Unsupervised Discovery of Rhyme Schemes

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Motivation

All swol'n with chafing, down Adonis sits,
Banning his boisterous and unruly beast: ?
And now the happy season once more fits,
That love-sick Love by pleading may be blest; ?
For lovers say, the heart hath treble wrong ?
When it is barr'd the aidance of the tongue. ?

Pronunciations change over time

- Shakespeare, 1593

Motivation

Stiff, strange, and quaintly coloured
As the broidery of Bayeux
The England of that dawn remains,
And this of Alfred and the Danes
Seems like the tales a whole tribe feigns
Too English to be true.

?
?

Pronunciations may be unknown

- Chesteron, 1911

Motivation

層樓危構出層霄，把酒登臨客恨饒。
草色不羞吳地短，雁聲空落楚天遙。
江山如畫知豪傑，風月無私慰寂寥。
六代繁華在何處？敗紅殘綠野蕭蕭。

?

?

?

?

- Wang Mian, c. 1300

Pronunciations may be unknown and not derivable from spelling

Motivation

- Therefore,

  we want a language-independent method of finding rhymes that does not need pronunciation information

- But

  why do we care about finding rhymes anyway?

Motivation

Rhyme scheme annotations are useful –

- Machine Translation of Poetry (Genzel et al., 2010)
  - Rather than dictionary pronunciations (unreliable), train on annotated data
- Digital Humanities (Google Books N-Grams, Perseus Library)
  - Track frequencies, usage trends of rhymes in a large corpus
  - Analyze rhyming word choices of a given poet, etc.
- Historical Linguistics
  - Reconstruct pronunciations from rhymes

  blest rhymes with beast → cue to how Shakespeare spoke!

Main Cue: Repetition of Rhyming Pairs

sits
beast
fits
blest
wrong
tongue

tongue
commander
wrong
slander
yet
wit

tongue
so
wrong
show
owe
surmise
eyes

False positives

me
mine
infamy
pine

she
collatine
me
mine

me
is
shine
is
mine

Model of Stanza Generation

- Pick a rhyme scheme $\mathtt{r}_1\mathtt{r}_2\ldots\ \mathtt{r}_n$
- For $\mathtt{i}$ from 1 to $\mathtt{n}$:
  - If $\mathtt{r}_i = \mathtt{r}_j = \mathtt{r}_k = \ldots$ for $\mathtt{j,\ k,\ldots < i}$:

    Generate word $\mathtt{w}_i$ with probability $\mathtt{P(w_i|w_j)P(w_i|w_k)}\ldots$
  - Else:

    Generate word $\mathtt{w}_i$ with prob. $\mathtt{P(w_i)}$

P(ababbcc)		
* P(tongue)	tongue	a
* P(so)	so	b
* P(wrong|tongue)	wrong	a
* P(show|so)	show	b
* P(owe|so)P(owe|show)	owe	b
* P(surmise)	surmise	c
* P(eyes|surmise)	eyes	c

= P(rhyme scheme)
*(P(stanza|rhyme scheme)

Learning Algorithm

- Find maximum likelihood rhyme scheme `r` for stanza `x`
- Unknown parameters:

  $\theta_{a,b}$ = strength of 'rhymingness' between word a and b

  ρ_r = prior probability of rhyme scheme r

- Probability of rhyming a with b

  $= P(a|b) = \theta_{a,b} / \Sigma_c \theta_{c,b}$

- Let search space for `r` = all rhyme schemes in the corpus

Expectation Maximization

- Initialize: $\theta_{x, y}$ and ρ_r
- E: posterior probability of rhyme scheme for each stanza.

  $P(\text{rhyme scheme } r | \text{stanza } x)$ under θ and ρ

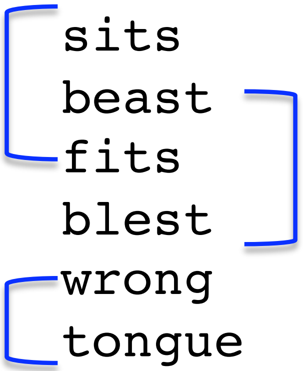
- M: Soft counts of rhymingness and prior probabilities

$$\theta_{a, b} = \Sigma_{x,r \,:\, a \text{ rhymes with } b} P(r|x)$$

$$\rho_r = \Sigma_x P(r|x) / \Sigma_{x, q} P(q|x)$$

Orthographic Cues

Initialization of θ


sits
beast
fits
blest
wrong
tongue

1. Uniform

2. Orthographic Similarity:

$$\theta_{a,b} = \frac{\text{\# letters in a and b}}{\text{min (length of a, length of b)}}$$

