Optical Character Recognition with a Neural Network Model for Coptic

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Virtual Short Paper

GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

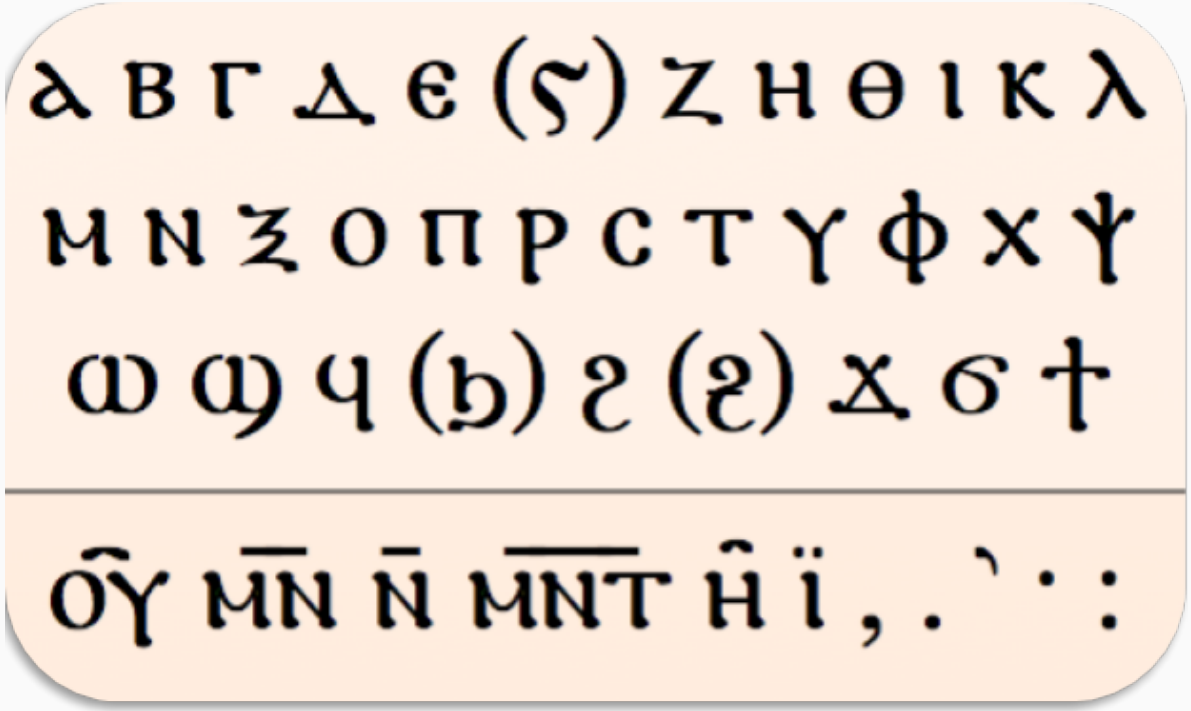
Coptic

About Coptic

- The final stage of the Ancient Egyptian language (third century)
- Multiple dialects (most important: Bohairic, Sahidic)
- Many manuscripts in Sahidic Coptic

Alphabet

- Simple: Ca. 30 unique characters
- No upper/lower case in historic texts
- Diacritics add some complexity, but not much
- Based on Greek alphabet



Coptic projects

- SFB 1136 (Goettingen)
  https://www.uni-goettingen.de/de/sfb-1136/521113.html
- Digital Edition of the Coptic old testament (Goettingen)
  http://coptot.manuscriptroom.com/
- Coptic SCRIPTORIUM (Georgetown/Pacific)
  http://copticscriptorium.org/

OCR Systems

Tesseract vs Ocropy, free OCR frameworks

Tesseract

- Font based learning
- Single characters are decomposed
- Decomposed parts are matched against given text

Input

- Fonts

Problem

- Few Coptic fonts available, not all historic variations covered

Ocropy/Ocropus

- Neural nets with online learning
- Model accuracy proportional to ground truth size
- But, size of ground truth is limited

Input

- Ground truth and corresponding images

Problem

- Limited data for learning

Tesseract vs Ocropy, free OCR frameworks

Tesseract

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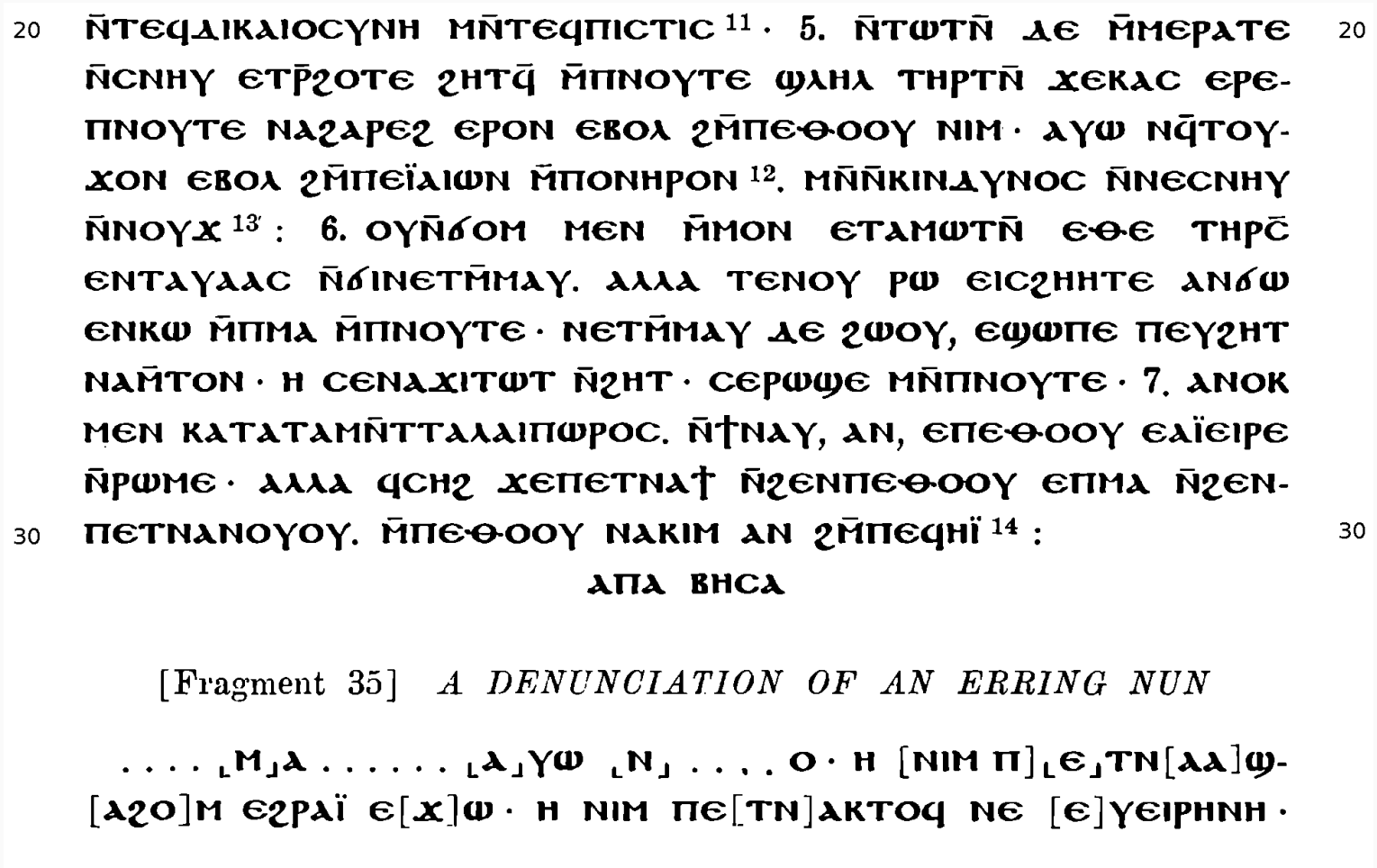
Pre-Processing

GIGO - principle

- Training: Data $\rightarrow$ training $\rightarrow$ model
- Garbage in, garbage out
- Cleaner images improve results tremendously
- Dust and stains can be cleaned algorithmically, but ...
- What if text itself is ~~noise~~ the problem?

