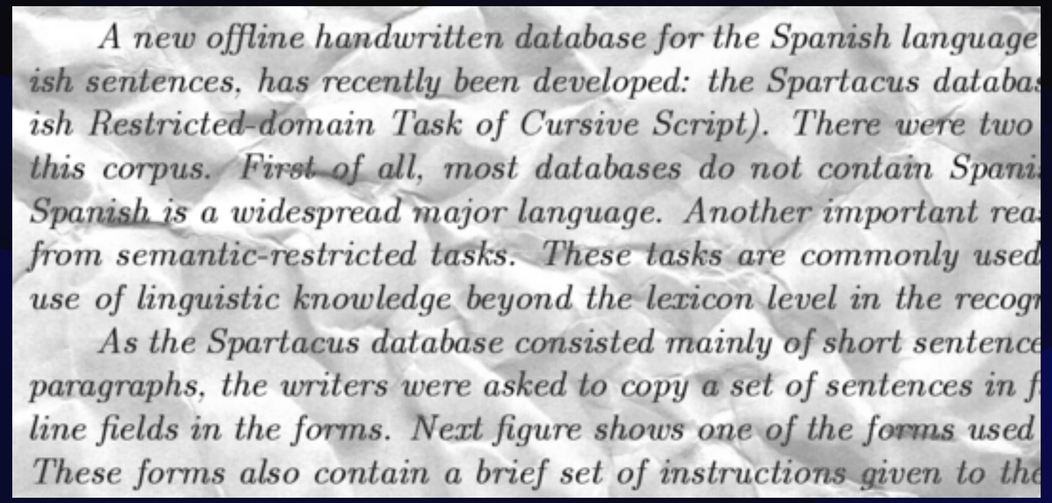
Text Document Enhancer

CSC 474 Project



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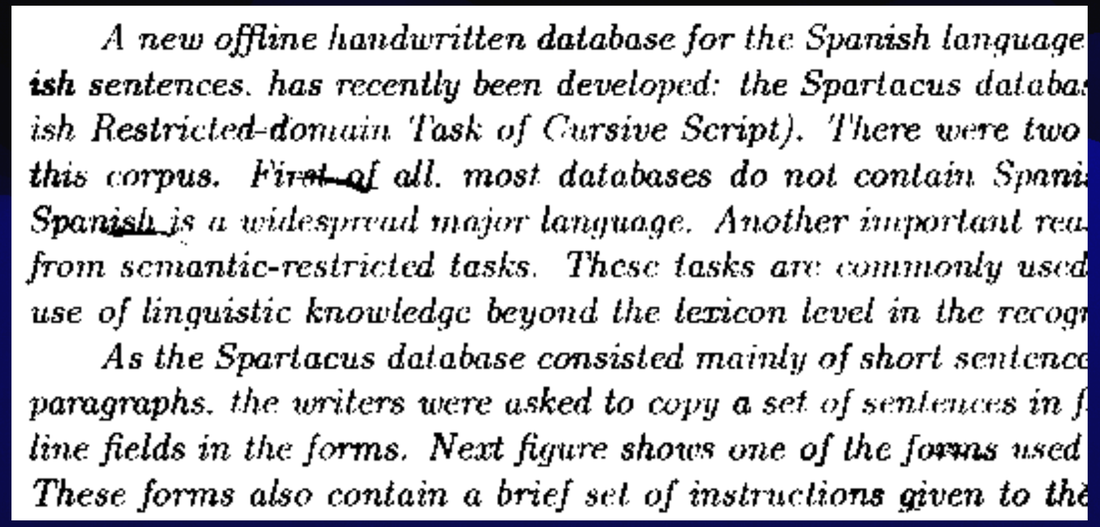
These forms also contain a brief set of instructions given to the

(Espaa-Boquera, Pastor-Pellicer, Castro-Bleda, & Zamora-Martinez, 2015)



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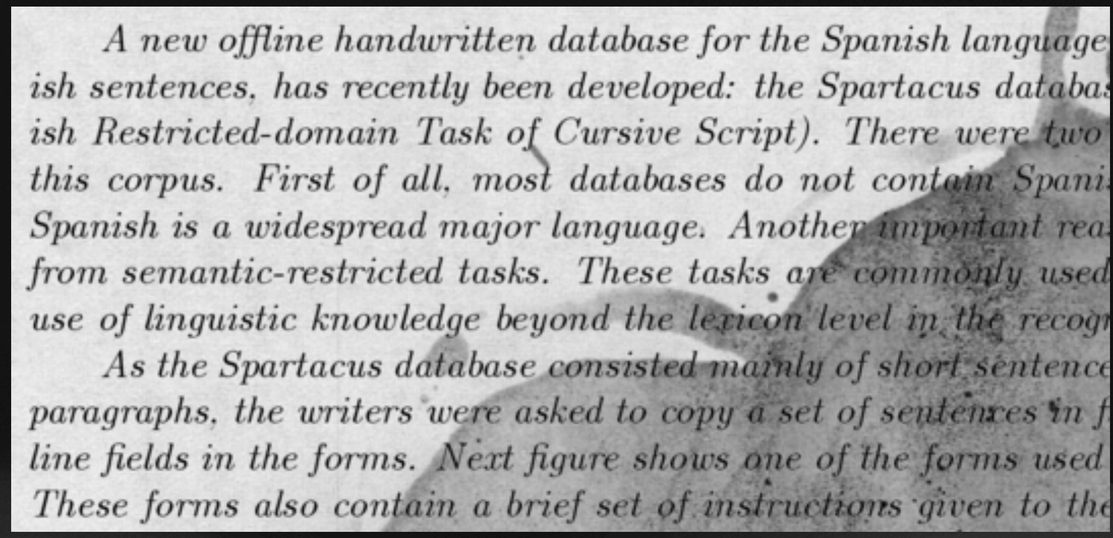
Project and Presentation Created by: Justyce Countryman

May 7, 2024

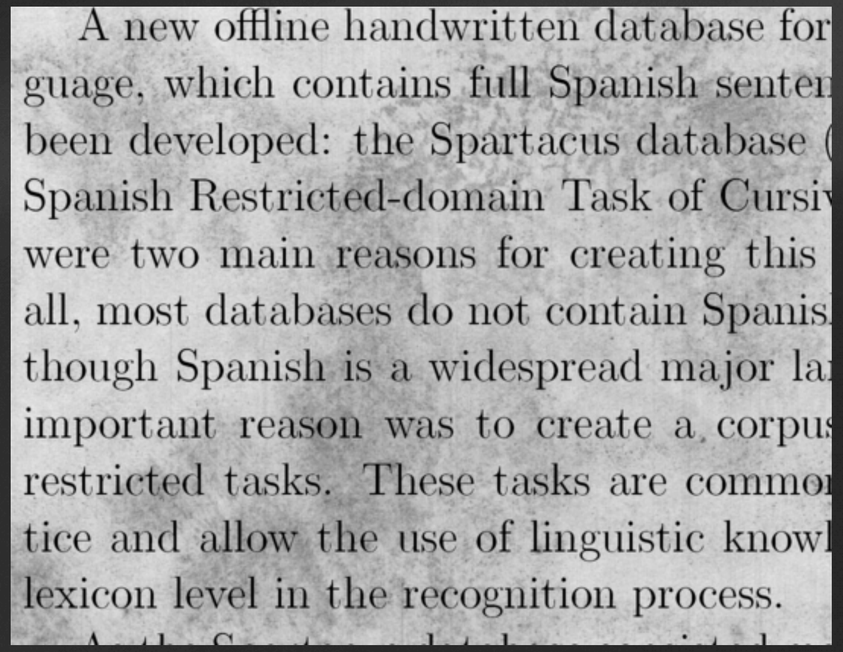
Project Vision & Purpose

- Text documents may consist of a noisy background that are difficult for computers and people to interpret.
- Need to consider noise variants commonly found in text documents.
- Reducing text document noise would greatly assist with:
  - Restoring old, distorted, and/or historical documents.
  - Increasing text visibility, which is especially advantageous for visually impaired individuals.
  - Useful for researching ideal image preprocessing techniques for all kinds of noise.



