Using FindSampo Linked Open Data Service and Portal for Spatio-temporal Data Analysis of Archaeological Finds in Digital Humanities

Heikki Rantala[1], Esko Ikkala[1], Mikko Koho[1], Jouni Tuominen[1], Ville Rohiola[2], and Eero Hyvönen[1]

[1] Semantic Computing Research Group (SeCo), Aalto University and Helsinki Centre for Digital Humanities (HELDIG), University of Helsinki, Finland
https://seco.cs.aalto.fi, firstname.lastname@aalto.fi
[2] Finnish Heritage Agency (FHA), Finland
https://www.museovirasto.fi/en, firstname.lastname@museovirasto.fi

Abstract. This paper presents and demonstrates how the in-use Linked Open Data (LOD) service and semantic portal FINDSAMPO can be used for Digital Humanities research, based on Citizen Science archaeological data integrated with GIS services.

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1   FindSampo Framework for Archaeological Finds

The recreational metal detecting has already a quite long-lasting tradition in Europe but during the last decade the popular hobby has spread even more and grown rapidly in many countries such as in Finland. At the same time, several countries have started to develop digital reporting services to collect, analyse, and study archaeological data [3]: 1) Portable Antiquities Scheme (PAS)[3] records archaeological discoveries found by the public in England and Wales since 1997 [1]; 2) Digital Metal Finds (DIME)[4] is an online platform for reporting metal detecting finds in Denmark [10]; 3) Portable Antiquities of the Netherlands (PAN)[5] is an online portal in use in the Netherlands [9]; 4) Metal-Detected Artefacts (MEDEA)[6] is an online portal developed in Flanders for metal detectors [2,10].

FINDSAMPO [5] is a new framework[7] aiming to improve the reporting process and analysis of archaeological finds based on collaboration of the public, academic researchers, archaeologists, and heritage managers [7]. This paper demon-

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[3] PAS: https://finds.org.uk/database. Some 1.4 million finds have been reported in PAS by more than 14,000 citizens by now.

[4] DIME: https://www.metaldetektorfund.dk

[5] PAN: https://portable-antiquities.nl

[6] MEDEA: https://vondsten.be

[7] More information and publications can be found on the project homepages https://seco.cs.aalto.fi/projects/sualt/ and https://blogs.helsinki.fi/sualt-project

strates, how the FINDSAMPO Portal[8] and the underlying LOD service[9], opened for public use on May 17, 2021, can be used for data exploration, analysis, and visualizations. In contrast to the aforementioned related works, FINDSAMPO is based on Linked Open Data. FINDSAMPO Portal is yet another member in the "Sampo" series[10] of Linked Open Data services and semantic portals [4], based on a national Semantic Web infrastructure[11] for DH.

2 Using FindSampo

The FINDSAMPO LOD service includes currently some 3000 archaeological finds made by the public. The FINDSAMPO Portal, based on the Sampo model, queries this data service with SPARQL, and offers search, exploration, and analysis tools for DH researchers and hobbyists. The finds can be filtered using faceted search [8] with hierarchical facets based on ontologies, and then visualized using maps with external layers from the GIS services[12] of the Finnish Heritage Agency (FHA), various types of charts, and a timeline.

The map visualizations can be used to show finds made by the public and the registered archaeological sites of FHA. As an example, Fig. 1 shows finds and archaeological sites along the Aura river in Turku, the former capital of Finland. A buffer zone of 200 meters where metal detecting is not recommended is automatically calculated and shown around the sites with a dashed line. The user can select from different base maps and map layers to suit the current purpose including street maps, satellite images, and an elevation model of the FHA. The maps can be used by researchers for analysis, and by hobbyists to get information on where it is appropriate to dig.

Fig. 2 shows the timeline visualization where all weapons have been filtered out using the object type facet. The timeline component groups the finds by province in which they were found (y-axis) and by period (x-axis). The start and end years for the periods are retrieved from the period ontology developed with domain experts, and the periods are indicated by the colors listed on the top. The user can observe that there are Stone Age and Bronze Age weapons found from only few provinces, but there are Iron Age weapon finds from every province. Interestingly not every province has medieval or later weapon finds.

The FINDSAMPO LOD service can also be used directly for research by querying the data with SPARQL and then by creating analyses of the results with for example Python or R libraries. As the data service is open, it can also be used to create new web services such as the FINDSAMPO portal by anyone.