Data

- Corpus of manually annotated rhyming poetry

English:

- Time period: 1450-1950
- 11613 stanzas, 93030 lines

From Sonderegger (2011), expanded and edited by us

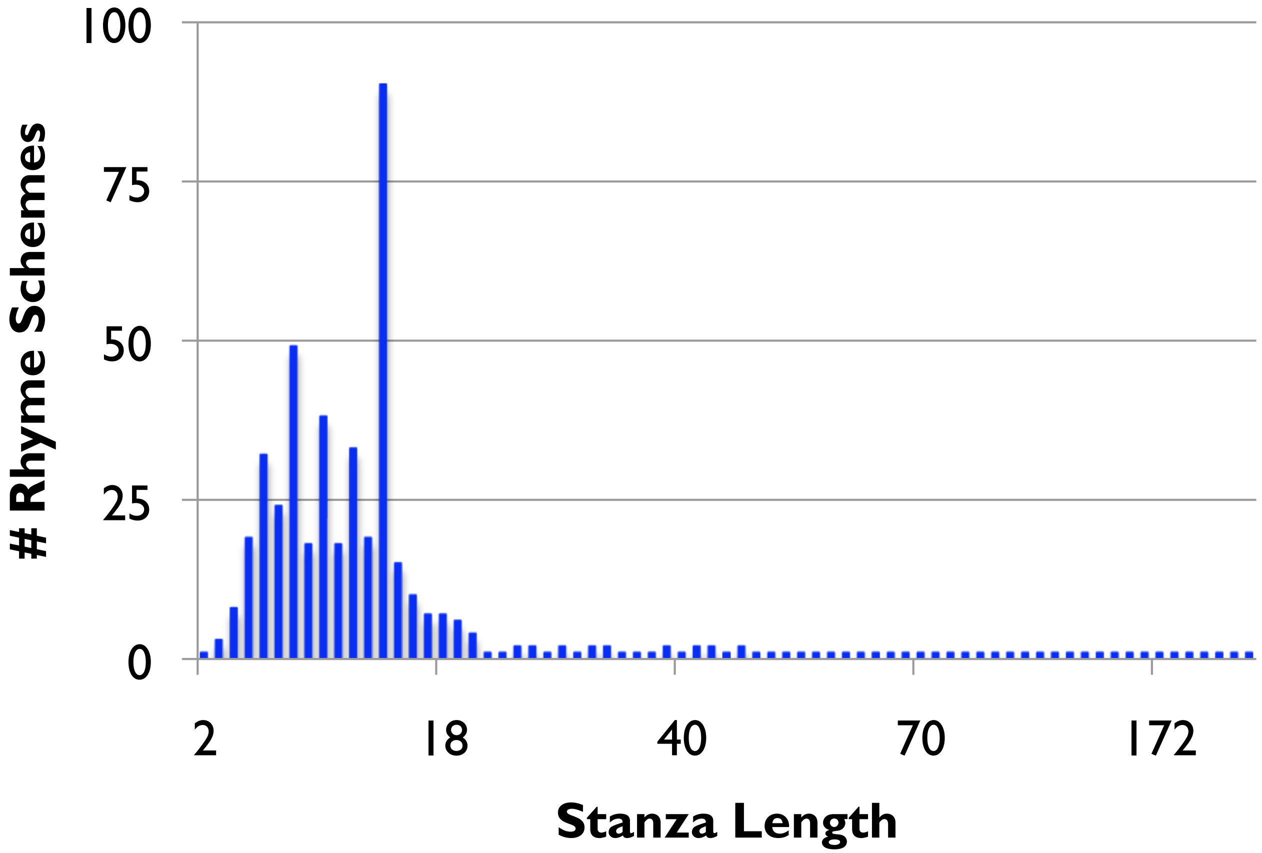
French:

- Time period: 1450-1650
- 2814 stanzas, 26543 lines

Collected for this project

Data

- # of rhyme schemes per stanza length (search space)



