Introduction to classification

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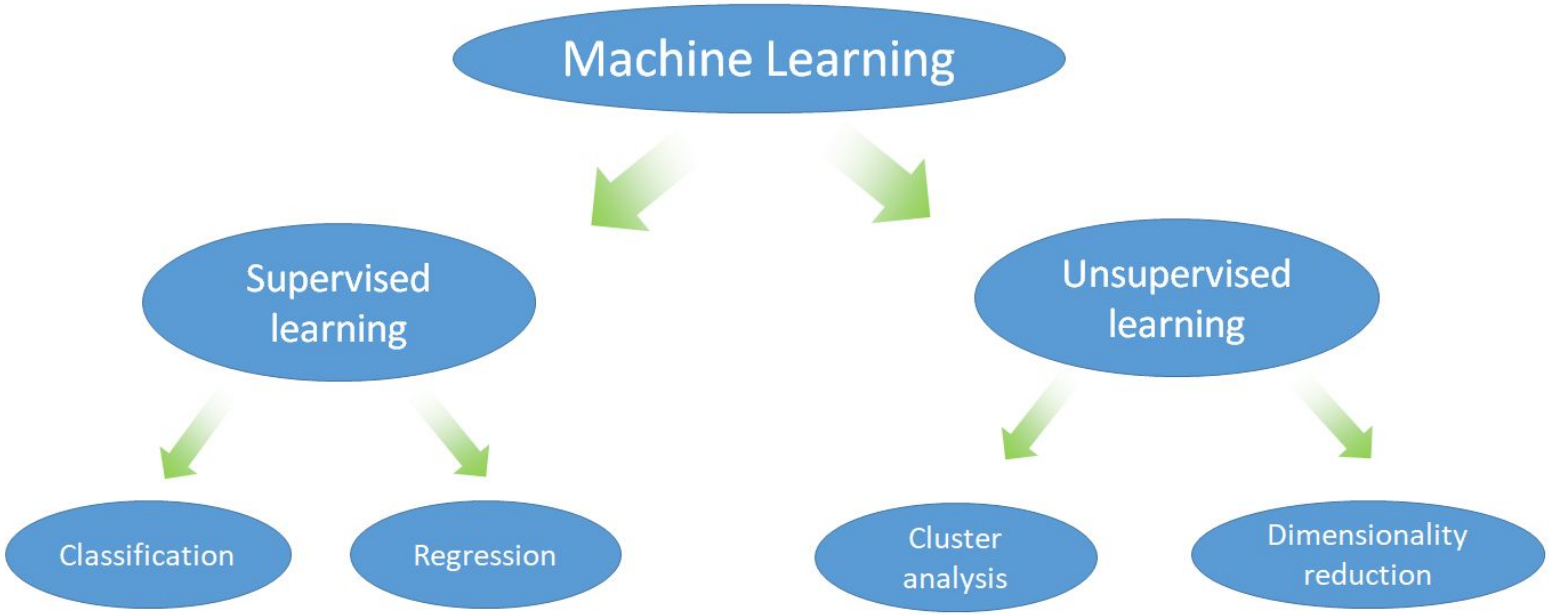
Budapest workshop

Classification in Machine Learning


Machine Learning
Supervised learning
Unsupervised learning
Classification
Regression
Cluster analysis
Dimensionality reduction

Unsupervised classification

Unsupervised learning

is a set of techniques that allow you to infer models to **extract knowledge of data sets where a priori is unknown**.

E.g.

- Cluster analysis
- Dimensionality reduction (PCA, MDS)

Supervised classification

Supervised learning

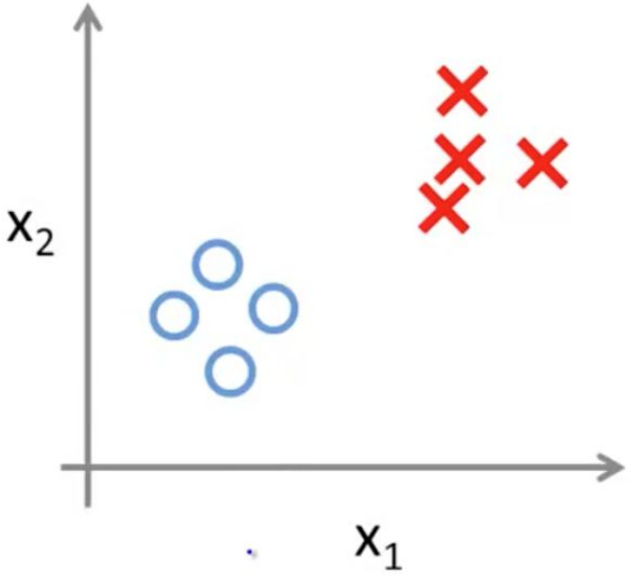
is a set of techniques that allows **future predictions** based on **behaviors or characteristics analyzed in historical data**.

E.g.

