ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

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Detecting Erroneous Handwritten Byzantine Text Recognition

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EST. 1837

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Detecting Erroneous HTR output

HTR output yields diverse error rates

⇒ manual (tedious, expensive) correction

⇒ delaying the preservation of manuscripts

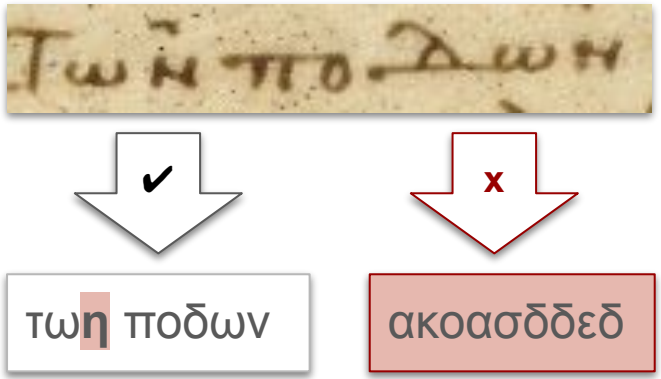
⇒ hindering the recognition of historical manuscripts

Detecting Erroneous HTR output

detecting erroneous/flawless HTR output

👉 easier for scrambled text

improved post-correction (e.g., when not to post-correct)



The Greek language: from antiquity to modern

10th to 16th c. CE

Contemporary: resembling what was considered as spoken language

Ancient: including Atticised Greek

NLP using both is beneficial

The Greek language: from antiquity to modern

Text from manuscripts and papyri in Byzantine Greek

Morphological categories gradually decreased or disappeared

Infinitives and participles present (≠ modern Greek)

Spelling conventions deviating from old orthographic rules (≠ ancient Greek)

The data: from the HTREC challenge

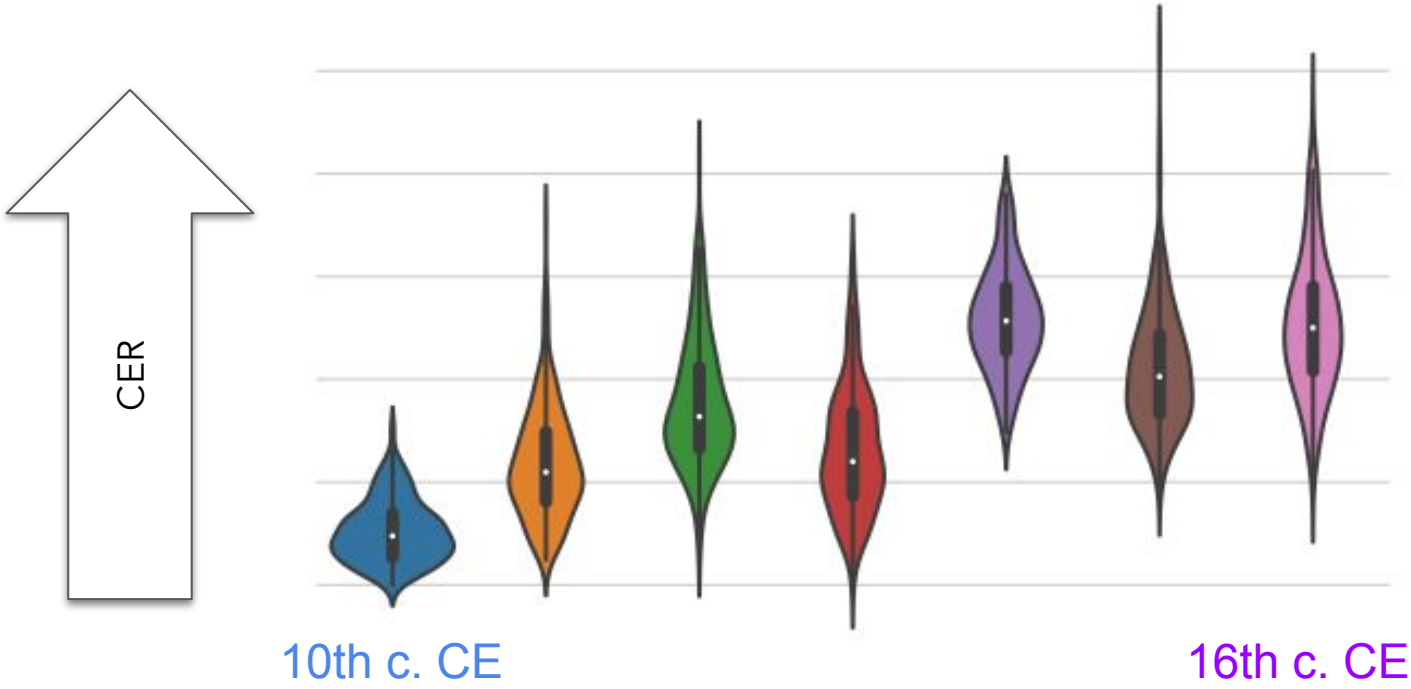
Transcriptions/Recognitions from the HTREC challenge

