Attributing authorship in the **noisy** digitised correspondence of Jacob and Wilhelm Grimm

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How digitisation methods impact computational text analysis

Digitisation:

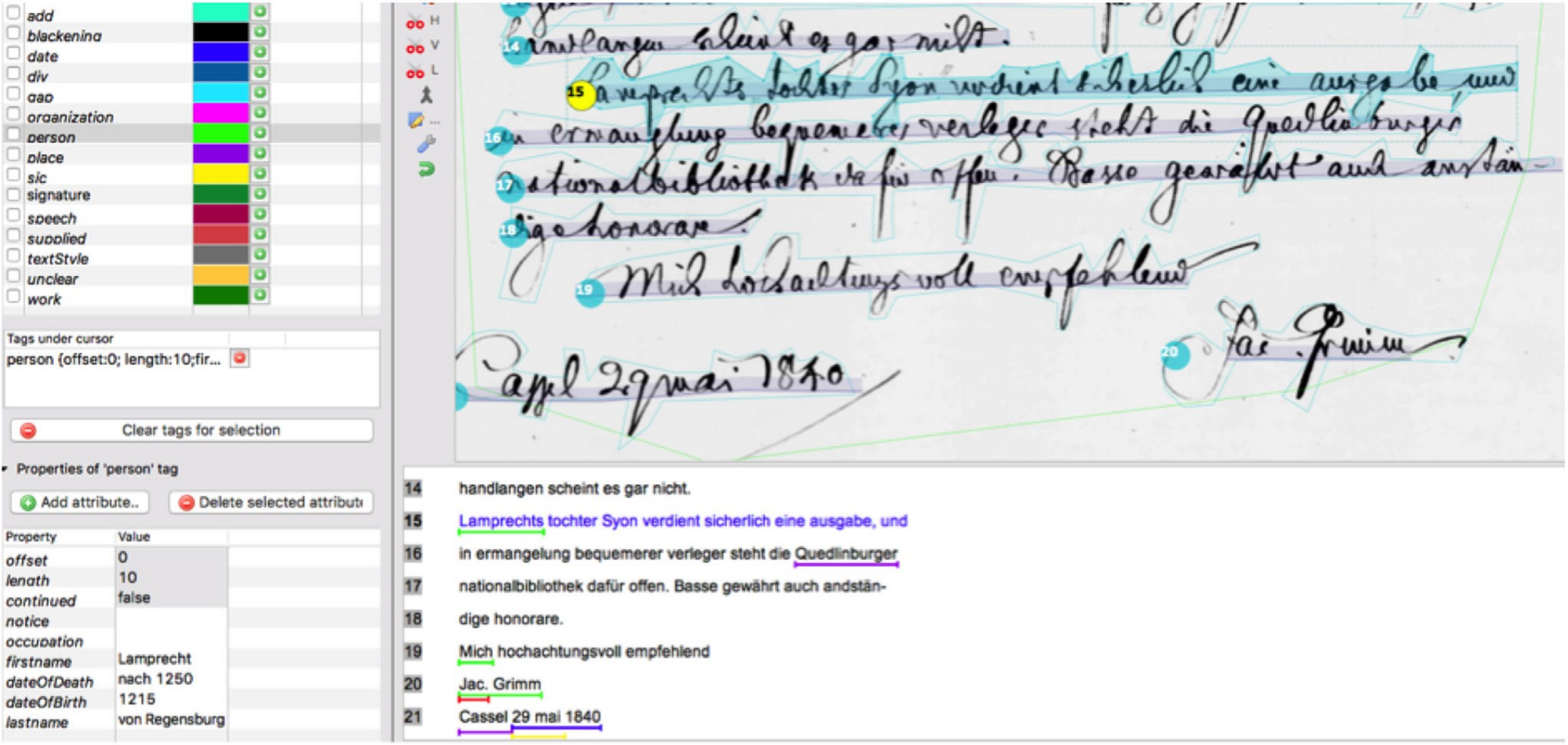
- Optical Character Recognition (OCR)
- Handwritten Text Recognition (HTR)
- Gold standard: human expert transcription

Analysis:

- Authorship attribution

(within and between the above)

Manual transcritption



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Jander, M. (2016). *Handwritten Text Recognition – Transkribus: A User Report*. Göttingen, Germany: eTRAP Research Group, University of Göttingen.