A .png text document file consisting of a coffee-stain like noise.

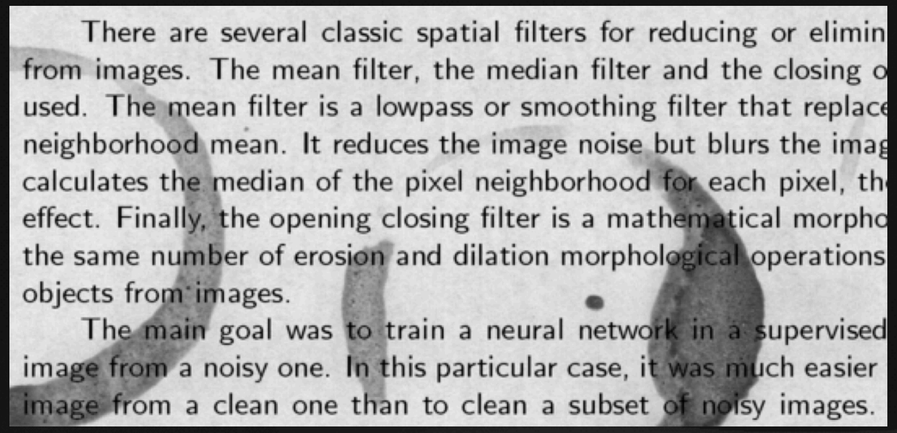
(Espaa-Boquera, Pastor-Pellicer, Castro-Bleda, & Zamora-Martinez, 2015)



A .png text document file consisting of an eraser-mark like noise.

(Espaa-Boquera, Pastor-Pellicer, Castro-Bleda, & Zamora-Martinez, 2015)

(1)



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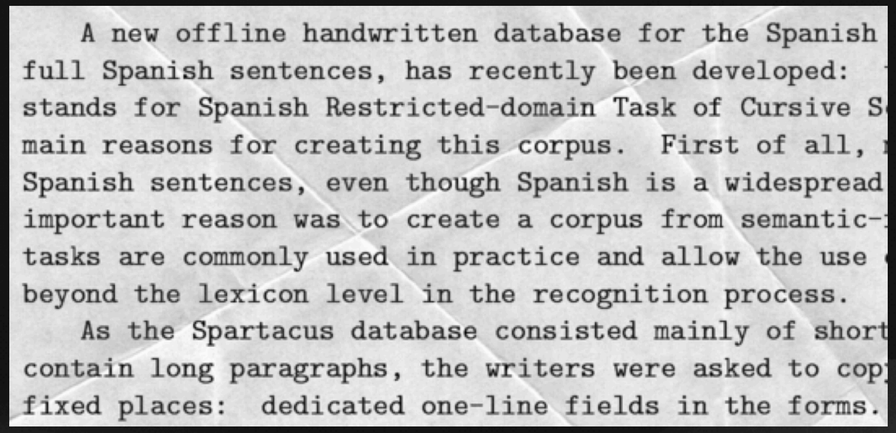
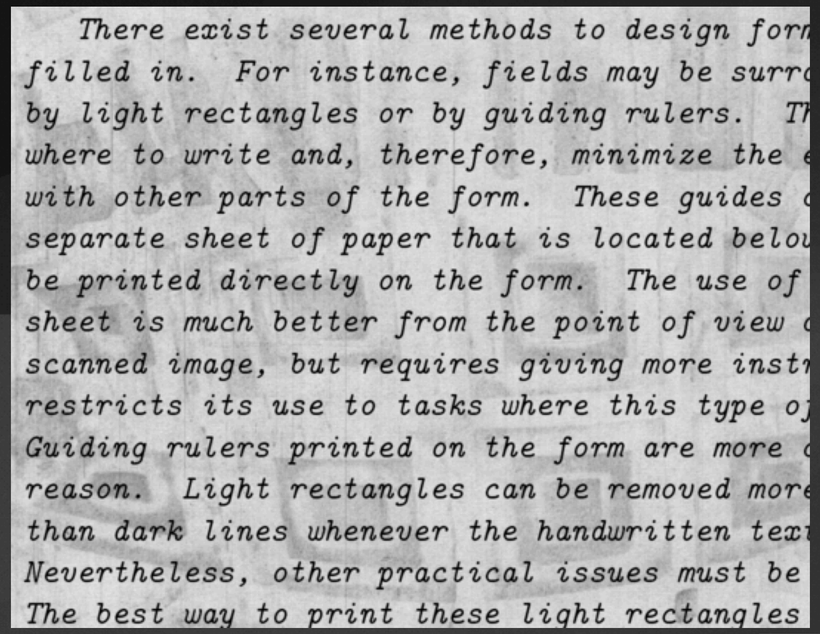


(3)



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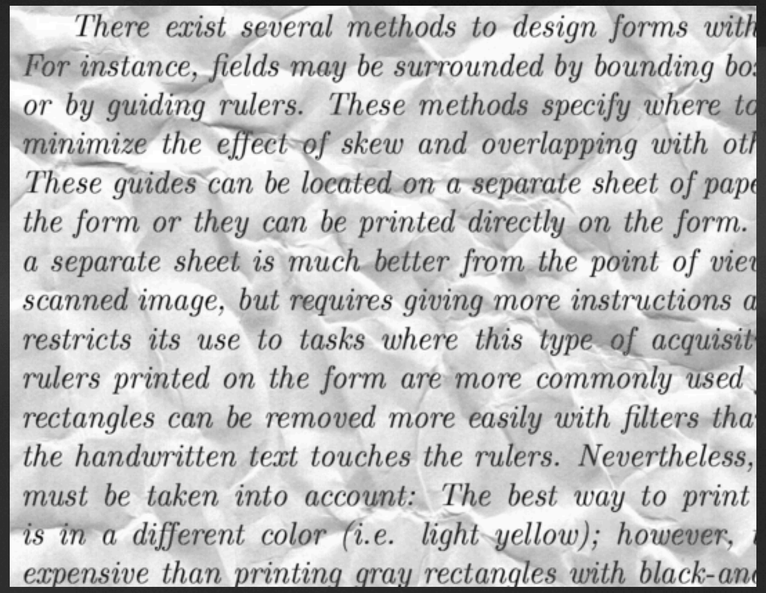

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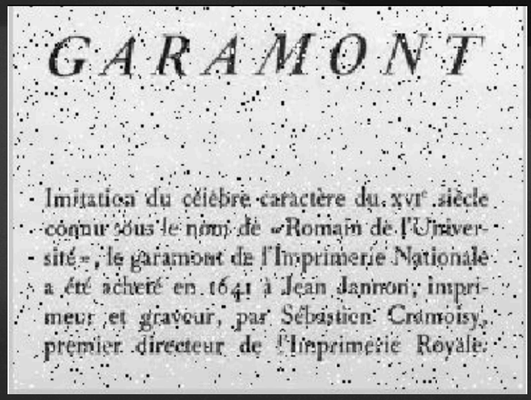


Noise Legend:

(1): Coffee-stained (2): Folded (3): Eraser-marked (4): Crumpled-up (5): Salt-and-pepper

(1), (2), (3), and (4): (Espaa-Boquera, Pastor-Pellicer, Castro-Bleda, & Zamora-Martinez, 2015)
(5): (Balamurugan, Sengottuvelan, & Sangeetha, 2013)

General Project Algorithm

While the user has not quit the program:

1: The user selects one of the subprograms.

