Hands-on: Authorship Attribution Through **Stylo**metry

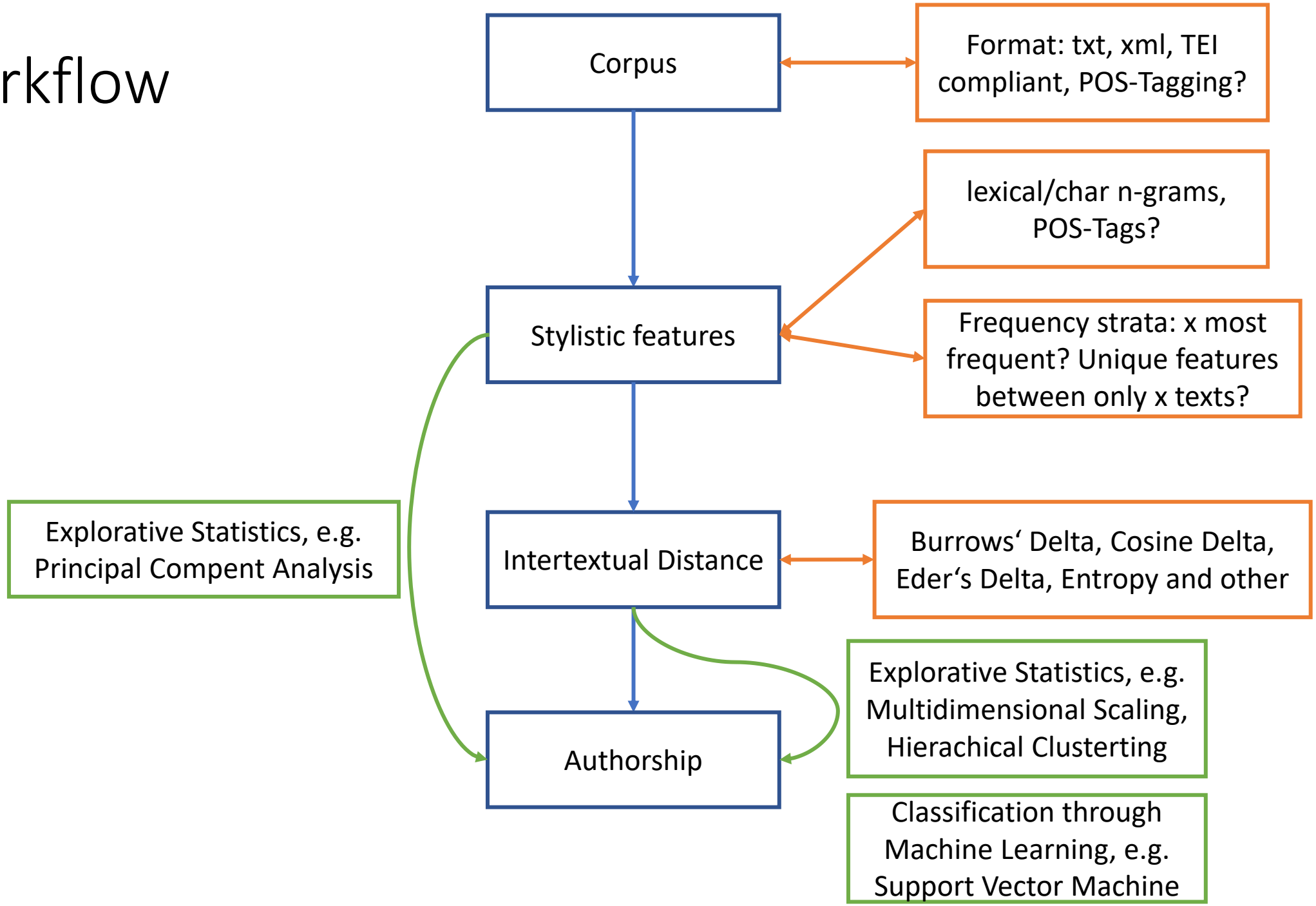
Nikola Krisztian Czindrity

ATDS 2022

Materials available at

https://github.com/NKCZ/atds2022stylo

Workflow

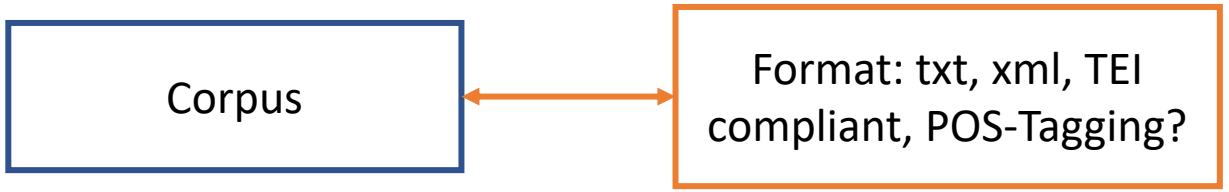

Corpus
Format: txt, xml, TEI compliant, POS-Tagging?
lexical/char n-grams, POS-Tags?
Stylistic features
Frequency strata: x most frequent? Unique features between only x texts?
Explorative Statistics, e.g. Principal Compent Analysis
Intertextual Distance
Burrows‘ Delta, Cosine Delta, Eder‘s Delta, Entropy and other
Explorative Statistics, e.g. Multidimensional Scaling, Hierachical Clusterting
Authorship
Classification through Machine Learning, e.g. Support Vector Machine

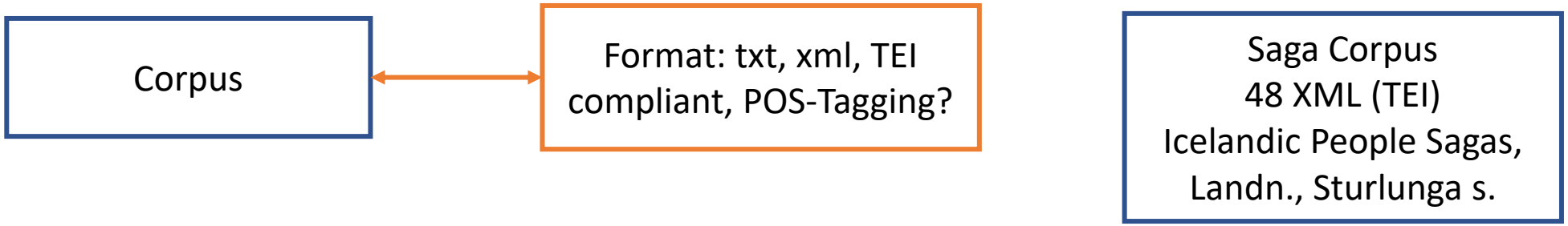
Good news: all covered in *Stylo*!

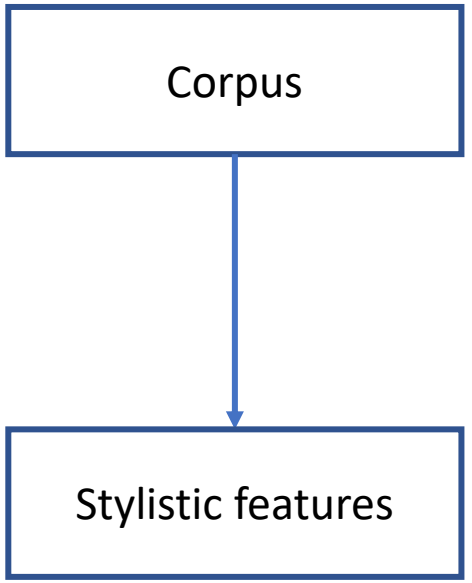
The following are required:

- R: https://www.r-project.org/
  - R for Windows: https://cran.r-project.org/bin/windows/base/
- RStudio: https://www.rstudio.com/products/rstudio/
- R-package *Stylo*:
  - run in your R-Enviroment: **install.packages("stylo")**
  - https://cran.r-project.org/web/packages/stylo/index.html
- OR
- try running it in Binder (see Github)

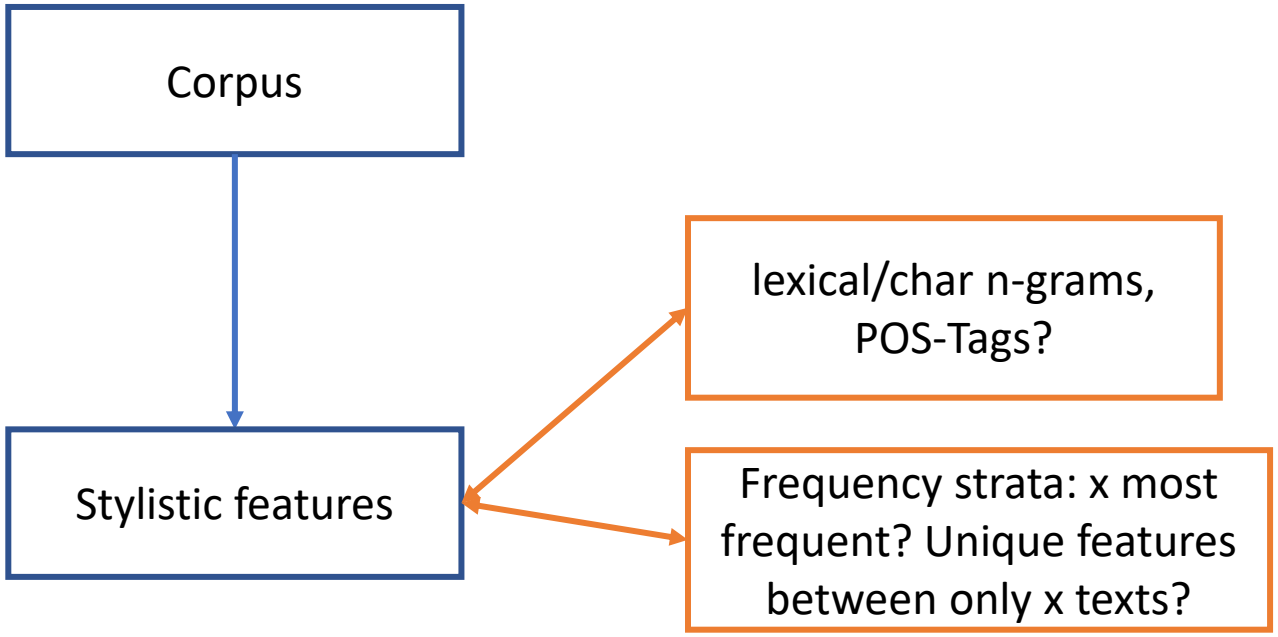
Corpus


Corpus
Format: txt, xml, TEI compliant, POS-Tagging?