Original Page



ⲛ̄ⲧⲉϥⲇⲓⲕⲁⲓⲟⲥⲩⲛⲏ ⲙ̄ⲛ̄ⲧⲉϥⲡⲓⲥⲧⲓⲥ [11] · 5. ⲛ̄ⲧⲱⲧⲛ̄ ⲇⲉ ⲙ̄ⲙⲉⲣⲁⲧⲉ
ⲛ̄ⲥⲛⲏⲩ ⲉⲧⲣ̄ϩⲟⲧⲉ ϩⲛⲧ̄ⲕ̄ ⲙ̄ⲡⲛⲟⲩⲧⲉ ⲱⲗⲏⲗ ⲧⲏⲣⲧⲛ̄ ϫⲉⲕⲁⲥ ⲉⲣⲉ-
ⲡⲛⲟⲩⲧⲉ ⲛⲁϩⲁⲣⲉϩ ⲉⲣⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲓⲙ · ⲁⲩⲱ ⲛ̄ⲧⲟⲩ-
ϫⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲓⲁⲓⲱⲛ ⲙ̄ⲡⲟⲛⲏⲣⲟⲛ [12]. ⲙ̄ⲛ̄ⲛ̄ⲕⲓⲛⲇⲩⲛⲟⲥ ⲛ̄ⲛⲉⲥⲛⲏⲩ
ⲛ̄ⲛⲟⲩϫ [13] : 6. ⲟⲩⲛ̄ⲇⲟⲙ ⲙⲉⲛ ⲙ̄ⲙⲟⲛ ⲉⲧⲁⲙⲱⲧⲛ̄ ⲉⲑⲉ ⲧⲏⲣ̄
ⲉⲛⲧⲁⲩⲁⲁⲥ ⲛ̄ⲇⲓⲛⲉⲧⲙ̄ⲙⲁⲩ. ⲁⲗⲗⲁ ⲧⲉⲛⲟⲩ ⲣⲱ ⲉⲓⲥϩⲏⲧⲉ ⲁⲛⲇⲱ
ⲉⲛⲕⲱ ⲙ̄ⲡⲙⲁ ⲙ̄ⲡⲛⲟⲩⲧⲉ · ⲛⲉⲧⲙ̄ⲙⲁⲩ ⲇⲉ ϩⲱⲟⲩ, ⲉⲱⲱⲡⲉ ⲡⲉⲩϩⲏⲧ
ⲛⲁⲙ̄ⲧⲟⲛ · ⲏ ⲥⲉⲛⲁϫⲓⲧⲱⲧ ⲛ̄ϩⲏⲧ · ⲥⲉⲣⲱⲱⲉ ⲙ̄ⲛ̄ⲡⲛⲟⲩⲧⲉ · 7. ⲁⲛⲟⲕ
ⲙⲉⲛ ⲕⲁⲧⲁⲧⲁⲙ̄ⲛ̄ⲧⲁⲗⲁⲓⲡⲱⲣⲟⲥ. ⲛ̄ⲧⲛⲁⲩ, ⲁⲛ, ⲉⲡⲉⲑⲟⲟⲩ ⲉⲁⲓⲉⲓⲣⲉ
ⲛ̄ⲣⲱⲙⲉ · ⲁⲗⲗⲁ ⲫⲥϩ ϫⲉⲡⲉⲧⲛⲁ† ⲛ̄ϩⲉⲛⲡⲉⲑⲟⲟⲩ ⲉⲡⲙⲁ ⲛ̄ϩⲉⲛ-
ⲡⲉⲧⲛⲁⲛⲟⲩⲟⲩ. ⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲁⲕⲓⲙ ⲁⲛ ϩⲙ̄ⲡⲉⲫⲏⲓ [14] :

ⲁⲡⲁ ⲃⲏⲥⲁ

[Fragment 35] *A DENUNCIATION OF AN ERRING NUN*

. . . . ⸢ⲙ⸣ⲁ . . . . . ⸢ⲁ⸣ⲩⲱ ⸢ⲛ⸣ . . . . ⲟ · ⲏ [ⲛⲓⲙ ⲡ]⸢ⲉ⸣ⲧⲛ[ⲁⲁ]ⲯ-
[ⲁϩⲟ]ⲙ ⲉϩⲣⲁⲓ ⲉ[ϫ]ⲱ · ⲏ ⲛⲓⲙ ⲡⲉ[ⲧⲛ]ⲁⲕⲧⲟϥ ⲛⲉ [ⲉ]ⲩⲉⲓⲣⲏⲛⲏ ·

- Flawless, almost ...

Original Page

20 ⲛ̄ⲧⲉⲫⲇⲓⲕⲁⲓⲟⲥⲩⲛⲏ ⲙ̄ⲛ̄ⲧⲉⲫⲡⲓⲥⲧⲓⲥ [11] · 5. ⲛ̄ⲧⲱⲧⲛ̄ ⲇⲉ ⲙ̄ⲙⲉⲣⲁⲧⲉ 20
ⲛ̄ⲥⲛⲏⲩ ⲉⲧⲣ̄ϩⲟⲧⲉ ϩⲏⲧⲫ̄ ⲙ̄ⲡⲛⲟⲩⲧⲉ ⲱⲗⲏⲗ ⲧⲏⲣⲧⲛ̄ ⲭⲉⲕⲁⲥ ⲉⲣⲉ-
ⲡⲛⲟⲩⲧⲉ ⲛⲁϩⲁⲣⲉϩ ⲉⲣⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲓⲙ · ⲁⲩⲱ ⲛⲫ̄ⲧⲟⲩ-
ⲭⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲓⲁⲓⲱⲛ ⲙ̄ⲡⲟⲛⲏⲣⲟⲛ [12]. ⲙ̄ⲛ̄ⲛ̄ⲕⲓⲛⲇⲩⲛⲟⲥ ⲛ̄ⲛⲉⲥⲛⲏⲩ
ⲛ̄ⲛⲟⲩⲭ [13] : 6. ⲟⲩⲛ̄ⲅⲟⲙ ⲙⲉⲛ ⲙ̄ⲙⲟⲛ ⲉⲧⲁⲙⲱⲧⲛ̄ ⲉⲑⲉ ⲧⲏⲣ̄ⲥ̄
ⲉⲛⲧⲁⲩⲁⲁⲥ ⲛ̄ⲅⲓⲛⲉⲧⲙ̄ⲙⲁⲩ. ⲁⲗⲗⲁ ⲧⲉⲛⲟⲩ ⲣⲱ ⲉⲓⲥϩⲏⲏⲧⲉ ⲁⲛⲅⲱ
ⲉⲛⲕⲱ ⲙ̄ⲡⲙⲁ ⲙ̄ⲡⲛⲟⲩⲧⲉ · ⲛⲉⲧⲙ̄ⲙⲁⲩ ⲇⲉ ϩⲱⲟⲩ, ⲉⲱⲱⲡⲉ ⲡⲉⲩϩⲏⲧ
ⲛⲁⲙ̄ⲧⲟⲛ · ⲏ ⲥⲉⲛⲁⲭⲓⲧⲱⲧ ⲛ̄ϩⲏⲧ · ⲥⲉⲣⲱⲱⲉ ⲙ̄ⲛ̄ⲡⲛⲟⲩⲧⲉ · 7. ⲁⲛⲟⲕ
ⲙⲉⲛ ⲕⲁⲧⲁⲧⲁⲙⲛ̄ⲧⲧⲁⲗⲁⲓⲡⲱⲣⲟⲥ. ⲛ̄ⲧⲛⲁⲩ, ⲁⲛ, ⲉⲡⲉⲑⲟⲟⲩ ⲉⲁⲓⲉⲓⲣⲉ
ⲛ̄ⲣⲱⲙⲉ · ⲁⲗⲗⲁ ⲫⲥϩ ϩⲉⲡⲉⲧⲛⲁⲧ ⲛ̄ϩⲉⲛⲡⲉⲑⲟⲟⲩ ⲉⲡⲙⲁ ⲛ̄ϩⲉⲛ-
30 ⲡⲉⲧⲛⲁⲛⲟⲩⲟⲩ. ⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲁⲕⲓⲙ ⲁⲛ ϩⲙ̄ⲡⲉⲫⲏⲓ [14] : 30

