    Branch(176.92) {
                      Branch(167.75) {
                        Leaf(Bihari, 1066.71),
                        Branch(244.83) {
                          Leaf(Bengali, 822.16),
                          Branch(200.33) {
                            Leaf(Assamese, 622.91),
                            Leaf(Oriya, 621.64),
                          }
                        }
                      },
                      Branch(190.09) {
                        Branch(125.13) {
                          Branch(168.55) {
                            Leaf(Sindhi, 751.50),
                            Leaf(Marwari, 751.75),
                          },
                          Branch(284.29) {
                            Leaf(Hindi, 633.56),
                            Branch(164.61) {
                              Leaf(Urdu, 470.12),
                              Branch(154.02) {
                                Leaf(Lahnda, 317.19),
                                Leaf(Panjabi, 316.85),
                              }
                            }
                          }
                        },
                        Branch(350.45) {
                          Leaf(Marathi, 694.13),
                          Leaf(Gujarati, 694.02),
                        }
                      }
                    }
                  }
                }
              }
            }
          }
        },
        Branch(3556.57) {
          Leaf(Tocharian_A, 410.41),
          Leaf(Tocharian_B, 400.03),
        }
      },
      Leaf(Hittite, 2582.56),
    }
  end
  //======================================================================
```

IPA.nytril

```
using Format, Units, Type, IPA.Features
//======================================================================

with IPA
  with Opens
    let Close     = enum {Name: Lang.Close}
    let NearClose = enum {Name: Lang.NearClose}
    let CloseMid  = enum {Name: Lang.CloseMid}
    let Mid       = enum {Name: Lang.Mid}
    let OpenMid   = enum {Name: Lang.OpenMid}
    let NearOpen  = enum {Name: Lang.NearOpen}
    let Open      = enum {Name: Lang.Open}
  end

  with Backnesses
    let Front     = enum {Name: Lang.Front}
    let NearFront = enum {Name: Lang.NearFront}
    let Central   = enum {Name: Lang.Central}
    let NearBack  = enum {Name: Lang.NearBack}
    let Back      = enum {Name: Lang.Back}
  end

  with Places
    let Bilabial       = enum {Name: Lang.Bilabial}
    let Labial         = enum {Name: Lang.Labial}
    let LabialVelar    = enum {Name: Lang.LabialVelar}
    let LabialPalatal  = enum {Name: Lang.LabialPalatal}
    let LabioDental    = enum {Name: Lang.LabioDental}
    let LinguoLabial   = enum {Name: Lang.LinguoLabial}
    let Dental         = enum {Name: Lang.Dental}
    let Alveolar       = enum {Name: Lang.Alveolar}
    let AlveoloPalatal = enum {Name: Lang.AlveoloPalatal}
    let PostAlveolar   = enum {Name: Lang.PostAlveolar}
    let Retroflex      = enum {Name: Lang.Retroflex}
    let Palatal        = enum {Name: Lang.Palatal}
    let PalatoAlveolar = enum {Name: Lang.PalatoAlveolar}
    let Velar          = enum {Name: Lang.Velar}
    let Uvular         = enum {Name: Lang.Uvular}
    let Pharyngeal     = enum {Name: Lang.Pharyngeal}
    let Glottal        = enum {Name: Lang.Glottal}
  end

  with Features
    let NoFeature   = flag {Name: Lang.NoFeatures, Abreviation: Empty}
    let Impossible  = flag {Name: Lang.Impossible, Abreviation: Empty}
    let Punctuation = flag {Name: Lang.Puncuation, Abreviation: Empty}
    let NonIPA      = flag {Name: Lang.NonIPA, Abreviation: Empty}
    let Diacritic   = flag {Name: Lang.Diacritic, Abreviation: Empty}
    let Voiced      = flag {Name: Lang.Voiced, Abreviation: "v"}
    let Rounded     = flag {Name: Lang.Rounded, Abreviation: "r"}
    let Velarized   = flag {Name: Lang.Velarized, Abreviation: "v"}
    let Ejective    = flag {Name: Lang.Ejective, Abreviation: "e"}
    let Pulmonic    = flag {Name: Lang.Pulmonic, Abreviation: "p"}
    let Nasal       = flag {Name: Lang.Nasal, Abreviation: "n"}
    let Tenuis      = flag {Name: Lang.Tenuis, Abreviation: "t"}
    let Lateral     = flag {Name: Lang.Lateral, Abreviation: "l"}
    let Sibilant    = flag {Name: Lang.Sibilant, Abreviation: "s"}
    let Fricative   = flag {Name: Lang.Fricative, Abreviation: "f"}
    let Approximant = flag {Name: Lang.Approximant, Abreviation: "a"}
    let Implosive   = flag {Name: Lang.Implosive, Abreviation: "i"}
    let Central     = flag {Name: Lang.Central, Abreviation: "c"}
    let TapFlap     = flag {Name: Lang.TapFlap, Abreviation: "F"}
    let Trill       = flag {Name: Lang.Trill, Abreviation: "T"}
    let Stop        = flag {Name: Lang.Stop, Abreviation: "|"}
    let Click       = flag {Name: Lang.Click, Abreviation: "K"}
    let Affricate   = flag {Name: Lang.Affricate, Abreviation: "a"}
    let Vowel       = flag {Name: Lang.Vowel, Abreviation: "V"}
    let Rhotic      = flag {Name: Lang.Rhotic, Abreviation: "R"}
    let Occlusive   = flag {Name: Lang.Occlusive, Abreviation: "O"}
    let Strident    = flag {Name: Lang.Strident, Abreviation: "S"}
    let Obstruent   = flag {Name: Lang.Obstruent, Abreviation: "o"}
    let Continuant  = flag {Name: Lang.Continuant, Abreviation: "c"}
    let Vibrant     = flag {Name: Lang.Vibrant, Abreviation: "V"}
    let Vocoid      = flag {Name: Lang.Vocoid, Abreviation: "D"}
    let Liquid      = flag {Name: Lang.Liquid, Abreviation: "l"}
    let Semivowel   = flag {Name: Lang.SemiVowel, Abreviation: "m"}
    let LongVowel   = flag {Name: Lang.LongVowel, Abreviation: "L"}
  end

  let FeatureMask = Vowel Nasal Vocoid LongVowel Semivowel Approximant Vibrant Lateral Affricate Occlusive
Strident Sibilant Obstruent Continuant Fricative Rhotic Liquid Trill TapFlap

  let Encode(text, sampa) = {
    Popup: SegmentPopup,
    Text: text,
    Sampa: sampa,
  }

  let Diac(description, text, sampa) = Encode(text, sampa) {
    Features: Diacritic,
    Description: description,
  }

  let Con(features, place, text, sampa) = Encode(text, sampa) {
    Features: features,
    Place: place,
  }

  let Vow(features, open, backness, text, sampa) = Encode(text, sampa) {
    Features: features | Vowel,
    Open: open,
    Backness: backness,
  }

  let Imp(features, place) = {
    Features: features | Impossible,
    Place: place,
  }
  let Dia(text, sampa) = Encode(text, sampa) {
    Features: Diacritic
  }

  let Punct(text) = Encode(text, text) {
    Features: Punctuation,
  }

  let NoSegment     = Encode("?", "!?") {Features: Impossible}
  let GapSegment    = Punct("-")
  let LeftSegment   = Punct("(")
  let RightSegment  = Punct(")")
  let SpaceSegment  = Punct(" ")

  with Segments
    //==================================
    // Extra segments found in word list
    //==================================


    let rn        = Con(Nasal Voiced Pulmonic Fricative, Places.Uvular, "r\u0303", "r~")

// French Cold "Froid"  Same as SAMPA "R"?
//    let r_nasal = Con(Nasal Voiced Pulmonic Fricative, Places.Uvular, "ʁ", "r~")

    //==================================
    // Pulmonic Consonants
    //==================================

    // Nasal
    let VlBilabialNasal              = Con(Pulmonic Nasal, Places.Bilabial, "m̥", "m_0")
    let m                            = Con(Voiced Pulmonic Nasal Occlusive, Places.Bilabial, "m", "m")
    let VdLabioDentalNasal           = Con(Voiced Pulmonic Nasal Occlusive, Places.LabioDental, "ɱ", "F")
    let VdLinguoLabioNasal           = Con(Voiced Pulmonic Nasal, Places.LinguoLabial, "n̼", "m_d")
    let VlAlveolarNasal              = Con(Pulmonic Nasal, Places.Alveolar, "n̥", "n_0")
    let n                            = Con(Voiced Pulmonic Nasal Occlusive, Places.Alveolar, "n", "n")
    let VlRetroFlexNasal             = Con(Pulmonic Nasal, Places.Retroflex, "ɳ̊", "n`_0")
    let VdRetroFlexNasal             = Con(Voiced Pulmonic Nasal Occlusive, Places.Retroflex, "ɳ", "n`")
    let VlPalatalNasal               = Con(Pulmonic Nasal, Places.Palatal, "ɲ̊", "J_0")
    let VdPalatalNasal               = Con(Voiced Pulmonic Nasal Occlusive, Places.Palatal, "ɲ", "J")
    let VlVelarNasal                 = Con(Pulmonic Nasal, Places.Velar, "ŋ̊", "N_0")
    let nya                          = Con(Voiced Pulmonic Nasal Occlusive, Places.Velar, "ŋ", "N")
    let VdUvularNasal                = Con(Voiced Pulmonic Nasal Occlusive, Places.Uvular, "ɴ", "N\\")

    // Stop
    let p                            = Con(Pulmonic Stop Occlusive, Places.Bilabial, "p", "p")
    let b                            = Con(Voiced Pulmonic Stop Occlusive, Places.Bilabial, "b", "b")
    let VlLabioDentalStop            = Con(Pulmonic Stop, Places.LabioDental, "p̪", "p_d")
    let VdLabioDentalStop            = Con(Voiced Pulmonic Stop, Places.LabioDental, "b̪", "b_d")
    let VlLinguoLabialStop           = Con(Pulmonic Stop, Places.LinguoLabial, "t̼", "")
    let VdLinguoLabialStop           = Con(Voiced Pulmonic Stop, Places.LinguoLabial, "d̼", "")
    let t                            = Con(Pulmonic Stop Occlusive, Places.Alveolar, "t", "t")
    let d                            = Con(Voiced Pulmonic Stop Occlusive, Places.Alveolar, "d", "d")
    let VlRetroflexStop              = Con(Pulmonic Stop Occlusive, Places.Retroflex, "ʈ", "t`")
    let VdRetroflexStop              = Con(Voiced Pulmonic Stop Occlusive, Places.Retroflex, "ɖ", "d`")
    let tya                          = Con(Pulmonic Stop Occlusive, Places.Palatal, "c", "c")
    let VdPalatalStop                = Con(Voiced Pulmonic Stop Occlusive, Places.Palatal, "ɟ", "J\\")
    let k                            = Con(Pulmonic Stop Occlusive, Places.Velar, "k", "k")
    let kw                           = Con(Pulmonic Stop Occlusive, Places.Labial, "kʷ", "k_W")

    let g                            = Con(Voiced Pulmonic Stop Occlusive, Places.Velar, "g", "g")
    let gw                           = Con(Voiced Pulmonic Stop Occlusive, Places.Labial, "gʷ", "g_W")

    let VlUvularStop                 = Con(Pulmonic Stop Occlusive, Places.Uvular, "q", "q")
    let VdUvularStop                 = Con(Voiced Pulmonic Stop Occlusive, Places.Uvular, "ɢ", "G\\")
    let VdEpiglottalStop             = Con(Pulmonic Stop, Places.Pharyngeal, "ʡ", ">\\")
    let GlottalStop                  = Con(Pulmonic Stop, Places.Glottal, "ʔ", "?")

    // Sibilant Fricative
    let s                            = Con(Pulmonic Sibilant Fricative Strident Obstruent Continuant, Places.
Alveolar, "s", "s")
    let zz                           = Con(Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant,
Places.Alveolar, "z", "z")
    let shh                          = Con(Pulmonic Sibilant Fricative Strident Obstruent Continuant, Places.
PostAlveolar, "ʃ", "S")
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    let gzah                        = Con(Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant,
Places.PostAlveolar, "ʒ", "Z")
    let VlRetroflexSibFricative     = Con(Pulmonic Sibilant Fricative Strident Obstruent Continuant, Places.
Retroflex, "ʂ", "s`")
    let VdRetroflexSibFricative     = Con(Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant,
Places.Retroflex, "ʐ", "z`")
    let VlPalatalSibFricative       = Con(Pulmonic Sibilant Fricative Strident Obstruent Continuant, Places.
Palatal, "ɕ", "s\\")
    let VdPalatalSibFricative       = Con(Voiced Pulmonic Sibilant Fricative Strident Obstruent Continuant,
Places.Palatal, "ʑ", "z\\")

    // Fricative
    let VlBilabialFricative         = Con(Pulmonic Fricative Obstruent Continuant, Places.Bilabial, "ɸ",
"p\\")
    let VdBilabialFricative         = Con(Voiced Pulmonic Fricative Obstruent Continuant, Places.Bilabial,
"β", "B")
    let f                           = Con(Pulmonic Fricative Obstruent Continuant Strident, Places.
LabioDental, "f", "f")
    let v                           = Con(Voiced Pulmonic Fricative Obstruent Continuant Strident, Places.
LabioDental, "v", "v")
    let VlLinguoLabialFricative     = Con(Pulmonic Fricative, Places.LinguoLabial, "θ̼", "")
    let VdLinguoLabialFricative     = Con(Voiced Pulmonic Fricative, Places.LinguoLabial, "ð̼", "")
    let th                          = Con(Pulmonic Fricative Obstruent Continuant, Places.Dental, "θ", "T")
    let VdDentalFricative           = Con(Voiced Pulmonic Fricative Obstruent Continuant, Places.Dental, "ð",
"D")
    let VlAlveolarFricative         = Con(Pulmonic Fricative, Places.Alveolar, "θ̠", "")
    let VdAlveolarFricative         = Con(Voiced Pulmonic Fricative, Places.Alveolar, "ð̠", "")
    let VlPostaveolarFricative      = Con(Pulmonic Fricative, Places.PostAlveolar, "ɹ̠̊","""")
    let VdPostalveolarFricative     = Con(Voiced Pulmonic Fricative, Places.PostAlveolar, "ɹ̝̊","""")
    let VdRetroflexFricative        = Con(Voiced Pulmonic Fricative, Places.Retroflex, "ɻ˔","")
    let sh                          = Con(Pulmonic Fricative Obstruent Continuant, Places.Palatal, "ç", "C")
    let VdPalatalFricative          = Con(Voiced Pulmonic Fricative Obstruent Continuant, Places.Palatal, "ʝ"
, "j\\")
    let xha                         = Con(Pulmonic Fricative Obstruent Continuant, Places.Velar, "x", "x")
    let VdVelarFricative            = Con(Voiced Pulmonic Fricative Obstruent Continuant, Places.Velar, "ɣ",
"G")
    let VlUvularFricative           = Con(Pulmonic Fricative Obstruent Continuant Strident, Places.Uvular,
"χ", "X")
    let VdUvularFricative           = Con(Voiced Pulmonic Fricative Obstruent Continuant Strident Rhotic
Liquid, Places.Uvular, "ʁ", "R")
    let VlPharyngealFricative       = Con(Pulmonic Fricative, Places.Pharyngeal, "ħ", "X\\")
    let VdPharyngealFricative       = Con(Voiced Pulmonic Fricative, Places.Pharyngeal, "ʕ", "?\\")
    let h                           = Con(Pulmonic Fricative, Places.Glottal, "h", "h")
    let VdGlottalFricative          = Con(Voiced Pulmonic Fricative, Places.Glottal, "ɦ", "h\\")

    // Approximant
    let VlLabioDentalApproximant    = Con(Pulmonic Approximant, Places.LabioDental, "ʋ̥", "")
    let VdLabioDentalApproximant    = Con(Voiced Pulmonic Approximant Vocoid Approximant, Places.LabioDental,
"ʋ", "v\\")
    let VlPostalveolarApproximant   = Con(Pulmonic Approximant, Places.Alveolar, "ɹ̥", "")
    let VdPostalveolarApproximant   = Con(Voiced Pulmonic Approximant Vocoid Rhotic Liquid, Places.Alveolar,
"ɹ", "r\\")
    let VlRetroflexApproximant      = Con(Pulmonic Approximant, Places.Retroflex, "ɻ̊", "")
    let VdRetroflexApproximant      = Con(Voiced Pulmonic Approximant Vocoid Rhotic Liquid, Places.Retroflex,
"ɻ", "r\\`")
    let VlPalatalApproximant        = Con(Pulmonic Approximant, Places.Palatal, "j̊", "")
    let jg                          = Con(Voiced Pulmonic Approximant Vocoid Semivowel Continuant, Places.
Palatal, "j", "j")
    let VlVelarApproximant          = Con(Pulmonic Approximant, Places.Velar, "ɰ̊", "")
    let VdVelarApproximant          = Con(Voiced Pulmonic Approximant Vocoid Semivowel Continuant, Places.
Velar, "ɰ", "M\\")
    let VdGlottalApproximant        = Con(Voiced Pulmonic Approximant, Places.Glottal, "ʔ̞", "")