While the user has not quit the subprogram:

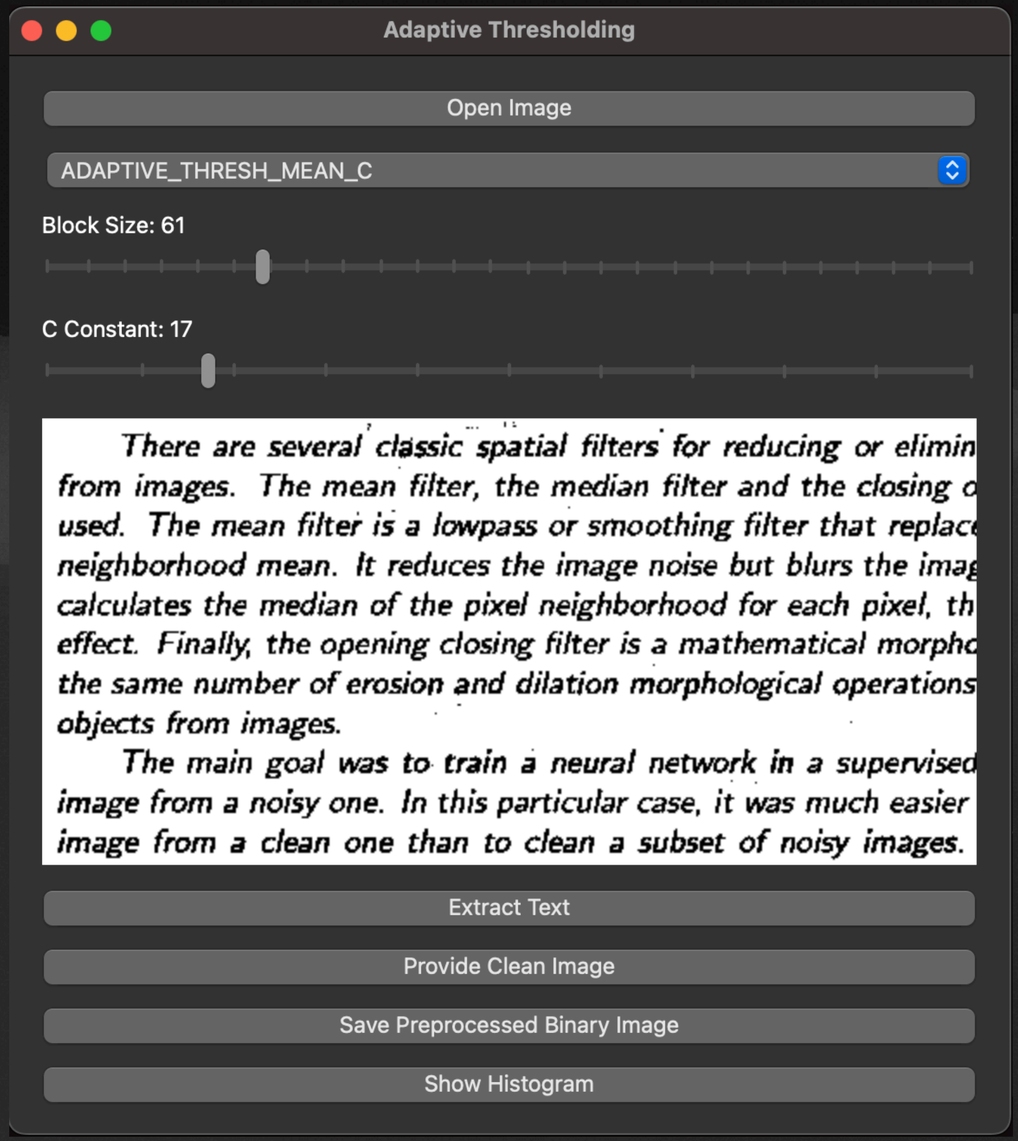
2: The user provides an image (preferably a text document).

3: The grayscale version of the image is then calculated.

4: Allow the user to change relevant parameters for the chosen subprogram, if any.

5: When requested by the user, perform the desired preprocessing operation, or a variant of the method if necessary, on the grayscale image with OpenCV, which will then be converted into a binary image to display to the user.

6: Dynamically update the displayed image based on changes to the parameters.



Text Extraction Accuracy Algorithm

Levenshtein Distance

1: Extract the text from the noisy and clean images.

2: Initialize a matrix with (number of words from the noisy image + 1) rows and (number of words from the clean image + 1) columns.

For each word in the noisy image:

    For each word in the clean image:

        If on the first row or the first column:

            3: Set the base distances that indicate the cost to get from a empty string to the current string.

        Otherwise, if the current noisy word is the same as the clean word:

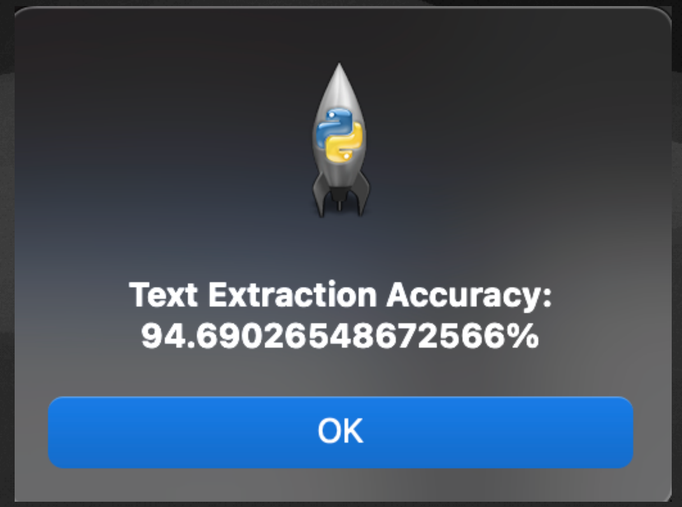
            4: Keep the distance the same.

        Otherwise:

            5: Check the distance for previously calculated neighbors and find the smallest distance + 1.

6: Set accuracy for the noisy image as ((max_distance - calculated_distance) / max_distance) * 100)

    max_distance: The length of the extracted text string from either the noisy or clean image, whichever is longer.
    calculated_distance: The cost calculated by the algorithm, which is found in the last row and column of the matrix.



“Get Best Image” Algorithm

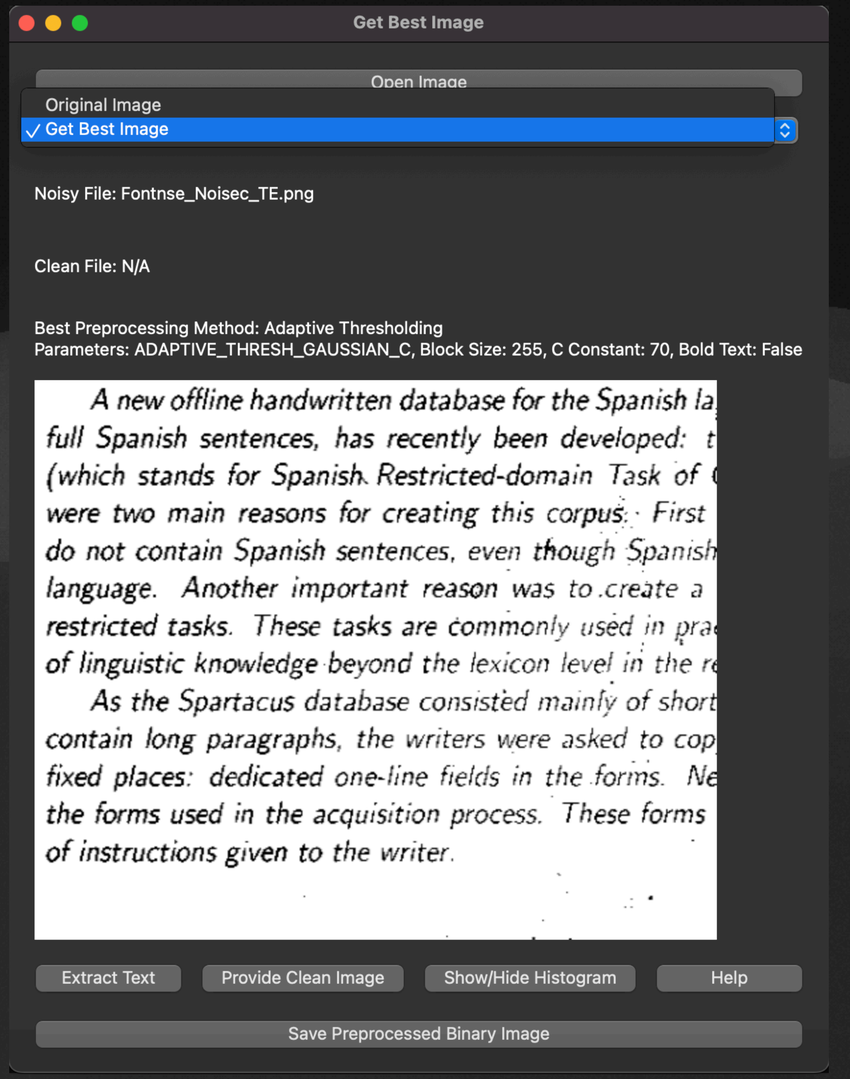
While the user has not quit the “Get Best Image” subprogram:

1: The user provides an image (preferably a text document).