Data set

HTR and human trans.:

- collection of 36,000 *personal* letters belonging to the Grimm family [1]
- Selected letters:
  Jacob 50 (**44**)
  (1793-1863)

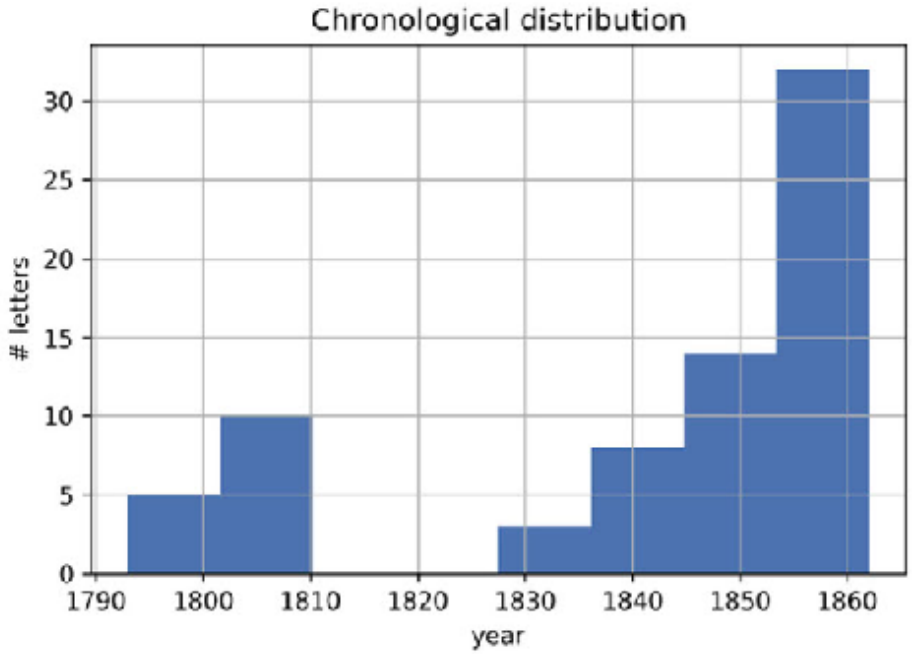
OCR:

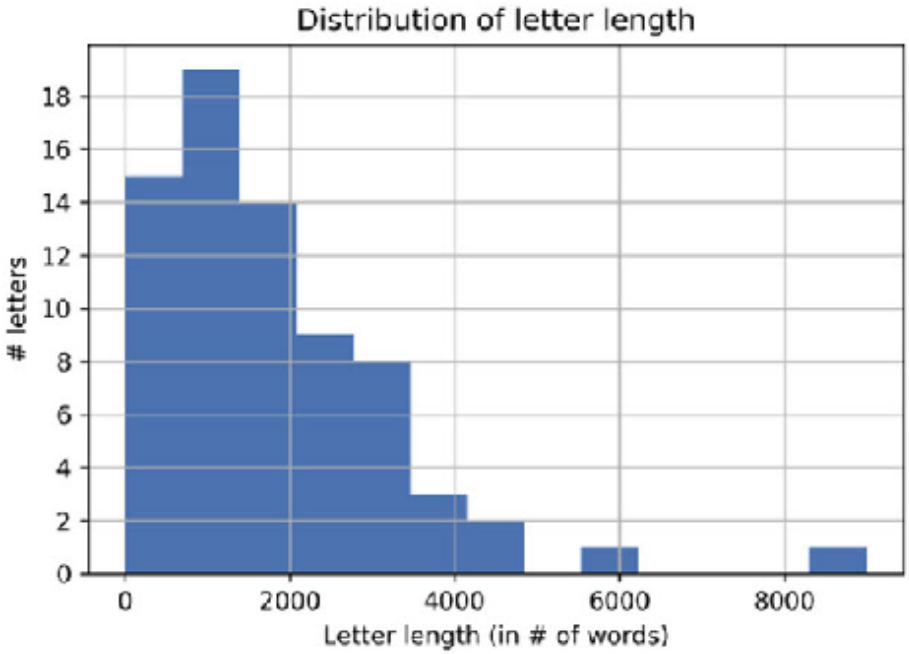
- seven-volume critical edition* [2]

Wilhelm 35 (**28**)
(1793-1859)

[1] Hessisches Staatsarchiv Marburg , *340 Grimm,* http://www.unimarburg.de/uniarchiv/grimm
[2] Rölleke, H. (2001). *Briefwechsel zwischen Jacob und Wilhelm Grimm* (Stuttgart: Hirzel Verlag)

