The Past, Present and Future of the Prior Internet Resources

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Abstract

In 2016, researchers from six different Danish universities gathered together to begin a research project called *The Primacy of Tense - A. N. Prior Now and Then*. The goals of the project were as diverse as its participants, ranging from themes in philosophy and logic to explorations in information science and history. This diversity was held together by a key idea: that it is important to study the links between Prior's canonical published work and the extensive collection of unpublished material he left behind after his death. Thus a key practical goal of the project was to further explore and transcribe Prior's Nachlass and make more of it available on the *Prior Internet Resources* (PIR). In this article we describe how the PIR came about, discuss how it has changed, and suggest several directions for its further development, so it can continue fostering research into Arthur Prior's work in the future.

Keywords: Arthur Prior, The Prior Internet Resources (PIR), reSearch Assistant, Nachlass, eResearch

1 Introduction

In 2016, the project *The Primacy of Tense - A.N. Prior Now and Then* (henceforth, the Prior project)[1] brought together scholars from six different Danish universities: Aalborg University, Roskilde University, Copenhagen University, the Technical University of Denmark, Aarhus University and the University of Southern Denmark. With Peter Øhrstrøm (AAU) and Patrick Blackburn (RUC) as chairpersons, the project focused on the philosophy and logic of the New Zealand born researcher Arthur Norman Prior. In the project description they declared:

> We will map Prior's work, looking for places where he endeavours to explain just what he takes the difference [between the internal and external view of time] to be, and will explore, extend and integrate a range of technical tools, developed since Prior's death, which critically articulate his internal or tensed view of time, and extend it in directions not considered by Prior.
>
> (The Primacy of Tense - A.N. Prior Now and Then - Aalborg University (aau.dk))

The project has carried out many such critical articulations of Prior's work - but one form of articulation has been particularly emphasised (and valued) throughout the project: those that draw on insights from Prior's Nachlass. Most of his Nachlass is stored in 28 boxes at the Bodleian Library in Oxford, and even before the project started, this Nachlass material had proved its worth. For example, David Jakobsen's Aalborg University PhD thesis (Jakobsen 2013) re-examined Prior's metaphysical views, drawing heavily on newly-discovered Nachlass texts. On the logical side, Patrick Blackburn and Klaus Frovin Jørgensen, during a visit to the Bodleian in 2014, drew on the archived correspondence between Hans Kamp and Arthur Prior to clarify the role that temporal reference and hybrid logic played in Prior's analysis of Kamp's "now" operator (Blackburn & Jørgensen 2016).

All in all, the project had many interesting and ambitious goals - and many of its goals were more comprehensively achieved than originally planned. For example, the project was originally intended to give rise to one book, but the reader has now found herself reading a paper from its

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[1] The project was funded by the Danish Council for Independent Research. DFF-FKK Grant ID: DFF-6107-00087.

fifth book. Indeed, the first book has even morphed into a book series called *Logic and Philosophy of Time*, published by Aalborg University Press. There are several reasons for this more comprehensive output, but (appropriately) the most basic one was *time*, namely the extended timespan over which the project ultimately unfolded. Begun in 2016, the project was meant to end in 2019. However, the project was first extended due to the (happy) news of maternity leave for the project's PhD student, and then once again due to the (unhappy) news of the Covid-19 crisis, which meant that parts of the project were delayed. Subsequently, the project carried on into 2023 when it (sadly) finally came to an end.

This extended timespan offered further opportunities for developing the ideas and goals of the project. A key practical goal that benefited was that of developing and enhancing the Aalborg University based *Prior Internet Resources* (PIR). These resources are a key element in the project's endeavour to explore links between Prior's well-known published works and the unpublished material in his Nachlass.

In this article we shall take a closer look at the PIR. We first present its past form(s), and its development into its present incarnation; this will naturally lead us to a discussion of possible transitions into the future, and thereby to explore the question: how should the PIR develop to ensure it remains a useful tool for the study of Prior's work, one that will foster further research into the logic and philosophy of time?

Accordingly, in Section 2, we turn to the Danish *Prior Internet Resources* and its three components: (a) Prior studies; (b) the Virtual Lab for Prior Studies; and (c) the Nachlass of A. N. Prior, and outline the transformations that led to the form each site has today. Then, in Section 3, we begin our discussion of developmental possibilities. We first focus on the *Nachlass of A. N. Prior*, arguing that this component would benefit by adding what we call a *reSearch Assistant*. Then, in Section 4, we turn to the *Virtual Lab for Prior Studies* and discuss the potential offered by OCR *handwriting recognition technologies*; we believe that not only could they could streamline the transcription process, but (with the help of the proposed reSearch Assistant) could make it a more powerful eResearch environment. Section 5 summarises and celebrates.

We assume that the typical reader has heard of Arthur Prior, and is likely to be familiar with some of his best-known achievements, most notably his invention of tense logic. For readers without such background, we suggest a quick visit to *Prior Studies* (https://research.prior.aau.dk/priorstudies/) for a brief introduction to

the life and work of Arthur N. Prior, the founder of modern temporal logic.

