A Null Model of Sound Change

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Slides: https://www.ling.upenn.edu/∼ceolin/ruse2019.pdf

The big picture

SOUND CHANGE AND FUNCTIONALISM

In 1994: 'The relative progress of sound change is determined **by phonetic factors alone**, without regard to the preservation of meaning' (Labov 1994:603)

The big picture

SOUND CHANGE AND FUNCTIONALISM

Today: 'Labov [...] comes to the conclusion that function plays no role in sound change and variation [...] In recent years the question has been reopened with new **sophisticated statistical techniques**' (Kiparsky 2016:14)

Current approaches to Functionalism

Synchronic analyses aimed at proving that the lexicon is organized in an **efficient** way (Graff 2012, Dautriche et al. 2017, Mahowald et al. 2018)

Analyses of specific instances of sound change, e.g. Mergers and **Functional Load** (Wedel et al. 2013), Lenition and **Informativity** (Cohen Priva 2017)

The predictions **in the long run** are **unclear**. To make predictions, we need a model of sound change!

My contribution

THIS TALK

I want to propose **a null* model of sound change**, i.e. a model that can make predictions about the outcome of (regular) sound changes

*neutral (Baxter et al. 2009, Kauhanen 2017), random

Starting point: Labov (1994), **Mergers** and **Splits**

A null model of sound change

1. **Mergers and Splits applied to a mini-lexicon**
2. **Alphabet**: 25 consonants, 13 vowels
   English orthography used as a convention
3. **Mini lexicon**: words that easily map to CVC representation (e.g., *bad, big, book, but, can, dad, for, get, god, him, head,...*)
4. **Feature representation** (hard problem, Dresher 2009)

Split

Algorithm for Splits

1. Pick one position in the syllable (onset, nucleus, coda) [**ONSET**]
2. Select one segment in the inventory available in that position [**k**] and one outside of the inventory [**s**]
3. Select conditioning environment [**e, i**]
4. **k** becomes **s** in the conditioning environment.

Mergers work the same way (only difference at point 2)

Example

Conditioned merger of **a** in **o** after [b m p f d l n s c g j]
Conditioned merger of **n** in **s** in onsets before [i u e o]

INPUT	->	OUTPUT
b**a**d	->	b**o**d
big	->	big
c**a**n	->	c**o**n
cut	->	cut
m**a**n	->	m**o**n
mom	->	mom
not	->	**s**ot
son	->	son

Probability distribution over Mergers and Splits?

Null hypothesis: **Mergers and splits are equiprobable**

'most reports of phonemic change involve mergers [...] [this fact] would lead to the odd conclusion that most languages are steadily reducing their vowel inventory [...] it stands to reason that just **as many phonemic splits must take place as mergers**' Labov (1994:331)

Results: 1 - Phoneme Frequencies

PHONEME FREQUENCIES - Testing the model on a fake lexicon of 100 words, with uniform distribution over phonemes.