Data set





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Data set

HTR training:

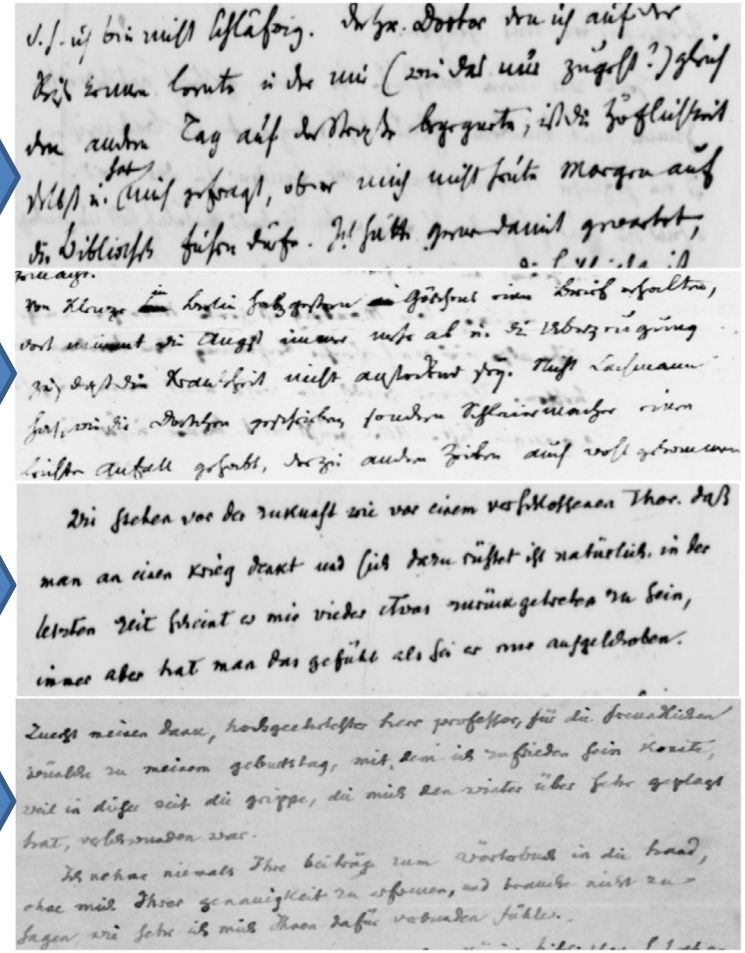
- 72 letters + 11 other documents
- 28,936 words

Error rate:	HTR	OCR
CHARACTERS	5.59%	2.21%
WORDS	19.15%	11.75%

Legibility and cleanliness

Wilhelm's letters:

- very low legibility
  (Br 5993, 7 years old)
- low legiability
  (Br 2680, 45 years old)
- medium legibility
  (Br 2743, 73 years old)
- high legibility
  (Br 2736, 69 years old)