2. The Prior Internet Resources

This paper outlines how the three branches of the Danish-built Arthur Prior websites, branches with different aims and functions, grew together to form something even more useful. Engerer & Albretsen (2017) introduced an umbrella term for these sites: the *Prior Internet Resources* (henceforth PIR), and we shall adopt their handy terminology throughout this paper. The three sites making up the PIR are:

Name	URL
Prior Studies	https://research.prior.aau.dk/priorstudies/
The Virtual Lab for Prior Studies	https://research.prior.aau.dk/
The Nachlass of A.N. Prior	https://nachlass.prior.aau.dk/

We now present all three in turn, starting with the oldest and simplest.

3. Prior Studies

The first component of the PIR was Prior Studies. This was launched in 1999 under the name Foundations of Temporal Logic - The WWW-site for Prior-studies, a joint project between Department of Information Studies - University of Copenhagen and Department of Communication and Psychology - Aalborg University.[2] The main focus of the site back then was the legendary box-lists of the contents of the Nachlass material of Arthur Prior stored at the Bodleian Library in Oxford. These lists, produced by Per Hasle, have long functioned as the guide to the Bodleian archival material, the material the library received after the death of Prior in 1969.[3] But the first version of the Prior Studies site was looking rather old-fashioned by 2017. As Volkmar Engerer and Jørgen Albretsen put it, "Priorstudies has a typical, though a bit outdated, research portal, outlook" (Engerer & Albretsen 2017, p. 231). In 2018 the site was changed significantly.

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[2] A version of this, with the shorter title "Foundations of Temporal Logic - The WWW-site for Prior-studies", can still be accessed from the home page of priorstudies.org (you can find the link by clicking on "Prior Links" on the menu on the left side of the home page).

[3] There are several sources that discuss this part of the story, for example, Sabir & Engerer (2019).

First of all the name was changed (while the emphasis on it being a WWW-site may have been noteworthy in 1999, this was no longer the case in 2018) and the site became: *Prior Studies - The Life and Work of Arthur Norman Prior*, now usually referred to simply as *Prior Studies*. Moreover, the design was updated to make it more accessible (in one earlier version, most of the main text was in the characteristic blue colour associated with links, making it hard to distinguish links from text). New features, including gateways to the YouTube channel *Prior Studies*[4] and to the archives containing material relevant to the study of Prior's work were added.

The site continues to offer general information relevant to scholars of Arthur Prior's logical and philosophical work.[5] Indeed, its bibliographical listing of secondary literature gathers together information not easily found elsewhere. In particular, part B (reviews of Prior's publications), part C (obituaries and memorial papers) and part D and (memoirs containing description of Prior) are extremely valuable resources. Part A (secondary literature on the writings of Prior) is perhaps a little more uneven: it is strong on early material, but contains only four references to work published in the 21st century. This has the unfortunate side effect of omitting any references to work published in (say) the special *Synthese* issue brought out for the Prior centenary,[6] or indeed to work published as part of the Prior project itself. Nonetheless, the overall usefulness of Prior Studies as a one-stop-shop for bibliographical information about Prior is undeniable.

Prior Studies continues to carry information about the celebrated box-lists mentioned earlier; these are still the essential tool for searching the physical Nachlass at the Bodleian Library. Today, however, there are other tools for studying Prior's Nachlass - and this brings us to perhaps the most important remaining function of the Prior Studies site: namely, that it functions as a gateway to *The Virtual Lab for Prior Studies* and *The Nachlass of A.N. Prior*. The remainder of the article focuses on these two newer sites.

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[4] https://www.youtube.com/@priorstudies1830ouTube

[5] For a fuller discussion of the development of Prior Studies in 2018, the reader should consult Sabir & Engerer 2019.

[6] Special Issue on The Logic and Philosophy of A.N. Prior, guest edited by Jørgen Albretsen, Per Hasle, and Peter Øhrstrøm, Volume 193, issue 11, November 2016.

4. The Virtual Lab

The second component of PIR, *The Virtual Lab for Prior Studies* is arguably the most important online tool for the Prior research community: it offers an extensive collection of photographs of Prior's Nachlass, including photographs of letters, articles, unpublished manuscripts, lecture notes, and other material - and it offer tools to help the user transcribe them.

The Virtual Lab came into being in three main steps. First, the Bodleian Library, shortly after the death of Prior in 1969, received 29 boxes containing letters to and from Prior, plus manuscripts, lecture notes, and so forth. Sadly, the contents of these boxes could only be studied at the Bodleian Library, and then only with written permission from Prior's heirs.

A second - crucial - step took place in 2007, when Mary Prior, Arthur Prior's wife, granted the Danish Prior Research Group permission to "edit and publish, separately or jointly, all scientifically relevant material by my late husband Arthur N. Prior, of which I am the copyright holder" (Typed statement). The research group were thereby granted special access to the boxes at the Bodleian, and not only to study the material, but also to publish it. However, access to the original materials remained physical, and thus restricted to Oxford.