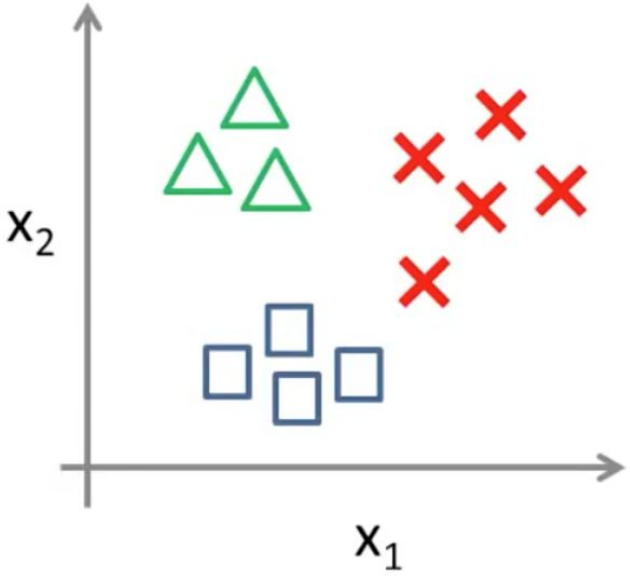
- Regression algorithms (linear regression, neural networks)
- Classification algorithms (logistic regression, Naive Bayes, Support Vector Machines, Random Forest)

Types of classification

Binary classification:



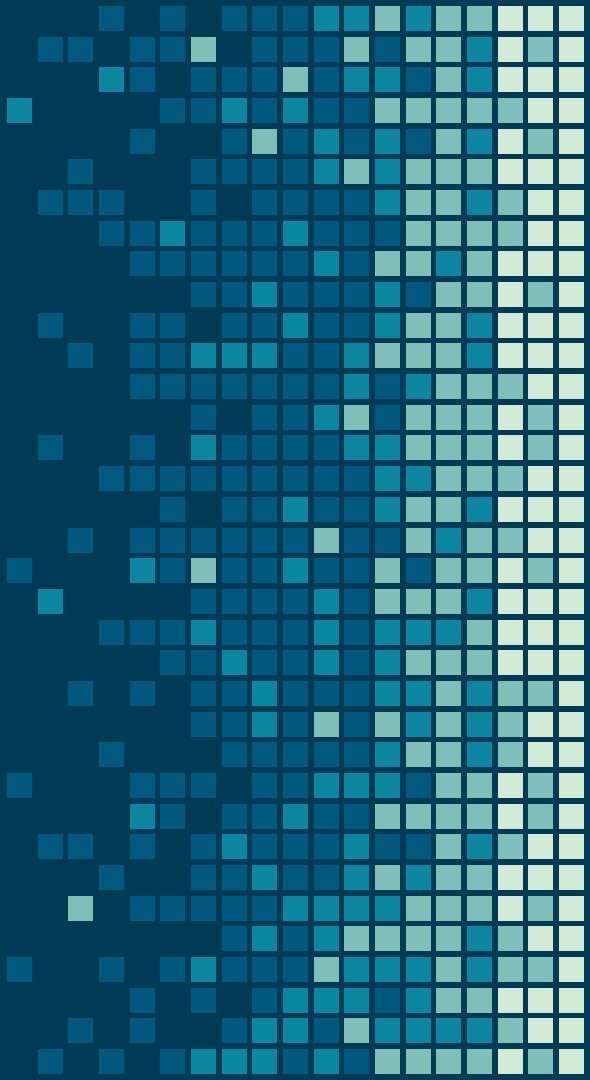
Multi-class classification:



Cross-validation

- Verifying the quality by performing classification on a series of subsets of the main corpus
- E.g. “leave-one-out” = doing classification for all the cases of “corpus – one text”, comparing results

Stylometry in authorship attribution – a classification task



Attribution vs verification

Attribution:

- Determining who of the known candidates from the closed set authored a given work

Verification:

- Determining **IF** one of the known candidates from the open set authored a given work

Classic authorship problems

Federalist papers, JK Rowling

Federalist Papers as an attribution case

- "A series of essays, anonymously published defending the document to the public"

(Lin-Manuel Miranda 2015)

- 85 texts authored by: Alexander Hamilton (51?), James Madison (29?) and John Jay (5)
- 12 letters of disputed authorship determined by stylometry

Mosteller, F., and D. L. Wallace (1964). Applied Bayesian and Classical Inference: The Case of The Federalist Papers. (and numerous other studies)

JK Rowling or Robert Galbraith?

- Who wrote “The Cuckoo's Calling”?
- Study by Patrick Juola (2013)

  “comparing against Rowling's own The Casual Vacancy, Ruth Rendell's The St. Zita Society, P.D. James' The Private Patient and Val McDermid's The Wire in the Blood…. Of the 11 sections of Cuckoo, six were closest (in distribution of word lengths) to Rowling, five to James.”

- Confirmed by the author

Our study

Questions:

1) Who wrote the ending?
2) Did the anonymous writer introduce changes to the rest of the play?