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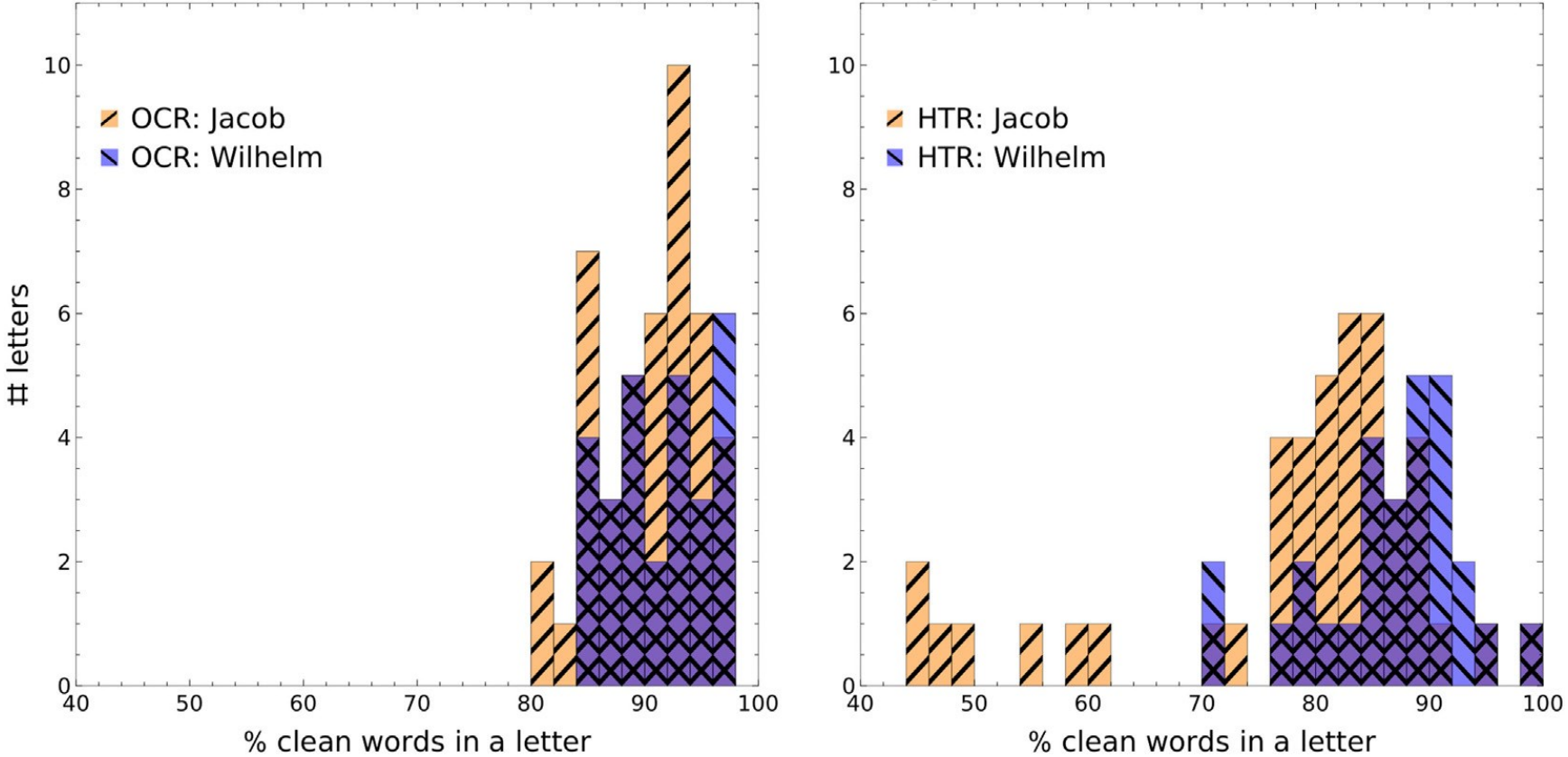