Corpus
Format: txt, xml, TEI compliant, POS-Tagging?
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.



Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.



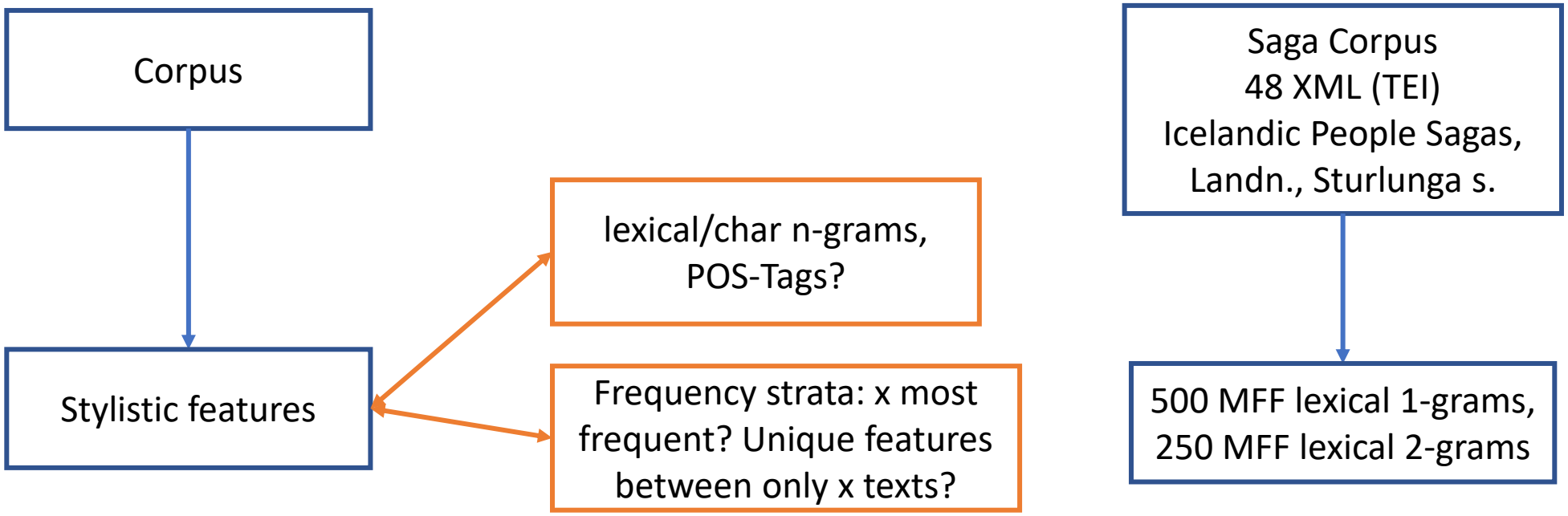
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Hmsk. Landn., Sturlunga s.

n-gram

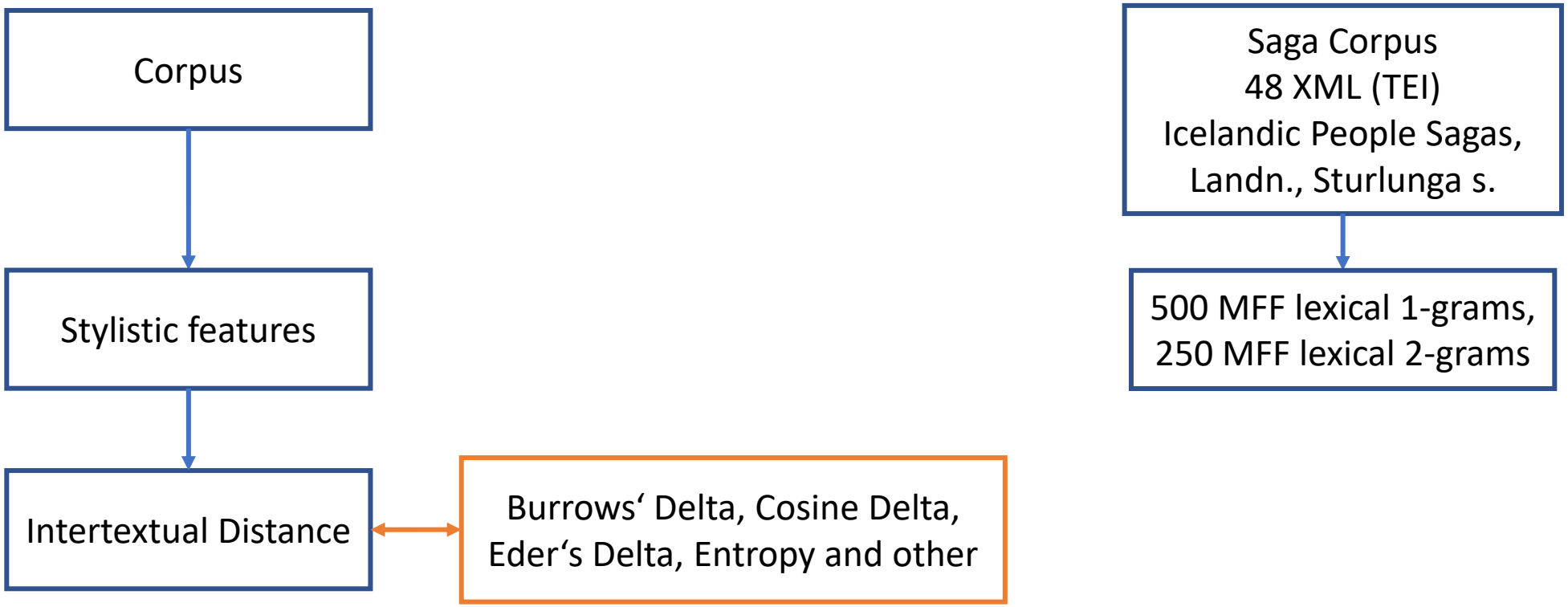
- S = „Úlfur hét maður, son Bjálfa og Hallberu, dóttur Úlfs hins óarga.“

(*Egils saga*, Ch. 1)

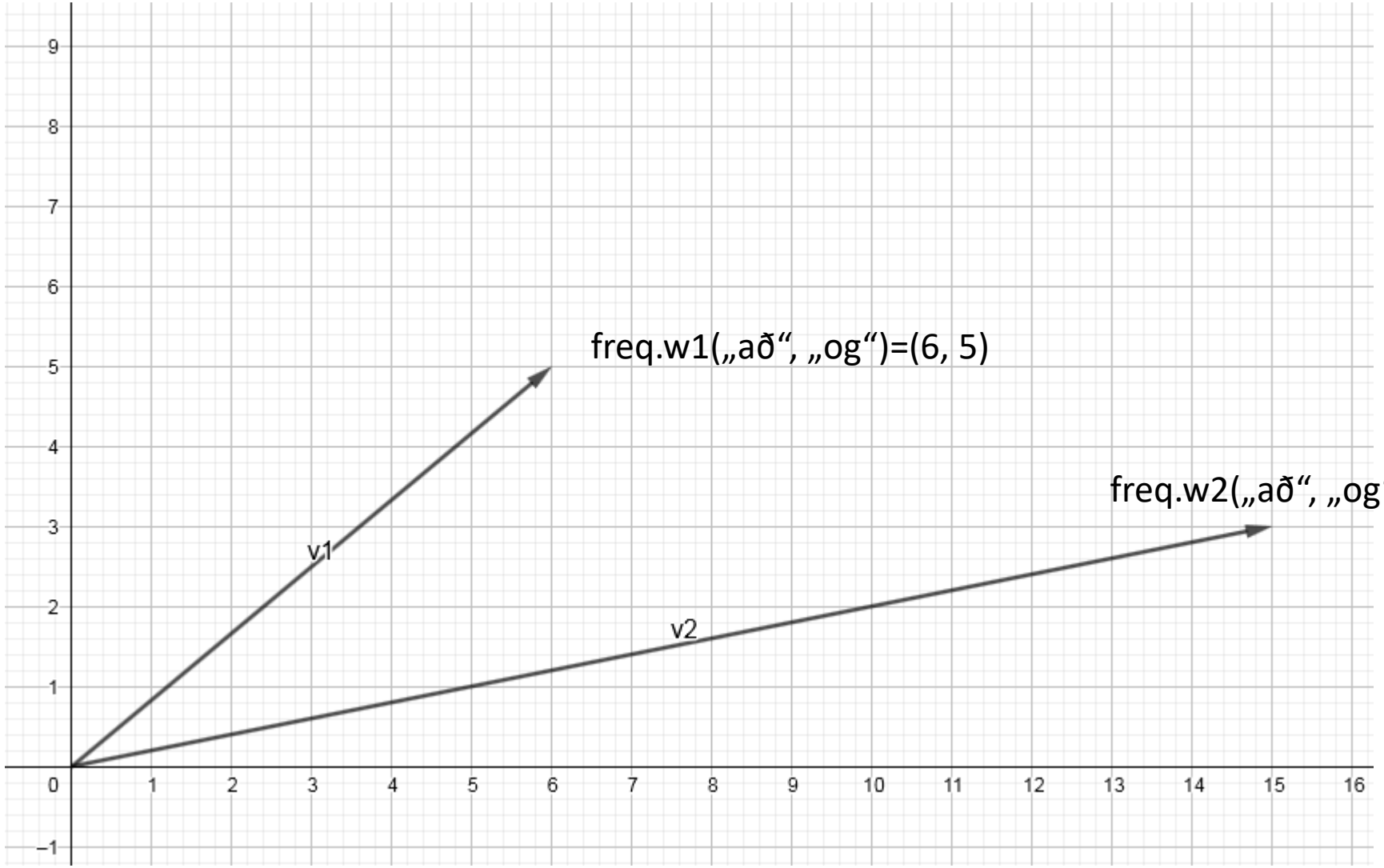
- Lexical 1-gram:
  - $S_{1\text{-lex-gram}}$ = {„Úlfur“, „hét“, „maður, „son“, „Bjálfa“, …, „óarga“}
- Lexical 2-gram:
  - $S_{2\text{-lex-gram}}$ = {„Úlfur hét“, „hét maður“, „maður son“, „son Bjálfa“, „Bjálfa og“, …, „hins óarga“}
- Character 4-gram:
  - $S_{4\text{-char\_gram}}$ = {„Úlfu“, „lfur“ , „fur “, „ur h“, …, „rga.“}


