Universität Hamburg
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CLUSTER OF EXCELLENCE
UNDERSTANDING
WRITTEN ARTEFACTS

Analysing research data in manuscript studies

The Visual Manuscript Analysis (VMA) lab, Cluster of Excellence: Understanding Written Artefacts, Universität Hamburg
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The Visual Manuscript Analysis (VMA) lab

The VMA lab leverages AI advances in **computer vision and machine learning for manuscript research**, addressing practical questions emerging from the study of historical documents. It is dedicated to the systematic visual analysis of manuscript images, exploring the landscape of historical documents with computational precision. It aims to contribute to the understanding of the past through cutting-edge technology.

Context: The research in VMA spans various topics within the field of document analysis and recognition (DAR), primarily within the following research directions: **Visual Navigation, Handwriting Style Analysis** and **Computational Restoration.** In addition to standard research outputs, such as articles, AI models and computer-vision systems, easy-to-use software tools are implemented for various reasons, including:

- Making some of the developed methods accessible enabling scholars to conduct independent experiments.
- Providing contained environments for rapid, individual testing.
- Illustrating a model's or system's potential to non-specialists in this discipline.

The Pattern Analysis Software Tools (PAST)

The PAST is a set of easy-to-use tools developed as **supplementary contributions** to make some the lab's methods more accessible to researchers from manuscript studies. They automate aspects of data processing, provide supporting information to address research questions, and offer insights through statistical analysis of research data.

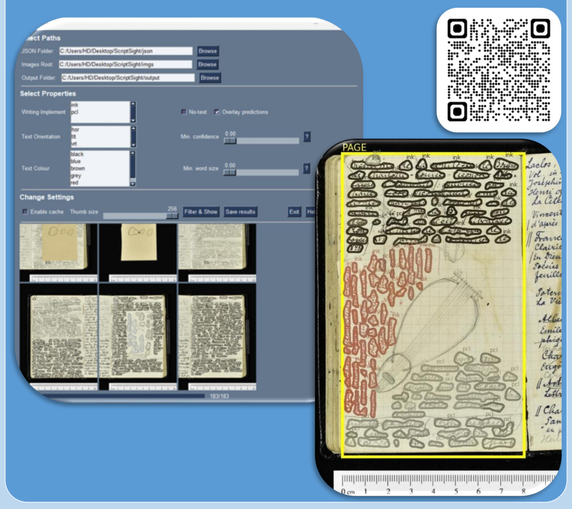
ScriptSight

Why was it needed?
To enable scholars to explore images of document pages using their 'Computational Visual Catalogues' (CVCs), which are generated by our AI models.

What does it do?
Multiple visual attributes, such as text orientation, colour, and used writing implements can be selected to isolate pages matching these specified criteria.

Input: Images and their CVC in JSON format.
Output: Matching images with optional overlaid predictions, saved to structured directories.

Impact and usability
- Providing accessibility to the underlying AI-models used to generate the CVC.
- Illustrating the potential of the underlying system.



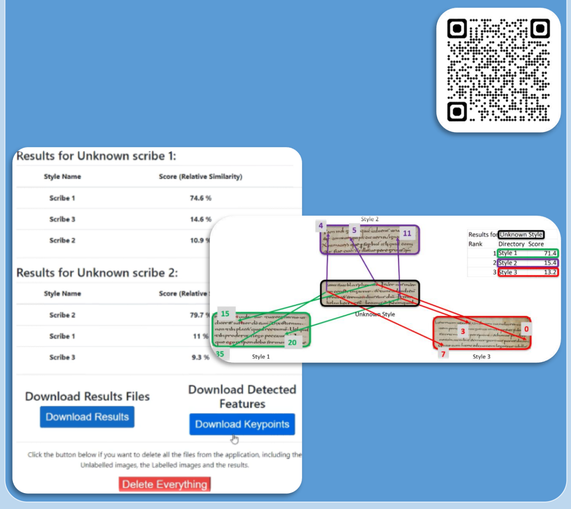
Handwriting Analysis Tool (HAT)

Why was it needed?
To measure the style similarity between different instances of handwriting without having any reference sample for these instances.

What does it do?
Multiple different handwriting styles can be analysed concurrently and sorted according to their similarity to a questioned or unknown style.

Input: Image samples from each style to be analysed, each containing at least a few lines of handwriting.
Output: Sorted list based on handwriting similarity with relative similarity measurements.

Impact and usability
- Several independent published work by scholars based on HAT analysis, see the list in HAT page.
- Used as an assessment tool for further research.



