

# Collaborative modeling of processes and ontologies

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DERI, Galway – April 7, 2011

# What is this about?

Develop a theoretical and practical framework that:

Supports the **integrated modeling** of Processes and Ontologies;

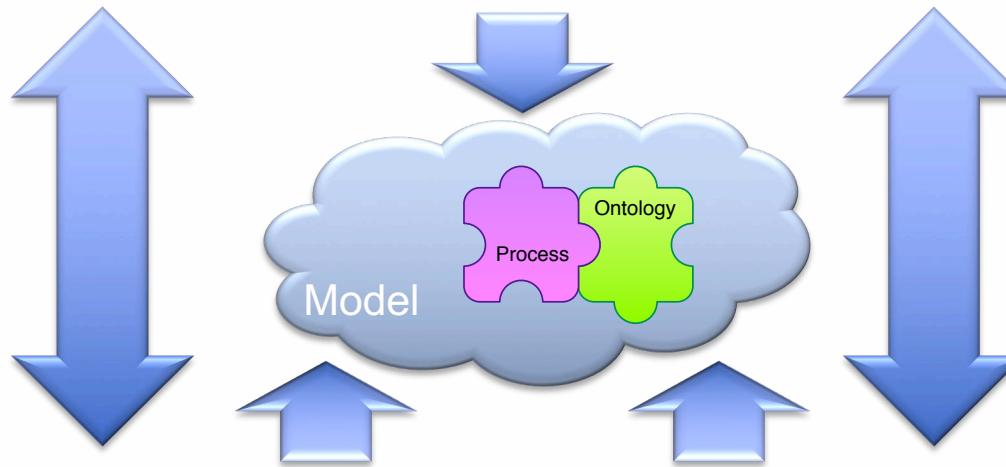
Fosters the **collaboration** between domain experts and knowledge engineers.

## WHY?

need of a comprehensive model which requires the description of both the dynamic component (processes) and the static component (ontology);

need for an agile collaboration between domain experts and knowledge engineers. Need to actively involve the domain experts in the modeling process.