    // Tap or Flap
    let VdBilabialDentalFlap        = Con(Voiced Pulmonic TapFlap, Places.Bilabial, "ⱱ̟", "")
    let VdLabioDentalFlap           = Con(Voiced Pulmonic TapFlap Vibrant, Places.LabioDental, "ⱱ", "")
    let VdLingualLabialStop         = Con(Voiced Pulmonic TapFlap, Places.LinguoLabial, "ɾ̼", "")
    let VlAlveolarFlap              = Con(Pulmonic TapFlap, Places.Alveolar, "ɾ̥", "")
    let VdAlveolarTap               = Con(Voiced Pulmonic TapFlap Rhotic Liquid Vibrant, Places.Alveolar, "ɾ"
, "4")
    let VlRetroflexFlap             = Con(Pulmonic TapFlap, Places.Retroflex, "ɽ̊", "")
    let VdRetroflexFlap             = Con(Voiced Pulmonic TapFlap Rhotic Liquid Vibrant, Places.Retroflex,
"ɽ", "r`")
    let VdUvularFlap                = Con(Voiced Pulmonic TapFlap, Places.Uvular, "ɢ̆", "")
    let VdPharyngealFlap            = Con(Voiced Pulmonic TapFlap, Places.Pharyngeal, "ʡ̆", "")
    // Trill
    let VlBilabialTrill                 = Con(Pulmonic Trill, Places.Bilabial, "ʙ̥", "")
    let VdBilabialTrill                 = Con(Voiced Pulmonic Trill Vibrant, Places.Bilabial, "ʙ", "B\\")
    let VlAlveolarTrill                 = Con(Pulmonic Trill, Places.Alveolar, "r̥", "")
    let r                               = Con(Voiced Pulmonic Trill Rhotic Liquid Vibrant, Places.Alveolar, "r",
"r")
    let VlRetroflexTrill                = Con(Pulmonic Trill, Places.Retroflex, "ɽ̊r̥","")
    let VdRetroflexTrill                = Con(Voiced Pulmonic Trill, Places.Retroflex, "ɽr", "")
    let VlUvularTrill                   = Con(Pulmonic Trill Rhotic Liquid Vibrant, Places.Uvular, "ʀ", "R\\")
    let VlPharyngealTrill               = Con(Pulmonic Trill, Places.Pharyngeal, "ʜ", "H\\")
    let VdPharyngealTrill               = Con(Voiced Pulmonic Trill, Places.Pharyngeal, "ʢ", "<\\")

    // Lateral Fricative
    let VlAlveolarLateralFricative    = Con(Pulmonic Lateral Fricative Obstruent Continuant Strident Lateral
Liquid, Places.Alveolar, "ɬ", "K")
    let VdAlveolarLateralFricative    = Con(Voiced Pulmonic Lateral Fricative Obstruent Continuant Strident
Lateral Liquid, Places.Alveolar, "ɮ", "K\\")
    let VlRetroflexLateralFricative   = Con(Pulmonic Lateral Fricative, Places.Retroflex, "ɭ̊˔", "")
    let VdRetroflexLateralFricative   = Con(Voiced Pulmonic Lateral Fricative, Places.Retroflex, "ɭ˔", "")
    let VlAlveolarPalatalFricative    = Con(Pulmonic Lateral Fricative, Places.Palatal, "ʎ̝̊","")
    let VdAlveolarPalatalFricative    = Con(Voiced Pulmonic Lateral Fricative, Places.Palatal, "ʎ̝", "")
    let VlVelarPalatalFricative       = Con(Pulmonic Lateral Fricative, Places.Velar, "ʟ̝̊","")
    let VdVelarPalatalFricative       = Con(Voiced Pulmonic Lateral Fricative, Places.Velar, "ʟ̝", "")

    // LateralApproximant
    let VlAlveolarLateralApproximant = Con(Pulmonic Lateral Approximant, Places.Alveolar, "l̥", "")
    let l                             = Con(Voiced Pulmonic Lateral Approximant Vocoid Rhotic Liquid Lateral,
Places.Alveolar, "l", "l")
    let ssha                          = Con(Voiced Velarized Pulmonic Lateral Approximant, Places.Alveolar, "ɫ"
, "5")
    let VlRetroflexLateral            = Con(Pulmonic Lateral Approximant, Places.Retroflex, "ɭ̊", "")
    let VdRetroflexLateral            = Con(Voiced Pulmonic Lateral Approximant Vocoid Rhotic Liquid Lateral,
Places.Retroflex, "ɭ", "n`")
    let VlPalatalLateral              = Con(Pulmonic Lateral Approximant, Places.Palatal, "ʎ̥", "")
    let yuh                           = Con(Voiced Pulmonic Lateral Approximant Vocoid Rhotic Liquid Lateral,
Places.Palatal, "ʎ", "L")
    let VlVelarLateral                = Con(Pulmonic Lateral Approximant, Places.Velar, "ʟ̥", "")
    let VdVelarLateral                = Con(Voiced Pulmonic Lateral Approximant Vocoid Rhotic Liquid Lateral,
Places.Velar, "ʟ", "L\\")
    let VdUvularLateral               = Con(Voiced Pulmonic Lateral Approximant, Places.Uvular, "ʟ̠", "")

    // Lateral tap/flap
    let VdAlveolarLateralFlap         = Con(Voiced Pulmonic Lateral TapFlap Vibrant Rhotic Liquid, Places.
Alveolar, "ɺ", "l\\")
    let VdRetroflexLateralFlap        = Con(Voiced Pulmonic Lateral TapFlap, Places.Retroflex, "ɭ̆", "")
    let VdPalatalLateralFlap          = Con(Voiced Pulmonic Lateral TapFlap, Places.Palatal, "ʎ̆", "")
    let VdVelarLateralTap             = Con(Voiced Pulmonic Lateral TapFlap, Places.Velar, "ʟ̆", "")


    //==================================
    // Non-Pulmonic Consonants
    //==================================

    // Clicks
    let VlBilabialTenuisClick         = Con(Ejective Tenuis Click Affricate, Places.Bilabial, "ʘ", "O\\")
    let VdBilabialTenuisClick         = Con(Voiced Ejective Tenuis Click Affricate, Places.Bilabial, "ʘ̬", "")
    let VlDentalTenuisClick           = Con(Ejective Tenuis Click Affricate, Places.Dental, "ǀ", "|")
    let VdDentalTenuisClick           = Con(Voiced Ejective Tenuis Click Affricate, Places.Dental, "ǀ̬", "")
    let VlAlveolarTenuisClick         = Con(Ejective Tenuis Click Affricate, Places.Alveolar, "ǃ", "!\\")
    let VdAlveolarTenuisClick         = Con(Voiced Ejective Tenuis Click Affricate, Places.Alveolar, "ǃ̬", "")
    let VlPalatalTenuisClick          = Con(Ejective Tenuis Click Affricate, Places.Palatal, "ǂ", "=\\")
    let VdPalatalTenuisClick          = Con(Voiced Ejective Tenuis Click Affricate, Places.Palatal, "ǂ̬", "")

    let VlBilabialNasalClick          = Con(Ejective Nasal Click Affricate, Places.Bilabial, "ʘ̃", "")
    let VlDentalNasalClick            = Con(Ejective Nasal Click Affricate, Places.Dental, "ǀ̃", "")
    let VlAlveolarNasalClick          = Con(Ejective Nasal Click Affricate, Places.Alveolar, "ǃ̃", "")
    let VlPalatalNasalClick           = Con(Ejective Nasal Click Affricate, Places.Palatal, "ǂ̃", "")

    let VlAlveolarTenuisLateralClick = Con(Ejective Tenuis Lateral Click Affricate, Places.Alveolar, "ǁ", " |
\\ | \\")
    let VdAlveolarTenuisLateralClick = Con(Voiced Ejective Tenuis Lateral Click Affricate, Places.Alveolar,
"ǁ̬", "")

    let VlBilabialImplosiveClick      = Con(Ejective Implosive Click Affricate, Places.Bilabial, "ɓ̥", "")
    let VdBilabialImplosiveClick     = Con(Voiced Ejective Implosive Click Affricate, Places.Bilabial, "ɓ",
"b_<")
    let VlAlveolarImplosiveClick     = Con(Ejective Implosive Click Affricate, Places.Alveolar, "ɗ̥", "")
    let VdAlveolarImplosiveClick     = Con(Voiced Ejective Implosive Click Affricate, Places.Alveolar, "ɗ",
"d_<")
    let VlRetroflexImplosiveClick    = Con(Ejective Implosive Click Affricate, Places.Retroflex, "ᶑ̊", "")
    let VdRetroflexImplosiveClick    = Con(Voiced Ejective Implosive Click Affricate, Places.Retroflex, "ᶑ",
"")
    let VlPalatalImplosiveClick      = Con(Ejective Implosive Click Affricate, Places.Palatal, "ʄ̊", "")
    let VdPalatalImplosiveClick      = Con(Voiced Ejective Implosive Click Affricate, Places.Palatal, "ʄ",
"J\\_<")
    let VlVelarImplosiveClick        = Con(Ejective Implosive Click Affricate, Places.Velar, "ɠ̊", "")
    let VdVelarImplosiveClick        = Con(Voiced Ejective Implosive Click Affricate, Places.Velar, "ɠ", "g_<"
)
    let VlUvularImplosiveClick       = Con(Ejective Implosive Click Affricate, Places.Uvular, "ʛ̥", "")
    let VdUvularImplosiveClick       = Con(Voiced Ejective Implosive Click Affricate, Places.Uvular, "ʛ",
"G\\_<")

    //===================================
    // Pulmonic Affricates
    //===================================

    // Sibilants
    let VlAlveolarAffricate          = Con(Pulmonic Sibilant Affricate Occlusive Strident, Places.Alveolar,
"ts", "")
    let VdAlveolarAffricate          = Con(Voiced Pulmonic Sibilant Affricate Occlusive Strident, Places.
Alveolar, "dz", "")
    let VlPostalveolarAffricate      = Con(Pulmonic Sibilant Affricate Occlusive Strident, Places.
PalatoAlveolar, "t̠ʃ", "")
    let VdPostalveolarAffricate      = Con(Voiced Pulmonic Sibilant Affricate Occlusive Strident, Places.
PalatoAlveolar, "d̠ʒ", "")
    let VlRetroflexAffricate         = Con(Pulmonic Sibilant Affricate Occlusive Strident, Places.Retroflex,
"ʈʂ", "")
    let VdRetroflexAffricate         = Con(Voiced Pulmonic Sibilant Affricate Occlusive Strident, Places.
Retroflex, "ɖʐ", "")
    let VlAlveoloPalatalAffricate    = Con(Pulmonic Sibilant Affricate Occlusive Strident, Places.
AlveoloPalatal, "tɕ", "")
    let VdAlveoloPalatalAffricate    = Con(Voiced Pulmonic Sibilant Affricate Occlusive Strident, Places.
AlveoloPalatal, "dʑ", "")

    // Non-Sibilants
    let VlBilabialNSAffricate        = Con(Pulmonic Affricate Occlusive, Places.Bilabial, "pɸ", "")
    let VdBilabialNSAffricate        = Con(Voiced Pulmonic Affricate Occlusive, Places.Bilabial, "bβ", "")
    let VlLabioDentalNSAffricate     = Con(Pulmonic Affricate Occlusive Strident, Places.LabioDental, "p̪f", ""
)
    let VdLabioDentalNSAffricate     = Con(Voiced Pulmonic Affricate Occlusive Strident, Places.LabioDental,
"b̪v", "")
    let VlDentalNSAffricate          = Con(Pulmonic Affricate Occlusive, Places.Dental, "t̪θ", "")
    let VdDentalNSAffricate          = Con(Voiced Pulmonic Affricate Occlusive, Places.Dental, "d̪ð", "")
    let VlAlveolarNSAffricate        = Con(Pulmonic Affricate, Places.Alveolar, "tɹ̝̊,""")
    let VdAlveolarNSAffricate        = Con(Voiced Pulmonic Affricate, Places.Alveolar, "dɹ̝", "")
    let VlPalatoAlveolarNSAffricate  = Con(Pulmonic Affricate, Places.PalatoAlveolar, "t̠ɹ̠̊˔", "")
    let VdPalatoAlveolarNSAffricate  = Con(Voiced Pulmonic Affricate, Places.PalatoAlveolar, "d̠ɹ̠˔,""")
    let VlPalatalNSAffricate         = Con(Pulmonic Affricate Occlusive, Places.Palatal, "cç", "")
    let VdPalatalNSAffricate         = Con(Voiced Pulmonic Affricate Occlusive, Places.Palatal, "ɟʝ", "")
    let VlVelarNSAffricate           = Con(Pulmonic Affricate Occlusive, Places.Velar, "kx", "")
    let VdVelarNSAffricate           = Con(Voiced Pulmonic Affricate Occlusive, Places.Velar, "gɣ", "")
    let VlUvularNSAffricate          = Con(Pulmonic Affricate, Places.Uvular, "qχ", "")
    let VdEpiglottalNSAffricate      = Con(Voiced Pulmonic Affricate, Places.Pharyngeal, "ʡʕ", "")
    let VlGlottalNSAffricate         = Con(Pulmonic Affricate, Places.Glottal, "ʔh", "")

    // Lateral
    let VlAlveolarLateralAffricate   = Con(Pulmonic Lateral Affricate, Places.Alveolar, "tɬ̝̊,""")
    let VdAlveolarLateralAffricate   = Con(Voiced Pulmonic Lateral Affricate, Places.Alveolar, "dɮ", "")
    let VlRetroflexLateralAffricate  = Con(Pulmonic Lateral Affricate, Places.Retroflex, "ʈɭ̊˔", "")
    let VdPalatalLateralAffricate    = Con(Voiced Pulmonic Lateral Affricate, Places.Palatal, "cʎ̝̊,""")
    let VlVelarLateralAffricate      = Con(Pulmonic Lateral Affricate, Places.Velar, "kʟ̝̊,""")
    let VdVelarLateralAffricate      = Con(Voiced Pulmonic Lateral Affricate, Places.Velar, "gʟ̝", "")

    //===================================
    // Ejective | Affricates
    //===================================

    // Central
    let VlAlveolarEjectiveAffricate       = Con(Ejective Central Affricate, Places.Alveolar, "tsʼ", "")
    let VlPalatoAlveolarEjectiveAffricate = Con(Ejective Central Affricate, Places.PalatoAlveolar, "t̠ʃ’", "")
    let VlRetroflexEjectiveAffricate      = Con(Ejective Central Affricate, Places.Retroflex, "ʈʂ’", "")
    let VlVelarEjectiveAffricate          = Con(Ejective Central Affricate, Places.Velar, "kx’", "")
    let VlUvularEjectiveAffricate         = Con(Ejective Central Affricate, Places.Uvular, "qχ’", "")

    // Lateral
    let VlAlveolarLateralEjective         = Con(Ejective Lateral Affricate, Places.Alveolar, "tɬ’", "")
    let VlPalatalLateralEjective          = Con(Ejective Lateral Affricate, Places.Palatal, "cʎ̝̊’""")
    let VlVelarLateralEjective            = Con(Ejective Lateral Affricate, Places.Velar, "kʟ̝̊’""")

    let VlLabialVelarApproximant          = Con(Approximant Vocoid Semivowel Continuant, Places.LabialVelar, 
"ʍ", "W")

// Pre-existing
//    let VlAlveoloPalatalFricative1      = NewConsonant(CPM(Categories.Other, Places.AlveoloPalatal)
Fricative, "ɕ", "")
//    let VlAlveoloPalatalFricative       = NewConsonant(CPM(Categories.Other, Places.AlveoloPalatal)
Fricative, "ʑ", "")


    let wh                                = Con(Nasal Voiced Approximant Nasal, Places.LabialVelar, "w\u0303", 
"w~")
    let w                                 = Con(Voiced Approximant Vocoid Semivowel Continuant, Places.
LabialVelar, "w", "w")