2: The grayscale version of the image is then calculated.

3: When the user wants to begin the preprocessing, send the grayscale image through several effective preprocessing methods that are the most likely to reduce background noise from the image.

4: Display the binary image that Tesseract believes is the most recognizable, not essentially the cleanest image.



Required Algorithm Adjustments for Implementation

- General Purpose
  - Limitations are set on which preprocessing parameters are user-adjustable, as well as what values they can be.
    - Example: Only odd kernel sizes allowed in adaptive thresholding, median filtering, and Gaussian blur.
- Text Extraction Accuracy
  - No changes required.
- “Get Best Image”
  - Only considers preprocessed images where its text string length is at least 90% of that of the original noisy text string.
    - The loss of text was occasionally preventing the project from achieving its intended purpose.
  - The effective (and tested) preprocessing methods used for this subprogram are Otsu’s, binary, and adaptive thresholding, as well as median filtering.

Additional Features

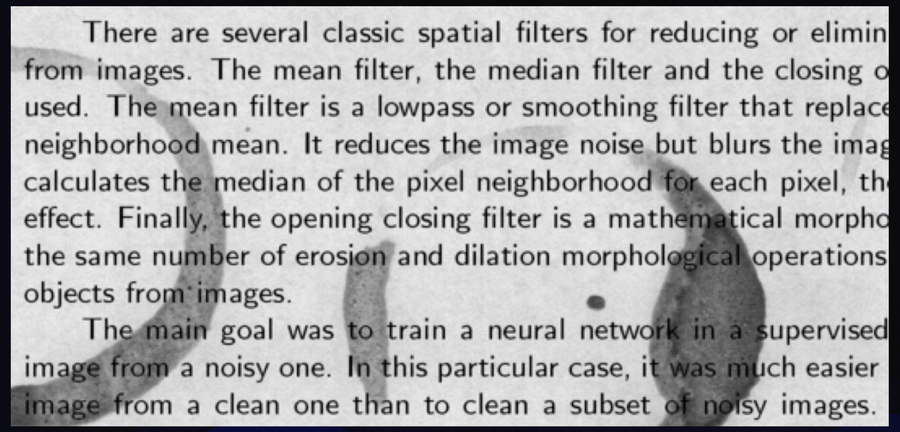
- In each of the subprograms, the user may also:
  - Save a preprocessed binary image.
  - Extract text with Tesseract.
  - Provide a clean version of the noisy image.
    - A text extraction accuracy can then be calculated between the noisy and clean text strings.
    - The “Get Best Image” subprogram will then rely on text extraction accuracies instead of Tesseract’s word confidence percentages.
  - Obtain and save the histogram for the current noisy image, whether preprocessed or not.
  - Bold the text of the current noisy image (Performs foreground dilation with a 2x2 matrix).
    - Not available in the “Get Best Image” subprogram.
  - If Otsu’s thresholding is selected, provide two directories, one clean and one noisy, and then retrieve a bulk text extraction accuracy.
  - Request help about when and how to use the subprogram.

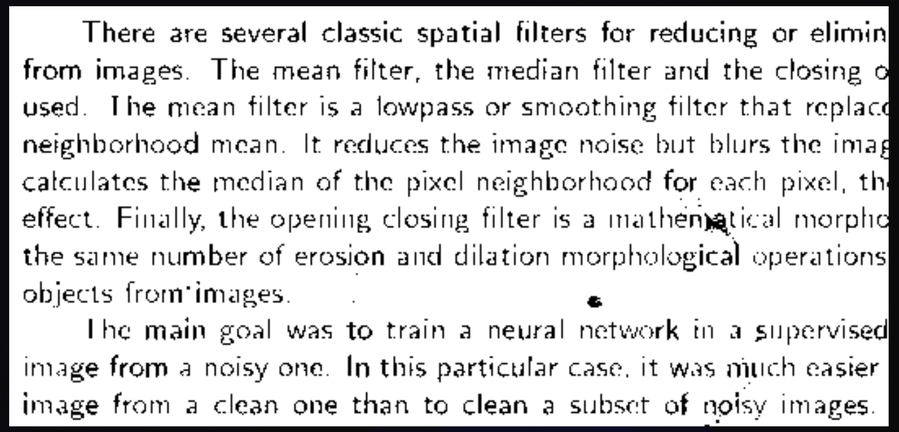
Error Handling & Quality Assurance

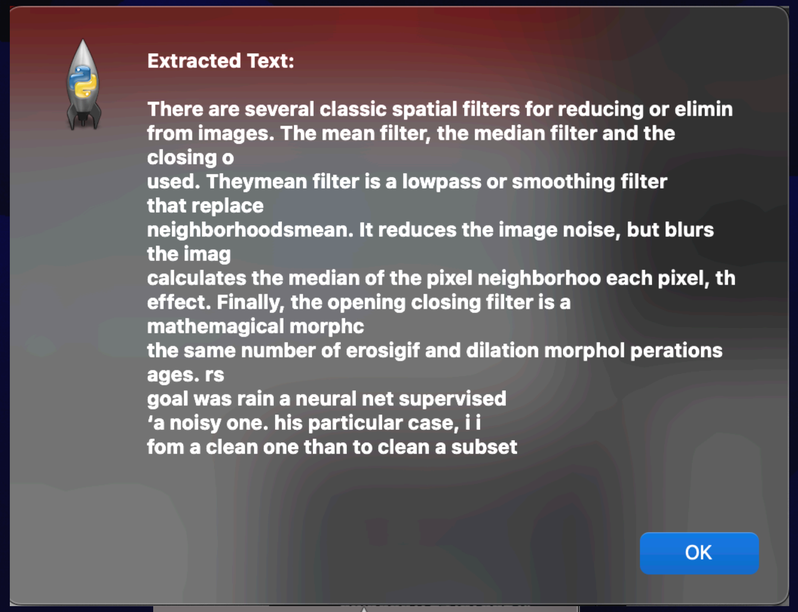
- Only OpenCV compatible formats allowed (.png, .tiff, .jpeg, .jpg, and .bmp).
- In the “Get Best Image” subprogram, the supplied image must have extractable text.
- GUI is dynamically updated with respect to the displayed images.
- Images that are too large are compressed to a size that allows for GUI reachability.
    - All preprocessing and calculations are done with the original image dimensions.

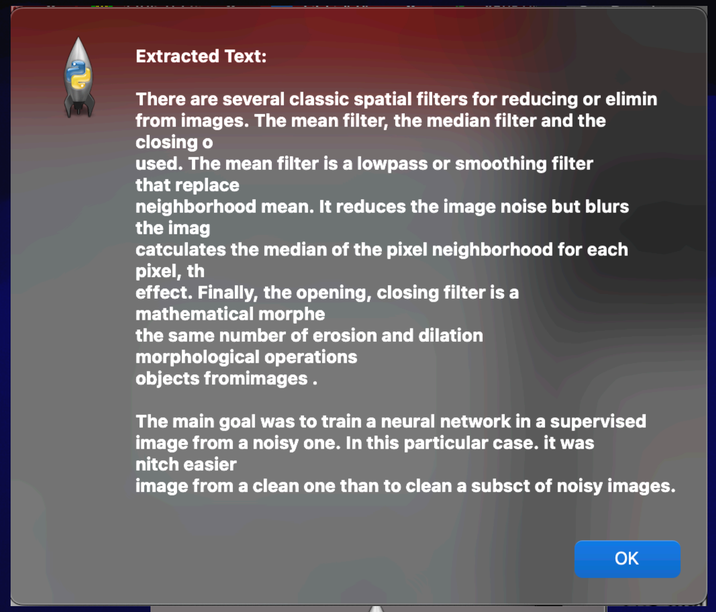
Project Performance!