# The research vision - architecture



Formal representation of integrated processes and ontologies

Architecture for collaborative conceptual modeling

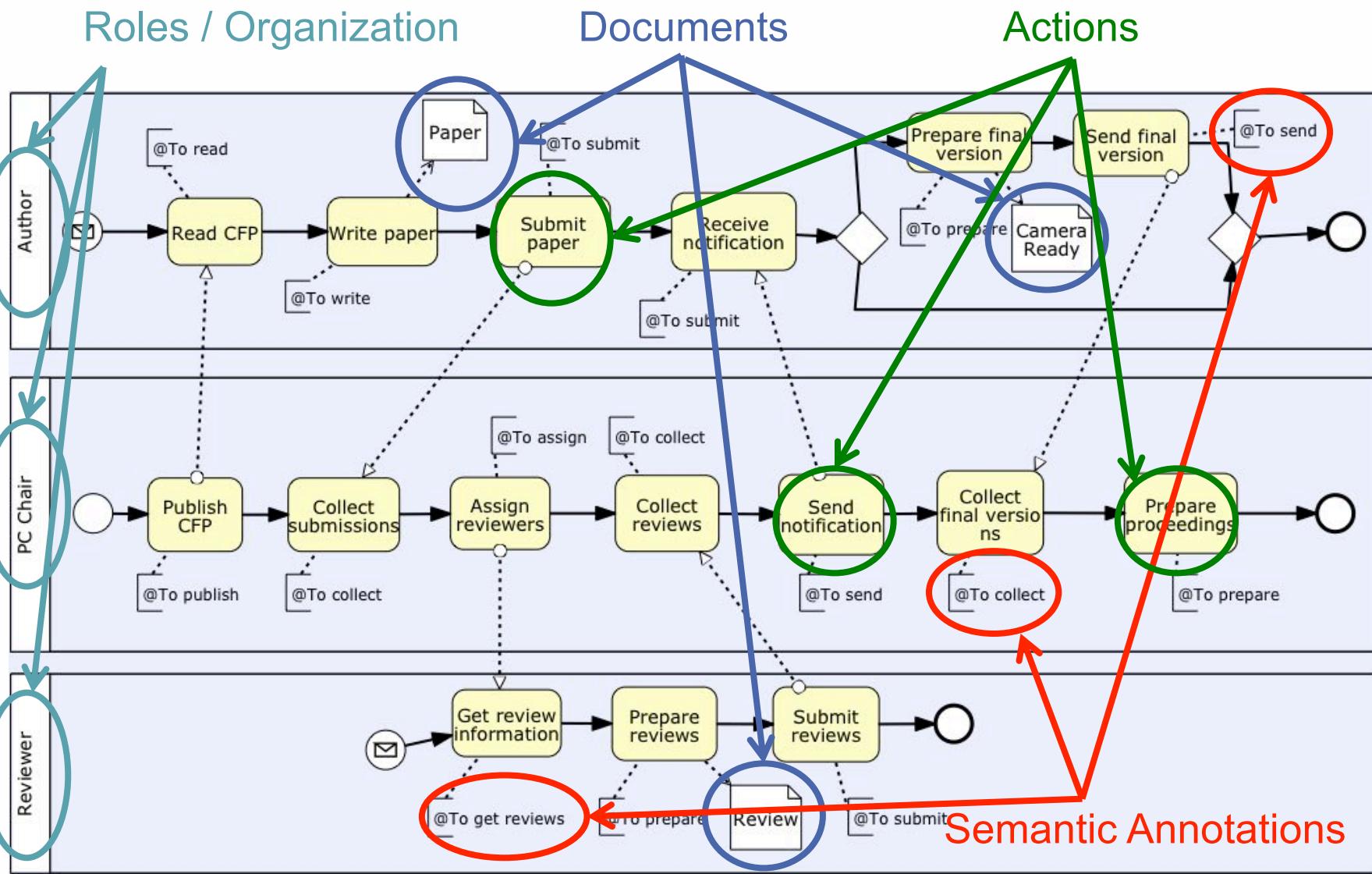
# Outline of the presentation

Formal representation of processes and ontologies

Architecture for collaborative conceptual modeling

The tool and some real usages

# Integrating processes and ontologies



# Integrating processes and ontologies

Example of queries and reasoning that involves both ontological knowledge and process knowledge:

*What are the activities performed by a certain role (e.g. PC Chair)?*

*Where are documents (e.g. reviews, notifications) produced?*

*What are the activities where something is published? What are the activities where something is sent out?*

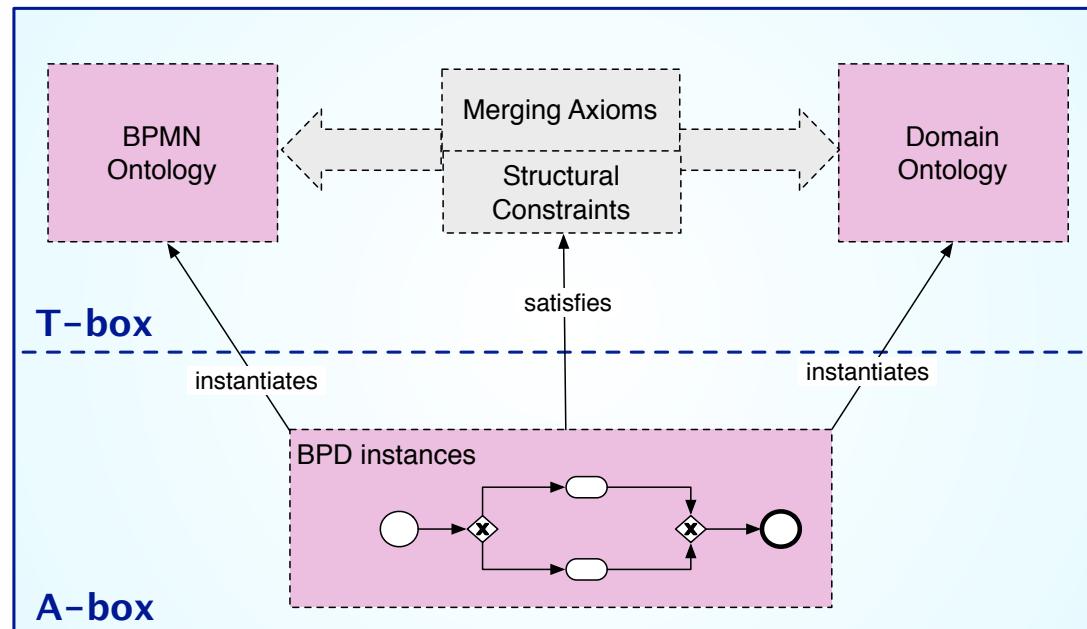
*What are the activities an author perform right before submitting something?*

