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Integrating OpenStreetMap and Linked Open Data to Make Mapping Historical Leiden Semantic

The social topography of cities has long been an important subject of research for scholars who explore the connections between socio-economic structures and urban spatial organisation.¹ Over the past two decades, archaeologists, historical geographers and historians have successfully introduced new digital tools and methods, most notably historical geographic information systems (HGIS), to this field of research, resulting in more refined spatial analyses of the various dimensions of past urban life. One of the pioneering projects for Europe's premodern period is the DECIMA-project on sixteenth-century Florence,² but similar mapping applications have been developed for Paris, London, and a number of cities in the Low Countries.³ Despite these advancements, the application of GIS in urban history still faces considerable technical and practical challenges, hindering the utilisation of spatial analysis techniques and questioning the added scholarly value of HGIS. This paper takes issue with this sceptical view by addressing two specific issues: the application of the OpenStreetMap (OSM) architecture and data model to the case of the premodern city of Leiden, which then enables the exploitation of the possibilities for analysis offered by Linked Open Data (LOD). These innovations will be demonstrated using Leiden's HGIS, which covers the city's premodern history (c. 1583-1832). More specifically, the historical analysis will focus on the evolution of service access and spatial equity patterns.⁴

The OSM architecture uses a topological data model that allows the combination of spatial relationships representing different spatial objects (point, line, and area features). This offers the advantage of emphasising the semantic characteristics of these objects. This means that objects, as for example roads, can exist within the HGIS regardless of their technical implementation as line or polygon features; they can be used simultaneously. This flexibility makes it possible to create a true semantic map, as it redirects the focus from the representation of cartographic elements to their semantic meaning.⁵ More importantly, the OSM data model offers a way to unlock the data within the HGIS as a LOD-repository.⁶ This way of structuring

¹ Dietrich Denecke and Gareth Shaw, *Urban Historical Geography: Recent Progress in Britain and Germany* (Cambridge: Cambridge University Press, 1988); Matthias Meinhardt and Andreas Ranft, *Die Sozialstruktur und Sozialtopographie vorindustrieller Städte* (München: Oldenbourg Verlag, 2005).

² Nicholas Terpstra and Colin Rose, eds., *Mapping Space, Sense, and Movement in Florence: Historical GIS and the Early Modern City*, Routledge Research in Digital Humanities (New York: Routledge, 2016). See the maps at <https://decima-map.net>.

³ See, for Paris (<http://alpage.huma-num.fr/fr>), London (<http://alpha.layersoflondon.org>), and the Low Countries (<http://www.hisgis.nl>).

⁴ Benjamin W. Stanley et al., 'Service Access in Premodern Cities: An Exploratory Comparison of Spatial Equity', *Journal of Urban History* 42, no. 1 (1 January 2016): 121–44, <https://doi.org/10.1177/0096144214566969>.

⁵ Krzysztof Janowicz, Simon Scheider, and Benjamin Adams, 'A Geo-Semantics Flyby', in *Reasoning Web. Semantic Technologies for Intelligent Data Access* (Berlin, Heidelberg: Springer, 2013), 230–50, https://doi.org/10.1007/978-3-642-39784-4_6.

⁶ Sören Auer, Jens Lehmann, and Sebastian Hellmann, 'LinkedGeoData: Adding a Spatial Dimension to the Web of Data', in *The Semantic Web - ISWC 2009* (Berlin, Heidelberg: Springer, 2009), 731–46, https://doi.org/10.1007/978-3-642-04930-9_46.

data enables us to semantically define relationships between geographic objects, which is particularly useful in mapping geographic objects that change over time. To express these semantic relations between objects, an OWL-specified ontology is being developed by the HisGIS research group at the Fryske Akademy. This ontology builds upon previously established frameworks that refine, at a theoretical level, the links between objects in LOD datasets.⁷ Moreover, semantic queries can be performed on the RDF triples, enabling more advanced analyses, informed by various historical research questions, in an efficient way. This architecture and data modelling make it possible, as will be demonstrated for the case of Leiden, for scholars to more systematically unlock and analyse fuzzy historical-geographical data and relations.

The sketched methodological approach facilitates research on Leiden's premodern social topography.⁸ An existing HGIS provides two snapshots of the city's spatial organisation, as well as the social and economic characteristics of its population, at the end of the sixteenth century and the early nineteenth century.⁹ By linking the geographic objects between these two points in time (for example, by linking streets to older filled-up canals, or nineteenth-century house numbers to older structures), it becomes possible to conduct diachronic spatial analyses. LOD also offers a better framework for connecting diverse historical data to each other in comparison to relational database systems. The innovative part of this pilot study is to provide a means of calculating the access of different parts of sixteenth-century Leiden to central services, such as markets, public buildings, water supply and churches. The examination of the spatial distribution of public services gives insight into patterns of service access inequality and the redistributive effects of these services. The analysis allows us to answer the question as to how socio-economic inequalities in sixteenth-century Leiden were reflected in the urban topography, but also the extent to which spatial patterns reproduced these inequalities. As such, the paper aims to contribute to a broader understanding of well-being in premodern towns by using more advanced digital techniques to analyse historical and geographic data.

⁷ Harry Halpin et al., 'When Owl:SameAs Isn't the Same: An Analysis of Identity in Linked Data', in *The Semantic Web – ISWC 2010* (Berlin, Heidelberg: Springer, 2010), 305–20, https://doi.org/10.1007/978-3-642-17746-0_20.

⁸ Leiden has exceptional rich archives for historical socio-topographical research. See, Hugo van Oerle, *Leiden binnen en buiten de stadsvesten: de geschiedenis van de stedenbouwkundige ontwikkeling binnen het Leidse rechtsgebied tot aan het einde van de Gouden Eeuw* (Leiden: Brill, 1975).

⁹ See, for the existing HGIS: hik.ergoedleiden.nl and www.hisgis.nl/leiden.