// This conflicts with another segment (VlPharyngealTrill)

//    let VlEpiglottalFricative             = Con(Fricative, Places.Pharyngeal, "ʜ", "H\\")


    let VdLabialPalatalApproximant        = Con(Voiced Approximant Vocoid Semivowel Continuant, Places.
LabialPalatal, "ɥ", "H")

    let SimultaneousSx                    = Con(Sibilant Fricative, Places.PostAlveolar, "ɧ", "x\\")
    let VdEpiglottalFricative             = Con(Voiced Fricative, Places.Pharyngeal, "ʢ", "?\\")
    let VlEpiglottalPlosive               = Con(Ejective, Places.Pharyngeal, "ʡ", "<\\")

    // Ejectives
    let VlBilabialStopEjective            = Con(Ejective Pulmonic Stop, Places.Bilabial, "p\u02BC", "p_>")
    let VlAveolarStopEjective             = Con(Ejective Stop, Places.Alveolar, "t\u02BC", "t_>")
    let VlRetroflexStopEjective           = Con(Ejective Stop, Places.Retroflex, "ʈ\u02BC", "t`_>")
    let VlPalatalStopEjective             = Con(Ejective Stop, Places.Palatal, "c\u02BC", "c_>")
    let VlVelarStopEjective               = Con(Ejective Stop, Places.Velar, "k\u02BC", "k_>")
    let VlUvularStopEjective              = Con(Ejective Stop, Places.Uvular, "q\u02BC", "q_>")
    let VlEpiglottalStopEjective          = Con(Ejective Stop, Places.Pharyngeal, "ʡ\u02BC", ">\\_>")
    let VlBilabialFricativeEjective       = Con(Ejective Fricative, Places.Bilabial, "ɸ\u02BC", "p\\_>")
    let VlLabiodentalFricativeEjective    = Con(Ejective Fricative, Places.LabioDental, "f\u02BC", "f_>")
    let VlDentalFricativeEjective         = Con(Ejective Fricative, Places.Dental, "θ\u02BC", "T_>")
    let VlAlveolarFricativeEjective       = Con(Ejective Fricative, Places.Alveolar, "s\u02BC", "s_>")
    let VlPostalveolarFricativeEjective   = Con(Ejective Fricative, Places.PostAlveolar, "ʃ\u02BC", "S_>")
    let VlRetroflexFricativeEjective      = Con(Ejective Fricative, Places.Retroflex, "ʂ\u02BC", "s`_>")
    let VlPalatalFricativeEjective        = Con(Ejective Fricative, Places.Palatal, "ɕ\u02BC", "s\\_>")
    let VlVelarFricativeEjective          = Con(Ejective Fricative, Places.Velar, "x\u02BC" , "x_>")
    let VlUvularFricativeEjective         = Con(Ejective Fricative, Places.Uvular, "χ\u02BC", "X_>")
    let VlPostalveolarLatFricEjective     = Con(Ejective Lateral Fricative, Places.Alveolar, "ɬ\u02BC", "K_>")

    //==================================
    // Vowels
    //==================================

    let e                         = Vow(Vocoid Continuant, Opens.Close, Backnesses.Front, "i", "i")
    let ee                        = Vow(LongVowel Vocoid Continuant, Opens.Close, Backnesses.Front, "iː", "i:"
)
    let eeh                       = Vow(Rounded Vocoid Continuant, Opens.Close, Backnesses.Front, "y", "y")

    let CloseCentralUnrounded     = Vow(NoFeature, Opens.Close, Backnesses.Central, "ɨ", "1")
    let CloseCentralRounded       = Vow(Rounded, Opens.Close, Backnesses.Central, "ʉ", "}")
    let CloseBackUnrounded        = Vow(Vocoid Continuant, Opens.Close, Backnesses.Back, "ɯ", "M")
    let u                         = Vow(Rounded Vocoid Continuant, Opens.Close, Backnesses.Back, "u", "u")

    let NearCloseCentralUnrounded = Vow(NoFeature NonIPA, Opens.NearClose, Backnesses.Central, "ɪ̈", "I\\")
    let NearCloseFrontUnrounded   = Vow(NoFeature, Opens.NearClose, Backnesses.NearFront, "ɪ", "I")
    let NearCloseFrontRounded     = Vow(Rounded, Opens.NearClose, Backnesses.NearFront, "ʏ", "Y")
    let NearCloseCentralRounded   = Vow(Rounded NonIPA, Opens.NearClose, Backnesses.Central, "ʊ̈", "U\\")
    let NearCloseBackRounded      = Vow(Rounded, Opens.NearClose, Backnesses.NearBack, "ʊ", "U")
    let uu                        = Vow(LongVowel Rounded, Opens.Close, Backnesses.Back, "uː", "u:")

    let ay                        = Vow(Vocoid Continuant, Opens.CloseMid, Backnesses.Front, "e", "e")
    let CloseMidFrontRounded      = Vow(Rounded Vocoid Continuant, Opens.CloseMid, Backnesses.Front, "ø", "2")
    let MidCentralUnrounded       = Vow(NoFeature, Opens.Mid, Backnesses.Central, "ɘ", "@\\")
    let Schwa                     = Vow(NoFeature, Opens.CloseMid, Backnesses.Central, "ə", "@")
    let ooh                       = Vow(Rounded, Opens.CloseMid, Backnesses.Central, "ɵ", "8")
    let CloseMidBackUnrounded     = Vow(Vocoid Continuant, Opens.CloseMid, Backnesses.Back, "ɤ", "7")
    let oh                        = Vow(Rounded Vocoid Continuant, Opens.CloseMid, Backnesses.Back, "o", "o")

    let MidFrontUnrounded         = Vow(NoFeature, Opens.Mid, Backnesses.Front, "ø̞", "")
    let MidBackUnrounded          = Vow(NoFeature, Opens.Mid, Backnesses.Back, "o̞", "")

    let eh                        = Vow(Vocoid Continuant, Opens.OpenMid, Backnesses.NearFront, "ɛ", "E")
    let ai                        = Vow(LongVowel Vocoid Continuant, Opens.Mid, Backnesses.Front, "eː", "e:")

    let OpenMidNearFrontRounded   = Vow(Rounded Vocoid Continuant, Opens.OpenMid, Backnesses.NearFront, "œ",
"9")
    let OpenMidCentralRounded     = Vow(Rounded, Opens.OpenMid, Backnesses.Central, "ɞ", "3\\")
    let aeh                       = Vow(NoFeature, Opens.OpenMid, Backnesses.Central, "ɜ", "3")
    let OpenMidBackUnrounded      = Vow(Vocoid Continuant, Opens.OpenMid, Backnesses.Back, "ʌ", "V")
    let OpenMidBackRounded        = Vow(Rounded Vocoid Continuant, Opens.OpenMid, Backnesses.Back, "ɔ", "O")
    let LongO                     = Vow(LongVowel Rounded Vocoid Continuant, Opens.Mid, Backnesses.Back, "oː",
"o:")

    let NearFrontUnrounded        = Vow(NoFeature, Opens.NearOpen, Backnesses.NearFront, "æ", "{")
    let FrontOpenRounded          = Vow(Rounded, Opens.NearOpen, Backnesses.NearFront, "ɶ", "&")
    let OpenMidSchwa              = Vow(Rounded, Opens.NearOpen, Backnesses.Central, "ɐ", "6")

    let OpenCentralUnrounded      = Vow(NoFeature, Opens.Open, Backnesses.Central, "ä", "a_\"")
    let ah                        = Vow(Vocoid Continuant, Opens.Open, Backnesses.NearFront, "a", "a")
    let aye                       = Vow(LongVowel Vocoid Continuant, Opens.Open, Backnesses.Central, "aː",
"a:")

    let OpenNearFrontRounded      = Vow(Rounded Vocoid Continuant, Opens.Open, Backnesses.NearFront, "ɶ", "&")
    let OpenBackUnrounded         = Vow(Vocoid Continuant, Opens.Open, Backnesses.Back, "ɑ", "A")
    let OpenBackRounded           = Vow(Rounded Vocoid Continuant, Opens.Open, Backnesses.Back, "ɒ", "Q")

    let uuh                       = Vow(Nasal Rounded, Opens.OpenMid, Backnesses.NearFront, "œ\u0303", "oe*")
// French One "un"
    let ey                        = Vow(Rounded Nasal, Opens.Close, Backnesses.Front, "y\u0303", "y~")
    let aa                        = Vow(Nasal, Opens.Open, Backnesses.NearFront, "a\u0303", "~a")
    let ahn                       = Vow(Nasal Rounded, Opens.NearOpen, Backnesses.Central, "ɐ\u0303", "a*")
// Supposed to be "ɛ̃"as in French Dog "chien"?
    let oon                       = Vow(Nasal Rounded, Opens.OpenMid, Backnesses.Back, "ɔ\u0303", "o*")
// French Fish "poisson"
    let aehn                      = Vow(Nasal, Opens.OpenMid, Backnesses.NearFront, "ɜ\u0303", "3*")
    let ehnn                      = Vow(Nasal, Opens.OpenMid, Backnesses.NearFront, "ɛ\u0303", "E*")
    let uh                        = Vow(Nasal Rounded, Opens.Close, Backnesses.Back, "u\u0303", "u*")
// Portuguese One "um"
    let en                        = Vow(Nasal, Opens.CloseMid, Backnesses.Front, "e\u0303", "e*")
// Portuguese Trail "se*da
    let een                       = Vow(Nasal, Opens.Close, Backnesses.Front, "i\u0303", "i*")
// Portuguese Tongue


// How to show rhotic vowels?
//     let OpenMidCentralRhotic       = Vow(Rhotic, Opens.OpenMid, Backnesses.Central, "ɝ", "")
//     let RhoticSchwa                = Vow(Rhotic, Opens.Open, Backnesses.NearFront, "ɚ", "@`")
  end

  with ImpossibleSegments
    let I10 = Imp(Pulmonic Nasal, Places.Pharyngeal)
    let I11 = Imp(Pulmonic Nasal, Places.Glottal)
    let I12 = Imp(Pulmonic Stop Voiced, Places.Pharyngeal)
    let I13 = Imp(Pulmonic Stop Voiced, Places.Glottal)
    let I14 = Imp(Pulmonic Sibilant Fricative, Places.Bilabial)
    let I15 = Imp(Pulmonic Sibilant Fricative, Places.LabioDental)
    let I16 = Imp(Pulmonic Sibilant Fricative, Places.LinguoLabial)
    let I17 = Imp(Pulmonic Sibilant Fricative, Places.Velar)
    let I18 = Imp(Pulmonic Sibilant Fricative, Places.Uvular)
    let I19 = Imp(Pulmonic Sibilant Fricative, Places.Pharyngeal)
    let I20 = Imp(Pulmonic Sibilant Fricative, Places.Glottal)
    let I21 = Imp(Pulmonic Trill, Places.Velar)
    let I22 = Imp(Pulmonic Trill, Places.Glottal)
    let I23 = Imp(Pulmonic TapFlap, Places.Velar)
    let I24 = Imp(Pulmonic TapFlap, Places.Glottal)
    let I25 = Imp(Pulmonic Lateral Fricative, Places.Bilabial)
    let I26 = Imp(Pulmonic Lateral Fricative, Places.LabioDental)
    let I27 = Imp(Pulmonic Lateral Fricative, Places.Pharyngeal)
    let I28 = Imp(Pulmonic Lateral Fricative, Places.Glottal)
    let I29 = Imp(Pulmonic Lateral Approximant, Places.Bilabial)
    let I30 = Imp(Pulmonic Lateral Approximant, Places.LabioDental)
    let I31 = Imp(Pulmonic Lateral Approximant, Places.Pharyngeal)
    let I32 = Imp(Pulmonic Lateral Approximant, Places.Glottal)
    let I33 = Imp(Pulmonic Lateral TapFlap, Places.Bilabial)
    let I34 = Imp(Pulmonic Lateral TapFlap, Places.LabioDental)
    let I35 = Imp(Pulmonic Lateral TapFlap, Places.Pharyngeal)
    let I36 = Imp(Pulmonic Lateral TapFlap, Places.Glottal)
    let I37 = Imp(Pulmonic Sibilant Affricate, Places.Bilabial)
    let I38 = Imp(Pulmonic Sibilant Affricate, Places.LabioDental)
    let I39 = Imp(Pulmonic Sibilant Affricate, Places.Velar)
    let I40 = Imp(Pulmonic Sibilant Affricate, Places.Uvular)
    let I41 = Imp(Pulmonic Sibilant Affricate, Places.Pharyngeal)
    let I42 = Imp(Pulmonic Sibilant Affricate, Places.Glottal)
    let I43 = Imp(Pulmonic Lateral Affricate, Places.Bilabial)
    let I44 = Imp(Pulmonic Lateral Affricate, Places.LabioDental)
    let I45 = Imp(Pulmonic Lateral Affricate, Places.Pharyngeal)
    let I46 = Imp(Pulmonic Lateral Affricate, Places.Glottal)
    let I47 = Imp(Ejective Lateral Fricative Affricate, Places.Bilabial)
    let I48 = Imp(Ejective Lateral Fricative Affricate, Places.LabioDental)
    let I49 = Imp(Ejective Lateral Fricative Affricate, Places.Pharyngeal)
    let I50 = Imp(Ejective Central Affricate, Places.Glottal)
    let I51 = Imp(Ejective Lateral Affricate, Places.Bilabial)
    let I52 = Imp(Ejective Lateral Affricate, Places.LabioDental)
    let I53 = Imp(Ejective Lateral Affricate, Places.Pharyngeal)
    let I54 = Imp(Ejective Lateral Affricate, Places.Glottal)
    let I55 = Imp(Ejective Tenuis Click Affricate, Places.Velar)
    let I56 = Imp(Ejective Tenuis Click Affricate, Places.Uvular)
    let I57 = Imp(Ejective Tenuis Click Affricate, Places.Pharyngeal)
    let I58 = Imp(Ejective Nasal Click Affricate, Places.Velar)
    let I59 = Imp(Ejective Nasal Click Affricate, Places.Uvular)
    let I60 = Imp(Ejective Nasal Click Affricate, Places.Pharyngeal)
    let I61 = Imp(Ejective Tenuis Lateral Click Affricate, Places.Bilabial)
    let I62 = Imp(Ejective Tenuis Lateral Click Affricate, Places.LabioDental)
    let I63 = Imp(Ejective Tenuis Lateral Click Affricate, Places.Velar)
    let I64 = Imp(Ejective Tenuis Lateral Click Affricate, Places.Uvular)
    let I65 = Imp(Ejective Tenuis Lateral Click Affricate, Places.Pharyngeal)
  end

  let AllSegments = Results.UsedSegments + ImpossibleSegments

  with DiacriticModifiers
    let UndefinedEscapeCharacter     = Diac("Undefined escape character", null, "*")
    let Nasalized                    = Diac("Nasalized", "\u0303", "_~")
    let Centralized                  = Diac("Centralized", "\u0308", "_\"")
    let Advanced                     = Diac("Advanced", "\u031F", "_+")
    let Retracted                    = Diac("Retracted", "\u0320", "_-")
    let RisingTone                   = Diac("RisingTone ", "\u030C", "_R")
    let Voiceless                    = Diac("Voiceless", "\u0325", "_0")
    let Implosive                    = Diac("Implosive", null, "_<")
    let Syllabic                     = Diac("Syllabic", "\u0329", "_=")
    let Ejective                     = Diac("Ejective", "\u02BC", "_>")
    let Pharyngealized               = Diac("Pharyngealized ", "\u02E4", "_?\\")
    let FallingTone                  = Diac("Falling tone", "\u0302", "_F")
    let NonSyllabic                  = Diac("Non-syllabic", "\u032F", "_^")
    let NoAudibleRelease             = Diac("No audible release", "\u031A", "_}")
    let RhoticHook                   = Diac("Rhotic hook", "\u02DE", "`")
    let AdvancedTongueRoot           = Diac("Advanced tongue root ", "\u0318", "_A")
    let Apical                       = Diac("Apical", "\u033A", "_a")
    let ExtraLowTone                 = Diac("Extra low tone", "\u030F", "_B")
    let LowRisingTone                = Diac("Low rising tone", "\u1DC5", "_B_L")
    let LessRounded                  = Diac("Less rounded", "\u031C", "_c")
    let Dental                       = Diac("Dental", "\u032A", "_d")
    let VelarizedOrPharyngealized    = Diac("Velarized or Pharyngealized", "\u0334", "_e")
    let GlobalFall                   = Diac("Global fall", "\u2198", "<F>")
    let Velarized                    = Diac("Velarized", "\u02E0", "_G")
    let HighTone                     = Diac("High tone", "\u0301", "_H")
    let HighRisingTone               = Diac("High rising tone", "\u1DC4", "_H_T")
```