Example of application exploiting semantically annotated business processes:

*Managing Cross-cutting concerns in business processes.*

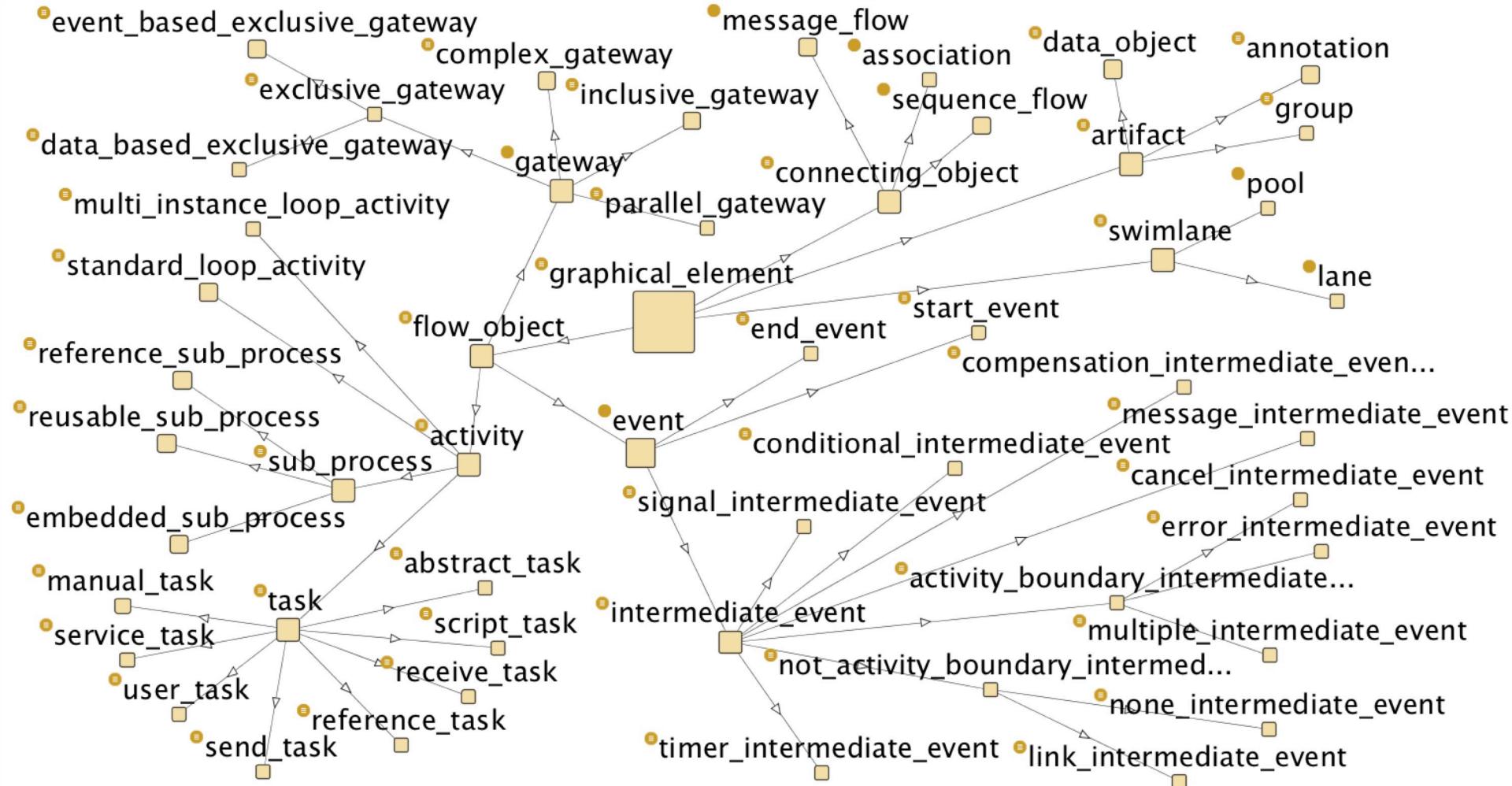
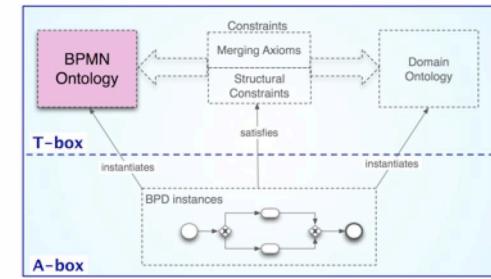
# Semantically Annotated Business Processes