Corpus
Stylistic features
lexical/char n-grams, POS-Tags?
Frequency strata: x most frequent? Unique features between only x texts?
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.
500 MFF lexical 1-grams,
250 MFF lexical 2-grams

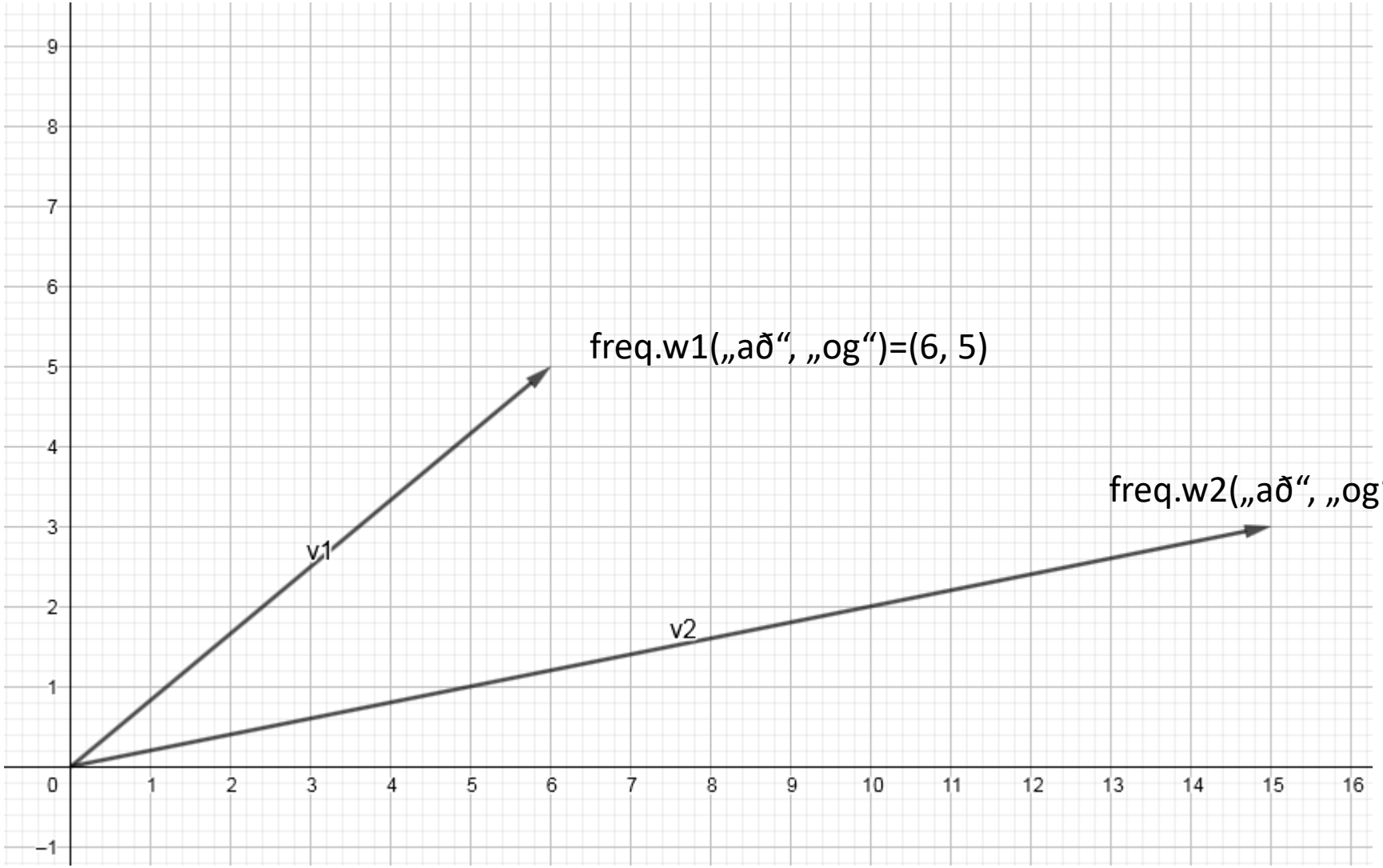

Corpus
Stylistic features
Intertextual Distance
Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.
500 MFF lexical 1-grams,
250 MFF lexical 2-grams


Corpus
Stylistic features
Intertextual Distance
Burrows‘ Delta, Cosine Delta,
Eder‘s Delta, Entropy and other
Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.
500 MFF lexical 1-grams,
250 MFF lexical 2-grams

Vector Space

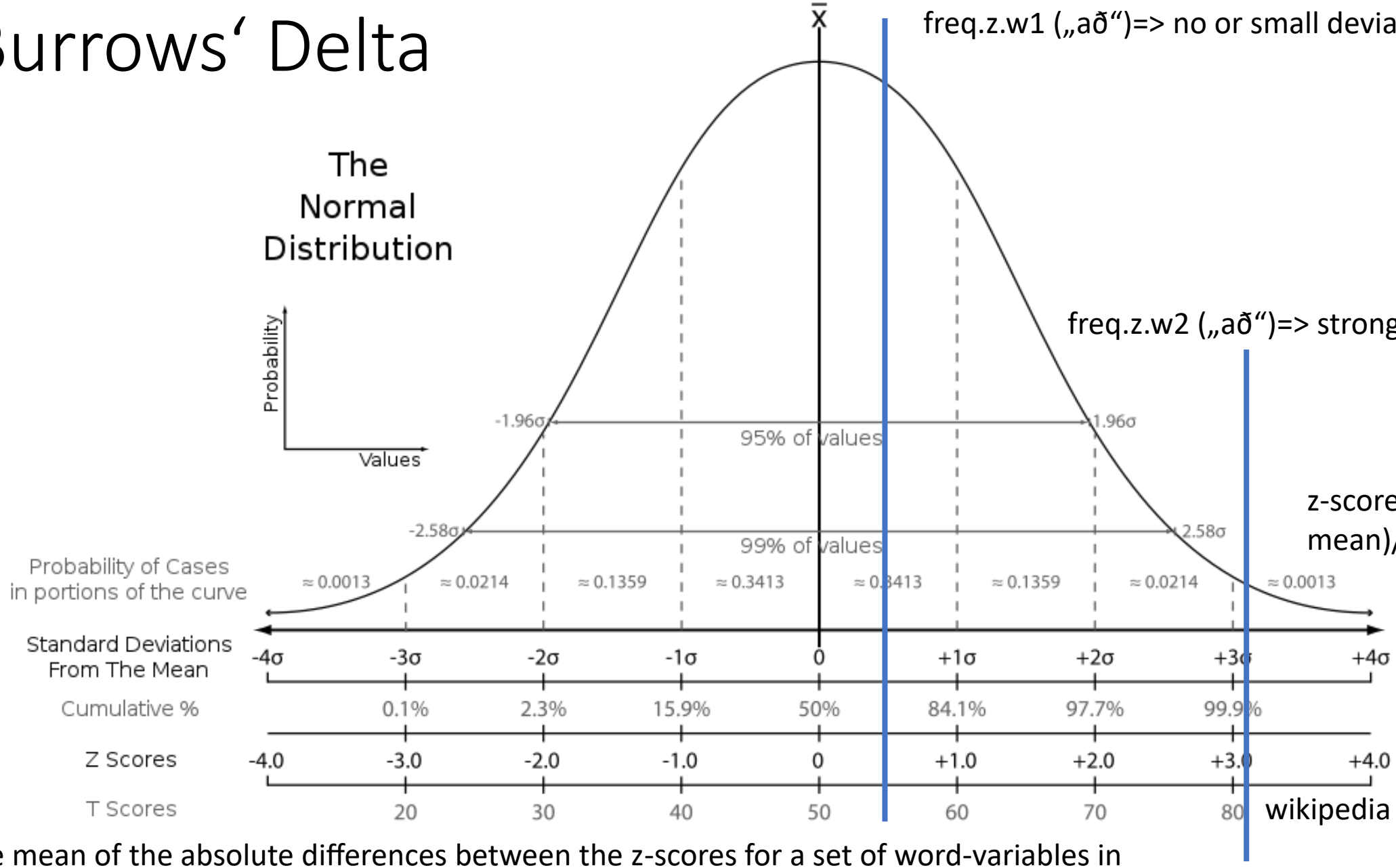


Vector Space



In that case 2-D, but it can be generalized to n-Dimensions.

