AI-powered-Historical-Text-Transcription

Data+ HTR project

View On GitHub

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Data+ 2022: AI-powered Historical Text Transcription

Introduction

The Rubenstein Library holds millions of pages of handwritten documents ranging from ancient Papyri to records of Southern plantations to 21st century letters and diaries. Only a small subset of these documents have been digitized and made available online, and even fewer have been transcribed. The lack of text transcripts for handwritten documents impairs discovery and use of the materials, and prohibits any kind of computational text analysis that might support new avenues of research, including research related to the histories of racial injustice.

While Optical Character Recognition (OCR) technology has made it possible to derive machine-readable text from typewritten documents in an automated way for several decades, the work of transcribing handwritten documents remains largely manual and labor-intensive. In the last few years, however, platforms like Transkribus have sought to harness the power of machine-learning by using Handwriting Text Recognition (HTR) to extract text from manuscripts and other handwritten documents held in libraries and archives. To date, the Rubenstein Library has conducted a few small-scale HTR experiments with mixed (and mostly disappointing) results. We have a lot to learn about the viability of HTR for our collections and about how to incorporate HTR into our existing workflows.

In this Data+ project, students will test the viability of AI-powered HTR for transcribing digitized handwritten documents in the Rubenstein library and make recommendations for how the library might incorporate HTR into existing workflows, projects, and interfaces. Source material will be drawn from the Duke Digital Collections and will initially focus on a subset of digitized 19th-20th century women's travel diaries, but could also include yet-to-be digitized materials related to the early history of Duke such as sermons, diaries, and lecture notes of our institution's first president, Braxton Craven. As we approach Duke's centennial, HTR-generated transcripts of the Craven materials would help support the university's ongoing investigation into its institutional connection to slavery.

Machine-Learning Pipelines

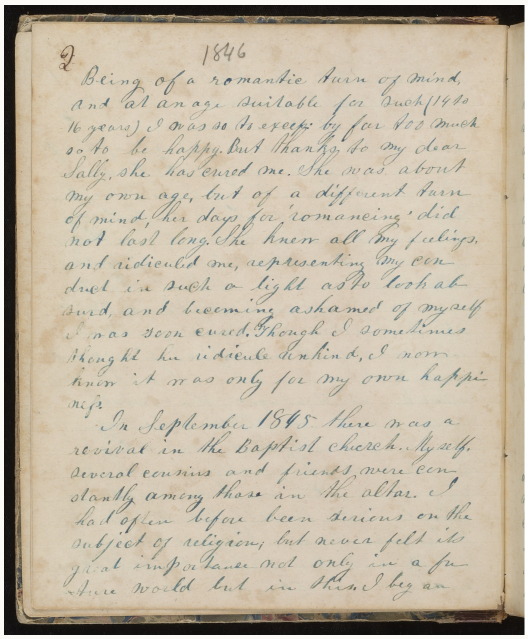
Sample Workflow:

```
graph TD;
    A[Pre-processing]-->B[OCR Engine];
    B-->C[Correction Algorithm];
    C-->D[Evaluation];
    D-->|reselection| B;
    D-->|Accuracy meets the standard| E[Model checkpoint];
```

Pre-processing

```
flowchart LR;
    A[greyscale]-->B[Background removal];
    B-->C[threshold];
```

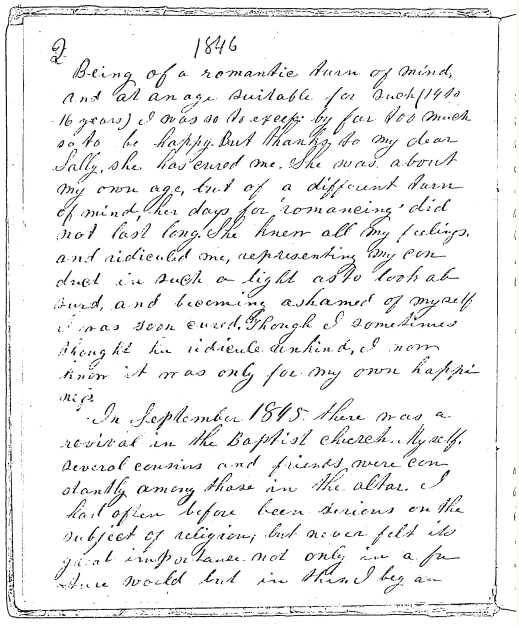
```
def get_greyscale(image):
    return cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

def remove_noise(image):
    return cv2.bilateralFilter(image, 5, 75, 75)

def thresholding(image):
    return cv2.adaptiveThreshold(image, 255, cv2.ADAPTIVE_THRESH_GAUSSIAN_C, cv2.THRESH_BINARY, 1
 9)
```



