

Applying the Semantic Web to Manage Knowledge on the Grid

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Overview

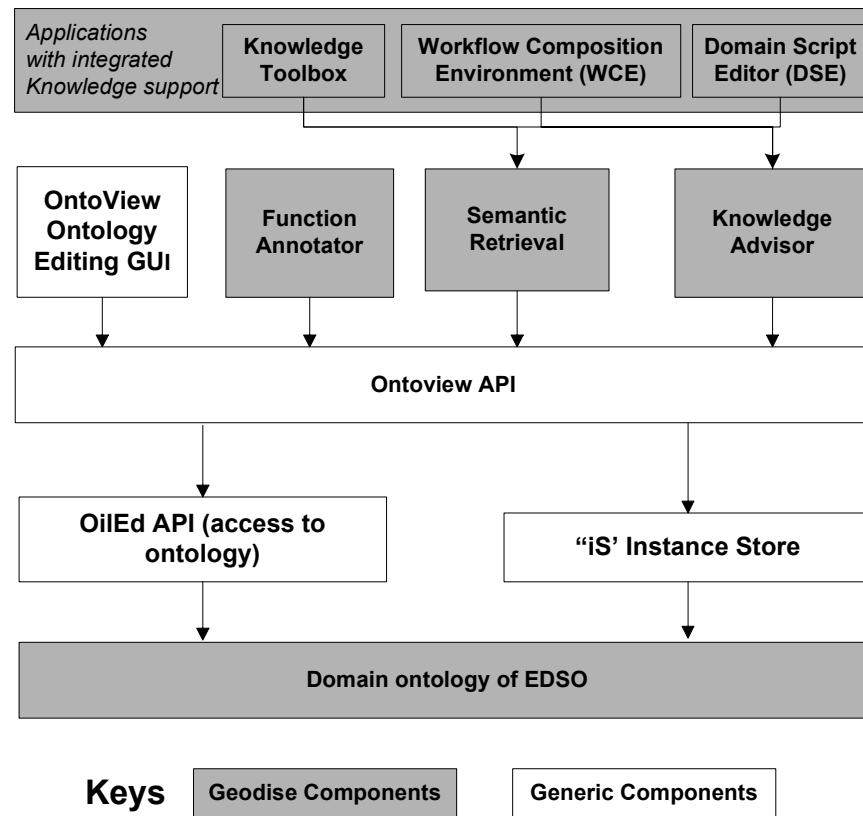
- **Background and purpose**
 - EDSO, Resource, knowledge support
- **A layered semantic infrastructure**
 - DL Ontology + Instance store, Ontoview, annotator and advisor
- **Life cycle of semantic web base KM**
 - Knowledge capture, binding and reuse
- **Demonstrations of various tools**
 - Ontoview,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

