

READ

**RECOGNITION & ENRICHMENT
OF ARCHIVAL DOCUMENTS**

D8.6

Large Scale Demonstrators – Zurich

Evaluation and Bootstrapping

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READ
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Executive Summary

This document gives an overview of the foundation of the involvement of StAZH in READ. Five main topics cover the work provided for READ by StAZH: First, the development of strategies for the execution of mass transcriptions. Second, the evaluation of handwritten text recognition (HTR) and alignment processes. Third, the delivery of documents as data for training and evaluation for READ partners (closely tied to number two). Fourth, the networking across archives and memory institutions with similar needs/work in similar areas. Fifth, the dissemination activities carried out in order to share the experience of using tools developed within READ, as well as have projects contribute themselves by providing documents for training. All five parts are reflected and described in this paper as they are currently carried out.

1 Introduction

The state archives of Zurich (StAZH) is one of the four large scale demonstrators (LSD), testing, implementing, and using the technologies developed in READ in a typical environment (archives, libraries, etc.). StAZH has been digitizing documents for more than ten years in order to make documents accessible for users or for long-term preservation. For six years, important series of documents of the archive have been made accessible by adding full text to the digitized materials. Furthermore, selected documents have been and are being prepared and published for scholarly editions. Hence, the archive has gathered expertise for the manual extraction and description of text in digital environments.

For READ, the transcriptions as well as the digitized images have been prepared for training, evaluation, and benchmarking of the software as well as the developed algorithms. By assessing the algorithms on different, esp. larger scales, it is possible to estimate costs for implementation and execution of the technology in typical institutional environments. Scholars as well as computer scientists gain insight into the consequences, the benefits, as well as the risks of the application on larger scales. A subordinate part of the task is the enlargement of the available material (esp. for training and evaluation), by the implementation of tools connecting images with texts on line basis (developed mainly in D 7.21.).

2 Main task: Strategies, Evaluation and Bootstrapping on Large Scales

The main task is carried out aiming at three trajectories:

First The identification of strategies to execute (mass-)transcriptions in institutional settings.

Second The evaluation of processes developed in READ for roll-out on larger scales, focusing on the identification of resources needed and resources saved for long-term mass-transcription projects.

Third The bootstrapping of text-image alignment tools helping to generate Ground Truth (GT) that can be used for training and evaluation of HTR models, as well as for purposes of benchmarking.

2.1 Bootstrapping of alignment tools

For **bootstrapping** and text-image alignment, the dialogue with URO yielded promising results and started with two volumes of aligned texts (about 1200 pages) from the StAZH corpus. After treatment with text-to-image (T2I) the layout analysis was able to identify and correctly assign more than 95% of the lines. Subsequent training of the model led to a character error rate (CER) of slightly above 5% on a test set (the test set contained the same hands, but the particular pages were not part of the training). This proved that the identified ceiling of the error rate can be reached with models spanning multiple hands (see also below 2.2.3).

Second, more than 100'000 pages from StAZH/TKR have been treated with a specialized T2I routine that builds on image files (JPEG) and transcriptions (in simple TEI XML).¹ A prerequisite was the identification of page numbers for image files, this has been outsourced (using money foreseen for Ground Truthing). The results are more than 100'000 pages of StAZH documents in PAGE XML on Transkribus that can be used for further training and testing. They have been made available via ZENODO.²

Further, the T2I has been implemented in Transkribus X, where it has been tested by StAZH on different use cases from different fields:

- “Parzival” manuscripts (600 pages): Medieval hands, transcriptions provided by a digital edition project at the University of Berne (MoU partner). Matching of more than 95% of lines possible. Trained model resulted for one hand in CER below 4%.
- “Semper” manuscripts (500 pages): Semper was a famous architect of the 19th century, transcriptions provided by a digital edition project at the ETH Zurich (MoU partner). Matching of about 90% of lines possible (due to difficult layout slightly below other matching jobs).
- “Itinera Nova” (about 10'000 pages): Crowd sourcing project in the city of Louvain (BE) regarding medieval and early modern city books, data provided and supported by University of Cologne and Institut für Dokumentologie und Editorik (IDE, MoU partner).

Other projects and institutions have been advised on the use and capabilities of T2I for their needs.