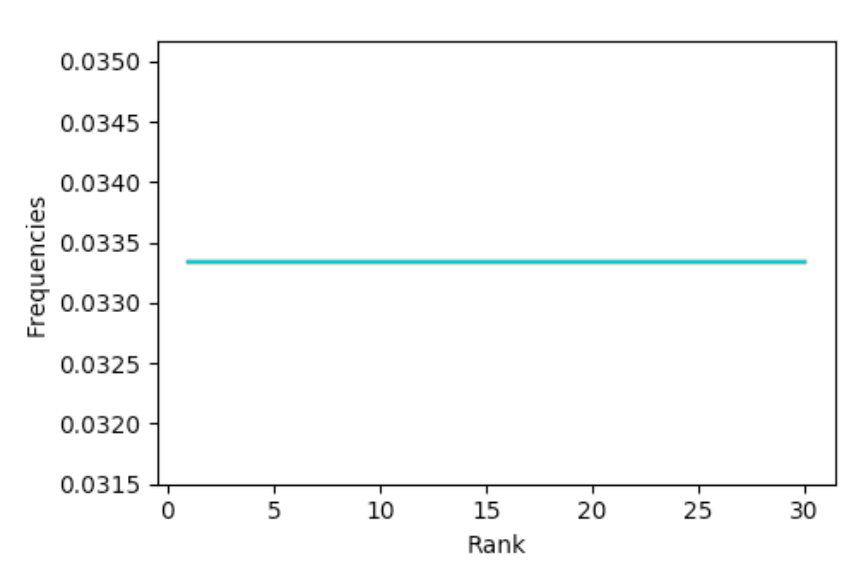

Figure 1: At start

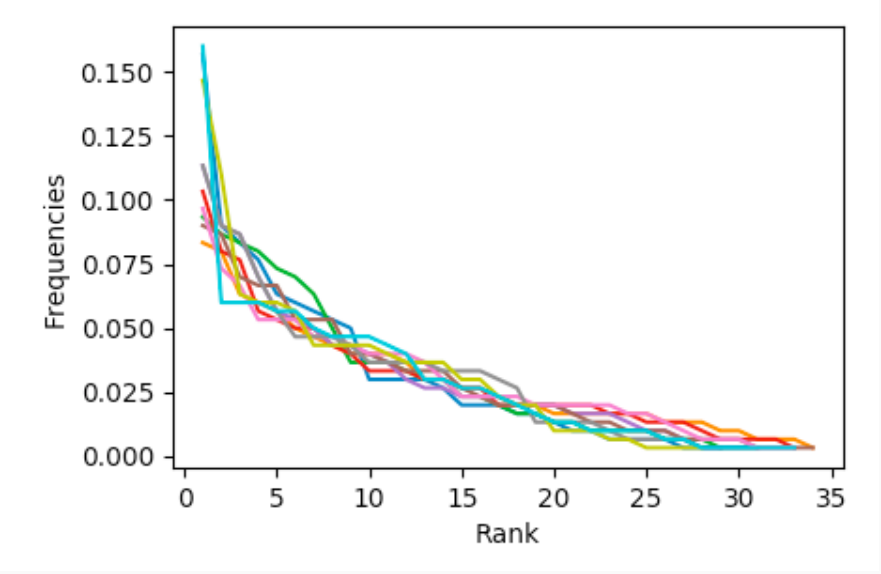

Figure 2: After 200 changes

Results: Yule-Polylogarithmic distribution over time

(cf. Tambovtsev and Martindale 2007, Nichols and Kauhanen 2019)