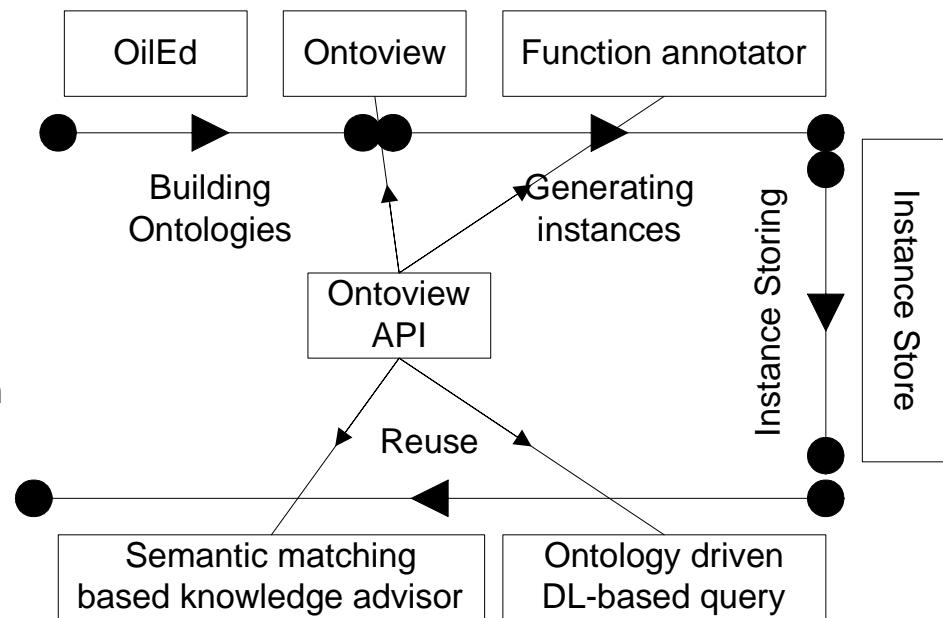
Layered Semantic Web Infrastructure

- **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



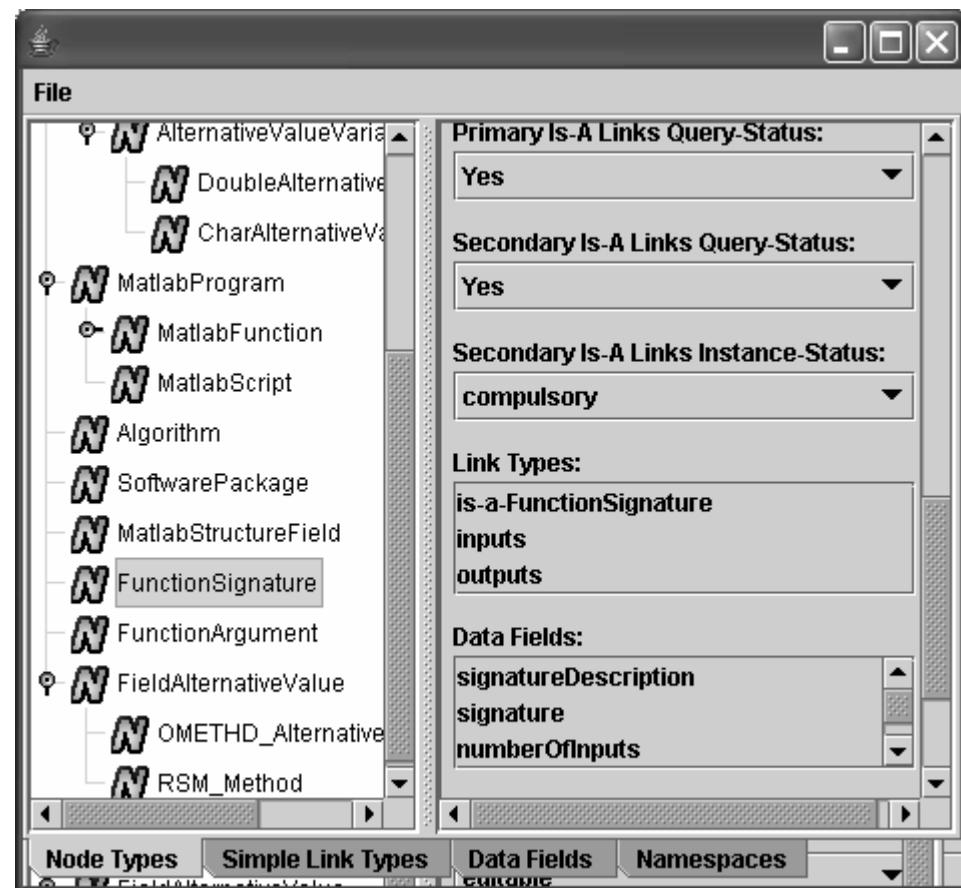
Knowledge Life cycle

- **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

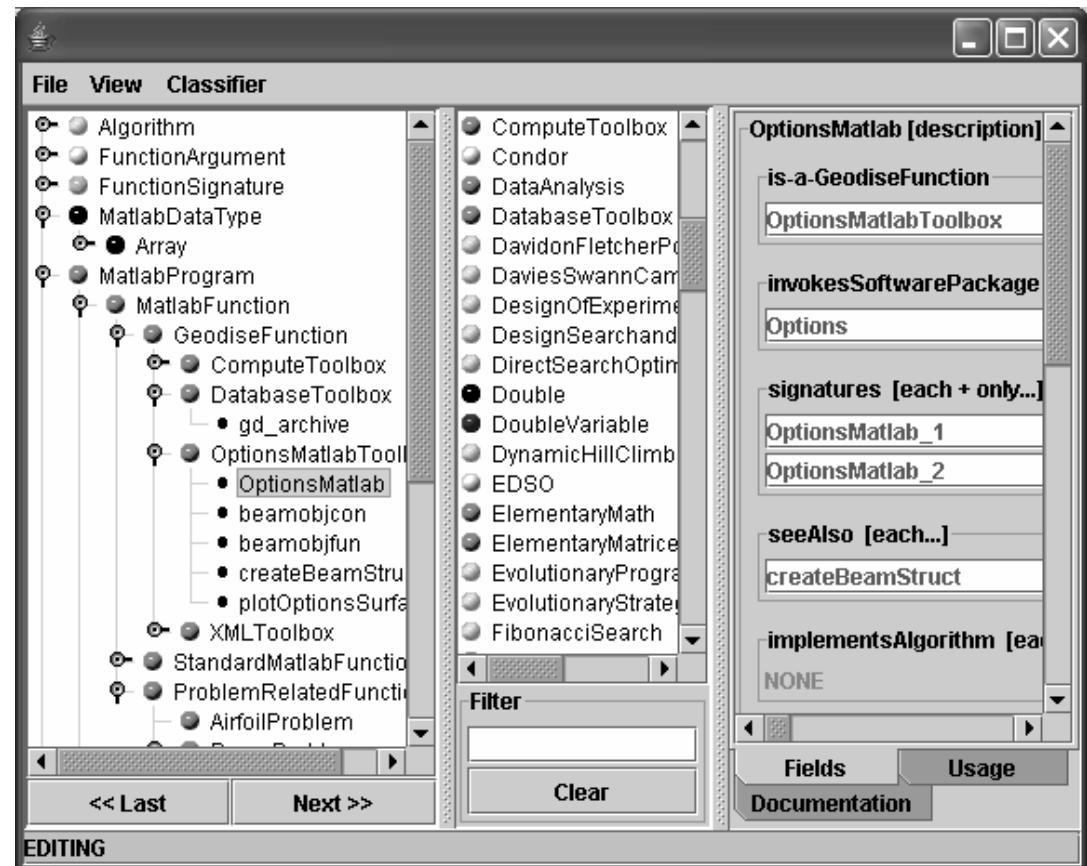


Function Annotation (Knowledge Binding)

