SEMANCO

SEMANTIC TOOLS FOR CARBON REDUCTION IN URBAN PLANNING

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SEMANCO News

• The prototype of the semanco platform was presented in the ICT 2013 exhibition in Vilnius, from 6th to 8th November. See the presentation here.

• Two papers from the SEMANCO project were presented at the ICT for Sustainable Cities conference held in Nice, France, between 9th and 11th of September. The papers can be read here.

• Two more SEMANCO papers were presented at the 26th International Workshop on Description Logics held in Ulm, Germany, between 23rd and 27th July. The papers can be read here.

• The project was also represented at the recent CONVR conference in London (30-31 October), with SEMANCO partners presenting the integrated platform at a dedicated stand.

• In February SEMANCO project partners will be hosting SEMANCO are organising a VoCamp on the 13th and 14th of February 2014, at the Engineering and Architecture School La Salle Campus, Barcelona, Spain.

• Finally, the project has undergone its second, highly successful Annual Review with the European Commission.

Welcome to the fourth SEMANCO Newsletter. For the SEMANCO project, 2013 has been an especially important and exciting year with some significant advancement in the project technology. Significantly in this regard has been the presentation of the first prototype of the SEMANCO platform at the ICT 2013 exhibition in Vilnius.

Our official Second Year Review took place in November and the project consortium was recognised as having made good progress, with the development of the SEIF and the integrated platform, and the implementation of the SEMANCO tools being acknowledged as a contribution to and advancement of the state of the art.

These key developments – the SEIF and the Integrated Platform – together with the development of the SEMANCO tools mean that the project is now well placed, supported by the developed technologies, to move into the implementation phase in the third year. We are looking forward to working with stakeholders over the next 12 months and beyond to implement and exploit the SEMANCO technology to achieve carbon reductions from the urban environment.

We are also looking forward eagerly to the next VoCAMP, “Integrating Multiple Domains and Scales”, which SEMANCO will be hosting in Feb 2014. See below for more details.

Here’s wishing you a happy New Year and hoping that 2014 will be as exciting and productive for you as it will be for the SEMANCO project!

Leandro Madrazo, SEMANCO Project Coordinator.

Semantic Energy Information Framework (SEIF)

The **SEIF** is one of the central technological components of the entire SEMANCO project as it facilitates access of the distributed data sources by the integrated platform's tools, allowing these tools to undertake the powerful energy assessments and analyses that are the aim of the project. That is, the SEIF allows stakeholders in urban planning processes to access data from distributed sources. The advantage of the SEIF is that it presents a single endpoint for SPARQL queries generated by the external tools – essentially unifying the means of access to the data sources. The core components of the SEIF are the mapping tools, a semantic data explorer (both described previously – see Newsletters **number 2** and **number 3**) and a Federation Engine to organise the data access and retrieval (described below).

The function of the SEIF is to make the process of querying the data sources very user-friendly by hiding the sub-tasks of query satisfaction from the client tool. These sub-tasks include the identification of relevant data sources; re-writing queries appropriate to the data source in question; and sequencing the execution of complex queries. Importantly, the SEIF ensures that the client tools need know nothing about the location of, or the structure and access protocols for, the data.

The SEIF is a remarkable and significant development of the project to date and is at the heart of technological implications of SEMANCO. It relies crucially on the underlying Energy Model (the Global Ontology: see **Newsletter number 3**), the mapping of data repositories, the integration of data sources and the ability to query them. Central to the successful implementation of the SEIF is the Federation Engine.

Interfacing the SEIF with External Tools and Data Sources

The interactions between the semantic framework and external tools for processing and analysing energy data is provided by means of our **Federation Engine** that facilitates the interoperability of various tools. As the SEIF is the mediator between tools and data sources, it is required to do more than be a conceptual energy model shared by both data and tools: it must also federate the data sources in such a way as to allow answers to data queries. The Federation Engine is the interface that integrates the interoperable tools and the data sources used by those tools, and this is done by means of standard SPARQL technology, a widely recognised and used language for querying databases and the standard language for Semantic Web applications(see our **Wiki** for more information on SPARQL).