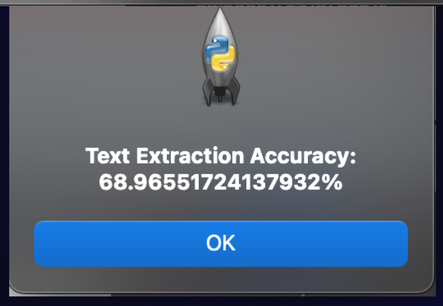
(1): Coffee-stained

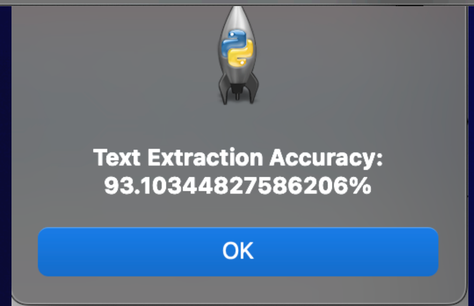




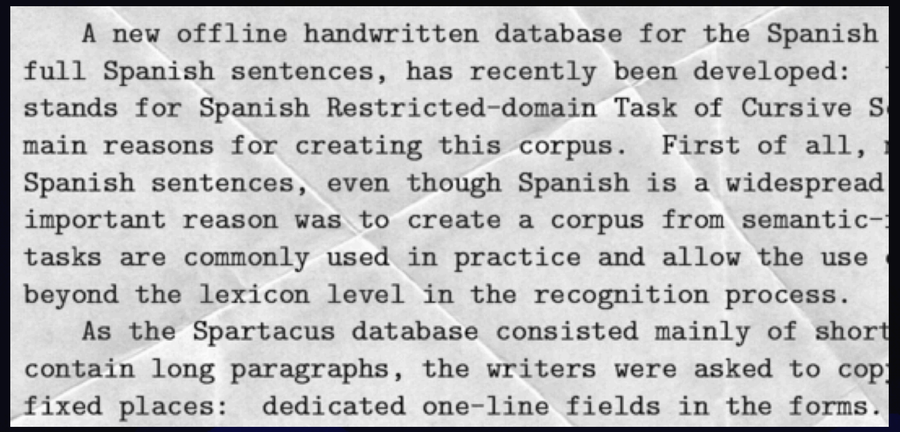








(2): Folded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Spanish sentences, even though Spanish is a widespread
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tasks are commonly used in practice and allow the use
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As the Spartacus database consisted mainly of short
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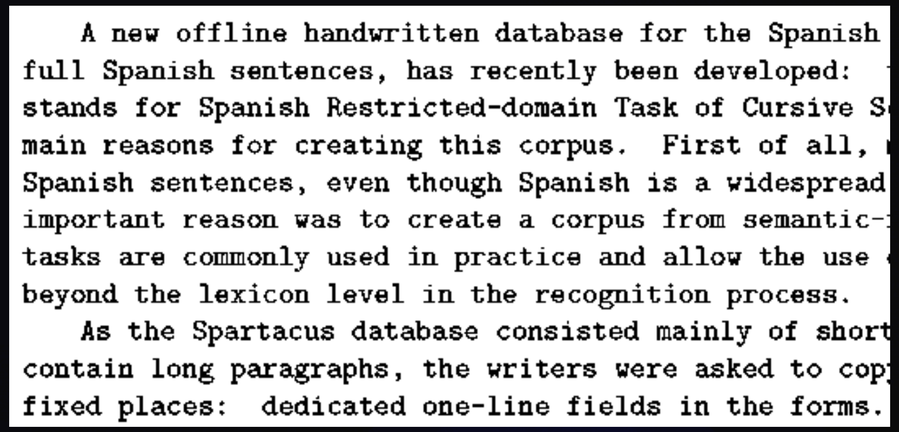