Burrows‘ Delta



freq.z.w1 („að“)=> no or small deviation

freq.z.w2 („að“)=> strong pos. deviation

z-score = (raw value-mean)/stand. deviation

wikipedia („Standard score“)

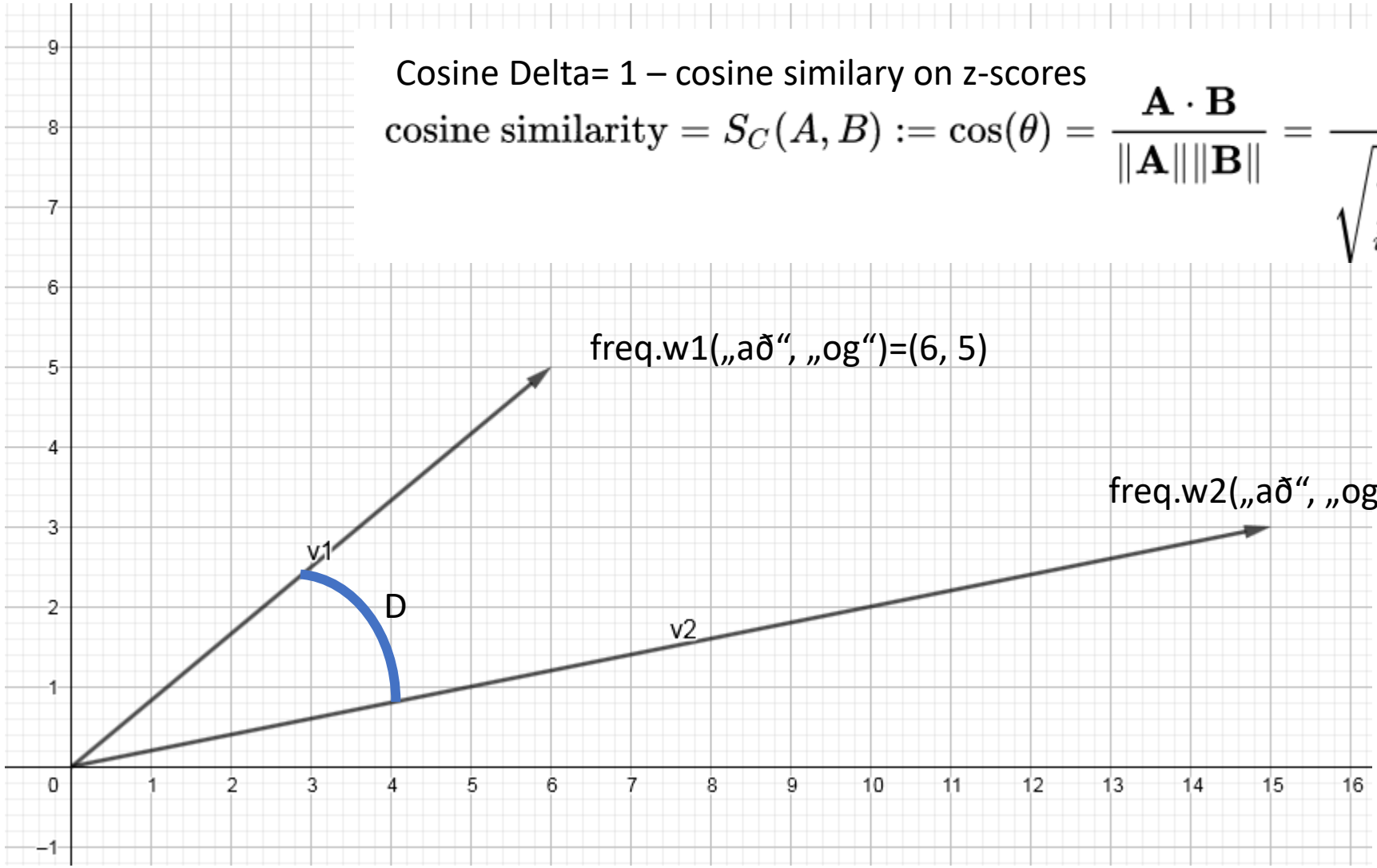
“the mean of the absolute differences between the z-scores for a set of word-variables in a given text-group and the z-scores for the same set of word-variables in a target text.” Burrows 2002

Cosine Similarity & Delta

Wikipedia („cosine similarity“)

Cosine Delta= 1 – cosine similary on z-scores

$$\text{cosine similarity} = S_C(A, B) := \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}}$$



