Applying the Semantic Web to Manage Knowledge on the Grid

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Overview

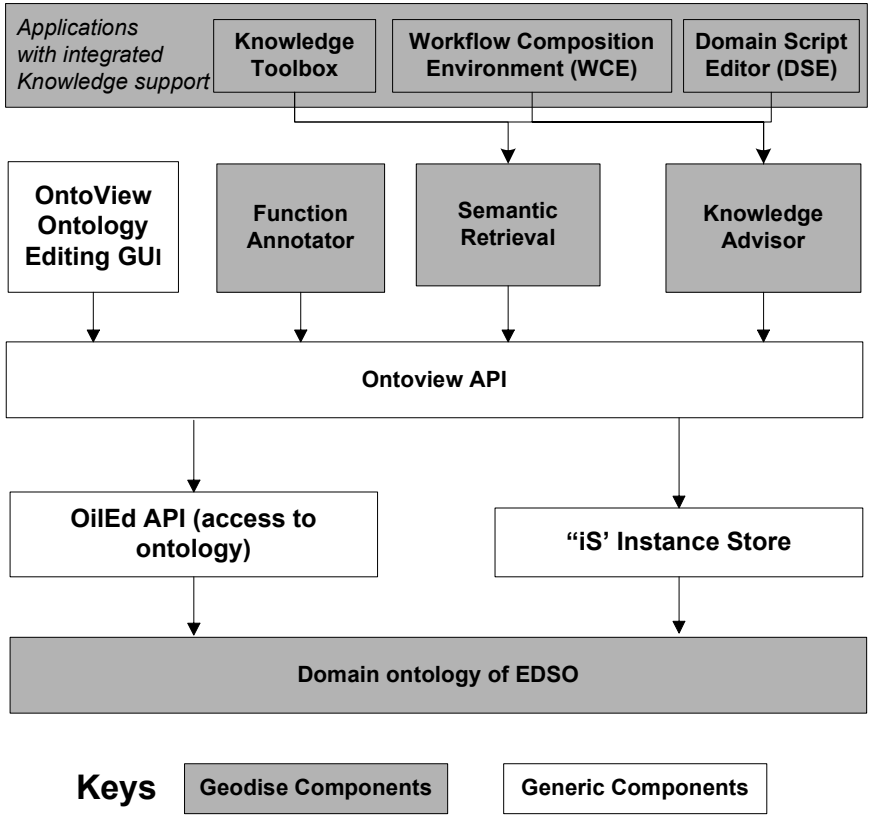
- Background and purpose
  - EDSO, Resource, knowledge support
- A layered semantic infrastructure
  - DL Ontology + Instance store, Ontoview, annotator and advisor
- Life cycle of semantic web base KM
  - Knowledge capture, binding and reuse
- Demonstrations of various tools
  - Ontoview, annotator, 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



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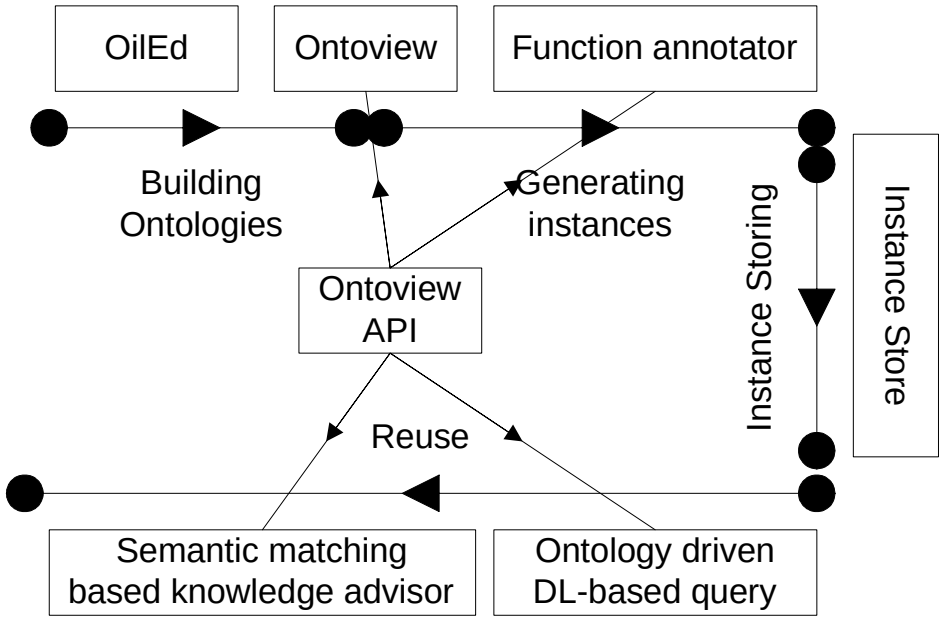
Knowledge Life cycle