Semantically annotated business processes are encoded into a logical knowledge base implemented in OWL

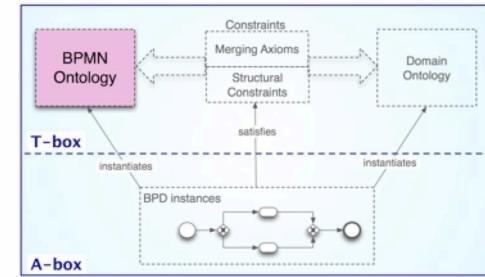


Note: Business Process Diagrams (BPDs) are specified using the Business Process Modelling Notation (**BPMN**).

# BPMN Ontology



# BPMN Ontology



Current version based on v1.1 of the BPMN specifications by OMG (to be update to v2.0)

It is not intended to model the dynamic behaviour of business process diagrams.

*if there are multiple outgoing Sequence Flow then only one Gate (or the DefaultGate) SHALL be selected during performance of the Process.*

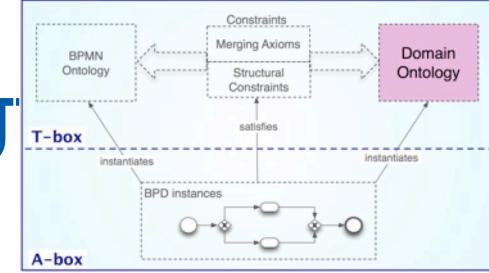
There are a few documented properties which are not represented due to expressiveness limitation imposed by Description Logics.

*all outgoing sequence flows connected to an inclusive gateway must have the same conditional expression attached*

Available for download at:

[http://dkm.fbk.eu/index.php/BPMN\\_Ontology](http://dkm.fbk.eu/index.php/BPMN_Ontology)

# Business Domain Ontology



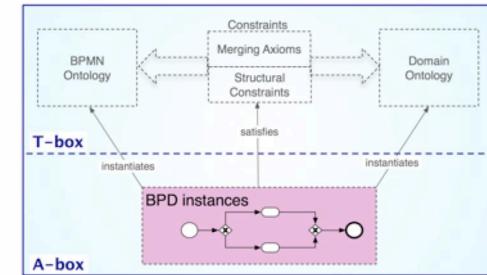
Represents the (specific) business domain.

Used to annotate the elements of the business process diagram.