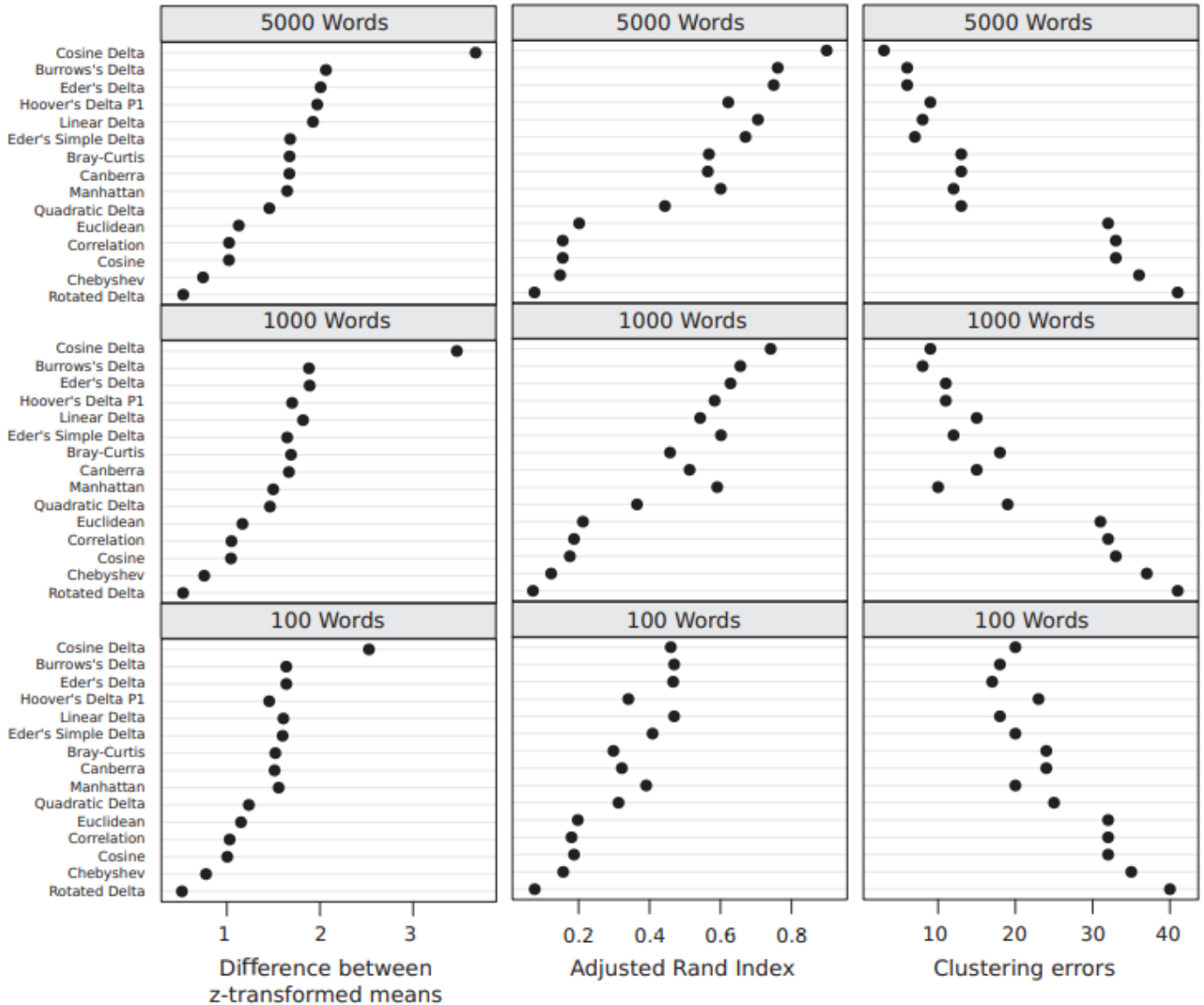
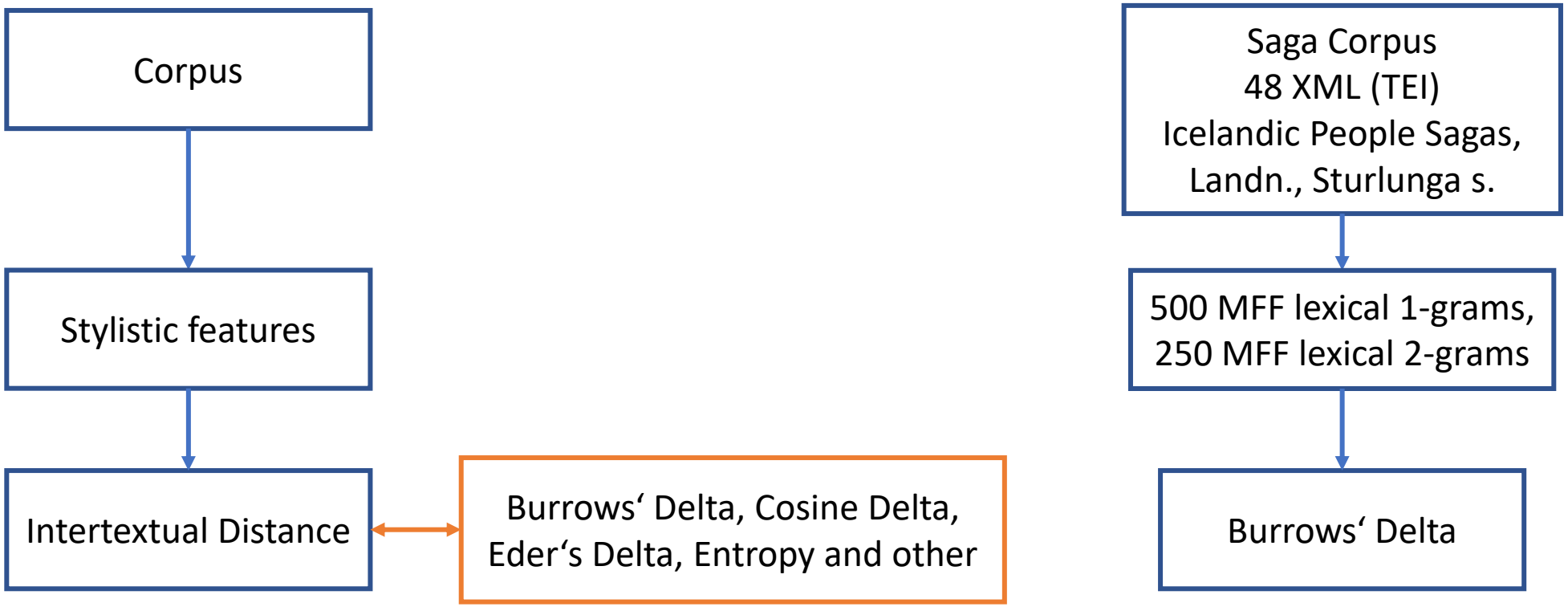
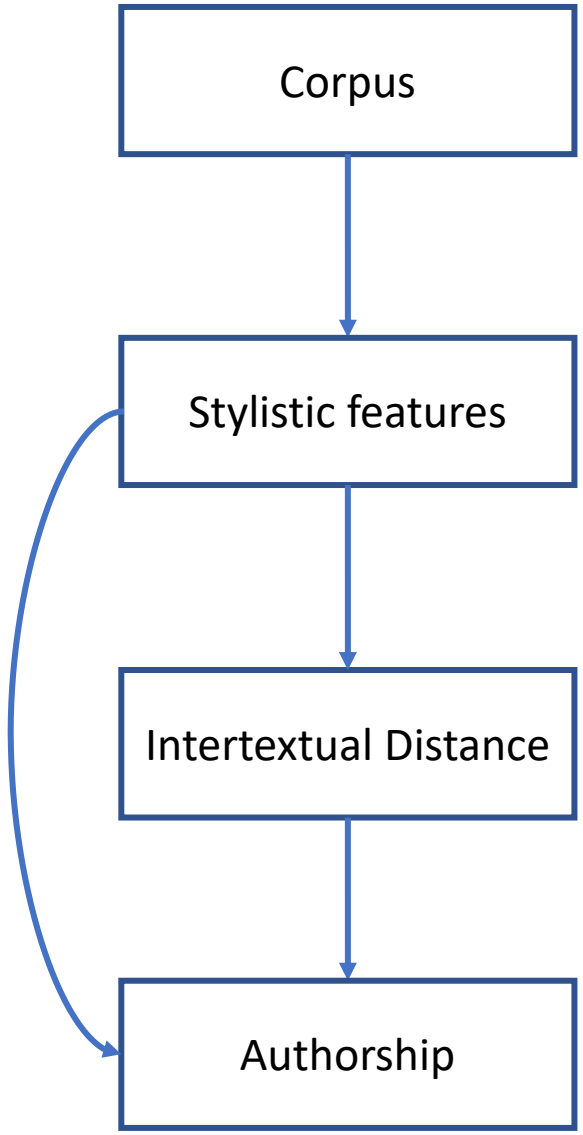


Fig. 4 Performance of distance measures on English texts. Indicated in terms of the difference between *z*-transformed means of ingroup (same author) and outgroup distances (different authors), as Adjusted Rand Index (higher values indicate better differentiation), and in terms of clustering errors (lower values indicate better differentiation). Distance measures are sorted according to their maximum performance in all test conditions. The non-Delta measures are popular basic distance measures on raw relative frequencies. Similar results for French and German

Evert et al. (2017)

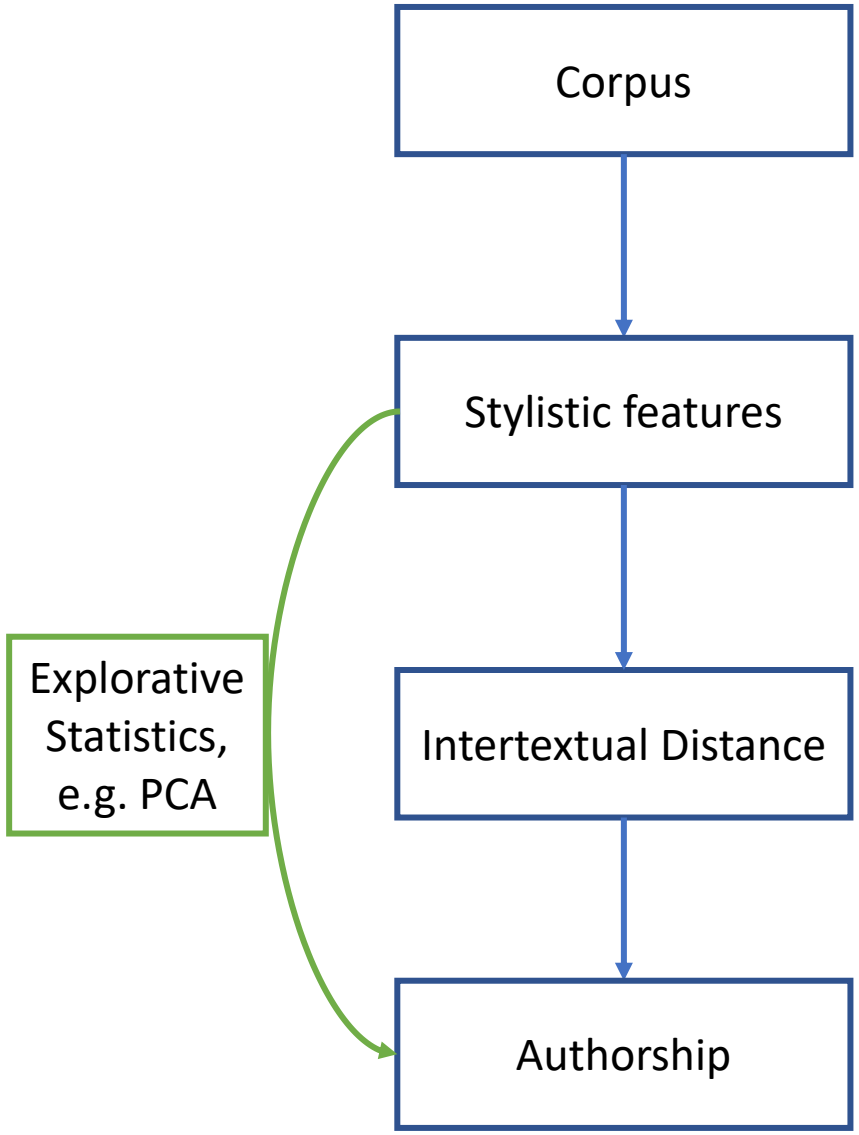

Corpus
Stylistic features
Intertextual Distance
Burrows‘ Delta, Cosine Delta, Eder‘s Delta, Entropy and other
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.
500 MFF lexical 1-grams, 250 MFF lexical 2-grams
Burrows‘ Delta