- **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

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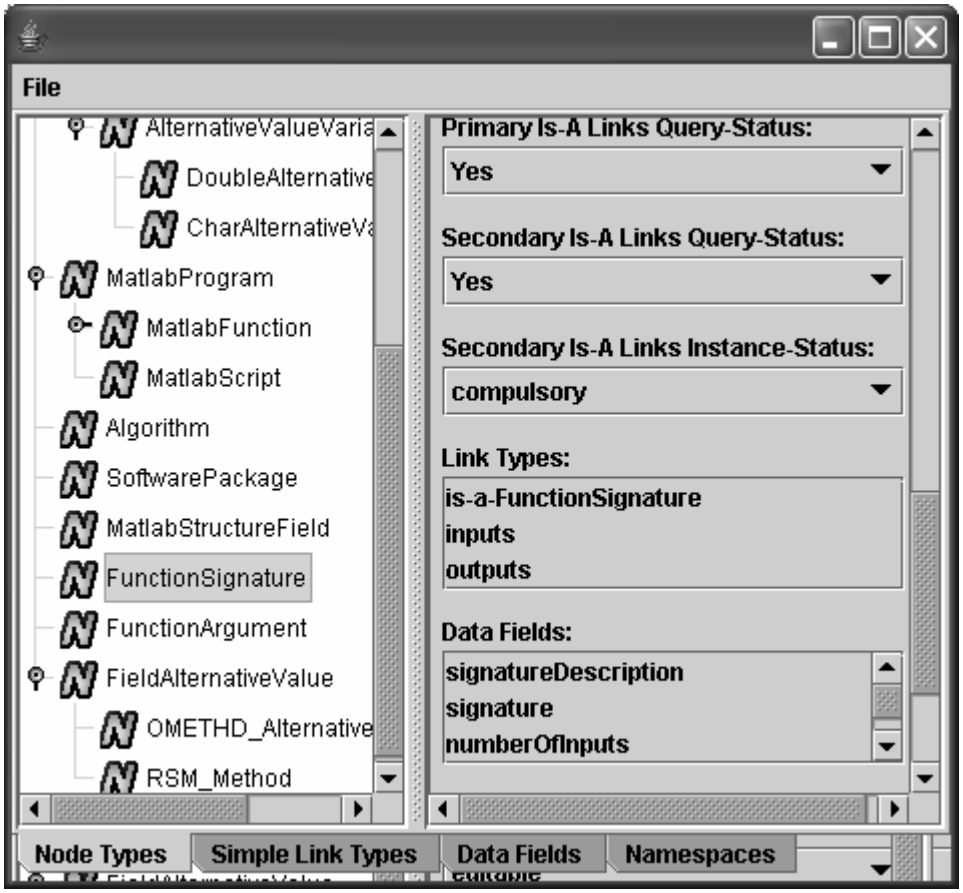
Knowledge Capturing

- 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



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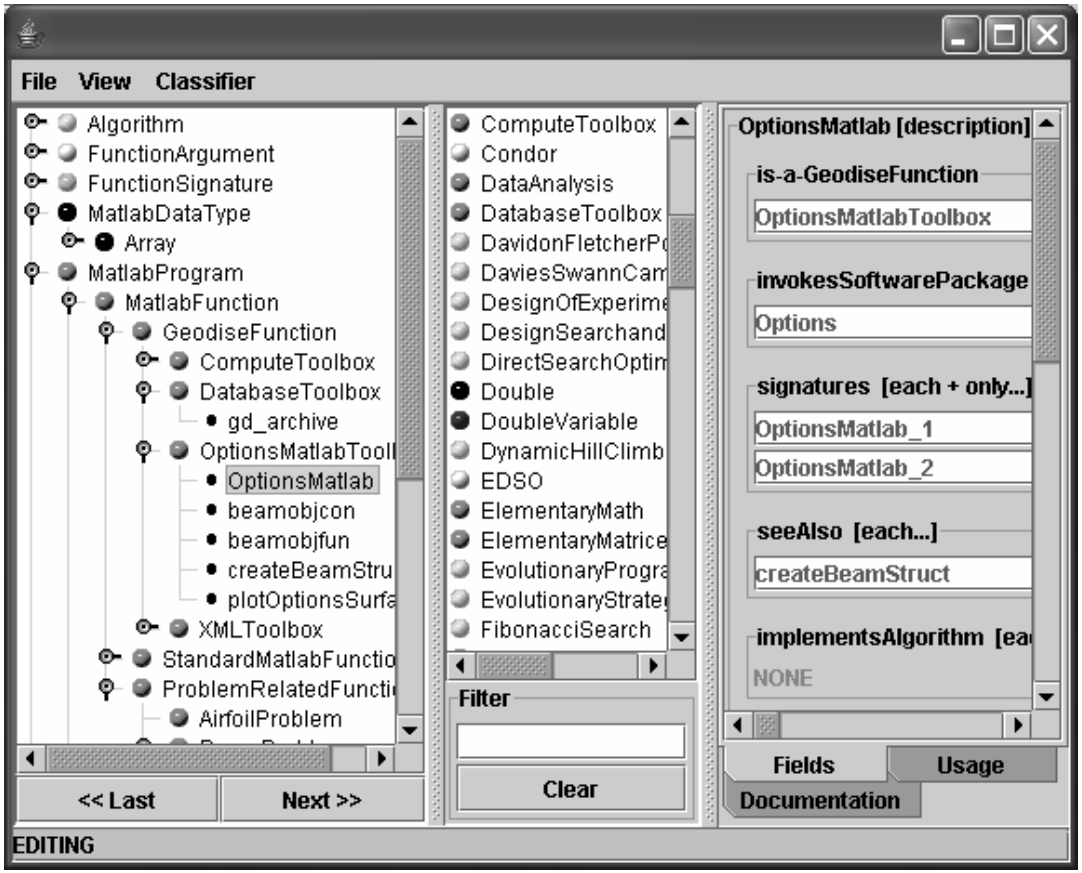
Function Annotation (Knowledge Binding)