1,875 lines transcribed and HTRed

HTR model ⇒ Transkribus (under)trained on 7 images (1/cent.)

Transcription	Recognition
ἐγγινομένα πάθη μὴ σβεννύντες ἀλλὰ τῇ εκλύσει (the born-in passions not extinguishing but the release)	ἐγγενομεναπαδημησμεννωτες ἀλλατῆε κλησει
τοῦ βίου τοῦ καθ ΄ εαυτοὺς πολλὰ γίνεσθαι συγχωροῦν (of the life of themselves many happening forgive)	του β ου του καλεαυτοὺς πολλαγινεσθαι συγχωρ όν
τες ἐμπυρίζουσι τὸν ἀμπελῶνα ἀλλὰ καὶ ὁ διὰ τες (- set on fire the vineyard but and the due to the)	εμπυριζου σιμαμπελῶνα ἀλλακαι ὅδξα

The data: and their character error rate



The data: organised for experiments

1,875 Transcriptions ⇒ labelled as flawless (0)

1,875 Recognitions ⇒ labelled as erroneous (1)

Perfectly balanced dataset of 3,744 text lines

80/10/10 train-dev-test split

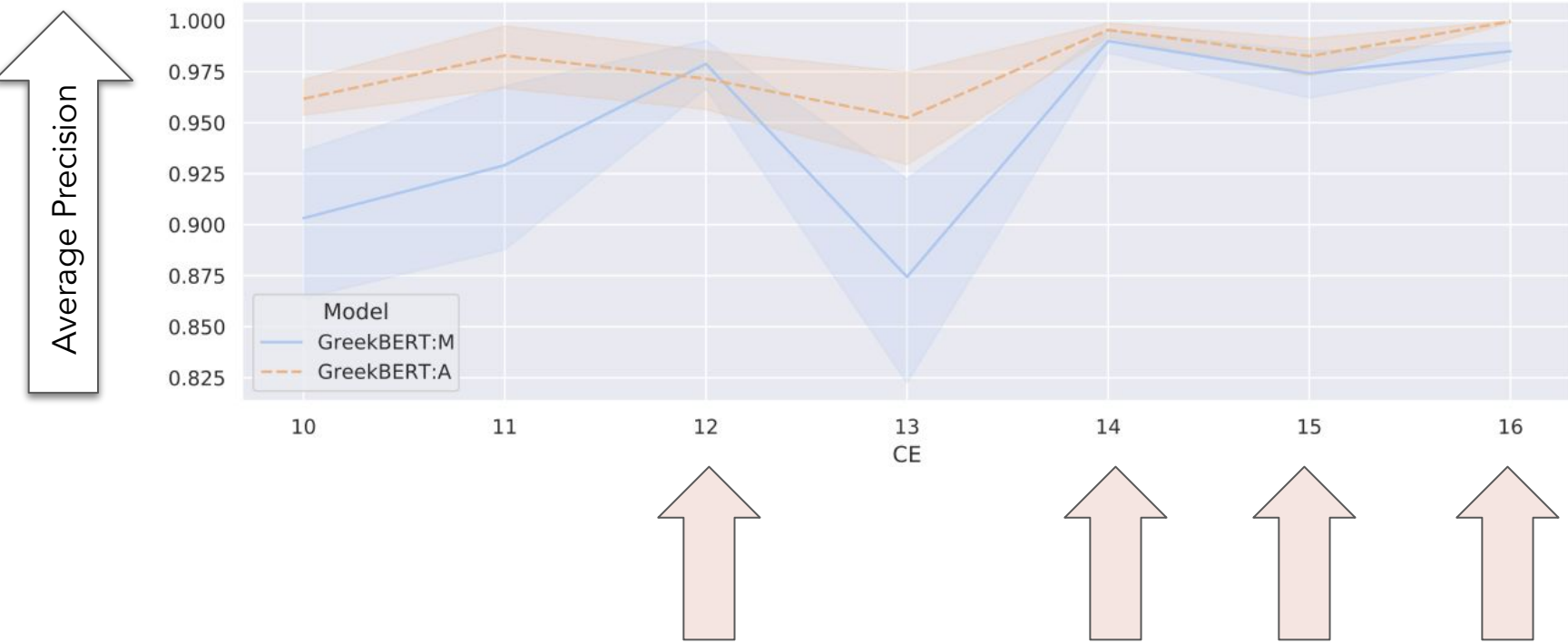
Experiments: machine learning

	AP	AUC	F1 (+)	F1 (-)
Random	0.52	0.50	0.49	0.47
SVM	0.66	0.65	0.60	0.51
Forest	0.64	0.65	0.64	0.50
MLP	0.79	0.79	0.73	0.69

Experiments: deep learning

	AP	AUC	F1 (+)	F1 (-)
Random	0.52	0.50	0.49	0.47
SVM	0.66	0.65	0.60	0.51
Forest	0.64	0.65	0.64	0.50
MLP	0.79	0.79	0.73	0.69
GRU	0.79	0.79	0.68	0.71
GreekBERT:M	0.95	0.94	0.88	0.88
GreekBERT:M+A	**0.97**	**0.97**	**0.90**	**0.91**

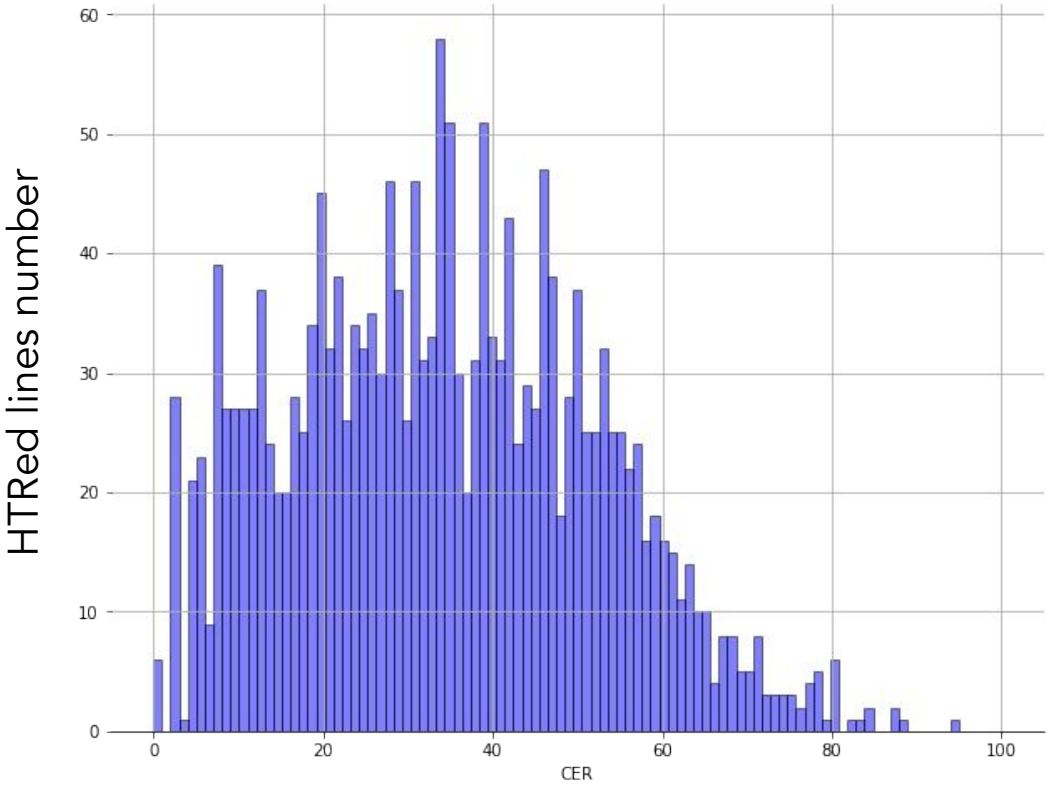
Evaluation per cent.



