Supervised Machine Learning for Hybrid Meter

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Motivation

- Scan and learn rhythm of medieval poetry
- Avoid rule-based approach

Previous Work

- Hartman, 1996
- Plamondon, 2006; McAleese, 2007; Greene et al., 2010; Agirrezabal et al., 2013; Navarro, 2015

Hybrid Meter

- Classical meter
- Medieval varieties

Scansion

- the process of determining the metrical value of each syllable in a line of poetry
- in a scanned line of meter, each syllable is marked as stressed/unstressed, or long/short

Scansion

- in qualitative meter, typical of English poetry, stress is the most important feature

Romeo and Juliet 1.1.1:

Two house | holds, both | alike | in dig|nity. |
| × × ´ | × × ´ | ×× ´ | × × ´|× × ´|

Scansion

- other languages such as Latin rely on syllable length, which is known as quantitative meter

Aeneid line 1:

ārma vi |rumque ca|nō, Troi |ae quī|prīmus ab|ōrīs
— ^ ^ | — ^ ^ |— — |— — | — ^ ^ |— —

Middle High German Meter

- the meter of 12th and 13th century Middle High German (MHG) epic verse uses hybrid meter
- both syllable stress and length play a role
- the predominating pattern is a simple alternation between stressed and unstressed syllables

Middle High German Meter

The Song of Hiawatha:

Should you ask me, whence these stories?
X' X | X' X | X' X | X' X

- trochaic tetrameter
- 4 units (feet): stressed–unstressed alternation

Middle High German Meter

Der Arme Heinrich:

Ein rîter sô gelêret was
X | X'X | X' X |X' X| X' ˆ

- each foot has two syllables, stressed–unstressed
- “Ein” in anacrusis, rest after “was”

Middle High German Meter

- a foot can also consist of one syllable
- the syllable must be phonologically long – double mora
- a long syllable has a long vowel or ends in a consonant
- English “tree” or “bed”

Middle High German Meter

- a foot can also consist of three syllables
- two of them must be phonologically short – half morae; together they function as one syllable
- a short syllable must end in a short vowel
- first syllable of “reduce”, second syllable of “China”

Middle High German Meter

der nam im manege schouwe (6)
X | X' X | ^' ^ X | — | X` ˆ

- the second foot consists of 3 syllables
- the third foot consists of 1 syllable

Middle High German Meter

- primary stress: the first or only stressed syllable of a word
- secondary stress: any following stressed syllable
- all other syllables are unstressed

der nam im manege schouwe (6)
X | X' X | ^' ^ X | — | X` ^

Middle High German Meter

- an unstressed “e” can be elided if an adjacent word starts or ends with a vowel

daran begundẹ er suochen (8)

X|X' X | X' X | — | X` ˆ

Middle High German Meter

- alternating rhythm of stressed and unstressed syllables is the guiding principle
- most of the deviations from pure trochaic tetrameter serve to preserve this rhythm
- the conditions for half morae, double morae, and elision are necessary, not sufficient

Metrical Values

- there are 8 possible metrical values for prediction:

1. mora – primary stress
2. mora – secondary stress
3. mora – unstressed
4. half mora – primary stress
5. half mora – secondary stress
6. half mora – unstressed
7. double mora (always stressed)
8. elision

Syllabification

- Sonority Sequencing Principle (SSP)
- Legality Principle (LP)

Data

	mean	std.	min.	max.
char. per line	21.34	3.39	9	32
syll. per line.	7.62	1.04	5	11
words per line	5.01	1.13	1	8
char. per word	4.26	1.96	1	17
syll. per word	1.52	.71	1	7
char. per syll.	2.80	.81	1	7

