Analyzing the Lives of Finnish Academic People
1640–1899 in Nordic and Baltic Countries:
AcademySampo Data Service and Portal

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Abstract
This paper shows how the newly published Linked Open Data (LOD) service and semantic portal AcademySampo can be used for Digital Humanities (DH) research. The original primary data, based on ten man years of digitization work, covers a significant part of the Finnish university history based on the student registries in 1640–1852 and 1853–1899. They contain biographical descriptions of 28,000 students of the University of Helsinki, originally the Royal Academy of Turku. AcademySampo also sheds light to the academic history of Sweden and Baltic countries through their shared history with Finland in the larger Swedish Empire. The Finnish student registries have been widely used by genealogists and historians by close reading. We argue that by using AcademySampo unprecedented new possibilities for DH research are now enabled: the underlying knowledge graph can be accessed and analyzed using Semantic Web technologies and tools and with the ready-to-use data-analytic tools of the portal. Examples of data-analysis are presented by using the AcademySampo system for studying migrations of students in Finland, Sweden, Russia, and Estonia, history of student nations, inheritance of occupations and social classes, lengths of family lines of students, and network analyses of students. Related analyses have been made before using biographical dictionaries but not for academic history and student registries.

Keywords
Linked Data, Data Analysis, Digital Humanities, Network Analysis, Cultural Heritage

1. Introduction

AcademySampo1 [1, 2] consists of two parts: 1) AcademySampo Portal2 2) AcademySampo Data Service3 published on the Linked Data Finland platform [3]. The AcademySampo Portal provides intelligent capabilities for searching and browsing with seamlessly integrated data analytical tools and visualizations for biographical and prosopographical4 research using statistics, networks, timelines, and maps. Using of the portal does not require special IT skills. The open Application Programming Interfaces (API) of the AcademySampo Data Service and its SPARQL endpoint, in turn, provide an easy-to-use opportunity to implement
new data analyses for DH researchers with some experience in the SPARQL query language\(^4\) and programming of the Semantic Web. For example, the YASGUI editor\(^5\), Jupyter\(^5\), Google Colab notebooks\(^6\), and Python scripts can be used. ACADEMYSAMPO is based on the Sampo model\(^6\) and its portal has been implemented using the Sampo-UI programming framework\(^7\) as an example of data service utilization opportunities in application development.

ACADEMYSAMPO is part of the Sampo portal series\(^7\) and uses the Linked Open Data Infrastructure for Digital Humanities in Finland (LODI4DH)\(^8\) that is part of the Finnish FIN-CLARIAH research infrastructure funded by the Academy of Finland\(^9\).

This paper describes how the ACADEMYSAMPO system can be used for DH research, including the portal as well as the LOD service. In Section 2 the LOD underlying the system is first briefly described. After this using the portal is illustrated by examples (Section 3) and using the underlying SPARQL endpoint is discussed and demonstrated (Section 4). In conclusion (Section 5), related works are discussed as well as the need for data literacy in using systems like ACADEMYSAMPO.

2. Primary Data and Knowledge Graph

ACADEMYSAMPO’s data form an extensive knowledge graph that has been produced algorithmically from the digitized student registers of the Royal Academy of Turku and the University of Helsinki in 1640–1852 and 1853–1899\(^10\) by extracting information from the texts and database structures. The data has been enriched by linking it both internally by artificial intelligence-based reasoning, and externally to other open datasets. The student registers describe all people who have received academic education in Finland in 1640–1899, as there were no other universities in Finland at that time. The descriptions of students tell not only about their studies, but also about their career after studies and relatives, as well as references to the literature. The original register of the Royal Academy of Turku was destroyed in the Great Fire of Turku in 1827, but it was reconstructed in the late 19th century by Vilhelm Lagus. The register was supplemented in the 20th century from various sources, and in the end the information was edited by Yrjö Kotivuori and Veli-Matti Autio in an effort of ca. ten man years.