- 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



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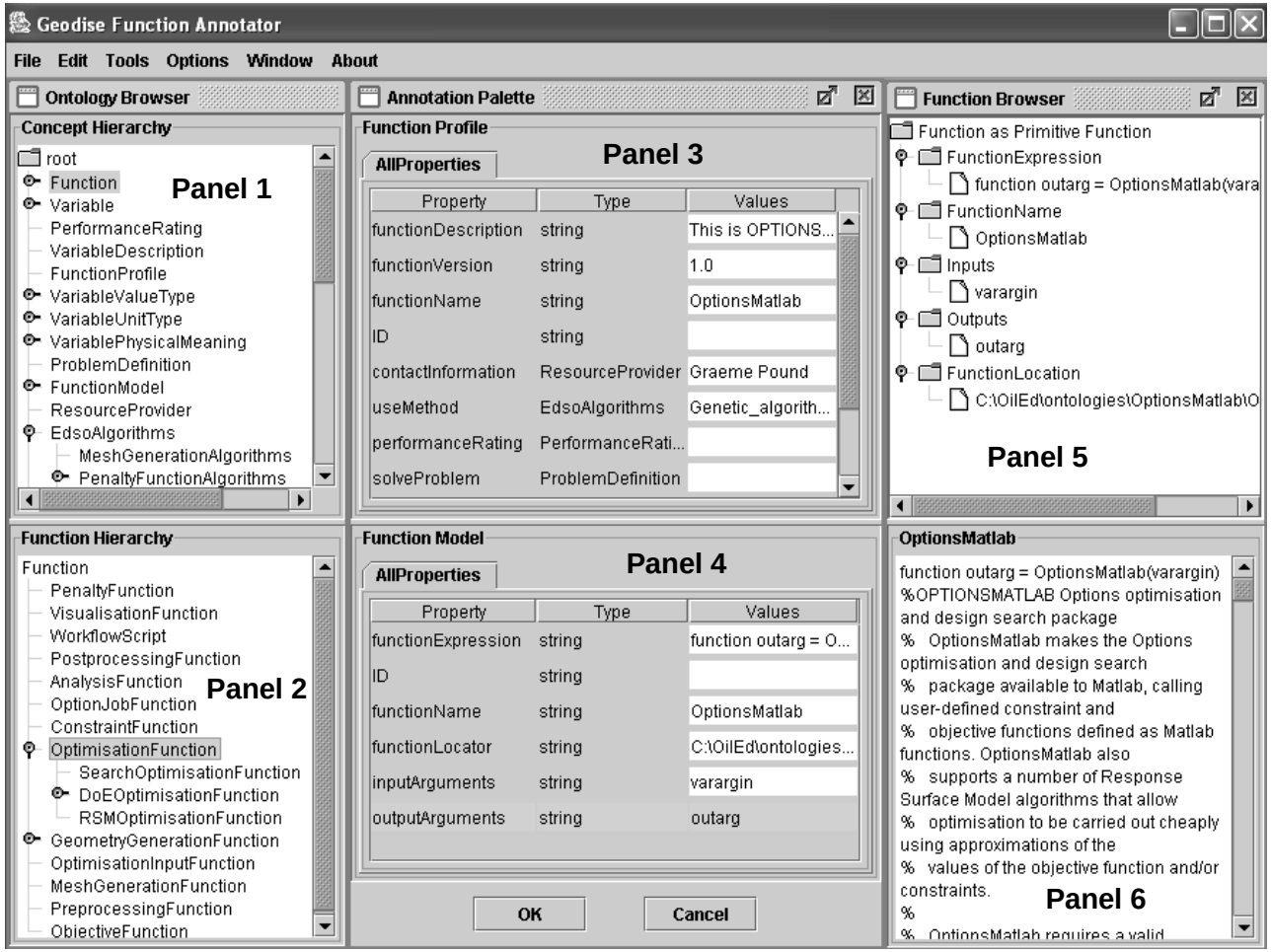
Function Annotator



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

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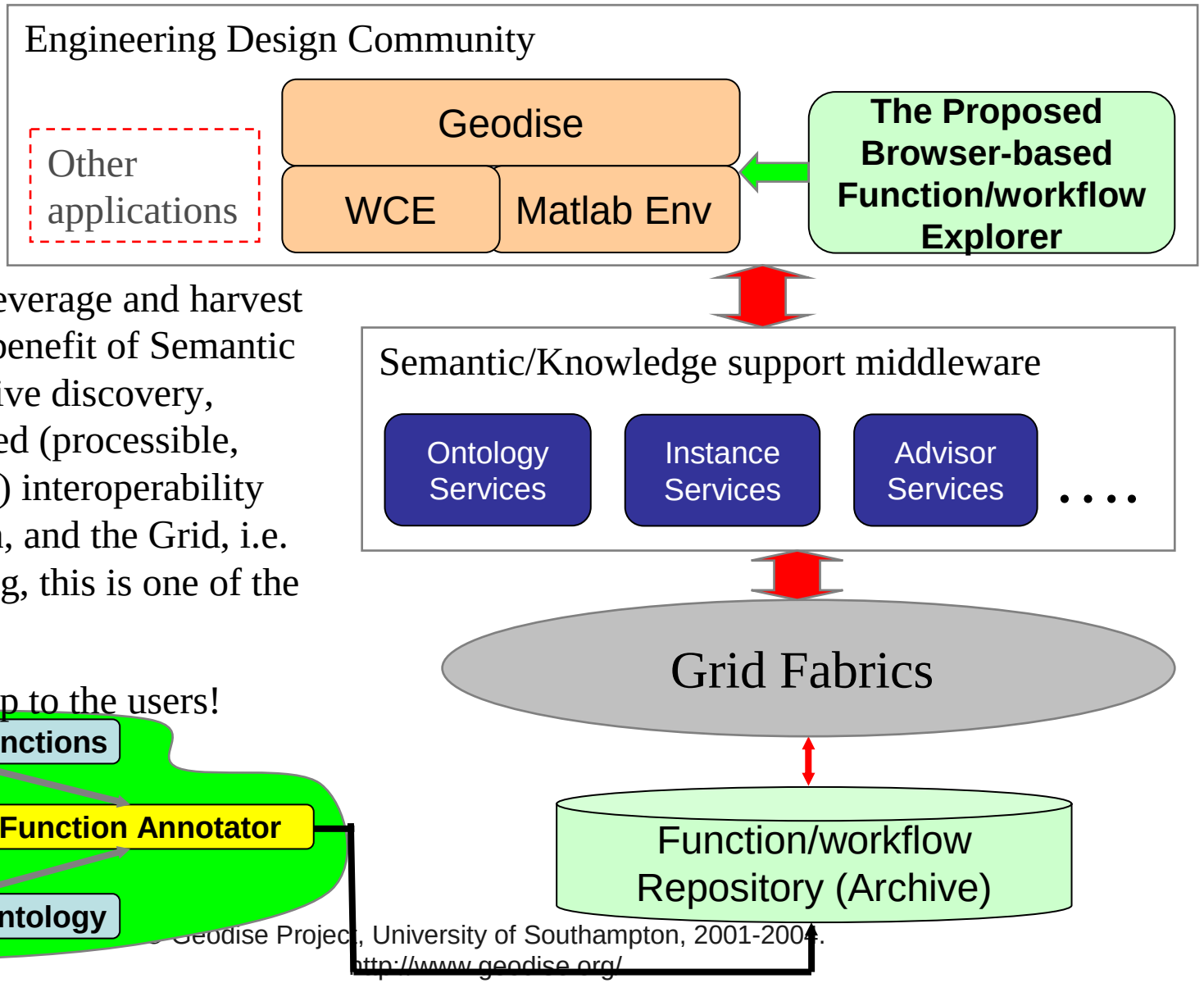
Knowledge Reuse