Evaluation per cent. ⇒ findings

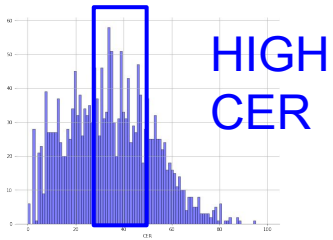
- The classification performance ~ the chronology of the manuscript
- Older manuscripts are benefit from further pre-training on ancient Greek
- Lines from recent manuscripts pose an easier classification challenge

Evaluation per error zone



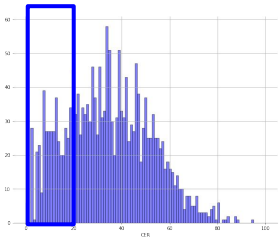
Evaluation per error zone

Evaluation per error zone



Evaluation per error zone

LOW CER

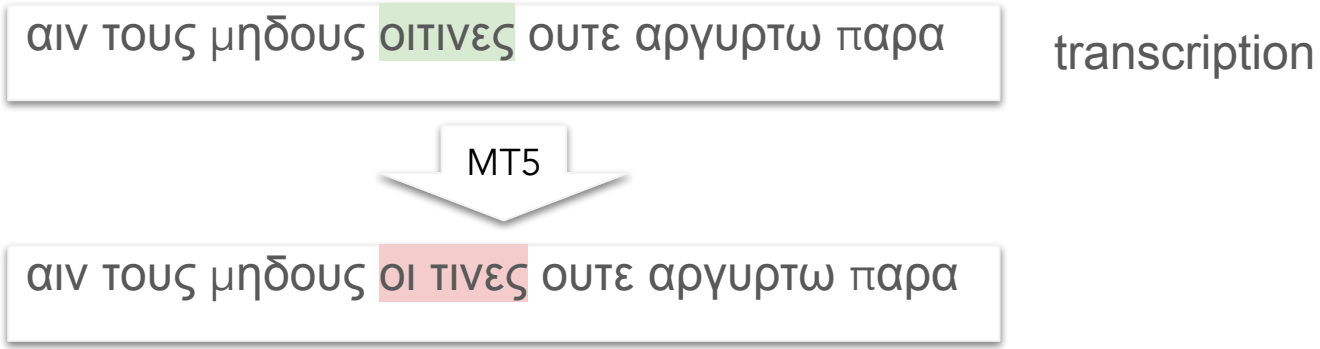


Substantiality assessment

Fine-tuned MT5 for the post-correction task (recognition ⇒ transcription)

Reduces CER in 11% of the (flawed) recognitions 👍 but:

Alters 80% of the (flawless) transcriptions 👎



Error analysis

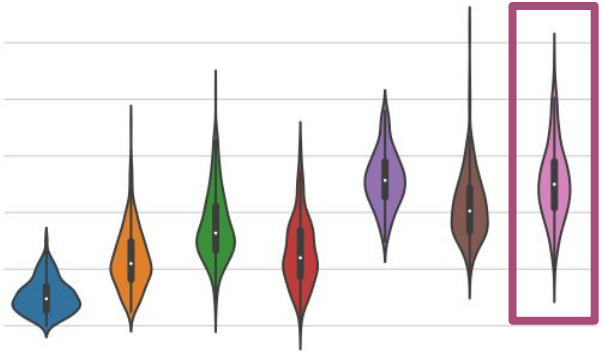
ἐγὼ δ ἀεί πως φιλακόλουθός εἰμι
(I am always readily following)

Error analysis

λα και γεδεων εκ των σκυλων των ισμαηληι
(- and Gedeon from the dogs the -)

[...] ισμαηλιτι
-κων [...]