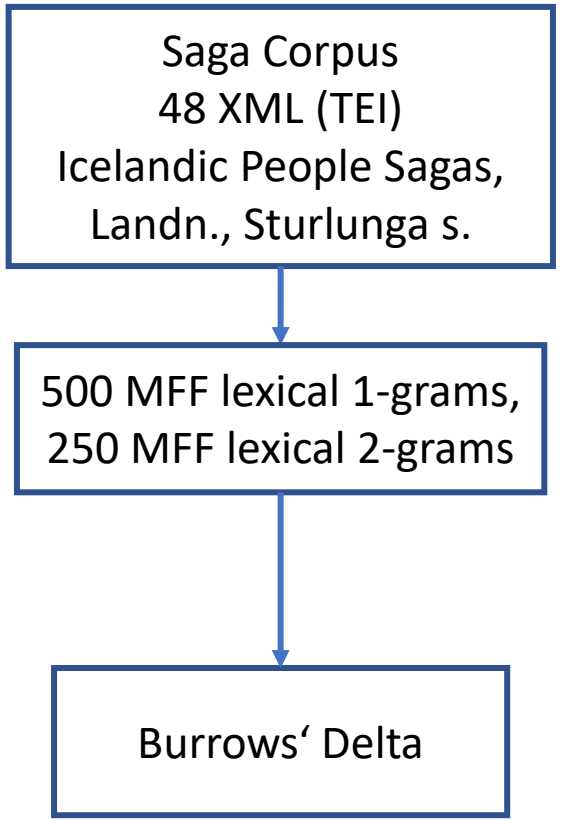


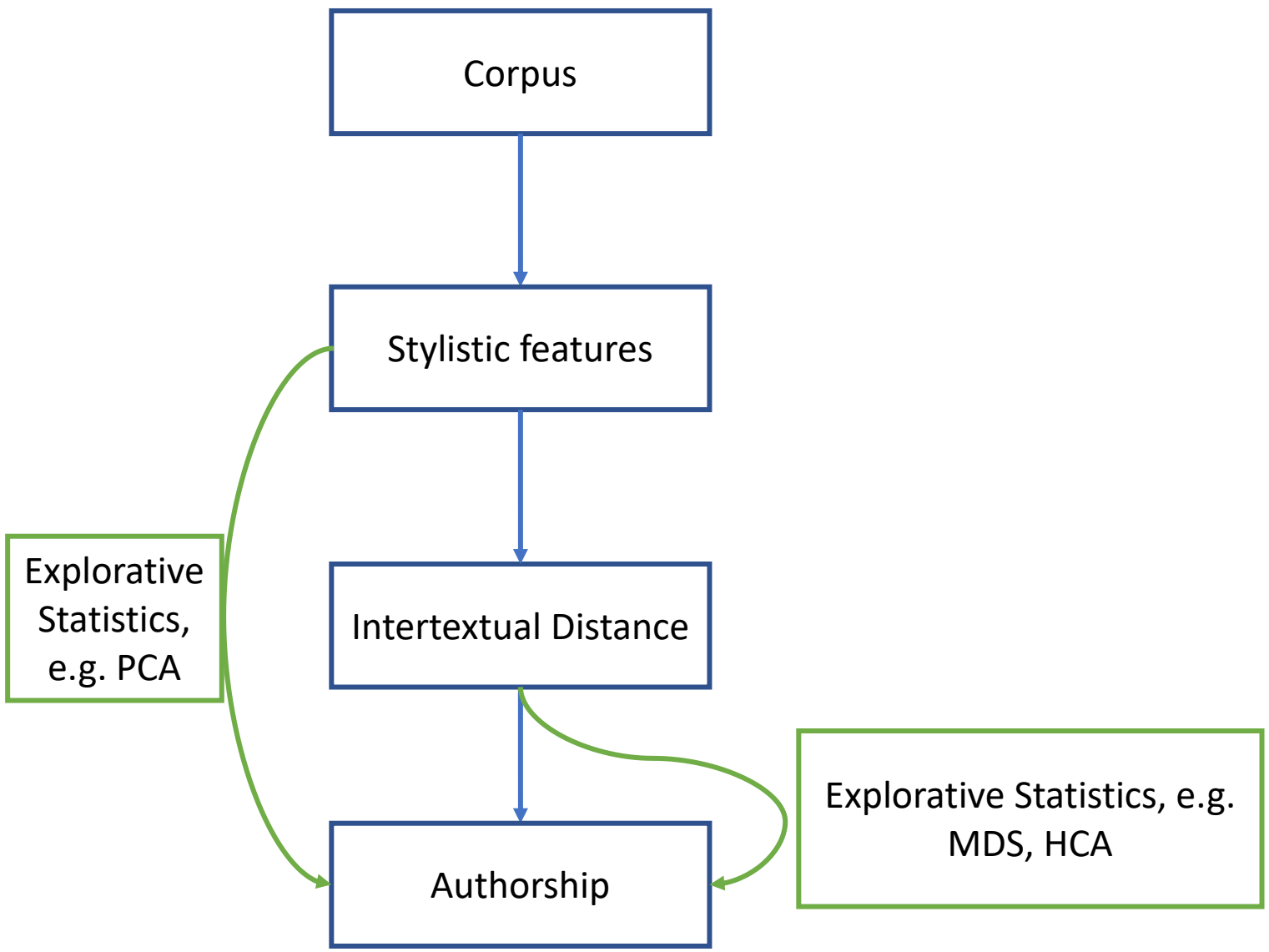
Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.

500 MFF lexical 1-grams,
250 MFF lexical 2-grams

Burrows‘ Delta


Corpus
Stylistic features
Explorative Statistics, e.g. PCA
Intertextual Distance
Authorship

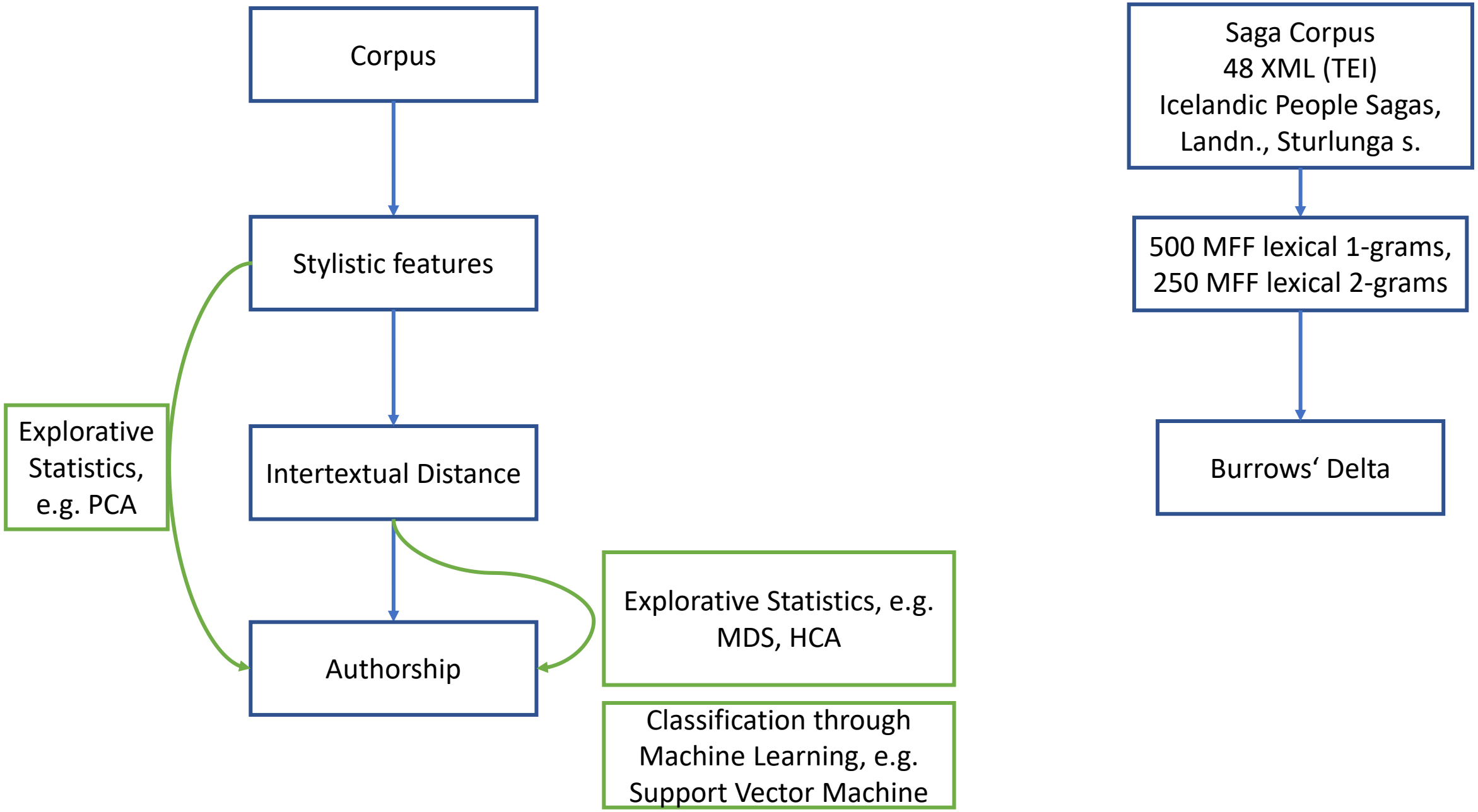

Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.
500 MFF lexical 1-grams, 250 MFF lexical 2-grams
Burrows‘ Delta