The registers 1640–1852 and 1853–1899 are digitized and provided by different people, and their tabular CSV data differ to some extent. The source information found in the table of records 1640–1852 includes, in addition to some technical information in the database: 1) the person’s registration number, 2) HTML text showing the person’s name, places and times of birth and death, parents, career events, relatives, students, references and 3) the date the record was created. If the person mentioned in the register 1640–1852 is found in either of the registers, the HTML link in question is manually created in connection with his / her mention to the person’s page using the registration number. However, in the register 1853–1899 there are no

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\(^4\)https://www.w3.org/TR/sparql11-query/
\(^5\)Jupyter Project and Tool: https://jupyter.org
\(^6\)Google Colab: https://colab.research.google.com/notebooks/intro.ipynb#recent=true
\(^7\)See: https://seco.cs.aalto.fi/applications/sampo/
\(^8\)LODI4DH initiative: https://seco.cs.aalto.fi/projects/lodi4dh/
\(^9\)FIN-CLARIAH: https://seco.cs.aalto.fi/projects/fin-clariah/
\(^10\)Student Registers of Helsinki University: https://www.helsinki.fi/fi/yliopisto/ylioppilasmatrikkeli-1640-1907
such links, and the references have had to be interpreted computationally. In addition, it has been possible to record additional textual information about other registers in the person. For example, Johan Ludvig Runeberg has more information on Lagus and Carpelan’s registers in Swedish.

The primary data used by the AcademySampo project was therefore mainly text in HTML format without structured metadata, such as places or times of birth, occupation, etc. The first technical challenge in creating linked data was to unambiguously identify the named entities mentioned in the text, such as marriages, rewards and promotions, and key concepts such as vocations. Their own challenges in extracting information were to distinguish between people of the same name, to reason for gender by name, and to infer different relationships, such as little cousin and thread, through other relationships.

The data of the AcademySampo was converted into Linked Data [9]11 by structuring the text descriptions of the Student register 1640–1852 for about 9500 people and the register 1853–1899 for about 18 450 people. This was done by identifying, through regular expressions, basic biographical information about students, their 47 000 relatives, 120 000 interpersonal relationships, 3000 historical places, 10 000 vocations, and 4000 academic student–teacher relationships. The “semantic glue” of the knowledge graph are the events related to the professional and family life of the 175 000 people identified in the texts, which link the people and organizations involved in different roles with places and times according to the CIDOC CRM12 ontology and ISO standard. The data has been enriched by linkage to external databases, such as the Finnish National Biography and other biographies of the Finnish Literature Society available as LOD in the BiographySampo system [10] and Wikidata13, and by inferring relationships between people [11, 12]. The public data service is available at the Linked Data Finland online14 for accessing and utilizing the data in research and application development.

3. Using AcademySampo Portal for Data Analysis

In accordance with the principles of the Sampo model and Sampo-UI programming framework, the AcademySampo Portal offers four application perspectives to the Student Register materials shown in Fig. 1: People, Places, Vocations, and Student Nations. Clicking on the corresponding icon opens views for searching and exploring people, places, vocations, and student nations, either as individuals or as groups of individuals through the methods of DH. In the following, the functionalities of the portal are first briefly described.

(1) People Perspective In the application view “People” one can search for a specific individual or group of people for prosopographical analysis using an ontology-based facet search. The faceted search for people is depicted in Fig. 2. The search facets are on the left and the results fill the rest of the page to the right. By default, the people in the result set are ordered by their degree of networking, e.g., by the number of links to external databases, with famous students such as poet Elias Lönnrot, president of Finland Juho Kusti Paasikivi, and poet

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11W3C Linked Data: https://www.w3.org/standards/semanticweb/data
12CIDOC CRM: http://cidoc-crm.org
13Wikidata: https://wikidata.org
14Homepage of the LOD service: https://www.ldf.fi/dataset/yoma
Johan Ludvig Runeberg among the top positions. The results can be sorted for example by date of birth or place of death.

In facet search, the result set is filtered by making selections from hierarchical facets. As an example, two facets have been opened in Figure 3. The upper one lists the organizations associated with the people from which the “Regiment Horn” has been selected, and the lower the student nations in which the people associated with the Regiment Horn can be found. Of these, the “Ostrobothnian Student Nation” has been selected, in which case all four people associated with the Horn Regiment and the Ostrobothnian Student Nation have been found through two facet selections. It should be noted that in reality there may be other such students.
but the search will not find them if, for some reason, it is not mentioned in AcademySampo material (historical data is often incomplete) or if, for some reason, the used algorithms have not been able to separate all the information from the text. All searching and data analysis are, of course, limited to the available data.

