

Quantifying Historical Text Recovery Techniques on Multi-Spectral Imagery

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HYPOTHESIS

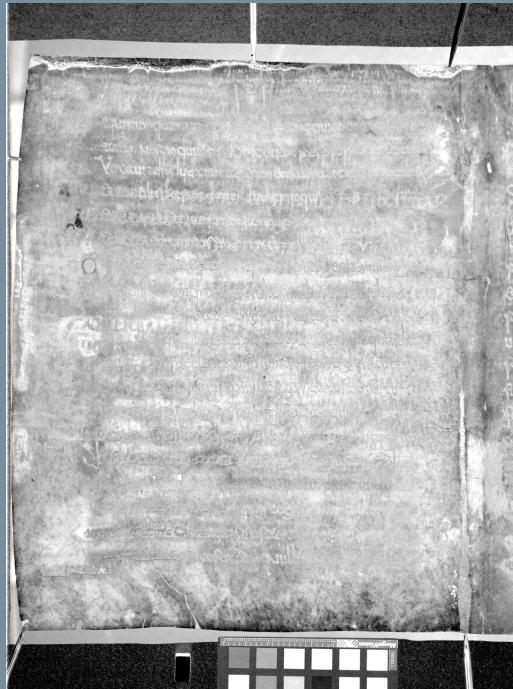
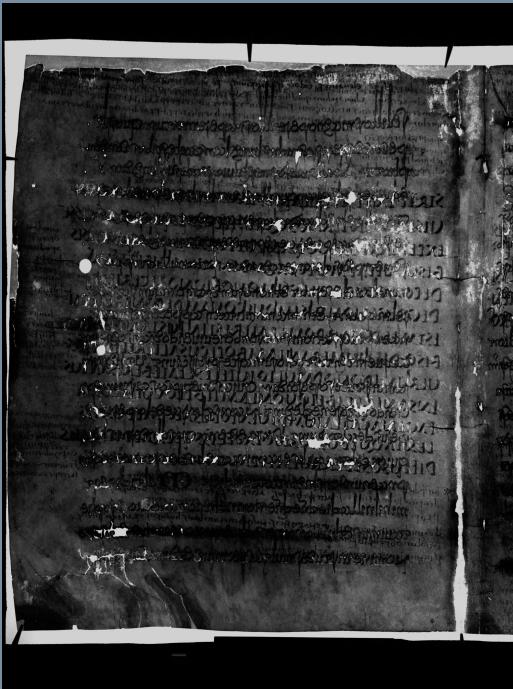
Based on current research understanding of linear and non-linear methods for image processing in addition the non-linear nature multi-spectral data gathered in the digital humanities, we expect the non-linear methods to perform better for image pre-processing than linear methods. We expect the way to handle the non-linear illumination from inks captured through various chemical reagent degradation will be separable by non-linear filters as well as wavelength specific techniques such as SAM. While the research of Giacometti et al. shows the robustness of PCA and ICA on documents that have been physically or chemically degraded current research argues that because of the non-linearity of some feature spaces in multi-spectral imaging using a non-linear feature space could produce even more robust results

THE GOAL

RECOVER TEXT FROM MULTISPECTRAL
IMAGERY. DAMAGED BY:

- CHEMICAL REAGENTS
- PHYSICAL DAMAGE
- PALIMPSESTS
- SCRATCH OUTS

THE DATA

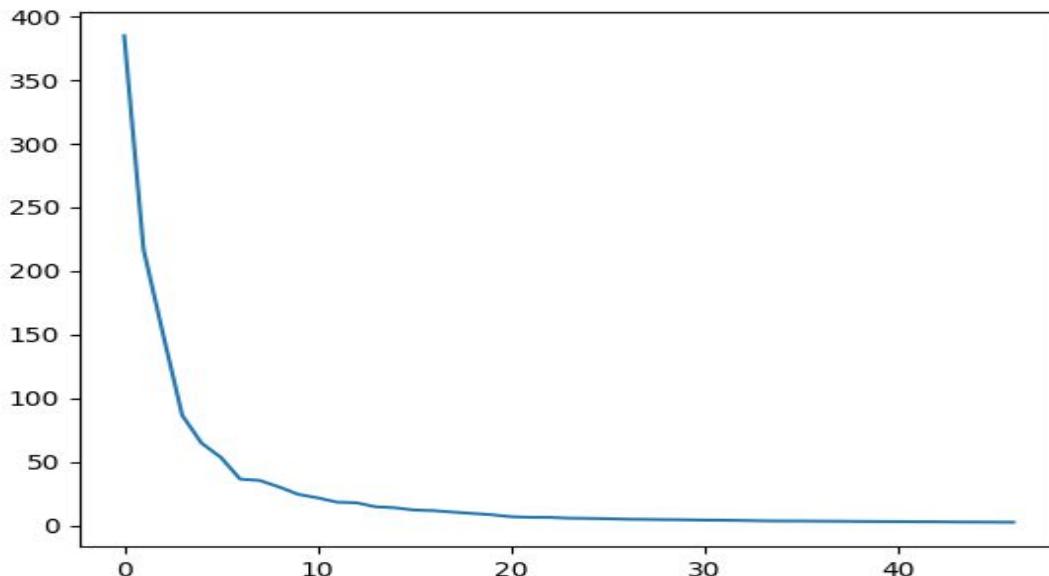


THE METHODS

OUR GOAL WAS TO TRY OUT THE FOLLOWING:

- **LINEAR METHODS**
 - **PCA** | PRINCIPAL COMPONENT ANALYSIS
 - **ICA** | INDEPENDENT COMPONENT ANALYSIS
 - **MNF** | MINIMUM NOISE FRACTION
 - **BLUR AND DIVIDE** | INDUSTRY STANDARD FOR THESE KINDS OF IMAGES
- **NON-LINEAR METHODS**
 - **KERNEL PCA** | KERNEL TRICK FOR PCA
- **NEURAL-NETWORK-BASED APPROACHES**
 - **GAN** | GENERATIVE ADVERSARIAL NEURAL NETWORK FOR DENOISING

PCA AND STATS



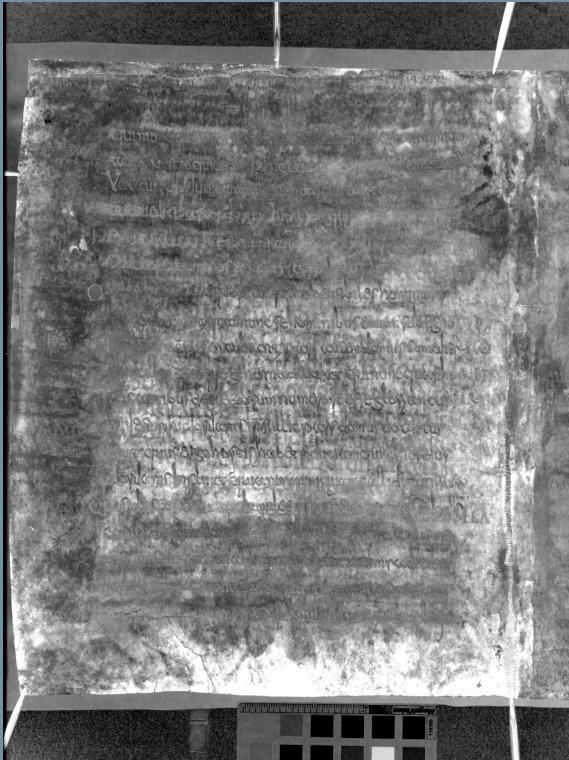
STATS:

- MEAN FID SCORE: **5.4E7**
- MIN FID SCORE: **2.6E7**
- RMF CONTRAST: **52**

RESULTS



RESULTS



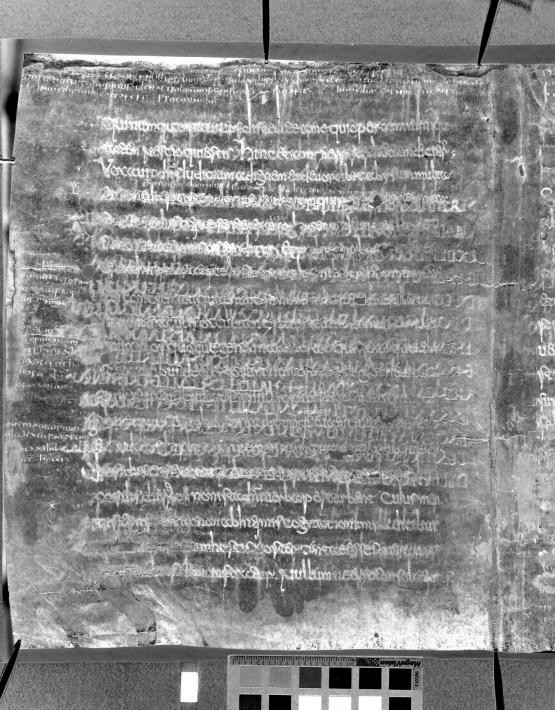
ICA AND STATS



STATS:

- MEAN FID SCORE: **5.2E7**
- MIN FID SCORE: **1.7E7**
- RMF SCORE: **48.5**

RESULTS



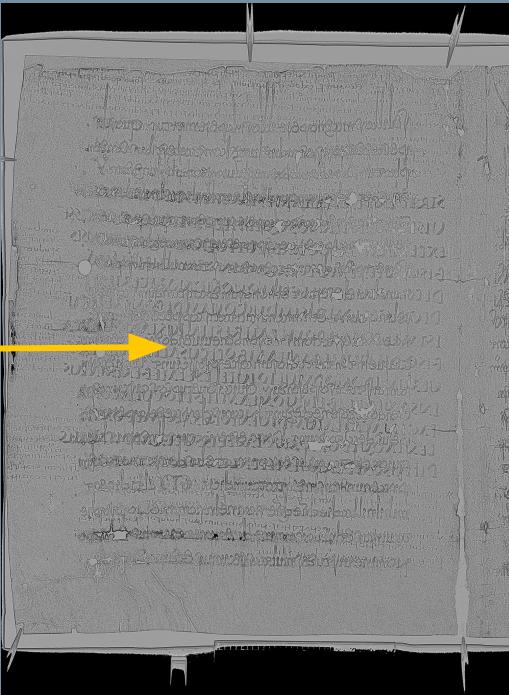
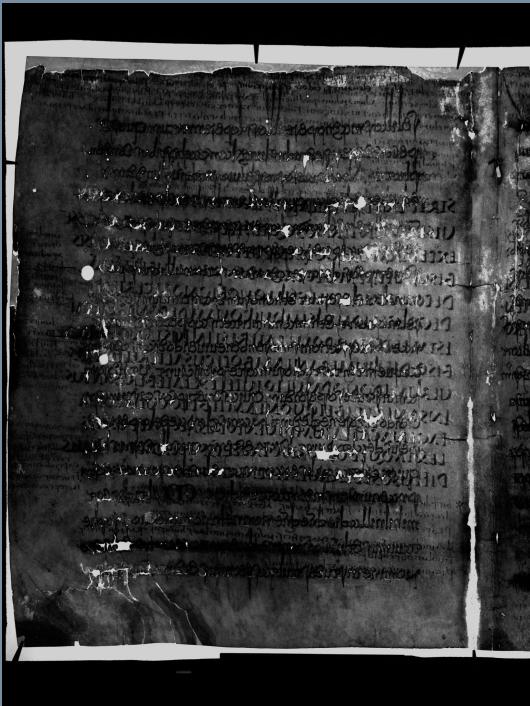
MNF AND STATS



STATS:

- MEAN FID SCORE: **5.6E7**
- MIN FID SCORE: **3.1E7**
- RMF SCORE: **51**

BLUR AND DIVIDE AND STATS

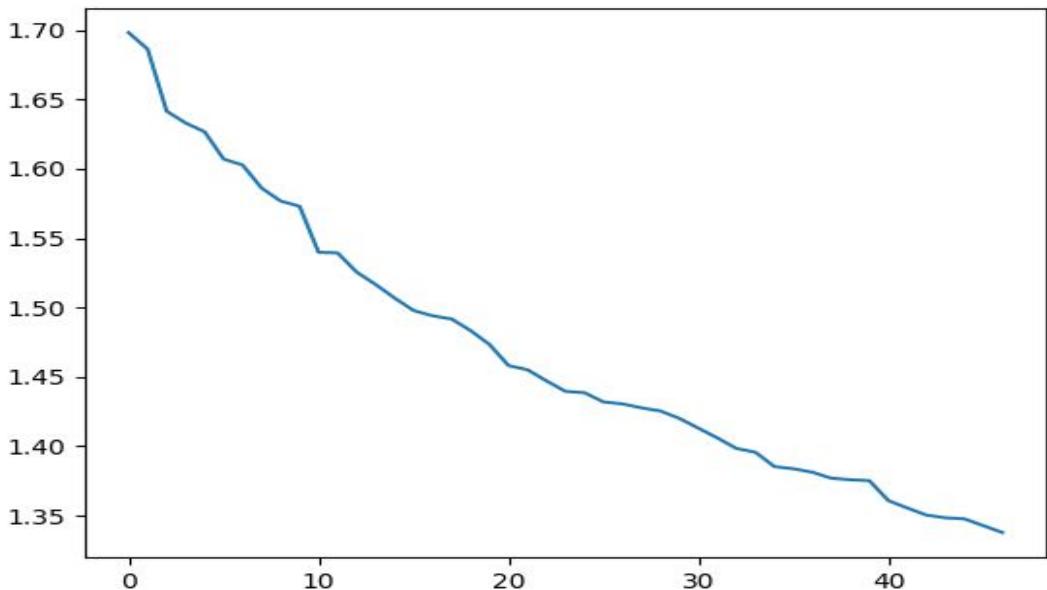


STATS:

- MEAN FID SCORE: **6.0E7**
- MIN FID SCORE: **6.0E7**
- RMF SCORE: **0.039**

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KERNEL PCA AND STATS



COSINE:

- MEAN FID SCORE: **5.5E7**
- MIN FID SCORE: **4.7E7**
- RMF SCORE: **14**

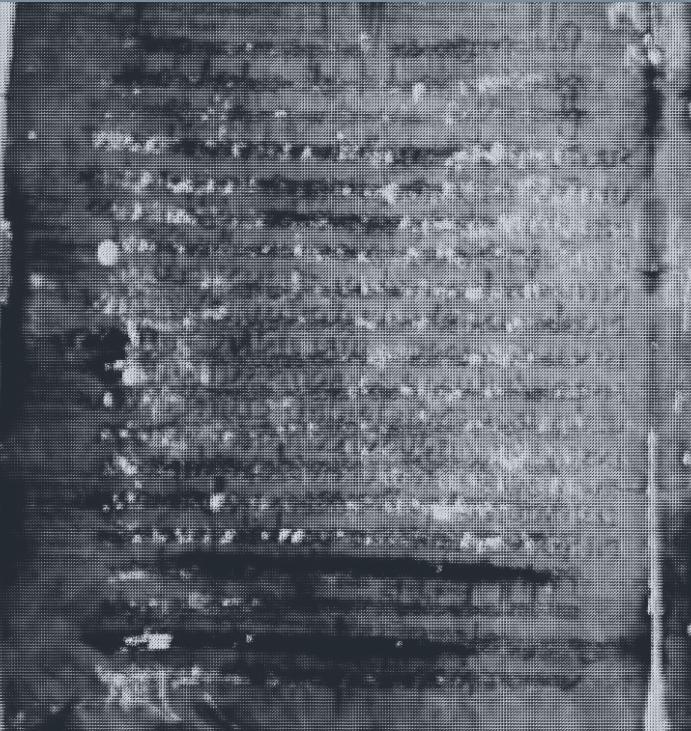
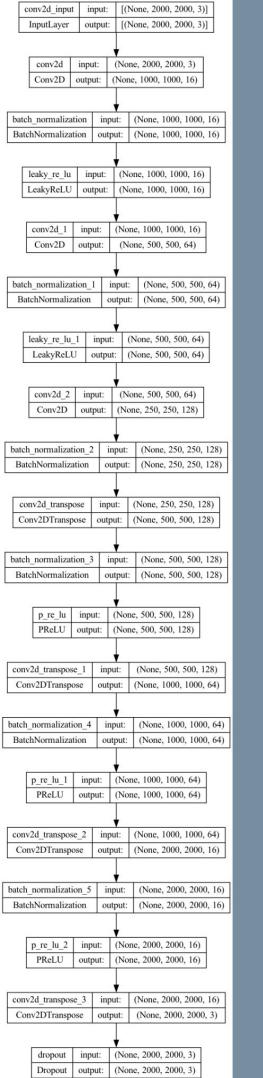
RBF:

- MEAN FID SCORE: **4.2E7**
- MIN FID SCORE: **4.2E7**
- RMF SCORE: **9.3**

RESULTS

[IMAGE NOT FOUND]

GAN AND RESULTS



STATS:

TOTAL PARAMS: 160,316,291

TRAINABLE PARAMS: 160,315,459

NON-TRAINABLE PARAMS: 832

EVALUATION

- WE NEED BETTER METRICS FOR QUANTIFYING OUR OUTPUT FID
- WE NEED A BETTER UNDERSTANDING OF TRANSFORMING KPCA FROM FEATURE TO IMAGE SPACE
- WE NEED TO QUANTIFY THE RELATIONSHIP BETWEEN CONTRAST AND IMAGE USABILITY
- WE NEED TO FURTHER GAN TRAINING MORE SAMPLES SO IT FITS TO MORE THAN JUST THAT ONE PAGE OF INFORMATION

THANKS AND WORKS CITED

THANKS TO:

- DR. HEYWORTH • FROM THE LAZARUS LABORATORY FOR THE SPACE, DATA, AND WISDOM
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- BRIAN J. GRIGLAK • FOR HELPING US TO UNDERSTAND ENVI'S IDL
- JENNY BLOOM • FROM L3 HARRIS FOR HELPING US DEBUG ENVI

WORKS CITED

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Robson, Tim Weyrich, Melissa Terras, Adam Gibson, The value of critical destruction: Evaluating multi-spectral image processing methods for the analysis of primary historical texts, Digital Scholarship in the Humanities, Volume 32, Issue 1, April 2017, Pages 101–122, <https://doi.org/10.1093/llc/fqv036>"

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THANK YOU!