2 1846

Being of a romantic turn of mind, and at an age suitable for such (14 to 16 years) I was so as exceedingly fond much so as to be happy. But thanks be to my dear Sally, she has cured me. She was about my own age, but of a different turn of mind, her days for 'romancing' did not last long. She knew all my failings, and ridiculed me, representing my conduct in such a light as to look absurd, and becoming ashamed of myself I was soon cured. Though I sometimes thought her ridiculously unkind, I now know it was only for my own happiness.

In September 1845 there was a revival in the Baptist church. Myself, several cousins and friends were constantly among those in the altar. I had often before been serious on the subject of religion, but never felt its great importance not only in a future world but in this. I beg an



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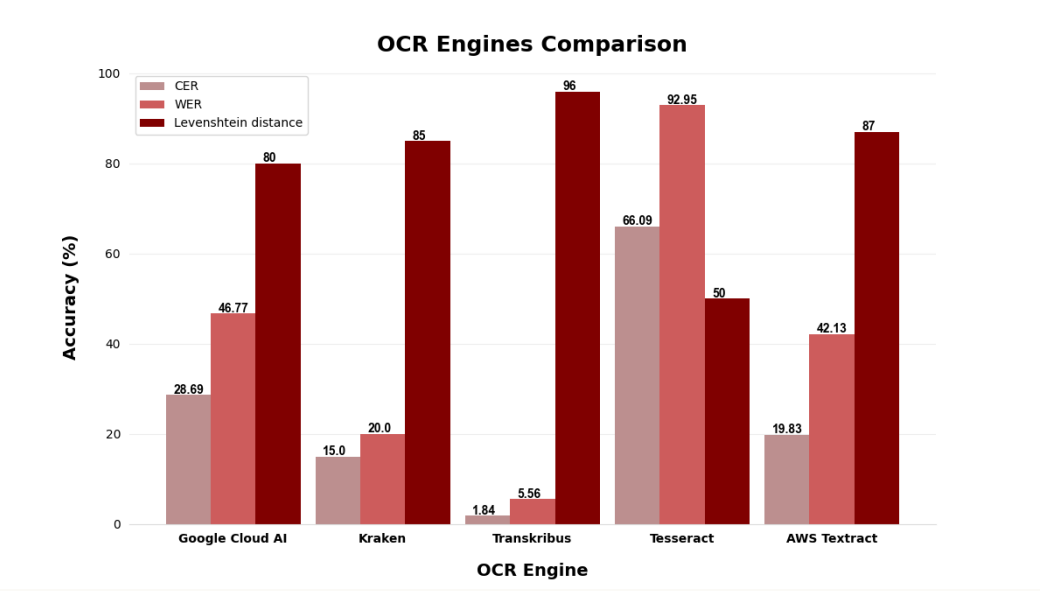
Symspell Algorithm

```
flowchart LR;
    A[Transcription Result]-->B[Rectified Result];
    B-->|Compare CER/WER/Levenshtein distance| C[Ground Truth];
```

```
sym_spell = SymSpell(max_dictionary_edit_distance=2, prefix_length=7)
dictionary_path = pkg_resources.resource_filename(
    "symspellpy", "frequency_dictionary_en_82_765.txt"
)
bigram_path = pkg_resources.resource_filename(
    "symspellpy", "frequency_bigramdictionary_en_243_342.txt"
)
# term_index is the column of the term and count_index is the
# column of the term frequency
sym_spell.load_dictionary(dictionary_path, term_index=0, count_index=1)
sym_spell.load_bigram_dictionary(bigram_path, term_index=0, count_index=2)

# lookup suggestions for multi-word input strings (supports compound
# splitting & merging)
file = open(r"")
content = file.read()

# max edit distance per lookup (per single word, not per whole input string)
suggestions = sym_spell.lookup_compound(content, max_edit_distance=2, transfer_casing=True)

result_after = ""
# display suggestion term, edit distance, and term frequency
for suggestion in suggestions:
    result_after += suggestion.term
```

```
Example:

Can yu readthis messa ge despite thehori    can you read this message despite the ho
ble sppelingmsitakes                        rrible spelling mistakes
```

