Transfiguring the Library as Digital Research Infrastructure: Making KBLab at the National Library of Sweden

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Abstract

This article provides an account of the making of KBLab, the data lab at the National Library of Sweden (KB). With increasing demand for libraries and other heritage institutions to provide access to their collections at scale, the organisational form of the lab and the harnessing of in-house competence in data science has become a pertinent response. The first part of the article offers an evaluative discussion of the work involved in establishing KBLab as both a physical and a digital site for researchers to use KB's digital collections at previously unimaginable scales. Beyond explaining how the lab aligns with KB's broader mission as a national library, we also elaborate upon the design of the technical setup and the processes of research coordination that the operation of a library lab presumes. The second part discusses how KBLab has deployed the library's collections as data to produce high quality Swedish AI models, which constitute a significant new form of digital research infrastructure. We situate this development work in the context of uneven AI coverage for smaller languages, and consider how the lab's models have contributed to the making of important AI infrastructure for the Swedish language. The conclusion raises the possibilities and challenges involved in continuing the type of library-based AI development we have initiated at KBLab.

Keywords: Library labs, Digital research infrastructure, National libraries, Collections as data, AI development.

Introduction

In an era of big data, significant new demands are being placed upon libraries (Hoy, 2014). As the world becomes increasingly amenable to processes of datafication, and more and more previously unquantified aspects of life are rendered into data (Cukier & Mayer-Schoenberger, 2013), the library as a cultural heritage institution has been forced into a period of creative transformation. This is partly a matter of developing collecting practices for the vast amount of material being produced online, and exploring sustainable ways to describe and store these web archive collections for future users (Bingham & Byrne, 2021). But it also involves strategies to meet the needs of users in the present, especially the novel requirements of digital scholarship (Ames & Lewis, 2020). Researchers in the humanities and social sciences pursuing digital approaches now routinely expect to be able to conduct analysis of library collections at previously unimaginable scales (ie. Underwood, 2019). Such an expectation is particularly evident at research and national libraries with legal deposit material, where it creates distinctive challenges for information systems that tend historically to have privileged the analogue object and single item use. How do these libraries go about providing access to their collections as data, when so much of their underpinning socio-technical imaginaries have been centred upon the individual book? (Jasanoff & Kim, 2009; Padilla, 2016)

This article explores this question via the organisational form of the *data lab*. Faced with increasing demands for computational access to collections over the past decade, university and national libraries have responded by instituting such labs – with LC Labs at Library of Congress, British Library Labs and Yale Digital Humanities Lab as characteristic examples. Broadly speaking, these amount to the creation of an internal platform where the professional expertise of data scientists can be harnessed towards the informational complexities of digitisation and facilitating new forms of digital research. Here we use the example of KBLab at the National Library of Sweden (*Kungliga biblioteket*, hereafter KB) to discuss what is involved in creating such a lab in a library setting. The first part details the infrastructural work required to make KB's digital collections available for large-scale analysis, as well as the practical and technical setup established at KBLab. The second part moves on to explain how the use of collections as the basis for development work with artificial intelligence (AI) has proved foundational in transforming the library into a digital research infrastructure. Though the particular details of KBLab are specific to the Swedish context, we raise broader arguments relevant for a wider international audience of library professionals, digital researchers and policy makers. The article therefore provides both a case study of the recent manifesto encouraging the growth of further labs in the heritage sector, *Open a GLAM Lab* (Mahey et al., 2019), and a principal justification for the value of library-centred AI development as a public good.[1]

KBLab as entrance point to the collections for research

In this opening section, we sketch the practical and organisational conditions that shaped the making of a data lab at the National Library of Sweden. How does KBLab align with and form part of KB's broader mission as a national library? What is it about a national library's collections that is particularly well-suited to the type of work that is possible in such a lab? And what is involved in creating access to this material in a lab environment? By addressing these questions, we provide the contextual detail necessary to make sense of the subsequent discussion of AI development in the library presented towards the end of the article.

[1] The acronym GLAM stands for Galleries, Libraries, Archives and Museums.

Library collections as data

The concern with making collections available is entirely central to KB's purpose as a publicly-funded heritage institution. The library's obligations to the research community in this regard are highlighted in the legal act defining its principal mission, where the opening paragraph describes KB as both a "national library" and a "national research infrastructure" (Förordning 2008: 1421). While the concrete tasks that pertain to this – ie. to collect, describe, preserve and make accessible material – are outlined in relation to the general good of aiding democratic development, the act specifically connects these activities to the end of safeguarding Swedish research quality. In this sense, KB is bound by law to maintain a close relationship with the shifting and dynamic needs of researchers. In practice, and given today's increasingly digitalised media ecology, this means incorporating the digital into a national research infrastructure and by turn becoming a digital research infrastructure. As we will demonstrate over the course of this article, KBLab comprises an essential component in both of these dimensions.

KB's collections can be characterised in terms of their considerable breadth and scale. While first introduced as a form of official censorship in 1661, with publishers forced to submit a copy of each work to the state for approval prior to public circulation, Sweden's legal deposit act has long since served to make the national library a guarantor of future cultural heritage. The law dictates that a copy of every publication issued in Swedish must be submitted to the library for preservation; since 1979 this has included audio-visual material as well as print, and since 2015 at least a degree of electronic publications (Konstenius, 2017). Beyond their historical depth and continuity over time, the collections thus also encompass cultural production from a diverse and shifting media landscape: ranging across newspapers, magazines and books through scientific journals and governmental reports to radio broadcasts, television shows and computer games. To give a sense of the scale involved, KB’s physical collections alone now number over 18 million items in the archives.

Although only a small part of these collections have yet been digitised, sufficient volumes of digital material exist to make the “collections as data” perspective outlined by Thomas Padilla and others highly pertinent (Padilla, 2019; Padilla et al., 2019). Such a framework entails exciting possibilities but also significant infrastructural challenges for the GLAM sector. In terms of the former, the creation of high quality, language-specific humanities data opens up new potential for researchers to be able to analyse the contents of digital collections at previously unimaginable scale, and often in previously inconceivable ways. The existence of such data is also especially valuable for the development of AI tools for smaller languages – a point which we return to in more depth below.