```
    let Aspirated                    = Diac("Aspirated", "\u02B0", "_h")
    let Palatalized                  = Diac("Palatalized", "\u02B2", "_j")
    let CreakyVoiced                 = Diac("Creaky voiced", "\u0330", "_k")
    let LowTone                      = Diac("Low tone", "\u0300", "_L")
    let LateralRelease               = Diac("Lateral release", "\u02E1", "_l")
    let MidTone                      = Diac("Mid tone", "\u0304", "_M")
    let Laminal                      = Diac("Laminal", "\u033B", "_m")
    let LinguoLabial                 = Diac("Linguo-Labial", "\u033C", "_N")
    let NasalRelease                 = Diac("Nasal release", "\u207F", "_n")
    let MoreRounded                  = Diac("More rounded", "\u0339", "_O")
    let Lowered                      = Diac("Lowered", "\u031E", "_o")
    let RetractedTongueRoot          = Diac("Retracted tongue root", "\u0319", "_q")
    let GlobalRise                   = Diac("Global rise", "\u2197", "<R>")
    let RisingFallingTone            = Diac("Rising falling tone", "\u1DC8", "_R_F")
    let Raised                       = Diac("Raised", "\u031D", "_r")
    let ExtraHighTone                = Diac("Extra high tone", "\u030B", "_T")
    let BreathyVoiced                = Diac("Breathy voiced", "\u0324", "_t")
    let Voiced                       = Diac("Voiced", "\u032C", "_v")
    let Labialized                   = Diac("Labialized", "\u02B7", "_W")
    let ExtraShort                   = Diac("Extra short", "\u02D8", "_X")
    let MidCentralized               = Diac("Mid-centralized", "\u033D", "_x")
    let Downstep                     = Diac("Down-step", "↓", "!")
    let Upstep                       = Diac("Up-step", "↑", "^")
    let SylableBreak                 = Diac("Sylable break", ".", ".")
    let PrimaryStress                = Diac("Primary stress", "ˈ", "\"")
    let SecondaryStress              = Diac("Secondary stress", "ˌ", "%")
    let Long                         = Diac("Long", "ː", ":")
    let HalfLong                     = Diac("Half-long", "ˑ", ":\\")
    let IndeterminacyinFrenchVowels  = Diac("Indeterminacy in french vowels", null, "/")
    let BeginNonsegmentalNotation    = Diac("Begin Non-segmental notation", null, "<")
    let Endnonsegmentalnotation      = Diac("End non-segmental notation", "", ">")
    let Voicedepiglottalfricative    = Diac("Voiced epiglottal fricative", "ʢ", "<\\")
    let Postalveolarclick            = Diac("Post-alveolar click", "!", "!\\")
    let MinorGroup                   = Diac("Minor group", " | ", " | ")
    let Dentalclick                  = Diac("Dental click", "|", " | \\")
    let MajorGroup                   = Diac("Major group", "‖", " |  | ")
    let Alveolarlateralclick         = Diac("Alveolar lateral click", "‖", " | \\ | \\")
    let Palatalclick                 = Diac("Palatal click", "ǂ", "")
//    let Linkingmark                  = Diac("Linking Mark", "\u203f", "-\\")
    let VoicelessDescender           = Diac("Voiceless descender", "\u030A", "")
    let CombiningMacron              = Diac("Combining macron", "\u0331", "")
    let TieBarBelow                  = Diac("Tie-bar below", "\u035C", "")
    let TieBarAbove                  = Diac("Tie-bar above", "\u0361", "")
    let ReadyMadeCombination         = Diac("Ready made combination", "\u026B", "")
    let Becomes                      = Diac("Becomes", "→", "")
    let Separator                    = Diac("Separator", "", "-")
  end

  //======================================================================

  let HasFeature(feature, f)     = (feature & f) != NoFeature
  let NotFeature(feature, f)     = (feature & f) == NoFeature
  let HasMask(feature, mask, f) = (feature & mask) == (f & mask)

  //======================================================================

  let SegmentColumns = 4
  let SegmentSize    = 40 pts

  let ShowSampa(sampa) = Span {
    Style.MonoFamily,
    sampa,
  }

  let SegmentName(segment) = Span {
    if (segment.Features.HasFeature(Vowel))
      segment.Open,
      Space,
      segment.Backness,
    else
      segment.Place,
    end,
    Space,
    Span {
      Separator: Space,
      if (segment.Features.HasFeature(Diacritic))
        segment.Description
      else
        each segment.Features,
      end
    }
  }

  let ShowCodePoint(c) = {Style.MonoFamily, TextRadix: 16, TextDigits: 4} Type.Integer(c)

  let CodePoints(text) = Span {
    Separator: Lang.Separator,
    if (text)
      ShowCodePoint(each text)
    end
  }

  let SegmentDisplay(segment, location) = Block {
    ParAlignment: ParAlignments.Center,
    Paragraph {
      LocationMark: location,
      SpaceBefore: 8 pts,
      SpaceAfter: 8 pts,
      TextHeight: SegmentSize,
      Style.IPAFamily,
      SpaceAfter: SegmentSize * 0.125,
      segment.Text,
    },
    Paragraph {
      TextHeight: 10 pts,
      SegmentName(segment),
    },
    Paragraph {
      TextHeight: 8 pts,
      ParBackground: 95%,
      CodePoints(segment.Text),
    },
    Paragraph {
      TextHeight: 8 pts,
      if (segment.Sampa and segment.Sampa.Length > 0)
        ParBackground: 90%,
        ShowSampa(segment.Sampa)
      else
        if (segment.Text.Length > 0)
          ParBackground: Colors.Red,
//        Assert(false, "Missing Sampa definition"),
        end
      end
    },
  }

  let SegmentPopup(segment) = Frame {
    Width: 2 inches,
    SegmentDisplay(segment, null)
  }

  let SegmentCell(ref segment) = Cell {
    Edge: 0.25 pts {Color: Colors.LightGray},
    Padding: 2 pts,
    SegmentDisplay(segment, segment.FullSymbolName)
  }

  let SegmentRow(segments) = Row {
    SegmentCell(each segments)
  }

  let AlphaOrder(x, y) begin
    var cl = Math.Compare(x.Text.Length, y.Text.Length);
    if (cl == 0)
      cl = -Math.Compare(x.Text, y.Text)
    end
    return cl;
  end

  let SortedSegments = Results.UsedSegments.Sort(false, AlphaOrder)
  let SegmentTable = Block {
    Table {
      Columns: [Metrics.Content.Width / SegmentColumns] * SegmentColumns,
      Style.TitleBar(Lang.IPAListing, SegmentColumns),
      SegmentRow(each (SortedSegments / SegmentColumns))
    },
    Style.TableNotes
  }

  let CharacterPopup(word) = Frame {
    Width: 2 inches,
    TextHeight: 14 pts,
    ParAlignment: ParAlignments.Center,
    Paragraph {
      ShowIPA(word),
      SpaceAfter: 8 pts,
    },
    Paragraph {
      TextColor: Colors.Red,
      "\"",
      ShowSampa(word.Sampa),
      "\"",
    },
  }

  let ShowIPA(word) = Span {
    (each WordToSegments(word)).Text
  }

  let ShowCharacter(c) = Span {
    Popup: SegmentPopup.Call(c.Segment),
//    Link: c.Segment.FullSymbolName,
    c.Character
  }

  let ShowSegment(ref segment, flags=Impossible) = Span {
    Style.IPAFamily,
    Popup: SegmentPopup.Call(segment),
//    Link: segment.FullSymbolName,
    if (segment.Features.HasFeature(flags))
      Assert(false, Lang.Impossible),
      TextColor: Colors.Red,
    end,
    if (segment.Features.HasFeature(Diacritic))
      "  ",
    end,
    segment.Text
  }

  let SegmentSound(ref segment) begin
    if (segment == SpaceSegment)
      return Space;
    end
    return segment.SymbolName
  end

  let LangHasMeaning(word, meaning) = word.Meaning == meaning
  let FindWordsWithMeaning(ref language, meaning) = language.Words.FindSlice(LangHasMeaning, meaning)

  //======================================================================
  // Build a dictionary with SAMPA text as the key
  //======================================================================

  let GatherText(set, ref segment) begin
    if (segment.Sampa.Length > 0)
      set.AddElement(segment.Sampa, ref segment)
    end
  end

  let SampaSet begin
    var set = Type.Dictionary(128);
    GatherText(set, each Segments);
    set.AddElement(" ", ref SpaceSegment);
    return set;
```

```
end

// Convert SAMPA text to an array of segment references
let WordToSegments(word) = SampaSet.FindTokens(word.Sampa, ref NoSegment)

//=======================================================================
// Code for Euler segment diagram
//=======================================================================

let ChartSize = 6 inches
let EX(x)     = ChartSize * x * 0.01
let EY(y)     = ChartSize * y * 0.01

let Enclosure(x, y, w, h, color) begin
  var size = Size(EX(w), EY(h));
  return Canvas {
    X: EX(x),
    Y: EY(y),
    Size: size,
    Figure {
      Stroke: 1 pts,
      Fill: color,
      Rectangle(Rect(0, size), Size(6 pts))
    }
  }
end

let NameBox(name, angle=0) = Paragraph {
  Transform: Rotate(angle),
  Space,
  name Bold,
  Space,
}

let MatchFeature(segment, data) = HasMask(segment.Features, FeatureMask, data)
let FeatureSegments(features)   = Results.UsedSegments.FindSlice(MatchFeature, features)

let FeatureFrame(x, y, width, name, features) = Canvas {
  X: EX(x),
  Y: EY(y),
  Frame {
    Width: EX(width),
    ParAlignment: ParAlignments.Center,
    if (name)
      name Bold,
    end,
    Paragraph {
      Separator: Space,
      IPA.ShowSegment(each FeatureSegments(features))
    }
  }
}

let VNameFrame(name, x, y, width, height, color) = Enclosure(x, y, width, height, color) {
  VAlign: VAligns.Center,
  NameBox(name, 90 degrees)
}

let FeatureChart = Canvas {
  TextHeight: 16 pts,

  VNameFrame(Lang.Occlusive, 10, 0, 90, 34, Color(255, 238, 238)) {
    HAlign: HAligns.Right,
  },
  VNameFrame(Lang.Continuant, 10, 35, 90, 37, Color(229, 255, 255)) {
    HAlign: HAligns.Right,
  },
  VNameFrame(Lang.Obstruent, 0, 11, 94, 40, Color(238, 238, 255, 50%)),
  VNameFrame(Lang.Vocoid, 0, 52, 78, 21, Color(238, 255, 238, 50%)),
  VNameFrame(Lang.Vibrant, 20, 74, 65, 17, Color(238, 238, 255)),

  Enclosure(11, 1, 83, 9, Color(255, 246, 246)),    // Nasals
  Enclosure(31, 12, 62, 21, Color(246, 242, 250)),  // Affricates
  Enclosure(11, 12, 19, 21, Color(246, 243, 250)),  // Plosives
  Enclosure(11, 36, 80, 14, Color(240, 247, 255)),  // Fricatives
  Enclosure(25, 75, 59, 7, Color(247, 247, 255)) {
    HAlign: HAligns.Left,
    VAlign: VAligns.Center,
    NameBox(Lang.TapFlap),
  },
  Enclosure(25, 83, 53, 7, Color(247, 247, 255)) {
    HAlign: HAligns.Left,
    VAlign: VAligns.Center,
    NameBox(Lang.Trill),
  },

  Enclosure(53, 13, 39, 36, Color(233, 248, 235, 50%)) {
    HAlign: HAligns.Center,
    NameBox(Lang.Strident),
  },

  Enclosure(62, 18, 25, 24, Color(245, 252, 220, 50%)), // Sibilants
  Enclosure(11, 53, 21, 18, Color(240, 255, 247)),      // Vowels
  Enclosure(33, 53, 61, 18, Color(240, 255, 247, 50%)) {
    HAlign: HAligns.Left,
    NameBox(Lang.Approximant),
  },

  Enclosure(35, 59, 21, 11, Color(248, 255, 225)), // Semivowels

  Enclosure(64, 43, 26, 59, Color(255, 238, 238, 50%)) {
    HAlign: HAligns.Center,
    VAlign: VAligns.Bottom,
    NameBox(Lang.Liquid),
  },

  Enclosure(65, 44, 14, 52, Color(255, 247, 221, 50%)) {
    HAlign: HAligns.Center,
    VAlign: VAligns.Bottom,
    NameBox(Lang.Rhotic),
  },

  Enclosure(80, 44, 9, 44, Color(238, 247, 230, 70%)) {
    HAlign: HAligns.Right,
    VAlign: VAligns.Bottom,
    NameBox(Lang.Lateral, 90 degrees),
  },

  FeatureFrame(11, 1, 84, Lang.Nasal, Nasal Occlusive),
  FeatureFrame(12, 14, 17, Lang.Plosive, Stop Occlusive),
  FeatureFrame(32, 14, 20, Lang.Affricate, Affricate Occlusive),
  FeatureFrame(54, 20, 7, null, Affricate Occlusive Strident),
  FeatureFrame(65, 18, 18, Lang.Sibilant, Affricate Occlusive Strident Sibilant),
  FeatureFrame(14, 38, 22, Lang.Fricative, Fricative Obstruent Continuant),
  FeatureFrame(54, 38, 6, null, Fricative Obstruent Continuant Strident),
  FeatureFrame(64, 36, 20, null, Fricative Obstruent Continuant Strident Sibilant),
  FeatureFrame(66, 44, 10, null, Fricative Obstruent Continuant Strident Rhotic Liquid),
  FeatureFrame(80, 44, 10, null, Fricative Obstruent Continuant Strident Lateral Liquid),
  FeatureFrame(12, 53, 19, Lang.Vowel, Vowel Vocoid Continuant),
  FeatureFrame(36, 60, 19, Lang.SemiVowel, Vocoid Semivowel Approximant Continuant),
  FeatureFrame(57, 62, 5, null, Vocoid Approximant),
  FeatureFrame(66, 60, 10, null, Vocoid Approximant Rhotic Liquid),
  FeatureFrame(82, 58, 5, null, Vocoid Approximant Rhotic Liquid Lateral),
  FeatureFrame(54, 76, 10, null, Vibrant TapFlap),
  FeatureFrame(66, 76, 10, null, Vibrant TapFlap Rhotic Liquid),
  FeatureFrame(77, 77, 10, null, Vibrant TapFlap Rhotic Liquid Lateral),
  FeatureFrame(54, 84, 10, null, Vibrant Trill),
  FeatureFrame(66, 84, 10, null, Vibrant Trill Rhotic Liquid),
}
//=====================================================================
// Code for drift diagram
//=====================================================================

let RowHeight  = 8 pts
let BoxWidth   = 5 pts
let BorderSize = 0.33 pts

let FeatureSet = [
  Voiced, Rounded, Velarized, Ejective,
  Pulmonic, Nasal, Tenuis, Lateral, Sibilant,
  Fricative, Approximant, Implosive, Central, TapFlap,
  Trill,
  Stop,
  Click,
  Affricate,
  Vowel,
  Rhotic,
  Occlusive,
  Strident,
  Obstruent,
  Continuant,
  Vibrant,
  Vocoid,
  Liquid,
  Semivowel,
  LongVowel,
]

let FeaturePopup(feature) = Frame {
  Width: 2 inches,
  Paragraph {
    feature.Name
  }
}

let FeatureHeader(feature) = Canvas {
  Height: RowHeight,
  Width: BoxWidth,
  Span {
    Popup: FeaturePopup.Call(feature),
    feature.Abreviation,
  },
}

let FeatureBox(feature, features0, features1) = Canvas {
  Height: RowHeight,
  Width: BoxWidth,
  if (features0.HasFeature(feature))
    if (not features1.HasFeature(feature))
      Background: Colors.Red,
    end
  else
    if (features1.HasFeature(feature))
      Background: Colors.Green,
    end
  end
}

let FeatureSegment(ref segment0, ref segment1) = Group {
  Height: RowHeight,
  BorderL: BorderSize,
  FeatureBox(each FeatureSet, segment0.Features, segment1.Features),
}

let DriftWords(line0, line, index) = Group {
  Vertical: true,
  FeatureSegment(line0.Segments[index], line.Segments[index]),
}

let DriftLang(line) = Canvas {
  PaddingLR: 3 pts,
  VAlign: VAligns.Center,
  Width: 1 inch,
  Height: RowHeight,
  Paragraph {
    ShowSegment(each line.Segments)
  },
}

let DriftWord(lines, index) = Group {
  Vertical: true,
  Group {
    FeatureHeader(each FeatureSet),
    BorderB: BorderSize,
    },
    DriftWords(lines[0], each lines, index)
  }

  let SegmentLength(line) = line.Segments.Length
  let MinLength(lines)    = Math.Min([3] + SegmentLength(each lines))

  let DriftChart(lines) = Group {
    TextHeight: RowHeight,
    Border: BorderSize,
    Group {
      Vertical: true,
      DriftLang(each lines),
    },
    DriftWord(lines, each 0..<MinLength(lines))
  }

  let DriftMeaning(meaning) begin
    var lines = Results.GetGeneText(meaning, each Results.UsedLanguages);

    return Group {
      MarginB: 8 pts,
      Vertical: true,
      Paragraph {
        Lang.Meaning, ": ",
        meaning Bold,
      },
      DriftChart(lines),
    }
  end

  let DriftSection = Block {
    DriftMeaning(each Results.UsedMeanings)
  }
end
```

Style.nytril