Five Available OCR Engine



Transkribus

Introducton

Transkribus is a comprehensive platform for the digitisation, AI-powered text recognition, transcription and searching of historical documents – from any place, any time, and in any language. Visit the official Transkribus website here.

Strength

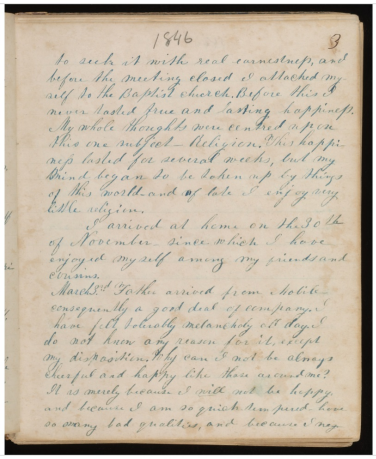
- extremely high accuracy in cursive hand written text recognition
- commercial product with mature software available

Weakness

- Low generalizability
- Not open-sourced, not replicable

DataSet & Accuracy

Training Set	Jeremy Bentham Project
Testing Set	Women Traveling Diaries
Accuracy w/ symspell algorithm	CER: 1.84, WER: 5.56, Levenshtein distance: 96 1
Accuracy w symspell algorithm	CER: 7.88, WER: 12.74, Levenshtein distance: 92



1846
3
to seek it with real earnestness, and
before the meeting closed I attached my-
self to the Baptist church. Before this I
never lasted frue and lasting happiness.
My whole thoughts were centred upon
this one subject Religion. This happi-
nes lasted for several weeks but my
Mind began to be token up by things
of this world and of late I enjoy very
little religion.
I arrived at home on the 30th
of November- since which I have

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Tesseract

Introducton

Tesseract was originally developed at Hewlett-Packard Laboratories Bristol and at Hewlett-Packard Co, Greeley Colorado between 1985 and 1994, with some more changes made in 1996 to port to Windows, and some C++izing in 1998. In 2005 Tesseract was open sourced by HP. From 2006 until November 2018 it was developed by Google. Visit Tesseract repository here.

Strength

- Extremely high accuracy in recognizing a majority of printed fonts
- Various line segmentation & Recognition mode
- High Generalizability
- Tesseract comes with a python wrapper class called Pytesseract

