Temporal Visualization and Data Analysis of Archaeological Finds: Case FindSampo

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Introduction

Cultural Heritage (CH) collections, data, and artefacts used to be available mainly in galleries, libraries, archives, and museums (GLAM). Nowadays CH data is available also online, and it can be searched, analysed, and presented using various methods and visualizations tools. However, many of these methods do not take adequate advantage of the nature of CH data. Even when the CH data dimensions are exploited, the choices of visualization sometimes fall short.

This paper concerns the semantic portal part of the Finnish archaeological finds framework FindSampo (Hassanzadeh et al. 2020), and especially its timeline-based visualisation application for studying archaeological artefacts and their categories in time. FindSampo has been created as part of the Finnish Archaeological Finds Recording Linked Open Database (SuALT) project[1], which is a response to the rapidly growing popularity of metal detecting in Finland. The project aims to develop digital web services to cater for archaeological finds made by members of the public, especially metal detectorists (Thomas et al. 2018). The goal of the FindSampo framework is to 1) support the metal detectorist community in learning archaeology and their hobby, 2) to help the Finnish Heritage Agency in recording the finds in their databases, and 3) to support Digital Humanities (DH) researchers by helping them to study the data with data-analytic tools. This paper provides an insight and a possible solution into one of the research questions posed by our collaborating archaeologists: how to visualize the temporal spread of finds on a timeline, filtered by their characteristics, such as object type, material, timing, and geographical location?

Sampo Platform for Studying Archaeological Finds

FindSampo portal is a new member of the "Sampo" series[2] of Linked Open Data (LOD) services and semantic portals, based on a national Semantic Web infrastructure. The prototype includes a

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user-centric faceted search combined seamlessly with data-analytics tools for visualising the filtered data on a table, a timeline chart, and on maps. There is also an option to export the results in CSV form for further analysis in external tools. The underlying LOD service is available to data-analysis using tools such as YASGUI for SPARQL querying (Rietweld and Hoekstra, 2017) or Jupyter[3] and Google Colab[4] for Python scripting.

In the design of the FindSampo portal, the technologies were chosen based on technical efficiency, user needs, and the nature of the data—especially the spatio-temporal dimension of the data. The prototype is based on the Sampo model[5], the Sampo-UI[6] framework, and several third-party libraries for, e.g., visualisations. The portal is a single-page application, and therefore page reloading is not needed when navigating around. This enables the user to use it more efficiently in places where the Internet connection is slow. FindSampo is based on modern JavaScript libraries, such as React[7], Redux[8], Material UI[9], and Sass[10] on the client side. The server is implemented using NodeJS[11] and ExpressJS[12] to enable a lightweight interaction with external services.

The portal provides several interactive linked views to the underlying data that deal with the find data (using keywords), geography (maps), timelines, and their interrelations. It caters for the spatial dimension of the data by providing two map views: a point map and heatmap. Therein the user can see the geographical distribution of the finds and learn about them.

FindSampo uses archaeological find collection data from the Finnish Heritage Agency as source data. The data contains approximately 3000 finds from Finland, ranging temporally from 8000 BC to 2000 AD, in a structured format, with each find described in terms of 50 metadata fields. The source data is converted into RDF format and published as LOD, which is used in the portal directly from a public SPARQL endpoint. FindSampo utilises Semantic Web and emerging Web technologies to provide a platform for studying archaeological finds. Semantic Web technologies[13], such as ontologies (Staab and Studer, 2009), are used for harmonizing the data within Finnish archaeological data sources and for establishing interoperability with international archaeological resources. For this purpose, the Finnish ontologies were aligned with, e.g., the Art and Architecture Thesaurus (AAT)[14] of the Getty Research Center, as suggested in the pan-European ARIADNEPlus initiative[15].

Visualizing Archaeological Finds on a Timeline

For the temporal dimension, the period associated with each find is converted to a discrete time span to accommodate all finds. The portal features a novel interactive timeline chart, where the user can easily see the distribution of the finds on a timeline. There the timeline segments represent finds which are grouped by the provinces of Finland they were found and assigned colours for

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[3] Jupyter: https://jupyter.org/

[4] Google Colab: https://colab.research.google.com/

[5] Sampo: https://en.wikipedia.org/wiki/Sampo

[6] Sampo-UI: https://seco.cs.aalto.fi/tools/sampo-ui/

[7] React: https://reactjs.org

[8] Redux: https://redux.js.org

[9] Material UI: https://material-ui.com

[10] Sass: https://sass-lang.com

[11] NodeJS: https://nodejs.org

[12] ExpressJS: https://expressjs.com

[13] Semantic Web standards: https://www.w3.org/standards/semanticweb/

[14] https://www.getty.edu/research/tools/vocabularies/aat/

[15] ARIADNEPlus: https://ariadne-infrastructure.eu/

conspicuity and differentiation. This provides the user with a new kind of perspective to the spatial distribution of the finds in time.