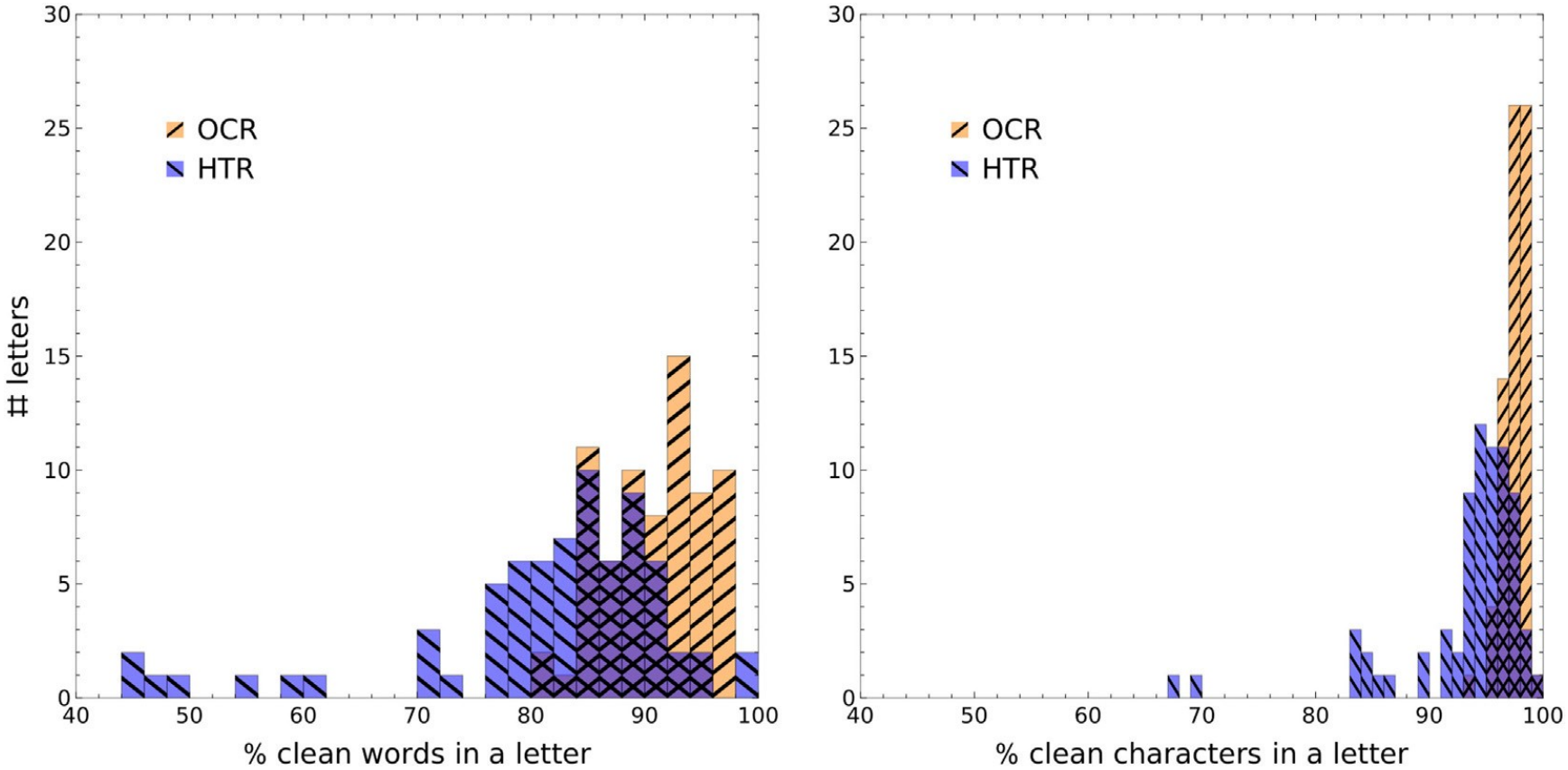
Legibility and cleanliness