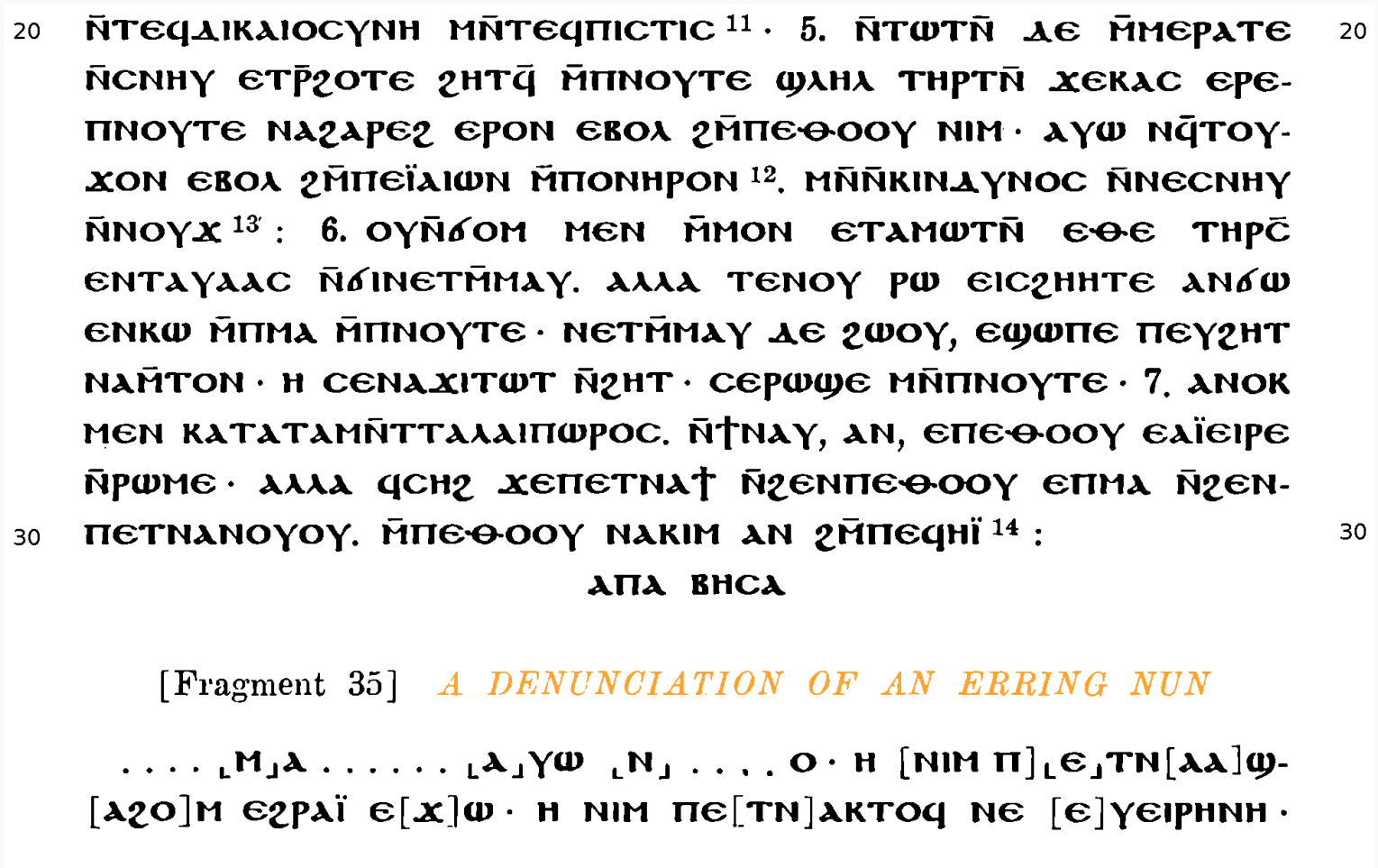
ⲁⲡⲁ ⲃⲏⲥⲁ

[Fragment 35] *A DENUNCIATION OF AN ERRING NUN*

. . . . ⌞ⲙ⌟ⲁ . . . . . ⌞ⲁ⌟ⲩⲱ ⌞ⲛ⌟ . . . . ⲟ · ⲏ [ⲛⲓⲙ ⲡ]⌞ⲉ⌟ⲧⲛ[ⲁⲁ]ⲯ-
[ⲁϩⲟ]ⲙ ⲉϩⲣⲁⲓ ⲉ[ⲭ]ⲱ · ⲏ ⲛⲓⲙ ⲡⲉ[ⲧⲛ]ⲁⲕⲧⲟⲫ ⲛⲉ [ⲉ]ⲩⲉⲓⲣⲏⲛⲏ ·

- Easily removable with ScanTailor

Foreign language



20 ⲛ̄ⲧⲉϥⲇⲓⲕⲁⲓⲟⲥⲩⲛⲏ ⲙ̄ⲛ̄ⲧⲉϥⲡⲓⲥⲧⲓⲥ [11] · 5. ⲛ̄ⲧⲱⲧⲛ̄ ⲇⲉ ⲙ̄ⲙⲉⲣⲁⲧⲉ 20
ⲛ̄ⲥⲛⲏⲩ ⲉⲧⲣ̄ϩⲟⲧⲉ ϩⲛⲧⲫ̄ ⲙ̄ⲡⲛⲟⲩⲧⲉ ⲱⲗⲏⲗ ⲧⲏⲣⲧⲛ̄ ⲭⲉⲕⲁⲥ ⲉⲣⲉ-
ⲡⲛⲟⲩⲧⲉ ⲛⲁϩⲁⲣⲉϩ ⲉⲣⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲓⲙ · ⲁⲩⲱ ⲛⲫ̄ⲧⲟⲩ-
ⲭⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲓⲁⲓⲱⲛ ⲙ̄ⲡⲟⲛⲏⲣⲟⲛ [12]. ⲙ̄ⲛ̄ⲛ̄ⲕⲓⲛⲇⲩⲛⲟⲥ ⲛ̄ⲛⲉⲥⲛⲏⲩ
ⲛ̄ⲛⲟⲩⲭ [13] : 6. ⲟⲩⲛ̄ⲇⲟⲙ ⲙⲉⲛ ⲙ̄ⲙⲟⲛ ⲉⲧⲁⲙⲱⲧⲛ̄ ⲉⲑⲉ ⲧⲏⲣ̄ⲥ̄
ⲉⲛⲧⲁⲩⲁⲁⲥ ⲛ̄ⲇⲓⲛⲉⲧⲙ̄ⲙⲁⲩ. ⲁⲗⲗⲁ ⲧⲉⲛⲟⲩ ⲣⲱ ⲉⲓⲥϩⲏⲧⲉ ⲁⲛⲇⲱ
ⲉⲛⲕⲱ ⲙ̄ⲡⲙⲁ ⲙ̄ⲡⲛⲟⲩⲧⲉ · ⲛⲉⲧⲙ̄ⲙⲁⲩ ⲇⲉ ϩⲱⲟⲩ, ⲉⲫⲱⲡⲉ ⲡⲉⲩϩⲏⲧ
ⲛⲁⲙ̄ⲧⲟⲛ · ⲏ ⲥⲉⲛⲁⲭⲓⲧⲱⲧ ⲛ̄ϩⲏⲧ · ⲥⲉⲣⲱⲫⲉ ⲙ̄ⲛ̄ⲡⲛⲟⲩⲧⲉ · 7. ⲁⲛⲟⲕ
ⲙⲉⲛ ⲕⲁⲧⲁⲧⲁⲙⲛ̄ⲧⲧⲁⲗⲁⲓⲡⲱⲣⲟⲥ. ⲛ̄ⲧⲛⲁⲩ, ⲁⲛ, ⲉⲡⲉⲑⲟⲟⲩ ⲉⲁⲓⲉⲓⲣⲉ
ⲛ̄ⲣⲱⲙⲉ · ⲁⲗⲗⲁ ⲫⲥϩ ϩⲉⲡⲉⲧⲛⲁϯ ⲛ̄ϩⲉⲛⲡⲉⲑⲟⲟⲩ ⲉⲡⲙⲁ ⲛ̄ϩⲉⲛ-
30 ⲡⲉⲧⲛⲁⲛⲟⲩⲟⲩ. ⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲁⲕⲓⲙ ⲁⲛ ϩⲙ̄ⲡⲉⲫⲏⲓ [14] : 30