- Support training

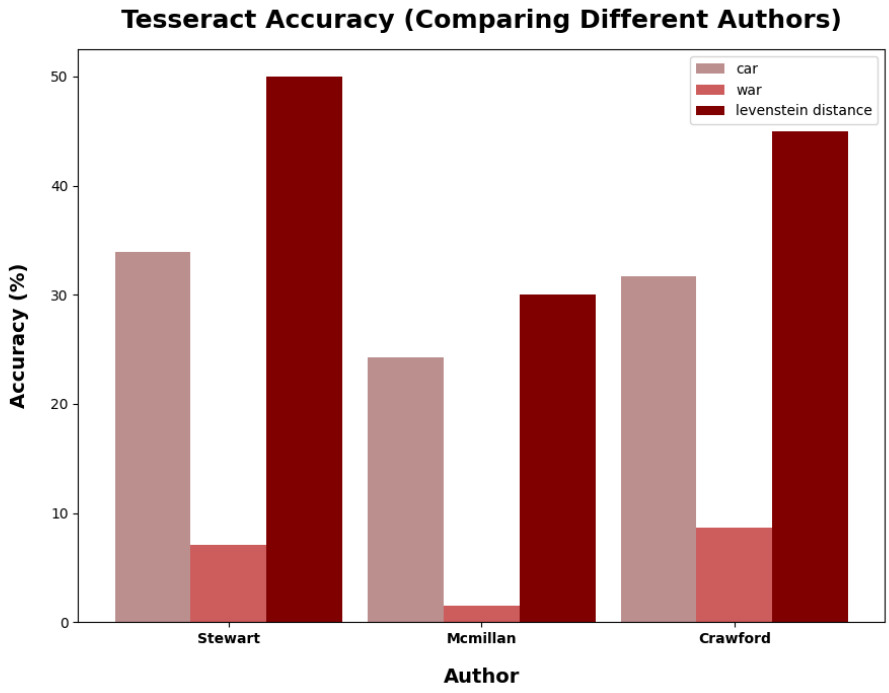
Weakness

- extremely tenuous training process (using shell scripts), nearly inable to train
- training is based on lines (segemented files paired up with ground-truth)
- Inable to recognize cursive fonts, accuracy changes correspondent with cursiveness.
- Low accuracy in transcribing vowels, especially a & e

DataSet & Accuracy

Training Set	tessdata_fast & tessdata_best
Testing Set	Women Traveling Diaries

Font type	Author	Accuracy
Non-cursive	N/A	> 95%, around 96% - 97% accuracy in both characters and words 2
Cursive	Crawford, Martha	CER: 68.28, WER: 91.38, Levenshtein distance: 45
Cursive	McMillan, Mary	CER: 75.74, WER: 98.44, Levenshtein distance: 30(nearly unrecognizable)
Cursive	Harriet, Sanderson	CER: 66.09, WER: 92.95, Levenshtein distance: 50



Kraken

Introducton

kraken is a turn-key OCR system optimized for historical and non-Latin script material.kraken's main features are: Fully trainable

layout analysis and character recognition; Right-to-Left, BiDi, and Top-to-Bottom script support; ALTO, PageXML, abbyXML, and hOCR output; Word bounding boxes and character cuts; Multi-script recognition support; Public repository of model files; Lightweight model files; Variable recognition network architectures. Visit the official Kraken website here.

DataSet & Accuracy

Training Set	IAM Handwriting Database
Testing Set	Women traveling diaries / IAM database
Accuracy w/ symspell algorithm	111
Accuracy w symspell algorithm	122

Strength

- Easily Trainable 3, training is based on pages
- Modular design, usable line segmentation tools