The Federation Engine ensures that queries need only to be written in SPARQL and use the vocabulary of the energy model. In all other respects, the queries are general and need not account for the specifics of any particular data source, or sources, from which the responses will be sought. Since queries are likely to be complex and to require information that is distributed over a variety of data sources, the Federation Engine handles the initial query from the client-tool by initially re-writing it, generating all possible queries that are semantically identical to it, in terms of the energy model. These are analysed into their basic patterns (or sub-queries), and, using the indexing service within the SEIF, these sub-queries are associated with the data sources that contain information relevant to the query.

The SEIF's index catalogue summarises the data stored in a single source by interrogating all the triples in that source (for more information on triples, see the SEMANCO Wiki, available via our **website**). This approach is an extension of QTree and was presented by members of the SEMANCO consortium at the 26th International Workshop on Description Logics in Ulm, Germany, in July 2013.

The sequence in which queries are made to data sources often has an impact on speed of execution and the amount of data needing to be transferred. Therefore, before the individual basic patterns are executed, the query execution is optimised. Following this operation, the Federation Engine sends queries to the relevant individual data sources, processes the responses and returns the result to the external client tool. Guidelines for the design of SPARQL queries generated by high-performance tools to query the SEIF are detailed in the SEMANCO report **Interfaces with External Tools**, available via the SEMANCO **website.**

The interoperability of the SEIF and various external tools has been successfully tested by SEMANCO researchers using three test cases. In the first of these, the energy model was queried by an external tool. In this case, the tool

needed to generate the options in a drop-down menu associated with a select box. In the test, select box was 'building uses' and the options were to be the building uses and sub-uses defined in the ontology's Standard Tables. The ontology structure was retrieved successfully; this result is generalizable – any ontology structure can be retrieved from the SEIF's energy model by a tool.

Secondly, a variety of data sources (with a corresponding variety of local ontologies) were queried by a tool in terms of the global ontology. This test verified that the tool does not need to have information regarding the local ontologies. That is, the tools of the integrated platform need only be aware of the SEIF's energy model, and do not need to know anything of the ontologies in the supporting data sources. In the test, the tool generated a query for the number of buildings of particular typologies to be listed.

In the third test, the ability of different tools to interrogate the SEIF was tested, verifying that the successful retrieval of data does not rely on the protocol specific to any one tool. In this test, two tools were used to retrieve a list of buildings of a particular typology and list their energy usage for heating. Both tools returned the same list, demonstrating that the result of the query is independent of the tool used.

By using a single SPARQL endpoint and the Federation Engine, the SEIF ensures the interoperability of the various tools and the data sources: tools see the SEIF as a single endpoint at which to direct queries and Federation Engine integrates query results from the disparate data sources before returning results to the tool from which the query originated. This is a powerful capability for applying semantic tools to carbon reduction and is an important result at this stage of the project.

SEMANCO Tools

The SEMANCO tool set is made of two types of tool: those for **identification and classification of buildings** based on GIS, map digitisation and photogrammetry and allowing energy modelling of the urban environment; and those **for energy analysis**, including data mining and the visual representation of data.

The energy modelling tools are designed to provide a baseline energy consumption and carbon emissions for each of the case study areas. The three case studies within the SEMANCO project each have different requirements and hence require different tools. The Manresa case study in Spain is dealing with assessing the overall energy efficiency of an urban area comprising both new and existing housing stock, with a particular focus on the effect of building shadows on cooling demands. Consequently, a critical aspect of this tool is its integration with URSOS software in the SEMANCO platform. This tool calculates the stand-alone energy efficiency for each building and modifies this according to the 3D built environment.

The Danish (North Harbour, Copenhagen) tool is based on Ramboll's Urban Energy Planning tool and uses information related to building typologies, together with data on the urban environment (e.g. the number and type of buildings) to calculate predicted energy demand. The tool is capable of producing not only a baseline for a given urban environment, but also a baseline projection to a given year, in the absence of any additional national and local climate change-mitigation interventions. This baseline projection can be used to identify the impact of planned future interventions against the 'do-nothing extra' baseline projection. The tool requires a 3D model of the urban environment and some realistic projections of future building energy use (this will typically be a function of the use to which the building is to be put, the nature of the energy supply, etc.)