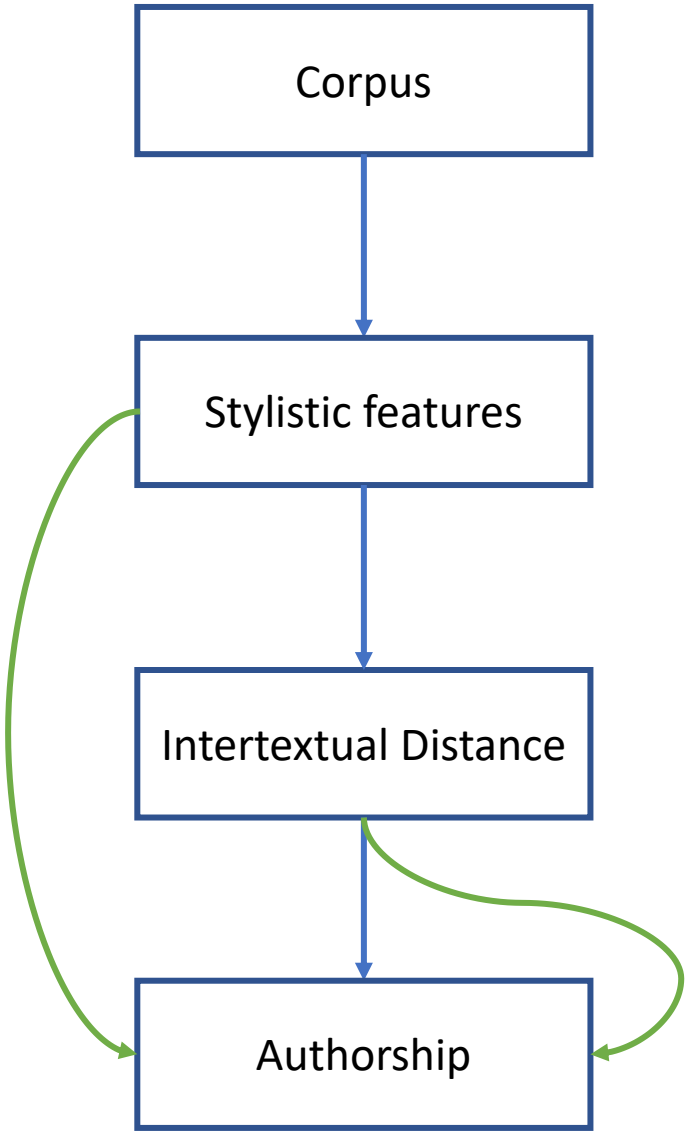


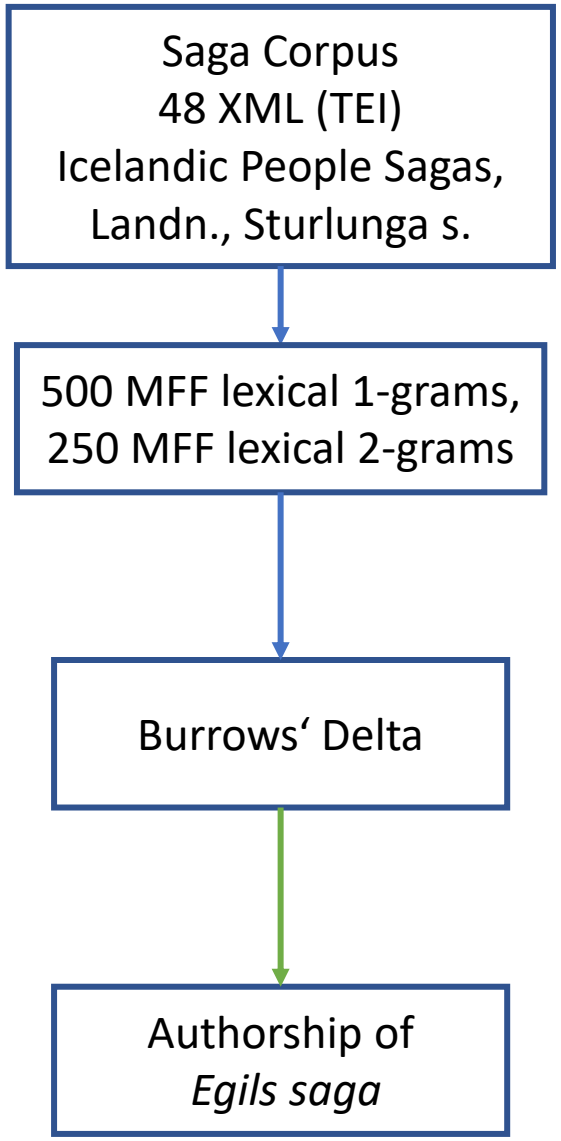
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.

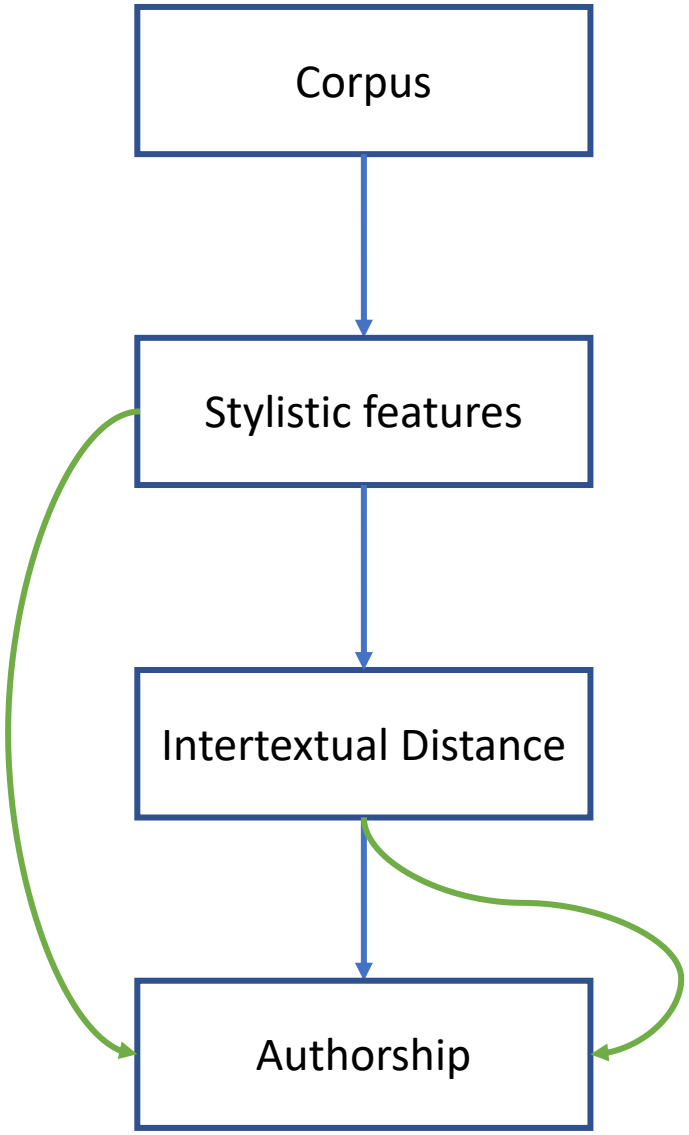
500 MFF lexical 1-grams,
250 MFF lexical 2-grams

Burrows‘ Delta


Corpus
Stylistic features
Intertextual Distance
Authorship
Explorative Statistics, e.g. PCA
Explorative Statistics, e.g. MDS, HCA
Classification through Machine Learning, e.g. Support Vector Machine
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.
500 MFF lexical 1-grams,
250 MFF lexical 2-grams
Burrows‘ Delta


Corpus
Stylistic features
Intertextual Distance
Authorship


Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.
500 MFF lexical 1-grams,
250 MFF lexical 2-grams
Burrows‘ Delta
Authorship of
Egils saga



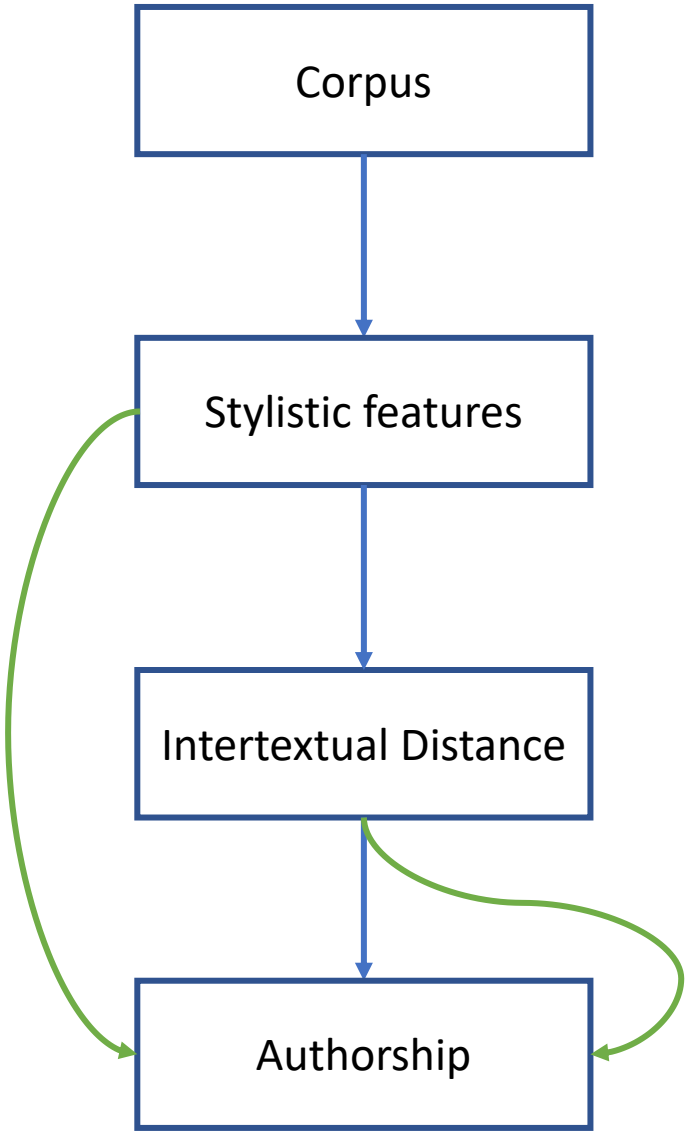
Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.

500 MFF lexical 1-grams,
250 MFF lexical 2-grams

Burrows‘ Delta

Is Egils saga closer to
Heimskringla?

Authorship of
Egils saga



Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.