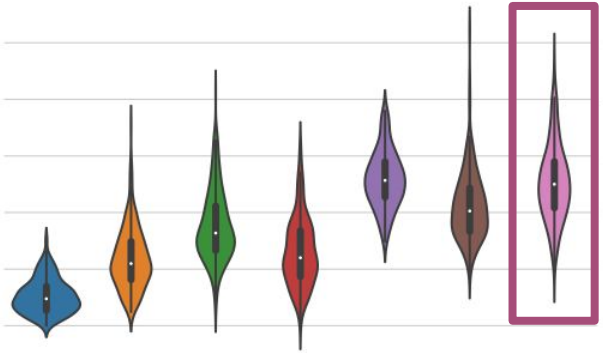
Error analysis: the 16th c. CE



highest avg. CER

‘πλοῦς,’ → HTR → ‘πλουοο’’

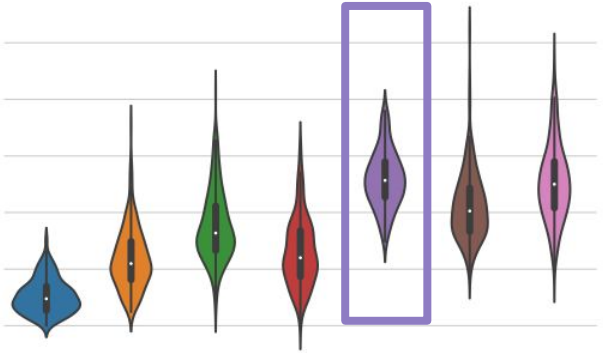
Error analysis: the 16th c. CE



highest avg. CER

‘ῶ πατρὶς’ → HTR → ‘ὤπαρις’

Error analysis: the 14th c. CE

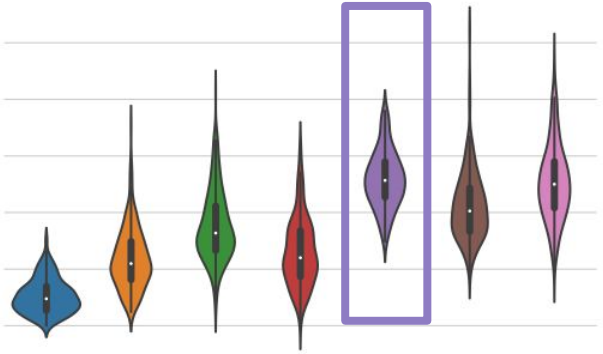


2nd highest

‘φ**έρ** ’ ἐπ ’ αὐτὴν ἴω’ → HTR → ‘φ**ρ**επαυ την ιςω’

The ligature of ‘ερ’ is not captured

Error analysis: the 14th c. CE



2nd highest

omega: horizontal eight-shaped

‘φέρ᾽ ἐπ᾽ αὐτὴν ἴω’ → HTR → ‘φρεπαυ την ιϛω’

Language and script generalisation

- Old, Middle, and Modern English and Japanese
- Common scripts in Greek and Latin manuscripts
- Common handwritten character shapes (E) in Latin scripts

Takeaways

- Detecting erroneous recognised lines ⇒ improves HTR in Byzantine Greek
- Fine-tuned PLMs perform well for the task, by contrast to baselines
- PLM pre-trained on modern and ancient Greek, strong for older centuries
- an application with T5

Future work:

- Larger dataset ⇒ more conclusions
- Calibrated evaluation sets ⇒ to focus on specific error types