Yet producing and providing access to humanities data is a far from trivial task. The library’s collections have a particular history that has shaped their form in the archives, producing data artefacts that need to be managed. To take one key example, we can consider the effects of optical character recognition (OCR) software within the production process of digitised heritage material (Traub et al., 2015). Since the particular terms of the Swedish legal deposit law have previously prioritised physical over digital examples, physical newspapers have been submitted to KB and then subsequently digitised. Beyond certain OCR errors with specific Swedish words, an effect of this digitisation is the loss of various aspects of metadata that we as humans take for granted. We might gain a digital copy from this process, but what we are left with is a mishmash of text blocks: we no longer know which blocks belong together to form part of the same article, which articles comprise part of the same section, nor which texts are editorial content rather than adverts. It is certainly possible to use machine learning to attempt to put Humpty together again and reconstruct the newspaper, but this is a complex and laborious undertaking (Rekathati, 2021). Making collections amenable to computational analysis is a qualified task that often demands considerable labour in terms of data cleaning and curation; humanities data is far from ready-made (cf. Gitelman, 2013).

It is within this particular context that KBLab came into being. On the one hand, there has been growing demand from scholars within the humanities and social sciences using digital approaches, who wish to be able to access digital collections in order to conduct large-scale analysis. As the pilot study that laid the ground for the founding of the lab suggested, “researchers, funding agencies and governmental research propositions are also increasingly pushing scholarship in a data intensive direction in order to promote digital scholarship” (Snickars, 2018: 29). On the other hand, there is the technical complexity involved in creating an infrastructure capable of providing access to these collections as data, when little has previously existed. Despite any suggestion to the contrary, enabling the production of high quality datasets fit for research can be a complicated and messy undertaking. We now turn to consider the specific details of how we sought to address this challenge through the making of a lab at KB.

Designing technical infrastructure

When the library formally initiated the project to establish a data lab in 2019, two particular user groups – and purposes – were specified. Internally, KBLab was conceived of as a resource for method development and AI innovation at KB: a means of providing staff and leadership with improved knowledge about the potential for automating various of the library’s working processes. Externally, the lab was intended to position itself among existing institutions and environments to become an established infrastructure for facilitating and supporting digital research. In the short term, it was to meet the needs of two major projects within the digital humanities and social sciences funded by the Swedish Research Council: “Welfare State Analytics. Text Mining and Modeling Swedish Politics, Media & Culture, 1945-1989” (based at Umeå University)[2] and “Mining for Meaning: The Dynamics of Public Discourse on Migration” (based at Linköping University).[3] That both of these wished to conduct large-scale analysis of mid to later twentieth-century material from KB’s collections – principally newspapers, but also fiction and periodicals – had an important effect on the technical and organisational development of the lab. Since the projects were concerned with the analysis of material still protected by copyright, our initial task was in designing a computing infrastructure to provide local access within the library itself.

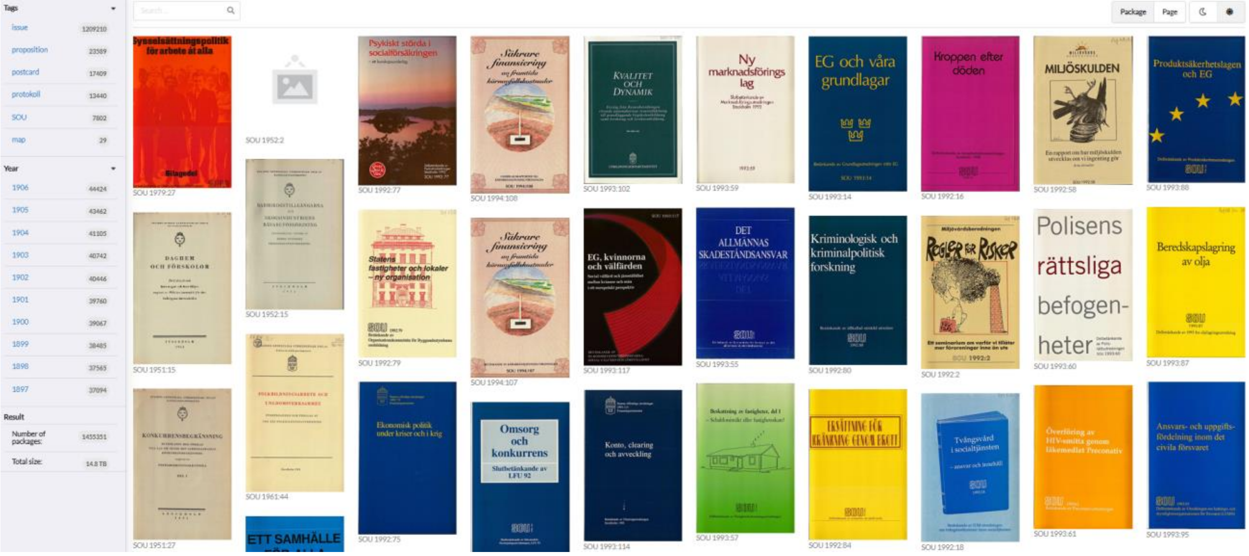
A key starting point in approaching this task was the conviction that a data lab at a library should offer experimental access to the collections. To merit the title of a lab, we sought to provide researchers with a laboratory space that enabled and encouraged exploration. Of course, one way of making digital collections available for further research is to produce predetermined datasets that can then be released to be analysed and used in diverse ways. However, and beyond the fact that copyright restrictions prevented such an approach in this instance, we wanted to create an environment that supported open-ended critical investigation rather than restricting access to the collections by offering already defined datasets. Based on our experience of the research process as something not necessarily linear – indeed, as often tangential and shaped by serendipitous findings far beyond the initial remit of enquiry (cf. Law, 2004) – we opted to design KBLab as an infrastructure where an exploratory working method would be possible, if not inevitable, for the researchers who come to use it. Once a research project is onboarded at the lab, it is therefore provided with *unlimited* access to KB’s digital collections, so that researchers can explore and design their own datasets as a result of contact with these collections.

[2] For more details, see: https://www.westac.se/en/.

[3] For more on which, see: https://liu.se/en/research/computational-text-analysis.