The user interface of the FINDSAMPO Portal is implemented with the Sampo-UI framework [6], and the source code is available on GitHub[13] with an open

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[8] Portal available at https://findsampo.fi
[9] LOD service available at: https://www.ldf.fi/dataset/findsampo
[10] For a list of Sampo portals, see https://seco.cs.aalto.fi/applications/sampo/.
[11] https://seco.cs.aalto.fi/projects/lodi4dh/
[12] https://kartta.museoverkko.fi/?lang=en
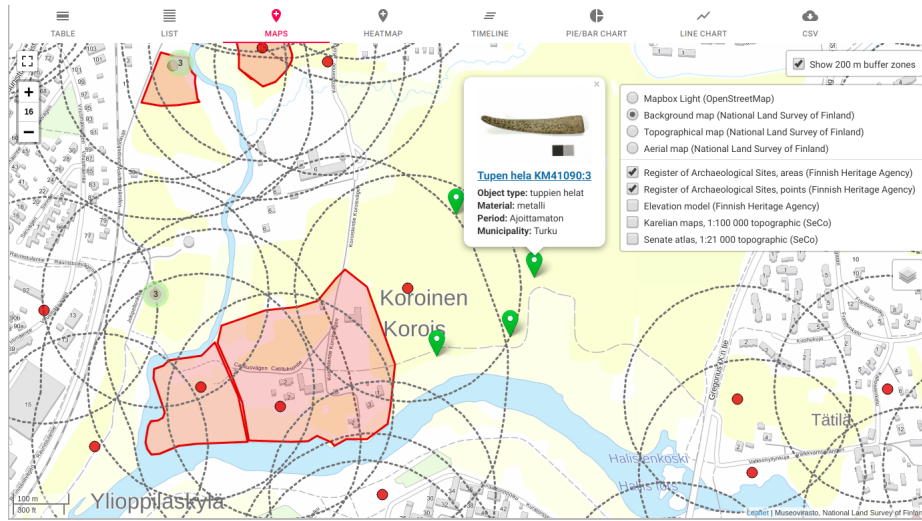[13] https://github.com/SemanticComputing/findsampo-web-app

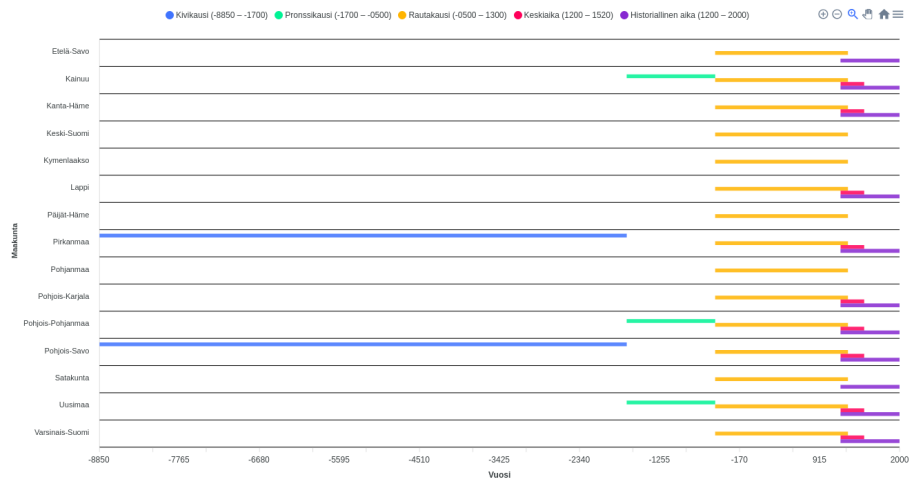**Fig. 1.** Archaeological finds and protected sites along the Aura river.

Fig. 2. FINDSAMPO portal's timeline visualization with all weapons selected.

license. The LOD service is run on the Linked Data Finland platform, which is powered by a combination of the Fuseki SPARQL server[14] and a Varnish Cache web application accelerator[15] for routing URIs, content negotiation, and caching.

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[14] https://jena.apache.org/documentation/fuseki2/

[15] https://varnish-cache.org

3 Discussion and Future Work

FindSampo takes the current state of archaeological find databases a step further by providing a framework for presenting the data in Linked Data format, and providing a prototype of a portal that can be used to easily access and analyze such data. This framework in not limited to the Finnish case, but can be applied to international data as well in the future.

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