Finding rhythm in prose and poetry

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in collaboration with Ryan Heuser

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Which is prose, which is verse?

her pleasure in the walk must arise
from the exercise and the day,
from the view of the last smiles of the year
upon the tawny leaves, and withered hedges
to swell the gourd, and plump the hazel shells
with a sweet kernel; to set budding more,
and still more, later flowers for the bees,
until they think warm days will never cease
Which is prose, which is verse?

mankind do know of hell
fled away into the storm
the castle or the cot
her vespers done of all
a richness that the cloudy
fix'd as in poetic sleep
cold fair isabel poor simple
little cottage i have found
last prayer if one of
one hour half-idiot he stands

readiness to measure time by
in a trio while i
your sisters severally to george
the weather is unfavourable for
be in time perhaps it
i shall horribly commit myself
as bad again just now
i shall have got some
bless you sunday evening my
bars at charles the first
How do we tell prose from verse?

**Typography** (long lines, short lines, indentation)

**Topic**

**Vocabulary** (*your sisters severally to George*)

**Rhythm** (rhyme, alliteration, assonance, parallelism, **meter**, …)
Do prose and verse have different phonology?

Authors: Five English and five Finnish authors who wrote both prose and verse (https://www.gutenberg.org):

- Keats, Shelley, Whitman, Wordsworth, Yeats (English)
- Erkko, Kaatra, Leino, Lönnrot, Siljo (Finnish)

Data: 500 randomly sampled five-word “lines” for each author-genre pair, about 10,000 lines in all
Scansion

Meter is about a correspondence between metrical positions (strong, weak) and their phonological realization (see, e.g., Kiparsky 1977, Prince 1989, Hayes, Wilson and Shisko 2012, Blumenfeld 2015).

w s w s w s w s w s

The cúrfew tólls the knéll of páring dáy

This correspondence is also called SCANSION.
Iambic pentameter

I can’t believe that I forgot my keys

I can’t believe that Ánn forgot her keys
Iambic pentameter

I cán’t believe that I forgót my kéys

It ráins álmost álways whén I visit
Iambic tetrameter (Finnish, V. A. Koskenniemi)

<table>
<thead>
<tr>
<th>w</th>
<th>s</th>
<th>w</th>
<th>s</th>
<th>w</th>
<th>s</th>
<th>s</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ei</td>
<td>sú.vi</td>
<td>ól.lut,</td>
<td>jú.han.nùs,</td>
<td>+ stress</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– stress</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>w</th>
<th>s</th>
<th>w</th>
<th>s</th>
<th>w</th>
<th>s</th>
<th>w</th>
<th>s</th>
<th>s</th>
</tr>
</thead>
<tbody>
<tr>
<td>kun</td>
<td>sýn.nyit,</td>
<td>Súo.men vá.pa.ùs,</td>
<td>+ stress</td>
<td>4</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– stress</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

‘No summer was, midsummer, when you were born, Finland Freedom’ (Google translate)
The general principles

Stress-based meters:

- A stressed syllable cannot occur in a weak position
- An unstressed syllable cannot occur in a strong position

Length-based meters:

- A long syllable cannot occur in a weak position
- An short syllable cannot occur in a strong position
The Kalevala meter (Leino 2002, p. 161):

\[
\begin{array}{cccccccc}
  s & w & s & w & s & w & s & w
  \end{array}
  \quad // \quad
  \begin{array}{cccccccc}
  s & w & s & w & s & w & s & w
  \end{array}
\]

Már.jat.ta, kó.re.a kúo.pus // se káu.an kó.to.na kás.voi

\[
\begin{array}{cccccccc}
  s & w & s & w & s & w & s & w
  \end{array}
  \quad // \quad
  \begin{array}{cccccccc}
  s & w & s & w & s & w & s & w
  \end{array}
\]

kór.ke.an í.son kó.to.na // é.mon tút.ta.van tú.vil.la

’Marjatta, who is the youngest Korean, it grew long at home, high big at home, mother's acquaintance huts.’ (Google translate)