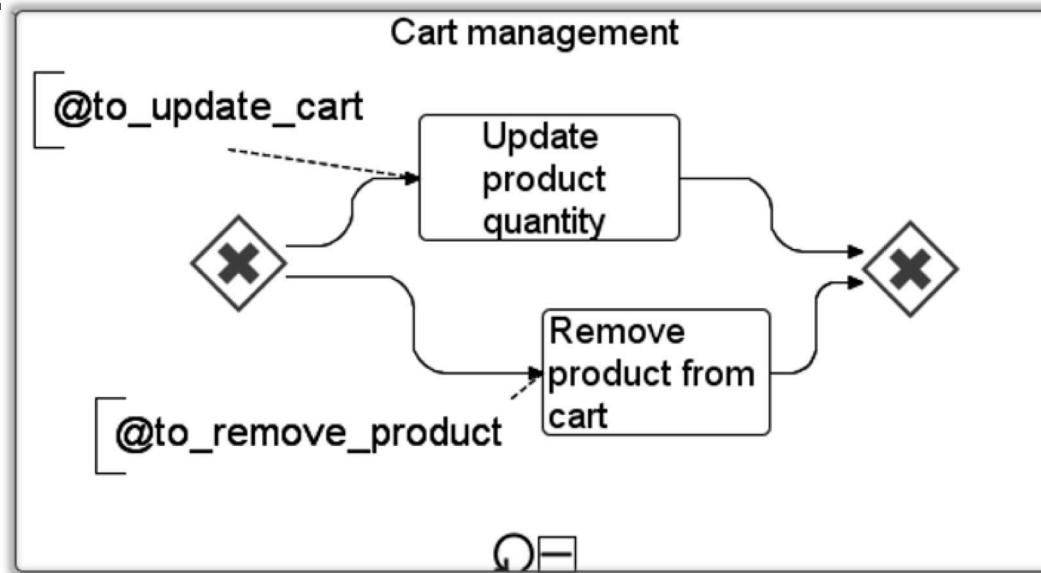
Can be composed of:

- Top level ontologies, such as DOLCE;
- Domain-specific ontologies.

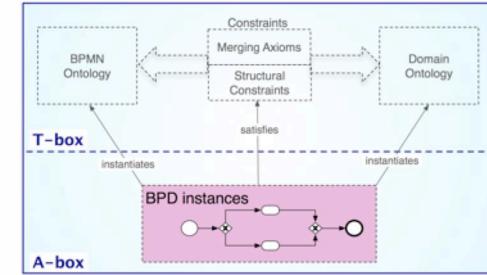
# BPD Instances



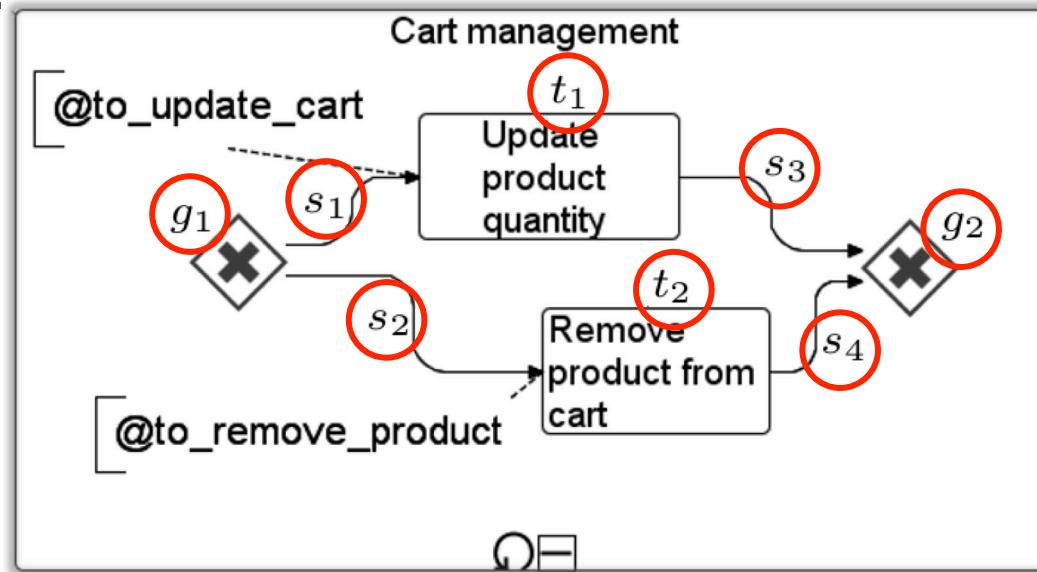
Represents the specific annotated business process diagram.