Evaluation

- Rhyme Scheme Accuracy
- Average F-Score

sits	a
beast	a
fits	b
blest	b
wrong	c
tongue	c

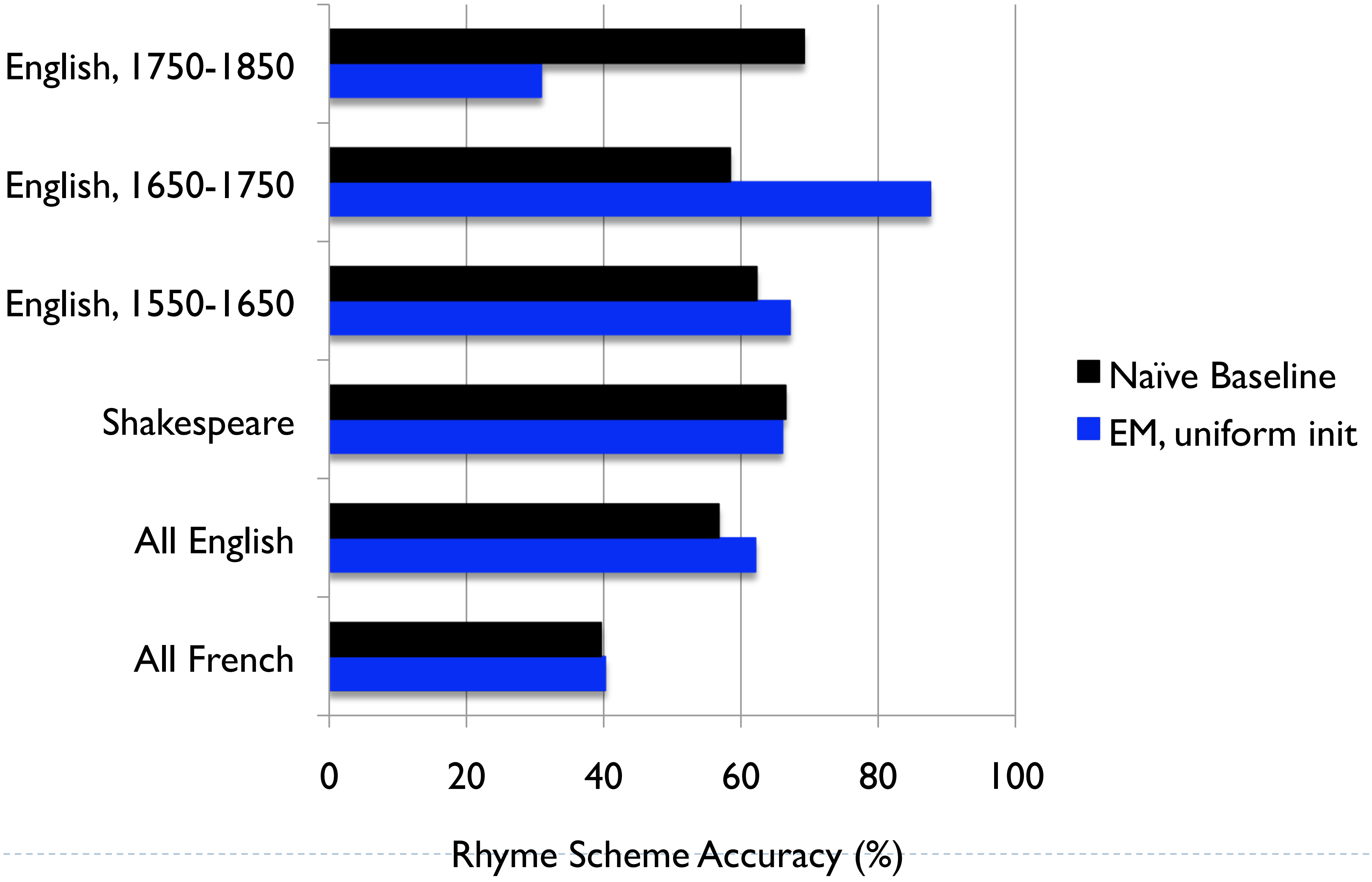
Incorrect rhyme scheme