Each person in the dataset has a separate instance page or “home page” showing his or her biographical information in the traditional way as well as related information and analyzes based on the entire material and supplementary data outside the registers. The instance pages are entered by clicking on the person in the facet result list. For example, Figure 4 shows the page of Johan Ludvig Runeberg (1804–1877). Instance pages are presented in a table format where the left column lists the characteristics associated with the person, such as university enrollment time, vocation, and student nation. On the right are the values such as the time of enrollment on 10 February 1822 and the vocations of “Lecturer at Porvoo High School”, “Docent” and “Author”, as well as links to further information. People are linked to Wikidata...
and BiographySampo. Wikidata links have been used to retrieve people’s Wikipedia pages and possible photos of people from Wikimedia Commons. Correspondingly, links to the National Biography have been retrieved from the Biography Office’s database. Links to the dissertation material in the Doria archive were already available in the source material.

For example, the page has a link to a larger biography at BiographySampo. The various Sampos and their underlying ontologies and data are gradually expanding into a kind national Cloud of LOD services, a kind of “SampoSampo” that is also connected to the international Linked Open Data (LOD) cloud.

**Analyzing and Visualizing an Individual Person** One of the innovations of Sampo portals is to offer the user, in addition to intelligent search and browsing functions, data analytical tools and visualizations for more detailed content exploration and knowledge discovery [13]. Tools can be selected from the tabs at the top of the search views (see Fig. 2), applying the tool to a set of search objects delimited by facets in the current view. There are also a number of data analytics tools on the different tabs of instance pages for examining that particular object. For example, in addition to the default table view (Fig. 4) (TABLE tab), the user can choose to explore a person’s relationships, academic relationships with other students, relationships with other people in the same organizations, or a network of events related to the person.

The FAMILY RELATIONS tab on the page of Johan Ludvig Runeberg (1804–1877) shows the network of his close relatives to a limited depth. Its data has been extracted from people mentioned in various contexts in the AcademySampo, and kinship has also been enriched by reasoning. The network shows, for example, that the wife of Runeberg’s son, sculptor Walter Magnus Runeberg, was Lina Elfving, who died in 1916. The ACADEMIC RELATIONS tab, on the other hand, shows J. L. Runeberg’s academic network as a visualization where the directed arcs depict teacher-student relationships and providers and recipients of private certificates.

Networks between people can be formed through the factors that unite them in different ways. For example, a tab on the person instance page visualizes connections with other students, based on whether they have been members in a same organization. The CONNECTIONS tab on J. L. Runeberg’s page shows an example of clusters formed using this criterion. Events extracted from the register data have also formed their own network on a separate RELATIONS tab (Figure 5). J. L. Runeberg, for example, was a student at the Oulu Trivial School from 1813 to 1814 and graduated with a master’s degree in promotion on July 10, 1827.

**Prosopographical Analysis** By making choices about facets, you can also narrow down groups of people and explore them. With a few clicks you can search for 18th-century students enrolled in the university (enrollment facet) who became professors (vocations facet) and who have been members of the Ostrobothnian Student Nation (Student Nations facet). There are 45 such people, such as Henrik Gabriel Porthan (1739–1804) who was mentioned as the father of Finnish history. The search result is based on the available data which may be incomplete, and the user must consider the possibility of errors and omissions, especially with the material from the older Academy of Turku. These may be due to the original data or errors made by the

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algorithms during the automatic concept identification and linking.

With the facet options, tools for prosopographical analysis are available in the TIMELINE, MIGRATION, MAP, and NETWORK tabs. The TIMELINE tab shows the annual births, university enrollments, and deaths. The result in example (Fig. 6) shows the charts for the total of 521 female students. The MIGRATION tab (Fig. 7) visualizes the mobility and immigration of Småland students (597) with arcs depicting the life cycles. The blue end of the arc indicates the place of birth and the red the place of death, which is most often in the territory of present-day Finland, and the thickness of the arc reflects the number of people associated with the arc. If a person was born and died in the same place, the arc is not displayed. By clicking on the arc, you will find related links to people’s pages. The MAP tab (Fig. 8) shows the approx. 3000 locations to which students are connected by approximately 175,000 events. For example, clicking on a marker in Ireland finds two related people, the other being the famous Johan Gadolin (1760–1855), who later discovered a new element, Yttrium. The NETWORK tab allows to explore the internal academic network of a group of people specified in the facet selections, for example (Fig. 9) the teacher-student network of 1480 male students born in Helsinki.