For year three, a small data set of StAZH has been ingested using T2I. In order to train a first HTR model for scripts from the 16th and 17th century.³ At the end of the

¹For the T2I see: D7.20.: Semi-supervised HTR Training. The TEI XML are provided as open data on ZENODO: <http://dx.doi.org/10.5281/zenodo.803239>

²The documents are available as Ground Truth on ZENODO: XXX. This is probably the largest collection of documents available for HTR training.

³About the project see, https://staatsarchiv.zh.ch/internet/justiz_innere/sta/de/ueber_uns/organisation/editionsprojekte/stillstand.html.

project (six months in year four) the whole collection will be ingested and used to train HTR models.

2.2 Strategies for Transcription/Recognition in Large-Scales

After establishing three strategic partnerships in year 2 with institutions intending to use or already using READ tools to recognize large amounts of documents (see list below), StAZH started planning its own large scale recognition project.

1. Federal Archives of Switzerland (BAR): Recognition of the minutes of the Federal Council (1848-1903): About 150'000 pages, without correction (see also business implementation in D 3.2., MoU partner).
2. University Library of Basle (UBB): Recognition of oldest journal in Basle (AVIS Blatt) using recursive neural networks (rNN) for German gothic script: About 70'000 pages (MoU partner).
3. University of Fribourg/e-Codices (e-Cod): Preparation of HTR model to provide keyword spotting (KWS) for selected document collections (starting with the world renowned Carolingian codices of Saint Gall monastery: About 1'000 pages). The e-codices corpus as a whole is more than 300'000 pages.

These three projects are used in order to describe needs and wants of large-scaled projects. The first project will be treated as business case, whilst the other two are using the open tools developed in READ under guidance of StAZH but without specialized technical support. The project by the University of Basle (in cooperation with the University Library of Basle) has been funded by the Swiss National Science Foundation and will run from November 2018 to October 2020.

2.2.1 Recognition project by StAZH

Starting mid-2019 StAZH will start with its project “Pilot Vormoderne Quellen”, where besides the digital scholarly edition of single documents, 150'000 pages of minutes by the city council (so called *Ratsmanuale*) will automatically be recognized. Ground Truth will be produced in-house, segmentation and possibly recognition of named entities will be carried out in cooperation with READ. StAZH will thus serve as founding member of the READ COOP.

All four projects can be used as comparison to the large transcription project TKR,⁴ that was finished in September 2017 at StAZH (TKR). All transcriptions were produced by experienced transcribers (recruited students). For the 198'709 pages the equivalent of 30 years of work had to be invested. The cost of the endeavour is roughly at 3 million Swiss Francs. The project will be the basis for future comparisons of costs involving HTR versus traditional methods.

⁴See “Transkription und Digitalisierung der Kantonsratsprotokolle und Regierungsratsbeschlüsse des Kantons Zürich seit 1803”, URL: http://www.staatsarchiv.zh.ch/internet/justiz_innere/sta/de/ueber_uns/organisation/editionsprojekte/tkr.html.

Compared to TKR the costs of the recognition project “Pilot Vormoderne Quellen” will be significantly lower. The current budget foresees about 20% of the costs, thanks to the use of Transkribus and READ tools. The quality of the recognized text will of course be different (we assume a CER of 5% of the initial recognition procedure compared to 99,5% by manual transcription).

2.2.2 Prerequisite: Layout Detection

Thanks to a stable **layout analysis** (LA), provided by URO, called “CITlab Advanced”, most of the problems regarding Layout Analysis have been erased (missing lines, incorrect text regions) with regard to the recognition on the large scale:

- Regular book layouts (one or two columns) are no longer problematic;
- Minutes with marginalia, indentation, etc. are correctly identified;
- Text and images are correctly separated.

Furthermore, almost no lines are missed and lines do not get incorrectly split in halves. As a result the Layout Analysis (LA) is comparable to results from established (commercial) OCR engines.

2.2.3 Evaluation of HTR processes

For the first phase of the **evaluation** process GT was produced manually in order to train first models of HTR. From the first models as well as tests of other models, first insights of the ceiling of the methods applied could be gained. In several scenarios CER of less than 5% could be achieved and first patterns determining the quality of the outcome identified. The results are comparable to the experience of other involved institutions (READ partner UCL, Transcribe Bentham and MoU partner University of Greifswald) dealing with manuscripts.