Setting up the experiment

Dataset

Problems we had to face:

- Small availability of Spanish (historical) texts
- Available corpus imbalanced in terms of:
  - author representation
  - gender
  - genre
  - nationality

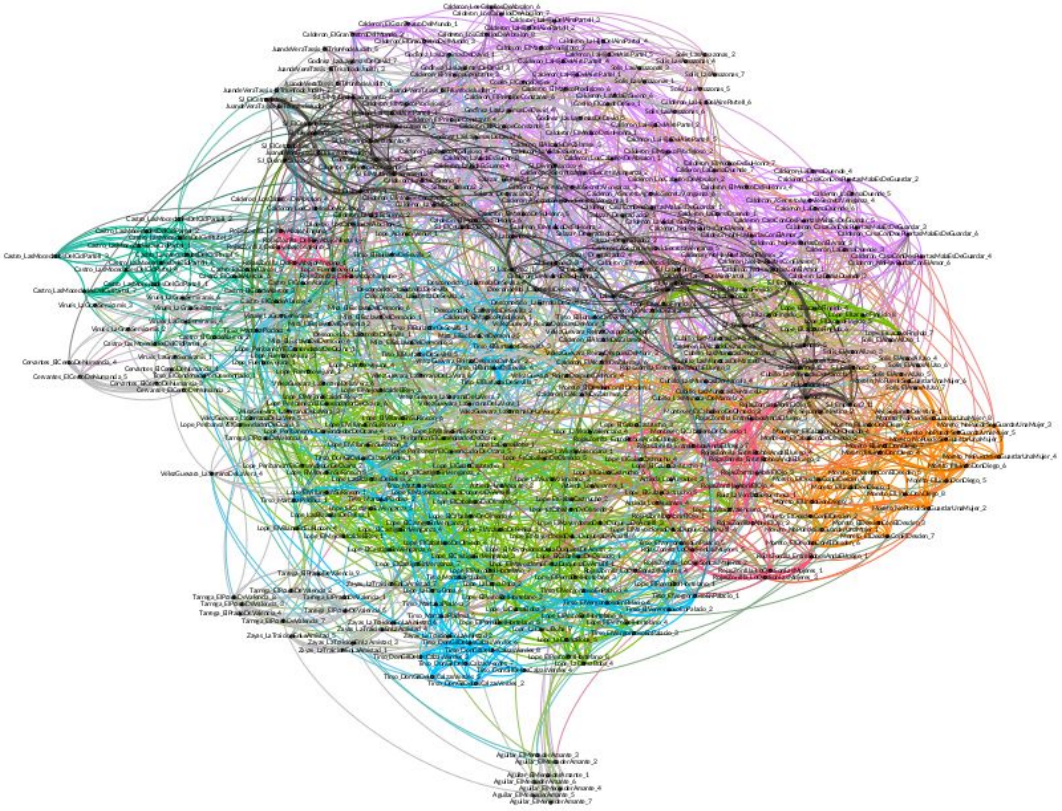
Dataset

Adopted solutions:

- *SC* and SJ's plays extracted from digital editions (Schmidhuber de la Mora, 2016; Cervantes Virtual Library).
- Poor OCR results – > transcription of Salazar's texts.
- Use of Canon-60 corpus (Oleza 2014), but just one genre: "comedia de capa y espada".

Results

Literary landscape



Authorship attribution vs verification

We know the author must be one of a few candidates

Relatively easy

e.g. classify(), rolling.classify()

We don't know if we have the author in our dataset

Still quite difficult

e.g. imposters()

Authorship attribution vs verification – our case

- cross-validated classification with SVM, NSC, Delta
- verification with “Imposters method” (Kestemont et al., 2016; Koppel and Winter, 2014)

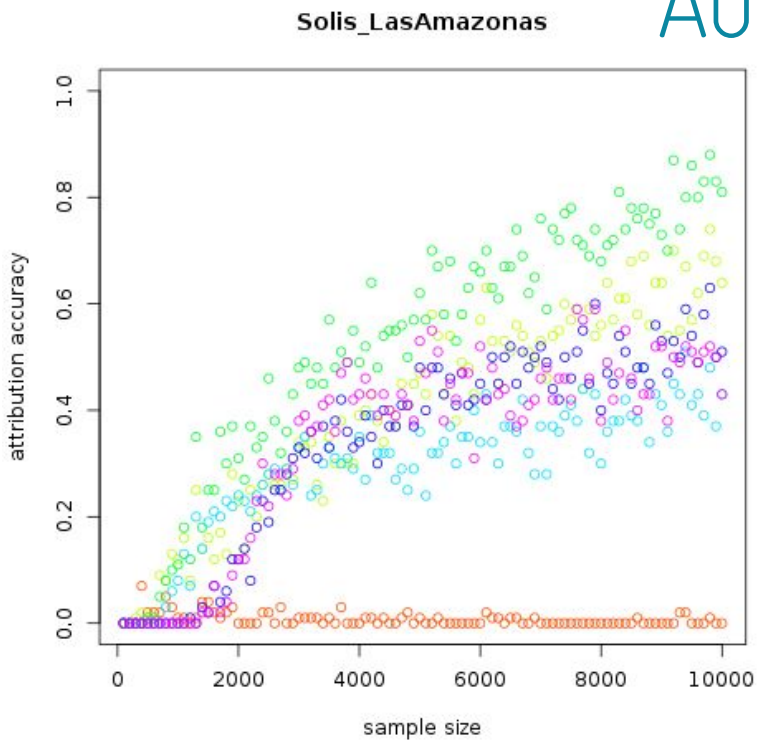
results inconclusive, pointed authors:

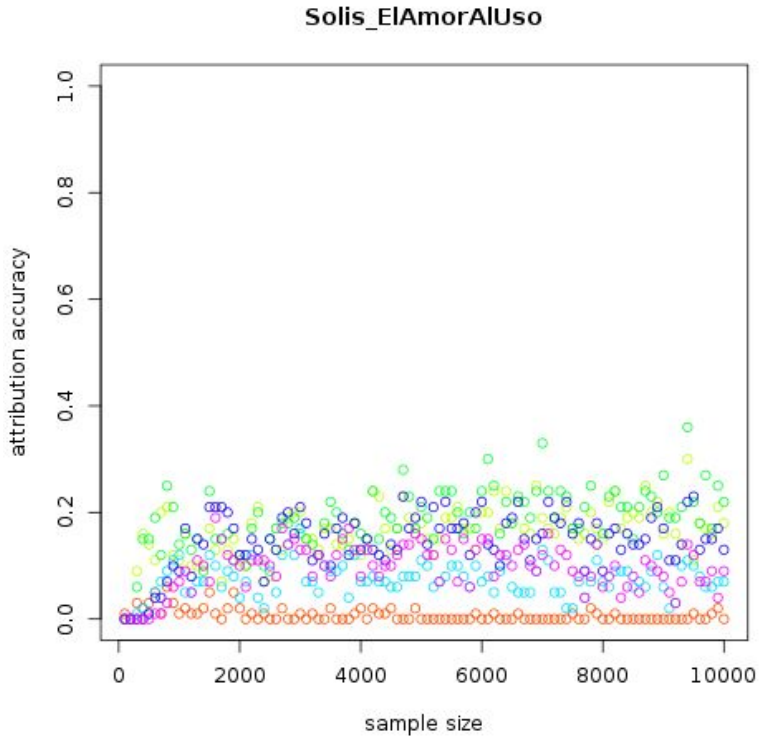
Calderón and Moreto to SJ, Solís and de Vera Tassis.

Adjusting – pruning the corpus

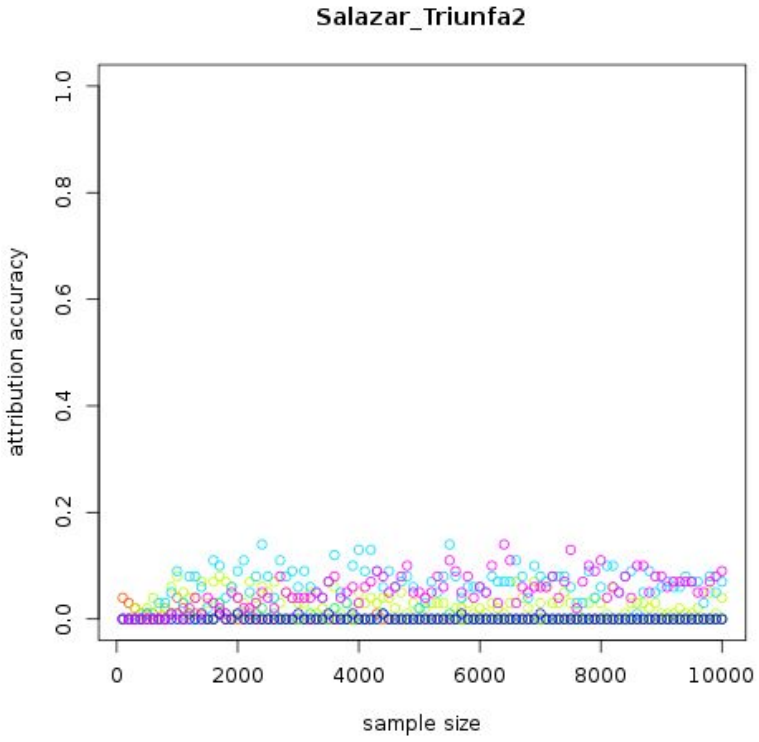
- removing ‘landscape’ authors who could not author the play
- determining strength of authorial signal (Eder 2017)