(2) Places Perspective

The Places view of the portal offers a similar facet search as in the People view, but now targeting historical places. You can search for places using the hierarchical facet or text search and see the search result as a table. In Figure 8, the user has searched AcademySampo’s more than 3000 historical sites for those with the word “university” in their name. As a result there are 14 universities from Finland, Sweden and Estonia and the rest of Europe with photos from Wikidata, such as the seven German universities mentioned in the registers. For Finnish place names, the location material, e.g. coordinate location, alternative labels, and hierarchy of places, has been extracted from the National Land Survey of Finland’s PNR database (Place Name Register) and from the ontology of the National Library’s Finto.fi ontology service. The most important source for foreign places has been Wikidata.

YSO Places: https://finto.fi/yso-paikat/fi/
Figure 6: The annual births, enrollments, and deaths of female students on the TIMELINE tab

Figure 7: The use of AcademySampo for prosopographical research. Curricula vitae of members of the Student Nation of Småland with the places of birth (blue end of the arch) and death (red end) providing also possible photographs and coats of arms. However, the earlier material contains many references to places in Sweden, which were geocoded using data from the international GeoNames database.²¹

The search result can also be visualized on the map on a separate MAP tab. Clicking on a place marker opens a pop-up window with a list of the people whose events, such as death or career-related events, are known to have occurred at the selected location. A link in the pop-up window leads to the person’s instance page for a more detailed investigation of the event.

²¹GeoNames: https://www.geonames.org
Figure 8: The MAP tab visualizes the lifetime places mentioned in about 175,000 events.

Figure 11 depicts the MAP tab zoomed to downtown Helsinki where you can find e.g. Helsinki Normal Lyceum. The placement of Norssi on the map is an example of the possibilities of linked data: only textual mentions of the Normal Lyceum are found in the registers, but the open-licensed information in Wikidata can also be used in AcademySampo. Clicking on the marker opens a pop-up window listing all 415 students and other school-related people found in the AcademySampo, such as Ivar Edvard Wilskman (1854–1932), a school gymnastics teacher and professor known as the father of Finnish sports. Further information about the students of Norssi can be found in the online service “Old Norssit on the Semantic Web” [14], one of the biographical registers preceding AcademySampo.

Figure 9: Academic teacher-student networks shown in the NETWORK tab.

22 Wikidata resource for Helsinki Normal Lyceum: https://www.wikidata.org/wiki/Q3269135
Figure 10: The Places view allows you to search for places and view them as a table or on the map.

Figure 11: The MAP tab in Places view shows the places and the people associated with them through events. The picture shows 415 students and other people connected to the Helsinki Normal Lyceum.

(3) Vocations Perspective The Vocations view allows to search for people and groups by vocations, as well as places related to the person. The classification of vocations used is based on the AMMO ontology of historical vocations [15] developed in the SeCo group, which is linked to e.g. to the international HISCO classification [23]. The AMMO ontology offers opportunities to study, for example, the social status of students or the inheriting of occupations across generations.

(4) Students Nations Perspective Student Nations have formed an important part of the student lives at the universities, bringing together students from the same area and creating links between the students and the university administration. The institution of student nations was established at the Royal Academy of Turku in 1643. Some of the current student nations of the University of Helsinki are heirs of the original departments, but many nations have been divided or merged into new nations over time. Completely new student nations have

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also been established while old ones have been abolished. In the Student Nations view you can search for nations having their own instance pages similarly as people and places. For example, members of the student nation at different times, curators, inspectors and honorary members have been gathered as links to their websites, insofar as they are mentioned in the register texts. In addition, the data includes references to Swedish student nations for example at the universities of Uppsala and Lund.

4. Using the SPARQL Endpoint for Data Analysis

A goal of this article is to encourage DH researchers to take advantage of the AcademySampo Data Service using SPARQL querying. Therefore, examples of the use of YASGUI, Google Colab, or Jupyter notebooks are introduced in the following. These tools provide a simple way to create analyzes of data and share the results as functional documents for others to evaluate and use according to the principles of open science.

YASGUI provides an easy-to-use web-based browser tool for writing SPARQL queries. The answers to the questionnaires can be examined e.g. in tabular form and can also be easily visualized in pre-programmed ways, such as displaying location data on a map, or generating various charts. For example, the chart on the left in Fig. 12 depicts the average age of students with respect to the year of enrollment. The trendline shows how the age at enrollment has evolved during the years shown in the chart, with an obvious increase between about 1825 and 1850. The query itself requires just over ten lines of SPARQL query language. This result has been visualized using a ready-made chart tool of YASGUI. The chart on the right shows the percentages by gender of students enrolled during the years 1889–1899 whose father is in the student register. This percentage is 18.4% for female and 11.5% for male students.