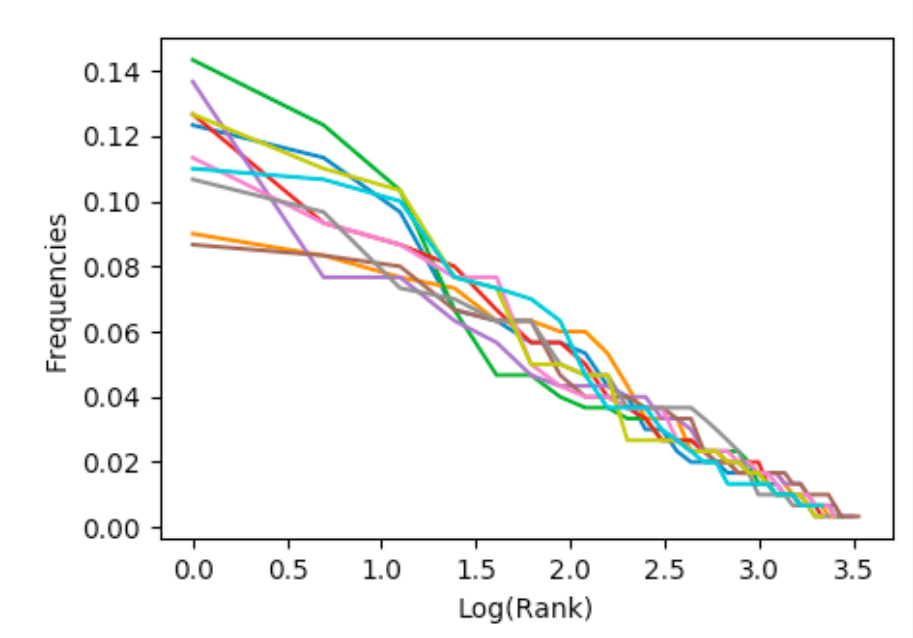

Figure 3: Yule-Polylog, R^2=0.96

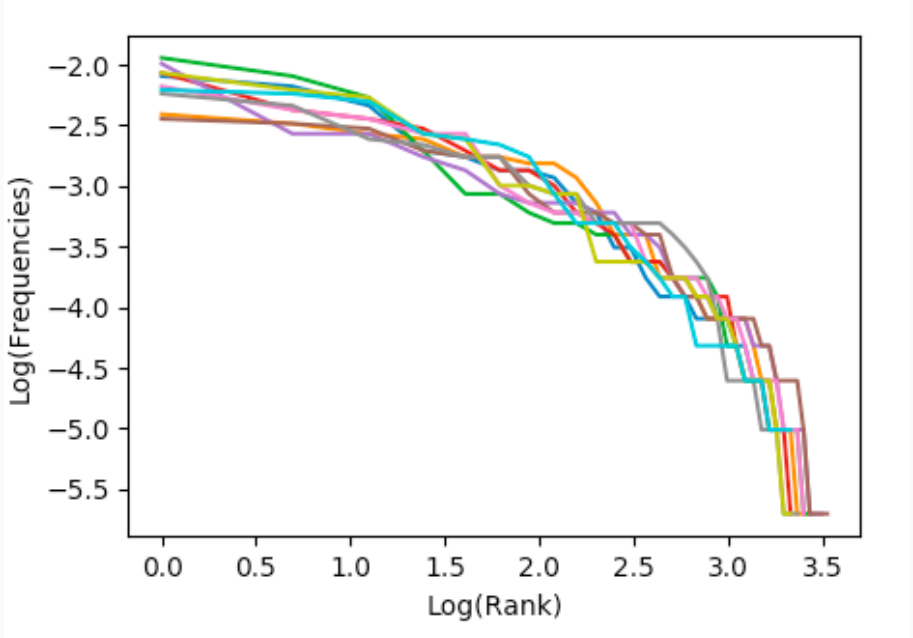

Figure 4: Zipfian, R^2=0.81

Results: Yule-Polylogarithmic distribution over time

Testing the model on ≈150 English frequent words.
Results after 200 changes

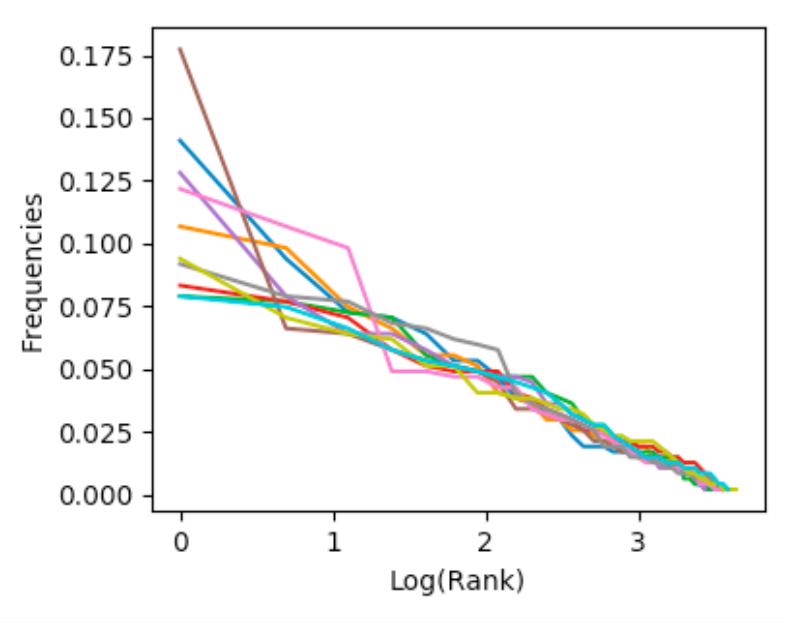

Figure 5: Yule-Polylog, R^2=0.97

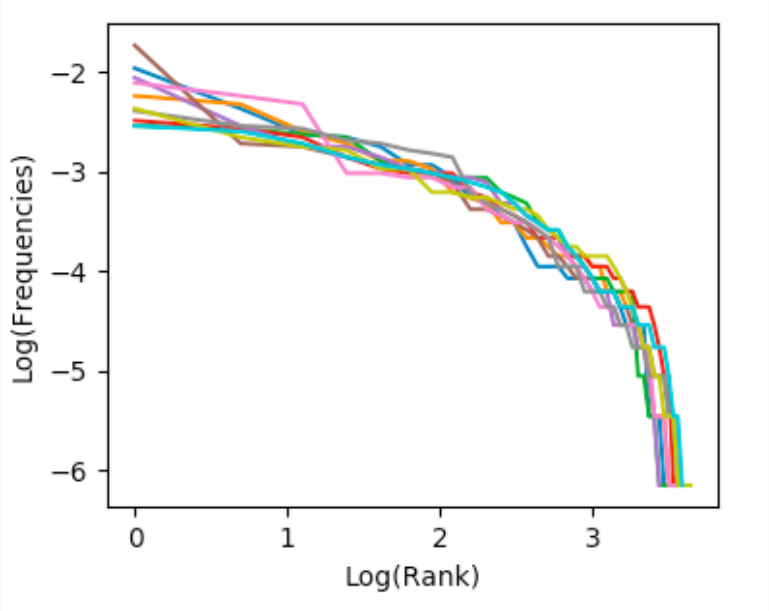

Figure 6: Zipfian, R^2=0.77

Results: 1 - Phonemic frequencies

FIRST CLAIM: power law distributions can **emerge** out of a model of sound change based on Mergers and Splits (cf. Sayeed and Ceolin 2019)

This **weakens** functional arguments based on the observation that phonemes are distributed according to power law distributions (Mandelbrot 1953, Tambovtsev and Martindale 2007, Taylor 2012)

Results: 2 - Lexical Clumpiness

LEXICAL CLUMPINESS

Dautriche et al. (2017) 'Results for four languages (Dutch, English, German, French) show that the space of monomorphemic word forms is **clumpier** than what would be expected by the best chance model according to a wide variety of measures [...] **The strongest evidence comes from minimal pairs**'

Results: Minimal Pairs and Phonemes over time

Results after 500 changes.