The timeline chart was implemented using the Timelines chart library[16] that was created by Vasco Asturiano[17]. It is made up of groups of finds layered one above the other. Each group contains layers of finds. It also features an interactive interface and a timeline brush at the bottom which users can use to explore the finds either by zooming (dragging) on the chart directly or on the timeline brush. Users can also click on a find to learn more about the find on its own landing page. This library was chosen for the implementation, because its evaluation suggests that it can facilitate visualisation design principles, such as serendipity, generosity, and criticality (Windhager et al. 2019). It is also capable of showing other dimensions of the data in addition to the temporal dimension by grouping the data using that dimension. For example, the finds shown in Figure 1 are grouped by the provinces of Finland they were found.
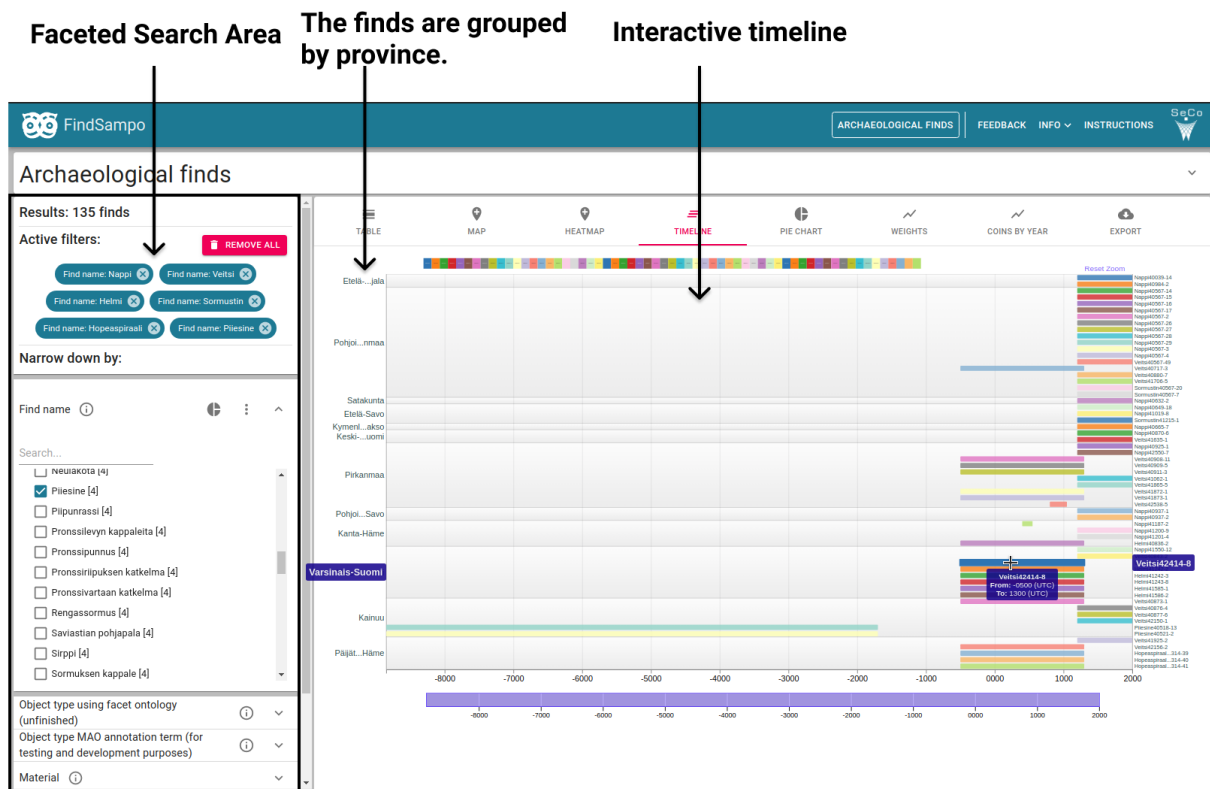

Fig. 1. The novel timeline visualization in the FindSampo portal's user interface, in which the faceted search filters the result set to be visualized.

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[16] Timelines-chart: https://github.com/vasturiano/timelines-chart
[17] Vasco Asturiano: https://bl.ocks.org/vasturiano/ded69192b8269a78d2d97e24211e64e0

References

Hassanzadeh, P., Hyvönen, E., Ikkala, E., Tuominen, J., Thomas, S., Wessman, A. and Rohiola, V.: FindSampo Platform for Reporting and Studying Archaeological Finds Using Citizen Science. 3rd Workshop on Humanities in the Semantic Web (WHiSe), CEUR Workshop Proceedings, Vol. 2695, 2020, pp. 33–40.

Hyvönen, E., Rantala, H., Ikkala, E., Koho, M., Tuominen, J., Thomas, S., Anafi, B., Wessman, A., Oksanen, E., Rohiola, V., Kuitunen J. and Ryyppö, M.: Citizen Science Archaeological Finds on the Semantic Web: The FindSampo Framework. Paper under evaluation. https://seco.cs.aalto.fi/publications/2020/hyvonen-et-al-findsampo-2020.pdf

Rietveld, L. and Hoekstra, R.. The YASGUI family of SPARQL clients. Semantic Web journal, Vol. 8, Nr. 3, 2017, pp. 373–383.

Staab, S. and Studer, R. (Eds.). Handbook on Ontologies (2nd Edition). Springer, 2009.

Thomas, S., Wessman, A., Tuominen, J., Koho, M., Ikkala, E., Hyvönen, E., Rohiola, V., and Salmela, U. (2018). SuALT: Collaborative Research Infrastructure for Archaeological Finds and Public Engagement through Linked Open Data. In: Digital Humanities in the Nordic Countries, 3rd Conference (DHN 2018), Book of Abstracts, Helsinki, Finland. http://heldig.fi/dhn2018/boa.pdf.

Windhager, F., Federico, P., Schreder, G., Glinka, K., Dörk, M., Miksch, S., and Mayr, E. (2019). "Visualization of Cultural Heritage Collection Data: State of the Art and Future Challenges". IEEE Transactions on Visualization and Computer Graphics, 25 (6), pp. 2311–2330.