```
using Type, Format, Units, Math, IO
//========================================================================

with Metrics
  let MarginL     = 0.75 inches
  let MarginR     = MarginL
  let MarginT     = 0.5 inches
  let MarginB     = 0.4 inches
  let Paper       = Type.Size(8.5 inches, 11 inches)
  let Content     = Type.Size(Paper.Width - MarginL - MarginR, Paper.Height - MarginT - MarginB)
  let TableSpace  = 24 pts
  let TreeWidth   = Content.Width

  let BoxSize     = Type.Size(18 pts, 20 pts)
  let CellSize    = Type.Size(BoxSize.Width * 2, BoxSize.Height)
end
//========================================================================

with Style
  let MainFamily           = {TextFamily: TextFamilies.TimesNewRoman}
  let SansSerif            = {TextFamily: TextFamilies.Calibri}
  let MonoFamily           = {TextFamily: TextFamilies.Consolas}
  let IPAFamily            = {TextFamily: TextFamilies.CambriaMath} // Also can be "Linux Libertine O"

  let ImpossibleBackground = {Background: 80%}
  let Used                 = {TextColor: Colors.Red}
  let TitleBackground      = {Background: 90%}
  let TableEdge            = {Edge: 0.3 pts}
  let ColumnEdge           = {EdgeR: 0.3 pts}
  let SegmentBottom        = {EdgeB: 0.25 pts {Color: 80%}}


  let RowBar(i) = {
    if (i mod 2 != 0)
      Background: 95%
    end
```

```
}

let WhitePaper = Document {
  Size: Metrics.Paper,
  MainFamily,
  TextHeight: 11.5 pts,
  MarginL: Metrics.MarginL,
  MarginR: Metrics.MarginR,
  MarginT: Metrics.MarginT,
  MarginB: Metrics.MarginB,
}

let NormalHeader(text) = Block {
  Span {{TextUppercase: true} text}
}

let PageSection = Section {
  SectionBreak: SectionBreaks.NextPage,
  Footer: Block {
    Distance: 0.5 inches,
    ParAlignment: ParAlignments.Center,
    PageNumber
  },
}

let TableNotes = Paragraph {
  SpaceAfter: Metrics.TableSpace,
}

let TitleWord(text) = Span {
  text[0],
  {TextHeight: 60%} text[1..]
}

let TitleCase(text) = Span {
  if (text)
    TextUppercase: true,
    Separator: Space,
    TitleWord(each text.Split(Space))
  end
}

let Title(text) = Paragraph {
  KeepWithNext: true,
  SpaceBefore: 12 pts,
  SpaceAfter: 6 pts,
  ParAlignment: ParAlignments.Center,
  TextHeight: 18 pts,
  text
}

let HeaderCentered(text) = Paragraph {
  KeepWithNext: true,
  SpaceBefore: 12 pts,
  SpaceAfter: 6 pts,
  ParAlignment: ParAlignments.Center,
  TitleCase(text)
}

let Header1(text) = Paragraph {
  KeepWithNext: true,
  SpaceBefore: 18 pts,
  SpaceAfter: 8 pts,
  TitleCase(text)
}

let Header2(text) = Paragraph {
  KeepWithNext: true,
  SpaceBefore: 12 pts,
  SpaceAfter: 6 pts,
  TextHeight: 14 pts,
  text
}

let Header3(text) = Paragraph {
  KeepWithNext: true,
  Border: 0.25 pts,
  ParBackground: 97%,
  SpaceAfter: 12 pts,
  TextHeight: 14 pts,
  text
}

let SourceFile(ref source) = Block {
  Style.Header3(source.Path.GetFileName),
  Paragraph {
    LeftIndent: 0.25 inches,
    ParAlignment: ParAlignments.Left,
    Style.MonoFamily,
    TextHeight: 8 pts,
    SourceSelection(source)
  }
}

let SourceCodeBlock = TextBlock {
  Style.MonoFamily,
  TextHeight: 10 pts,
  ParBackground: 97%,
}

let Author(author) = Span {
  Link: author.FullSymbolName,
  author.Title,
}

let Collect(list, node) begin
  if (node.Label)
    list.AddElement(node.Label, node)
  end
  Collect(list, each node);
end

let GetTimes(node) begin
  var list = Type.List(100);
  Collect(list, node);
  return list[1..];
end

let ByYear(x, y) = x.Branch.Compare(y.Branch)

let TimelineNodes = GetTimes(Info.LanguageTree).Sort(true, ByYear)

let TimelineRow(options, node) = Group {
  X: options.Width - options.Width * node.Branch / options.MaxYear,
  Figure {
    Fill: Colors.Green,
    Rectangle(Type.Rect(Type.Point(0), Type.Size(5, options.TextHeight)))
  },
  Paragraph {
    Space,
    node.Label,
  }
}

let ShowTimeline(options) = Group {
  Vertical: true,
  TextHeight: options.TextHeight,
  TimelineRow(options, each TimelineNodes),
  Group {
    Vertical: true,
    Background: 90%,
    ChartAxis {
      Width: options.Width,
      Start: options.MaxYear,
      Stop: 0,
    },
    Frame {
      HAlignment: HAligns.Center,
      "Years"
    }
  }
}

let ShowLanguageTree = Block {
  ShowTree(Info.LanguageTree),
  Header2("Last Branch"),
  ShowTimeline({
    Width: Metrics.TreeWidth,
    TextHeight: 10 pts,
    MaxYear: Math.Max((each TimelineNodes).Branch)
  })
}

let ShowTree(tree) = Group {
  Vertical: true,
  Tree {
    Curvature: 30%,
    Bevel: 20%,
    Marker: {Style.IPAFamily, TextHeight: 4 pts}Chars.Circle {TextColor: Colors.Gray},
    Width: Metrics.TreeWidth,
    ValueLabel: Lang.Years,
    ValueAxis: ChartAxis,
    tree
  },
}

let ShowAbstract(content) = Block {
  HeaderCentered(content.Title),
  Block {
    content.Body
  }
}

let ShowContent(content) = Block {
  Header1(content.Title),
  Block {
    content.Body
  }
}

let ShowAuthorFull(author) = Block {
  LeftIndent: 0.25 inches,
  Paragraph {
    LocationMark: author.FullSymbolName,
    FirstIndent: -0.25 inches,
    Span {
      Separator: Space,
      if (author.Website)
        Link: author.Website,
      end,
      author.First, author.Middle, author.Last,
    }
  },
  Span {
    Separator: Lang.Separator,
    author.Address
  },
  Span {"{0}: "(Lang.EMail), author.EMail},
  Empty
}

let AppendixRow(appendix) = Paragraph {
  LeftIndent: 20 pts,
  FirstIndent: -20 pts,
  EachIndex + 1,
  ")",
  Tab,
  Span {
    Link: Lang.Appendix + EachIndex,
    appendix.Title
  }
}

let ShowAppendixTable = Block {
  HeaderCentered(Lang.Appendices),
  AppendixRow(each Appendix)
}

let ShowAuthors(authors) = Block {
  HeaderCentered(Lang.Authors),
  ShowAuthorFull(each authors),
}

let ShowReference(ref r) = Paragraph {
  LeftIndent: 0.25 inches,
  FirstIndent: -0.25 inches,
  if (r.Author)
    TitleCase(r.Author),
    if (r.Title)
      Lang.Separator,
      r.Title,
    end,
  else
    r.Title
  end,
  if (r.Year)
    Lang.Separator,
    r.Year,
  end,
  if (r.Publisher)
    Lang.Separator,
    Italic r.Publisher,
    r.Page,
  end,
  if (r.Link)
    ". : ",
     Span {
       Link: r.Link,
       TextColor: Colors.DarkBlue,
       r.Link
      }
  end,
}

let ShowReferences(references) = Block {
  HeaderCentered(Lang.References),
  ShowReference(each references)
}

let ShowAppendix(appendix) = PageSection {
  Paragraph {
    BorderB: 1 pts,
    ParAlignment: ParAlignments.Center,
    TextHeight: 14 pts,
    SpaceAfter: 8 pts,
    LocationMark: Lang.Appendix + EachIndex,
    "{0} {1} - "(Lang.Appendix, EachIndex+1),
    appendix.Title,
  },
  Block {
    appendix.Content
  }
}

let LanguageRow(lang) = Row {
  Background: ((EachIndex mod 2) == 0 ? Colors.White : 97%),
  lang.Name,
}

let ShowLanguageList(list) = Table {
  PaddingLR: 2,
  Columns: [1.5 inch],
  Row {
    Background: Colors.DarkGray,
    TextColor: Colors.White,
    Lang.Name,
  },
  Edge: 0.25 pts {Color: Colors.DarkGray},
  LanguageRow(each list)
}
```

```
  let HeaderCell(d, halign=HAligns.Left) = Cell {
    HAlign: halign,
    VAlign: VAligns.Center,
    Style.SansSerif,
    Style.TitleBackground,
    EdgeB: 1 pts,
    Padding: 2 pts,
    d
  }

  let TitleBar(name, columns) = Row {
    Cell {
      Padding: 2 pts,
      ParAlignment: ParAlignments.Center,
      Background: 40%,
      TextHeight: 16 pts,
      TextColor: Colors.White,
      ColumnSpan: columns,
      name
    }
  }
end
//======================================================================

let Logo = Frame {
  Width: 5 inches,
  Height: 0.5 inches,
  Padding: 4 pts,
  Background: Type.Color(51, 66, 81),
  Table {
    Columns: [4.3 inches, 0.6 inches],
    Row {
      Block {
        "Transactions of the" {TextColor: Type.Color(129, 166, 207), Bold, TextHeight: 12 pts},
        "Bayesian Society" {Bold, TextHeight: 20 pts, TextColor: Colors.White}
      },
      Read(Folders.Source FileName("bayes") Extensions.PNG) {Width: 0.5 inches}
    }
  }
}
//======================================================================
```

References.nytril

```
using IO, Format
//======================================================================

with Authors
  with DMGoldstein
    let Title  = "D. M. Goldstein"
    let First  = "David"
    let Middle = "M."
    let Last   = "Goldstein"
    let Address = ["UCLA", "Los Angeles, CA 90095-1543", "USA"]
    let Website = Domain("https://linguistics.ucla.edu") Folder("person") Folder("david-goldstein")
    let EMail   = "dgoldstein@humnet.ucla.edu"
  end

  with JPHuelsenbeck
    let Title  = "J. P. Huelsenbeck"
    let First  = "John"
    let Middle = "P."
    let Last   = "Huelsenbeck"
    let Address = ["UC Berkeley", "3040 Valley Life Sciences Building #3140", "Berkeley, CA 94720-3140", "USA"
]
    let Website = Domain("https://vcresearch.berkeley.edu") Folder("faculty") Folder("john-huelsenbeck")
    let EMail   = "johnh@berkeley.edu"
  end

  with SHMcCreight
    let Title  = "S. H. McCreight"
    let First  = "Shawn"
    let Middle = "H."
    let Last    = "McCreight"
    let Address = ["3060 San Pasqual St.", "Pasadena, CA 91107", "USA"]
    let Website = Domain("https://nytril.com")
    let EMail   = "shawn.mccreight@gmail.com"
  end
end
//======================================================================

let WikipediaLink(name) = Domain("en.wikipedia.org") Folder("wiki") Folder(name)

with References
  with RevBayes
    let Author    = "Höhna, Landis, Heath, Boussau, Lartillot, Moore, Huelsenbeck, Ronquist"
    let Year      = 2016
    let Title     = "RevBayes: Bayesian phylogenetic inference using graphical models and an interactive
model-specification language"
    let Publisher = "Systematic Biology"
    let Pages     = "65:726-736"
    let Link      = Domain("http://www.revbayes.com")
  end

  with WordLists
    let Author    = null
    let Year      = 2019
    let Title     = "IPA Symbols Chart Complete"
    let Publisher = "InternationalPhoneticAlphabet.org"
    let Link      = Domain("http://www.internationalphoneticalphabet.org") Folder("ipa-charts") Folder("ipa-
symbols-chart-complete")
  end

  with IPAInformation
    let Author    = null
    let Year      = 2019
    let Title     = "IPA Symbols Chart Complete"
    let Publisher = "InternationalPhoneticAlphabet.org"
    let Link      = Domain("http://www.internationalphoneticalphabet.org") Folder("ipa-charts") Folder("ipa-
symbols-chart-complete")
  end

  with IPAWikipedia
    let Author    = null
    let Year      = 2019
    let Title     = "International Phonetic Alphabet"
    let Publisher = "Wikipedia"
    let Link      = WikipediaLink("International_Phonetic_Alphabet")
  end

  with ASJP
    let Author    = "Wichmann, Søren, Eric W. Holman, and Cecil H. Brown (eds.)"
    let Year      = 2018
    let Title     = "The ASJP Database (version 18)"
    let Publisher = "ASJP"
    let Link      = Domain("asjp.clld.org")
  end

  with XSAMPA
    let Author    = null
    let Year      = 2016
    let Title     = "Extended Speech Assessment Methods Phonetic Alphabet"
    let Publisher = "Wikipedia"
    let Link      = WikipediaLink("X-SAMPA")
  end

  with DistinctiveFeature
    let Author    = null
    let Year      = 2020
    let Title     = "Distinctive Feature"
    let Publisher = "Wikipedia"
    let Link      = WikipediaLink("Distinctive_feature")
  end

  with Lunter
    let Author    = "G. A. Lunter, I. Miklós, Y. S. Song, and J. Hein"
    let Year      = 2003
    let Title     = "An Efficient Algorithm for Statistical Multiple Alignment on Arbitrary Phylogenetic
```

```
Trees"
    let Publisher = "Journal Of Computational Biology"
  end
end
//======================================================================
```

WordForms.nytril