- Function Query
  - Identify functions based on their semantics criteria (Semantics → Functions)
- Advice
  - Retrieve semantics (Entity → Semantics)
  - Function assembly (Service composition)
  - Function configuration
- Service Oriented Architecture

Service-oriented Semantics Application Scenario



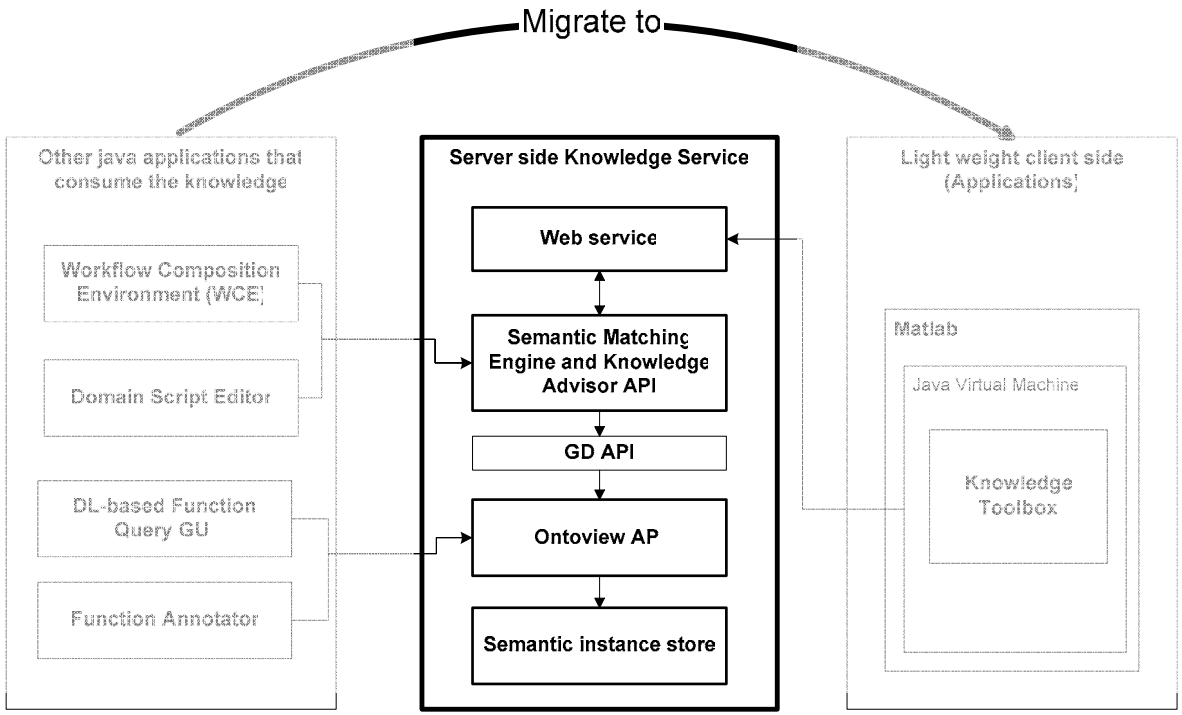
If we want to leverage and harvest the maximum benefit of Semantic web, i.e. effective discovery, machine-enabled (processible, understandable) interoperability and automation, and the Grid, i.e. resource sharing, this is one of the realisations.

The choice is up to the users!