The technical challenge this involved was in how to enable exploration without compromising security. Our solution was to offer indirect access though an Application Program Interface (API). Researchers can conduct searches of KB's digital collections via the lab's API that will give results in the form of a representation of the original data, rather than the unnecessary risk of exposing the library's databases through direct access to the files themselves (Malmsten, 2020). These representations take the shape of JSON files, a data form reflecting the longer history of KB's engagement with linked data and one which is particularly apposite for a digital research infrastructure since it is machine-readable (Malmsten, 2009). Another key aspect of the linked data model underpinning the lab's design is the presence of Uniform Resource Identifiers (URIs) in the lab environment. By providing stable and persistent URIs for the archival material, researchers are able to find their way back to the same point in the collections and ultimately to demonstrate that their results are reproducible. Through establishing an API and an information model that makes linked data of the digital archive, we could thus create programmatic access to the library's collections at KBLab that offers researchers the autonomy to steer their own exploratory processes.

In addition to making the material searchable through the API, we also created a graphical user interface (GUI) for the lab environment (see figure 1). This serves to strengthen the lab's functionality as a research infrastructure in various, overlapping ways. Firstly, it provides a means of validation: in accessing the material in visual form, researchers can verify and navigate among their results. Secondly, it provides a way for scholars within the humanities and social sciences without programming skills to access and interact with the material in the lab environment. This can be particularly important for multi-disciplinary projects that seek to combine the perspectives of data science with more traditional forms of expertise in close reading and analysis within various humanities disciplines. It is also pertinent for mixed-methods analyses that, beyond conducting large-scale computational analysis, wish to incorporate investigation of visual aspects of the material (and therefore also need to be able to see the individual object rather than an aggregation of its textual contents). Thirdly, it allows for the annotation of the material, which can prove a significant element in projects that utilise machine learning by training models based on the collections. There is a specific function within the interface that allows users to annotate according to their own chosen labels and then extract the particular text that has been annotated (see figure 2).



Tags	
issue	1209210
proposition	23589
postcard	17409
protokoll	13440
SOU	7802
map	29

Year	
1906	44424
1905	43462
1904	41105
1903	40742
1902	40446
1901	39760
1900	39067
1899	38485
1898	37565
1897	37094

Result	
Number of packages:	1455351
Total size:	14.8 TB

Figure 1: Visualising a lab environment for explorative research, KBLab’s GUI.

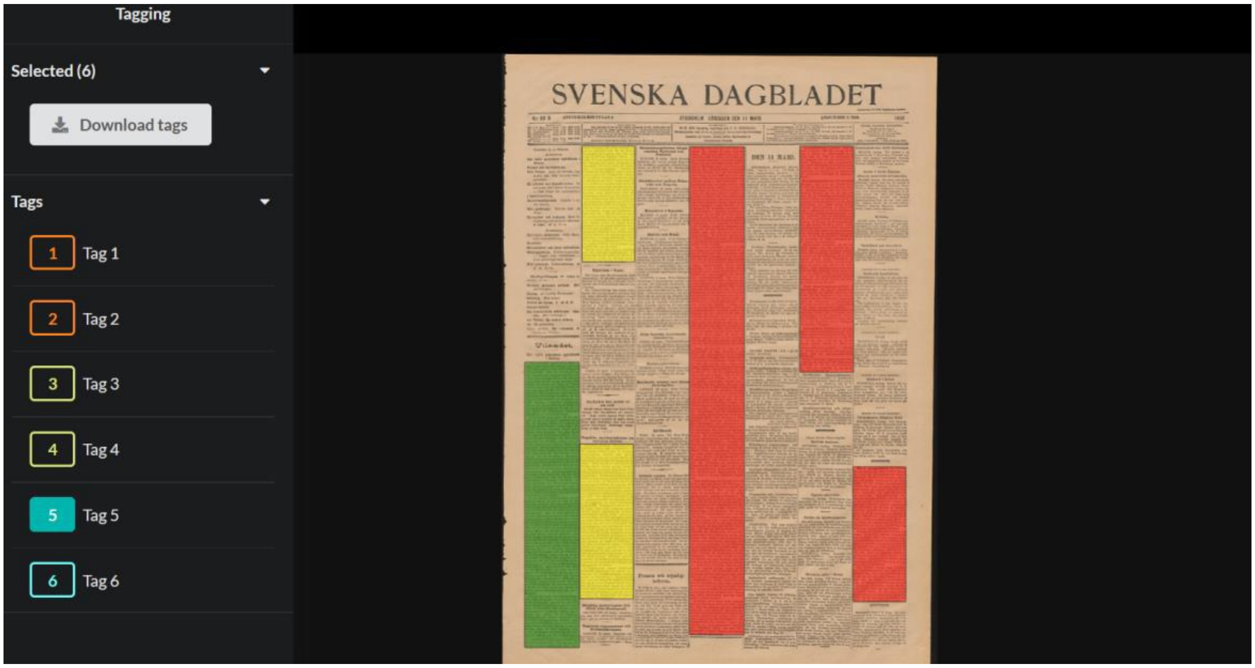


Figure 2: Annotating and extracting research data in the lab environment.

We made the lab's GUI available to researchers outside the lab itself through a prototype service called *betalab* (https://betalab.kb.se/). On the one hand, this forms part of the onboarding process for research projects that have been granted access to use KBLab. Prior to gaining access to the physical premises of the lab, researchers can use betalab to test and accustom themselves to the lab environment – in certain cases, they can even design and prepare scripts to be run on-site once they have access (which can prove a significant time-saving approach for geographically disparate projects). On the other hand, we also use betalab as an access point for those parts of the digital collections that are available at the lab but not subject to copyright restrictions. This open data includes historical newspaper material up to 1906, the Swedish Government Official Reports (SOU's) and various parliamentary data. If, for example, a research project wished to access newspaper material in machine-readable, structured form to conduct an investigation into nineteenth-century crime reporting, we would provide them with access to this data via betalab. In this sense, it provides an important complement to the primary part of the lab environment – datalab.kb.se – that can be accessed on-site at KBLab's premises.

For research projects that need to use KBLab for large-scale computational analysis of those parts of the collections protected by copyright, we established a computer lab at KB's locale at Karlavägen in Stockholm. This physical manifestation of the lab as research infrastructure is significantly a matter of computing power: since the terms of Swedish copyright legislation mean it is not currently possible for these projects to move the data outside the lab for external processing, we needed to ensure that we have sufficient computational resources in-house to meet the researchers' needs. To this end, we have built a local computing infrastructure with three levels: a) powerful workstations at the computer lab; b) a server environment for computation and access to the material via an API; and c) two NVidia DGX A100 servers for more computationally heavy analysis. (We have also since been granted access to the EU's supercomputing infrastructure for our own development work, which we return to discuss more below.)