Table 1: Summary statistics for annotated dataset

Annotation

ein/MORA WBY/WBY rî/MORA_HAUPT ter/MORA WBY/WBY sô/MORA_HAUPT WBY/WBY ge/MORA lê/MORA_HAUPT ret/MORA WBY/WBY was/MORA_HAUPT

daz/MORA_HAUPT WBY/WBY er/MORA WBY/WBY an/MORA_HAUPT WBY/WBY den/MORA WBY/WBY buo/MORA_HAUPT chen/MORA WBY/WBY las/MORA_HAUPT

swaz/MORA WBY/WBY er/MORA_HAUPT WBY/WBY dar/MORA WBY/WBY an/MORA_HAUPT WBY/WBY ge/MORA schri/MORA_HAUPT ben/MORA WBY/WBY vant/MORA_HAUPT

der/MORA_HAUPT WBY/WBY was/MORA WBY/WBY hart/DOPPEL man/MORA_NEBEN WBY/WBY ge/MORA nant/MORA_HAUPT

dienst/MORA_HAUPT man/MORA WBY/WBY was/MORA_HAUPT WBY/WBY er/MORA WBY/WBY zuo/EL ou/DOPPEL we/MORA_NEBEN

Annotation

Annotator 1 \ Annotator 2	×	×́	×̀	—	◡	◡́	ẹ	◡̀
×	285	4	0	1	3	0	0	0
×́	0	225	1	0	1	0	0	0
×̀	1	2	74	0	2	0	0	0
—	1	2	0	72	0	0	0	0
◡	1	0	0	0	36	0	0	0
◡́	0	1	0	0	0	17	0	0
ẹ	0	0	0	0	0	0	9	0
◡̀	0	0	0	0	0	0	0	1

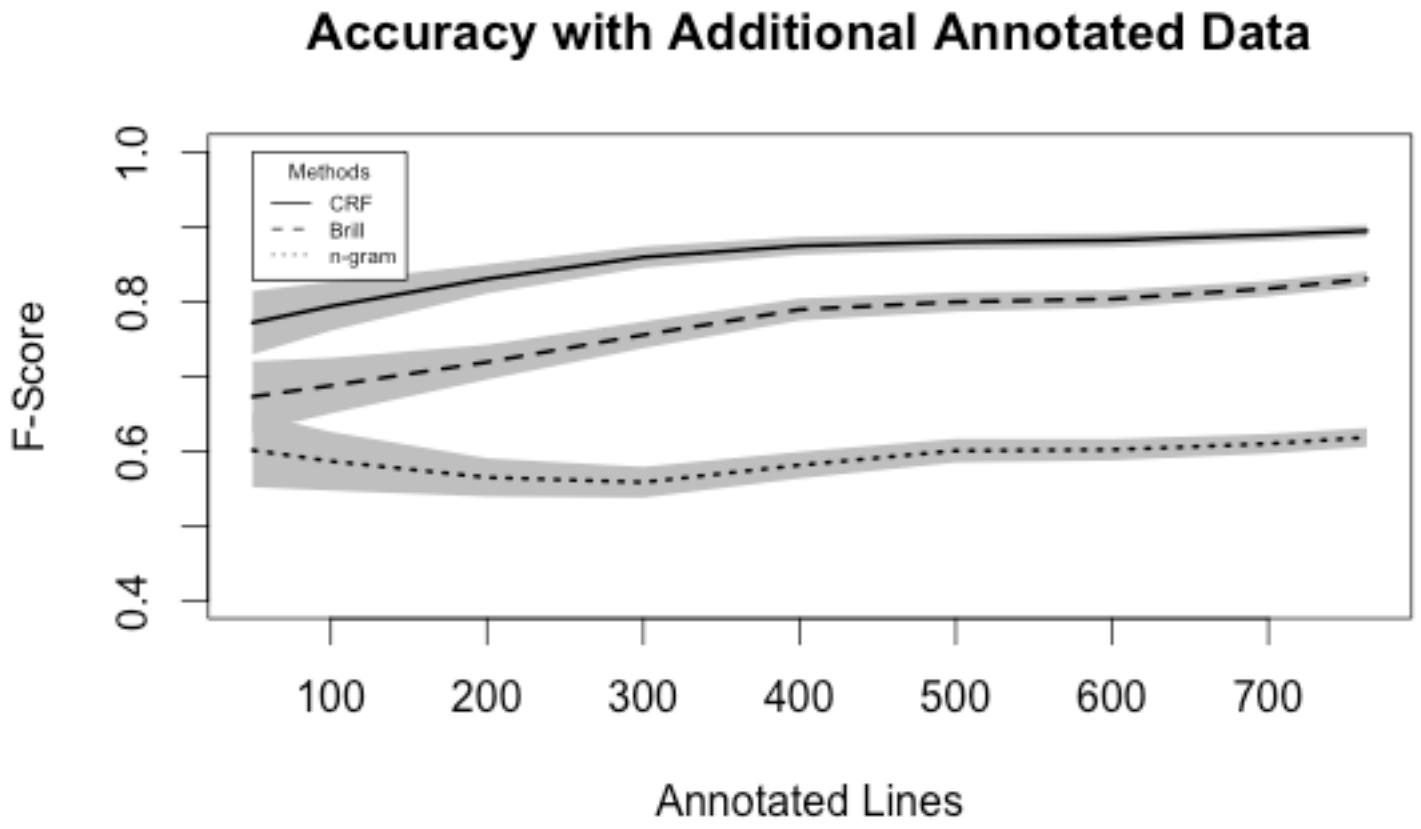
Table 2: Inter-annotator agreement confusion matrix