Human-assessed legibility (very low excluded):

- Jacob: 36 low/9 medium–high
- Wilhelm: 15 low/13 medium–high



Legibility and cleanliness



Stylometry and authorship attribution based on:

words/word n-gram/character n-gram frequencies.

How is the

word frequency distribution

affected by errors in HTR/OCR?

Lexical richness

Out of many diversity indices:

- Shannon entropy (tails) $H = -\sum_{t=1}^{T} p_t \log p_t$
- Simpson's index (core) $D = \sum_{t=1}^{T} p_t^2$
  (inverse participation ratio)

Simple, least arbitrary, theoretically understood, known limiting values

Tweedie, F.J., and Baayen, R.H. (1998). How variable may a constant be? Measures of lexical richness in perspective. *Computers and the Humanities* 32: 323–52. doi:10.1023/A:1001749303137

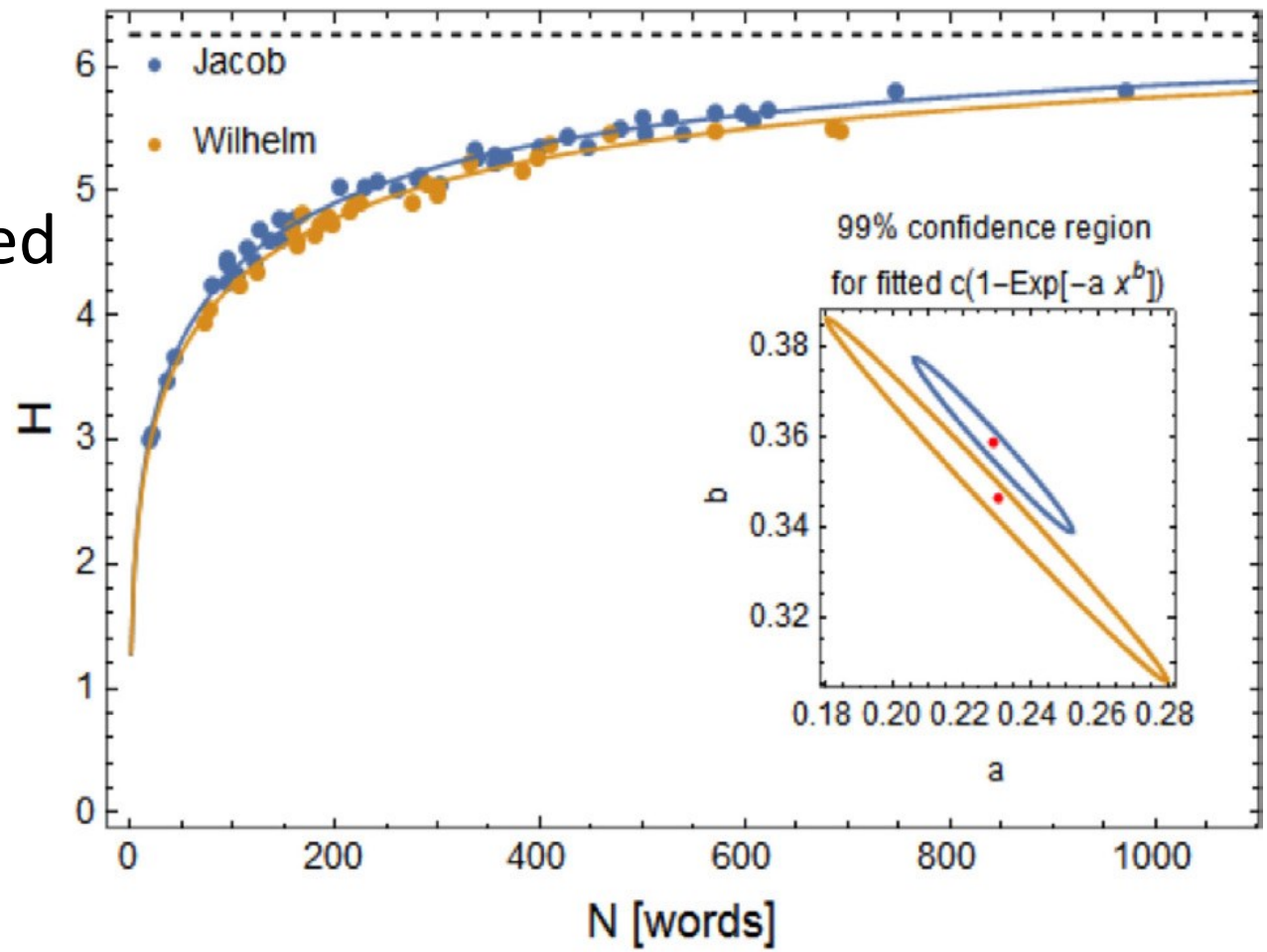
Lexical richness

- HTR produces enough errors to significantly yield lower richness per letter
- in short letters probably caused by HTR omitting or merging words
- no other correlations between text richness and cleanliness of HTR or OCR

OCR is more viable for stylometric measurements.

Lexical richness

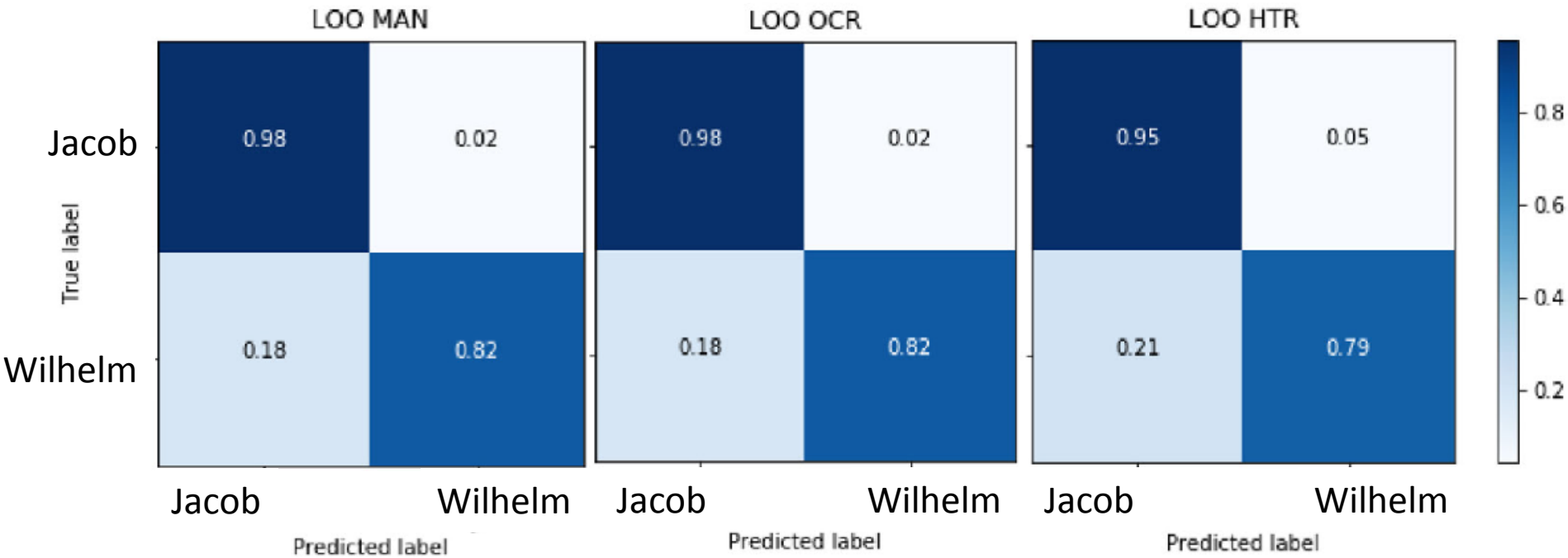
- can be authorial marker, but…
- depends on **text length**
- can be modelled