Correct pair

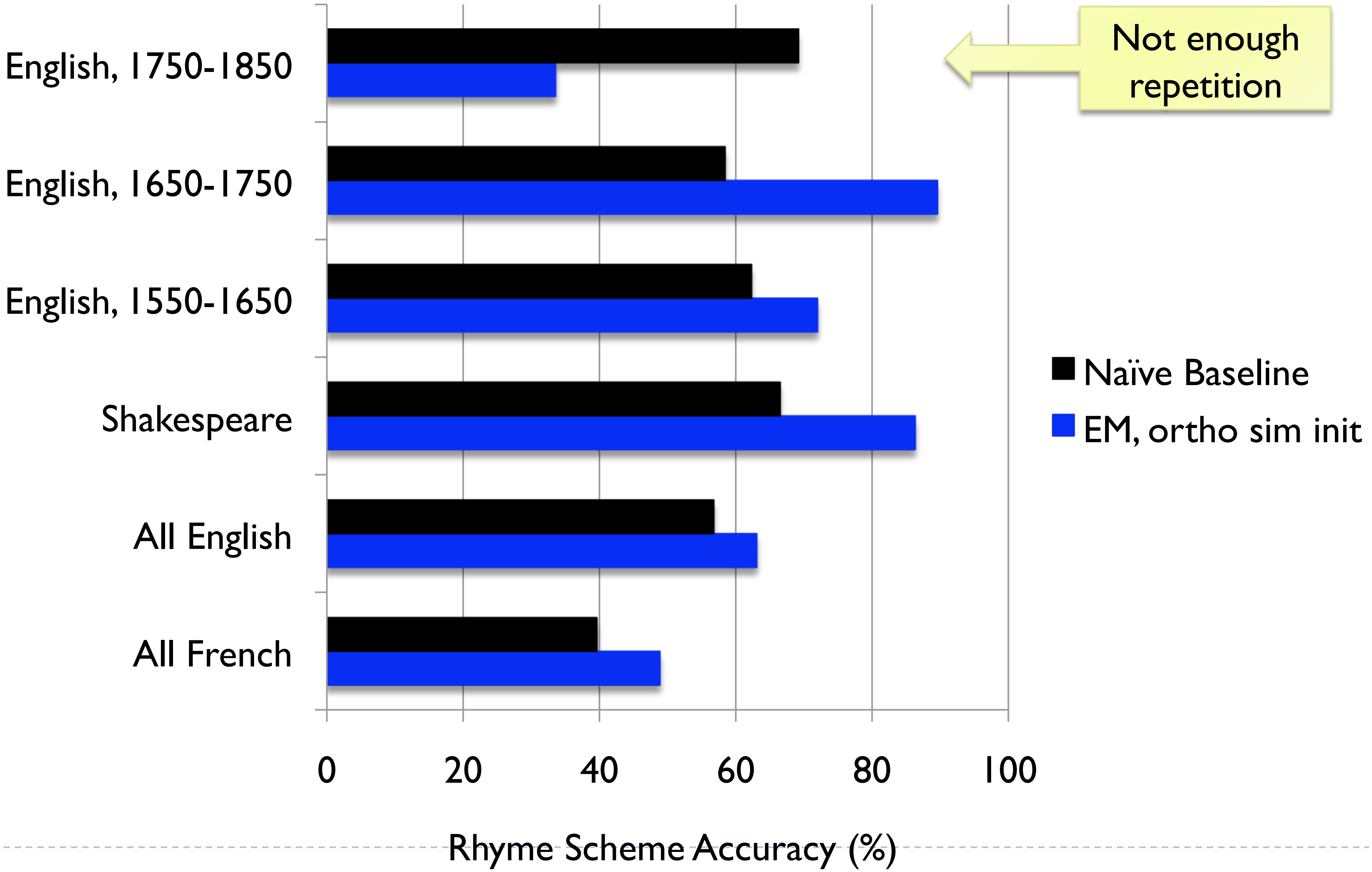
- For each word token, look at set of words that rhyme according to gold standard and inferred rhyme scheme