fixed places: dedicated one-line fields in the forms.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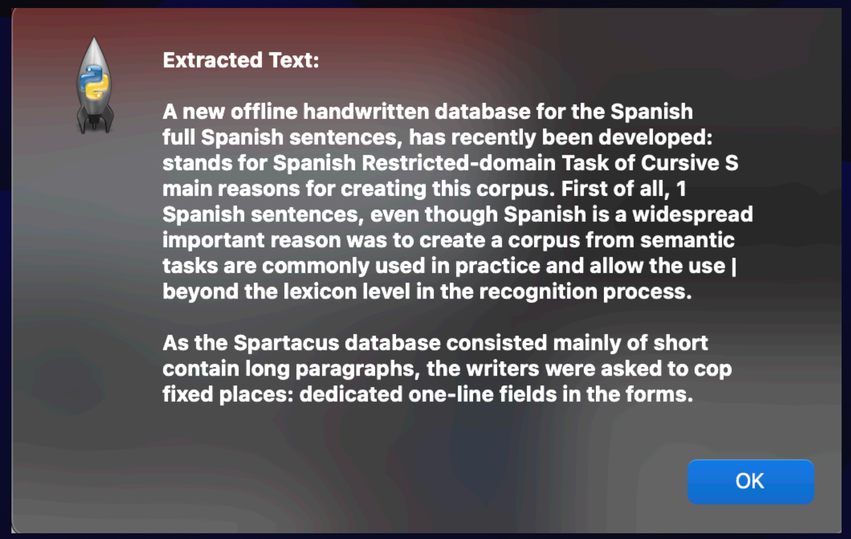
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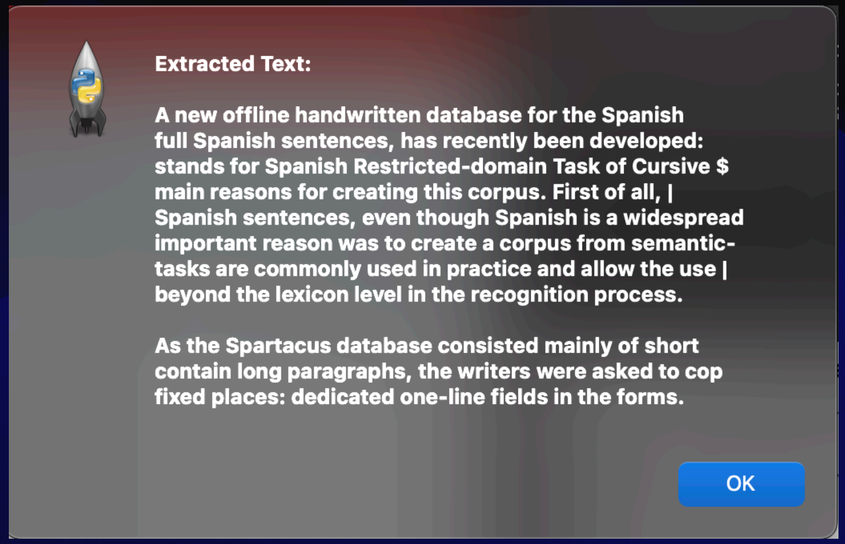
OK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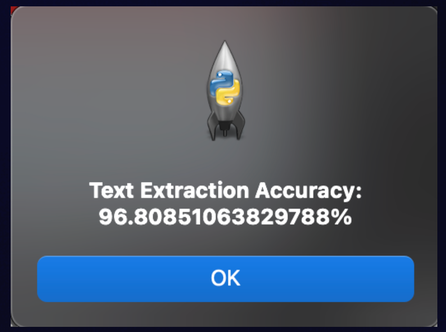
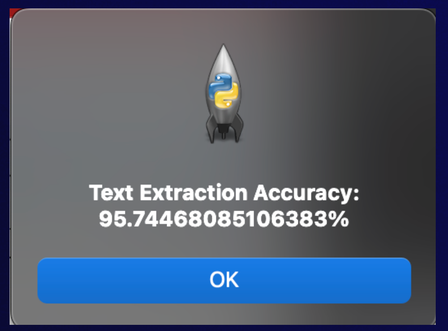
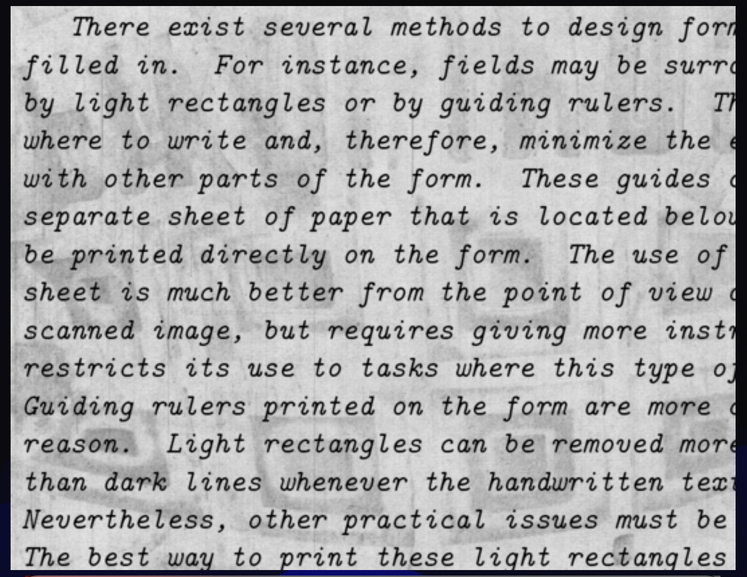
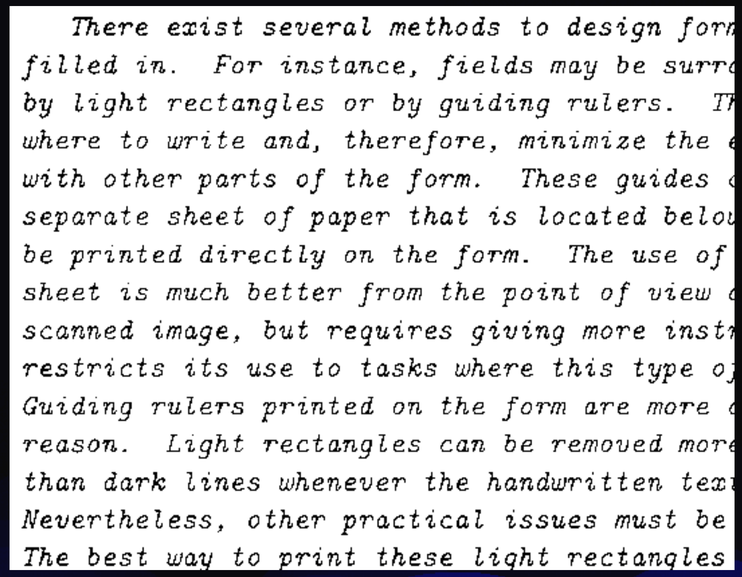
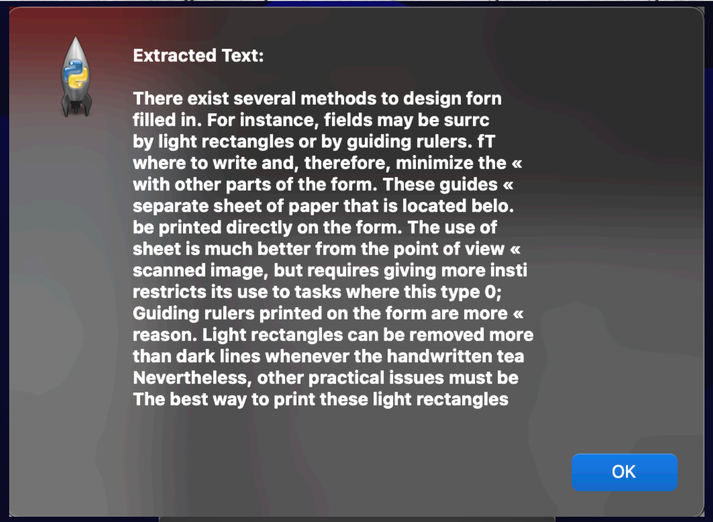