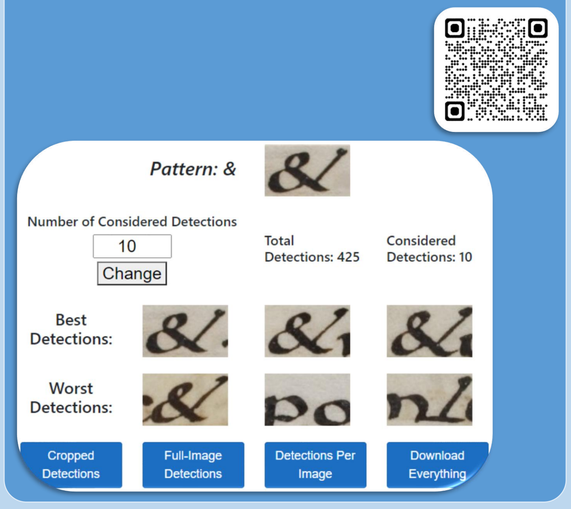
Visual-Pattern Detector (VPD)

Why was it needed?
To automatically locate and recognise a set of pre-selected visual patterns in a collection of images using only a single example.

What does it do?
It searches for selected visual patterns in a specified set of images, allowing the recall–precision balance of detected patterns to be controlled visually.

Input: Cropped visual patterns to be located, and a set of images to be searched.
Output: Detected patterns as annotations on the original images or as cropped images.

Impact and usability
- Used to run quick tests before commencing further development.
- Used when no pattern examples are available.



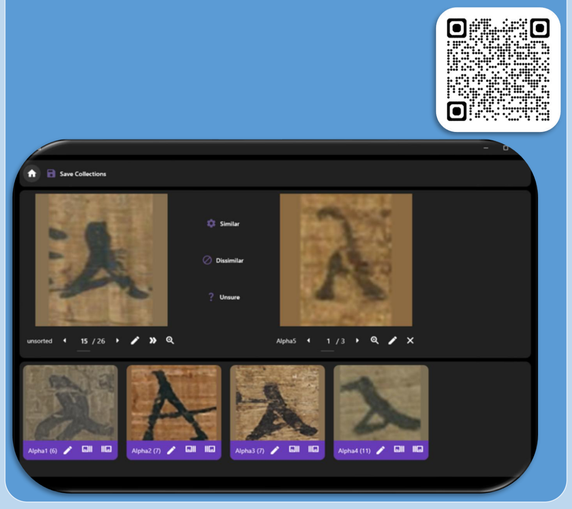
Visual Similarity Annotation Tool (V-SAT)

Why was it needed?
To enable experts to create training datasets for similarity-based models, such as Siamese networks and supervised clustering approaches.

What does it do?
It streamlines the organisation of image collections. Whether you have a structured folder hierarchy or a jumble of unsorted images, it simplifies the process.

Input: Images of the patterns you want to compare.
Output: Organised directory of subfolders, which can be used to train similarity-based models.

Impact and usability
- Used for specific cases where domain experts are required to visually inspect certain patterns and provide their 'ground truth' annotations.



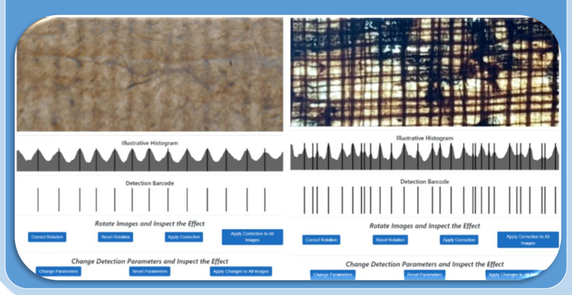
Line Detection Tool (LDT)

Why was it needed?
To analyse images of writing supports in order to detect lines (such as sieve imprints or papyri fibres) and estimate their density.

What does it do?
- Detecting lines in pre-selected orientation.
- Calculating min and max spacing, and density.
- Generating visualisation of detection histogram.

Input: Images of line regions to be analysed.
Output: Calculated values of the aforementioned measurements in a tabular form.

Impact and usability
- Automating the process of detecting lines and calculating all relevant measurements.
- Facilitating the comparison between samples.