- Compute precision and recall;
  average F-Score over all tokens

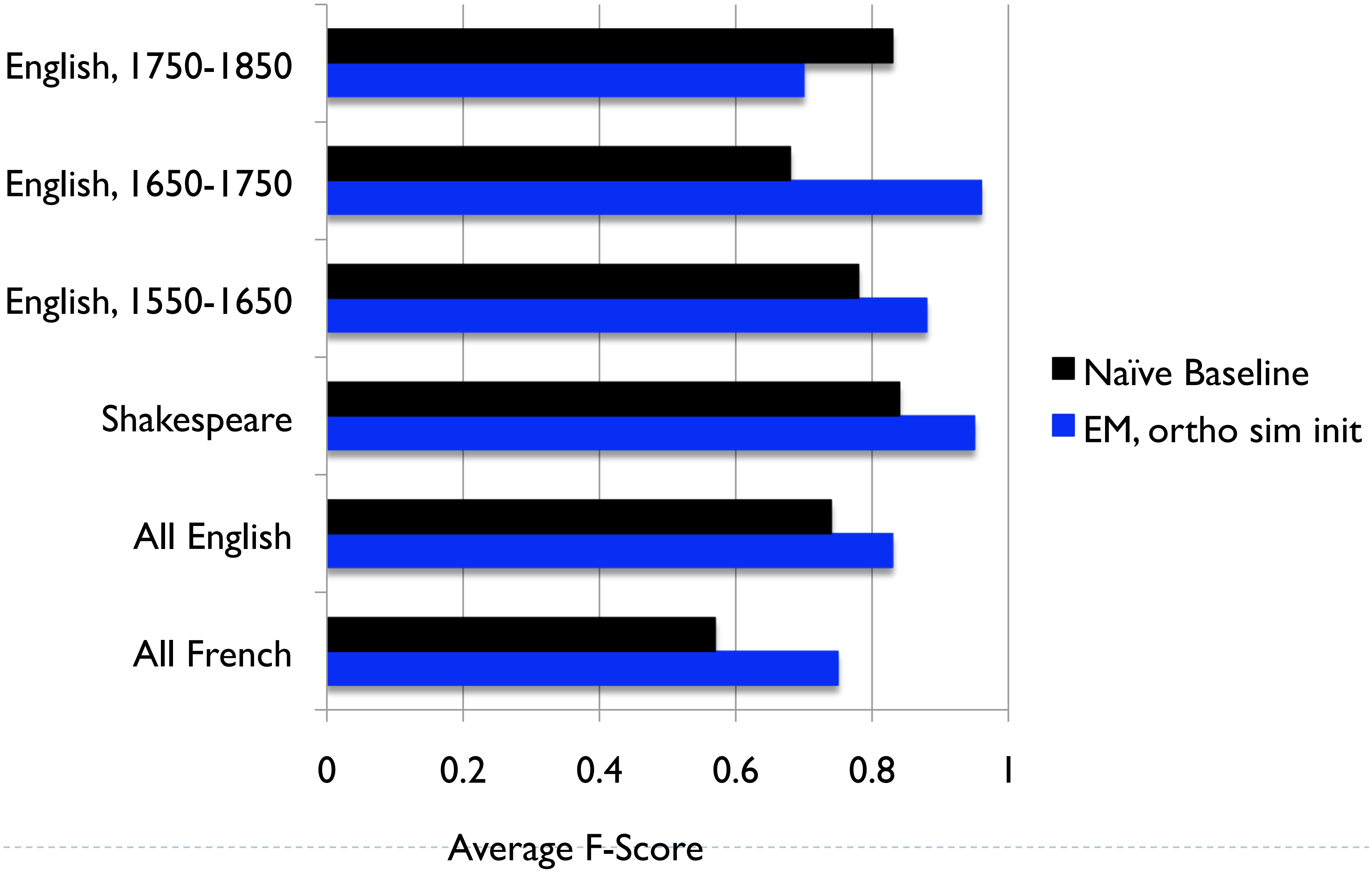
Results


English, 1750-1850
English, 1650-1750
English, 1550-1650
Shakespeare
All English
All French
0
20
40
60
80
100
Rhyme Scheme Accuracy (%)
Naïve Baseline
EM, uniform init