In a second phase, in 2017, it could be shown that even for more than one hand the same ceiling could be reached, by providing more GT (produced with T2I, see above).

The training of 760 pages of GT (more than 20 different hands, spanning 80 years) at the end of 2016 led to an average of 18,6% of errors on character level. The model can be used not only for the documents written in Zürich but most hands in German kurrent. Although from a humanities standpoint the error-rate is underwhelming, the model demonstrates that it is possible to train HTR models that are suitable not only for the recognition of one but multiple diverging hands.

The question remains, how many writers can be fitted into one model with CER rates below 10% and whether it is possible to build models broad enough to recognize writers/hands unknown. This question is still being pondered, since the implementation of HTR+ (see D.7.9.) in Transkribus was slightly delayed and the training of more than 100'000 pages for an HTR model will be carried out end of 2018/beginning 2019.

In order to prepare further tests about the adaptability of HTR models, different document sets from different times have been gathered in order to build general HTR

models with focus on 19th century German kurrent and Medieval scripts (gothic book scripts and administrative hands of the 14th and 15th century).

In the second year, the broadening of quantity in terms of HTR models but especially in terms of GT prepared using semi-supervised training methods could be achieved. In order to be able to use semi-automatic training, the models built in year one were used and eventually re-trained with more GT.

The result of the evaluation allows us to conclude that an acceptable CER can be achieved, given a sufficient quantity of GT. Combined with the newly introduced HTR+ general models for certain scripts are going to be available at the end of project READ. For German kurrent (at least for the 19th century) enough material is available and only needs to be combined (esp. from ABP, StAZH, and possibly Greifswald). Gothic book writings of the 13th, 14th and 15th century have been assembled by founding a Working Group, thus these scripts will also be recognized with a high probability with a Character Error Rate below 10%. Finally scripts of the administration (running gothic scripts for 14th and 15th century scripts) are currently being prepared. We expect to deliver a good model at the end of project READ as well (mostly thanks to two MoU partner: Itinera Nova, city archives of Leuven/University of Cologne; Projekt Königsfelden, Universität Zürich).

Thanks to the T2I tool by URO (see above 2.1) the production of GT has been severely sped-up and eventually led to enorm amounts of training data. Consequently, a broad and dependable HTR for similar documents could be build.

2.2.4 Evaluation of KWS processes

Due to KWS based on confidence matrices (see below and D 7.15.), also with imperfect HTR recognition (i.e. the German kurrent model from StAZH with 18,6% CER) a very high recall (around 99%) can be achieved. A feature that will be helpful for archives and other memory institutions that want to make large amounts of images searchable without having to go through correction processes.

In year three, different data have been made searchable using Key Word Spotting:

- The minutes of the Federal Council of Switzerland by BAR (used internally for questions by customer);
- Baptizing, marriage and death records by State Archives of Berne (used internally, currently as test for the municipality of Trub);
- Old finding aids of the State Archives of Zurich (regarding charters, letters, and seals).

Besides technical aspects of the compatibility of the used algorithms, it needs to be evaluated what target groups are expecting as results of KWS and how they experience long loading times (KWS is time consuming) as well as problematic results (such as false-positive). The feedback by peer-groups (archives and scholars) is generally very good and first projects start using the tools. Still, these tests are still ongoing and in discussion with NAF which aims to use the approach for their digitization strategies.

2.3 Networking and further involvement in READ

In order to get to know needs as well as ideas from stakeholders (with focus on scholars and archives), StAZH is part of several dissemination activities with one of the goals being to build a sustainable network of interested stakeholders.

Within Switzerland four institutions with matching interests have been identified (see above, plus State Archives of Berne): All of them are using the tools provided within READ to make their documents better accessible, still they are separated as different use cases.