The UK (Newcastle) case study focuses on energy issues in existing houses and is based upon the UK's SAP methodology. This assessment method currently requires specialist personnel to visit individual properties to perform a detailed assessment of energy performance. So, the purpose of the tool is to automate the SAP assessment process allowing rapid targeting of houses in need of interventions. SAP assessment takes consideration of such factors as building materials, building size, ventilation and heating provision, etc. as input to building physics modelling. The tool developed for the SEMANCO case study reduces the scope of the SAP assessment to allow for accurate remote evaluation of building energy performance.

In addition, analysis tools have been developed that combine the visual-based approach with data mining. For complex data tasks, data must be retrieved and formatted in each subtask so as to facilitate the next sub-task and, where data is unavailable, it must be approximated by probabilistic methods.

Furthermore, the outcome of the tasks must be visualised in ways that enable non-technical stakeholders to critically evaluate information and make informed decisions. To date, there are five key components of the SEMANCO energy analysis toolset that have been developed. Firstly, the data analysis workflow model has been defined. This is a business model of the operation of the SEMANCO platform and provides details of how the various actors within the analysis chain will interact with the SEMANCO platform and with each other. Secondly, a series of tools have been created that allow for the generation of SPARQL queries and the querying of RDF data stores for data analysis, as well as data visualisation services. Finally, the SEMANA web-based service has also been developed to integrate external tools such as RapidMiner (facilitating data mining) with the implementation of internal services. Other external tools, such as Mondrain and JFreeChart, have also been integrated to facilitate the presentation of data as charts etc.

These tools allow the advanced analysis of urban energy related data on a variety of scales. For instance at the neighbourhood scale, the tools can help to select materials and technologies to be used for building refurbishment. At the municipal scale, the goal can be to optimize the energy consumption and to reduce the CO2 emissions in a new planned area or in a refurbishment plan; and at the regional scale, the tools can help to define a range of strategies to achieve the previously established sustainability objectives. The data analysis tools also are required to mitigate for the inevitability of missing data: unknown energy data relating to yet-to-be-built buildings, data missing due to the prohibitive cost of its acquisition, etc.

SEMANCO Integrated Platform

These tools are unified with the workflow model by means of a **web-based GUI** which integrates the SEMANCO tools and components, allows interaction between users and supports workflow. The integrated platform is the front-end by which different types of user can interact with the tools that access the semantic data. This is a crucial point in the project as it brings together for the first time several key strands of work. The building energy modelling and analysis tools have been integrated into the platform, meaning that the tools are linked with the semantic data and can be interacted with via appropriate interfaces.

The platform allows users to define urban energy system models of interest to them and to apply the various interoperating tools to these models in order to calculate baselines and to perform scenario planning. Interactive 3D models, diagrams and tables can be used to access information of interest, such as high CO2 emission areas, areas of fuel poverty, and energy inefficient buildings.

Users can collaborate in the creation, maintenance and operation of the models in order to make current energy assessments and to inform planning decisions, with the integrated platform allowing access to, analysis and presentation of relevant data from disparate sources. The platform is therefore the nexus between the tools and the data, allowing interaction with the SEIF and exploration of the semantic data explorer (allowing users who are not expert in ontologies to explore the data sources using natural language and to support users in the efficient formulation of queries).

In all, the technological developments made by the SEMANCO project partners have delivered a powerful prototype semantic tool. The web-based GUI integration of the tools with the SEIF to allow, via the Federation Engine, the efficient querying of a number of disparate data sources is set to greatly enhance the capability for decision makers to achieve managed carbon reduction in urban planning.

Upcoming Highlights

• SEMANCO are organising the 4th VoCamp, “Integrating multiple domains and scales”, which will take place on Thursday 13th and Friday 14th of February 2014, at the Engineering and Architecture School La Salle Campus, Barcelona, Spain. This VoCamp will focus on the application of ontologies to integrate multiple domains and scales in order to develop models of urban energy systems which help different actors - urban planners, consultants, policy makers, dwellers- to take better informed decisions to reduce energy consumption and carbon emissions in urban environments. To get more information about this workshop and register please use the online form or contact e-mail available on the **SEMANCO website**.

Visit the SEMANCO website for more details: **www.semanco-project.eu**
If you would like to become a member of the SEMANCO Dissemination Network, please contact Chris Ennis at c.ennis@tees.ac.uk

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