The guiding principles that shaped the technical work to establish this solution have been pragmatism, flexibility and a desire to create autonomy for the researchers who use it. The workstations in the computer lab, for instance, use the Linux-based system Ubuntu, as this allows researchers to create and control their own software environments according to their particular needs and preferences. Likewise, to enable researchers to manage their own back-up for code and work-in-progress, we created gitlab, an internal, server-based git function. We elected to start by acquiring consumer rather than enterprise hardware for the lab: in part due to the (relatively) limited resources we had at our disposal, but also because it allowed us to move quickly and adapt according to the shifting needs of researchers as these emerged. The work involved in establishing this setup has depended upon KB's existing staff expertise within IT-architecture and systems design; without the input of an experienced and creative IT-architect, the making of KBLab would not have been possible.

Research coordination

With the lab established as an entrance point to the collections, another important organisational matter to be dealt with was research coordination. A significant aspect of this involved determining the principles and procedures via which access to the computer lab should be granted. In particular, and given that demand to use KBLab among researchers has consistently been greater than our on-site capacity (cf. Fridlund, 2021: 9), how should places at the limited number of workstations be allocated? To address this in a fair and transparent manner that aligns with KB's values and missions as a public authority, we made applying to the lab part of the library's broader process for managing research and development applications.[4] Researchers who are interested in collaborating with KBLab therefore begin by submitting a brief project outline describing what they would like to do in their proposed research. This application is then subjected to an initial screening to confirm that the project actually involves research elements – ie. that there are questions and hypotheses amenable to further exploration – before we proceed to making a decision about the specific terms according to which collaboration might be possible. Important to note in this context is that we make no judgement upon the substantive content of the research proposal, apart from confirming the presence of a research question and determining its essential feasibility.

The question of sustainable funding is central to the existence of any lab (Mahey et al., 2019: 129), and this also impacts how we deal with new applications to KBLab. While the initial outlay for the lab was financed through a combination of internal funding from the library and

[4] For more details about this process, see: https://kb.se/in-english/research-collaboration/criteria-for-collaboration.html.

external funding from the projects mentioned above, our working assumption is that research projects based at the lab should be self-financing – ie. that they pay an overhead fee to cover the running costs (technical and administrative) in utilising the lab, in line with a general Swedish praxis for the use of research infrastructure. Given the configuration of funding for academic research in Sweden, this means researchers have to include a budget post for use of the lab in their applications to research funding organisations such as the Swedish Research Council (VR) and Riksbankens Jubileumsfond (RJ). It also means researchers need to coordinate applying for a place at the lab with the process of submitting a funding application to these organisations.

The advantage of this approach is that it serves as a mechanism for quality control: by granting access to projects that have been awarded funding following a competitive, peer-reviewed process, we can ensure that the research allocated a place at the lab is of the highest calibre. However, a potential disadvantage is that it can favour larger projects proposed by established researchers at the expense of smaller initiatives by less well-established scholars. To counter this, we adopt a pragmatic cost-benefit analysis when considering each potential project, which can allow the overhead fee for use of the lab to be waived in certain cases. For example, if a project involves significant infrastructural gains for the library beyond the particulars of the project itself, then such a solution might be possible. A typical instance where infrastructural positives outweigh any overhead costs is the various Masters projects in machine learning that we have hosted at the lab, which have explored how AI models can help make the library's collections more accessible (ie. Rekathati, 2020; Henning, 2022).

A further dimension that affects how we assess the overhead costs for a potential project at the lab is the level of data science competence in the project team in relation to the complexity of the proposed research. The underlying issue here is finding productive forms of collaboration between expertise in AI and machine learning, on the one hand, and more traditional qualitative competences in the humanities and social sciences, on the other (cf. Kemman, 2021; Fano & Haffenden, 2022). Based on our experience, outsourcing the requisite expertise for large-scale data analysis to technical staff outside the project is the *least* effective way of dealing with this question. Such an approach tends to be problematic, partly since it risks making vital technical labour invisible and uncredited, and partly because it lends itself to a situation where researchers in the humanities and social sciences are publishing work where they do not properly understand either the methods used or their subsequent results.

On this basis, we recommend that projects based at KBLab need to incorporate data science competence within their project team, so that this perspective is represented and accountable at all stages of the research process. In practice, this means we are reluctant to grant lab space to proposals lacking the necessary technical skills, instead referring these to other infrastructural organisations such as the various Swedish centres for digital humanities who can provide greater levels of support. To proposals that have included the necessary expertise, we offer an overhead fee that is adjusted according to the technical complexity and demands of the specific project: ranging from a standard rate that includes initial support and advice in using the lab, to higher levels when a greater degree of development work is required from the lab's staff to make the project possible. In each case, ascertaining the particular needs and requirements of a proposal presumes an ongoing dialogue with the researcher and deliberation from several of the lab's staff.

Once a project has been offered a place at the lab and received research funding, it is ready for onboarding. We designed this process in accordance with the particular model of explorative research practices mentioned above in the discussion of the lab's technical setup. A thorough introductory phase clarifies the formal terms for using the lab, where researchers sign a personal user agreement stipulating the legal conditions for accessing and using the data available at KBLab, as well as receiving a copy of our code of conduct (see appendix 1). This is followed by a hands-on guide where the researcher(s) will be shown how to access data via the lab's API, how to manage ongoing results and which among the lab's various tools might be of interest. After this introduction, researchers are ready to work autonomously at the lab: beyond consulting with lab staff in the event of problems, they are free to begin interacting with the collections at KBLab according to their particular interests.

A final point worth noting about this process of research coordination – from initial application through to onboarding – is the centrality of specialised staff to its effective operation. Given that such coordination entails a trust-based dialogue with researchers throughout, it has been important that both the lab's manager and internal coordinator and the library's broader research strategist have doctoral degrees and themselves experience of conducting research. Providing informed and professional infrastructural service for researchers presumes the presence of qualified research competence within the library.

