Software Project NLP with NNs

Proto-Word Reconstruction with RNNs

Project Sketch

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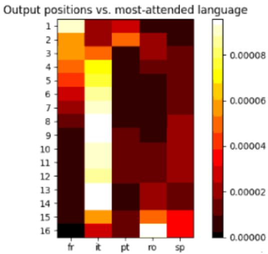
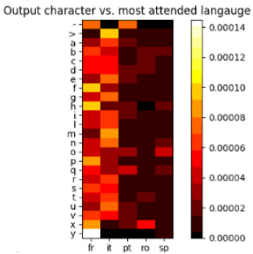
Baseline

Start from Meloni et al. (2019):

- Romance dataset (not publicly availabe)
- Character-based encoder-decoder architecture with Bahdanau attention
- Characters encoded as 100-bit vectors (localist representation), character embeddings shared over all languages
- Output one character of the reconstructed word per timestep
- Difference to Machine Translation:
  Sentence → word, word → character
- Evaluate impact of individual languages on reconstruction:





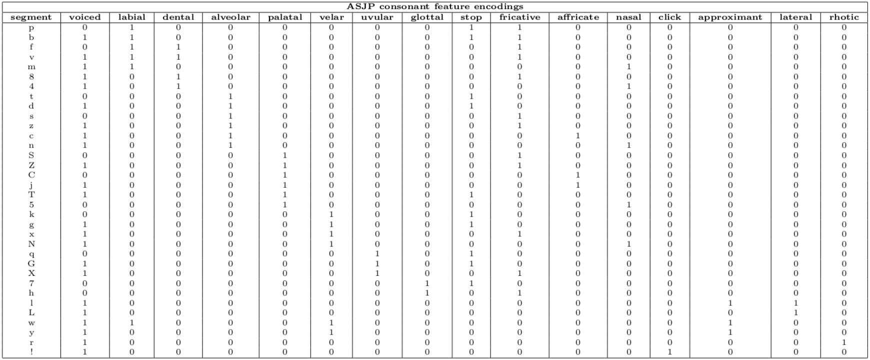
Model

Idea:

- Use distributed feature encodings to represent characters, not embeddings
- Use the stem of the Latin word as the proto-form, since nominative inflection is seldom preserved in modern Romance
- Start with ASJP (easily available) transcriptions (Brown et al. (2008)), later switch to IPA (richer annotation).
- Pairwise alignments of sequence chunks (following Ciobanu and Dinu (2018))

Lat. acc. sing *corticem* 'bark' → ASJP {kortike}										
	1	2	3	4	5	6	7	8	9	10
lat.	-	k	o	-	r	t	i	k	-	e
it.	-	k	o	-	r	t	e	t	C	a
spa.	-	k	o	-	r	t	e	8	-	a
fr.	e	k	o	-	r	-	-	-	-	-
rom.	s	k	o	a	r	-	-	c	-	3

Model, feature encoding



ASJP consonant feature encodings

segment	voiced	labial	dental	alveolar	palatal	velar	uvular	glottal	stop	fricative	affricate	nasal	click	approximant	lateral	rhotic
p	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
b	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
f	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0
v	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0
m	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
8	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
4	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
t	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
d	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
s	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
z	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
c	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
n	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
S	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Z	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
C	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
j	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
T	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
5	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
k	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
g	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
x	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
N	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
q	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
G	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
X	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
7	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
h	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
l	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
L	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
w	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0
y	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
r	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
!	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Model, continued

Input:

- One column represents the input at a single timestep:

$$
\begin{aligned}
I_{T=t_1} &= (-,-,-,e,s) \\
I_{T=t_2} &= (k,k,k,k,k) \\
&\dots \\
I_{T=t_{10}} &= (e,a,a,-,3)
\end{aligned}
$$

- Attention: Meloni et al. (2019) attend on different languages in the cognate set.
  In our case it depends on how whe present the data to the model:
  Either (as in the paper) perform a pass through the model to reconstruct a single character (each $I_{T=t_i}$ a sequence of inputs), or
- Use the matrix/vector $I_{T=t_i}$ at a single time step, and perform only one pass

TODO: Draw model architecture

Model, expectations

But: The direct precursor of it. *corteccia*, spa. *corteza* etc. is the adjective lat. *corticeus, -a, -um*

- We expect the model to reconstruct an a-stem noun instead of a consononat stem
- Spurious sounds (fr. *e*-, rom. *s*-) should be dropped
- Ambiguous sounds may not indicate a clear rule (lat. -*k*- vs. rom. -*c*- vs. spa. -*8*-)

TODO: more items

Milestones

Minimal:

- Reconstruction with ASJP encodings, small Swadesh list as data
- Then switch to IPA encodings
- Try different language family (initial guess on unseen data)
- Examinate the influence of differrent (or absent) alignments on model performance

Great to have:

- Use larger dataset (asked Ciobanu for hers)
- Ensure compatibility with the LingPy [1] WordList [2] class

[1] http://lingpy.org/

[2] http://lingpy.org/reference/lingpy.basic.html#lingpy.basic.wordlist.Wordlist

Timeline?

References

Brown, C. H., Holman, E. W., Wichmann, S., and Velupillai, V. (2008). Automated classification of the world's languages: a description of the method and preliminary results. *Language Typology and Universals*, 61(4):285–308.

Ciobanu, A. M. and Dinu, L. P. (2018). Ab Initio: Automatic Latin Proto-word Reconstruction. In *Proceedings of the 27th International Conference on Computational Linguistics*, pages 1604–1614, Santa Fe, New Mexico, USA. Association for Computational Linguistics.

Meloni, C., Ravfogel, S., and Goldberg, Y. (2019). Ab Antiquo: Proto-language Reconstruction with RNNs. arXiv: 1908.02477.