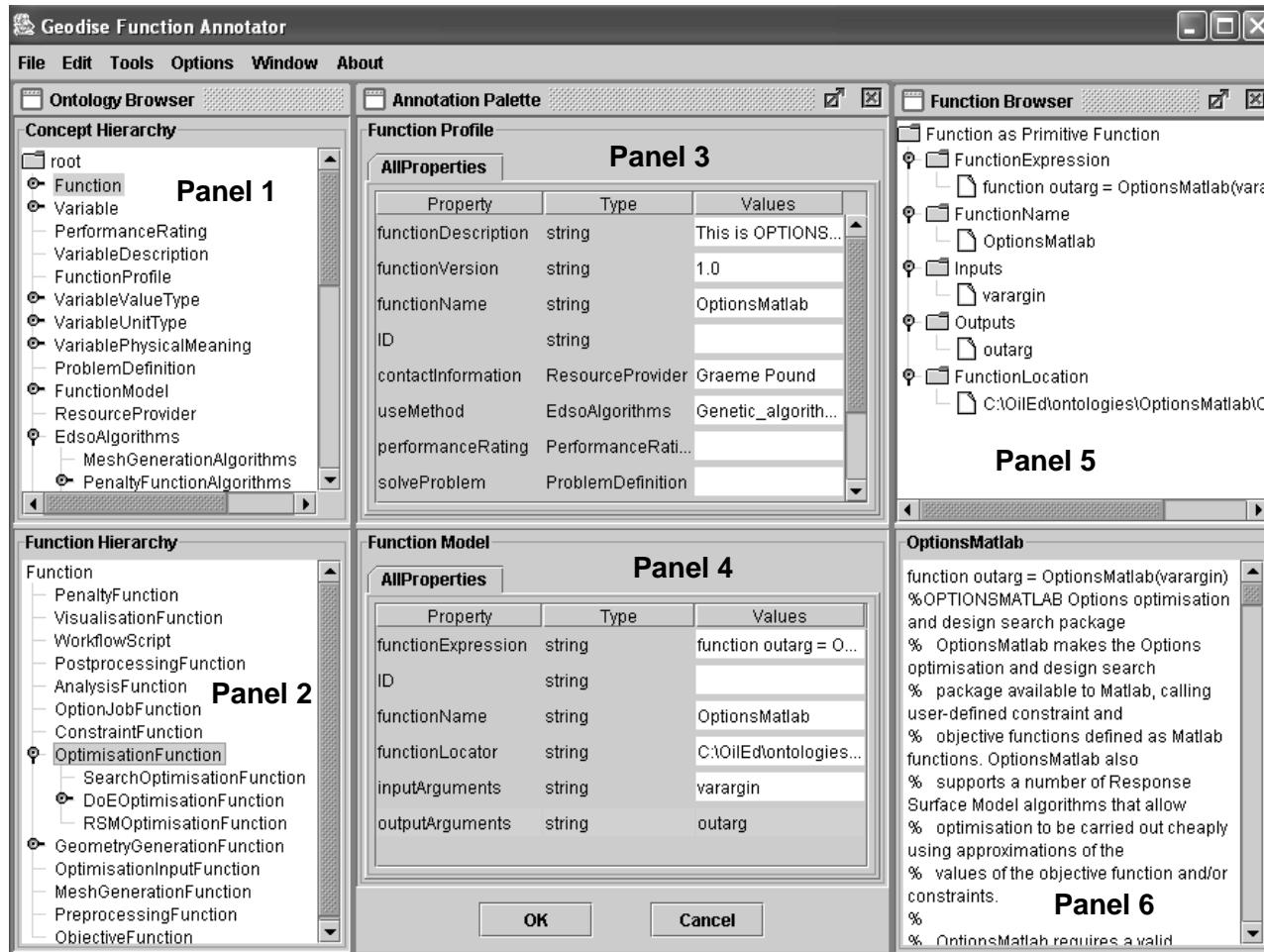
- Generating semantic instances
 - Binding ontology with semantics content
 - Populating the semantic web based knowledge base
- Supporting Tools
 - Through Ontoview editor
 - High flexibility (can generate instances of any ontology concept)
 - sometimes tedious
 - Through a customized function annotator
 - 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



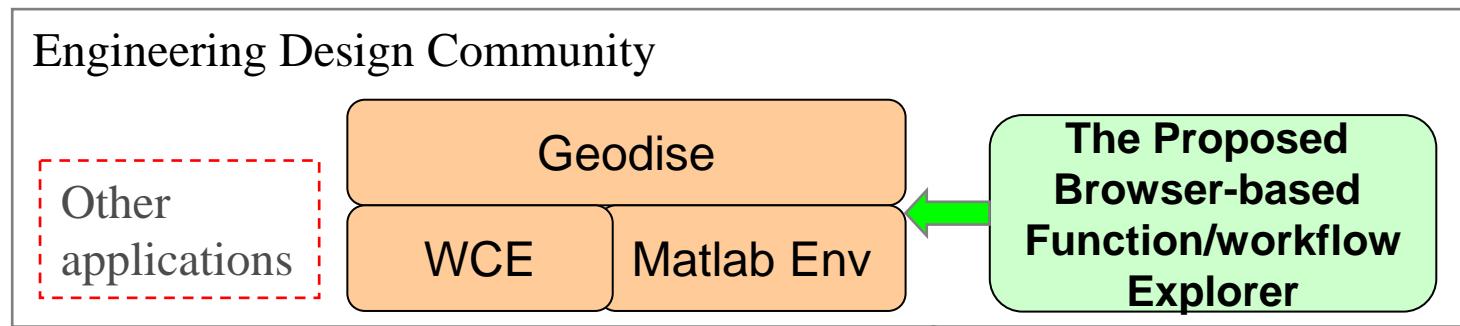
- Customised for Matlab functions
 - Automatic parsing Matlab function source
- Instantiating abstract nodes defined in ontology
- Semi-automatic filling of the ontology driven forms