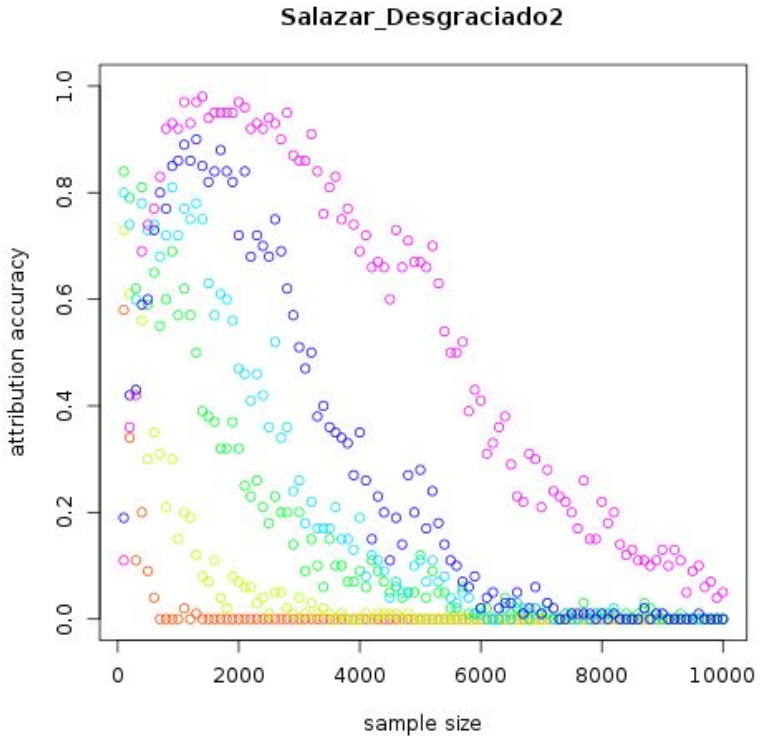
Authorial signal strength



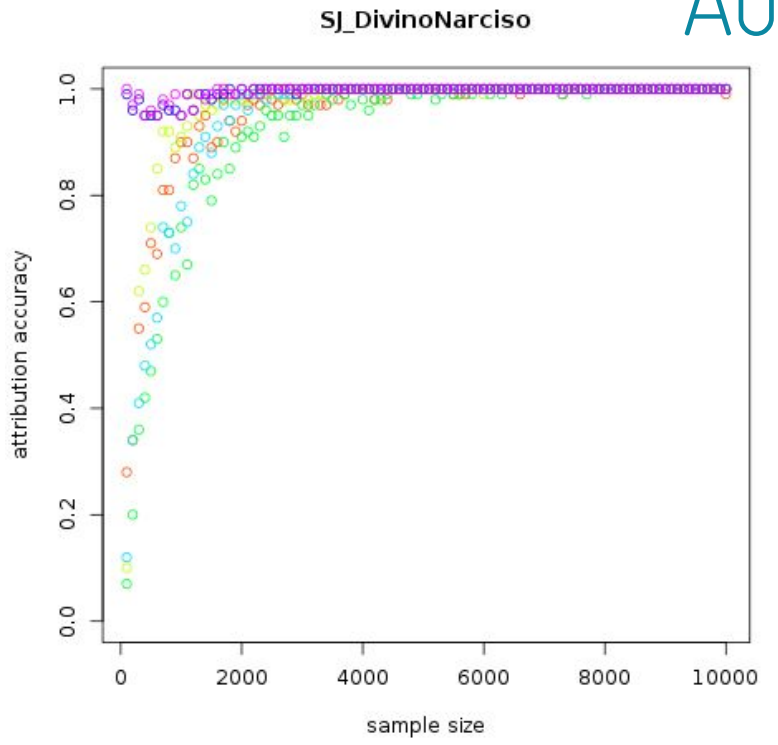


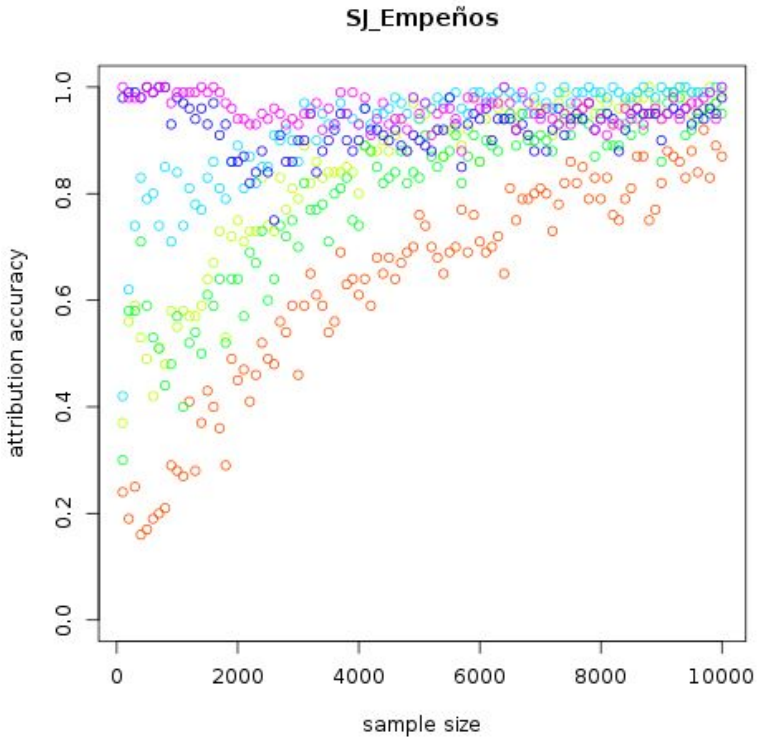
Authorial signal strength





Authorial signal strength





Revised approach

Cross validation & classification on just these three authors:

- SJ attributed as the author in almost all settings
- some results point to Solís influence in the last two thousand words
- the most reliable results: SVM and 100-500 MFWs range (from 54.8% to 81.2% accuracy, with the average of 72.75%)

Rolling Classify

- Problem that requires detecting multiple authorial voices
  - Salazar's voice and the anonymous author
  - Use of Rolling Classify (Eder 2016)