- A long stressed syllable cannot occur in a weak position
- A short stressed syllable cannot occur in a strong position.
- Both principles can be violated in the line-initial foot.
Metrical constraints

Mainstream English and Finnish meters pay attention to different constraints (Hanson and Kiparsky 1996 = H&K, pp. 287-8):

- Shakespeare’s iambic pentameter:
  \[ *W/PEAK \text{ ‘w may not contain a peak’} \]

- Finnish iambic-anapestic (trochaic-dactylic) meters:
  \[ *S/UNSTRESSED \text{ ‘s may not contain an unstressed syllable’} \]
The constraint \(*W/PEAK*

A PEAK is the main stress of a polysyllable:

\[mány, réptìle\] (peak + trough)

\[imménse, màintáin\] (trough + peak)

\[kéen\] (neither)
*W/PEAK violations

Néver cóme póison fróm só swéet a pláce

(Richard III.1.2)
Néver cáme póison fróm só swéet a pláce

#Néver had rát-póison só swéet a táste

(Richard III.1.2)
Phonological constraints

**PEAKPROMINENCE**  ‘No stressed short syllables’

**WEIGHT-TO-STRESS**  ‘No unstressed long syllables’

**NOCLASH**  ‘No adjacent stressed syllables’

**NOLAPSE**  ‘No adjacent unstressed syllables’

short syllable: \(CV\)

long syllable: \(CVV, CVC, CVVC, CVCC\)

(see, e.g., Prince 1990, Prince and Smolensky 1993/2004)
Questions

Do prose and verse differ objectively in terms of these constraints?

1. Based on H&K 1996, we would expect
   - English verse to violate *W/PEAK less than English prose
     (How about Finnish verse/prose?)
   - Finnish verse to violate *S/UNSTRESSED less than Finnish prose
     (How about English verse/prose?)

2. Should we expect PEAKPROMINENCE, WEIGHT-TO-STRESS, NOCLASH, and NOLAPSE to be violated less in verse than in prose?
“I wish our clever young poets would remember my homely definitions of prose and poetry; that is, prose = words in their best order; poetry = the best words in their best order.”

Samuel Taylor Coleridge, 12 July 1827

Method

• We need phonologically and metrically annotated corpora.

• We used PROSODIC (Heuser, Falk, and Anttila 2010-2011), phonological analysis and metrical scansion software developed at Stanford, available at https://github.com/quadrismegistus/prosodic
**PROSODIC**

Input:
- Metrical constraints parametrized by the user
- Plain text (from keyboard or text file)

Output:
- Phonologically annotated text (stress, weight, syllabification, etc.)
- All the possible metrical scansion
- For each scansion, violation count for each constraint
Phonological annotation

English from the CMU Dictionary (Weide 1998) and OpenMary (http://mary.dfki.de/); Finnish syllabifier written by Josh Falk.

<table>
<thead>
<tr>
<th>Word</th>
<th>P:</th>
<th>S:</th>
<th>W:</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>'aÉ\textipa{\textipa{a}}</td>
<td>P</td>
<td>H</td>
</tr>
<tr>
<td>shall</td>
<td>'Êf\textipa{\textipa{A}}\textipa{\textipa{l}}</td>
<td>P</td>
<td>H</td>
</tr>
<tr>
<td>horribly</td>
<td>'hÉ&quot;É³\textipa{\textipa{rÉ}}\textipa{\textipa{.bliÉ}}</td>
<td>P</td>
<td>U</td>
</tr>
<tr>
<td>commit</td>
<td>kÉ\textipa{\textipa{.mÉ\textipa{\textipa{at}}}}</td>
<td>P</td>
<td>U</td>
</tr>
<tr>
<td>myself</td>
<td>`maÉ\textipa{\textipa{a}}\textipa{\textipa{.sÉ\textipa{\textipa{&gt;l}}}}f</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>kellon</td>
<td>'kel.l\textipa{\textipa{on}}</td>
<td>P</td>
<td>U</td>
</tr>
<tr>
<td>avutonta</td>
<td>'a.vu.`ton.ta</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>ontuva\textipa{\textipa{a}}</td>
<td>on.tu.v\textipa{\textipa{a}}</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>naksutusta</td>
<td><code>nak.su.</code>tus.ta</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>ei</td>
<td>'ei</td>
<td>P</td>
<td>H</td>
</tr>
</tbody>
</table>
Metrical scansion