Weakness

- Lack maintenance
- require MacOS/linux operating system
- Long training period

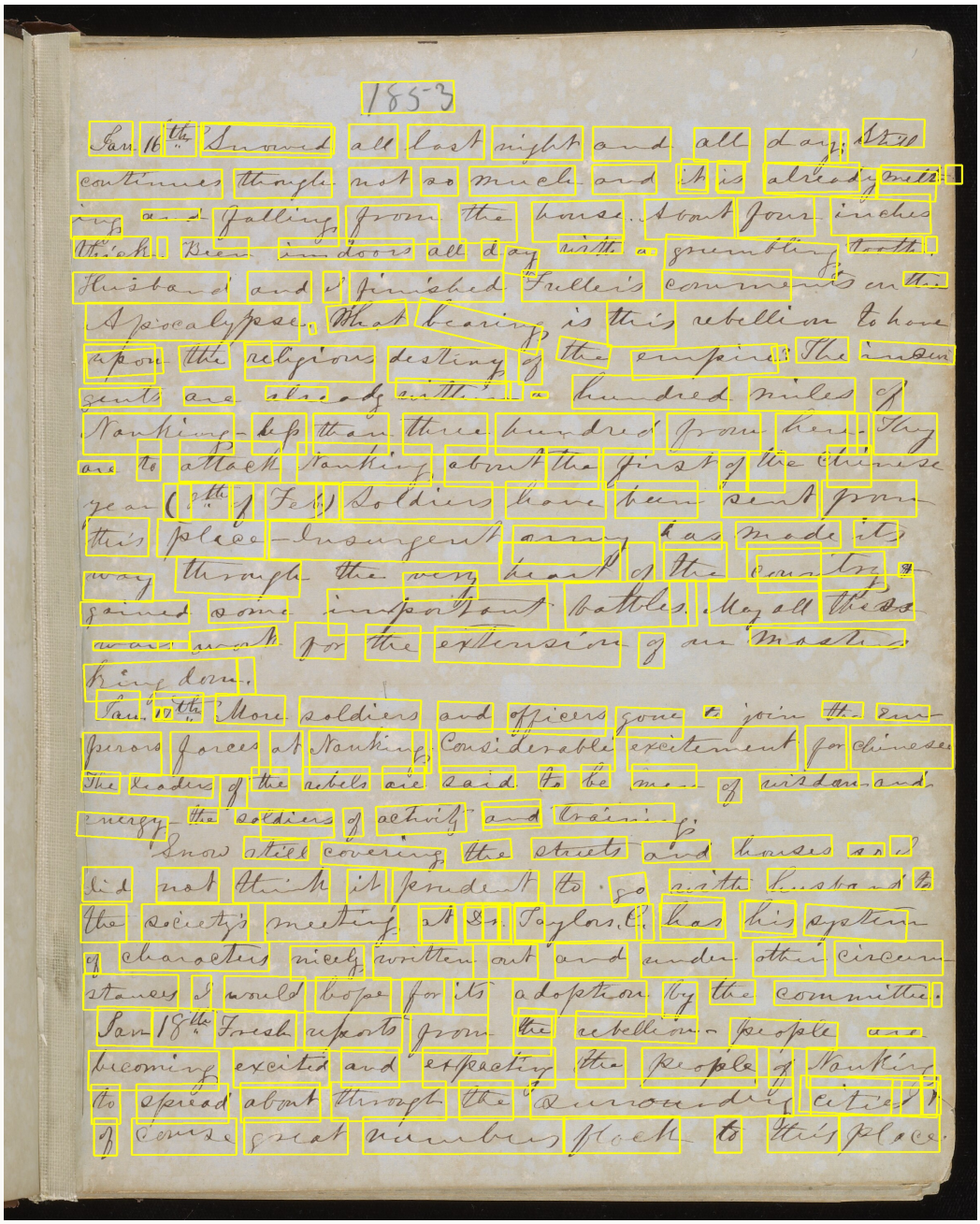
Google Cloud Vision OCR

Introducton

Data & Accuracy

Training Set	N/A
Testing Set	Women traveling diaries
Accuracy w/ symspell algorithm	CER: 28.69, WER: 46.77, Levenshtein distance: 80
Accuracy w symspell algorithm	CER: 31.43, WER: 49.45, Levenshtein distance: 78

Particular Strength:



AWS Textract

Introduction

Amazon Textract is based on the same proven, highly scalable, deep-learning technology that was developed by Amazon's computer vision scientists to analyze billions of images and videos daily. You don't need any machine learning expertise to use it. Amazon Textract includes simple, easy-to-use APIs that can analyze image files and PDF files. Amazon Textract is always learning from new data, and Amazon is continually adding new features to the service.

Data & Accuracy

Training Set	N/A
Testing Set	Women traveling diaries
Accuracy w symspell algorithm	CER: 19.83, WER: 42.13, Levenshtein distance: 87

Future Direction

1. Retrain Kraken/Tesseract using different dataset or using labeled women traveling diaries
2. Explore the viability of developing generalizable HTR models for genres of handwritten documents in the Rubenstein (e.g. 19th century diaries from the same hand vs. 20th century business correspondence from different hands).
3. Better self-designed post OCR correction algorithm
4. Further computational analysis and visualization of HTR-generated text using NLP or other text-mining techniques or methods.

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1. The current lowest CER produced by the general HTR tool (support more than cursive handwriting) in the industry is around 2.75%. ↩

2. The data is released by the official tesseract UNLV testing site. More specific information can be found here ↩

3. The training Set of all the OCR Engines require highly consistent and legible hand-written documents, which can provide high quality ground-truth files. Joined-up writing documents are relatively harder to train. ↩