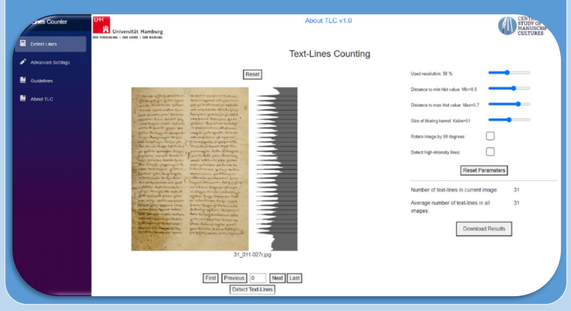
Text-Lines Counter (TLC)

Why was it needed?
To automatically detect, count and mark the text lines in images of handwritten manuscripts.

What does it do?
Detecting and counting text lines in each image of handwritten manuscripts, including pages of vertical text-lines and bright text-lines on darker background.

Input: Images of manuscript pages with text lines.
Output: Number of lines per page and the average per manuscript.

Impact and usability
- The interactive design allowed rapid testing and comparison of several manuscripts over a very short period.



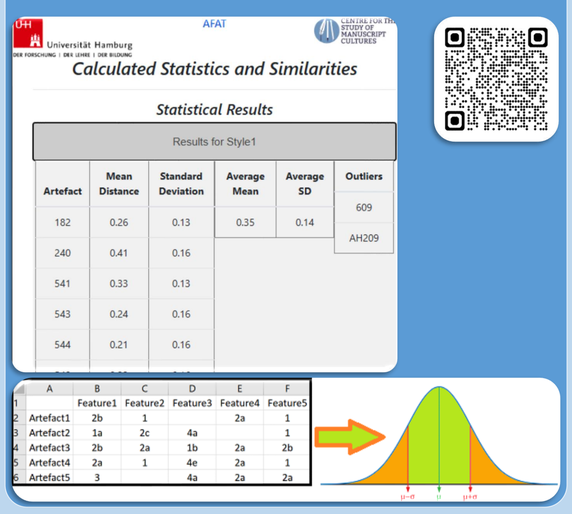
Artefact-Features Analysis Tool (AFAT)

Why was it needed?
To calculate statistical information from manually generated tabular data which consists of distinctive features of different artefacts.

What does it do?
- Calculating individual statistics within each table.
- Calculating general statistics for a whole table.
- Calculating distances between different tables.

Input: The values in these tables are positive integers, which describes the particular variant of a given feature in an artefact.
Output: The mentioned calculations in tabular form.

Impact and usability
- Providing quantitative measurements for experts' observations of visual features that cannot be extracted automatically.



Artefact	Mean Distance	Standard Deviation	Average Mean	Average SD	Outliers
182	0.26	0.13	0.35	0.14	609
240	0.41	0.16			AH209
541	0.33	0.13			
543	0.24	0.16			
544	0.21	0.16			

	A	B	C	D	E	F
1		Feature1	Feature2	Feature3	Feature4	Feature5
2	Artefact1	2b	1		2a	1
3	Artefact2	1a	2c	4a		1
4	Artefact3	2b	2a	1b	2a	2b
5	Artefact4	2a	1	4e	2a	1
6	Artefact5	3		4a	2a	2a

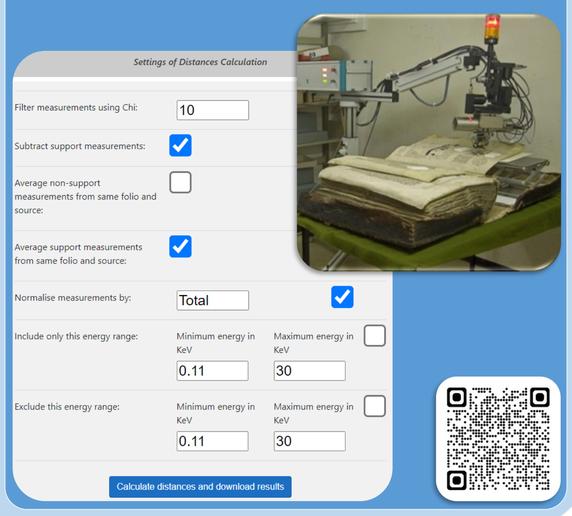
X-Ray Fluorescence Data Analysis Tool (XRF-DAT)

Why was it needed?
To automate and speed up the analysis of multiple XRF spectroscopy point measurements.

What does it do?
Analyses tabular data generated by XRF spectroscopy on written artefacts, particularly their inks, pigments and writing supports.

Input: Tabular data files generated by XRF spectroscopy point measurements.
Output: Processed data tables, similarity measurements and scatter-plot tables.

Impact and usability
- Automating the process and avoiding mistakes.
- Reduces processing time from weeks to seconds.
- Calculating similarity between measurements.



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