Figure 13 shows visualization of the geographical data using the YASGUI editor. The markers on the map are colored according to the student nation to which the majority of student born there belonged to. It can be seen that the base areas of the Student Nations are formed quite clearly. One can see, for example, that the Baltic countries and Russia have been the base area of the student nation of Vyborg. Implementing this visualization has required only a slightly more complex query to retrieve the data in appropriate format.
For more complex analysis or more customized options, the results of a SPARQL query can be analyzed using libraries in different programming languages. Google Colab provides an easy way to write and run Python code online as Jupyter notebooks using a web browser, edit them collaboratively, and share results easily and visually. A document can consist of explanatory text snippets, code snippets that can be interpreted, and visualizations produced using Python code and libraries. As an example, Fig. 12 illustrates the proportion of students whose father has also studied at the University. It can be noticed that in it, when grouped by gender, women have a higher proportion. This visualization was created using Python library Matplotlib, after downloading relevant data with a SPARQL query.

The data service on the Linked Data Finland platform provides more information and documentation about the data publication and the SPARQL endpoint. The publication follows Tim Berners-Lee’s five-star model, but the seven-star model proposed in the LDF platform gives a sixth star because the data release also includes a description of the data model to facilitate data reuse. The seventh star would require data validation, which has not been done systematically at this stage.
5. Discussion

**Related Work** Representing and analyzing biographical is a new research and application field. In 2015, the first Biographical Data in Digital World workshop BD2015 was held presenting several works on studying and analyzing biographies as data [16], and the proceedings of BD2017 contain more similar works [17]. In [18], analytic visualizations were created based on U.S. Legislator registry data. The idea of biographical network analysis is related to the Six Degrees of Francis Bacon system\(^2\) [19, 20] that utilizes data of the Oxford Dictionary of National Biography. However, in our case faceted search can be used for filtering and studying target groups. Work on AcademySampo is continuation to our earlier biographical LOD systems on Norssit Alumni register [14], the U.S. Congress Prosopographer [21], and BiographySampo [10].

Extracting Linked Data from texts has been studied in several works [22]. In [23] language technology was used for extracting entities from biographies and in [24] from news.

**Data Literacy Needed** The entities, concepts and relationships identified from the register texts form the basis for AcademySampo’s links, search functionalities, data analysis and visualizations. The structured metadata data of a system like AcademySampo is largely automatically generated and requires a new kind of data literacy to use it [25]. The structures and links highlighted by the system are based on the original texts, which may be incomplete or incorrect in some respects. In addition, the algorithms used may not be able to identify all the desired expressions from the text, and errors may occur in the identification of the entities in the data and in the identification of their meanings. Identifiable concepts can also be incompatible with each other (e.g., vocational titles from different eras) and their meaning can change over time (e.g., historical places and regions). Systems based on linked ontological data strongly highlight data inconsistencies, errors, and omissions in the user interface.

For example, there are both discontinued and still operating student nations in the database, and the place ontology includes areas which were previously part of Finland and Sweden but later annexed by the Soviet Union. Such data presentation challenges stem not so much from the methods of linked data as from the ontological complexity of the real world being described and the shortcomings and inaccuracies associated with historical register data, but defining and using ontologies in search, browsing, and data analysis reveals data structures. In traditional search systems, problems are somehow swept under the rug in textual data and human interpretation when reading data. The aim of AcademySampo is to facilitate the researcher’s work in reviewing and researching register material by automatically extracting interesting references, links and visualizations whenever technically possible, an example of the “distant reading” of digital humanities [26]. Using semantically linked, rich data easily creates a misconception that the data and links would be complete and the gaps in the data would be flawed. It must be recalled that the knowledge extracted by a system such as AcademySampo is, of course, based only on the available data. For example, for people who do not have their own article in the register, such as most of the students’ wives and relatives or characters like James Cook, no information other than mentions in the descriptions of the register people is available.

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\(^2\)http://www.sixdegreesoffrancisbacon.com
European Heritage\textsuperscript{28}, and the EU COST action Nexus Linguarum\textsuperscript{29} on linguistic data science. CSC – IT Center for Science has provided computational resources for the work, e.g. the national server infrastructure hosting LDF.fi.

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