Collections-based models as digital infrastructure

Having discussed the making of the lab as a physical site for researchers to access the collections, we now turn to discuss how we have harnessed the collections as the basis for new digital tools that in themselves constitute a significant form of research infrastructure. Whereas the number of researchers who can use the on-site lab is necessarily limited by practical constraints, the creation of such tools that can be distributed beyond the library has enabled us to have a far greater reach. In the remainder of this article, we outline our work in producing and releasing collections-based models at KBLab: how have KB's digital collections enabled the emergence of a library-based form of AI development? In what contexts are the lab's AI models being used and to what effect?

Library collections as training data

The past five years have witnessed rapid rates of development within the field of AI and machine learning. For instance, the release of transformer-based language models like BERT – ie. Bidirectional Encoder Representations from Transformers – has proved the basis for unprecedented performance in many natural language processing tasks (Devlin et al., 2019). However, the emergence of such AI tools has occurred according to existing global hierarchies of power and resources: they are far from being equally available to all languages and actors. While Google AI developed dedicated BERT models with cutting-edge capabilities for major languages like English and Chinese, other languages had to make do with a less powerful multilingual model. Where big tech companies lacked the commercial interest to train these tools for particular languages, actors within the academy and beyond have tended to take the initiative to produce state-of-the-art monolingual models (ie. Virtanen et al., 2019; Martin et al., 2020; Kummervold et al., 2021). For so-called lesser-resourced languages, significant bottlenecks to doing so were the availability of sufficient computational resources and training data. In the instance of Sweden, the first monolingual BERT model was created by the Public Employment Agency using solely data from Swedish Wikipedia, which while better than Google's multilingual model was still considerably less effective than the English BERT (Haffenden et al. 2023: 35-36).

Yet the prevailing paradigm for producing state-of-the-art AI models enables national libraries and other heritage institutions to contribute to development in novel ways, especially in the case of smaller languages. With the emphasis on unsupervised learning in current AI development – ie. when vast algorithms called artificial neural networks learn through being exposed to huge volumes of unlabelled training data, rather than, as previously, from smaller amounts of (expensively) annotated data (cf. Radford et al., 2018) – new opportunities have emerged for the custodians of large amounts of high quality, language-specific data.

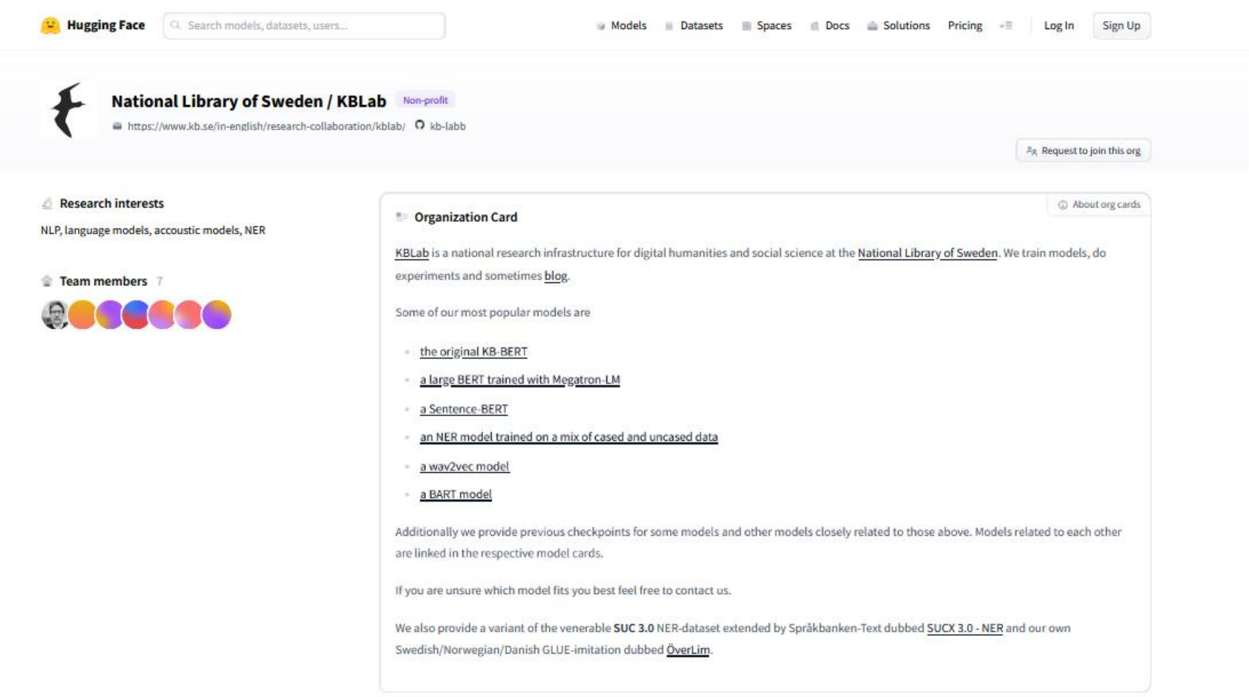
In such a context, the breadth and depth of KB's collections mentioned above becomes a uniquely valuable resource for the making of cutting-edge tools for Swedish AI. Indeed, the fact that legal deposit provides KB with something approaching population data for the language means there is an important *democratic* dimension to harnessing the library's collections as training data. With recourse to a broader and more representative range of data than that available to other actors (who have access chiefly to Swedish data that can be scraped from the web), KB has the potential to produce AI models of greater quality and effect. Given that this data cannot be shared beyond the library due to copyright and GDPR legislation, this creates a powerful rationale for the training of models in-house at KBLab (Haffenden, et al. 2023: 35).