ⲁⲡⲁ ⲃⲏⲥⲁ

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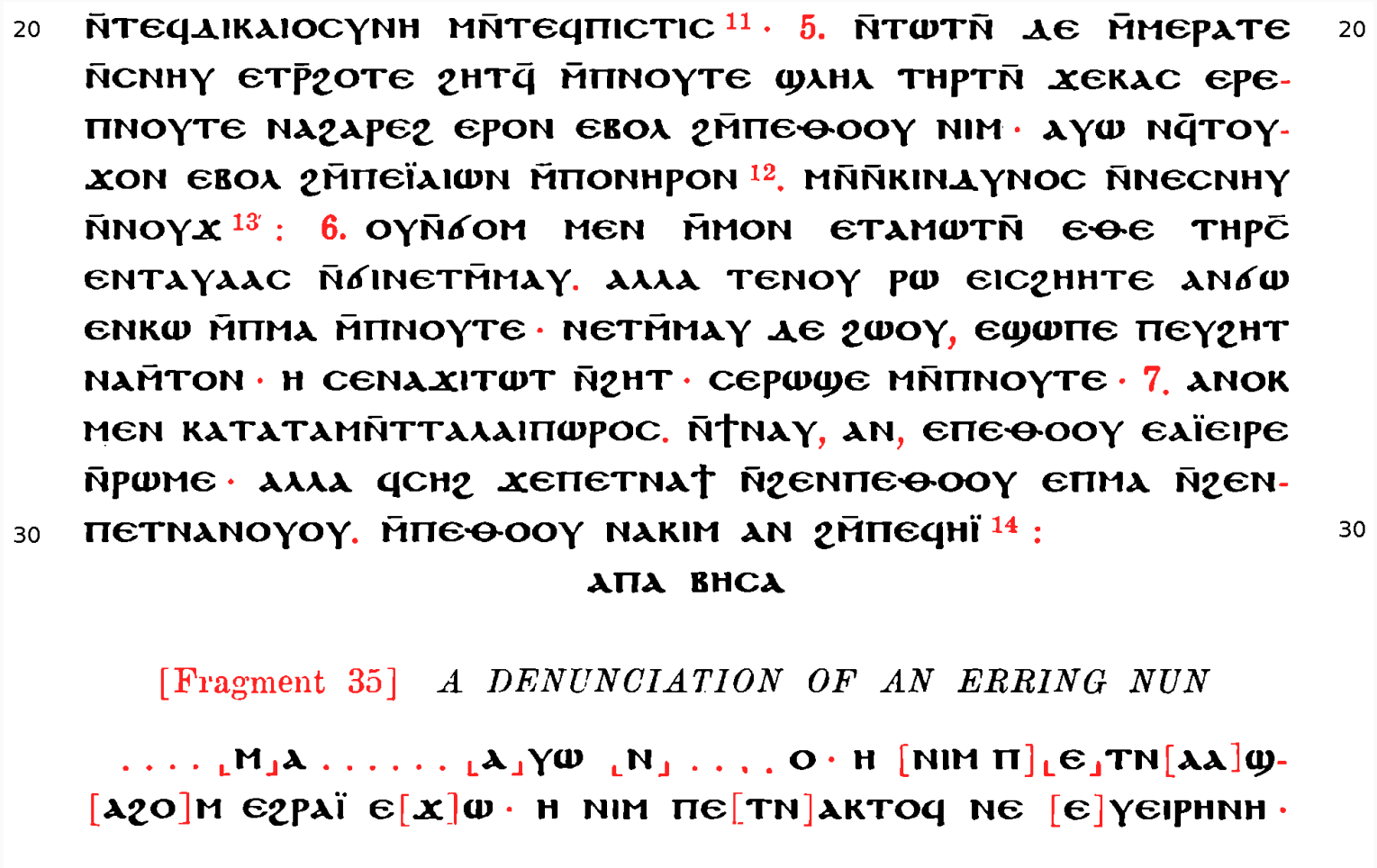
. . . . ⌞ⲙ⌟ⲁ . . . . . ⌞ⲁ⌟ⲩⲱ ⌞ⲛ⌟ . . . . ⲟ · ⲏ [ⲛⲓⲙ ⲡ]⌞ⲉ⌟ⲧⲛ[ⲁⲁ]ⲯ-
[ⲁϩⲟ]ⲙ ⲉϩⲣⲁⲓ ⲉ[ⲭ]ⲱ · ⲏ ⲛⲓⲙ ⲡⲉ[ⲧⲛ]ⲁⲕⲧⲟⲫ ⲛⲉ [ⲉ]ⲩⲉⲓⲣⲏⲛⲏ ·

- No multilingual OCR models for Coptic

Annotations


20 ⲛ̄ⲧⲉϥⲇⲓⲕⲁⲓⲟⲥⲩⲛⲏ ⲙ̄ⲛ̄ⲧⲉϥⲡⲓⲥⲧⲓⲥ [11] · 5. ⲛ̄ⲧⲱⲧⲛ̄ ⲇⲉ ⲙ̄ⲙⲉⲣⲁⲧⲉ 20
ⲛ̄ⲥⲛⲏⲩ ⲉⲧⲣ̄ϩⲟⲧⲉ ϩⲛⲧⲫ̄ ⲙ̄ⲡⲛⲟⲩⲧⲉ ⲱⲗⲏⲗ ⲧⲏⲣⲧⲛ̄ ⲭⲉⲕⲁⲥ ⲉⲣⲉ-
ⲡⲛⲟⲩⲧⲉ ⲛⲁϩⲁⲣⲉϩ ⲉⲣⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲓⲙ · ⲁⲩⲱ ⲛⲫ̄ⲧⲟⲩ-
ⲭⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲓⲁⲓⲱⲛ ⲙ̄ⲡⲟⲛⲏⲣⲟⲛ [12]. ⲙ̄ⲛ̄ⲛ̄ⲕⲓⲛⲇⲩⲛⲟⲥ ⲛ̄ⲛⲉⲥⲛⲏⲩ
ⲛ̄ⲛⲟⲩⲭ [13] : 6. ⲟⲩⲛ̄ⲅⲟⲙ ⲙⲉⲛ ⲙ̄ⲙⲟⲛ ⲉⲧⲁⲙⲱⲧⲛ̄ ⲉⲑⲉ ⲧⲏⲣ̄ⲥ̄
ⲉⲛⲧⲁⲩⲁⲁⲥ ⲛ̄ⲅⲓⲛⲉⲧⲙ̄ⲙⲁⲩ. ⲁⲗⲗⲁ ⲧⲉⲛⲟⲩ ⲣⲱ ⲉⲓⲥϩⲏⲧⲉ ⲁⲛⲅⲱ
ⲉⲛⲕⲱ ⲙ̄ⲡⲙⲁ ⲙ̄ⲡⲛⲟⲩⲧⲉ · ⲛⲉⲧⲙ̄ⲙⲁⲩ ⲇⲉ ϩⲱⲟⲩ, ⲉⲱⲱⲡⲉ ⲡⲉⲩϩⲏⲧ
ⲛⲁⲙ̄ⲧⲟⲛ · ⲏ ⲥⲉⲛⲁⲭⲓⲧⲱⲧ ⲛ̄ϩⲏⲧ · ⲥⲉⲣⲱⲱⲉ ⲙ̄ⲛ̄ⲡⲛⲟⲩⲧⲉ · 7. ⲁⲛⲟⲕ
ⲙⲉⲛ ⲕⲁⲧⲁⲧⲁⲙⲛ̄ⲧⲧⲁⲗⲁⲓⲡⲱⲣⲟⲥ. ⲛ̄ⲧⲛⲁⲩ, ⲁⲛ, ⲉⲡⲉⲑⲟⲟⲩ ⲉⲁⲩⲉⲓⲣⲉ
ⲛ̄ⲣⲱⲙⲉ · ⲁⲗⲗⲁ ⲫⲥϩϩ ⲭⲉⲡⲉⲧⲛⲁ† ⲛ̄ϩⲉⲛⲡⲉⲑⲟⲟⲩ ⲉⲡⲙⲁ ⲛ̄ϩⲉⲛ-
30 ⲡⲉⲧⲛⲁⲛⲟⲩⲟⲩ. ⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲁⲕⲓⲙ ⲁⲛ ϩⲙ̄ⲡⲉⲫⲏⲓ [14] : 30