```
//======================================================================

using WordMeanings

with WordMeanings
  let I         = enum
  let You       = enum
  let We        = enum
  let This      = enum
  let That      = enum
  let Who       = enum
  let What      = enum
  let Not       = enum
  let All       = enum
  let Many      = enum
  let One       = enum
  let Two       = enum
  let Big       = enum
  let Long      = enum
  let Small     = enum
  let Woman     = enum
  let Man       = enum
  let Person    = enum
  let Fish      = enum
  let Bird      = enum
  let Dog       = enum
  let Louse     = enum
  let Tree      = enum
  let Seed      = enum
  let Leaf      = enum
  let Root      = enum
  let Bark      = enum
  let Skin      = enum
  let Flesh     = enum
  let Blood     = enum
  let Bone      = enum
  let Grease    = enum
  let Egg       = enum
  let Horn      = enum
  let Tail      = enum
  let Feather   = enum
  let Hair      = enum
  let Head      = enum
  let Ear       = enum
  let Eye       = enum
  let Nose      = enum
  let Mouth     = enum
  let Tooth     = enum
  let Tongue    = enum
  let Claw      = enum
  let Foot      = enum
  let Knee      = enum
  let Hand      = enum
  let Belly     = enum
  let Neck      = enum
  let Breast    = enum
  let Heart     = enum
  let Liver     = enum
  let Drink     = enum
  let Eat       = enum
  let Bite      = enum
  let See       = enum
  let Hear      = enum
  let Know      = enum
  let Sleep    = enum
  let Die      = enum
  let Kill     = enum
  let Swim     = enum
  let Fly      = enum
  let Walk     = enum
  let Come     = enum
  let Lie      = enum
  let Sit      = enum
  let Stand    = enum
  let Give     = enum
  let Say      = enum
  let Sun      = enum
  let Moon     = enum
  let Star     = enum
  let Water    = enum
  let Rain     = enum
  let Stone    = enum
  let Sand     = enum
  let Earth    = enum
  let Cloud    = enum
  let Smoke    = enum
  let Fire     = enum
  let Ash      = enum
  let Burn     = enum
  let Path     = enum
  let Mountain = enum
  let Red      = enum
  let Green    = enum
  let Yellow   = enum
  let White    = enum
  let Black    = enum
  let Night    = enum
  let Hot      = enum
  let Cold     = enum
  let Full     = enum
  let New      = enum
  let Good     = enum
  let Round    = enum
  let Dry      = enum
  let Name     = enum
end

let Def(meaning, sampa) = {
  Meaning: meaning,
  Sampa: sampa,
}
//=======================================================================

let WordList.Catalan = [
  Def(I, "Zo"),
  Def(You, "tu"),
  Def(We, "nuzaltr3s"),
  Def(One, "un"),
  Def(Two, "dos"),
  Def(Person, "p3rson3"),
  Def(Fish, "peS"),
//  Def(Dog, "gos"),
  Def(Dog, "k3"),
  Def(Louse, "poL"),
  Def(Tree, "abr3"),
  Def(Leaf, "fuL3"),
  Def(Skin, "peL"),
  Def(Blood, "saN"),
  Def(Bone, "os"),
  Def(Horn, "korn"),
  Def(Horn, "ba53"),
  Def(Ear, "urEL3"),
  Def(Eye, "uL"),
  Def(Nose, "nas"),
  Def(Tooth, "den"),
  Def(Tongue, "LeNgw~3"),
  Def(Knee, "j3noL"),
  Def(Hand, "ma"),
  Def(Breast, "pit"),
  Def(Liver, "fej3"),
  Def(Drink, "bEur3"),
  Def(See, "bEur3"),
  Def(Hear, "s3nti"),
  Def(Die, "muri"),
  Def(Come, "b3ni"),
  Def(Sun, "sol"),
  Def(Star, "3streL3"),
  Def(Water, "aixw~3"),
  Def(Stone, "pe8r3"),
  Def(Fire, "fok"),
  Def(Path, "k3mi"),
  Def(Mountain, "mon"),
  Def(Night, "nit"),
  Def(Full, "plE"),
  Def(New, "nou"),
  Def(Name, "nom"),
]
//======================================================================

let WordList.French = [
  Def(I, "j3"),
  Def(You, "ti"),
//  Def(You, "vu"),
  Def(We, "nu"),
  Def(This, "s3si"),
  Def(That, "s3la"),
  Def(Who, "ki"),
  Def(What, "kwa"),
  Def(Not, "n3 pa"),
  Def(All, "tu"),
  Def(Many, "boku"),
  Def(One, "oe*"),
  Def(Two, "de"),
  Def(Big, "gra*"),
  Def(Long, "lo*"),
  Def(Small, "p3ti"),
  Def(Woman, "fam"),
  Def(Man, "om"),
  Def(Person, "om"),
  Def(Fish, "pw~aso*"),
  Def(Bird, "wazo"),
  Def(Dog, "Sia*"),
  Def(Louse, "pu"),
  Def(Tree, "arbr3"),
  Def(Seed, "gran"),
  Def(Leaf, "f3y"),
  Def(Root, "rasin"),
  Def(Bark, "ekors"),
  Def(Skin, "po"),
  Def(Flesh, "vy~a*d"),
  Def(Blood, "sa*"),
  Def(Bone, "os"),
  Def(Grease, "grais"),
  Def(Egg, "3f"),
  Def(Horn, "korn"),
  Def(Tail, "ke"),
  Def(Feather, "ply~m"),
  Def(Hair, "S3ve"),
  Def(Head, "t3t"),
  Def(Ear, "ore"),
  Def(Eye, "3y"),
  Def(Nose, "ne"),
  Def(Mouth, "buS"),
  Def(Tooth, "da*"),
  Def(Tongue, "la*g"),
  Def(Claw, "o*gl"),
  Def(Foot, "py~e"),
  Def(Knee, "j3nu"),
  Def(Hand, "ma*"),
  Def(Belly, "va*tr"),
  Def(Neck, "ku"),
  Def(Breast, "pw~atrin"),
  Def(Heart, "k3r"),
  Def(Liver, "fw~a"),
  Def(Drink, "bw~a"),
  Def(Eat, "ma*g"),
  Def(Bite, "mord"),
  Def(See, "vw~a"),
  Def(Hear, "o*ta*dr"),
  Def(Know, "savw~a"),
  Def(Sleep, "dormi"),
  Def(Die, "muri"),
  Def(Kill, "tue"),
  Def(Swim, "naje"),
  Def(Fly, "vw~ale"),
  Def(Walk, "marSe"),
  Def(Come, "v3ni"),
  Def(Lie, "seta*dr"),
  Def(Lie, "etra*da*dE"),
  Def(Sit, "sasw~a"),
  Def(Sit, "etrasi"),
  Def(Stand, "s3l3ve"),
  Def(Stand, "s3t3nird3vu"),
  Def(Give, "done"),
  Def(Say, "di"),
  Def(Sun, "sole"),
  Def(Moon, "len"),
  Def(Star, "etw~ol"),
  Def(Water, "o"),
  Def(Rain, "plui"),
  Def(Stone, "py~er"),
  Def(Sand, "sabl"),
  Def(Earth, "ter"),
  Def(Cloud, "nuaj"),
  Def(Smoke, "fEme"),
  Def(Fire, "fe"),
  Def(Ash, "sa*dr"),
  Def(Burn, "brule"),
  Def(Path, "rut"),
  Def(Mountain, "mo*taj"),
  Def(Red, "ruj"),
  Def(Green, "ver"),
  Def(Yellow, "jon"),
  Def(White, "bla*"),
  Def(Black, "nw~ar"),
  Def(Night, "nui"),
  Def(Hot, "So"),
  Def(Cold, "fr~wa"),
  Def(Full, "pl3*"),
  Def(New, "nuvo"),
  Def(Good, "bo*"),
  Def(Round, "ro*"),
  Def(Dry, "s3k"),
  Def(Name, "no*"),
]
//======================================================================

let WordList.Friulian = [
  Def(I, "yo"),
  Def(You, "tu"),
  Def(We, "nou"),
//  Def(We, "noaltris"),
  Def(One, "uN"),
  Def(Two, "doi"),
  Def(Person, "pErsoN"),
  Def(Fish, "pes"),
//  Def(Dog, "CaN"),
  Def(Dog, "ky~aN"),
  Def(Louse, "pEdoli"),
  Def(Tree, "arbul"),
  Def(Leaf, "fw~eE"),
  Def(Skin, "py~el"),
  Def(Blood, "saNk"),
  Def(Bone, "vw~es"),
  Def(Horn, "kw~ar"),
  Def(Ear, "oreli"),
  Def(Eye, "voli"),
  Def(Nose, "nas"),
  Def(Tooth, "dint"),
  Def(Tongue, "leNgE"),
  Def(Knee, "zEnoli"),
  Def(Knee, "jEnoli"),
  Def(Hand, "man"),
  Def(Breast, "pet"),
  Def(Liver, "fiat"),
  Def(Liver, "fy~at"),
  Def(Drink, "bevi"),
  Def(See, "viodi"),
  Def(See, "vy~odi"),
  Def(Hear, "sintei"),
  Def(Die, "murei"),
  Def(Come, "vi5ei"),
  Def(Sun, "soreli"),
  Def(Star, "stelE"),
  Def(Water, "agE"),
  Def(Stone, "py~erE"),
//  Def(Fire, "fouk"),
  Def(Fire, "fuk"),
  Def(Path, "stradE"),
  Def(Mountain, "mont"),
  Def(Mountain, "monta5E"),
  Def(Night, "5ot"),
  Def(Full, "plen"),
//  Def(New, "5ouf"),
  Def(New, "5uf"),
  Def(Name, "non"),
]
//======================================================================

let WordList.Italian = [
  Def(I, "io"),
  Def(You, "tu"),
  Def(We, "noi"),
  Def(One, "uno"),
  Def(Two, "due"),
  Def(Person, "persona"),
  Def(Fish, "peSe"),
  Def(Dog, "kane"),
  Def(Louse, "pidokky~o"),
  Def(Tree, "albero"),
  Def(Leaf, "foLa"),
  Def(Skin, "pElle"),
  Def(Blood, "saNgwe"),
  Def(Bone, "osso"),
  Def(Horn, "korno"),
  Def(Ear, "orekkyo"),
  Def(Eye, "okkyo"),
  Def(Nose, "naso"),
  Def(Tooth, "dante"),
  Def(Tongue, "liNgwa"),
  Def(Knee, "jinokkyo"),
  Def(Hand, "mano"),
  Def(Breast, "pEtto"),
  Def(Liver, "fegato"),
  Def(Drink, "bere"),
  Def(See, "ved"),
  Def(Hear, "ud"),
  Def(Die, "mor"),
  Def(Come, "vEn"),
  Def(Sun, "sole"),
  Def(Star, "stella"),
  Def(Water, "akwa"),
  Def(Stone, "pyEtra"),
  Def(Fire, "fwoko"),
  Def(Path, "sentyaro"),
  Def(Mountain, "monta5a"),
  Def(Night, "notte"),
  Def(Full, "pyEno"),
  Def(New, "nwovo"),
  Def(Name, "nome"),
]
//======================================================================

let WordList.Latin = [
  // David: Comments are placed with two forward slashes

  Def(I, "ego:"),
  Def(You, "tu:"),
  Def(We, "no:s"),
  Def(One, "u:nus"),
  Def(Two, "duo"),
  Def(Person, "perso:na"),
//  Def(Person, "homo", "homo:"),
  Def(Fish, "piskis"),
  Def(Dog, "kanis"),
  Def(Louse, "pedikulus"),
  Def(Tree, "arbor"),
  Def(Leaf, "foly~u*"),   //I don't understand the representation for Leaf
  Def(Skin, "kutis"),
  Def(Blood, "sang_Wis"),
  Def(Bone, "o:s"),
  Def(Horn, "kornu:"),
  Def(Ear, "auris"),
  Def(Eye, "okulus"),
  Def(Nose, "na:sus"),
  Def(Tooth, "de:ns"),
  Def(Tongue, "liNgw~E"),   //I don't know what E represents here
  Def(Knee, "genu:"),
  Def(Hand, "manus"),
  Def(Breast, "pektus"),
  Def(Breast, "mama"),   //The word for Breast is wrong---mamilla or pectus?
  Def(Liver, "jekur"),
  Def(Drink, "bibere"),
  Def(See, "wide:re"),
  Def(Hear, "audi:re"),
  Def(Die, "mori:"),
  Def(Come, "veni:re"),
  Def(Sun, "so:5"),
  Def(Star, "ste:la"),
  Def(Water, "ak_Wa"),
  Def(Stone, "lapis"),
  Def(Fire, "iNnis"),
  Def(Path, "wia"),
  Def(Mountain, "mo:ns"),
  Def(Night, "noks"),
  Def(Full, "ple:nus"),
  Def(New, "nowus"),
  Def(Name, "no:men"),
]
//======================================================================

let WordList.Portuguese = [
  Def(I, "eu"),
  Def(You, "tu"),
  Def(We, "noS"),
  Def(One, "u*"),
  Def(Two, "doiS"),
  Def(Person, "pErzon"),
  Def(Fish, "paiS3"),
  Def(Dog, "ka*u*"),
  Def(Louse, "pioLu"),
  Def(Tree, "Ervur3"),
  Def(Leaf, "foLa"),
  Def(Skin, "pEl3"),
  Def(Blood, "sa*x3"),
  Def(Bone, "osu"),
  Def(Horn, "Sifr3"),
  Def(Ear, "oraLa"),
  Def(Eye, "oLu"),
  Def(Nose, "nariS"),
  Def(Tooth, "de*t3"),
  Def(Tongue, "li*gua"),
  Def(Knee, "ZuaLu"),
  Def(Hand, "ma*u"),
  Def(Breast, "saiuS"),
  Def(Liver, "fixa8u"),
  Def(Drink, "b3b"),
  Def(See, "ver"),
  Def(Hear, "ov"),
  Def(Die, "mur"),
  Def(Come, "vir"),
  Def(Sun, "sol"),
  Def(Star, "3Strela"),
  Def(Water, "Egw~a"),
  Def(Stone, "pEdra"),
  Def(Fire, "fogu"),
  Def(Path, "se*da"),
  Def(Mountain, "mo*ta5a"),
  Def(Night, "noyt3"),
  Def(Full, "Seyu"),
  Def(New, "novu"),
  Def(Name, "nom3"),
]
//=========================================================================

let WordList.Romanian = [
  Def(I, "ew"),
  Def(You, "tu"),
  Def(We, "noy"),
  Def(One, "unu"),
  Def(Two, "doy"),
  Def(Person, "om"),
  Def(Fish, "peSte"),
  Def(Dog, "kaine"),
  Def(Louse, "paduke"),
  Def(Tree, "arbore"),
  Def(Tree, "pom"),
  Def(Leaf, "frunz3"),
  Def(Skin, "pyele"),
  Def(Blood, "s3nje"),
  Def(Bone, "os"),
  Def(Horn, "korn"),
  Def(Ear, "ureke"),
  Def(Eye, "oky"),
  Def(Nose, "nas"),
  Def(Tooth, "dinte"),
  Def(Tongue, "limb3"),
  Def(Knee, "jenuNky"),
  Def(Hand, "m3n3"),
  Def(Breast, "s3n"),
  Def(Liver, "fikat"),
  Def(Drink, "bea"),
  Def(See, "vedea"),
  Def(Hear, "auzy"),
  Def(Die, "mury"),
//  Def(Die, "pieri"),
//  Def(Die, "raposa"),
  Def(Come, "veny"),
  Def(Sun, "soare"),
  Def(Star, "stea"),
//  Def(Star, "steaua"),
  Def(Water, "ap3"),
  Def(Stone, "pyatr3"),
  Def(Fire, "fok"),
  Def(Path, "cale"),
  Def(Mountain, "munte"),
  Def(Night, "noapte"),
  Def(Full, "plin"),
  Def(New, "now"),
  Def(Name, "nume"),

  /*
  Romanian 1
  Def(You, "tu"),
  Def(We, "noi"),
  Def(One, "unu"),
  Def(Two, "doi"),
  Def(Person, "persoan3"),
  Def(Fish, "peSte"),
  Def(Dog, "k3ne"),
  Def(Louse, "p3duke"),
  Def(Tree, "pom"),
  Def(Tree, "arbore"),
  Def(Leaf, "frunz3"),
  Def(Skin, "py~ele"),
  Def(Blood, "s3nje"),
  Def(Bone, "os"),
  Def(Horn, "korn"),
  Def(Ear, "ureke"),
  Def(Eye, "oky~"),
  Def(Nose, "nas"),
  Def(Tooth, "dinte"),
  Def(Tongue, "limb3"),
  Def(Knee, "jenuNky~"),
  Def(Hand, "m3n3"),
  Def(Breast, "py~ept"),
  Def(Breast, "s3n"),
  Def(Liver, "fikat"),
  Def(Drink, "bea"),
  Def(See, "vedea"),
  Def(Hear, "auzy~"),
  Def(Die, "mury~"),
  Def(Come, "veny~"),
  Def(Sun, "soare"),
  Def(Star, "stea"),
  Def(Water, "ap3"),
  Def(Stone, "py~atr3"),
  Def(Fire, "fok"),
  Def(Path, "k3rare"),
  Def(Mountain, "munte"),
  Def(Night, "noapte"),
  Def(Full, "plin"),
  Def(New, "nou"),
  Def(Name, "nume"),
*/