Making and distributing collections-based AI

Against this backdrop of enhancing the quality of Swedish AI infrastructure towards global state-of-the-art, we have been using the library's digital collections to train new AI tools since the lab was established in 2019. The first phase of this development work focused specifically upon text, with the aim of improving the capabilities available for automated analysis of Swedish text in light of recent innovations with transformer models. Here we turned to the breadth and depth of KB's collections to train a BERT model for Swedish capable of processing what we referred to as "the living language of the national community" (Malmsten et al., 2020). To create such data representativity, we produced a large and diverse training corpus that made substantial use of the library's digitised newspaper archives dating back to 1945, as well as more recent online material and social media to capture more colloquial language use. Making this material amenable to machine learning so it could be used as training data also involved painstaking and laborious processes of data curation, which in turn depended upon the specialised competence in data science and programming of the lab's staff. The language model that this enabled, KB-BERT, proved significantly more effective than existing models and has since become the standard model to use for Swedish language processing (we return to this question of use below).[5]

In line with the increasingly multi-modal direction of current AI innovation and the multimedia inclinations of recent humanities scholarship, our development efforts at KBLab have also moved beyond solely text. Here we have been able to take advantage of the diversity of media forms stored in the archive: ranging across a variety of different modes, KB is guardian of unparalleled collections of Swedish text, images, sound, and film, which equates to a considerable range of possibilities for training new models. A pertinent example is our work at the lab in producing improved tools for automated sound recognition (ASR). This involved using the library's enormous, and often largely unexplored, holdings of audio-visual material from the twentieth century. More specifically, we utilised KB's digitised national and local radio programmes from the past two decades to produce a corpus of over 1,4 million hours of spoken Swedish, including dialects from all the regions in the country (Malmsten et al., 2022). This was then used as training data for Swedish versions of the wav2vec 2.0 model developed by Facebook (now Meta) AI (Baevski et al., 2020). As was the case with KB-BERT, the collections-based models that this produced, entitled VoxRex, outperformed existing multilingual and monolingual models for speech-to-text tasks (Malmsten et al., 2022).[6] As we will explain below, the existence of cutting-edge tools for Swedish speech-to-text creates a range of synergy effects, both within and beyond heritage institutions.

[5] This model is available here: https://huggingface.co/KBLab/bert-base-swedish-cased.
[6] Available here: https://huggingface.co/KBLab/wav2vec2-large-voxrex-swedish.



National Library of Sweden / KBLab

https://www.kb.se/in-english/research-collaboration/kblab/ kb-labb

Research interests

NLP, language models, accoustic models, NER

Team members 7

Organization Card

KBLab is a national research infrastructure for digital humanities and social science at the National Library of Sweden. We train models, do experiments and sometimes blog.

Some of our most popular models are

- the original KB-BERT
- a large BERT trained with Megatron-LM
- a Sentence-BERT
- an NER model trained on a mix of cased and uncased data
- a wav2vec model
- a BART model

Additionally we provide previous checkpoints for some models and other models closely related to those above. Models related to each other are linked in the respective model cards.

If you are unsure which model fits you best feel free to contact us.

We also provide a variant of the venerable **SUC 3.0** NER-dataset extended by Språkbanken-Text dubbed SUCX 3.0 - NER and our own Swedish/Norwegian/Danish GLUE-imitation dubbed ÖverLim.

Figure 3: Open access Swedish AI models available for download.

To ensure the AI tools we produce at KBLab can benefit as many as possible, we release our models open access via the data science community platform HuggingFace (see figure 3).[7] To date, we have made available 46 models in this way so that users are able to download and experiment according to their particular interests. In addition to the KB-BERT and VoxRex models mentioned above, these include a canonical Swedish SpaCy, a zero-shot classifier, Sentence-BERT and BERT models fine-tuned for named-entity recognition (NER), as well Swedish versions of the latest Whisper models for ASR released by OpenAI.[8] Beyond training our own models for Swedish text and sound, we have also collaborated with other actors in developing multimodal tools that connect image and text to enable new forms of image search (Carlsson et al., 2022). As

[7] This has been our policy for distribution for all of the models we have released so far, and will continue to remain so for predictive models. The situation with generative models is more complex, since there is a risk for such tools to be used in ways that counter the democratic goals of the library's mission - ie. in creating misinformation and fake news. On this basis, a more considered and restrictive distribution policy will be pursued in relation to generative models, should we produce them in the future.

[8] See our organisation page here: https://huggingface.co/KBLab.

part of the transparent and accountable approach to AI development that we pursue at the lab, we make sure to document the data we have used to train our models through a combination of HuggingFace descriptions, blog posts and research articles.[9] We also share our code via Github.[10] In this way, we seek to make it possible for users of the lab's models to understand how these tools have been made, and to consider how, in light of the particular values and emphases contained within the data in KB's collections, the models might need to be adjusted for use in specific applications (cf. Fridlund, 2021: 14).

The value of collections-based models in practice

If we turn to tracing the value of the models trained at the lab, these are being put to use in a diverse range of contexts. The initial impetus towards producing these models was as a means for making the library's huge, but therefore often largely uncharted holdings of digital material more accessible; through creating such tools we thought we might help the library better understand and describe its own collections, while simultaneously improving research access to this material. That this has come to fruition is demonstrated, for instance, in the various Master's projects at KBLab that have shown how KB-BERT could be used for the automated enrichment of metadata in the digital newspaper archive (ie. Estmark, 2021). It is also evident in a pilot project exploring how a topic modelling approach built upon our Swedish Sentence-BERT, BERTopic, might be used to provide a sort of automated subject headings that offer more fine-grained navigation of the collections (cf. Fano & Haffenden, 2022b). Perhaps most striking, though, is the positive feedback loop created by the lab's development work with sound data mentioned above: first, KB's collections enabled the production of state-of-the-art ASR models; these models can then be used for speech-to-text to make these collections amenable to text searching; and text transcriptions of

[9] See, for instance: https://kb-labb.github.io/posts/2023-01-16-sentence-transformer-20/.
[10] See: https://github.com/kb-labb.

the radio and television material can be used as new training data for yet another generation of new and better models at the lab. AI development and improved metadata thus work hand-in-hand to improve the accessibility of the material, thereby enhancing the library's function as a research infrastructure.

Beyond the library and research projects based at the lab, KBLab's models have proved valuable for both a surprising array of academic research and for information-intensive organisations outside the academy, in the public and private sector alike. In terms of the former, KB-BERT has now been utilised by medical researchers seeking to develop new lifestyle treatments for diabetes patients; in attempts to automatically identify the presence of implants (ie. pacemakers or stents) in heart patients prior to MRI scans; and for the classification of legal documents (Dwibedi et al., 2022; Jerdhaf et al., 2020; Avram et al., 2021). In terms of the latter, the lab's models have been put to work in automating and streamlining the information handling processes of various public authorities, including local councils, the Swedish Tax Agency (*Skatteverket*), the Swedish Courts (*Domstolsverket*) and most recently, the support function of State administration (*Statens servicecenter*).[11] As a growing number of Swedish organisations and companies start to become aware of the possibilities presented by AI, they are increasingly turning to our models for easy to access and state-of-the-art performance (Fridlund, 2021: 14; Juhlin, 2022: 36-41).