This changed significantly in 2010 when the third step was taken: the Bodleian Library allowed the material to be photographed and stored online, under the condition that (a) the library retained the copyrights of the photographs, and that (b) the material was stored online behind a firewall. With these permissions in hand, Jørgen Albretsen began to develop the virtual lab in 2011. In essence, *the Virtual Lab* is an online platform where the digital photographs could be accessed (by authorised users with a user account and login) to be studied and ultimately transcribed for publication in *The Nachlass of A.N. Prior* (as discussed below). *The Virtual Lab for Prior Studies* was officially inaugurated in 2014 at the Author Prior Centenary Conference, at Balliol college in Oxford,[7] and made it possible to access the Bodleian archival material worldwide.

Today, the material stored in *The Virtual Lab for Prior Studies* is far more comprehensive than the original Bodleian material, thanks to several donations made by Martin Prior, Arthur Prior's only son. Martin Prior donated letters, notes, notebooks, scrapbook material, pictures, and even

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[7] Prior was based at Balliol college in his final years.

some items from Arthur Prior's personal library. The material was donated on several occasions, the first in 2017, and while a substantial part of it can already be found in *The Virtual Lab for Prior Studies*, several pieces are still awaiting scanning, transcription and uploading to the part of The Virtual Lab for Prior Studies that has become known as the Martin Prior Collection (or Martin's collection).

The purpose and importance of the Virtual Lab can be summarised as follows:

> [T]he main purpose of The Virtual Lab for Prior Studies is to make the archival material accessible for examination and transcription. Registered users are free merely to browse and download the material, but the hope is that they will become active transcribers, converting the material into searchable digital materials (PDF files).
> (Sabir & Engerer 2019, p. 206)

During the transcription process, an item is typically enriched with information provided by the transcriber and the proof reader; typical additions include information about people, places, academic work, ideas, and so on, mentioned in the document. Figure 1 illustrates the transformation from the Bodleian Library or the archive at Aalborg University to The Virtual Lab for Prior Studies, and finally *The Nachlass of A.N. Prior*.[8] Thus, it is in *The Virtual Lab for Prior Studies* that the documents undergo their transformation from photographs of Prior's Nachlass to digitally enriched entities in the *The Nachlass of A.N. Prior*.[9]
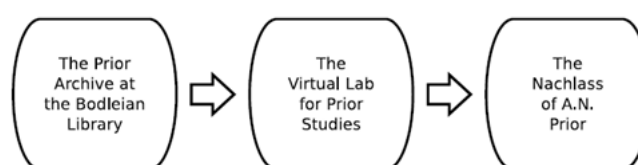

Figure 1: Travelling from the Archive to the Nachlass

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[8] First presented in Sabir & Engerer 2019.

[9] For further discussion of the journey from a physical document located either at the Bodleian or at Aalborg University, to photographed documents in *The Virtual Lab for Prior Studies*, and finally to a digitally enriched document in *The Nachlass of A.N. Prior*, see (Engerer & Sabir 2020).

5. The Nachlass of A.N. Prior

The third and final component of the PIR is *The Nachlass of A.N. Prior*. This site offers full text versions of the material from *The Virtual Lab for Prior Studies*, material which has been transcribed and commented on by international and Danish-based Prior scholars.

Over the project period, the number of items in the Nachlass has increased significantly. In 2019, The Nachlass of A.N. Prior contained transcriptions of 68 previously unpublished letters and papers from the Prior archives (Sabir & Engerer, 2019 p. 205). By 2023, the num-ber had increased to 112, with an equal share of 56 letters and 56 papers.

Having discussed the past and present of the PIR, it is time to look to its future. While both *The Nachlass of A.N. Prior* and the *Virtual Lab* were updated in 2018, the updates were mostly restricted to design and presentation. In the two following sections we will discuss how these components of the PIR could be functionally updated with the goal of fostering further research on the logic and philosophy of Arthur Prior. We start with *The Nachlass of A.N. Prior*.

Screenshot 1: Search in The Nachlass of A.N. Prior

To put it another way: it is merely the metadata about the documents that are searchable; the actual texts themselves are not. Accordingly, the site's search engine is mostly useful if the researcher knows more-or-less exactly what she is looking for. Indeed, if the researcher wishes to interrogate the Nachlass in a more exploratory manner, for example, by

searching for a key concept like "Tense", then she would be presented with the following search hits:[10]

Class.	Author	Recipient	Title	Date
Paper	Arthur N. Prior		"A wants me to relativise my tenses to dates. It seems to me …"	
Paper	Arthur N. Prior		Postulate-Sets for Tense Logic	1966

Screenshot 1: Search result from The Nachlass of A.N. Prior

This is not particularly helpful. Of course, the user could download the individual PDF files from the Nachlass, and use (say) Adobe Reader to search for sentences and keywords. However, this only allows for the examination of one document at a time; it does not search across documents, or collate the information.