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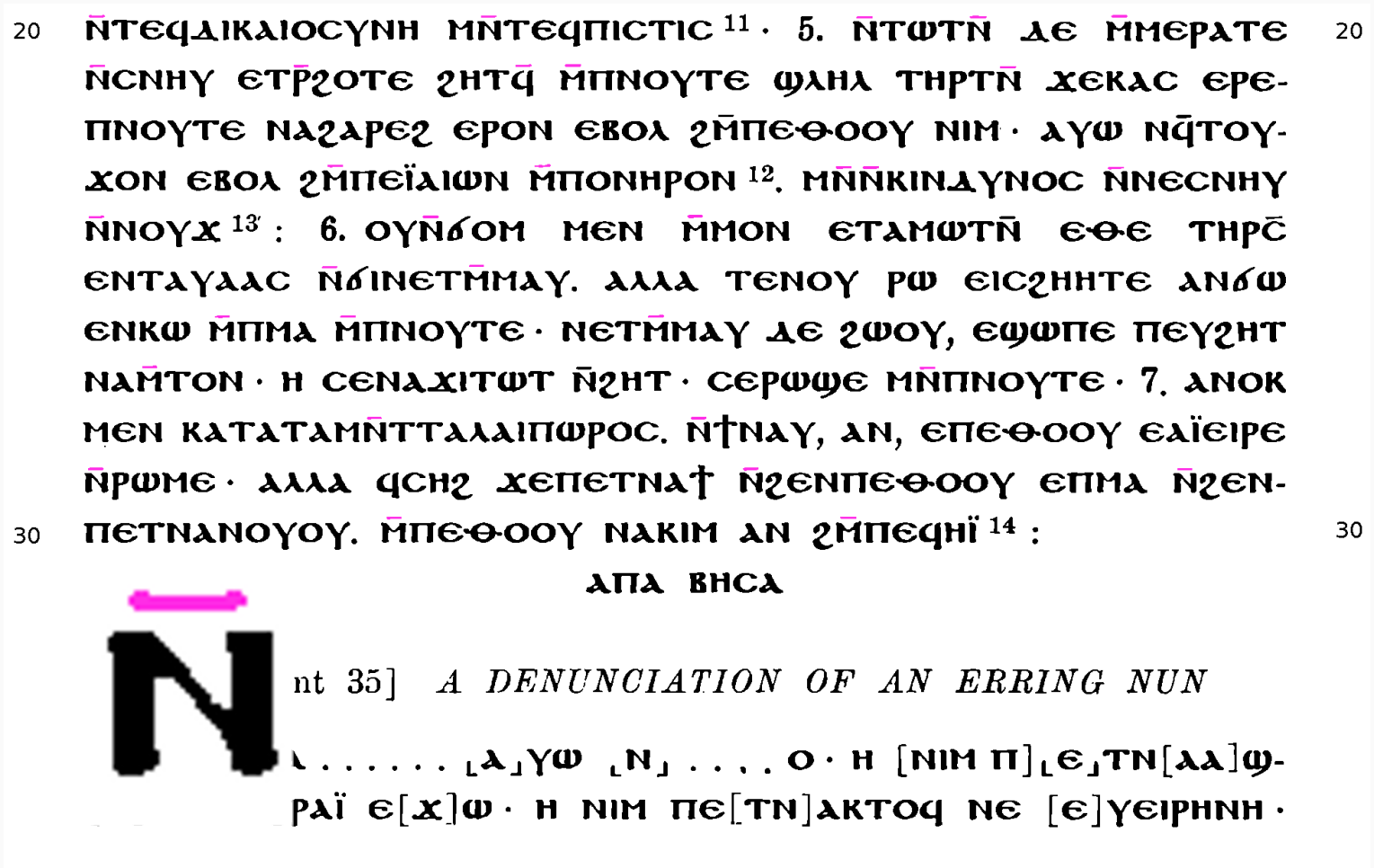
[ⲁϩⲟ]ⲙ ⲉϩⲣⲁⲓ ⲉ[ⲭ]ⲱ · ⲏ ⲛⲓⲙ ⲡⲉ[ⲧⲛ]ⲁⲕⲧⲟⲫ ⲛⲉ [ⲉ]ⲩⲉⲓⲣⲏⲛⲏ ·

- Special characters might not be part of any model (⸢ ⸣)
- Not all annotations wanted

Language specific variations


20 ⲛ̄ⲧⲉϥⲇⲓⲕⲁⲓⲟⲥⲩⲛⲏ ⲙ̄ⲛ̄ⲧⲉϥⲡⲓⲥⲧⲓⲥ [11] · 5. ⲛ̄ⲧⲱⲧⲛ̄ ⲇⲉ ⲙ̄ⲙⲉⲣⲁⲧⲉ 20
ⲛ̄ⲥⲛⲏⲩ ⲉⲧⲣ̄ϩⲟⲧⲉ ϩⲏⲧϥ ⲙ̄ⲡⲛⲟⲩⲧⲉ ⲱⲗⲏⲗ ⲧⲏⲣⲧⲛ̄ ⲭⲉⲕⲁⲥ ⲉⲣⲉ-
ⲡⲛⲟⲩⲧⲉ ⲛⲁϩⲁⲣⲉϩ ⲉⲣⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲓⲙ · ⲁⲩⲱ ⲛϥ̄ⲧⲟⲩ-
ⲭⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲓⲁⲓⲱⲛ ⲙ̄ⲡⲟⲛⲏⲣⲟⲛ [12]. ⲙ̄ⲛ̄ⲛⲕⲓⲛⲇⲩⲛⲟⲥ ⲛ̄ⲛⲉⲥⲛⲏⲩ
ⲛ̄ⲛⲟⲩⲭ [13] : 6. ⲟⲩⲛ̄ⲇⲟⲙ ⲙⲉⲛ ⲙ̄ⲙⲟⲛ ⲉⲧⲁⲙⲱⲧⲛ̄ ⲉⲑⲉ ⲧⲏⲣ̄ⲥ̄
ⲉⲛⲧⲁⲩⲁⲁⲥ ⲛ̄ⲇⲓⲛⲉⲧⲙ̄ⲙⲁⲩ. ⲁⲗⲗⲁ ⲧⲉⲛⲟⲩ ⲣⲱ ⲉⲓⲥϩⲏⲧⲉ ⲁⲛⲇⲱ
ⲉⲛⲕⲱ ⲙ̄ⲡⲙⲁ ⲙ̄ⲡⲛⲟⲩⲧⲉ · ⲛⲉⲧⲙ̄ⲙⲁⲩ ⲇⲉ ϩⲱⲟⲩ, ⲉⲱⲱⲡⲉ ⲡⲉⲩϩⲏⲧ
ⲛⲁⲙ̄ⲧⲟⲛ · ⲏ ⲥⲉⲛⲁⲭⲓⲧⲱⲧ ⲛ̄ϩⲏⲧ · ⲥⲉⲣⲱⲱⲉ ⲙ̄ⲛ̄ⲡⲛⲟⲩⲧⲉ · 7. ⲁⲛⲟⲕ
ⲙⲉⲛ ⲕⲁⲧⲁⲧⲁⲙⲛ̄ⲧⲧⲁⲗⲁⲓⲡⲱⲣⲟⲥ. ⲛ̄ⲧⲛⲁⲩ, ⲁⲛ, ⲉⲡⲉⲑⲟⲟⲩ ⲉⲁⲓⲉⲓⲣⲉ
ⲛ̄ⲣⲱⲙⲉ · ⲁⲗⲗⲁ ⲫⲥⲏϩ ⲭⲉⲡⲉⲧⲛⲁϯ ⲛ̄ϩⲉⲛⲡⲉⲑⲟⲟⲩ ⲉⲡⲙⲁ ⲛ̄ϩⲉⲛ-
30 ⲡⲉⲧⲛⲁⲛⲟⲩⲟⲩ. ⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲁⲕⲓⲙ ⲁⲛ ϩⲙ̄ⲡⲉϥⲏⲓ [14] : 30