Knowledge Reuse

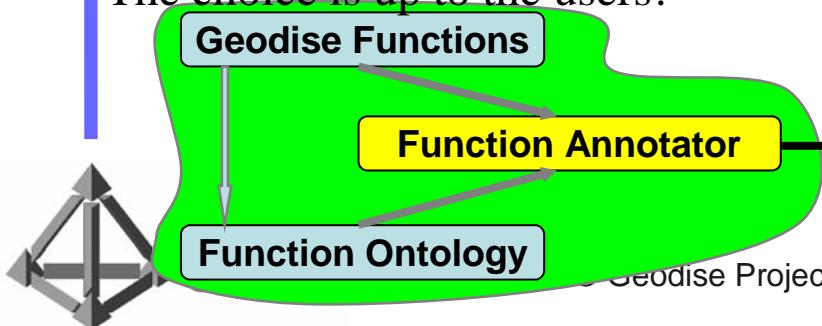
- Function Query
 - Identify functions based on their semantics criteria (Semantics → Functions)
- Advice
 - Retrieve semantics (Entity → Semantics)
 - Function assembly (Service composition)
 - Function configuration
- Service Oriented Architecture

Service-oriented Semantics Application Scenario



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

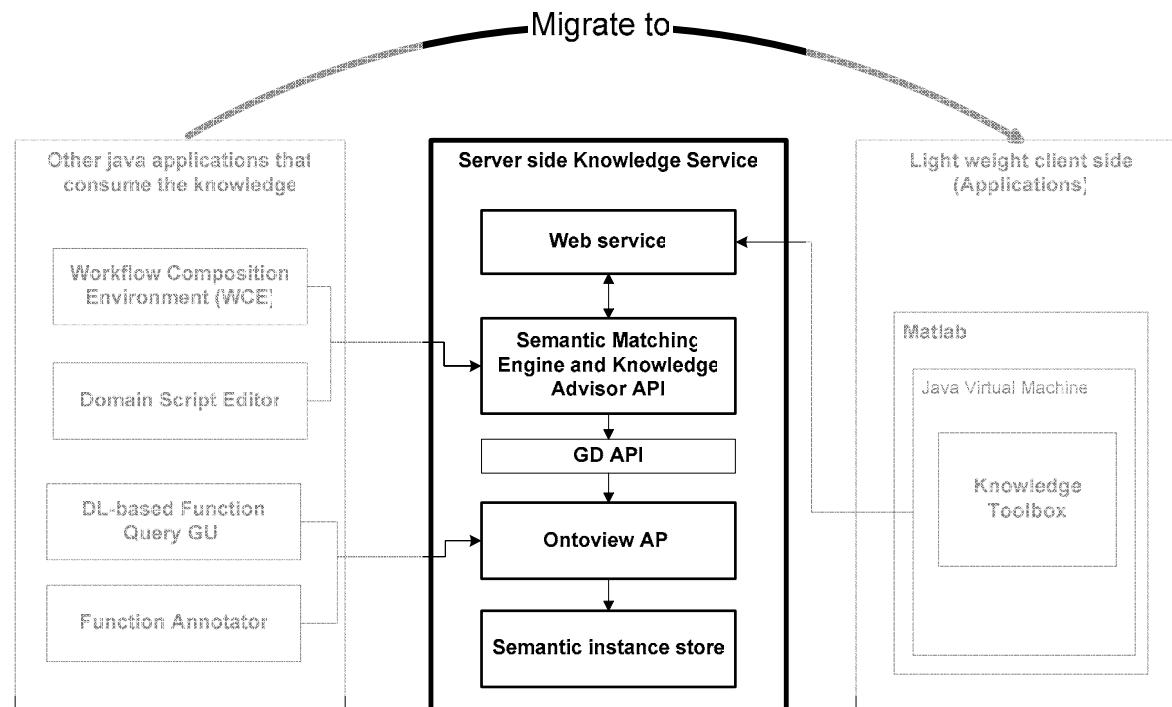
The choice is up to the users!



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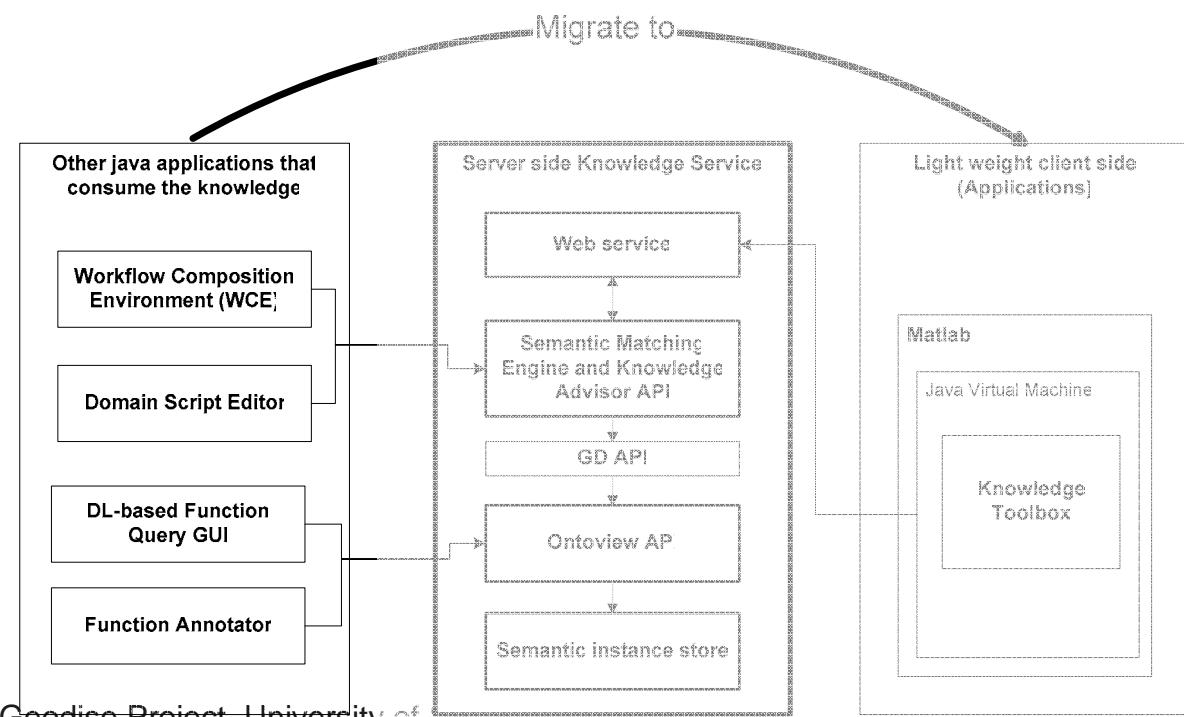
Towards Service Oriented Paradigm