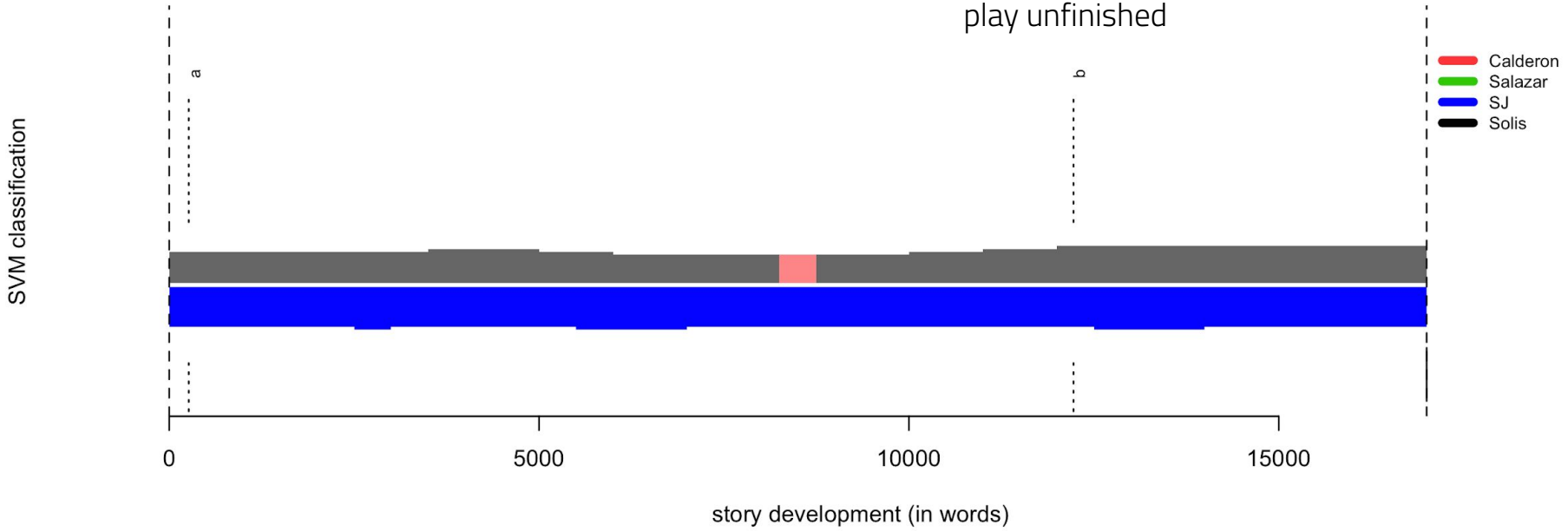
Rolling Classify

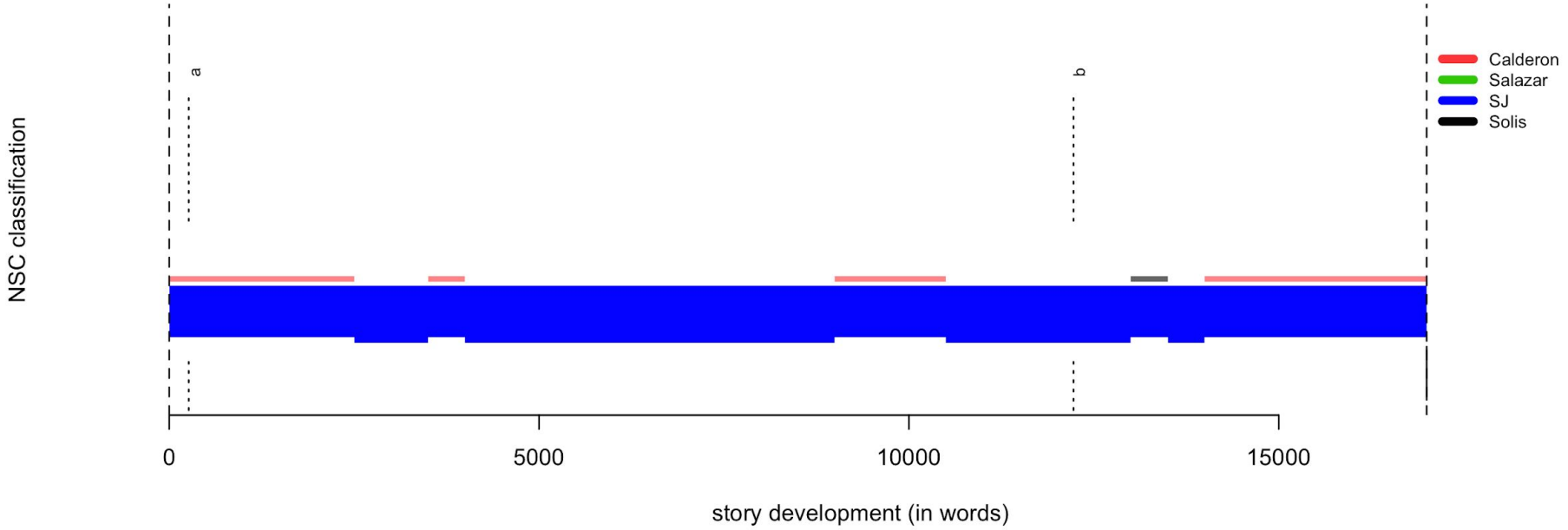
Experiment conditions:

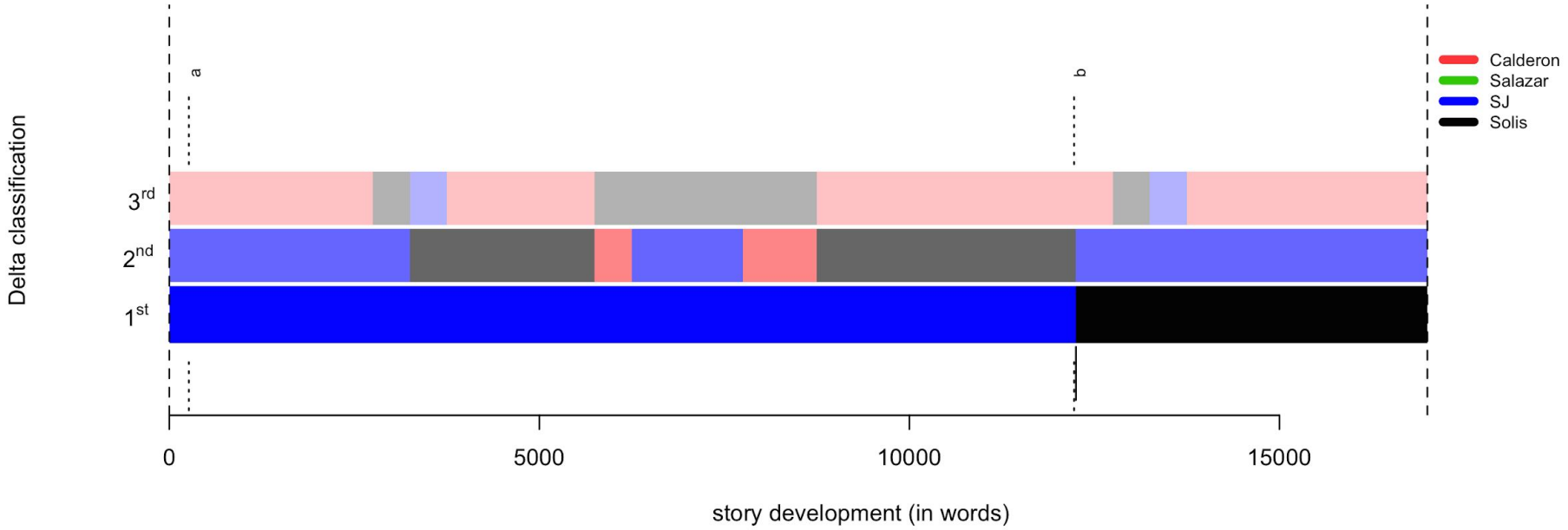
- SVM, NSC and Delta
- 500 MFW
- 5000 words-per-slice
- Authors: candidates (Salazar and SJ), control authors (Calderón and Solís)

beginning and the first encounter of protagonists, doña Beatriz and don Juan → very feminist confrontation

where Salazar left the play unfinished




NSC classification
a
b
Calderon
Salazar
SJ
Solis
0
5000
10000
15000
story development (in words)


Delta classification
a
b
3rd
2nd
1st
Calderon
Salazar
SJ
Solis
0
5000
10000
15000
story development (in words)

Concluding remarks

Importance of taking corpus evaluation steps in all analyses, and especially in the case of historic works, for which it is impossible to create a truly balanced corpus.

Various authors seem important for the text and the situation is quite blurry.

regression analysis

a set of statistical processes for estimating the relationships between a dependent variable (often called the 'outcome variable') and one or more independent variables (often called 'predictors', 'covariates', or 'features').

The most common form of regression analysis is linear regression, in which a researcher finds the line (or a more complex linear combination) that most closely fits the data according to a specific mathematical criterion.

For example, the method of ordinary least squares computes the unique line (or hyperplane) that minimizes the sum of squared distances between the true data and that line (or hyperplane).

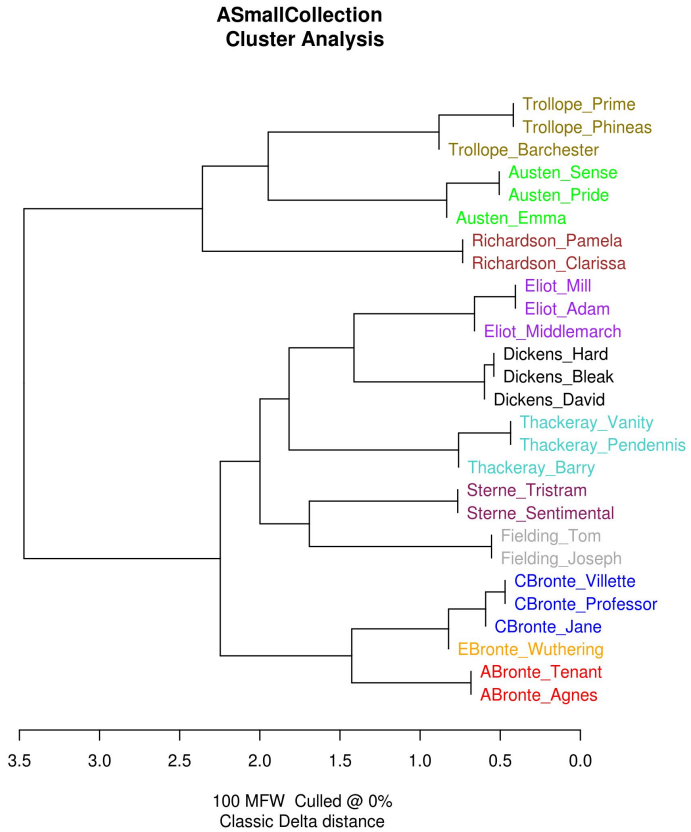
(further slides are an optional quick mention)