Geodise Project, University of Southampton, 2001-2004.
http://www.geodise.org/

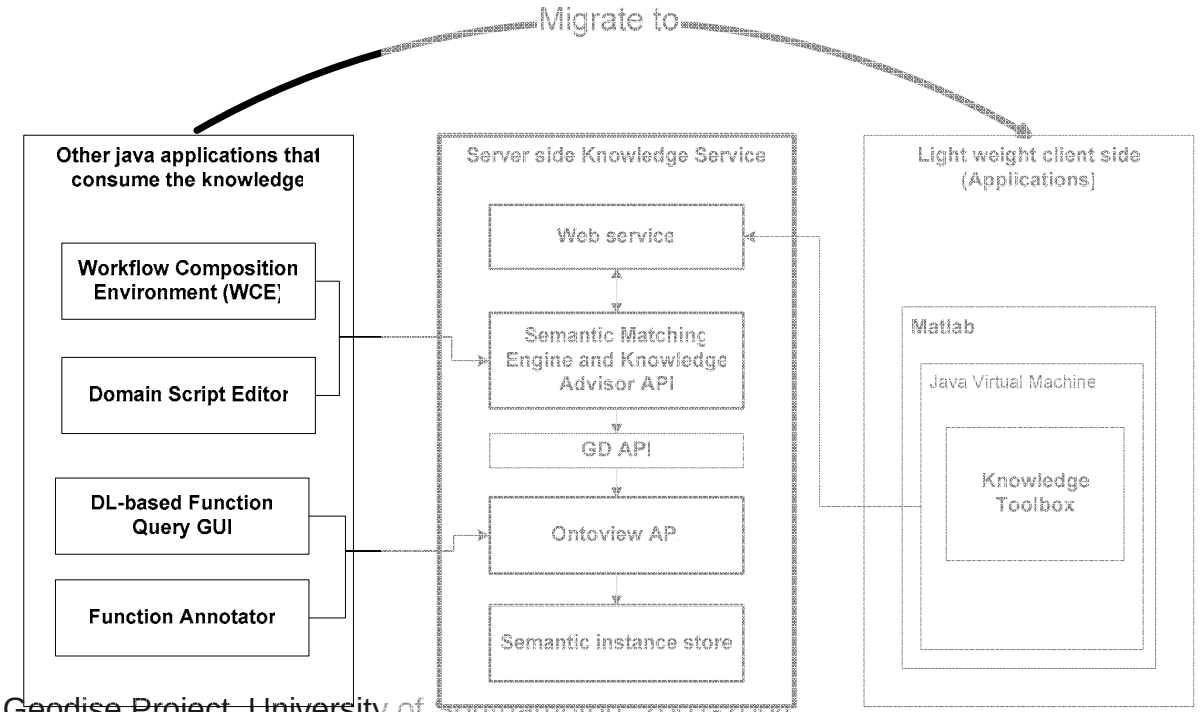
Towards Service Oriented Paradigm

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



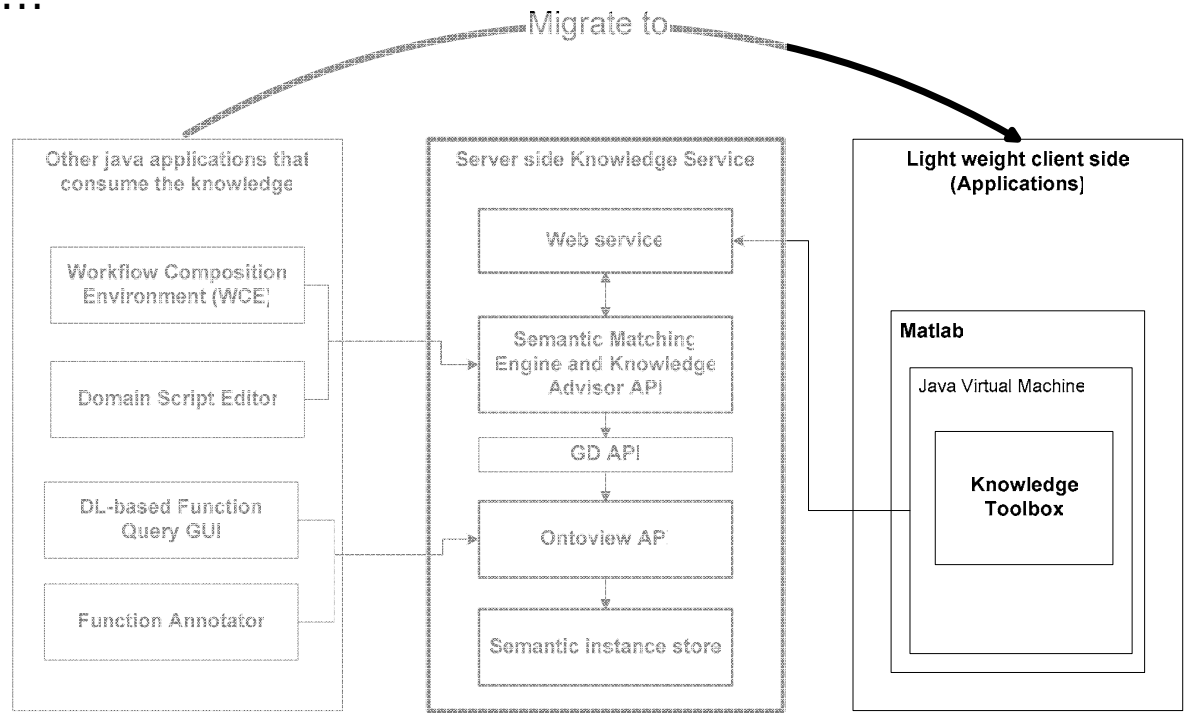
Towards Service Orientated Paradigm

- 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?