For 10-syllable line the upper bound is $2^{10} = 1,024$ candidate scansions. PROSODIC takes the following steps:

- assign each scansion a constraint violation vector
- discard harmonically bounded scansions
  (for harmonic bounding, see, e.g., McCarthy 2008:80-83)
- return the remaining scansions with violations for each constraint

Stress ambiguities are resolved by scansion, e.g., $a = [\text{ə}]$ vs. $á = [\text{ɛɪ}]$; $in$ vs. $ín$, etc.
Four metrical constraints (we’ve seen two above)

*W/STRESSED  No stressed syllable in a weak position.
*S/UNSTRESSED No unstressed syllable in a strong position.
*W/PEAK      No peak in a weak position.
*S/TROUGH    No trough in a strong position.

Initial assumptions (to be revised later):
•  position size = syllable
•  only one syllable per position
Never came poison from so sweet a place

Only the iambic scansion is possible.

[parse #1 of 1]: 5 errors
1 w ne *W/PEAK, *W/STRESSED
2 s VER *S/UNSTRESSED, *S/TROUGH
3 w came *W/STRESSED
4 s POI
5 w son
6 s FROM
7 w so
8 s SWEET
9 w a
10 s PLACE
Never had rat-poison so sweet a taste

The trochaic scansion is optimal. Note how PROSODIC selects á = [eɪ].

[parse #1 of 2]: 5 errors
1  s  NE
2  w  ver
3  s  HAD  *S/UNSTRESSED
4  w  rat  *W/STRESSED
5  s  POI
6  w  son
7  s  SO  *S/UNSTRESSED
8  w  sweet  *W/STRESSED
9  s  A
10  w  taste  *W/STRESSED
Never had rat-poison so sweet a taste

The iambic scansion is also predicted to be possible, but worse.

[parse #2 of 2]: 8 errors

1 w ne *W/STRESSED, *W/PEAK
2 s VER *S/TROUGH, *S/UNSTRESSED
3 w had
4 s RAT
5 w poi *W/STRESSED, *W/PEAK
6 s SON *S/TROUGH, *S/UNSTRESSED
7 w so
8 s SWEET
9 w a
10 s TASTE
To be or not to be that is the question

Only the iambic scansion is possible.

[parse #1 of 1]: 3 errors
1  w  to
2  s  BE  *S/UNSTRESSED
3  w  or
4  s  NOT
5  w  to
6  s  BE  *S/UNSTRESSED
7  w  that
8  s  IS  *S/UNSTRESSED
9  w  the
10 s  QUE
11 w  stion
Relaxing the meter

Relaxing the meter by allowing weak positions up to two syllables (= resolution) we get the dactylic scansion (Blumenfeld 2015, 84).

[parse #1 of 2]: 1 errors
1 s TO *S/UNSTRESSED
2 w be or
3 s NOT
4 w to be
5 s THAT
6 w is the
7 s QUE
8 w stion
How about prose scansion?

The great advantage of PROSODIC is that it blindly analyses any text, metered verse as well as unmetered prose.

The key point:

The resulting constraint violation profiles yield rich information about differences among texts.
The only thing we have to fear is fear itself

From the FDR inaugural address. No violations.

1 w the
2 s ONL
3 w y
4 s THING
5 w we
6 s HAVE
7 w to
8 s FEAR
9 w is
10 s FEAR
11 w its
12 s ELF
Fear itself is the only thing we have to fear

This is a construct.