Admittedly, using a reference manager like *Mendeley*[11] might sometimes do the trick. Even so, this requires that the documents are downloaded and stored in the program, and filling in the meta-data about the files is often a rather time consuming task. Moreover, there is no way of storing search records or results.

Screenshot 3: Search on "Prior" in a local Mendeley library

Thus it would be useful for the Prior scholar wishing to explore the contents of *The Nachlass* of A.N. Prior in more depth, if the site offered a search tool for searching for keywords and sentences in and across PDF files, a tool which could store the search records and their results.

Julie Lundbak Kofod, in her recent PhD thesis (Kofod 2022), has demonstrated the potential of such a tool. As part of her PhD work she searched the Nachlass for occurrences of the words 'relativity',

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[10] Search conducted on August 6th, 2021.

[11] Since 2009 Mendeley has become a widespread (and free) research tool for handling references and compiling bibliographical lists compatible with both Word and LaTeX.

'relativistic' and 'physics'. Relativity (particularly special relativity) is a topic that Prior returned to several times in his career. Indeed, it is mentioned in his very first paper on tense logic (Prior 1958) and in an Appendix to his best known book *Past, Present and Future* (Prior 1967) where he famously conjectured that the Diodorean modal logic of (two dimensional) Minkowski Spacetime was **S4.2**; Prior's conjecture was eventually proved correct by Robert Goldblatt (Goldblatt 1980).[12] But can the Nachlass cast any light on the development of Prior's thoughts on special relativity? Kofod showed in Chapter 4 of her thesis (which is a lightly modified version of Kofod (2020)) that it could; she did so by isolating two of Prior's early "standpoints" on special relativity from Nachlass material. However, what is relevant for the present discussion is that she did so by writing and using a PDF search tool which she described as follows:

> **The search program is a** prototype of a search engine written in Python that can work through a collection of PDFs, searching several PDFs for multiples words at one time, The program outputs a list with the text in which the individual search-words occur, stating on which page and how many times they were found.
>
> (Kofod 2020, p. 232)

This search tool - which we view as a prototype of the type of reSearch Assistant of the kind we would like to see embedded in the PIR - is a Python[13] program that can search a library of multiple PDF files using a list of search words. The program then performs the required searches on the PDFs and outputs a new list with a file name for the relevant paper, the search word, and the page number on which it was found.

For example, suppose we apply our prototype reSearch Assistant to the archival material in *The Nachlass of A.N. Prior* and search for "time" and "logic". Then we will obtain the following search hits, where the first

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[12] Robert Goldblatt, like Arthur Prior, is a New Zealander. Indeed, he is one of Arthur Prior's "PhD grandchildren". Goldblatt had Max Cresswell as a PhD supervisor, and Cresswell was Prior's PhD student (while Prior was a professor at Manchester University). Robert Goldblatt is probably New Zealand's best known mathematical logician; his best known work is on modal and temporal logic and related systems.

[13] Python is one of the most popular contemporary program languages. It is widely used in many applications including machine learning, and is excellent for writing file manipulation scripts such as the one described here.

line is the file name of the paper "Faith, Unbelief and Evil. A Fragment of a Dialogue":

```
20111020215118.pdf
time found on page 3
logic found on page 4
logic found on page 5
logic found on page 6
logic found on page 8
time found on page 9
time found on page 10
time found on page 11
logic found on page 12
time found on page 13
```

Screenshot 4: Search result using reSearch Assistant for the Nachlass

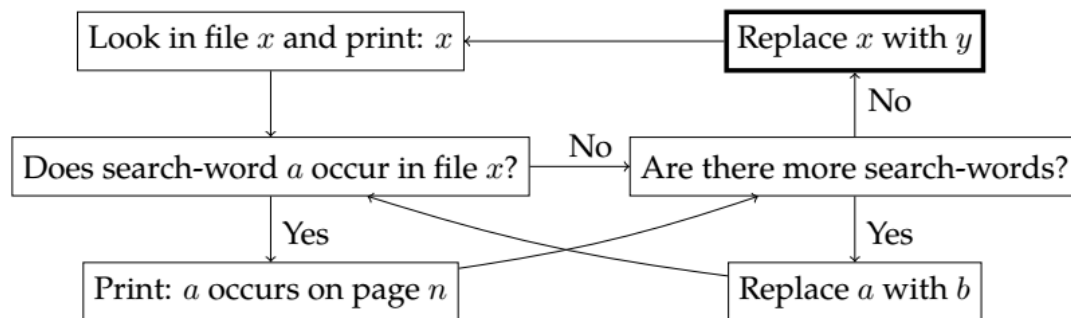Figure 2 shows the flow diagram of how the reSearch Assistant carries out a search; the figure is from Kofod (2020).