[11] For KB-BERT being used as the basis of a new search application for precedent in state bureaucracy, see: https://www.statenssc.se/nyheter/nyhetsarkiv/2023-03-14-ai-baserad-soktjanst-ska-underlatta-remisshanteringen-i-staten.

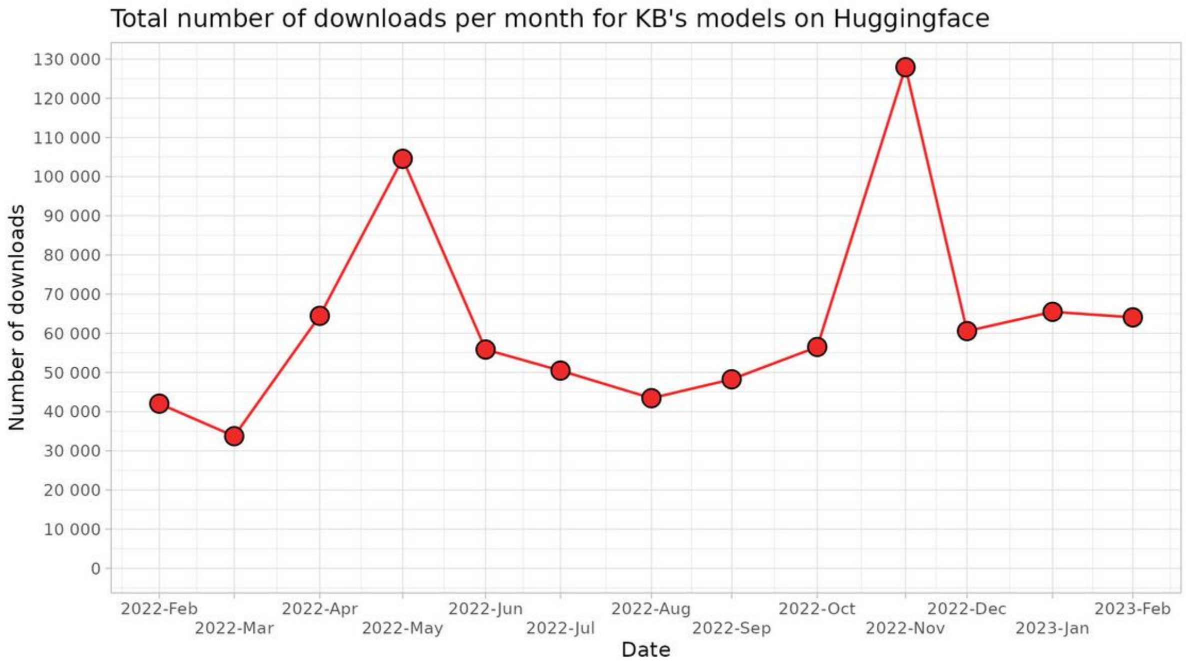


Figure 4: Download statistics for KBLab's open access AI models for the past year

However, the most striking evidence of the scale of the impact of the lab's collections-based models is quantitative in nature, with statistics showing over a million downloads since they were made available on our HuggingFace page (see figure 4).[12] Of course, these figures need to be contextualised: this does not refer to the number of discrete users, but rather the total number of times the models have been used (within, say, a particular application). Yet while we have no way of knowing further details about such usage – apart from what can be traced via citation of our articles and cases where we have come into contact with the specific developers (cf. Juhlin, 2022: 20-22) – these statistics can still be taken as a forceful demonstration of the reach of our work with producing new AI tools. As both of the independent evaluations of the lab's first two years have highlighted, the widespread uptake of models trained at the library indicates a pertinent way in which the lab's development work reinforces and furthers KB's democratic commitments

[12] These download statistics are also available here: https://github.com/kb-labb/huggingface_stats.

(Fridlund, 2021: 14; Juhlin, 2022). In making and releasing AI models using the library's data, KBLab thus offers a powerful new way of sharing the value of the collections outside the library itself.

Library-based AI development as a public good

The principal merit of this type of AI development is the way it can simultaneously enhance the library's functions as national research infrastructure and guarantor of democratic values (Förordning 2008: 1421). As a form of digital infrastructure, open access collection-based models enable a wide range of AI applications for Swedish, which would have proved difficult, if not impossible, without such infrastructural tools in place (cf. Edwards et al., 2009). As a means of encouraging and enabling democratic social development, there are distinctive yet mutually reinforcing aspects of these models that are worth accentuating and that we now turn to consider.

That we are facilitating an expansion of Swedish AI implementation by making the models freely available is intensified by the particular logic of the models' architecture. More specifically, the relative resource allocation between the pre-training and fine-tuning phases of a Transformer model lends itself to effective dissemination: while pre-training for a general purpose model like KB-BERT is computationally expensive and presumes large amounts of data, subsequent fine-tuning can be carried out with but a fraction of the data and computational resources (Haffenden et al., 2023: 33). This means that a far wider range of social actors outside resource-intensive environments like the university can consider downloading the models, experimenting with them, and applying them to their own particular use cases. Our work at the lab is thereby contributing to a democratising of both the technology and the library's data (Fridlund, 2021: 13). In this sense, KBLab is helping to share the newly-found value of the collections as data – understood as a form of publicly funded and maintained *commons* (cf. Harvey, 2011) – to new groups of users than those traditionally reached by the library and beyond.

This form of library-based development can even counter some of the more problematic aspects of an AI future driven purely by private sector actors, particularly the growing deficit of data accountability. As emergent AI technologies become more mature and increasingly governed by commercial concerns, there has been a concurrent move towards treating training data and methods as trade secrets to be protected from competitors. This was exemplified in recent discussions about the lack of transparency surrounding OpenAI's release of GPT-4, with one scientific researcher, Sasha Luccioni, suggesting "it's just completely impossible to do science with a model like this", given the lack of access to details about the data used to make it (Sanderson, 2023). Such opaque practices can also be connected to a wider culture of silence in the tech industry that precludes critical voices about, for example, the overreliance on vast, unaccounted-for web materials in training new models, as the case of Timnit Gebru amply illustrates (Bender et al., 2021; Gebru, 2021). By contrast, in adhering to careful practices of documentation, scrutinising the workings of data representativity and pursuing more representative models based on the breadth of the library's collections, we are engaged in an accountable form of AI work at the lab that can variously complement and challenge that of private tech companies (Fridlund, 2021: 14). Insofar as it is more open and operates according to other imperatives than commercial interest, library-based AI development can constitute one of the much-needed "alternatives to the hugely concentrated power of a few large tech companies and the elite universities closely intertwined with them" (Gebru, 2021).