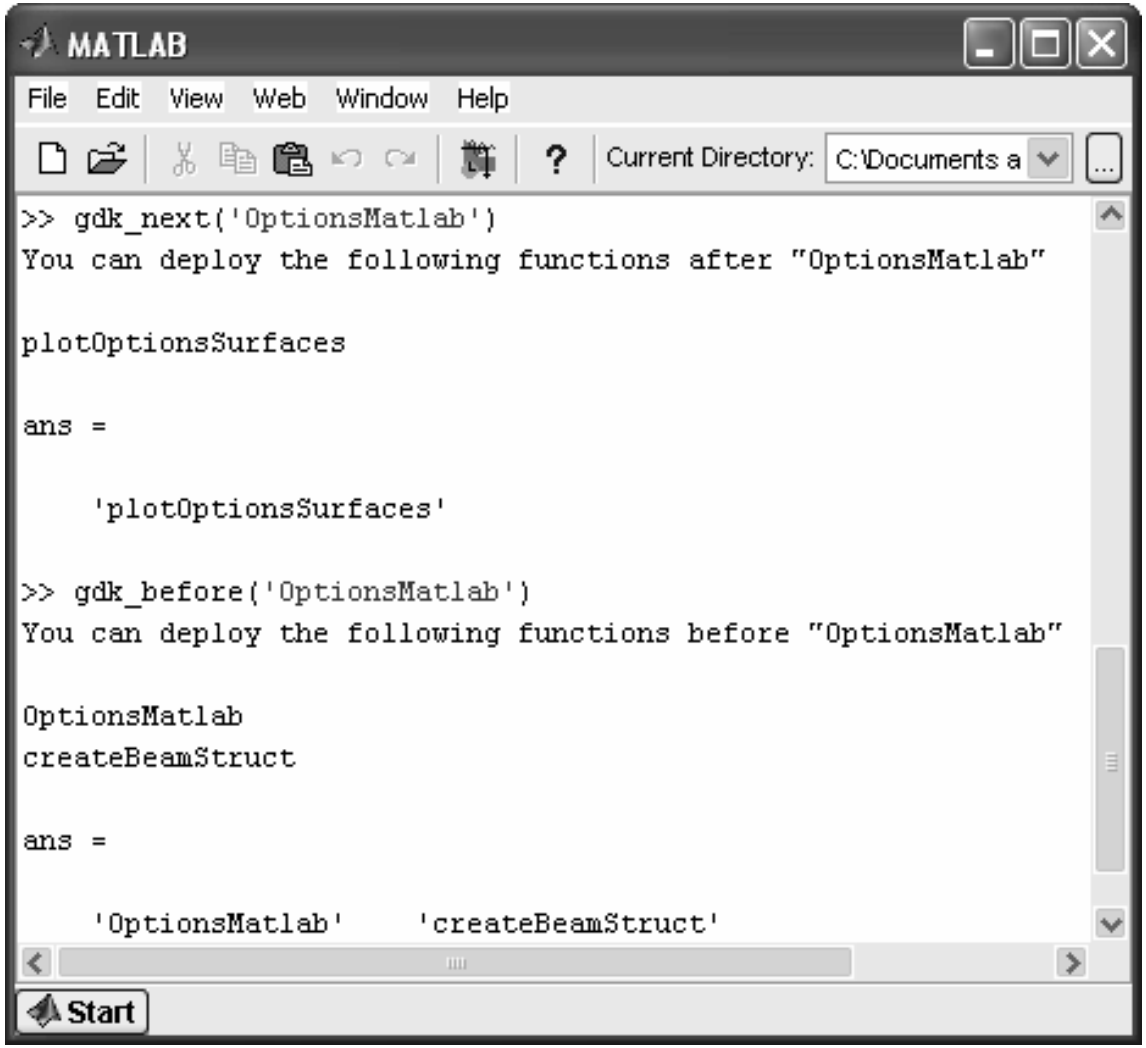
Towards Service Orientated Paradigm

- 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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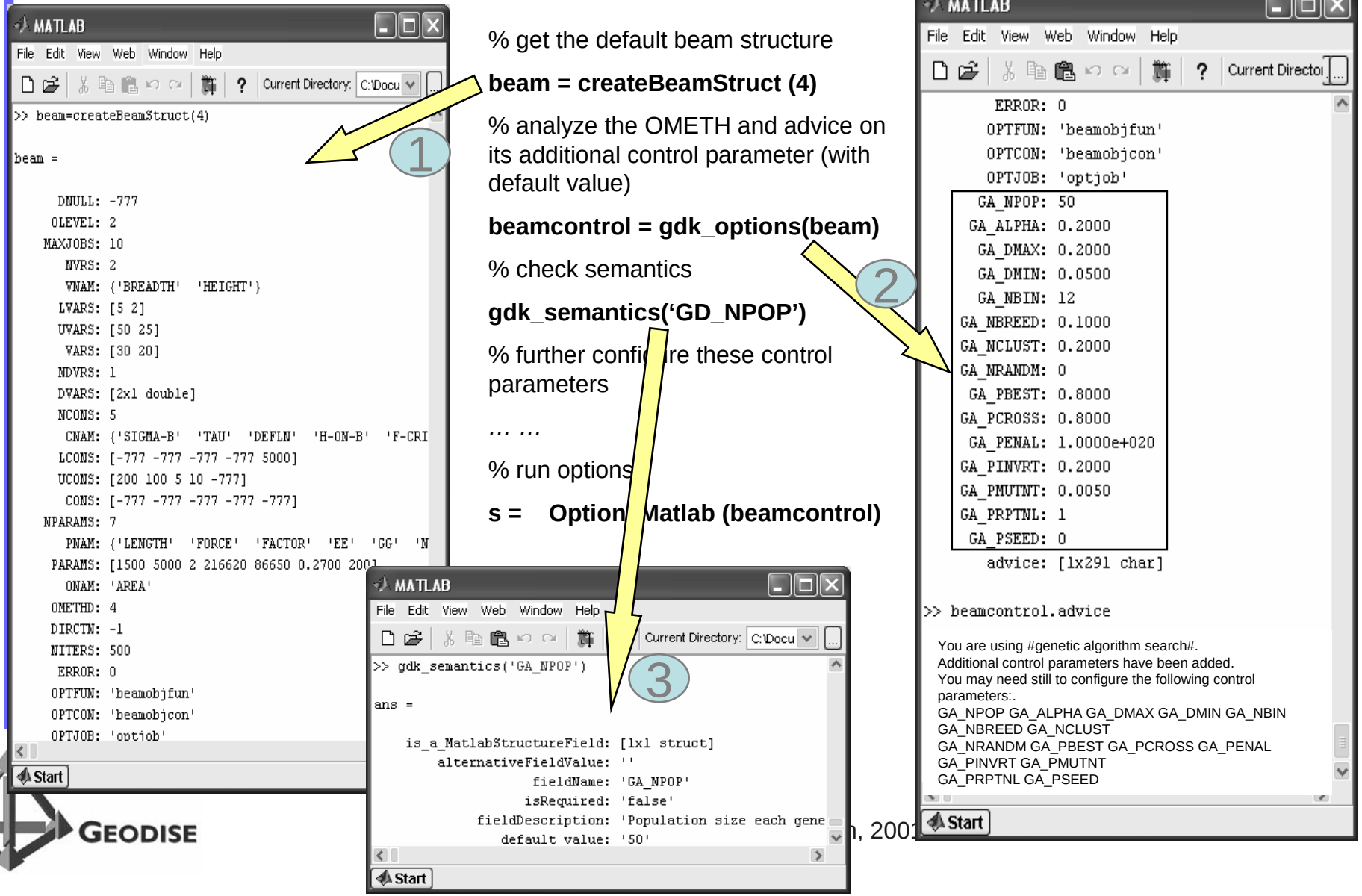
Advice on Function Configuration