ⲁⲡⲁ ⲃⲏⲥⲁ

nt 35] *A DENUNCIATION OF AN ERRING NUN*

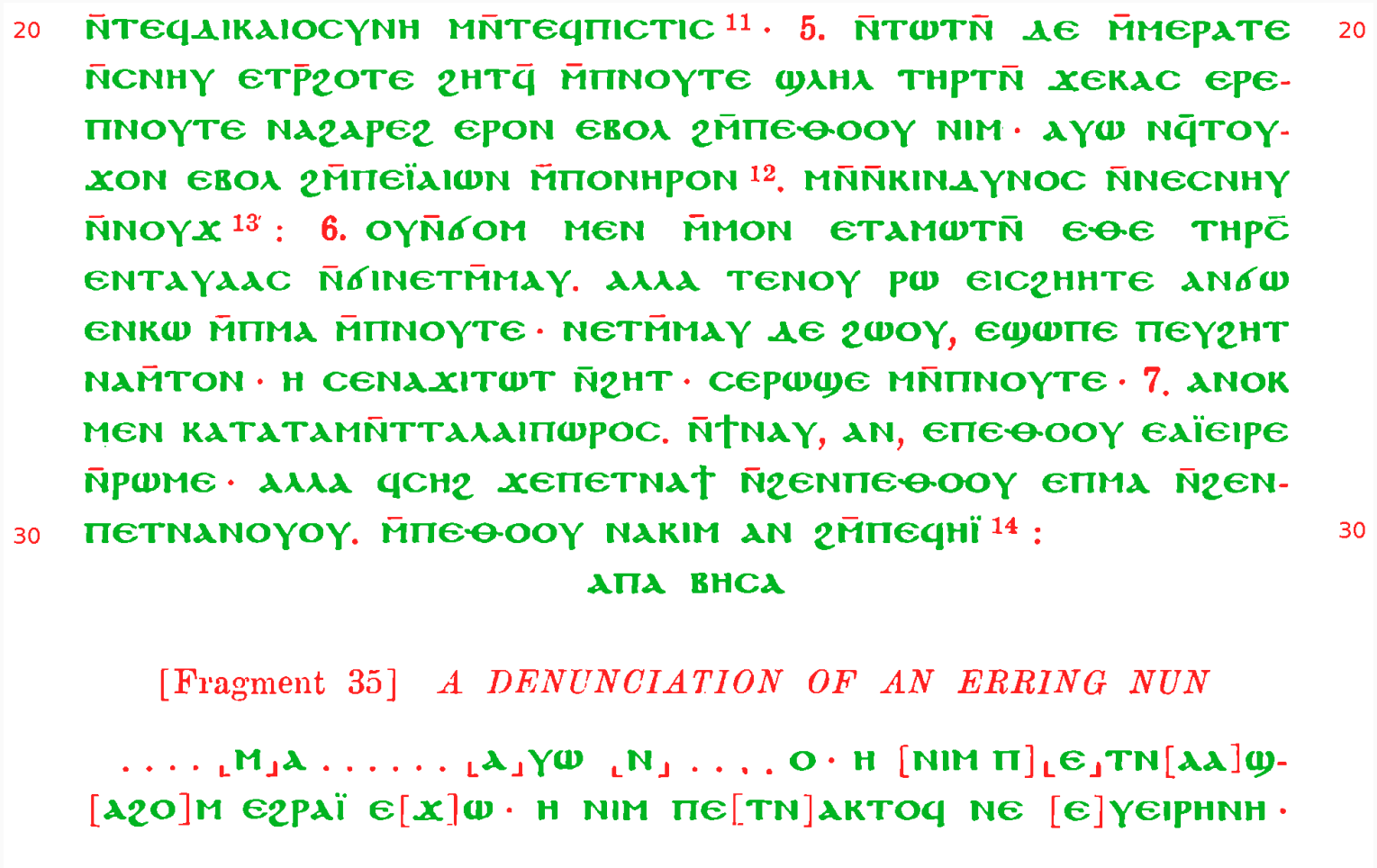
ⲗ . . . . . ⲁ ⲩⲱ ⲛ . . . . ⲟ · ⲏ [ⲛⲓⲙ ⲡ]ⲉⲧⲛ[ⲁⲁ]ⲱ-
ⲣⲁⲓ ⲉ[ⲭ]ⲱ · ⲏ ⲛⲓⲙ ⲡⲉ[ⲧⲛ]ⲁⲕⲧⲟϥ ⲛⲉ [ⲉ]ⲩⲉⲓⲣⲏⲛⲏ ·

- Might also not be included in a model

Previous work

- Coptic models created by Moheb for Tesseract (2013)
- Trained with several Coptic fonts, no non-Coptic letters support
- No support for diacritics
- Non-Coptic letters get replaced with similar Coptic letters

The good, the bad, and the problematic



20 ⲛ̄ⲧⲉϥⲇⲓⲕⲁⲓⲟⲥⲩⲛⲏ ⲙ̄ⲛ̄ⲧⲉϥⲡⲓⲥⲧⲓⲥ [11] · 5. ⲛ̄ⲧⲱⲧⲛ̄ ⲇⲉ ⲙ̄ⲙⲉⲣⲁⲧⲉ 20
ⲛ̄ⲥⲛⲏⲩ ⲉⲧⲣ̄ϩⲟⲧⲉ ϩⲛⲧⲫ̄ ⲙ̄ⲡⲛⲟⲩⲧⲉ ⲱⲗⲏⲗ ⲧⲏⲣⲧⲛ̄ ⲭⲉⲕⲁⲥ ⲉⲣⲉ-
ⲡⲛⲟⲩⲧⲉ ⲛⲁϩⲁⲣⲉϩ ⲉⲣⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲓⲙ · ⲁⲩⲱ ⲛⲫ̄ⲧⲟⲩ-
ⲭⲟⲛ ⲉⲃⲟⲗ ϩⲙ̄ⲡⲉⲓⲁⲓⲱⲛ ⲙ̄ⲡⲟⲛⲏⲣⲟⲛ [12]. ⲙ̄ⲛ̄ⲛ̄ⲕⲓⲛⲇⲩⲛⲟⲥ ⲛ̄ⲛⲉⲥⲛⲏⲩ
ⲛ̄ⲛⲟⲩⲭ [13] : 6. ⲟⲩⲛ̄ⲇⲟⲙ ⲙⲉⲛ ⲙ̄ⲙⲟⲛ ⲉⲧⲁⲙⲱⲧⲛ̄ ⲉⲑⲉ ⲧⲏⲣ̄
ⲉⲛⲧⲁⲩⲁⲁⲥ ⲛ̄ⲇⲓⲛⲉⲧⲙ̄ⲙⲁⲩ. ⲁⲗⲗⲁ ⲧⲉⲛⲟⲩ ⲣⲱ ⲉⲓⲥϩⲏⲧⲉ ⲁⲛⲇⲱ
ⲉⲛⲕⲱ ⲙ̄ⲡⲙⲁ ⲙ̄ⲡⲛⲟⲩⲧⲉ · ⲛⲉⲧⲙ̄ⲙⲁⲩ ⲇⲉ ϩⲱⲟⲩ, ⲉⲱⲱⲡⲉ ⲡⲉⲩϩⲏⲧ
ⲛⲁⲙ̄ⲧⲟⲛ · ⲏ ⲥⲉⲛⲁⲭⲓⲧⲱⲧ ⲛ̄ϩⲏⲧ · ⲥⲉⲣⲱⲱⲉ ⲙ̄ⲛ̄ⲡⲛⲟⲩⲧⲉ · 7. ⲁⲛⲟⲕ
ⲙⲉⲛ ⲕⲁⲧⲁⲧⲁⲙⲛ̄ⲧⲧⲁⲗⲁⲓⲡⲱⲣⲟⲥ. ⲛ̄ⲧⲛⲁⲩ, ⲁⲛ, ⲉⲡⲉⲑⲟⲟⲩ ⲉⲁⲓⲉⲓⲣⲉ
ⲛ̄ⲣⲱⲙⲉ · ⲁⲗⲗⲁ ⲫⲥϩ ϩⲉⲡⲉⲧⲛⲁ† ⲛ̄ϩⲉⲛⲡⲉⲑⲟⲟⲩ ⲉⲡⲙⲁ ⲛ̄ϩⲉⲛ-
30 ⲡⲉⲧⲛⲁⲛⲟⲩⲟⲩ. ⲙ̄ⲡⲉⲑⲟⲟⲩ ⲛⲁⲕⲓⲙ ⲁⲛ ϩⲙ̄ⲡⲉϥⲏⲓ [14] : 30