Text Extraction Accuracy:
96.80851063829788%
OK

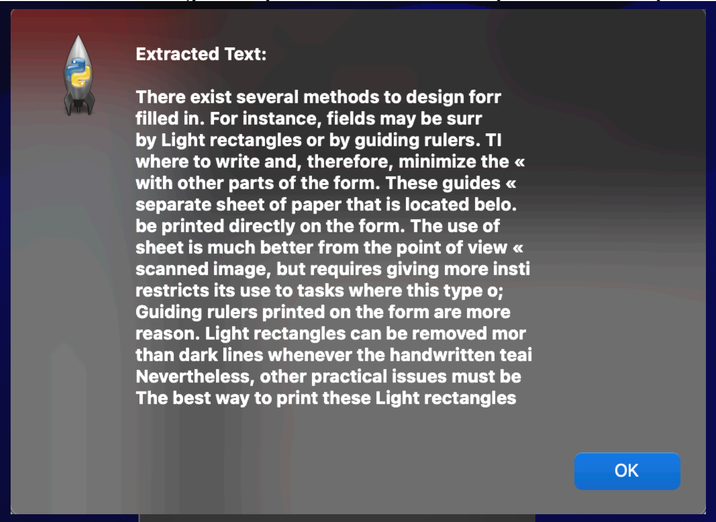

Text Extraction Accuracy:
95.74468085106383%
OK

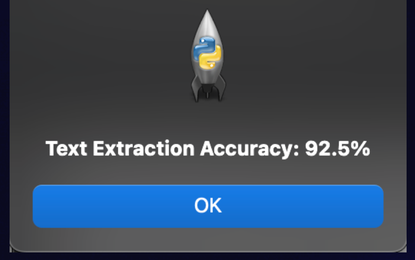
(3): Eraser-marked

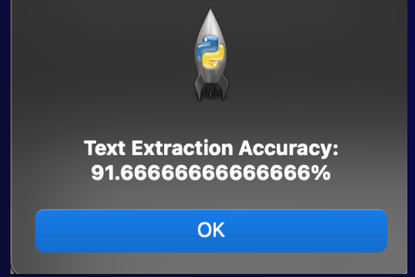




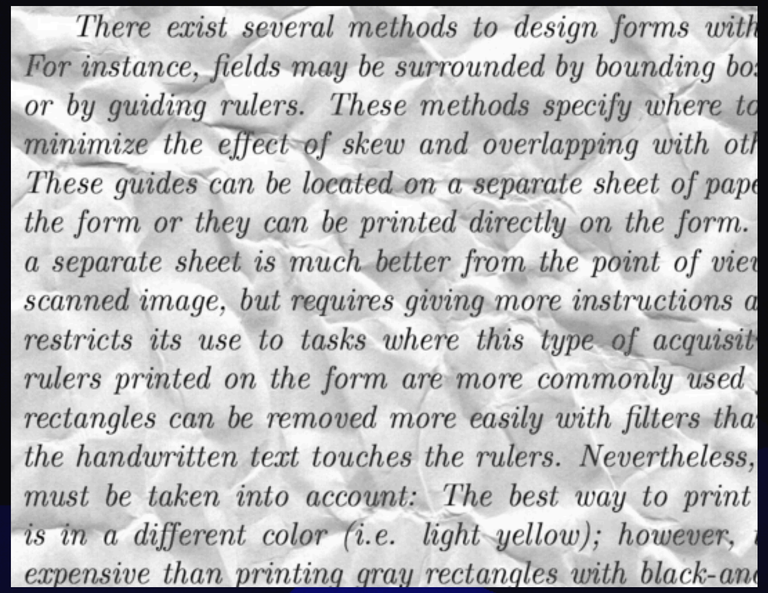


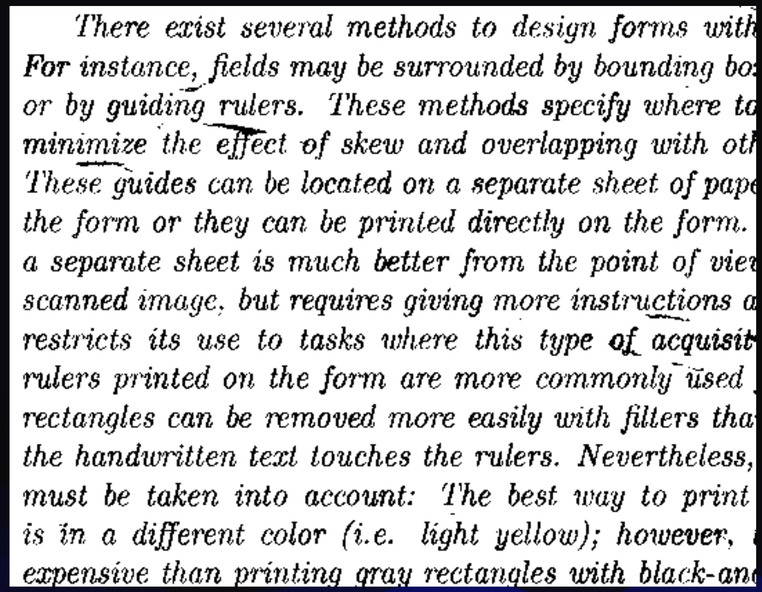


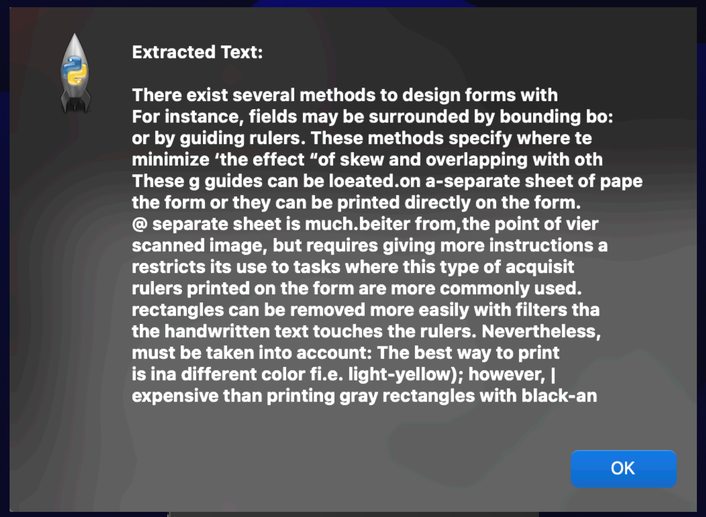


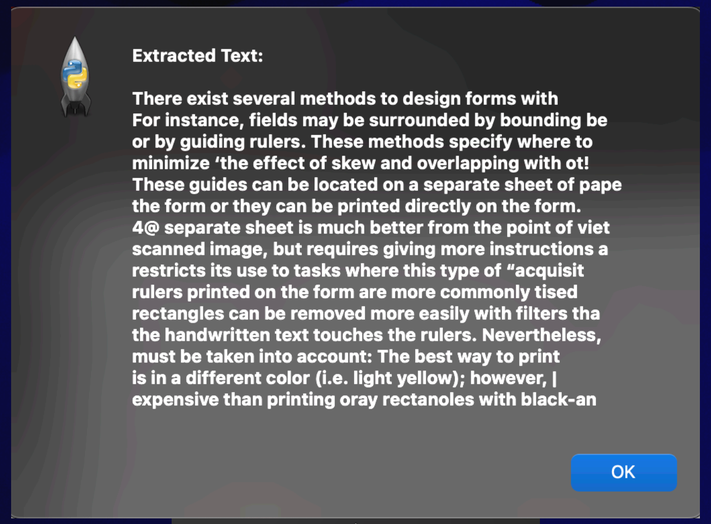


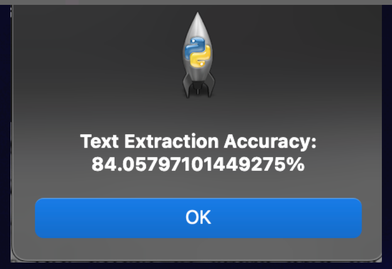
(4): Crumpled-up

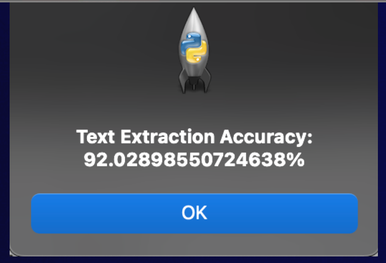




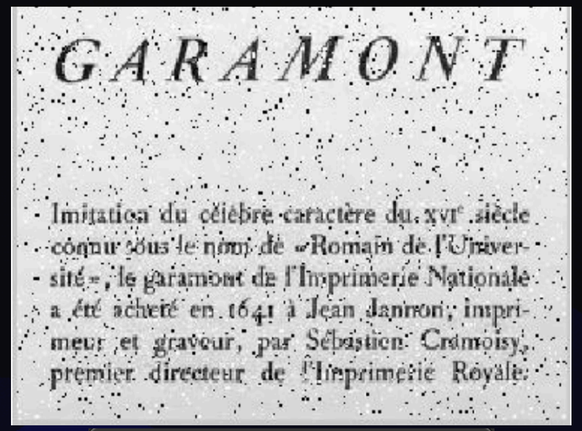


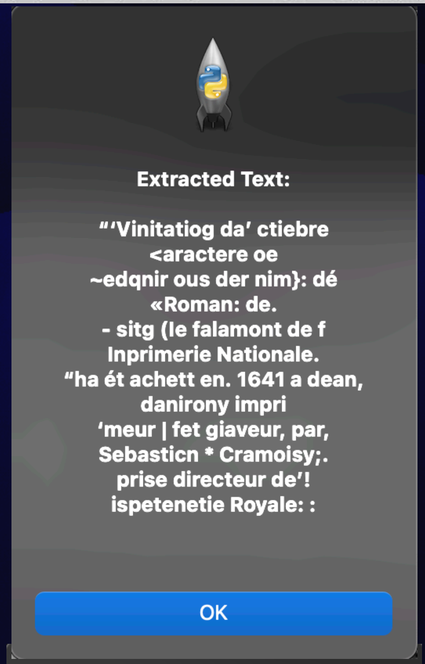


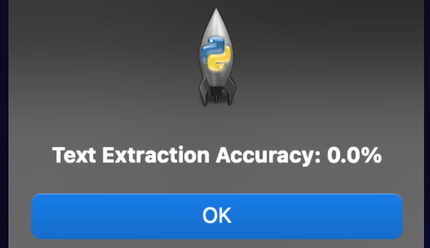


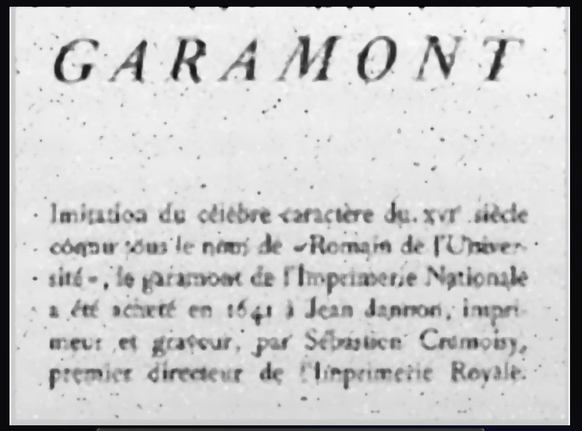


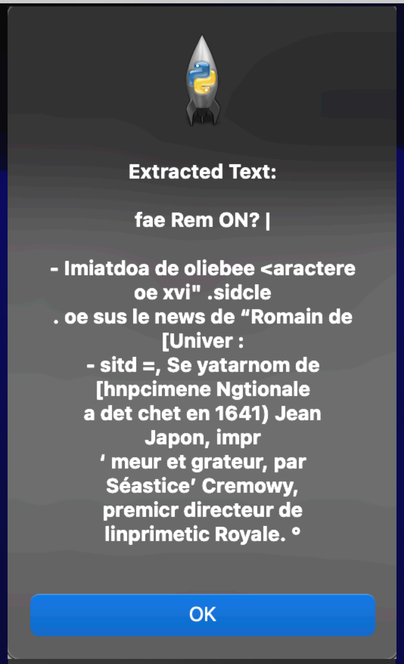
(5): Salt-and-pepper

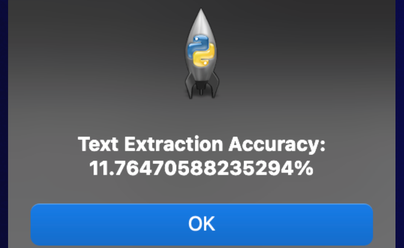


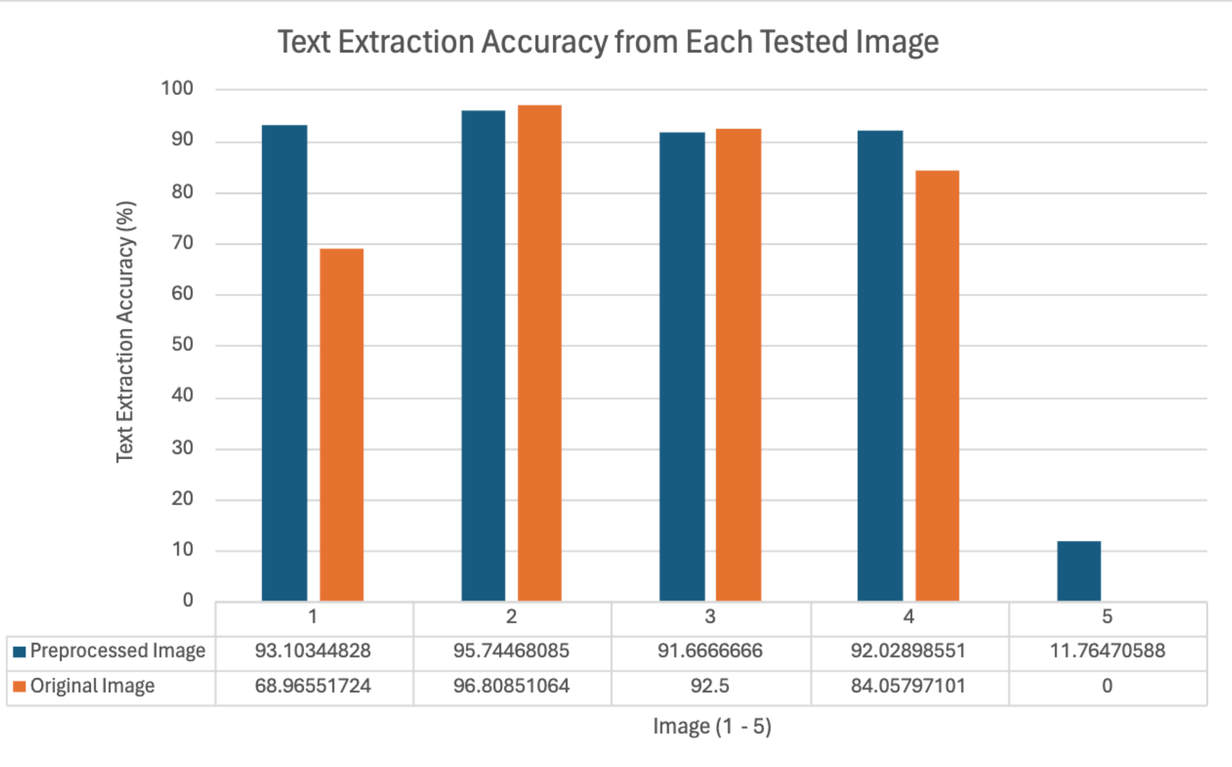




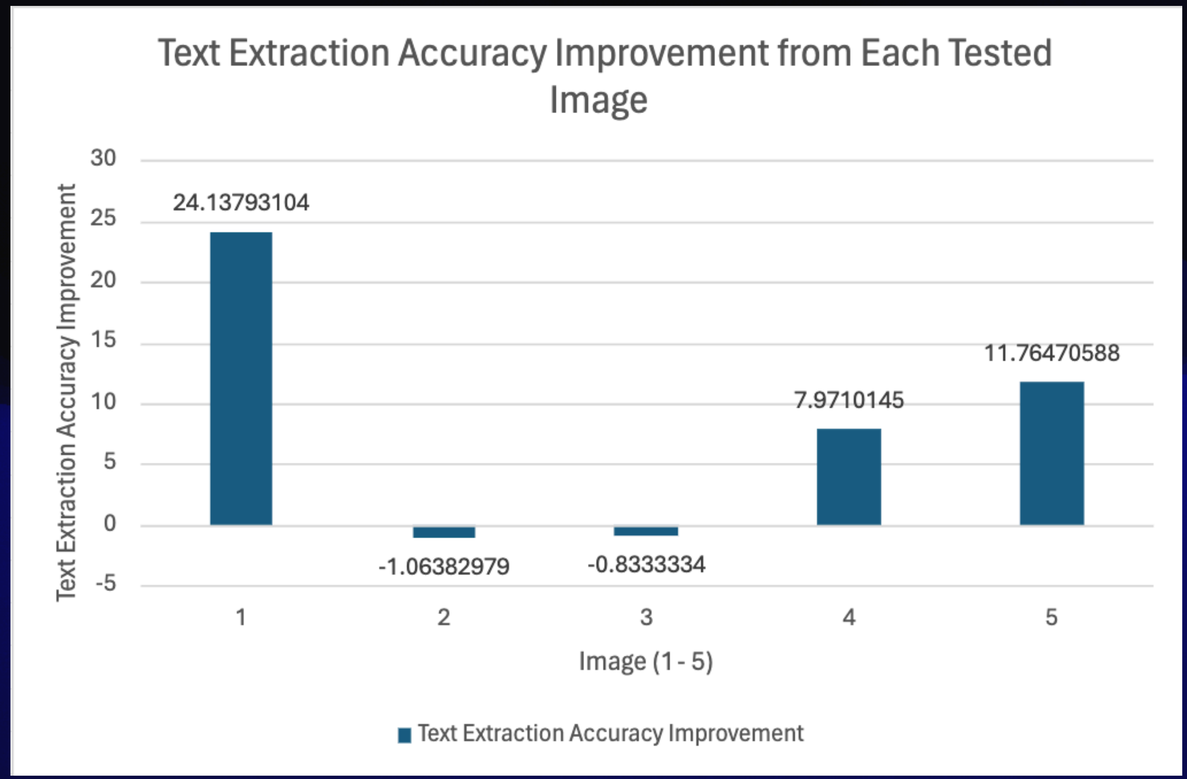








	1	2	3	4	5
Preprocessed Image	93.10344828	95.74468085	91.6666666	92.02898551	11.76470588
Original Image	68.96551724	96.80851064	92.5	84.05797101	0



Discussion of Results & What's Next

- Light noise types (Folding creases and eraser marks) resulted in Tesseract becoming less confident about the calculated preprocessed images, ultimately leading to a lower text extraction accuracy.
- On the other hand, heavy types of noise (Coffee stains, crumples, and salt-and-pepper) got Tesseract more confident in the resulting preprocessed images.
- Tesseract is not essentially grading on user-readability, but rather computer-readability.
- There is no "one-size-fits-all" solution to image processing, it's all about trial and error.
  - Encouraged me to combine individual solutions together to create a complete solution.
- The nature of this project, along with the skills that were learned, will be appreciated in many other image processing fields and projects.

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