Models

- N-gram
- Brill Tagger
- Conditional Random Fields

CRF Model

- Position within line
- Length of syllable in characters
- Syllable characters
- Elision
- Syllable weight and length
- Word boundaries


Accuracy with Additional Annotated Data
Methods
CRF
Brill
n-gram
F-Score
0.4
0.6
0.8
1.0
100
200
300
400
500
600
700
Annotated Lines

Results

			held-out	
metrical value	**F**	**obs.**	**F**	**obs.**
mora - unstr.	.922	2403	.938	253
mora - prim.	.918	2025	.947	216
mora - sec.	.856	437	.880	37
double mora	.842	425	.865	34
half mora - unstr.	.574	231	.585	41
half mora - prim.	.771	103	.737	11
elision	.763	65	.500	2
half mora - sec.	0	4	0	0
(macro) average	.894		.904	

Table 3: CRF model F-score for individual metrical values and (macro) average in development and on held-out data

Rules

CRF	Brill
(1) not $\acute{\times}$ if next syll. is end of line	(1) $\acute{\times} \rightarrow \times$ if at word boundary and following syll. is $\acute{\times}$
(2) — if end of line is next syll.	(2) $\acute{\times} \rightarrow$ — if followed by $\grave{\times}$ and word boundary
(3) ẹ if last char is "e" and first char. of next syll. is "e"	(3) $\times \rightarrow \grave{\times}$ if end of line
(4) not — if syll. is open and light	(4) $\grave{\times} \rightarrow \acute{\times}$ if monosyllabic
(5) $\times$ if syll in pos. +7 is not end of line	(5) $\times \rightarrow \acute{\times}$ if following syll. is "ge"

Table 4: Top five CRF features and Brill rules

Scansion Output

502: von a-râ-bîe des gol-des
X / X' X / X` X / ---' / X` Zweisilbig klingend

503: he-ter ma-ne-gen knol-len brâht
/ X' X / X' ◡ ◡ / X' X / X' Einsilbig männlich

504: liu-te vin-ster sô diu naht
/ X' X / X' X / X' X / X' Einsilbig männlich

505: wârn al-le die von za-za-manc
X / X' X / X' X / X' X / X` Dreisilbig klingend

506: bî den dûht in diu wî-le lanc
/ X' X / X' ◡ ◡ / X' X / X' Einsilbig männlich

Future Work

Wolfram – *Parzival* and *Willehalm*
Hartmann – *Iwein*, *Erec*, *Der arme Heinrich*, *Gregorius*

"wârheit":

- Wolfram = 8/51 (15.7%)
- Hartmann = 28/33 (84.8%)

"minnen":

- Wolfram = 8/73 (11.0%)
- Hartmann = 13/16 (81.3%)

Conclusion

- Supervised learning is well-suited for complicated meter
- Rules generated by supervised models can supplement current pedagogy practices

Source code

- https://github.com/henchc/CLFL_2016