ⲁⲡⲁ ⲃⲏⲥⲁ

[Fragment 35] *A DENUNCIATION OF AN ERRING NUN*

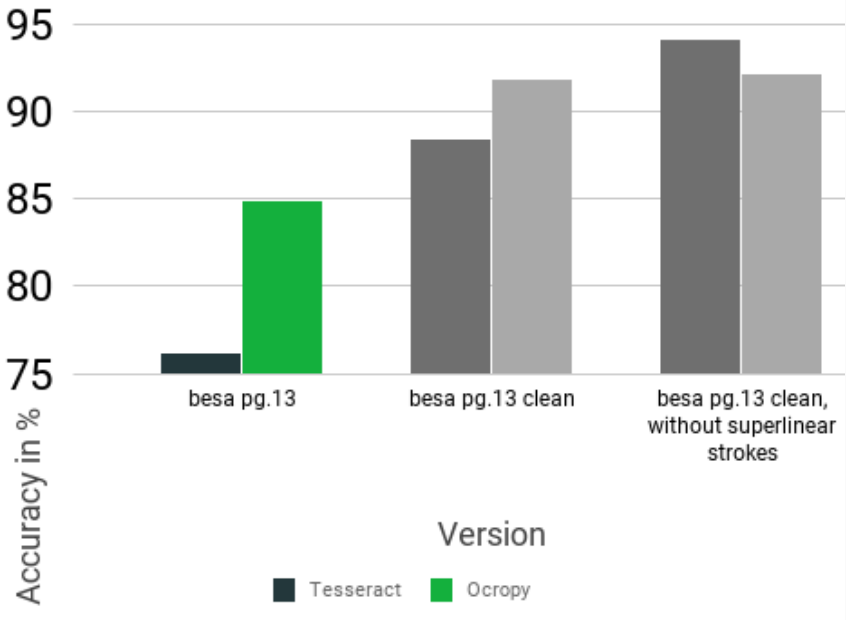
. . . . ⌞M⌟A . . . . . ⌞A⌟YW ⌞N⌟ . . . O · H [NIM P]⌞E⌟TN[AA]Ψ-
[AϩO]M ЄϩPAÏ Є[X]W · H NIM ПЄ[TN]AKTOϥ NЄ [Є]YЄIPHNH ·

- Even clean scans still contain noise

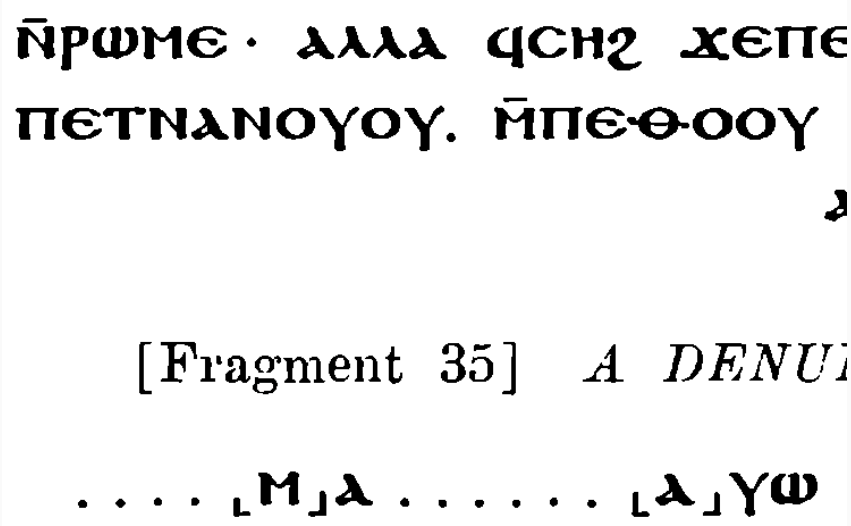
Results

Without line numbers

Accuracy



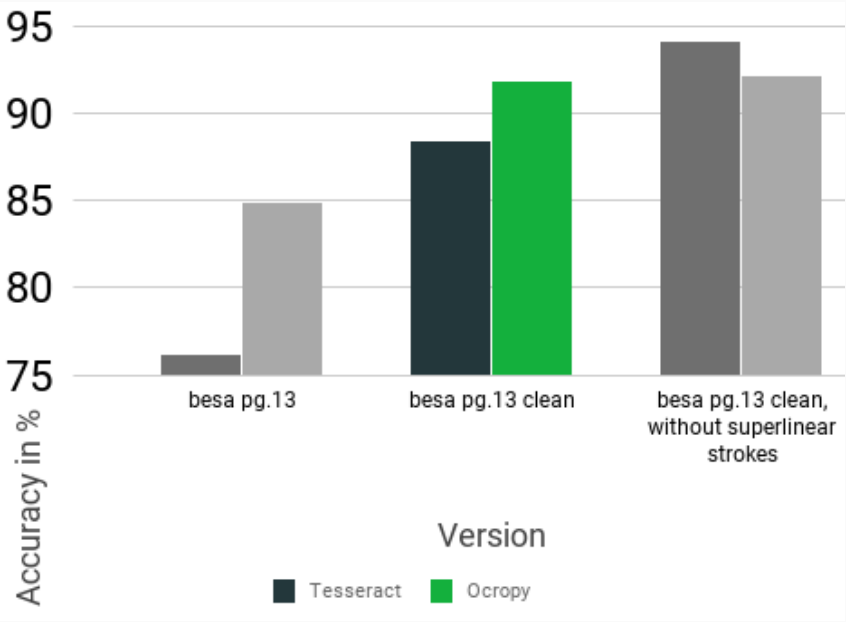
Input



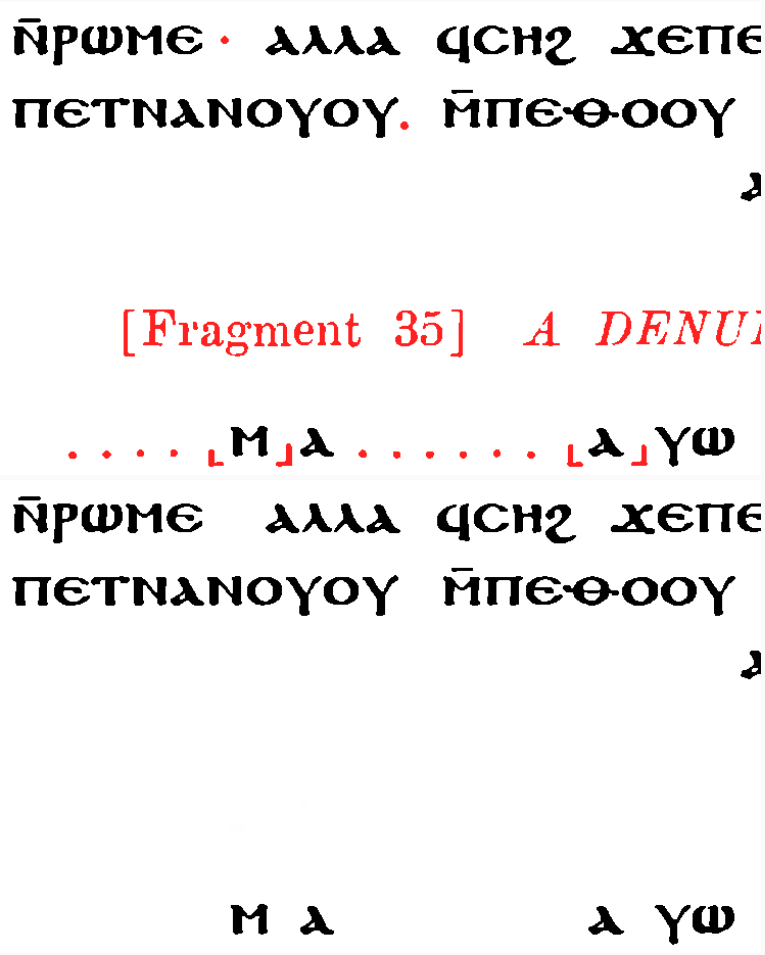
- Without time consuming pre-processing
- **Ocropy** model trained on 10 pages more accurate
- Non-multilingual **Tesseract** model less accurate