Results

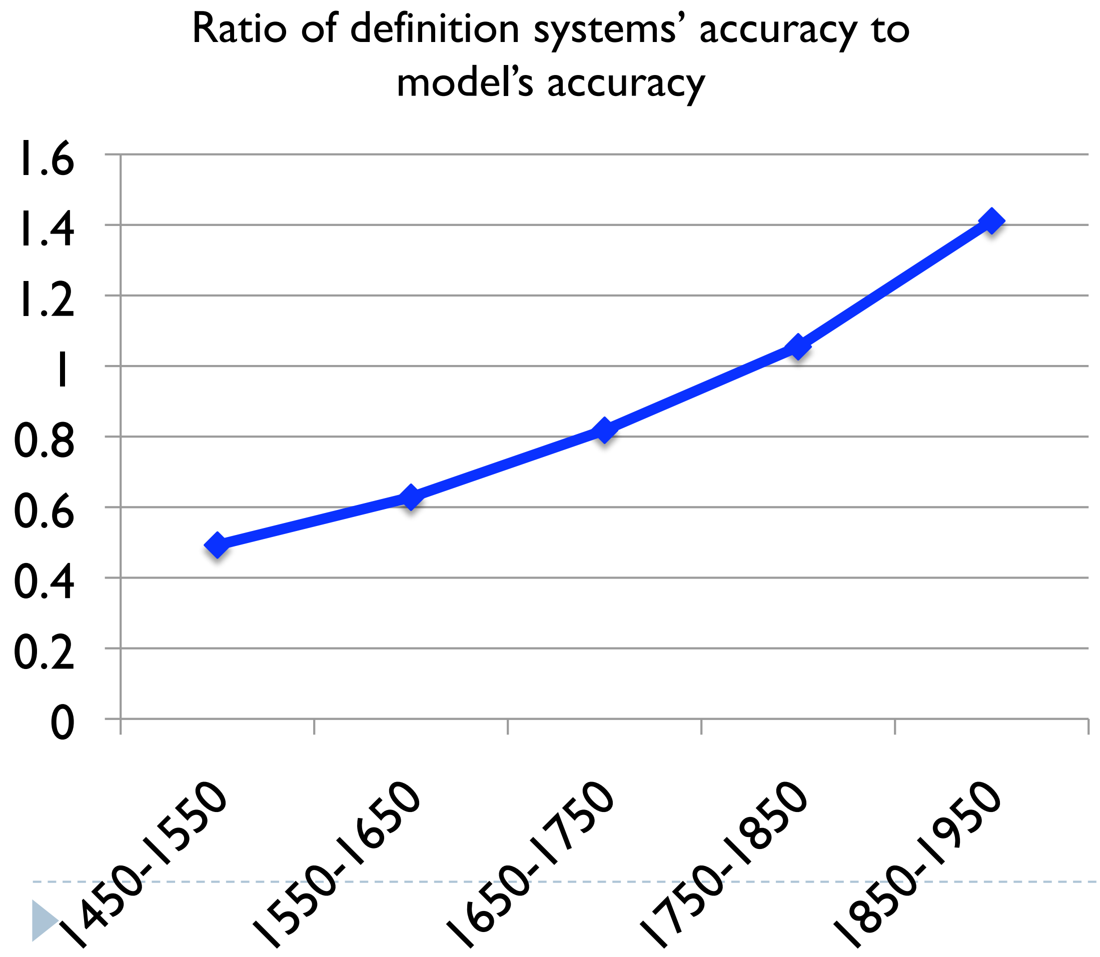

Not enough repetition

Results


English, 1750-1850
English, 1650-1750
English, 1550-1650
Shakespeare
All English
All French
0
0.2
0.4
0.6
0.8
1
Average F-Score
■ Naïve Baseline
■ EM, ortho sim init

Results

- Comparison with using rhyming definition + CELEX



	Rhymes found by Model	**Rhymes found by definition**
1450-1550	left/craft, shone/done	edify/lie, adieu/hue
1550-1650	speak/break, doe/two	obtain/vain, breed/heed
1650-1750	most/cost, presage/rage	see/family, blade/shade
1750-1850	it/basket, o'er/shore	ice/vice, head/tread
1850-1950	of/love, again/rain	old/enfold, within/win

Stanza Dependencies

- This model generates each stanza independently

- But there are connections across stanzas

My mother's maids, when they did sew and spin,
They sang sometime a song of the field mouse
That, for because her livelihood was but thin,

Would needs go seek her townish sister's house.
She thought herself endured too much pain;
The stormy blasts her cave so sore did souse

Wyatt, c. 1500

Stanza Dependencies

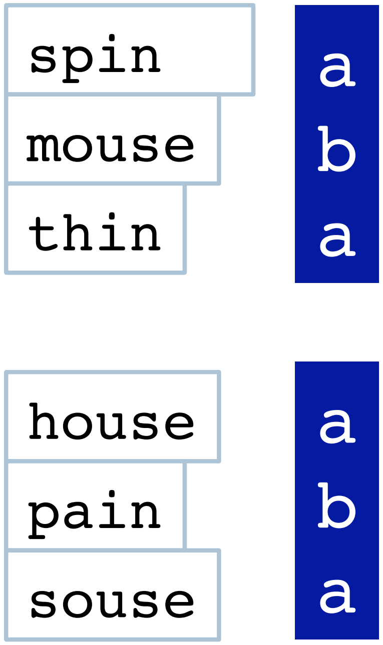
- *Solution*: Assume Markov dependencies (each stanza is only related to previous)