Figure 2: Structure of the reSearch Assistant

Kofod's PhD search for terms related to relativity is a good example of why searching for keywords and sentences in and across multiple PDF files (and collating the information) can be useful: it makes it easier for researchers to search for when and where various themes emerged, and may help us pin-down transitions in Prior's thought. We shall note another such example from Kofod's thesis later on, but it is first worth pointing out that searches in and across PDF files can be useful in other ways too.

Here's a fictitious example. Suppose a researcher wanted to find out whether Prior had mentioned robots in his writings. Then, using the

present setup, she would have to search through all 112 papers to conclude that the Nachlass does not mention robots. Without some sort of reSearch Assistant (equipped with a "search everything!" option) this would be rather time consuming. More generally, it often happens that a researcher exploring a corpus does not go in with a fixed idea ("I need to know *exactly* what Arthur Prior wrote on special relativity!") but wants to experiment, to play with new keywords, to stumble serendipitously across new ideas.[14] Gaining an overview of keywords and phrases - both present and absent - in a large body of text can be enlightening. To put it another way: adding a research tool with such search capabilities enables the users to shift from being *needy* users, to being *exploitative* users (this terminology is from Sabir and Engerer (2019)). Such users enter the Nachlass not for a specific encounter (say "relativity") but in the hope of serendipitous discovery, and the ideal reSearch Assistant should help make this possible.

At present no such tool is integrated into the PIR. Kofod's experiments with her prototype were conducted by downloading all the transcription PDFs in the Nachlass into a single directory and searching that. Obviously it would be easier if no downloading (or installation of Python) was required, and the user merely needed to click on the desired files, input the words and sentences to be searched for. Carrying out such an integration is certainly feasible and worthwhile. It is also worth noting that Kofod's own prototype PDF search script is not the only candidate. Indeed, in her PhD thesis, Kofod also experimented with the open source program *DocFetcher*. Using this to search in and across multiple PDF files (this search included material from a local collection of Prior's works including Nachclass material and a number of published books), she showed that there was an important shift in the way Prior used the word "quasi", and how often he used it. In particular, starting with Prior's two late papers "Tense logic and the logic of earlier and later" (Prior 1968a), and "Quasi-propositions and Quasi-individuals" (Prior 1968b), such expressions as "quasi-modality" became increasingly common and acquired a special meaning.[15] All of which leads us to conclude that while no such reSearch Assistant is currently integrated into PIR, such a tool would be a welcome and timely addition.

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[14] It is rarely explicitly described in published papers how the cited material was found or chosen, but a well-known and well-described method is the snowball method; see for example Coleman (1958) and Goodman (1961; 2011).

[15] See "Total Quasiness", Chapter 6 of Kofod (2022). The appendix to this chapter (pages 147-148) discusses the searches she made and their results.

4. A New Dimension for the Virtual Lab

As stated in the project description, one of the Prior project's main aims was to explore the links between Prior's published and unpublished Nachlass material - and indeed, if possible to discover new material.[16] The *Virtual Lab* is the driving force behind the PIR - this is where the raw images are turned into text - and accordingly the project description declared that "an important goal of the project is to continue developing the Prior VL [*The Virtual Lab for Prior Studies*]."[17] Following up on this goal, the Prior project developed the design and format significantly.

Firstly, there has been a noticeable change in format. At the beginning of the project the site looked like this:
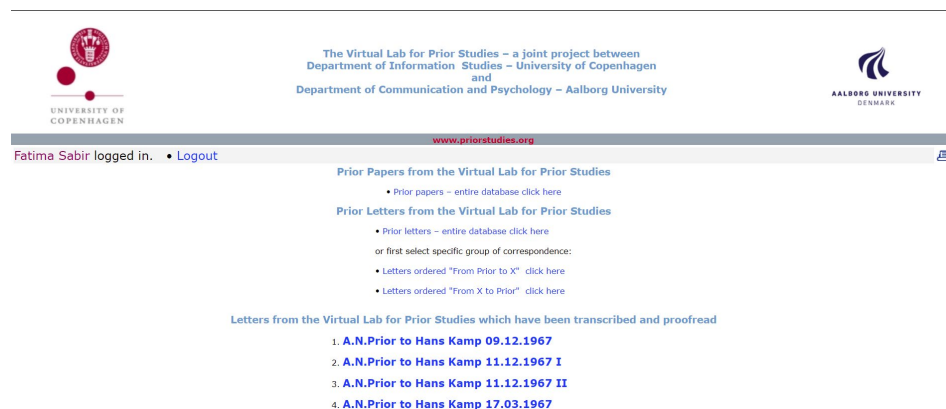
Screenshot 5: The "old" lab

By clicking on the "Prior papers - entire database click here" the user enters the lab, where she is presented with a simple search function:

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[16] The project was spectacularly successful in this last goal, thanks to Martin Prior, who (among other things) donated three little handwritten essays, one on religion, one on science and one on religion. All three were written by Arthur Prior at the age of 16, and (together with a list the young Prior called My Ideal Library) were published, with accompanying commentaries, as Three Little Essays: Arthur Prior in 1931, the third volume in the book series Logic and Philosophy of Time (Jakobsen et al 2020).