1 w fear *W/STRESSED
2 s ITS *S/TROUGH, *S/UNSTRESSED
3 w elf *W/STRESSED, *W/PEAK
4 s IS *S/UNSTRESSED
5 w the
6 s ONL
7 w y
8 s THING
9 w we
10 s HAVE
11 w to
12 s FEAR
Our experiment

The goals:

• Use PROSODIC to listen to differences between prose and verse.
• Put H&K’s claim about English and Finnish meters to empirical test.
Background

In our data, each line has five words with no punctuation.

Therefore, any difference between prose and verse can only depend on the choice and arrangement of words, not on line length.

Metrical parameter setting:
- \( s \) = one syllable
- \( w \) = one or two syllables

Violation counts were normalized by dividing the sum of violations by the number of scansions and the number of syllables in the line.
English: Mean violation scores (phonology)
English: Mean violation scores (phonology)

Whitman is different (NOCLASH, NOLAPSE). Free verse scans like prose?
Lönnrot seems different (NOCLASH). Why?
Lönnrot is again different (PEAKPROM). Is this because of Kalevala meter?
Taking a closer look at the data

- For metrical constraints, raw mean violations are not helpful.

- In order to understand the data better we modeled it using LOGISTIC REGRESSION (see, e.g., Baayen 2008, Dalgaard 2008).

- The advantage of logistic regression is that it allows us to consider several predictors at once.
Mixed-effects logistic regression (Bates et al. 2014)

- **Dependent variable:** prose vs. verse
- **Predictors:** constraint violations, normalized and centered
- **Random variable:** author

- Only 6 constraints (4 phonological, 2 metrical) were included in the final model.
Summary of results

Which constraint violations predict which genre?

<table>
<thead>
<tr>
<th>Phonology</th>
<th>ENGLISH</th>
<th>FINNISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAKPROM</td>
<td>prose</td>
<td>prose</td>
</tr>
<tr>
<td>WSP</td>
<td>prose</td>
<td>prose</td>
</tr>
<tr>
<td>NOLAPSE</td>
<td>prose</td>
<td>prose</td>
</tr>
<tr>
<td>NOCLASH</td>
<td>verse</td>
<td>verse</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metrics</th>
<th>ENGLISH</th>
<th>FINNISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>*W/PEAK</td>
<td>prose</td>
<td>(non-sig.)</td>
</tr>
<tr>
<td>*S/UNSTRESSED</td>
<td>verse</td>
<td>prose</td>
</tr>
</tbody>
</table>
Model summary (English)

Positive estimate means the predictor favors prose.

**ENGLISH**
Random effects:

<table>
<thead>
<tr>
<th>Groups Name</th>
<th>Variance</th>
<th>Std.Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>author (Intercept)</td>
<td>0.001642</td>
<td>0.04053</td>
</tr>
</tbody>
</table>

Number of obs: 4998, groups: author, 5

Fixed effects:

|                          | Estimate | Std. Error | z value | Pr(>|z|) |
|--------------------------|----------|------------|---------|---------|
| (Intercept)              | -0.09753 | 0.03524    | -2.767  | 0.005653** |
| PeakProm.norm            | 2.08197  | 0.34404    | 6.051   | 1.44e-09 *** |
| WSP.norm                 | 0.76773  | 0.24316    | 3.157   | 0.001592 ** |
| NoClash.norm             | -1.04891 | 0.29099    | -3.605  | 0.000313 *** |
| NoLapse.norm             | 5.51222  | 0.34636    | 15.915  | < 2e-16 *** |
| strength.w.not.p.norm    | 3.89676  | 1.02916    | 3.786   | 0.000153 *** |
| stress.s.not.u.norm      | -4.99254 | 0.81942    | -6.093  | 1.11e-09 *** |

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Model summary (Finnish)

Positive estimate means the predictor favors prose.