Classification in stylo

Classification algorithm

- k-nearest neighbors (v. good)
- Support Vector Machine (best)
- Nearest Shrunken Centroids
- Naive Bayes

What y


ASmallCollection
Cluster Analysis
Trollope_Prime
Trollope_Phineas
Trollope_Barchester
Austen_Sense
Austen_Pride
Austen_Emma
Richardson_Pamela
Richardson_Clarissa
Eliot_Mill
Eliot_Adam
Eliot_Middlemarch
Dickens_Hard
Dickens_Bleak
Dickens_David
Thackeray_Vanity
Thackeray_Pendennis
Thackeray_Barry
Sterne_Tristram
Sterne_Sentimental
Fielding_Tom
Fielding_Joseph
CBronte_Villette
CBronte_Professor
CBronte_Jane
EBronte_Wuthering
ABronte_Tenant
ABronte_Agnes
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
100 MFW Culled @ 0%
Classic Delta distance

Classify

- It trains a model for pre-defined groups of texts, e.g. authors.
- Then it computes distances (differences) between texts, …
- … represented as rows of frequencies of most frequent words.

Classify

- compares the trained models with test texts, using:
  - **Delta classifier** (lazy learner introduced by Burrows)
  - **k-NN classifier** (lazy learner relying on >1 neighbors)
  - **Support Vector Machines**, a high-performance non-probabilistic classifier
  - **Naive Bayes**, a classical yet slightly outdated classifier
  - **Nearest Shrunken Centroids**, a classifier for high-dimensional datasets
- A final report of the classifier's performance is outputted

Classify

Different structure:

- primary_set
- secondary_set

Running:

- library(stylo)
- classify()

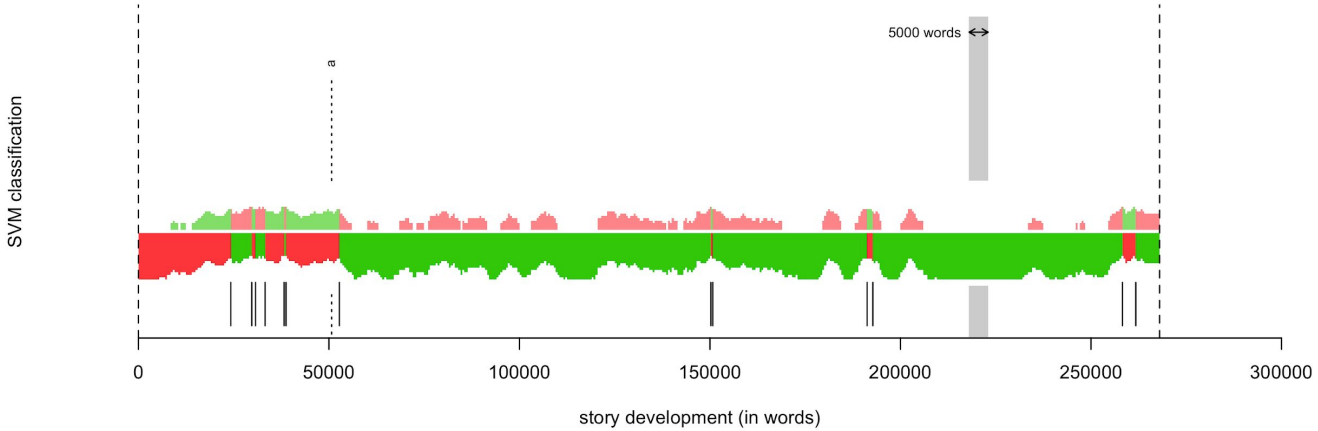
Good idea to save results in a new variable, e.g.

- results = classify()

Rolling classify

- Looks for traces of authors in a co-authored text…
- … by sliding through this text sequentially in order to detect peculiarities.
- Produces a graph of the respective strengths of these traces.

Rolling classify



Red = Guillaume de Lorris

Green = Jean de Meun

The **thickness** of the bottom stripe indicates **certainty of classification** and a *vertical dashed line* the *commonly-accepted*

Rolling classify

Different subfolder structure:

- reference_set (individual writings)
- test_set (collaborative text)

Rolling classify

Running the function:

- library(stylo)
- Example:

  rolling.classify(write.png.file = TRUE,
  classification.method = "svm", mfw = 100,
  training.set.sampling = "normal.sampling",
  slice.size = 5000, slice.overlap = 4500)