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



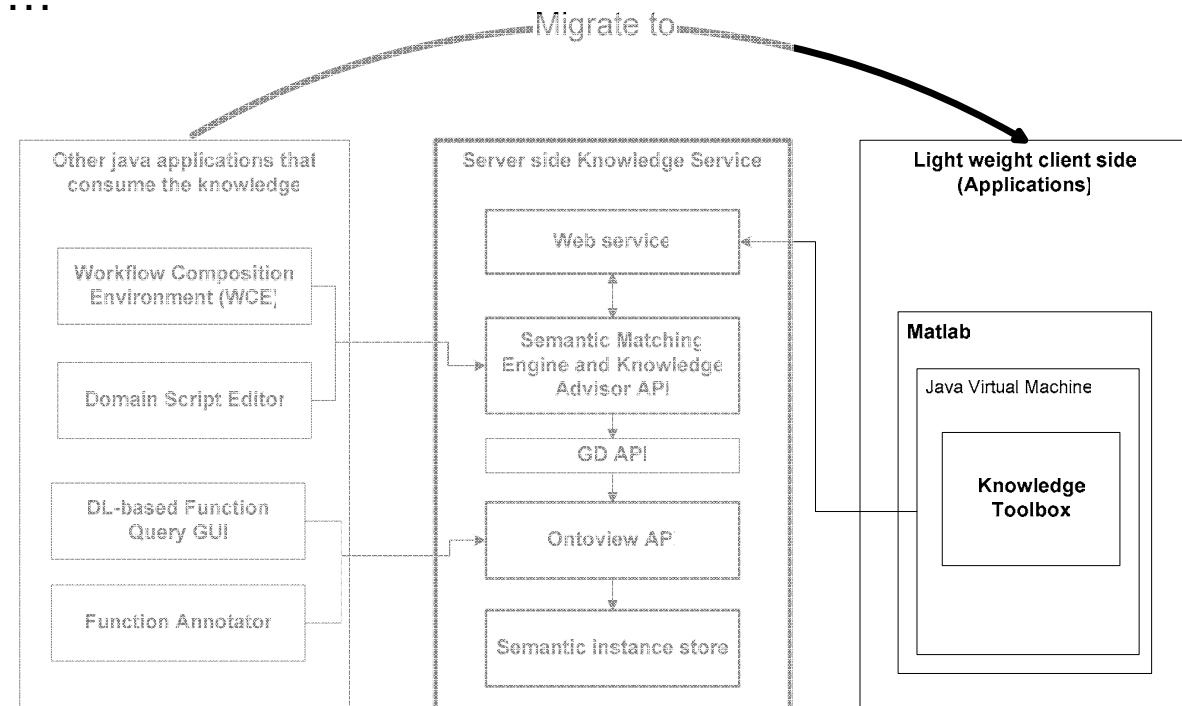
Towards Service Orientated Paradigm

- 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

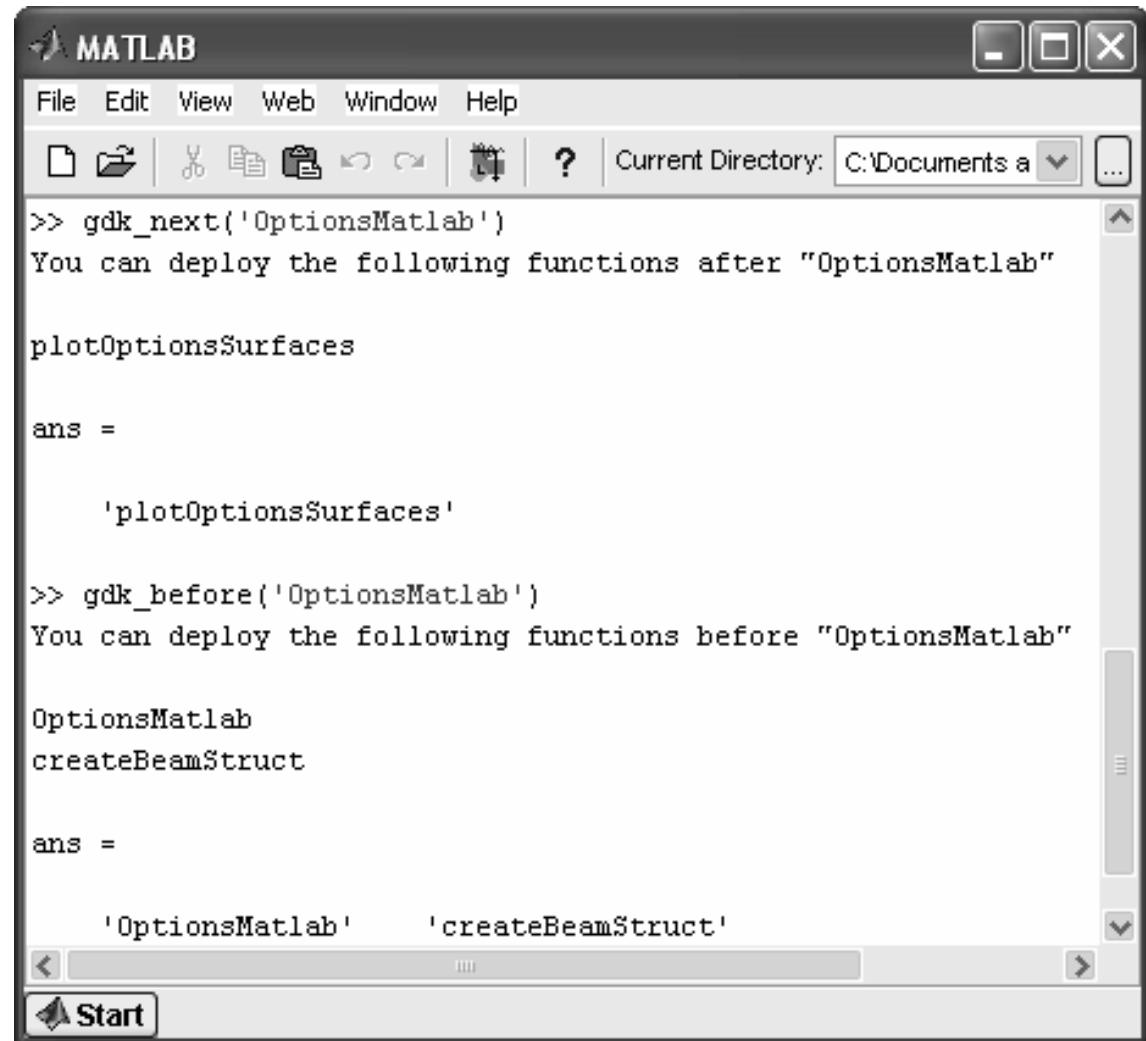
- Client (to the right)
 - Matlab PSE
 - Knowledge Toolbox
 - Matlab → Java
 - Web service consumer
- Illustrations follows ...



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



The screenshot shows the MATLAB interface with the following text in the command window:

```
>> gdk_next('OptionsMatlab')
You can deploy the following functions after "OptionsMatlab"

plotOptionsSurfaces

ans =

    'plotOptionsSurfaces'

>> gdk_before('OptionsMatlab')
You can deploy the following functions before "OptionsMatlab"

OptionsMatlab
createBeamStruct

ans =

    'OptionsMatlab'    'createBeamStruct'
```

Advice on Function Configuration

Window 1: MATLAB Command Window

```
>> beam=createBeamStruct(4)
```

beam =

```
DNULL: -777
OLEVEL: 2
MAXJOBS: 10
NVRs: 2
VNAM: {'BREADTH' 'HEIGHT'}
LVARS: [5 2]
UVARS: [50 25]
VARS: [30 20]
NDVRs: 1