[17] Project description on The Primacy of Tense - A.N. Prior Now and Then - Aalborg University (aau.dk). Accessed on 19th of February 2023.

Screenshot 6: Search function in the "old" lab

Screenshot 7 gives an example of a search in the "old" lab. Here a document is marked green, when it has already been transcribed, proofread and can be found in the Nachlass. Yellow means that the document is assigned to a user for transcription, but that either the user has not completed the transcription or the transcription has not been proofread. Finally, red means that a document has not been transcribed by anyone.

Screenshot 7: Search result on "Time" in the "old" lab

Today, the user is met with a contemporary modern design site after login, one where the search function is more accessible (it is no longer in a second layer in the site, but is visible at the top layer) - see Screenshots 8 and 9.

The Virtual Lab for Prior Studies

The Virtual Lab currently contains **1663** documents.

Was this page not what you expected? Try either the old search page for papers or the old search page for letters.

Title

| Document title | -- Select a document ∨ |

Classification, No. and Collection

| All classifications ∨ | Document No. | -- Select a collection ∨ |

Author

| First name | Last name |

Recipient (Only applicable for letters)

| First name | Last name |

Date

| -- Select a day ∨ | -- Select a month ∨ | -- Select a year ∨ |

Search

Screenshot 8: The lab today

The nuances of green, yellow, and red have changed slightly, and the metadata in the search results give a little more information.

Showing search results

Show 1(∨ entries

No.	Class.	Author	Recipient	Title	Collection	Date	Comment
1616	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 01.04.1954 (B56)	Martin's Collection	April 01 1954	
1660	Letter	Arthur Norman Prior	Mary Prior	Arthur N. Prior to Mary Prior 01.07.1954 (B5)	Martin's Collection	July 01 1954	
1622	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 01.09.1947 (B63)	Martin's Collection	September 01 1947	Written Sunday evening. Date is the date of arrival of the letter
1625	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 03.08.1965 (B66)	Martin's Collection	August 03 1965	Written Tuesday
1603	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 03.12.1946 (B45b)	Martin's Collection	December 03 1946	Written Tuesday. Given same identifier as B45 for unknown reasons. Potential mistake.
1627	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 04.11.1946 (A2)	Martin's Collection	November 04 1946	
1629	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 04.12.1946 (A4)	Martin's Collection	December 04 1946	
1621	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 09.04.1951 (B62)	Martin's Collection	April 09 1951	Unfinished *Transcription assigned to: Patrick Smith*
1628	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 09.08.1954 (A3)	Martin's Collection	August 09 1954	
1619	Letter	Arthur N. Prior	Mary Prior	Arthur N. Prior to Mary Prior 10.04.1951 (B59)	Martin's Collection	April 10 1951	*Transcription assigned to: Patrick Smith*

Showing 1 to 10 of 87 entries

Previous 1 2 3 4 5 … 9 Next

Screenshot 9: Search result in the lab

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It is a substantial resource: the lab currently holds 1663 documents. However, relatively little has happened to the site's functionality, and here we feel that more could usefully be done. As we said at the start of the paper, one of the main barriers to the goal of ensuring that the lab fosters discoveries about Prior's philosophy and logic and thereby further research is *time* - and indeed, the extended lifetime of the project has been a significant factor in many of the enhancements made to PIR. However, time is not just required for work *on* the lab, it is also needed when working *in* the lab.

During the course of the Prior project, several documents have been transcribed and commented on, and then sent on the journey from the lab to the *Nachlass*, which increased in size from 68 documents by 2019 to 112 documents by 2023. This is certainly no small accomplishment. Nonetheless, despite this dedicated work, over a thousand documents still await transcription. Could the transcription process be speeded up - and, more to the point, speeded up in a way that might be helpful to Prior researchers? We think it could be.

A first (very modest) idea might be to test the many (often free) tools for speech-to-text. At the moment transcription at workshops is typically done with at least one person reading the handwritten material out loud, while another is transcribing the words being read; afterwards the two (the reader, and the transcriber) go through the transcribed text and check it against the handwritten text. However, if tools of speech-to-text were used by the reader, perhaps a little time and effort by the transcriber might be saved.