]
//======================================================================

let WordList.Romansh = [
  Def(I, "yaw"),
  Def(You, "ti"),
  Def(We, "nus"),
  Def(One, "en"),
  Def(Two, "dus"),
  Def(Person, "k3rSTawn"),
  Def(Fish, "peS"),
  Def(Dog, "Tawn"),
  Def(Louse, "pluL"),
  Def(Tree, "plant3"),
  Def(Leaf, "feL"),
  Def(Skin, "pel"),
  Def(Blood, "saNk"),
  Def(Bone, "os"),
  Def(Horn, "korn3"),
  Def(Ear, "ureL3"),
  Def(Eye, "eL"),
  Def(Nose, "nas"),
  Def(Tooth, "dEnt"),
  Def(Tongue, "lyewNg3"),
  Def(Knee, "Z3neye"),
  Def(Hand, "mawn"),
  Def(Breast, "pET"),
  Def(Liver, "5irom"),
  Def(Drink, "bayv3r"),
  Def(See, "v3zayr"),
  Def(Hear, "udir"),
  Def(Die, "murir"),
  Def(Come, "v35ir"),
  Def(Sun, "suleL"),
  Def(Star, "Stayl3"),
  Def(Water, "aw3"),
  Def(Stone, "krap"),
  Def(Fire, "fyew"),
  Def(Path, "vi3"),
  Def(Mountain, "munto53"),
  Def(Night, "noT"),
  Def(Full, "playn"),
  Def(New, "nof"),
  Def(Name, "num"),
]
//==================================================================

let WordList.Spanish = [
  Def(I, "yo"),
//  Def(You, "ustet"),
  Def(You, "tu"),
  Def(We, "nosotros"),
  Def(This, "este"),
  Def(That, "ese"),
  Def(That, "akely~a"),
  Def(Who, "kien"),
  Def(What, "ke"),
  Def(Not, "no"),
  Def(All, "todos"),
  Def(Many, "muCos"),
  Def(One, "uno"),
  Def(Two, "dos"),
  Def(Big, "grande"),
  Def(Long, "largo"),
  Def(Small, "peke5o"),
  Def(Small, "Ciko"),
  Def(Woman, "muher"),
  Def(Man, "ombre"),
  Def(Person, "persona"),
  Def(Fish, "peskado"),
  Def(Fish, "pes"),
  Def(Bird, "ave"),
  Def(Bird, "paharo"),
  Def(Dog, "pero"),
  Def(Louse, "pioho"),
  Def(Tree, "arbol"),
  Def(Tree, "palo"),
  Def(Seed, "semiya"),
  Def(Leaf, "oha"),
  Def(Root, "rais"),
  Def(Bark, "kortesa"),
  Def(Bark, "kaskara"),
  Def(Skin, "piel"),
  Def(Flesh, "karne"),
  Def(Blood, "sangre"),
  Def(Bone, "weso"),
  Def(Grease, "grasa"),
  Def(Egg, "wevo"),
  Def(Horn, "kw~erno"),
  Def(Tail, "kola"),
  Def(Tail, "rabo"),
  Def(Feather, "pluma"),
  Def(Hair, "pelo"),
  Def(Hair, "cabeyo"),
  Def(Head, "kabesa"),
  Def(Ear, "oreha"),
  Def(Eye, "oho"),
  Def(Nose, "naris"),
  Def(Mouth, "boka"),
  Def(Tooth, "diente"),
  Def(Tongue, "lengw~a"),
  Def(Claw, "gara"),
  Def(Foot, "pie"),
  Def(Foot, "pata"),
  Def(Knee, "rodiya"),
  Def(Hand, "mano"),
  Def(Belly, "bariga"),
  Def(Neck, "kw~eyo"),
  Def(Neck, "peskw~eso"),
  Def(Breast, "peCo"),
  Def(Breast, "seno"),
  Def(Heart, "korason"),
  Def(Liver, "igado"),
  Def(Drink, "bebe"),
//  Def(Drink, "toma"),
  Def(Eat, "kome"),
  Def(Bite, "morde"),
  Def(See, "ve"),
  Def(Hear, "oir"),
  Def(Know, "sabe"),
  Def(Know, "konose"),
  Def(Sleep, "dormi"),
  Def(Die, "mori"),
  Def(Kill, "mata"),
  Def(Swim, "nada"),
  Def(Fly, "vola"),
  Def(Walk, "anda"),
  Def(Walk, "kamina"),
  Def(Come, "veni"),
  Def(Lie, "akosta"),
  Def(Lie, "eCa"),
  Def(Sit, "senta"),
  Def(Stand, "esta de pie"),
  Def(Give, "da"),
  Def(Say, "desi"),
  Def(Sun, "sol"),
  Def(Moon, "luna"),
  Def(Star, "estreya"),
  Def(Water, "agw~a"),
  Def(Rain, "yuvia"),
  Def(Stone, "piedra"),
  Def(Sand, "arena"),
  Def(Earth, "tiera"),
  Def(Cloud, "nube"),
  Def(Smoke, "humo"),
  Def(Fire, "fuego"),
  Def(Ash, "senisa"),
  Def(Burn, "kema"),
  Def(Burn, "arde"),
  Def(Path, "senda"),
  Def(Mountain, "sero"),
  Def(Mountain, "monta5a"),
  Def(Red, "roho"),
  Def(Red, "kolorado"),
  Def(Green, "verde"),
  Def(Yellow, "amariyo"),
  Def(White, "blanko"),
  Def(Black, "negro"),
  Def(Night, "noCe"),
  Def(Hot, "kaliente"),
  Def(Cold, "frio"),
  Def(Full, "yeno"),
  Def(New, "nuevo"),
  Def(Good, "bw~eno"),
  Def(Round, "redondo"),
  Def(Dry, "seko"),
  Def(Name, "nombre"),
]
//======================================================================

let WordList.Walloon = [
  Def(I, "Ce"),
  Def(You, "te"),
  Def(We, "nos"),
  Def(One, "E*"),
  Def(Person, "o*m"),
  Def(Dog, "Ce*"),
  Def(Skin, "pow"),
  Def(Ear, "oreye"),
  Def(Eye, "ui"),
  Def(Drink, "bwEr"),
  Def(Hear, "Sute"),
  Def(Die, "murrir"),
  Def(Come, "vnir"),
  Def(Star, "twEl"),
  Def(Water, "Ew3"),
  Def(Fire, "fE"),
  Def(Path, "vwa*y"),
  Def(Full, "pli*"),
  Def(New, "novEl"),
]
//======================================================================
```

Tables.nytril

```
using Format, Units, IPA, IPA.Features
//======================================================================

with Results
  let FindMeaning(word, data) = word.Meaning == data;

  let GetGeneText(meaning, ref language) begin
    var words    = language.Words.FindSlice(FindMeaning, meaning, 1);
    var segments = words.Length == 1 ? IPA.WordToSegments(words[0]) : [ref IPA.NoSegment];
    return {
      Language: ref language,
      Meaning: meaning,
      Word: words[0],
      Segments: segments,
      Count: segments.Length
    }
  end

  let GetMeaningRecord(meaning) begin
    var cells = GetGeneText(meaning, each UsedLanguages);
    return {
       Cells: cells,
       MaxLength: Math.Max((each cells).Count)
    };
  end

  let AddBlank(list, index) begin
    list.AddReference(IPA.GapSegment);
  end

  let AddWord(list, langindex, meaning) begin
    var ma   = WordMeaningArray[EachIndex];
    var cell = ma.Cells[langindex];
    var pad  = ma.MaxLength - cell.Count;
    list.AddReference(IPA.LeftSegment);
    list.AddReference(each cell.Segments);
    if (pad > 0)
      AddBlank(list, each 1..pad);
    end
    list.AddReference(IPA.RightSegment);
  end

  let GetSegments(langindex) begin
    var list = Type.List(150);
    AddWord(list, langindex, each UsedMeanings);
    return list;
  end

  let SegmentToCharacter(ref segment) begin
    if (segment.Features.HasFeature(Punctuation))
      return {
        Character: segment.Text,
        Segment: ref segment
      }
    end

    var f = UniqueSegments.FindIndex(DisplayCharacters.SameSegment, {Segment: ref segment});
    if (f.Length == 1)
      return {
        Character: Nexus.CharacterList[f[0]],
        Segment: ref segment
      }
    else
      return {
        Character: '?',
        Segment: ref IPA.NoSegment
      }
    end
  end

  let GetTaxaArray(ref lang) begin
    var segments = GetSegments(EachIndex);
    return {
      Name: lang.SymbolName,
      Segments: segments,
      Characters: SegmentToCharacter(each segments)
    }
  end

  let LangHasWords(ref language) = language.Words != null
  let UsedLanguages              = FindSlice(Languages, LangHasWords)
  let UsedMeanings               = CompleteMeanings.Find
  let WordMeaningArray           = GetMeaningRecord(each UsedMeanings);
  let UniqueSegments             = DisplayCharacters.FindUniqueSegments(UsedLanguages)
  let TaxaArray                  = GetTaxaArray(each UsedLanguages)
  let LanguageTreeFile           = Nexus.TreeFile(Info.LanguageTree)
  let CharacterFile              = Nexus.CharacterFile(TaxaArray)

//  let UsedSegments = UniqueSegments
  let UsedSegments = IPA.Segments

end
//======================================================================
// Consonants
//======================================================================

with MatchingConsonants
  let PulmonicTable = {
    Title: Lang.PConsonants,
    ColWidth: 45 pts,
    Exclude: Affricate Ejective,
    Include: Pulmonic,
    All: NoFeature,
    Manners: [Nasal, Stop, Sibilant Fricative, Fricative, Approximant, TapFlap, Trill, Lateral Fricative,
Lateral Approximant, Lateral TapFlap],
    RowMask: Nasal Stop Sibilant Fricative Approximant TapFlap Trill Lateral Velarized,
    Notes: Lang.SymbolPairVoiced
  }

  let NonPulmonicTable = {
    Title: Lang.NPConsonants,
    ColWidth: 80 pts,
    Exclude: Vowel Pulmonic Central,
    Include: Ejective Click Implosive,
    All: NoFeature,
    Manners: [Ejective Stop, Ejective Fricative, Ejective Lateral Fricative, Click Tenuis, Click Nasal, Click
Tenuis Lateral, Implosive],
    RowMask: Lateral,
    Notes: Lang.SymbolPairVoiced
  }

  let PulmonicAffricatesTable = {
    Title: Lang.PulmonicAffricates,
    ColWidth: 50 pts,
    Exclude: Vowel,
    Include: Affricate Sibilant Lateral,
    All: Pulmonic Affricate,
    RowLabels: [Lang.Sibilant, Lang.NonSibilant, Lang.Lateral],
    Manners: [Sibilant, NoFeature, Lateral],
    RowMask: Pulmonic Affricate Sibilant Fricative Lateral,
  }

  let EjectiveAffricatesTable = {
    Title: Lang.EjectiveAffricates,
    ColWidth: 50 pts,
    Exclude: Vowel Click Implosive Pulmonic,
    Include: Ejective Affricate Central Lateral,
    All: Ejective Affricate,
    Manners: [Central, Lateral],
    RowMask: Pulmonic Approximant Central Lateral,
  }

  let ShowTables begin
    var segments = Type.Dictionary(256);
    return Block {
      MatchingOptions.ShowTable(segments, each [PulmonicTable, NonPulmonicTable]),
      PageBreak,
      MatchingVowels.ShowTable(segments),
      MatchingOptions.ShowTable(segments, each [PulmonicAffricatesTable, EjectiveAffricatesTable]),
      MatchingOther.ShowTable(segments),
    }
  end
end
//========================================================================

with DisplayWords
  let WordRow(word) begin
    var segments = WordToSegments(word);

    return Row {
      Style.RowBar(EachIndex),
      Cell {
        Style.SansSerif,
        Style.TitleBackground,
        word.Meaning
      },
      Cell {
        ShowSampa(word.Sampa)
      },
      Cell {
        Span {
          if (segments)
            ShowSegment(each segments)
          end
        },
      },
      Cell {
        Span {
          Separator: "-",
          SegmentSound(each segments)
        }
      }
    }
  end

  let HeaderCell(d) = Cell {
    Style.SansSerif,
    Style.TitleBackground,
    EdgeB: 1 pts,
    Padding: 2 pts,
    d
  }

  let ShowTable(language) = Block {
    Table {
      Columns: [0.8 inches, 1 inches, 1 inches, Metrics.Content.Width - 2.5 inches],
      Style.TitleBar(language.Name, 4),
      Row {
        HeaderCell(Lang.Meaning),
        HeaderCell(Lang.Sampa),
        HeaderCell(Lang.IPA),
        HeaderCell(Lang.Sounds),
      },
      WordRow(each language.Words)
    },
    Style.TableNotes
  }
end
//========================================================================

with AllWords
  let AddCell(meaning, ref language) = Cell {
    ShowIPA(each IPA.FindWordsWithMeaning(language, meaning))
  }

  let AddRow(ref language, meanings) = Row {
    Cell {
      Style.SansSerif,
      TextColor: Colors.DarkGray,
      language.Name
    },
    AddCell(each meanings, language)
  }

  let MeaningTable(languages, meanings) = Block {
    Table {
      Edge: 0.5,
      Columns: [70 pts] + [54 pts] * meanings.Length,
      Row {
        Style.TitleBackground,
        Style.SansSerif,
        Empty,
        each meanings,
      },
      AddRow(each languages, meanings)
    },
    Paragraph,
  }

  let ShowTable(languages, meanings) = Block {
    TextHeight: 12 pts,
    MeaningTable(languages, each (meanings / 8))
  }
end
//=======================================================================

with DisplayCharacters
  let WordMatch(meaning, def) = meaning == def.Meaning
  let CompleteWord(def)       = Results.UsedMeanings.Contains(WordMatch, def)
  let GetWordList(language)   = language.Words.FindSlice(CompleteWord)


  let CollectWord(set, word) begin
    var segments = WordToSegments(word);
    set.AddReference(each segments);
  end

  let CollectLanguage(set, language) begin
    CollectWord(set, each GetWordList(language));
  end

  let FindUniqueSegments(languagelist) begin
    var set = Type.Dictionary(256);
    CollectLanguage(set, each languagelist);
    return set.ValueList;
  end

  let SameSegment(ref segment, data) = segment == data.Segment

  let CollectLangWord(set, ref segment, word) begin
    var segments = WordToSegments(word);
    if (segments.Contains(SameSegment, {Segment: ref segment}))
      set.AddElement(word.Sampa, word);
    end
  end

  let CollectLanguageWords(set, ref segment, language) begin
    CollectLangWord(set, segment, each GetWordList(language));
  end

  let WordsWithSegment(ref segment) begin
    var set = Type.Dictionary(256);
    CollectLanguageWords(set, segment, each Results.UsedLanguages);
    return set.ValueList;
  end

  let CharacterRow(ref segment) = Row {
    Cell {
      HAlign: HAligns.Center,
      Style.TitleBackground,
      Nexus.CharacterList[EachIndex]
    },
    Cell {
      HAlign: HAligns.Center,
      ShowSegment(segment, Diacritic | Impossible),
    },
    Cell {
      Style.IPAFamily,
      Span {
        Separator: Lang.Separator,
        ShowIPA(each WordsWithSegment(segment))
      }
    }
  }

  let ShowTable = Block {
    Table {
      Style.TableEdge,
      Columns: [0.5 inches, 0.7 inches, 6 inches],
      Row {
        Style.HeaderCell("Char.", HAligns.Center),
        Style.HeaderCell(Lang.Segment, HAligns.Center),
        Style.HeaderCell("Words containing this segment")
      },
      CharacterRow(each Results.UniqueSegments),
    },
    Style.TableNotes
  }
end
//====================================================================
// Consonants
//====================================================================

with MatchingOptions
  let CheckFlags(sflags, rflags, options) = sflags.NotFeature(options.Exclude) and sflags.HasFeature(options.
Include) and sflags.HasMask(options.RowMask | rflags, rflags)

  let AnyManners(flags, data)             = CheckFlags(data.Features, flags | data.Options.All, data.Options)

  let MatchRow(segment, data)             = segment.Place == data.Place and CheckFlags(segment.Features, data.
Features, data.Options)

  let MatchInclude(segment, data)         = segment.Place == data.Place and segment.Features.NotFeature(data.
Options.Exclude) and

