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Linked geodata: CityGML represented as a virtual knowledge graph

As cities become systems of increasingly complex infrastructures, it is crucial to have smart and sustainable ways of handling all this complex infrastructure in our modern day cities. From ensuring emergency services reach you quickly to helping reduce energy consumption in buildings, digital 3D city models are becoming essential tools for modern urban management. One way to seamlessly incorporate all these complex systems and models for urban planning purposes into one comprehensive model is through the knowledge graph technology.

CityGML is a common standard used worldwide for representing 3D city models with many cities around the world applying these types of models to manage infrastructure and planning. However, CityGML struggles with integrating with other types of data formats in an effective way. Through the knowledge graph approach multiple types of data formats can be modelled and linked as one large graph-like model without losing important information and context.

In this thesis a framework was developed to transform CityGML data consisting of buildings in Malmö, Sweden into a virtual knowledge graph. The framework utilized multiple tools in order to create a virtual knowledge graph that contains all the building information from the original data. The graph can then be queried to retrieve information that would be of interest for urban planners.

The framework was successfully used to create a virtual knowledge graph that was efficient and complete with all the important building data. The resulting graph contained 224212 pairs of nodes and edges that represented all the information from the 420 buildings in the original data. Storing geographic information and other types of data in this manner is more efficient as multiple models can be stored in the same knowledge graph while ensuring that the information is accurate and easy to update. The method can be used for many different applications, be it optimizing traffic flow or making comprehensive city models containing everything from the a whole city down to the smallest bolt in a building.

Utilizing the knowledge graph approach could serve to improve many different applications in urban planning and management in the future. By turning complex urban data into one larger, interconnected web of knowledge, we creating a smarter and more sustainable way to manage and work with geographic information and data in urban planning.

Keywords: Physical Geography and Ecosystem analysis, CityGML, geospatial knowledge graph, interoperability, data integration

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