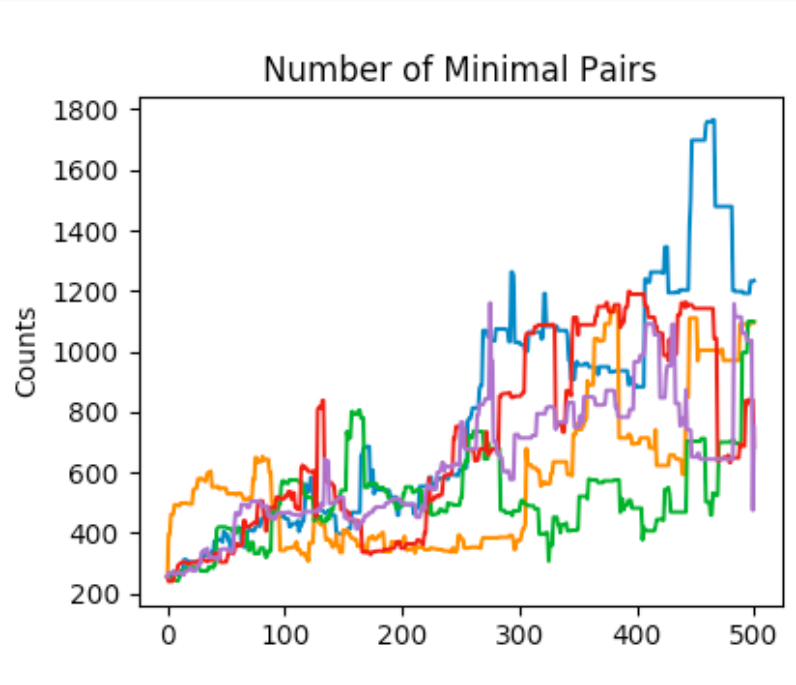

Figure 7: Minimal Pairs

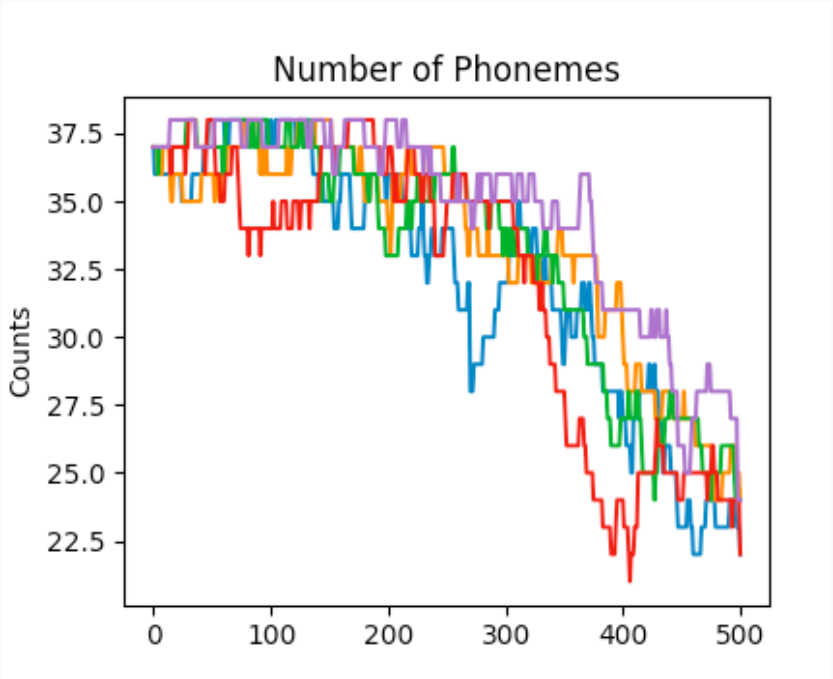

Figure 8: Phonemes

Irreversibility of Mergers

Mergers are **irreversible** (Garde's principle, Labov 2010:121)

(A) ⟶ (B) /e/ > /a/ +2 Minimal Pairs (MP)

sad	**sa**d
s**e**t	**sa**t
far	f**ar**
h**e**r	h**ar**

(A) ⟵ (B) -2 MP complicated in a single step

Irreversibility of Mergers

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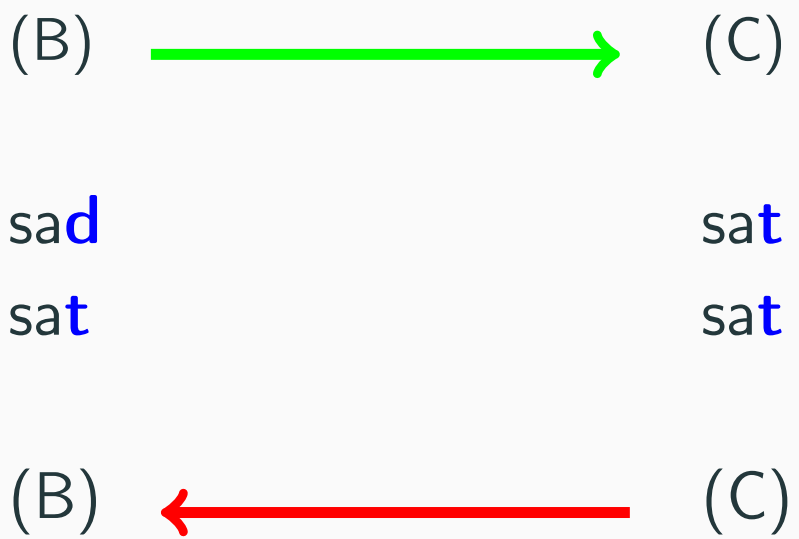

Results: Minimal Pairs and Phonemes over time

Results after 1000 changes.