                                            segment.Features.HasFeature(data.Options.Include) and
                                            data.Options.Manners.Contains(AnyManners, {Features: segment.
Features, Options: data.Options})

  let MatchPlace(place, options)          = AllSegments.Contains(MatchInclude, {Place: place, Options: options
})
  let GetPlaces(options)                  = Places.FindSlice(MatchPlace, options)


  let SegmentText(segments, ref segment) begin
    if (segment.Features.NotFeature(Impossible))
      segments.AddReference(segment)
    end
    return ShowSegment(segment);
  end

  let SegmentBox(segments, ref segment, color) = Canvas {
    HAlign: HAligns.Center,
    Size: Metrics.BoxSize,
    if (segment.Text)
      TextHeight: Metrics.BoxSize.Height - 4 pts,
      TextColor: color,
      SegmentText(segments, segment)
    else
      Style.ImpossibleBackground
    end
  }

  let ShowBox(segments, ref segment, color) = SegmentBox(segments, segment, color) {
    if (segment.Features.HasFeature(Voiced))
      X: Metrics.BoxSize.Width
    end
  }

  let MatchError(matches) = matches.Length > 2 or (matches.Length == 2 and matches[0].Features.HasFeature(
Voiced) == matches[1].Features.HasFeature(Voiced))

  let SegmentBlock(segments, matches) = Cell {
    Style.SegmentBottom,
    if (matches.Length > 0)
      if (matches.Length == 1 and matches[0].Features.HasFeature(Impossible))
        Style.ImpossibleBackground
      else
        TextHeight: 1 pts,
        Span {
          Canvas {
            Size: Metrics.CellSize,
            ShowBox(segments, each matches, MatchError(matches) ? Colors.Red : Colors.Black)
          }
        }
      end
    end
  }

  let AddCell(segments, options, place, flags) = SegmentBlock(segments, AllSegments.FindSlice(MatchRow, {Place
: place, Features: flags, Options: options}))

  let AddRow(segments, options, places, flags) begin
    var allflags = flags | options.All;
    return Row {
      Cell {
        VAlign: VAligns.Center,
        EdgeR: 0.5 pts,
        Style.TitleBackground,
        PaddingLR: 2 pts,
        TextHeight: 7 pts,

        if (options.RowLabels)
          options.RowLabels[EachIndex],
        else
          flags,
        end,
      },
      AddCell(segments, options, each places, allflags)
    }
  end

  let PlaceHeader(place) = Style.HeaderCell(place.Name, HAligns.Center)

  let ShowTable(segments, options) begin
    var places = GetPlaces(options);

    return Block {
      Table {
        Style.TableEdge,
        Columns: [options.ColWidth {EdgeR: 0.5 pts}] +
                 [Metrics.CellSize.Width {HAlign: HAligns.Center, EdgeR: 0.25 pts}] * places.Length,

        Style.TitleBar(options.Title, places.Length+1),
        Row {
          TextHeight: 6 pts,
          Style.HeaderCell(Bold Lang.Manner),
          PlaceHeader(each places)
        },
        AddRow(segments, options, places, each options.Manners),
      },
      Style.TableNotes {
        Lang.ImpossibleShaded,
        Space,
        options.Notes
      },
    }
  end
end
//========================================================================
// Vowels
//========================================================================

with MatchingVowels
  let AddBlock(set, matches) = Cell {
    Style.SegmentBottom,
    HAlign: HAligns.Center,
    TextHeight: Metrics.BoxSize.Height,
    if (matches.Length == 2)
      Span {
        MatchingOptions.SegmentText(set, matches[0]),
        " • " {TextColor: Colors.LightGray},
        MatchingOptions.SegmentText(set, matches[1]),
      }
    else
      if (matches.Length == 1)
        MatchingOptions.SegmentText(set, matches[0]),
      end
    end
  }

  let MatchVowelAny(ref segment, data)      = segment.Features.HasMask(Vowel LongVowel Nasal, data.Feature |
Vowel) and segment.Open == data.Open
  let MatchVowelPair(ref segment, data)     = segment.Backness == data.Backness and MatchVowelAny(segment,
data)
  let FindAnyOpen(set, feature, open)       = Results.UsedSegments.Contains(MatchVowelAny, {Open: open,
Feature: feature})
  let AddCell(set, feature, open, backness) = AddBlock(set, Results.UsedSegments.FindSlice(MatchVowelPair, {
Open: open, Feature: feature, Backness: backness}))

  let AddRow(set, feature, open) begin
    if (FindAnyOpen(set, feature, open))
      return Row {
        Cell {
          VAlign: VAligns.Center,
          Style.TitleBackground,
          open.Name
        },
        AddCell(set, feature, open, each Backnesses)
      };
    else
      return null
    end
  end

  let ShowVowelTable(set, feature, title) = Table {
    HAlign: HAligns.Center,
    Style.TableEdge,
    Columns: [(1 inch){EdgeR: 0.5 pts}] + [Metrics.BoxSize.Width*3 {EdgeR: 0.25 pts}] * Backnesses.Length,
    Style.TitleBar(title, Backnesses.Length+1),
    Row {
      TextHeight: 10 pts,
      Style.HeaderCell(Empty),
      Style.HeaderCell(each Backnesses, HAligns.Center)
    },
    AddRow(set, feature, each Opens)
  }

  let ShowTable(set) = Block {
    ShowVowelTable(set, NoFeature, Lang.Vowels),
    Style.TableNotes {
      Lang.SymbolPairRounded,
    },
    ShowVowelTable(set, LongVowel, Lang.LongVowels),
    Paragraph,
  }
end
//======================================================================
// Diacritic markers
//======================================================================

with MatchingDiacritics
  let ColumnDiv = 3

  let AddCell(ref segment) = Cell {
    Paragraph {
      LeftIndent: 0.5 inches,
      FirstIndent: -0.5 inches,
      LocationMark: segment.FullSymbolName,
      ShowSegment(segment) {
        TextHeight: 18 pts,
        Tab,
      },
      segment.Description
    }
  }

  let AddRow(segments) = Row {
    AddCell(each segments)
  }

  let ShowTable = Block {
    Table {
      Style.TableEdge,
      Columns: [Metrics.Content.Width / ColumnDiv] * ColumnDiv,
      Style.TitleBar(Lang.Diacritics, ColumnDiv),
      AddRow(each DiacriticModifiers / ColumnDiv),
    },
    Style.TableNotes
  }
end
//======================================================================
// Segments not in other lists
//======================================================================

with MatchingOther
  let MatchOther(ref segment, set) = not set.ContainsReference(segment)

  let ColumnDiv = 2

  let AddCell(ref segment) = {
    Cell {
      VAlign: VAligns.Center,
      HAlign: HAligns.Center,
      TextHeight: 20 pts,
      LocationMark: segment.FullSymbolName,
      ShowSegment(segment),
    },
    Cell {
      VAlign: VAligns.Center,
      SegmentName(segment)
    }
  }

  let AddRow(segments) = Row {
    AddCell(each segments)
  }

  let ShowTable(set) = Block {
    Table {
      Style.TableEdge,
      Columns: [Metrics.BoxSize.Width, Metrics.Content.Width * 0.5 - Metrics.BoxSize.Width] * ColumnDiv,
      Style.TitleBar(Lang.OtherSegments, ColumnDiv*2),
      AddRow(each (FindSlice(Results.UsedSegments, MatchOther, set) / ColumnDiv)),
    },
    Style.TableNotes
  }
end
//======================================================================
// Find the list of meanings for which there is a word in every language
//======================================================================

with CompleteMeanings
  let ContainsMeaning(word, data)    = word.Meaning == data.Meaning
  let WithoutMeaning(language, data) = not language.Words.Contains(ContainsMeaning, data)

  let CollectMeanings(set, ref meaning) begin
    if (not Results.UsedLanguages.Contains(WithoutMeaning, {Meaning: ref meaning}))
      set.AddReference(meaning)
    end
  end

  let Find begin
    var set = Type.Dictionary(128);
    CollectMeanings(set, each WordMeanings);
    return set.ValueList;
  end
  let AddRow(ref meaning) = Row {
    Cell {
      HAlign: HAligns.Center,
      Style.TitleBackground,
      EachIndex+1
    },
    Cell {
      meaning.Name
    }
  }

  let ShowTable = Block {
    Table {
      Style.TableEdge,
      Columns: [0.5 inches, 4 inches],
      Style.TitleBar(Lang.Meanings, 3),
      Row {
        Style.HeaderCell(Empty),
        Style.HeaderCell(Lang.Meaning)
      },
      AddRow(each Results.UsedMeanings),
    },
    Style.TableNotes
  }
end
//======================================================================
// Segment Tree
//======================================================================

with SegmentTree
  let AddNode(name) = Node {
    Bevel: 20%,
    Curvature: 20%,
    Label: name
  }

  let AddSegment(set, ref segment) begin
    set.AddReference(segment);
    return ShowSegment(segment)
  end

  let AddSegments(set, name, func, data) begin
    var segments = Results.UsedSegments.FindSlice(func, data);
    if (segments.Length > 0)
      return Node {
        Label: Frame {
          Width: 3.5 inches,
          Paragraph {
            LeftIndent: 1 inches,
            FirstIndent: -1 inches,
            Span {
              TextColor: Colors.DarkGray,
              name,
              ":\t",
            },
            Span {
              TextHeight: 14 pts,
              Separator: Space,
              AddSegment(set, each segments),
            }
          }
        }
      }
    else
      return null
    end
  end

  let MatchVowel(ref segment, data) = segment.Features.HasFeature(Vowel) and segment.Backness == data.Backness
  let AddVowels(set, backness)      = AddSegments(set, backness.Name, MatchVowel, {Backness: backness})

  let MatchFlags(ref segment, data) = not data.Set.ContainsReference(segment) and segment.Features.HasMask(
data.All, data.Features) and segment.Features.HasMask(data.Other, data.Other)
  let AddFlag(set, all, flags, f)   = AddSegments(set, f.Name, MatchFlags, {Set: set, All: all, Features:
flags, Other: f})
```

```
  let AddConsonants(set, name, all, flags) = AddNode(name) {
    AddFlag(set, all, flags, each [Tenuis, Click, Nasal, Ejective, Fricative, Sibilant, Lateral, Stop,
Approximant, TapFlap, Trill, NoFeature]),
  }

  let AddVoicedPairs(set, name, all, flags) = AddNode(name) {
    AddConsonants(set, Lang.Voiced, all Voiced, flags Voiced),
    AddConsonants(set, Lang.Voiceless, all Voiced, flags),
  }

  let ShowTree begin
    var set1 = Type.Dictionary(256);
    var set2 = Type.Dictionary(256);
    var all  = Vowel Pulmonic Affricate;

    return Block {
      Tree {
        Width: 7 inches,
        LabelGap: 3 pts,
        Node {
          AddNode(Lang.Vowels) {
            AddVowels(set1, each Backnesses)
          },
          AddNode(Lang.Affricates) {
            AddVoicedPairs(set1, Lang.NonPulmonic, all, Affricate),
            AddVoicedPairs(set1, Lang.Pulmonic, all, Pulmonic Affricate),
          },
          AddNode(Lang.Consonants) {
            AddVoicedPairs(set1, Lang.Pulmonic, all, Pulmonic),
            AddVoicedPairs(set1, Lang.NonPulmonic, all, NoFeature),
          },
          AddSegments(set2, Lang.OtherSegments, MatchingOptions.MatchOther, set1)
        }
      }
    }
  end
end
//======================================================================
// SAMPA table
//======================================================================

with SAMPAConversion
  let ShowSampaLine(segment) = Span {
    segment.Sampa
  }

  let AddRow(ref segment) = Row {
    Cell {
      ShowSampa(segment.Sampa)
    },
    Cell {
      ShowSegment(segment)
    },
    Cell {
      segment.SymbolName
    }
  }

  let AlphaOrder(x, y) begin
    var cl = Math.Compare(x.Sampa.Length, y.Sampa.Length);
    if (cl == 0)
      cl = -Math.Compare(x.Sampa, y.Sampa)
    end
    return cl;
  end

  let SortedSampa = IPA.SampaSet.Sort(false, AlphaOrder)

  let ShowTable = Block {
    Table {
      Style.TableEdge,
      Columns: [0.75 inches, 0.75 inches, 4 inches],
      Row {
        Style.HeaderCell(Lang.Sampa),
        Style.HeaderCell(Lang.IPA),
        Style.HeaderCell(Lang.Segment)
      },
      AddRow(each SortedSampa),
    },
    Style.TableNotes
  }
end
//======================================================================
```

Main.nytril

```
using Format, Units, Math, IO

include "English"
include "Library"
include "Languages"
include "LanguageTree"
include "IPA"
include "Style"
include "References"
include "WordForms"
include "Tables"
//======================================================================

let Main.Run = [
//  Write(RevBayes.SourceFile, Info.RevSourcePath),
  Write(Results.LanguageTreeFile, Info.LanguageTreePath),
  Write(Results.CharacterFile, Info.CharacterPath),
  Write(WhitePaper, Info.PaperPath Extensions.PDF),
//  Write(WhitePaper, Info.PaperPath Extensions.Word),
  IO.OpenDocument(Info.PaperPath Extensions.PDF),
]
//======================================================================

with Info
  let MainFolder       = Folders.Source
  let OutputFolder     = MainFolder Folder("Output")
  let PaperPath        = OutputFolder FileName("Paper")
  let LanguageTreePath = OutputFolder FileName("LanguageTree") Extensions.Nexus
  let RevSourcePath    = OutputFolder FileName("Analysis") Extensions.RevBayes

  let CharacterPath    = OutputFolder FileName("Characters") Extensions.Nexus
  let Journal          = "Transactions of the Beysian Society"
  let Publisher        = "The Baysian Society"
  let Title            = "Simulated Feature Evolution using the TKF91 Model"
  let LanguageTree     = LanguageBranches.Romance

  let AuthorList = Span {
    Separator: Lang.Separator,
    LastSeparator: " {0} "(Lang.And),
    Style.Author(each Authors)
  }
end
//======================================================================

let Watch = WhitePaper

let WhitePaper = Style.WhitePaper {
  Title: Info.Title,
  Author: Info.AuthorList,
//  Description: "Test Description",
//  Comment: "Test Comment",
//  Subject: "Test Subject",
//  Keywords: "Test Keywords",

  Style.PageSection {
    Header: Style.NormalHeader(Info.Journal) {
      Distance: 0.125 inches,
      Even: Style.NormalHeader(Info.Journal),
      First: Block {
        Paragraph {
          ParAlignment: ParAlignments.Center,
          Logo,
        },
      }
    },
    Block {
      ParAlignment: ParAlignments.Center,
      Style.Title(Info.Title),
      Paragraph {
        Info.AuthorList
      },
    },
    Style.ShowAbstract(Abstract),
    Style.ShowContent(each Content),
    Style.ShowAuthors(Authors),
    Style.ShowAppendixTable,
    Style.ShowReferences(References),
  },
  Style.ShowAppendix(each Appendix)
}
//======================================================================

let AddAppendix(title, content) = {Title: title, Content: content}

let Appendix = [
  AddAppendix(Lang.LanguagePhylogeny, Style.ShowLanguageTree),
//  AddAppendix("Meanings with words in every language", CompleteMeanings.ShowTable),
  AddAppendix("Words in each language by meaning", AllWords.ShowTable(Results.UsedLanguages, Results.
UsedMeanings)),
  AddAppendix("Feature Change", IPA.DriftSection),
  AddAppendix("Character file", Results.CharacterFile Style.MonoFamily),
  AddAppendix("Segments in the target word list", DisplayCharacters.ShowTable),
  AddAppendix("Segment Groups", MatchingConsonants.ShowTables),
  AddAppendix(Lang.Diacritics, MatchingDiacritics.ShowTable),
  AddAppendix("Euler Feature Diagram", IPA.FeatureChart),
  AddAppendix(Lang.IPAFullName, IPA.SegmentTable),
  AddAppendix("Feature Tree", SegmentTree.ShowTree),
  AddAppendix("SAMPAConversion", SAMPAConversion.ShowTable),
  AddAppendix("Word Lists by Language", DisplayWords.ShowTable(each Results.UsedLanguages)),
  AddAppendix("Language Tree File", Results.LanguageTreeFile Style.MonoFamily),
  AddAppendix(Lang.NytrilSourceCode, Style.SourceFile(each System.SourceList)),
]
//======================================================================

with Abstract
  let Title = Lang.Abstract
  let Body  = Block {
    Paragraph {
      "It all started in a little town called Madrid..."
    }
  }
end
//======================================================================

with Content.Introduction
  let Title = Lang.Introduction
  let Body  = Block {
    Paragraph {
      "In this paper, we attempt to do the impossible!"
    }
  }
end
//======================================================================

with Content.Methods
  let Title = Lang.Methods
  let Body  = Block {
    Paragraph {
      "We used any and all means necessary."
    }
  }
end
//======================================================================

with Content.Conclusion
  let Title = Lang.Conclusion
  let Body  = Block {
    Paragraph {
      "Vene Vidi Vici"
    }
  }
end
//======================================================================
```