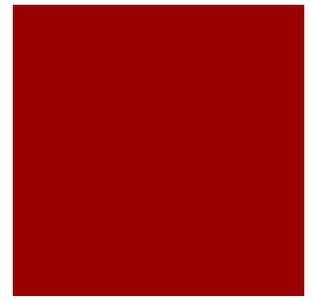


# Priors in Bayesian Learning of Phonological Rules

Michael Zhong

# Three Questions



How do you represent and learn phonological rules?

Where does a MDL-based prior fail in this situation?

How can we do better?

# Terminology

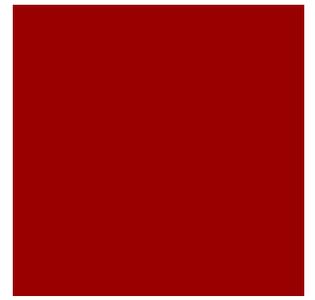


Stem: [walk, jump, bark, food, multiply]

Suffixes: [-ing, -ed, -s, -es]

Signatures: [walk, jump, bark], <ed.ing.s>

# Minimum Description Length



$\text{Max}(\text{Pr}(H)\text{Pr}(DIH))$

$\text{Min}(-\log\text{Pr}(H) - \log\text{Pr}(DIH))$

$-\log\text{Pr}(H) \Rightarrow$  proportional to the length of H

$-\log\text{Pr}(DIH) \Rightarrow$  length of D using H encoding

# Linguistica (Goldsmith 2001)



## Trade-off:

Grouping words into signatures makes modeling individual words more difficult

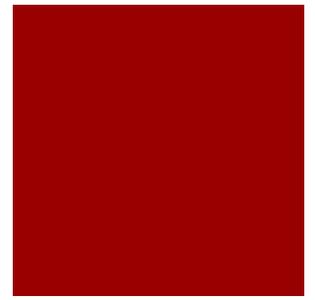
Assigning words to signatures reduces the number of stems, and thus the length of the grammar

# Sample Linguistica Grammar



1.  $(\{work, roll\} \times \{\epsilon, ed, ing, er\})$
2.  $(\{din, bik\} \times \{\epsilon, ed, ing, er\})$
3.  $(\{wait\} \times \{\epsilon, ed, er\})$
4.  $(\{carr\} \times \{y, ied, ier\})$
5.  $(\{carry\} \times \{\epsilon, ing\})$
6.  $(\{beach, match\} \times \{\epsilon, es\})$

# Problem with Linguistica



The (e)ing problem. Beach(+es) and Stomach(+s)

Can only handle Stem-Final Deletion

Not mentioned, but I found this awkward too:

{din, bik}x{e, ed, ing, er}

# Morpho-Phonological Grammar (their approach)

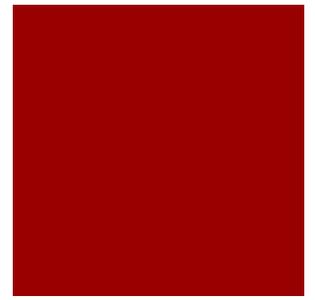


Keep signatures, stems, suffixes

Add idea of rule

e.g. e € / CeiC

# Representing Rules



$Xy_t y_f X$

E.g. jump+ed => CpeC

Why?

Allows insertions, deletions, and substitutions to be handled

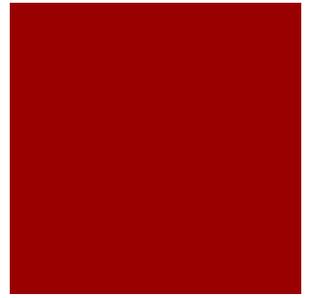
# Linguistica

1. ( $\{work, roll\} \times \{\epsilon, ed, ing, er\}$ )
2. ( $\{din, bik\} \times \{\epsilon, ed, ing, er\}$ )
3. ( $\{wait\} \times \{\epsilon, ed, er\}$ )
4. ( $\{carr\} \times \{y, ied, ier\}$ )
5. ( $\{carry\} \times \{\epsilon, ing\}$ )
6. ( $\{beach, match\} \times \{\epsilon, es\}$ )

# New approach

1. ({work, roll, dine, carry}x{€, ed, ing, er})
2. ({bike}x{€, ed, ing, er, s})
3. ({wait}x{€, ed, er})
4. ({booth, worker, beach, match}x{€, s})

With 5 rules



# Problems with the author's algorithm?



(Where Bayesian Analysis comes into play)

Collapsing signatures lowers corpus likelihood

Stronger explanatory power of signature (prior) often not enough to counterbalance

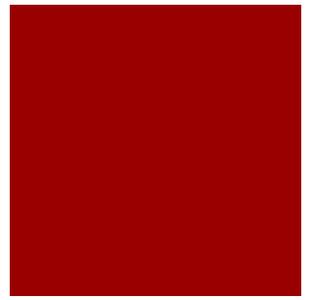
# Prior Used



Trivially, the number of bits used to describe the grammar

Problem?

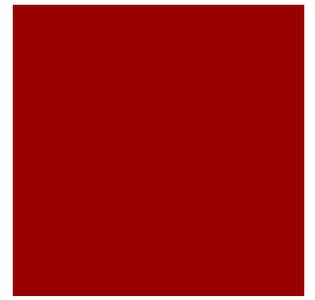
# Poor Incentivizing



{certif, empt, hurr} x {ied, y}

{certify, empty, hurry} x {€, ed}

# Tweaking the prior



Assign a fixed cost to each stem

Assign signature cost that varies based on the length of all the suffixes

Final question: What makes this approach better?

What are some weaknesses?

# Questions

1. Can the prior be adjusted to include prefixes? If so, why isn't it?
2. Can a similar prior be designed for other languages?
3. To what degree are the modifications arbitrary?