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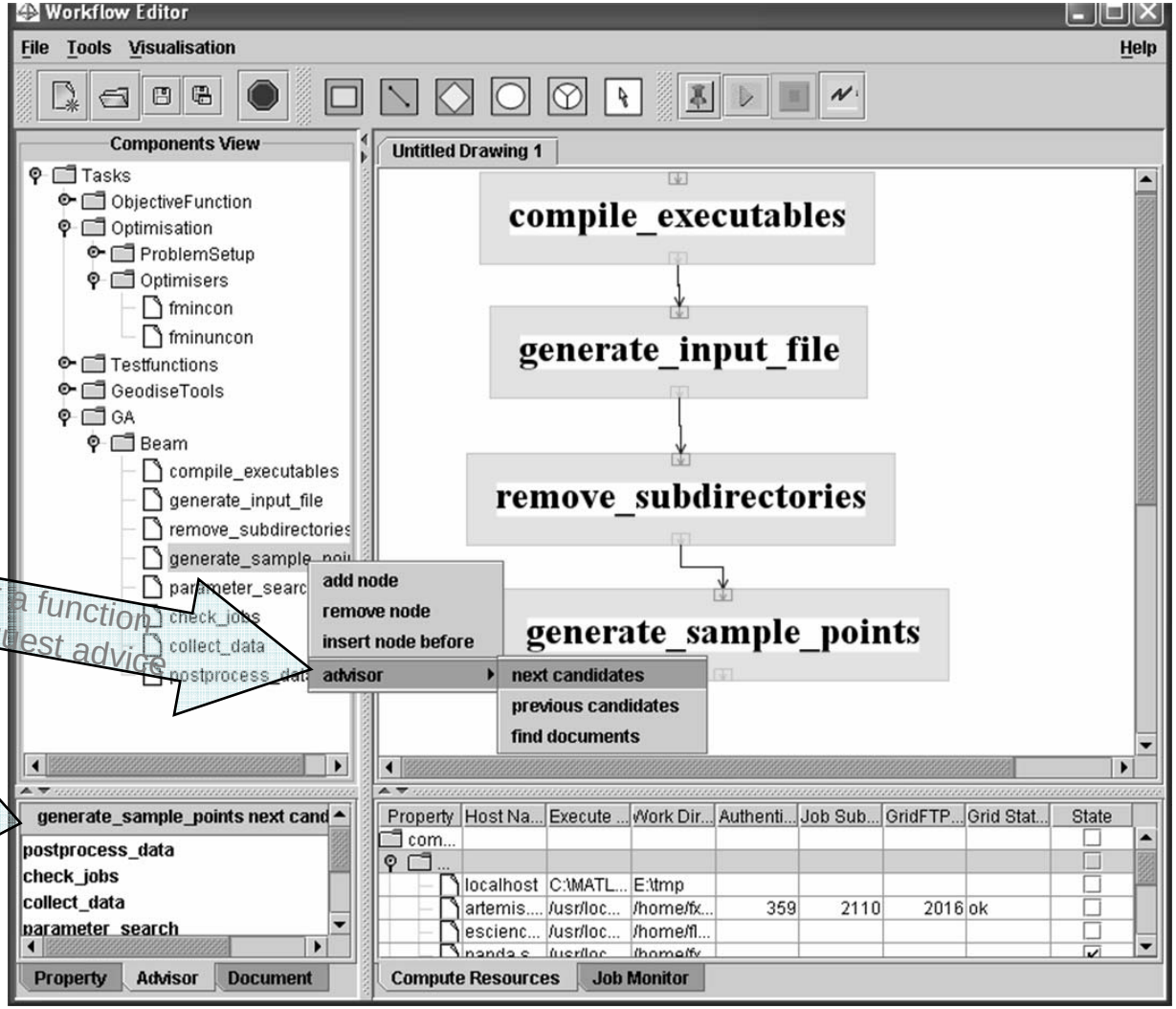
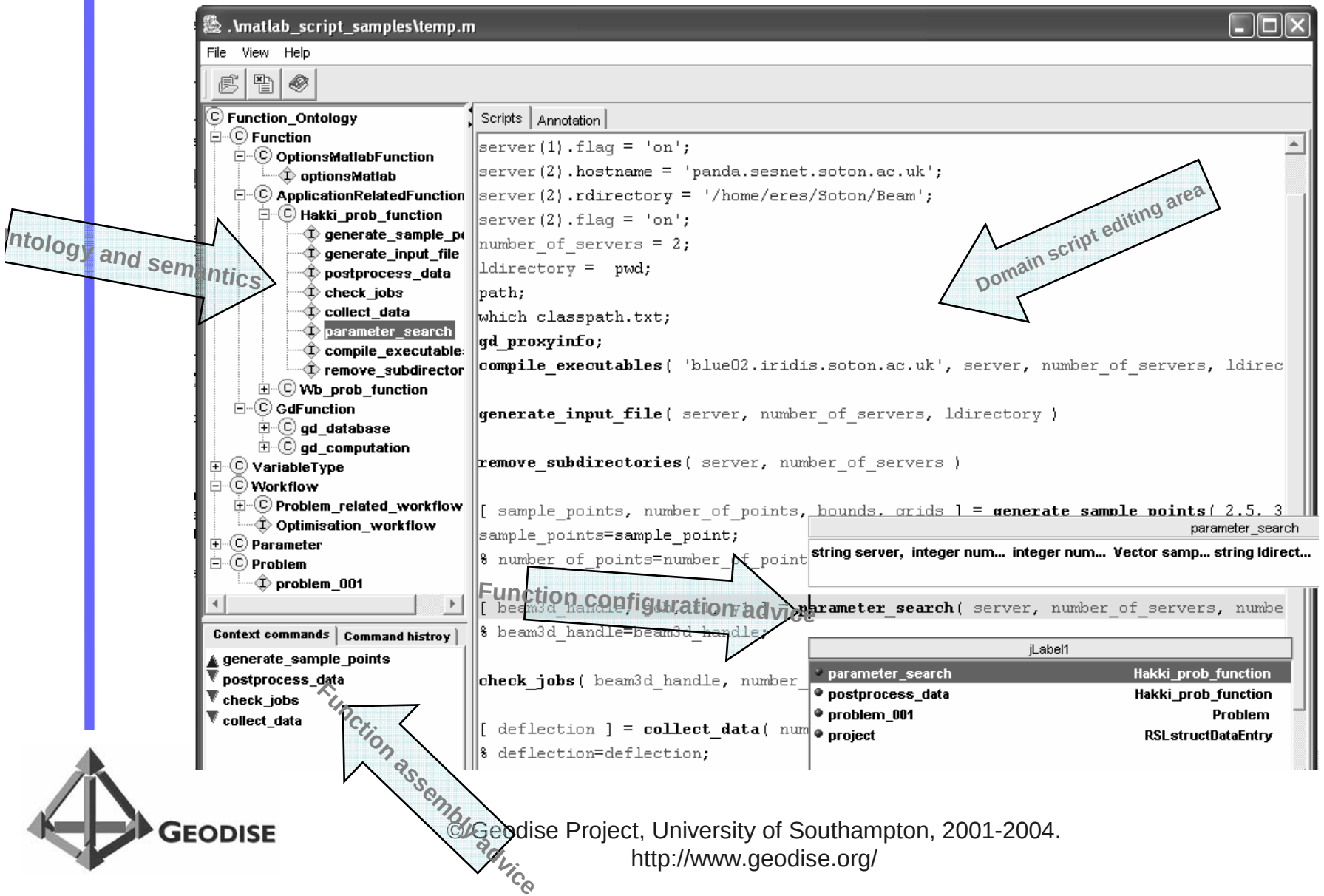
Advice on Function Assembly