Nonetheless, this modest idea is essentially a (rather minor) nudge to the existing setup. Given the ocean of documents that await transcription, emptying it one drop at a time seems somewhat on the slow side. We would like to suggest a more potent experiment: trying out the multiple online tools that can transform handwritten material into texts. This technology is called *Optical Character Recognition* (OCR), and it enables users to convert handwritten documents into text that are both readable and searchable. There are many different OCR programs; a quick search will reveal such names as *Adobe Acrobat Professional*, *FineReader*, and *Microsoft OneNote*. Moreover, they are easy to use, and YouTube has several videos on how to use OCR programs to turn handwritten material into PDFs:
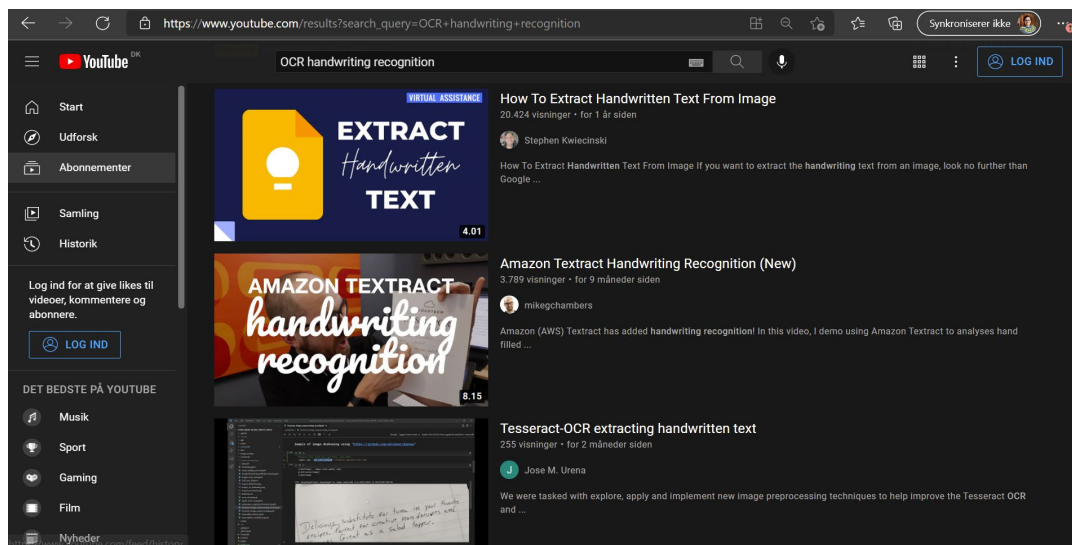
This technology is nothing particularly new; indeed "Isolated character recognition is now yesterday's technology" (Nishiwaki et al. 2022, p. 29). However OCR has been considerably refined over the last few years, and there is now easy access to it, and we think it might be helpful to Prior researchers. Crucially, we think that OCR can be used in ways that mesh naturally with the existing architecture of the PIR.

The basic idea is simple: attempt to produce transcriptions for *all* the Nachlass material using this technology. At present, the online *Virtual Lab* site consists of a collection of photographs which registered users can access; the goal would be to turn it into a site consisting of the same photographs, *plus its accompanying OCR produced transcription*. Thus, when a registered user looks for interesting material to transcribe, they are not totally dependent on deciphering the handwriting; they can, should they so wish, also consult the accompanying machine-generated transcription. To put it more simply: transcribers are not *forced* to begin from scratch. They can - if they want - consult the OCR transcription attempt, and inexperienced users may find this helpful.

It is important to note that we are *not* suggesting that these OCR transcriptions be made freely available on the *Nachlass* site. The *Nachlass* is meant to contain carefully transcribed and commented documents - documents that truly reflect Arthur Prior's work - and this should not change. But having OCR transcriptions available for each image to registered users may help speed up the transcription process, and - just

as importantly - may help guide potential transcribers towards interesting documents to transcribe *humanly*.

But there is another - potentially far more important - use of such transcriptions, and this will take us back to our earlier discussion of our reSearch Assistant proposal. We do think it would be extremely valuable if registered users of the Virtual Lab could access *all* OCR transcriptions using such a reSearch Assistant.

Kofod's PhD search for terms related to relativity provides a good example of why this might be useful. First, extending her search for keywords and sentences in and across multiple PDF files to cover the entire Nachlass seems sensible. It may well be that her earlier search (which was confined to the material then available at the Nachlass site) has uncovered all that Prior wrote on these topics. But maybe there is something else, and maybe it's important. We don't know - but it would be lovely to find out.[18]

Here it's important to make a brief point about the underlying logic of searches that cover OCR transcribed material: a negative search result does *not* mean there is no relevant Nachlass material, and a positive search result does *not* mean that there is. This is because OCR transcription is (far from) 100% reliable. There's not much that can be done about the negative result. Maybe, somewhere out there in the ocean of Nachlass documents, Prior did indeed make a joke about "robots" - but a clumsy OCR transcription has managed to turn this into a remark about someone called "Robert"! But such extended searches would certainly be helpful in the case of positive results. The relevant (by assumption, non-human transcribed) document(s) would be noted by the reSearchAssistant as potentially interesting. The researcher could then access the document(s) thus pinpointed, assess whether or not the OCR transcriptions were correct or not. Assuming that at least some of them were, then further candidates relevant to the researcher's interests have been successfully fished out of the ocean, and have become interesting

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[18] OCR could also be incorporated into the reSearch Assistant. Indeed, OCR was added to the Python prototype search engine described in Kofod (2020). It was added as an extra layer at the top of the program, so that every file first went through OCR before the search was carried out. The extra step of course slowed down the search, but enabled searches within and across bigger collections of Prior's material, namely material only available in non-searchable files such as scans of published texts. However OCR was not tried on any of Prior's handwritten materials.

candidates for the full human-driven process of transcription and comment.