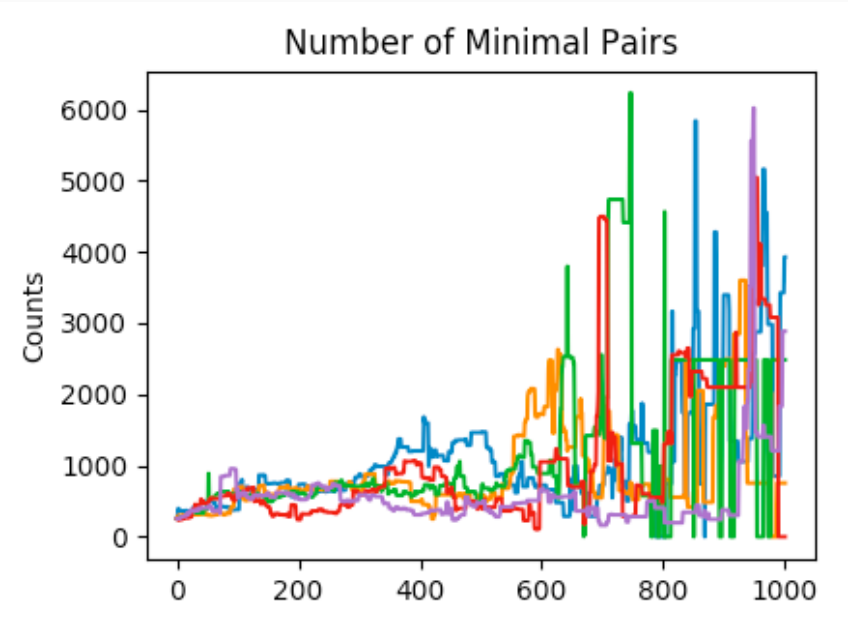

Figure 9: Minimal Pairs

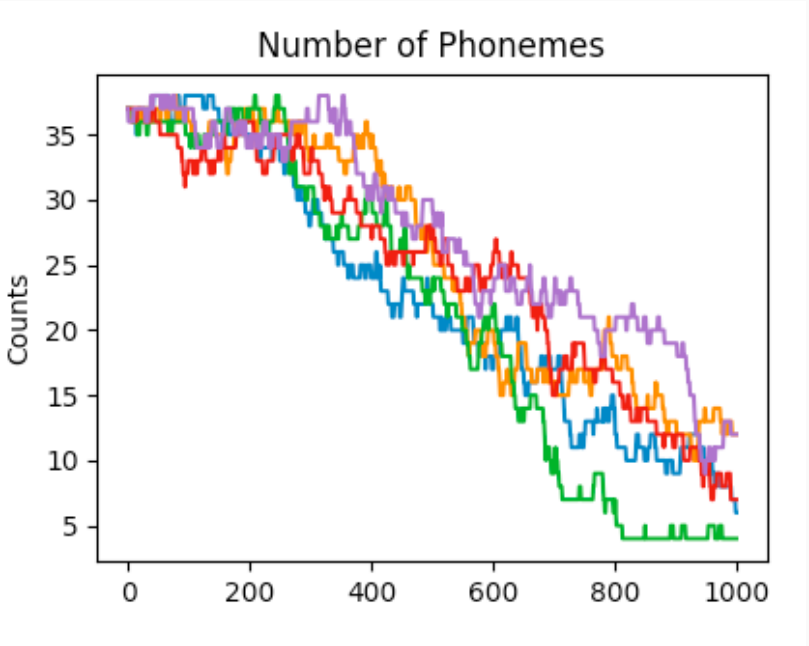

Figure 10: Phonemes

Results: 2 - Lexical Clumpiness

SECOND CLAIM: there is a pressure towards lexical clumpiness in the lexicon, and it is not just a matter or probability distribution over mergers and splits. **Irreversibility of mergers** is the cause.

This needs not to be driven by functional considerations.

Other things are useful for communication (e.g., borrowing words, word compounding) because they create new phonemic contexts. **Not regular sound change**.

Conclusions

SUMMARY

I proposed a null model of sound change to see if we can derive patterns identified in contemporary languages from regular sound change

The **polylogarithmic** distribution of phonemes and **lexical clumpiness** emerge from a null model

We should not be using these properties (among others) to argue for functional pressures (e.g. communication efficiency, learnability)

Thank you!

Thanks to the reviewers of my abstract, Ryan Budnick, Spencer Caplan, Aletheia Cui, Jordan Kodner, Caitlin Richter, Ollie Sayeed, David Wilson, Bob Berwick, Robin Clark, Rolf Noyer, Don Ringe, Meredith Tamminga, Charles Yang

Questions?