- Generative model of stanzas $x^1\ x^2\ x^3 \ldots x^m$

  - Generate scheme r^1 and stanza x^1 as before

  For $i = 2$ to m

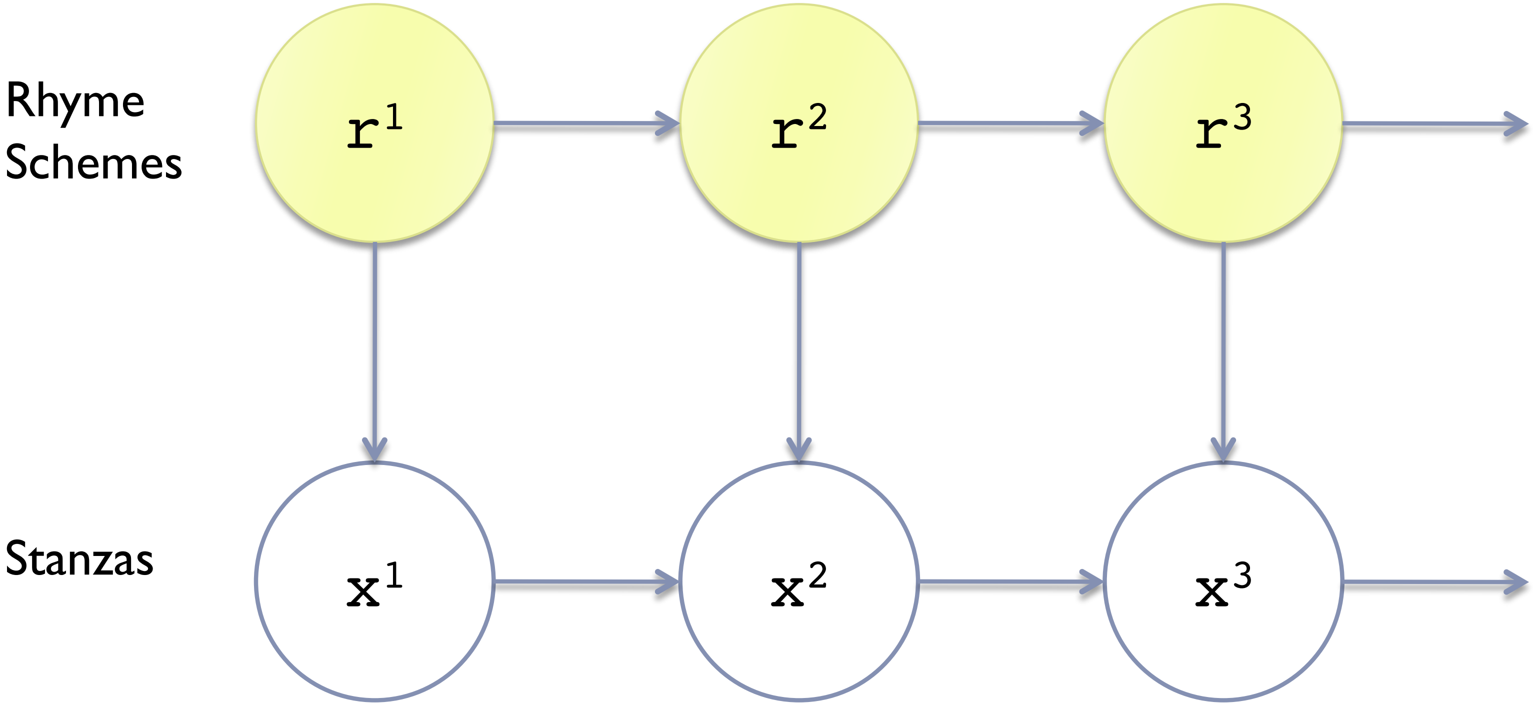
  - Pick rhyme scheme r^i with prob. $P(r^i \mid r^{i-1})$
  - Generate stanza x^i with prob. $P(x^i \mid r^i,\ x^{i-1})$