**FINNISH**

Random effects:

<table>
<thead>
<tr>
<th>Groups Name</th>
<th>Variance</th>
<th>Std.Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>author (Intercept)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Number of obs: 5000, groups: author, 5

Fixed effects:

|                | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | -0.06681 | 0.02976    | -2.245  | 0.0248   * |
| PeakProm.norm  | 3.97300  | 0.34936    | 11.372  | < 2e-16 *** |
| WSP.norm       | 1.25149  | 0.28942    | 4.324   | 1.53e-05 *** |
| NoClash.norm   | -2.27557 | 0.44093    | -5.161  | 2.46e-07 *** |
| NoLapse.norm   | 3.00841  | 0.39749    | 7.568   | 3.78e-14 *** |
| strength.w.not.p.norm | -5.35819 | 3.33638  | -1.606  | 0.1083  |
| stress.s.not.u.norm | 3.86222  | 1.52721   | 2.529   | 0.0114   * |

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
English: PeakProm, Weight-To-Stress, No Clash
Finnish: **PeakPROM, Weight-to-Stress, No Clash**
Conclusions

Phonology

English and Finnish show the same differences between prose and verse:

- stress **lapses** are characteristic of **prose**
- stress **clashes** are characteristic of **verse**

Metrics

English verse avoids peaks in weak positions (H&K 1996), hence violations of *W/PEAK* are highly predictive of prose (p = 0.001).

Finnish verse avoids unstressed syllables in strong positions (H&K 1996), hence violations of *S/UNSTRESSED* are predictive of prose (p = 0.05).
Conclusions

Constraint violations depend on two things:

- \texttt{PEAKPROM} and WSP depend on word choice (up to lexical ambiguity).
- \texttt{NOCLASH} and \texttt{NOLAPSE} depend in addition on word linearization.

$\rightarrow$ Prose and verse differ in the choice and linearization of words.
Questions for future work

• Are there differences across prose types?

  “You campaign in poetry. You govern in prose.”
  Mario Cuomo, *The New Republic*, 4 April 1985,
  https://en.wikiquote.org/wiki/Mario_Cuomo

• Which phonological properties are invariant across styles, genres, etc.

• Which phonological properties vary?
References


Open problem 1: English function word stress

(i) Words considered unstressed in the sample ($n = 48$):

ah, am, an, and, are, be, been, bout, can, could, had, has, hast, hath, he, her, him, his, if, i'll, is, it, its, lest, may, my, of, or, she, should, so, the, their, them, there's, they, thine, though, to, us, was, we, were, while, would, yore, you, your

(ii) Words considered stress-ambiguous in the sample ($n = 119$):

a, ad, age, all, art, as, at, back, but, by, can't, dare, de, di, did, die, do, does, done, don't, dost, down, each, few, for, force, from, grand, have, he'll, here, here's, how, i, i'd, in, i've, la, last, least, less, like, me, might, mine, mode, more, most, much, must, near, need, next, nor, o, off, on, one, one's, ought, out, pains, per, piece, place, pour, round, route, rue, sake, sang, save, say, shall, since, sit, sole, some, son, such, than, that, that's, thee, theirs, then, there, these, they'd, this, those, thou, through, thy, till, tout, up, we'll, we're, what, what's, when, whence, where, which, who, whom, whose, why, wil, will, wilt, with, ye, yet, you'd, you'll, you're, yours
Open problem 2: English syllable weight

(i) (Unambiguously) closed syllables are heavy.
(ii) Open syllable weight depends on the vowel:
    • tense vowels count as heavy
    • lax vowels count as light

Problems:

CITY S IH1 T IY0 /# [ S '1 IH ] [ T '0 IY ] #/ S:PU W:LH
CITY S IH1 T IY0 /# [ S '1 IH T ] [ '0 IY ] #/ S:PU W:HH
CITY S IH1 T IY0 /# [ S '1 IH [ T ] '0 IY ] #/ S:PU W:AH
Open problem 3: Syllabifying Finnish diphthongs

Several vowel pairs allow variable syllabification (vowel sequence vs. diphthong) depending on stress (Anttila and Shapiro, in progress):

/au/, /eu/, /ou/, /iu/, /iy/, /ey/, /äy/, /öy/

Consider /au/:

vá.pa.us ~ va.paus  ‘freedom’
rák.ca.us ~ rak.kaus  ‘love’
láu.ca.us ~ láu.kaus  ‘shot’
(*lá.u.ca.us, *lá.u.kaus)