Practical work proposals

Proposals by students for new themes are very welcome; following its adoption, these themes are developed in accordance with the general by-laws published in the UC page.

Some general conditions that all projects must follow (subject to discussion on a case-by-case basis) are:

1. Involving web semantics technologies (URI, RDF, SPARQL, OWL, etc) to represent and query data, information and knwoledge;

2. Involving the gathering of knowledge from different existing knowledge sources, represented using web semantics technologies and/or create more/new linked data, which can derive into new knowledge.;

3. Implement the [Linked Open Data Principles].

The projects for this unit instance may follow or be inspired by the topics presented below.

Ontology-Driven Diagnostics Knowledge Graph for Manufacturing Systems

Objective:
The aim of this project is to design and implement a knowledge graph that supports complex diagnostics in manufacturing systems. The project will leverage semantic web technologies to represent machine components, failure events, and diagnostic actions, integrating multiple data sources such as machine logs, sensor outputs, and maintenance records. The focus is on enabling reasoning over these heterogeneous data sources to identify possible root causes of failures and support diagnostic decision-making.

Key Components:

- Use RDF and OWL to model manufacturing system components, events, and diagnostics concepts.
- Apply SPARQL to query root causes, dependencies, and historical maintenance patterns.
- Implement reasoning rules (SWRL or SHACL) to infer possible failure chains and suggest diagnostic hypotheses.
- Connect the knowledge graph with external Linked Open Data sources (e.g., Wikidata for general component knowledge, SSN/SOSA ontology for sensor integration).

Expected Outcomes:

- A knowledge graph capable of representing diagnostic knowledge in manufacturing contexts.

- Visualizations of causal chains and diagnostic pathways to aid engineers and decision-makers.
- Demonstrated application of Linked Data principles to enrich diagnostic knowledge.

Linked Data for Predictive & Preventive Maintenance in Production Lines

Objective:
This project aims to explore how semantic web technologies can be applied to predictive and preventive maintenance in manufacturing production lines. The focus is on modeling equipment dependencies and failure propagation using ontologies, enabling early detection of cascading failures and recommending corrective actions.

Key Components:

- Create or extend production line ontologies with classes for ErrorContext, CorrectiveAction, and Job.
- Use SPARQL queries to simulate "what-if" scenarios (e.g., the failure of one machine and its effect on subsequent processes).
- Integrate with SSN/SOSA ontology to incorporate real-time sensor and IoT data.
- Leverage reasoning engines to infer cascading effects, resource bottlenecks, and possible mitigations.

Expected Outcomes:

- A semantic dashboard for production lines, showing failure propagation and suggesting preventive strategies.
- Reasoning-based insights into workflow bottlenecks and cascading dependencies.
- Integration of semantic knowledge into diagnostic pipelines for improved decision support.
- A demonstration of how Linked Data principles and ontologies can enhance manufacturing resilience.

Automated Knowledge Base Population Using Semantic Web Technologies:

1. **For a Smart City Infrastructure**

This project focuses on automatically building a knowledge base that represents and manages data from various smart city infrastructure components (e.g., traffic management systems, energy grids, public transport). The goal is to automate the population of this knowledge base with '*real-time*' sensor data, GIS data, and IoT device feeds to optimize city planning and operations.

Suggestion of Semantic Web Technologies:

- **GeoSPARQL** for managing geospatial data.
- **SSN/SOSA Ontology** for representing IoT sensor data (e.g., traffic and energy usage sensors).
- **FOAF** and **PROV Ontology** for representing public services, citizens, and tracking city resources.

Expected Outcomes: Infer patterns such as traffic bottlenecks or power grid overloads and recommend mitigation strategies (e.g., rerouting traffic). A smart city knowledge base that can be queried to optimize city services. Automated insights into city operations, '*real-time*' issue detection (e.g., traffic congestion), and predictive analytics for urban planning.

2. **For e-commerce product management**

Similar to previous on a different application area.

Suggestion of Semantic Web Technologies:

- GoodRelations Ontology (for e-commerce data).
- Product Ontology for standardizing product categories, brands, and features.

3. **For Health**

Similar to previous on a different application area.

Suggestion of Semantic Web Technologies:

- FHIR Ontology (for integrating healthcare records).
- SSN/SOSA Ontology (for sensor data).
- SNOMED CT for medical terms and diagnostics integration.
- RDF, OWL, and SPARQL for data structuring, ontology modeling, and querying.

To trigger new project ideas:

If you've used Google, you've used the cornucopia of Linked data across the Web, through Google's Knowledge Graph (Google's Knowledge Graph is reportedly supported by [Freebase – the knowledge acquired by Google in 2010.]) If you've enjoyed the efficiency of rich snippets, you've enjoyed the riches schema.org ([based on RDF]) brings to the world of search since 2011. If you've used Wikidata – the structured encyclopedia – you've been using a giant RDF knowledge graph, describing about 100 million topics with over 10 billion properties and relationships. That is also one of the sources from which Google's Knowledge Graph is updated.

Apply these knowledge sources in an area of your interest (a tool to promote knowledge sharing within your Master programme?) to develop a project that both interest you and provides meaningful outputs for you and your colleagues.