Without line numbers

Accuracy



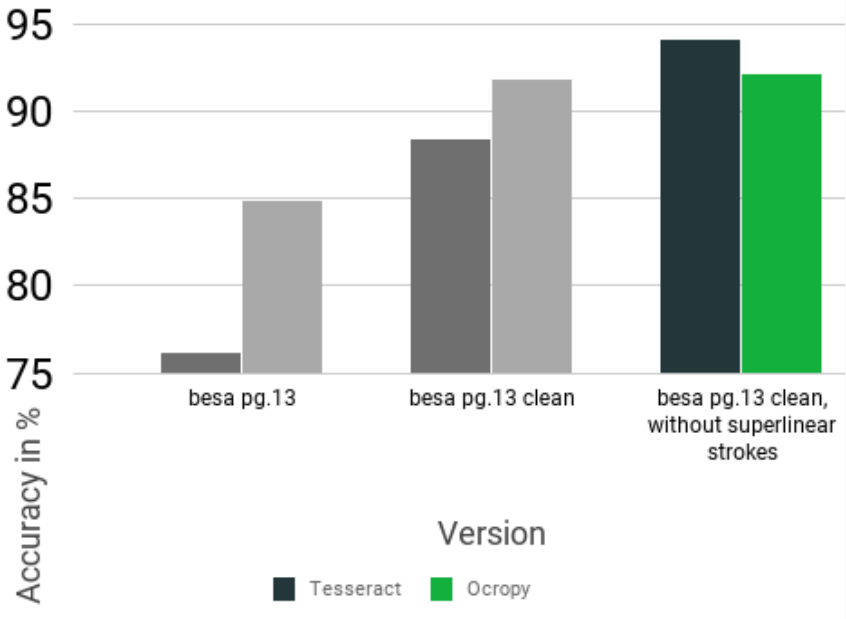
Input



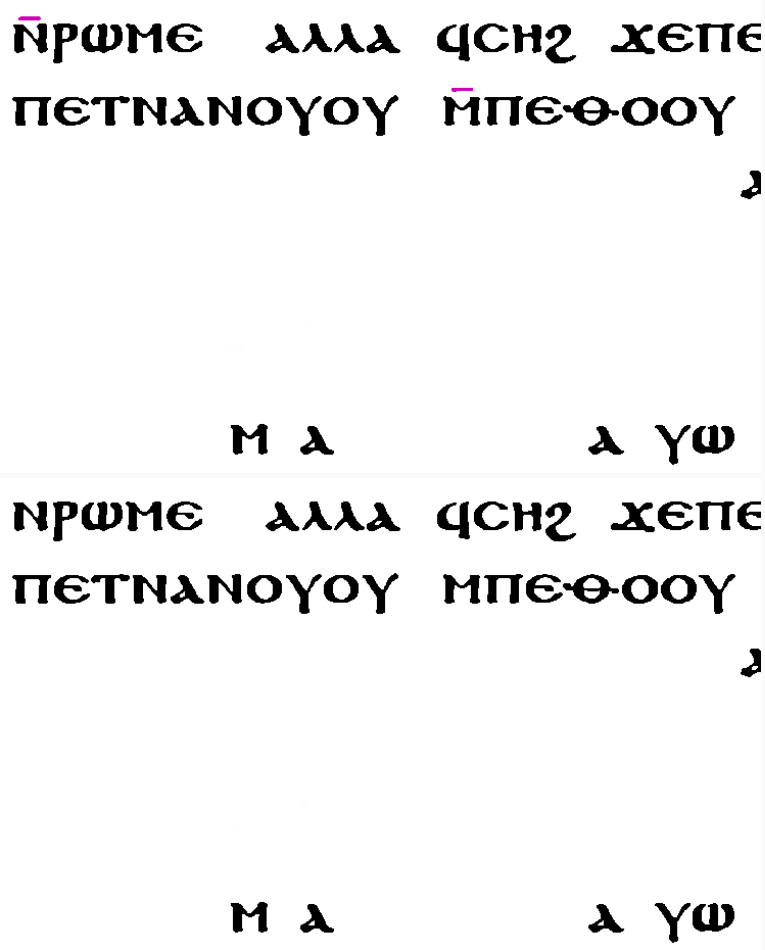
- Without non-Coptic letters
- Difference results mostly from diacritics

Without line numbers

Accuracy

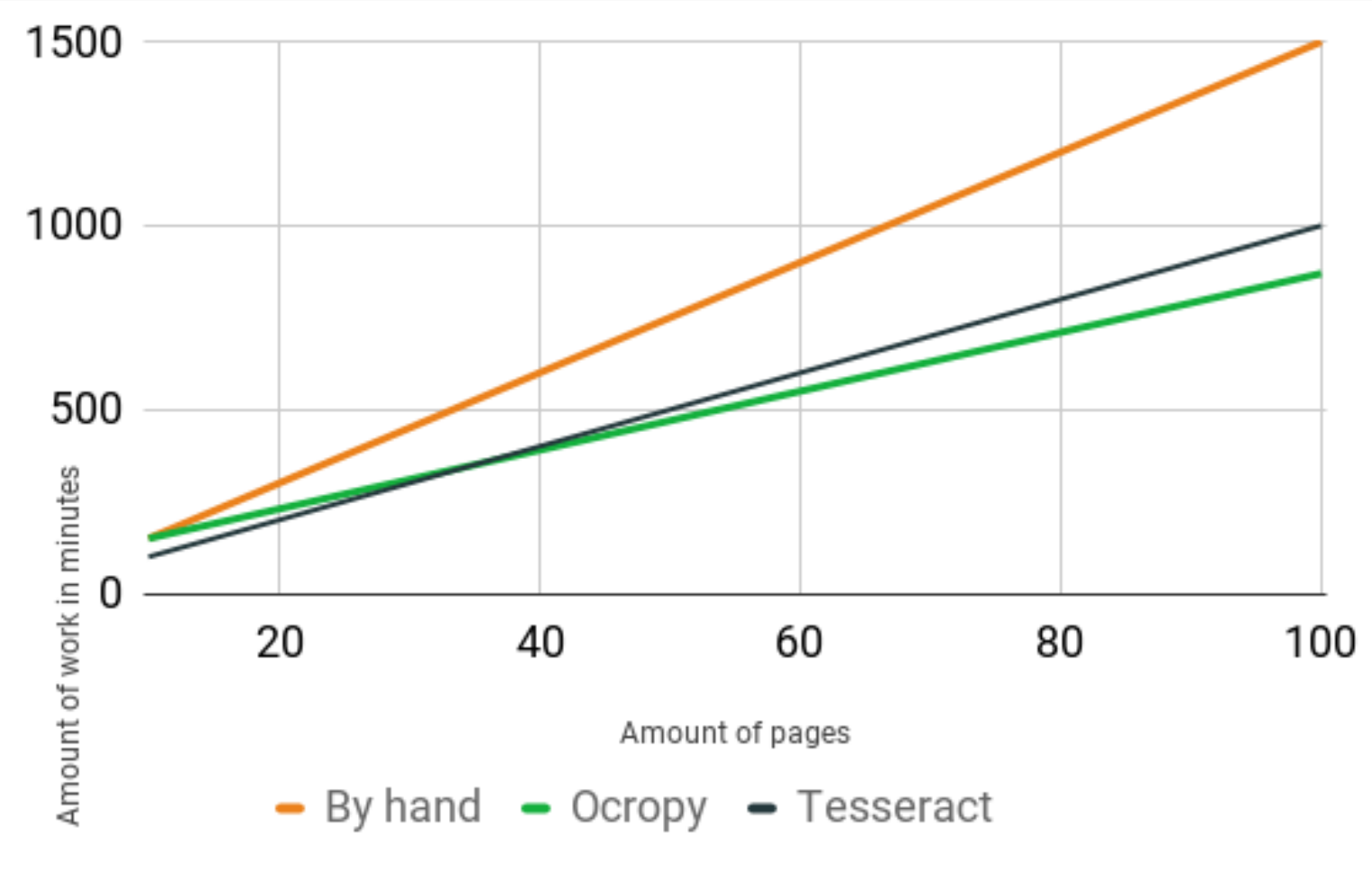


Input



- Diacritics removed
- Pure Coptic **Tesseract** model outperforms **Ocropys** mixed model

Workload comparison



- Utilising OCR decreases human workload

Roundup

- Utilisation of OCR beneficial for most clean documents
- **Tesseract** best for monolingual documents with limited fonts and font variations
- **Ocropy** best for large documents with multiple languages

Road ahead

- Approached by Google for collaboration on OCR for Coptic
- Create data set for Coptic OCR testing
- Transition from typeset to handwritten Coptic texts
- Combination of different models

Thank you.

Questions?

Get our Ocropy models at

Presentation

Kirill Bulert, So Miyagawa

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