Outline

Exemplar Approach to Vowel Harmony

Connectionist models (aka Neural Networks)

Exemplar-Modelling Vowel Harmony with Recurrent Neural Networks: Literature Review

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Outline

- Exemplar approach to vowel harmony
- Connectionist Models
    - Where does this experiment fit in?

Exemplar Approach to Vowel Harmony

VH as an evolutionary process

- vowel harmony is the result of a diachronic process of sound change motivated by perturbatory effects of coarticulation on listener perception (Ohala, 1994; Blevins, 2004)
- evidence suggests it is possible to extract phonological patterns corresponding to VH from coarticulatory patterns (Przezdziecki, 2005)
    - counter-claim: phonetic basis for VH irrelevant from a synchronic point of view (Anderson, 1980; Nevins, 2010)
- motivates search for models that integrate phonetic features and phonological structures

Motivating the exemplar approach

- mental lexicon integrates detailed representations of acoustic/auditory, articulatory, visual, spatial, and even social inputs
- phonological patterns are implicitly learnt through repeated exposure to sequences of such inputs and 'words' are a natural organisational unit for this process (lexically driven learning)
- exemplar models have been argued to be particularly suited to modelling language change as an evolutionary process
- Wedel (2006); Port (2007); Johnson (2007); Coleman (2002); Johnson (2006)

Connectionist models (aka Neural Networks)

Connectionist accounts in linguistics

- linked to psycholinguistically motivated accounts of production/perception, and processing (Dell et al., 1999; Hawkins and Smith, 2001; Port, 1990)
- proposed and/or shown to be compatible with emergent/exemplar accounts of phonological acquisition (Bybee and McClelland, 2005; Lathroum, 1989; Hare, 1990; Rodd, 1997; Cole, 2009; Alderete and Tupper, 2018; Cole, 2009)
- but, actual early implementations were often limited in scope by constraints on computational processing and storage

Where does this experiment come in?

- it is now possible to train such models to learn semantic representations directly from raw phonetic or text inputs with no annotation at the phonological or syntactic level
- resurgence of interest in testing if and how the representations learnt by such ”end-to-end” models maps to traditional linguistic structures (Alishahi et al., 2017; Doucette, 2017; Gulordava et al., 2018; Ravfogel et al., 2018; van Schijndel and Linzen, 2018; Enguehard et al., 2017; Linzen et al., 2016)

Where does this experiment come in?

proposed aim: replicate methodology from Alishahi et al. (2017) to test the representation of VH structures in an RNN model trained in an exemplar-compatible way [1]

[1] project repo: https://github.com/irfus/ExemplarNNetHarmony

References

Alderete, J. and Tupper, P. (2018). Connectionist approaches to generative phonology. *The Routledge Handbook of Phonological Theory. Routledge*.

Alishahi, A., Barking, M., and Chrupała, G. (2017). Encoding of phonology in a recurrent neural model of grounded speech. In *Proceedings of the 21st Conference on Computational Natural Language Learning (CoNLL 2017)*, page nil.

References ii

Anderson, S. R. (1980). Problems and perspectives in the description of vowel harmony. *Issues in Vowel Harmony*, page 1.

Blevins, J. (2004). Evolutionary phonology.

Bybee, J. and McClelland, J. L. (2005). Alternatives to the combinatorial paradigm of linguistic theory based on domain general principles of human cognition. *The Linguistic Review*, 22(2-4):nil.

Cole, J. (2009). Emergent feature structures: harmony systems in exemplar models of phonology. *Language Sciences*, 31(2-3):144–160.

References iii

Coleman, J. (2002). Phonetic representations in the mental lexicon. *Phonetics, phonology and cognition*, pages 96–130.

Dell, G. S., Chang, F., and Griffin, Z. M. (1999). Connectionist models of language production: Lexical access and grammatical encoding. *Cognitive Science*, 23(4):517–542.

Doucette, A. (2017). Inherent biases of recurrent neural networks for phonological assimilation and dissimilation. In *Proceedings of the 7th Workshop on Cognitive Modeling and Computational Linguistics (CMCL 2017)*, pages 35–40.

Enguehard, E., Goldberg, Y., and Linzen, T. (2017). Exploring the syntactic abilities of rnns with multi-task learning. *arXiv preprint arXiv:1706.03542*.

References iv

Gulordava, K., Bojanowski, P., Grave, E., Linzen, T., and Baroni, M. (2018). Colorless green recurrent networks dream hierarchically. *CoRR*.

Hare, M. (1990). The role of trigger-target similarity in the vowel harmony process. *Annual Meeting of the Berkeley Linguistics Society*, 16(1):140.

Hawkins, S. and Smith, R. (2001). Polysp: A polysystemic, phonetically-rich approach to speech understanding. *Italian Journal of Linguistics*, 13:99–188.

Johnson, K. (2006). Resonance in an exemplar-based lexicon: the emergence of social identity and phonology. *Journal of Phonetics*, 34(4):485–499.

References v

Johnson, K. (2007). Decisions and mechanisms in exemplar-based phonology. *Experimental approaches to phonology. In honor of John Ohala*, pages 25–40.

Lathroum, A. (1989). Feature encoding by neural nets. *Phonology*, 6(02):305–316.

Linzen, T., Dupoux, E., and Goldberg, Y. (2016). Assessing the ability of lstms to learn syntax-sensitive dependencies. *arXiv preprint arXiv:1611.01368*.

Nevins, A. (2010). *Locality in Vowel Harmony*. EBSCO ebook academic collection. MIT Press.

References vi

Ohala, J. J. (1994). Towards a universal, phonetically-based, theory of vowel harmony. In *Third International Conference on Spoken Language Processing*.

Port, R. (2007). How are words stored in memory? beyond phones and phonemes. *New Ideas in Psychology*, 25(2):143–170.

Port, R. F. (1990). Representation and recognition of temporal patterns. *Connection Science*, 2(1-2):151–176.

Przezdziecki, M. (2005). *Vowel harmony and coarticulation in three dialects of Yoruba: phonetics determining phonology*. PhD thesis, Cornell University.

References vii

Ravfogel, S., Tyers, F. M., and Goldberg, Y. (2018). Can lstm learn to capture agreement? the case of basque. *CoRR*.

Rodd, J. (1997). Recurrent neural-network learning of phonological regularities in turkish. *CoNLL97: Computational Natural Language Learning*.

van Schijndel, M. and Linzen, T. (2018). Modeling garden path effects without explicit hierarchical syntax. In *Proceedings of the 40th Annual Conference of the Cognitive Science Society*, pages 2600–5.

Wedel, A. B. (2006). Exemplar models, evolution and language change. *The Linguistic Review*, 23(3):nil.