Applying the Semantic Web to Manage Knowledge on the Grid

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Overview

• Background and purpose
  – EDSO, Resource, knowledge support

• A layered semantic infrastructure
  – DL Ontology + Instance store, Ontoview, annotator and advisor

• Life cycle of semantic web base KM
  – Knowledge capture, binding and reuse

• Demonstrations of various tools
  – Ontoview, annotator, advisor, knowledge toolbox, etc.

• Summary and future work
Background and purposes

• Grid based EDSO
  – Engineering Design Search & Optimisation
  – Resources of distributed computation, distributed storage and distributed knowledge
  – Toolbox of Grid enabled Matlab functions

• Describe and share resources using Ontology and Semantic Grid technologies
  – Components: Matlab functions – the toolbox,
  – Domain knowledge: optimisation methods, valid configurations, etc.

• Provide knowledge through reusing the semantics
  – Retrieval of the semantics (direct use)
  – Advice (more advanced usage)
    - On function configuration
    - On workflow composition
  – Web services, distributed and service oriented architecture
Layered Semantic Web Infrastructure

- **EDSO Domain Ontology**
  - Concepts and relations in a domain
  - Obtained through KA
  - Represented in DAML+OIL

- **Generic Ontology manipulation and storing mechanism**
  - Ontoview API and editors
  - Ontology further refined and populated in Ontoview

- **Geodise knowledge services/demonstrators**
  - Function Annotator
  - Semantic Retrieval GUI
  - Knowledge advisor service

- **Geodise Apps integrated with knowledge**
  - Knowledge toolbox in Matlab
  - WCE standalone tool
  - DSE standalone tool
Knowledge Life cycle

- **Knowledge Capturing**
  - Knowledge Acquisition, building Ontologies

- **Knowledge Binding**
  - Annotation: Creating instances of ontological concepts
  - Ontoview editor, function annotator

- **Knowledge Modeling**
  - Specification of useful knowledge:
    - Semantic retrieval, advice on function configuration and assembly

- **Knowledge Reusing**
  - Semantic-based function query and knowledge advisor

Illustration follows
Knowledge Capturing

- Knowledge Acquisition
  - From Domain experts and domain documents.
  - Build in OilEd and maintain in Ontoview

- Ontology
  - Concepts
    - Node Type
  - Relationships
    - Hierarchy
    - Link Type & Data Field

- Result
  - DAML+OIL format
Function Annotation
(Knowledge Binding)

• Generating semantic instances
  – Binding ontology with semantics content
  – Populating the semantic web based knowledge base

• Supporting Tools
  – Through Ontoview editor
    - High flexibility (can generate instances of any ontology concept)
    - Sometimes tedious
  – Through a customized function annotator
    - Automatic parsing
    - Lack of flexibility (only deal with functions at the moment)
  – We use both
Ontoview Editor

- Creating + maintaining the ontology
- Generating Concrete nodes (semantic instances)
  - Instantiating abstract nodes defined in ontology
  - Filling ontology driven forms with semantic content
Function Annotator

- Customised for Matlab functions
  - Automatic parsing Matlab function source
- Instantiating abstract nodes defined in ontology
- Semi-automatic filling of the ontology driven forms
Knowledge Reuse

• Function Query
  – Identify functions based on their semantics criteria (Semantics \(\rightarrow\) Functions)

• Advice
  – Retrieve semantics (Entity \(\rightarrow\) Semantics)
  – Function assembly (Service composition)
  – Function configuration

• Service Oriented Architecture
If we want to leverage and harvest the maximum benefit of Semantic web, i.e. effective discovery, machine-enabled (processable, understandable) interoperability and automation, and the Grid, i.e. resource sharing, this is one of the realisations.

The choice is up to the users!
Towards Service Oriented Paradigm

- Server (in the middle)
  - Semantic layer
  - Interfaces at different level
    - Web service
    - Java APIs
Towards Service Orientated Paradigm

- Other java applications (to the left)
  - Consume the service via Knowledge service APIs
  - WCE, DSE, FA, DL-FQ
  - To be moved to client side in the right?
Towards Service Orientated Paradigm

- Client (to the right)
  - Matlab PSE
  - Knowledge Toolbox
    - Matlab → Java
    - Web service consumer

- Illustrations follows …
Advice on Function Assembly
(Integrated in Matlab – Knowledge Toolbox)

• Goal
  – Function assembly
  – What can be deploy next and before?

• Mechanism
  – Matlab → Java → WSDL → Web service
  – Function semantic interface
  – Semantic matching

• Pre-requirements
  – Function has been annotated
  – Semantics available in the instance store

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Advice on Function Configuration

You are using a genetic algorithm search. Additional control parameters have been added. You may need still to configure the following control parameters:

- GA_NPOP
- GA_ALPHA
- GA_DMAX
- GA_DMIN
- GA_NBIN
- GA_NBREED
- GA_NCLUST
- GA_NRANDM
- GA_PBEST
- GA_PCROSS
- GA_PENAL
- GA_PINVRT
- GA_PMUTNT
- GA_PRPTNL
- GA_PSEED

% get the default beam structure
beam = createBeamStruct(4)
% analyze the OMETH and advice on its additional control parameter (with default value)
beamcontrol = gdk_options(beam)
% check semantics
gdk_semantics('GD_NPOP')
% further configure these control parameters
……
% run options
s = OptionsMatlab(beamcontrol)
Advice on Function Assembly
(Integrated in WCE – workflow advisor)
Advice on Function Assembly
(Integrated in Domain Script Editor)
Summary & Conclusions

• Purpose and background of KM in EDSO
• A layered semantic infrastructure
  – DL Ontology + Instance store, Ontoview, annotator and advisor
• Life cycle of semantic web base KM
  – Knowledge capture, binding and reuse
• Demonstrations of various tools

• Long process
• Preparation of ontologies and semantics instances are important
• Integration is not easy
• Reusing in a smart way is the key (reuse in engineer’s favorite PSE)
Future Work

• Allow engineers to curate knowledge themselves in their favorite PSE (more integration)
  - WSE, Matlab

• Synchronization
  - Engineers’ need to maintain local knowledge of their own
  - Selectively synchronize local knowledge with centralized knowledge

• Target more resources
  - Workflow
  - Grid fabrics

• More interfaces to the knowledge repository
  - More advanced advice on OptionsMatlab in Matlab
  - Function Browser