DVARS: [2x1 double]
NCONS: 5
CNAM: {'SIGMA-B' 'TAU' 'DEFLN' 'H-ON-B' 'F-CRI'
LCONS: [-777 -777 -777 -777 5000]
UCONS: [200 100 5 10 -777]
CONS: [-777 -777 -777 -777 -777]
NPARAMS: 7
PNAM: {'LENGTH' 'FORCE' 'FACTOR' 'EE' 'GG' 'N
PARAMS: [1500 5000 2 216620 86650 0.2700 2001
ONAM: 'AREA'
OMETHD: 4
DIRCTN: -1
NITERS: 500
ERROR: 0
OPTFUN: 'beamobjfun'
OPTCON: 'beamobjcon'
OPTJOB: 'optjob'
```

Window 2: MATLAB Command Window

```
% 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 = Option Matlab (beamcontrol)
```

Window 3: MATLAB Command Window

```
>> gdk_semantics('GA_NPOP')
```

```
ans =
```

```
is_a_MatlabStructureField: [1x1 struct]
alternativeFieldValue: ''
fieldName: 'GA_NPOP'
isRequired: 'false'
fieldDescription: 'Population size each gene
default value: '50'
```

Window 2: MATLAB Command Window (continued)

```
GA_NPOP: 50
GA_ALPHA: 0.2000
GA_DMAX: 0.2000
GA_DMIN: 0.0500
GA_NBIN: 12
GA_NBREED: 0.1000
GA_NCLUST: 0.2000
GA_NRANDM: 0
GA_PBEST: 0.8000
GA_PCROSS: 0.8000
GA_PENAL: 1.0000e+020
GA_PINVRT: 0.2000
GA_PMTNT: 0.0050
GA_PRPTNL: 1
GA_PSEED: 0
```