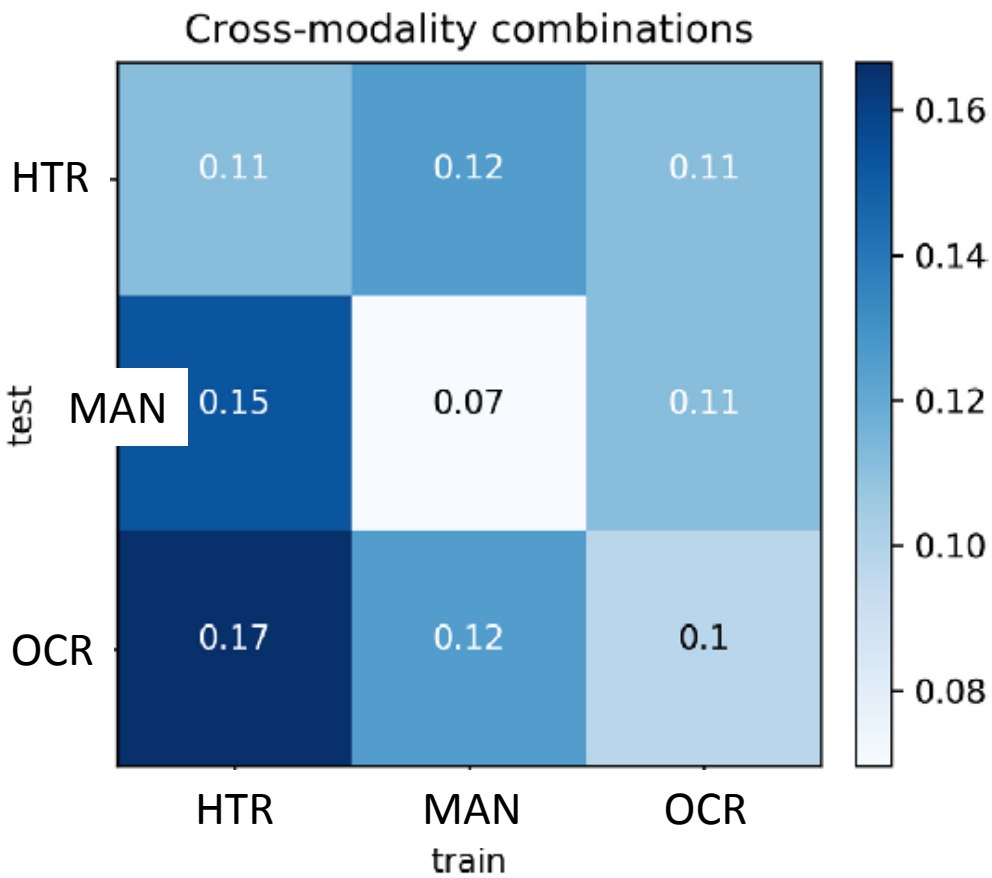
Authorship attribution

- 2- to 4-grams
- SVM (linear kernel)
- Leave-one-out cross-validation

	MAN	OCR	HTR
Accuracy	91.66	91.66	88.88
F1 score	88.46	88.46	84.61



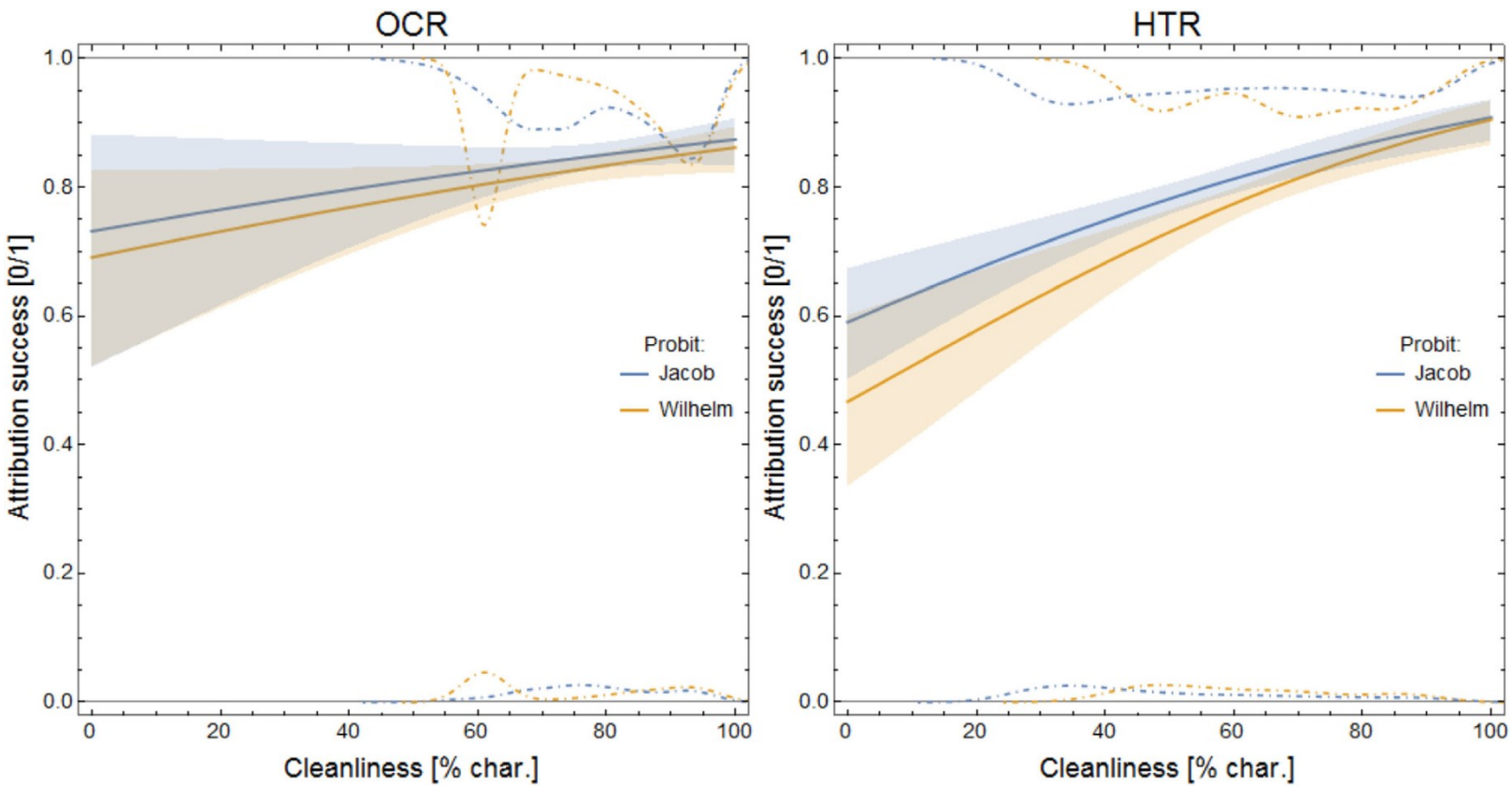
Authorship attribution



Authorship attribution

How OCR/HTR errors affect attribution?

- Texts (>1500 chars) made up from random original lines
- Burrows delta, 100 most frequent words



Conclusions

- human-assessed legibility agrees with HTR errors
- errors in **HTR** affect lexical richness
- **text-length corrected lexical richness** distinguishes Jacob and Wilhelm
- significant relation between auth. attr. **performance** and **cleanliness** for **HTR**
- auth. attr. **performs** as **well** on **OCR** as on human transcription

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M. Eder

M. Büchler

eTRAP
Electronic Text Reuse Acquisition Project

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