spin a
mouse b
thin a

house a
pain b
souse a

Stanza Dependencies

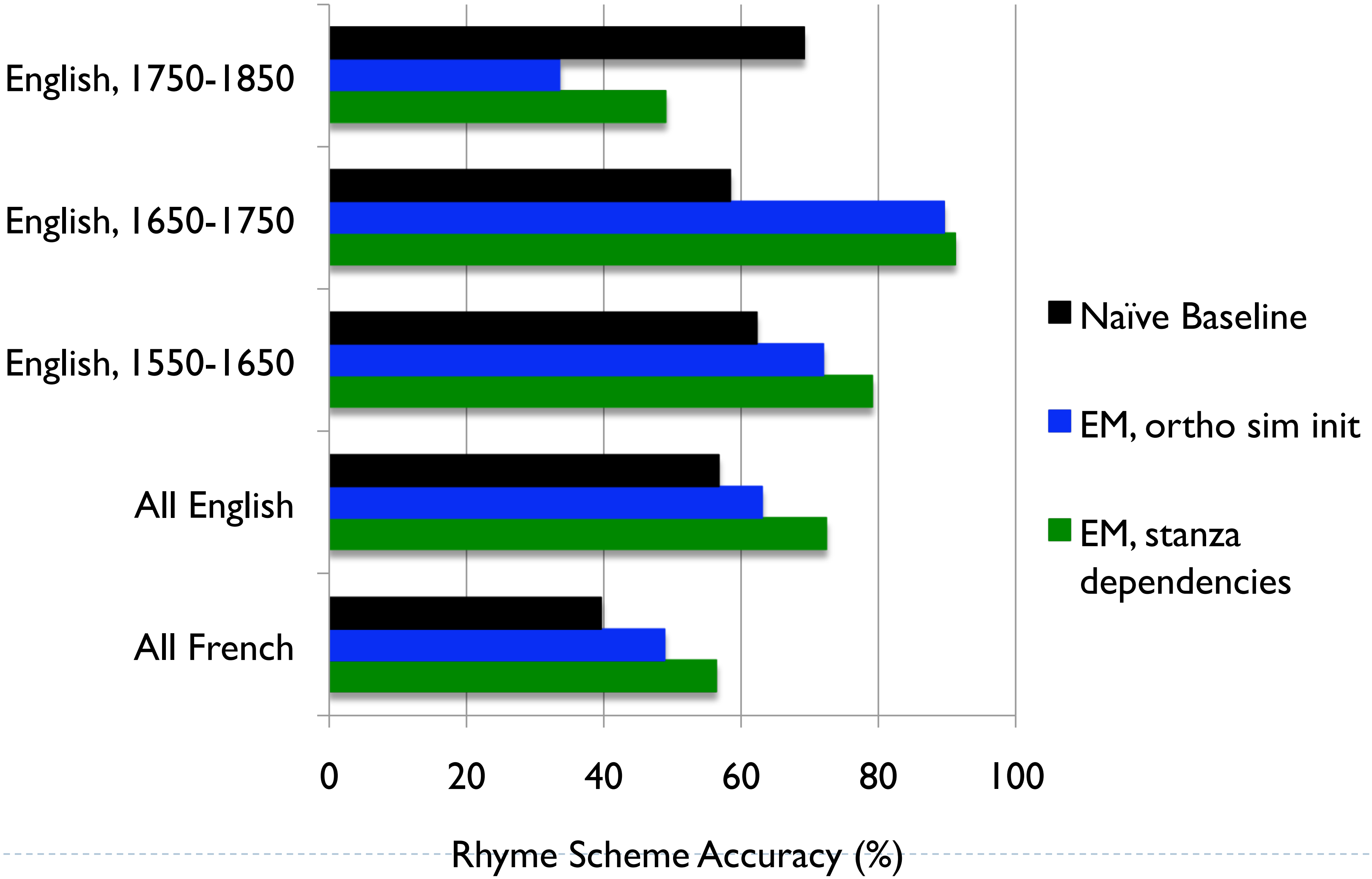


Autoregressive HMM

E-Step: compute posteriors with forward-backward algorithm

M-Step: update θ , ρ

Results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60
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Rhyme Scheme Accuracy (%)
■ Naïve Baseline
■ EM, ortho sim init
■ EM, stanza dependencies

Future Work

- Make use of rhyme transitivity
- Use orthographic similarity and/or rhyming definitions to regularize θ
- Text normalization – infer that

  speake/weake = speak/weak
  speaking/weaking = speak/weak
- Incorporate partial supervision when available
- Test on other languages = collect and annotate more data!

Conclusion

- Introduced the problem of unsupervised rhyme scheme annotation
- Solutions using generative models of stanza and rhyme scheme creation
- Outperforms baseline, marked improvements over using pronunciation information for pre-1800 text
- Annotated data and rhyme scheme discovery code in Python available on the ACL Anthology/ACL 2011 proceedings

Thanks for your grace
in this chase.