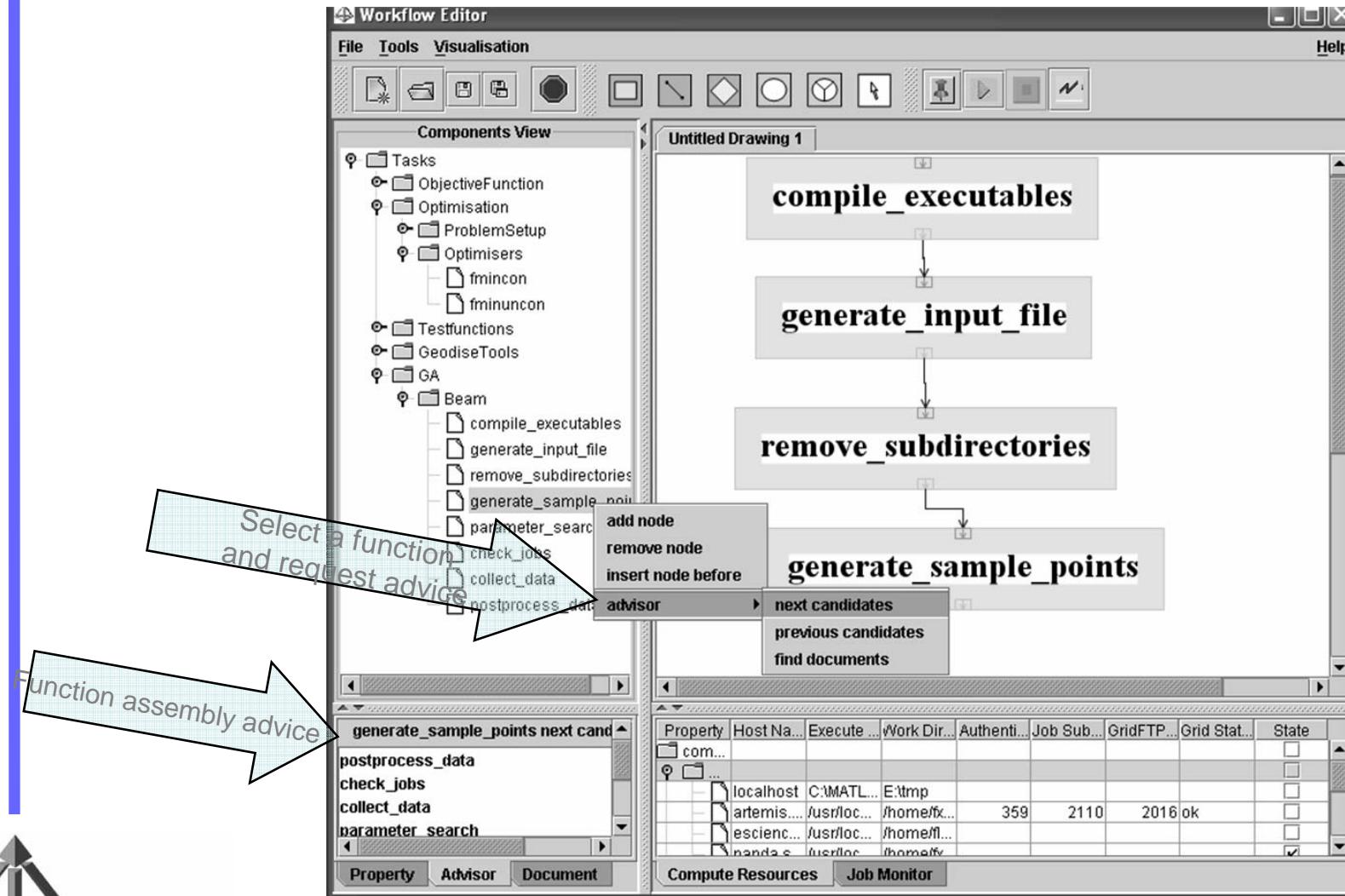
```
advice: [1x291 char]
```

```
>> beamcontrol.advice
```

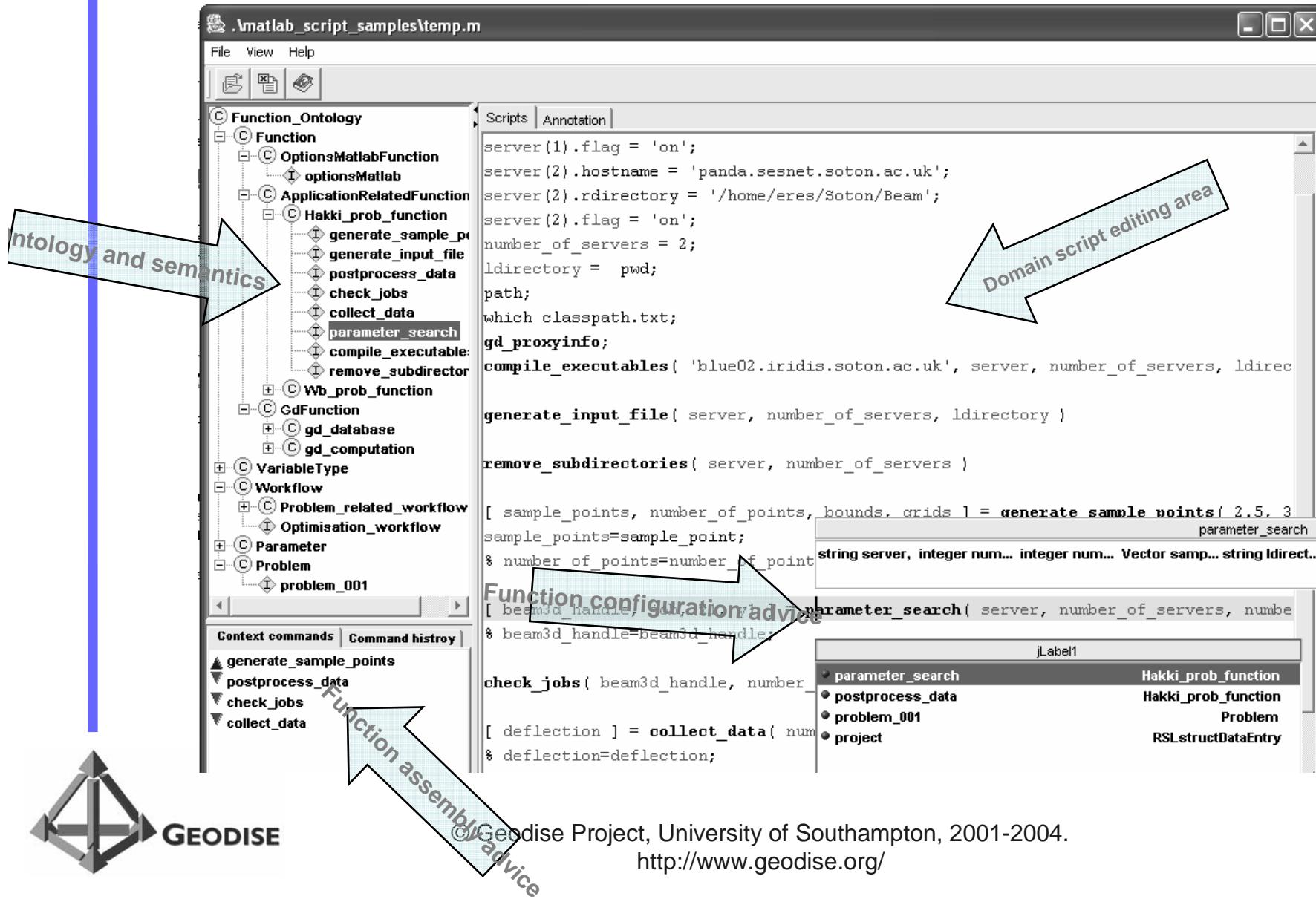
```
You are using #genetic algorithm search#.
Additional control parameters have been added.
You may need still to configure the following control
parameters.:
GA_NPOP GA_ALPHA GA_DMAX GA_DMIN GA_NBIN
GA_NBREED GA_NCLUST
GA_NRANDM GA_PBEST GA_PCROSS GA_PENAL
GA_PINVRT GA_PMTNT
GA_PRPTNL GA_PSEED
```