To sum up, Kofod's experiments suggest that even a unified free text search tool of the kind we have described would be a potent addition to the *Virtual Lab* toolkit. But other approaches are certainly possible. For example, an anonymous referee suggested it might be interesting to explore the use of a controlled language for eResearch on Prior's work. We are in hearty agreement with the spirit of such suggestions.[19] The key point of this article is that the present form of the PIR is best regarded as the "current snapshot" of an evolving eResearch environment, an environment that has the potential to become even more flexible and useful.

For example, it is tempting to try applying machine learning technology directly to the handwritten Nachlass material. Here the idea would be to use the existing transcribed material - all of which was produced by (human) experts on Prior's writing - as training material for a neural net. How well could such a system perform? It would be interesting to find out.

6. Final reflections

The paper is essentially a celebration of the PIR. It is a remarkable tool, one that has proved itself in multiple ways, and the efforts of Peter Øhrstrøm, Per Hasle, David Jakobsen, Jørgen Albretsen, Martin Prior, and the many other designers, dreamers, developers, and users who have contributed so much to it in various ways, deserve the warmest appreciation and thanks from scholars interested in the work of Arthur Prior.

For the PIR *is* truly useful. There is perhaps a temptation to think that such specialised internet resources are less important in the age of Google search - but this is mistaken. If we simply do a Google search - indeed, even if we restrict ourselves to a Google Scholar search - this will typically yield far too much. For example, a boolean search using the keywords

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[19] As the referee pointed out, this would involve creating a set of topical subject terms ("descriptors"), that is, content related metadata for each document in the Nachlass. He or she argues that one of the advantages of such an approach would be the prospect of generating a Priorean ontology, and suggests that the existence of such a "Thesaurus" might help researchers orient themselves in advance to the topics the Nachlass covers.

"time", "logic" and "Arthur Prior" offers an overwhelming choice of approximately 2,500 hits.
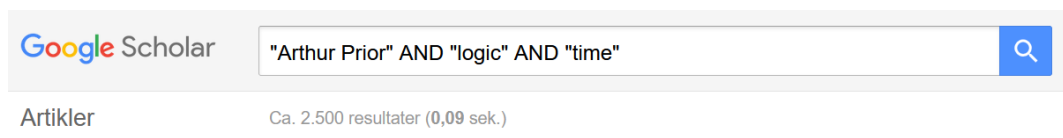
Screenshot 11: Google Scholar search on the 15th August, 2021.

On the other hand, the same search in the Web of Science reveals far too little, resulting in merely 11 entries:[20]
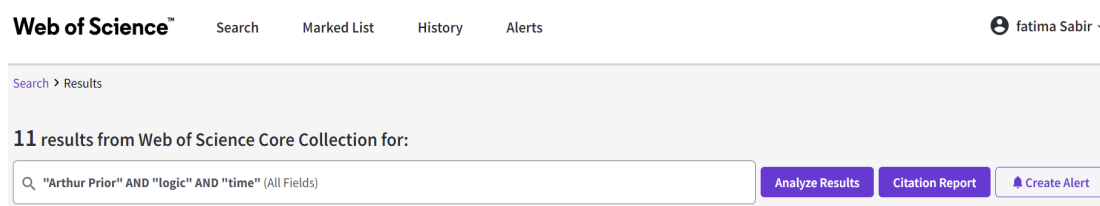
Screenshot 12: Web of Science search on the 15th August, 2021.

The PIR offers far more. It offers excellent access to secondary sources - indeed as a reference to the non-technical literature on Prior from the late 20th century it is truly excellent. Crucially - indeed, *uniquely* - it offers not only online access to the Nachlass material (Oxford may be lovely, but it is expensive to visit) but also the tools to transcribe and comment on the photographs. But as we said at the start - what of the future? If we were to attempt to summarise our wishlist in light-hearted fashion it would simply be this: adding a reSearch Assistant to the PIR - and allowing it to play even with the less-than-perfect transcriptions produced by OCR - could help turn the PIR into an even more pleasant playground for progress on Prior than at present.

Acknowledgements

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[20] This figure surprised us at first, though upon reflection it is perhaps more disappointing than surprising. Basically, the Web of Science does not contain anything like a full database of works relevant to the study of Prior, perhaps because it is more geared toward hard sciences than the humanities and social sciences. But we draw attention to this database as for some researchers interested in Prior (for example, computer scientists) this database may well be the very first place where they search.

donations of material relevant to the study of the work of his father, today to be found in Martin's collection, physically at Aalborg University and online at the PIR.

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