Yet using publicly-funded heritage data as the basis for a more ethical AI development is dependent upon sourcing new forms of resources. Although it was possible to produce cutting-edge tools at the lab when these were of a proportion of a BERT model, the pace of recent AI innovation has led to new models at a scale that makes this far more challenging. To give a sense of the leap in scale: where BERT had hundreds of millions of parameters, GPT-3 has over 175 billion and GPT-4 is suspected to have far more – though, of course, this latter figure remains shrouded in secrecy as yet. While we have the prerequisite training data and specialised expertise in data science to produce larger models, a significant bottleneck has been locating sufficient computational resources. To solve this, and to be able to further our work in producing state-of-the-art models for Swedish, we sought the help of ENCCS (EuroCC National Competence Centre Sweden) to apply to use the EU's infrastructure for supercomputers, EuroHPC.[13] Gaining access to first HPC Vega (in Slovenia, with 240 GPUs) and now HPC Meluxina (in Luxembourg, with 800 GPUs), has enabled development work of a different scale at the lab (ie. Kurtz & Öhman, 2022). In becoming the first public authority to use these EU-funded development resources, KBLab is furthering the prospect of a Swedish AI that is open, accountable and democratically inclined.

Finally, contributing to the making of a national AI infrastructure in this way also demands novel collaboration. With the release of KB-BERT establishing the lab as a key player in Swedish language technology, we have since become involved in national and international networks that include a diversity of actors who are engaged in AI questions: from researchers and university departments, to coordinating organisations, public authorities and private companies. Forming new relationships and collaborating with this configuration of groups beyond those that the library has traditionally cooperated with is an important step in trying to work effectively in the rapidly

[13] For further details about the granting of such access to EuroHPC, see: https://www.eurocc-access.eu/success-stories/success-story-national-library-of-sweden-has-now-access-to-vega/ and https://enccs.se/news/2022/10/national-library-of-sweden-accesses-meluxina/.

evolving space of AI development. A recent example was our role in a project, together with the National Language Bank of Sweden at Gothenburg University, the Swedish Research Institute (RISE) and AI Sweden, to provide a set of benchmarks for evaluating Swedish language models (Kurtz, 2022).[14] By working together to make it easier for users of Swedish AI to determine which models might best fit their purpose, we are helping to make recent innovations more widely accessible. In this way, the lab's research collaboration with external actors is also leading to improved infrastructure.

Concluding remarks

In this article, we have discussed how the establishment of a data lab at the National Library of Sweden has enhanced the library as a digital research infrastructure. We elaborated upon the practical and technical considerations that shaped the making of KBLab as a physical site where researchers can now access the collections at unprecedented scales. We also explained how the library's digital collections have enabled the lab to play an important role in contributing to the development of a national AI infrastructure for the Swedish language. To conclude, we offer some reflections about the possibilities and challenges facing the lab as a node for the type of library-based AI development we have outlined here.

One of the key justifications for library labs in particular, and GLAM labs more generally, is that they provide new ways of sharing the value of cultural heritage material. As we have suggested, establishing such a lab can lead to a snowball effect with various positive, if often unforeseen, consequences. In particular, the consolidation of in-house expertise within data science and machine learning opens up significant possibilities for heritage institutions that are

[14] See: https://www.ai.se/en/node/81535/superlim.

increasingly becoming custodians of large volumes of digital material. Through working in tandem with domain specialists (ie. librarians, archivists, curators, etc), such labs can make these collections available at scale to researchers and other users so that they can pursue new lines of enquiry. Adopting a collections as data approach also creates significant opportunities to be able to contribute to AI development, especially for lesser-resourced languages that have not been prioritised by major commercial actors. By using high quality, language-specific heritage data to contribute to national infrastructure, and engaging in novel collaboration with external actors, these labs can play a role in democratising this data, while laying claim to a powerful new form of social relevance in the process. In short, GLAM labs create new and unexpected lives for collections far beyond the heritage sector itself.

Yet there are various challenges in maintaining such a lab and securing its future. While it might seem a platitude, it is far easier to start a lab, with all the start-up energy and buzz this entails, than it is to entrench one as a given part of a heritage organisation. In part, this is related to the thorny question of funding and a systematic tendency to underinvest in digital research infrastructure (Knowles et al., 2021). But it is also connected more specifically to the difficulty of attracting and retaining highly-qualified staff within publicly-financed AI development, when the demand for this data science expertise in the private sector is intensifying. There are even complexities to be addressed concerning how this expertise should be integrated within the wider organisation: should data scientists be centralised within a lab, as is the case with KBLab, or are there arguments for distributing this competence across the organisation as a whole? How are fruitful interactions between data scientists and domain experts best encouraged? (Haffenden et al., 2023: 45) In dealing with such questions, and seeking to navigate a way forwards through the rapidly shifting terrains of digitalisation and AI innovation, there is a compelling need for strategic leadership and direction.

Establishing KBLab at the National Library of Sweden has been a demanding yet creative process that has produced various synergy effects. Making the library's collections available for large-scale digital research also enabled the production of new AI tools, which can be used within the library for increasing the searchability of the collections and beyond the library for analysing data in a wide range of contexts. Our work in building digital research infrastructure and contributing to the development of national AI infrastructure has therefore proved largely symbiotic. In sharing our account of this process, we hope we might encourage others to test our conviction that future interactions of AI and the library can be mutually rewarding.

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Appendix 1.

KBLab's Code of Conduct

KBLab is an open and friendly working environment, where collaboration is encouraged, questions are welcomed, and the commitment to critical, open-ended and independent enquiry is foundational. This openness is essential for new research ideas and projects to flourish.

A prerequisite for such an environment is being kind to one another. To maintain this space for open enquiry, we expect all people connected to KBLab to behave according to the principles of mutual respect and decency. Not honouring these principles can lead to access to KBLab being withdrawn.

If you have any questions about this code, please contact us at at kblabb@kb.se.