Advice on Function Assembly

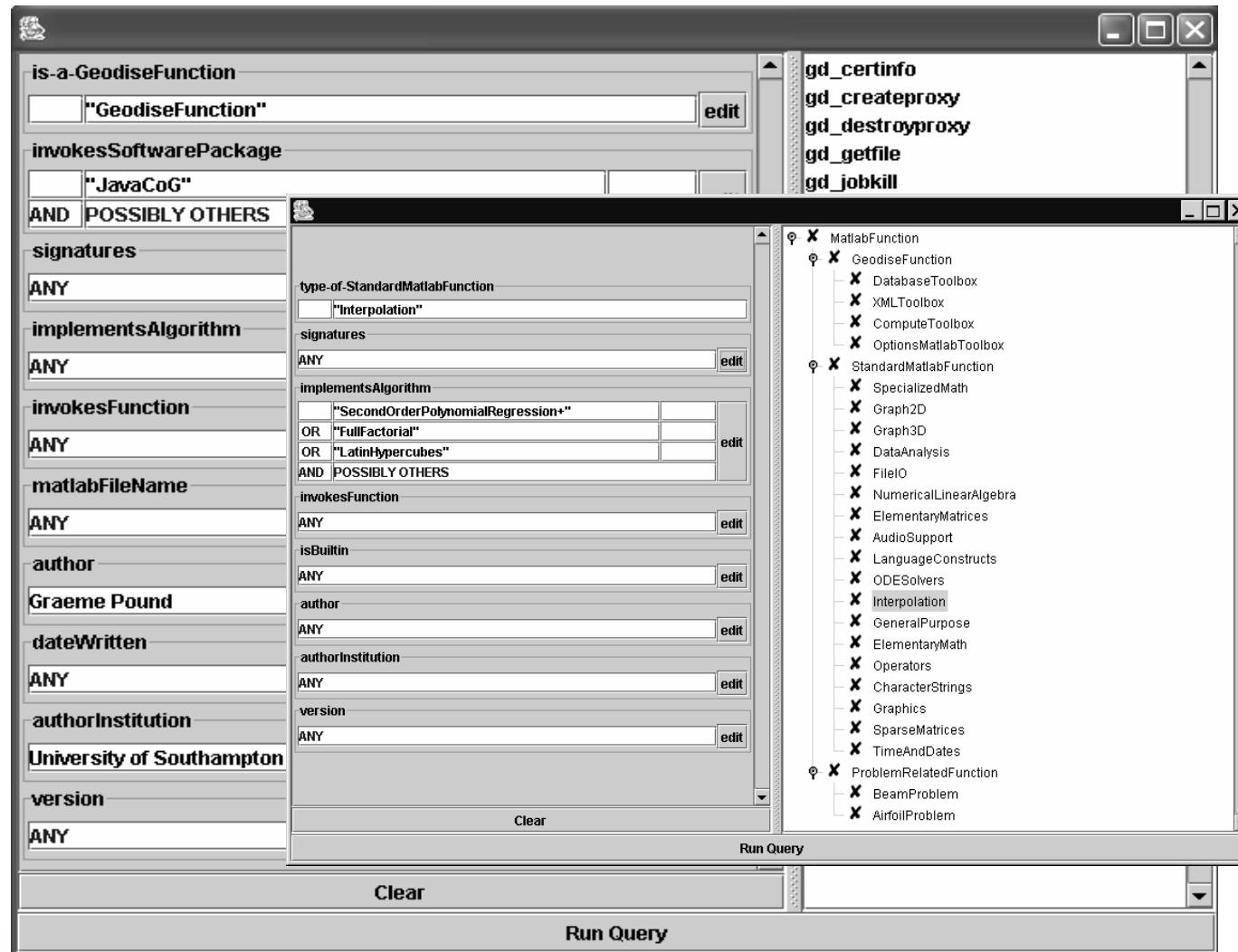
(Integrated in WCE – workflow advisor)



Advice on Function Assembly (Integrated in Domain Script Editor)



DL-Based Function Query GUI



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