(Integrated in WCE – workflow advisor)

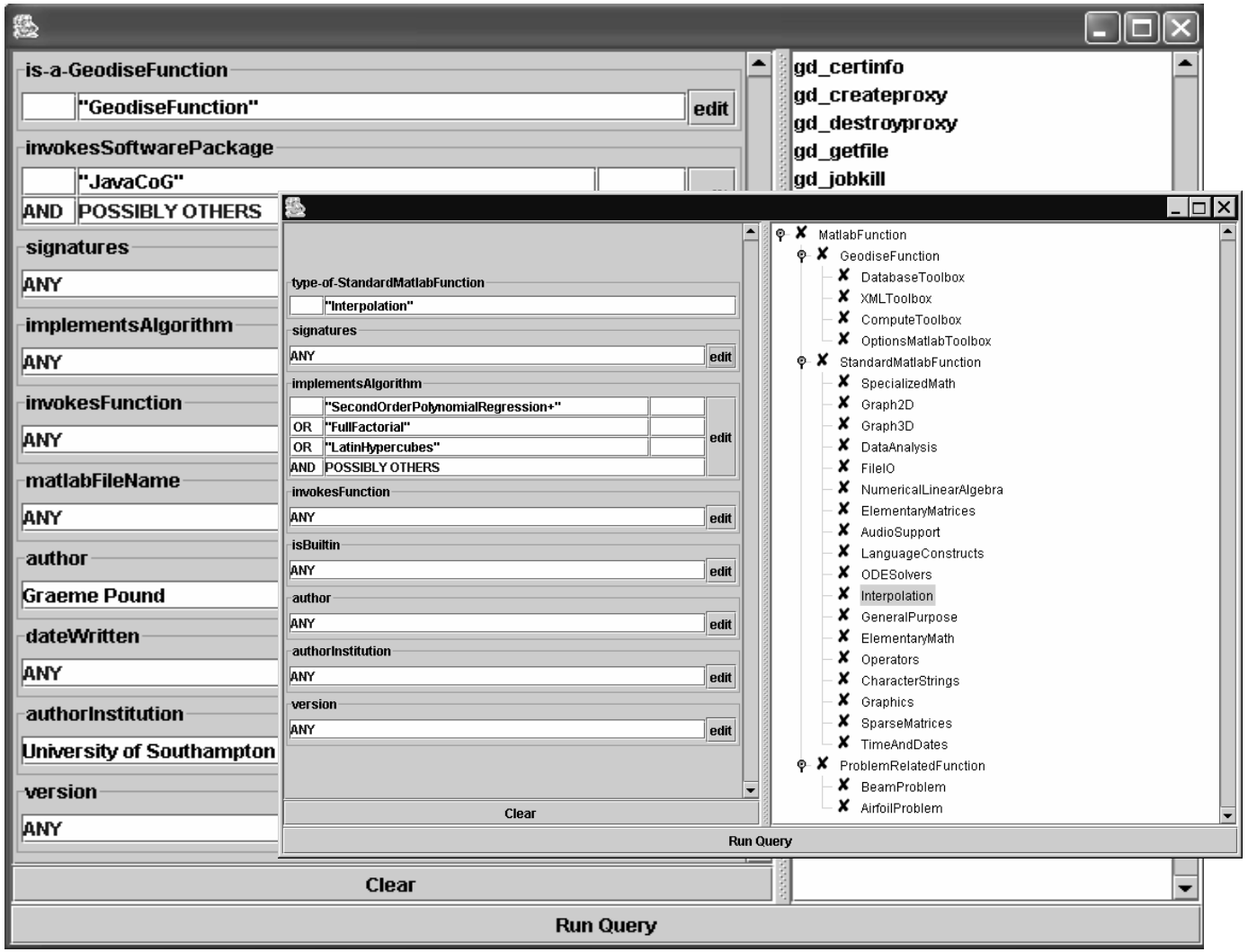


Advice on Function Assembly

(Integrated in Domain Script Editor)



DL-Based Function Query GUI



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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