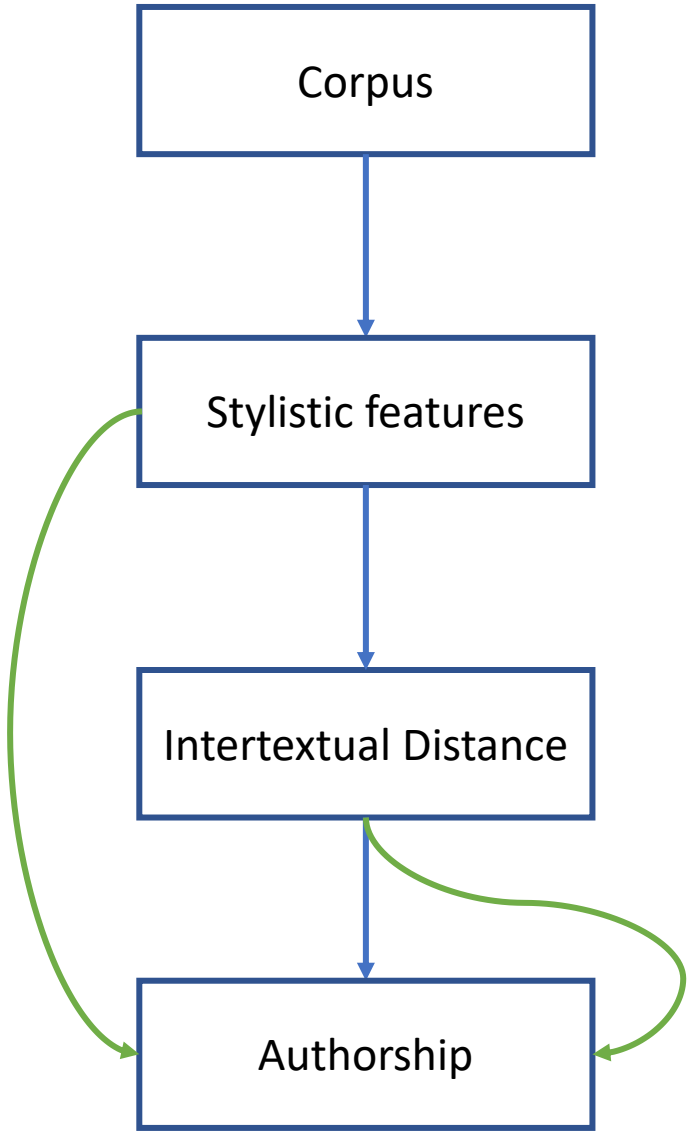
500 MFF lexical 1-grams,
250 MFF lexical 2-grams

Burrows‘ Delta

Authorship of
Egils saga

Is Egils saga closer to
Heimskringla?

Burrows‘ Delta - Yes
PCA, MDS, HCA – likely



Saga Corpus
48 XML (TEI)
Icelandic People Sagas,
Landn., Sturlunga s.

500 MFF lexical 1-grams,
250 MFF lexical 2-grams

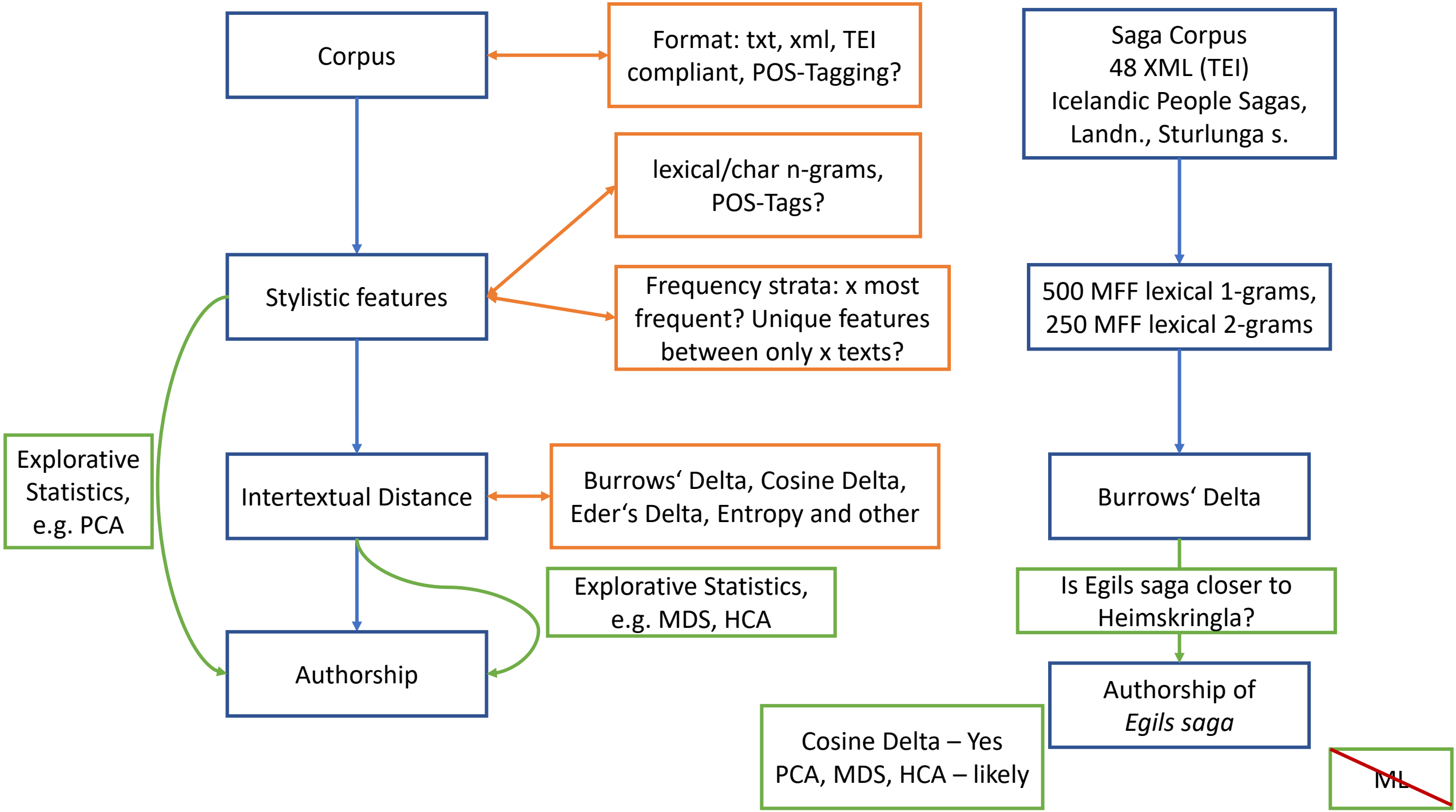
Is Egils saga closer to Heimskringla?

Burrows‘ Delta

Burrows‘ Delta - Yes
PCA, MDS, HCA – likely

Authorship of *Egils saga*

~~Classification through Machine Learning, e.g. Support Vector Machine~~


Corpus
Format: txt, xml, TEI compliant, POS-Tagging?
Saga Corpus
48 XML (TEI)
Icelandic People Sagas, Landn., Sturlunga s.
lexical/char n-grams, POS-Tags?
Stylistic features
Frequency strata: x most frequent? Unique features between only x texts?
500 MFF lexical 1-grams, 250 MFF lexical 2-grams
Explorative Statistics, e.g. PCA
Intertextual Distance
Burrows‘ Delta, Cosine Delta, Eder‘s Delta, Entropy and other
Burrows‘ Delta
Explorative Statistics, e.g. MDS, HCA
Is Egils saga closer to Heimskringla?
Authorship
Authorship of *Egils saga*
Cosine Delta – Yes
PCA, MDS, HCA – likely
ML

Sources & further Information I

- Materials at https://github.com/NKCZ/atds2022stylo

- Corpus:

  - *Saga Corpus* = The Saga Corpus, ed. Eiríkur Rögnvaldsson / Sigrún Helgadóttir. (online: URL http://www.malfong.is/index.php?lang=en&pg=fornritin; 2021).

- General information on stylometry:
  - Patrick Juola, Authorship Attribution. In: Foundations and Trends in Information Retrival 1(3) (2007), 233-334.
  - Efstathios Stamatatos, A Survey of Modern Authorship Attribution Method. In: JASIST 60(3) (2008), 539-556.
  - Maciej Eder / Jan Rybicki / Mike Kestemon, Stylometry with R: a package for computational text analysis. In: R Journal 8(1) (2016), 107-121.
  - Stefan Evert / Thomas Proisl / Fotis Jannidis / Isabella Reger / Steffen Pielström / Christof Schöch / Thorsten Vitt, Understanding and explaining Delta measures for authorship attribution. In: DSH 32(Suppl. 2) (2017), 4–16.
  - Burrows 2002 = John Burrows, ‘Delta’: a Measure of Stylistic Difference and a Guide to Likely Authorship. In: LLC 17(3) (2002), 267-287.
  - Burrows 2007 = John Burrows, All the Way Through: Testing for Authorship in Different Frequency Strata. In: LLC 22(1) (2007), 27-47.

Sources & further Information II

- Authorship through stylometry: *Egils saga*
  - Sigurður Ingibergur Björnsson / Steingrímur Páll Kárason / Jón Karl Helgason, Stylometry and the Faded Fingerprints of Saga Authors. In: In Search of the Culprit. Aspects of Medieval Authorship, ed. Lukas Rösli / Stefanie Gropper (Berlin/Boston 2021), 97-122.
  - Haukur Þorgeirsson, How similar are Heimskringla and Egils saga? An application of Burrows' delta to Icelandic texts. In: EJSS 48(1) (2018), 1-18.