1. BAR is interested in transcriptions of their minutes without dealing themselves with the technology. This is a typical case of outsourcing (from the archival point of view) on a contractual basis. Therefore this type of deal could be demonstrating how a future business case might look like. Also, this case was chosen as demonstrator for **Document Understanding**, in order to test how much information about specific parts (header, heading, page number, etc.) could be provided (see also D 6.15.). For the implementation a first offer without inclusion of Document Understanding was made, priced at Euro 50'000 for 150'000 pages. Due to a change in management, the project had to be put on hold for the time being.
2. UBB and the University of Basle are interested in a high quality recognition, to use the text with Document Understanding tools to provide the different snippets as basis for historical research. The recognition project stands at the beginning and the text needs to be exported into other formats and systems. GT and corrections are provided by student assistants in Transkribus X.
3. University of Fribourg/e-Codices is interested in providing scholars access to their vast amounts of texts using KWS. With a scholarly audience in mind, providing false-positives (erroneously found words) is negligible as long as high recall can be ensured. Providing GT for different models (starting with Carolingian minuscules as a pilot), along with discussions about the implementation of the search are currently underway. First models for Carolingian minuscules have been trained.
4. State Archives of Berne cares for the searchability of their registers concerning baptizing, marriage, and death records using KWS. A first test is underway. If successful the whole collection will be made available.⁵

The four trajectories demonstrate different needs of institutions and projects, giving an idea of the variety of ways dealing with archival (and other) documents. As a lesson learned, it can be said that the tools developed are of use to all of the institutions. But each case needs to be handled separately in order to determine what outcomes are expected and what goals should be deemed realistic. Also, financially the projects differ widely: From several tenth-of-thousands of Euros spent by the institutions for the entire recognition process, to some hours invested by students.

⁵The collection is already online but not searchable:
<https://www.query.sta.be.ch/archivplansuche.aspx?ID=37>.

For the rest of project READ, the mentioned projects will be followed up and presented as use cases in order to be able to inform the cooperative in founding about “best practices” and how to handle requests by different institutions (together with UCL and NAF).

The produced GT of, as well as the documents provided by StAZH were used for competitions (part of WP 3.7.) as well as tasks in document understanding (part of WP 6.6. and experiments in D 7.9, D 7.11, D 7.15, D 7.18, D 7.21).

2.4 Dissemination and Allocating GT

Another way to get evaluation data for HTR processes is the dissemination of the software Transkribus X. In order to collect feedback from memory-institutions as well as interested scholars, several workshops and talks (part of WP 2.6.) were held. As a result, new MoU partners were acquired and document collections have been tested out in Transkribus. For interested groups (especially the institutions mentioned above), the flow of information is running informally in order to get to know more about specific needs and problems.

Most of the dissemination of StAZH has been carried out in form of workshops in different places from Poland to the United Kingdom.⁶ In order to engage scholarly discussions, besides talks about theorizing machine learning for text recognition (Cologne) two papers have been prepared and have been accepted for print in two journals (Das Mittelalter and Geschichte & Informatik, see below p. 11).

Within a specialized dissemination group, regular calls led to a mutual understanding of who was serving what user groups in order to spread the knowledge about READ but also to get meaningful feedback.

Interested parties and projects have been approached to share their documents in order to prepare general HTR models for different time frames (esp. Gothic Hands Working Group). The search for suitable and accessible GT is still ongoing and for the end of the project (Y4) substantial results are expected.

Due to the heavy involvement in dissemination activities, one person month has been reallocated from the pool for Large Scale Demonstrators (WP8) to Dissemination (WP2). For the end of READ (Y4), about two person month remain and will be used for dissemination (WP3) and business implementation (WP4).

2.5 Sub contract

According to the Grant Agreement (GA) of the project sub contracts are mainly foreseen for generating GT and for involving institutions via a Memorandum of Understanding. Details are described in the GA, p. 89f.

According to the GA StAZH has therefore involved two subcontractors for producing GT (digitexx & a student researcher at the state archives), the amount will be billed in year four.

⁶See the Dissemination Report D 2.3. for details.

2.6 Publications

- Abstract: Hodel, Tobias: Konsequenzen automatischer Texterkennung – Ein Aufriss zur Texterkennung mit Machine Learning. In: Vogeler, Georg (Hg.): DHd 2018. Kritik der digitalen Vernunft. Konferenzabstracts. Universität zu Köln. 26. Februar bis 2. März 2018, online: dhd2018.uni-koeln.de/, S. 249-251.
- In print: Hodel, Tobias: READING Handwritten Documents: Projekt READ und das Staatsarchiv Zürich auf dem Weg zur automatischen Erkennung von handschriftlichen Dokumenten. In: Geschichte & Informatik, 2019.
- In print: Hodel, Tobias: Handschriften automatisiert lesen: Projekt READ. In: Das Mittelalter, (accepted, appearing 2019).