# BPD Instances



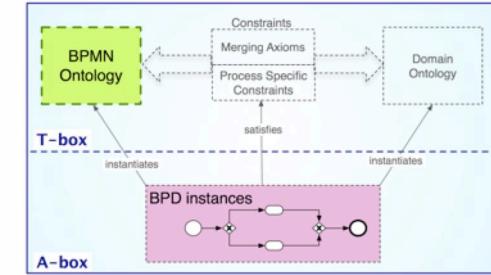
Represents the specific annotated business process diagram.



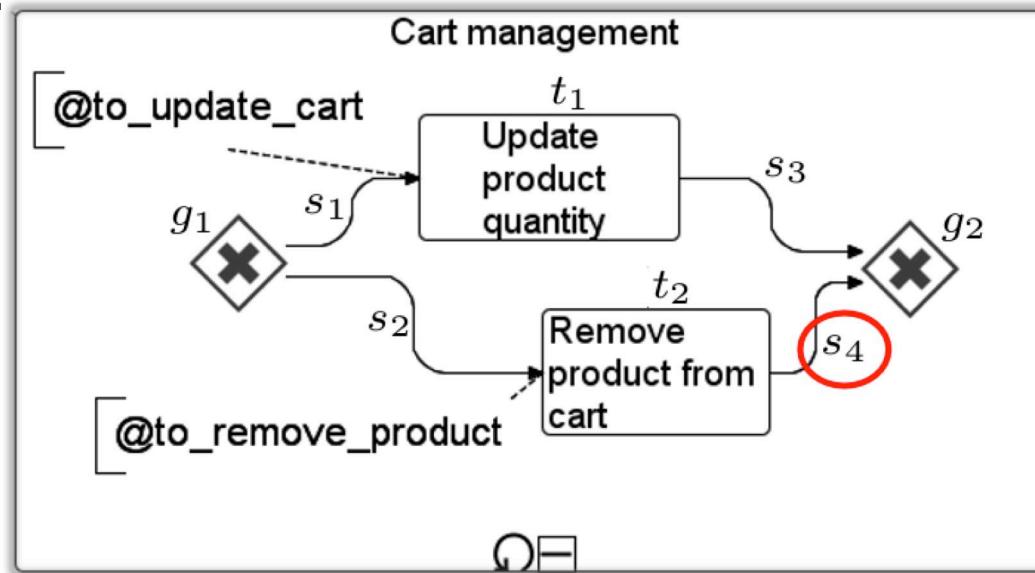
Create an individual for each graphical element of the business process.

*s<sub>1</sub>, s<sub>2</sub>, s<sub>3</sub>, s<sub>4</sub>, t<sub>1</sub>, t<sub>2</sub>, g<sub>1</sub>, g<sub>2</sub>*

# BPD Instances



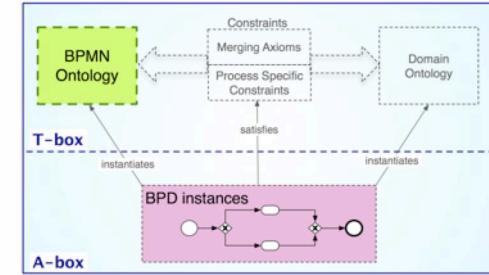
Represents the specific annotated business process diagram.



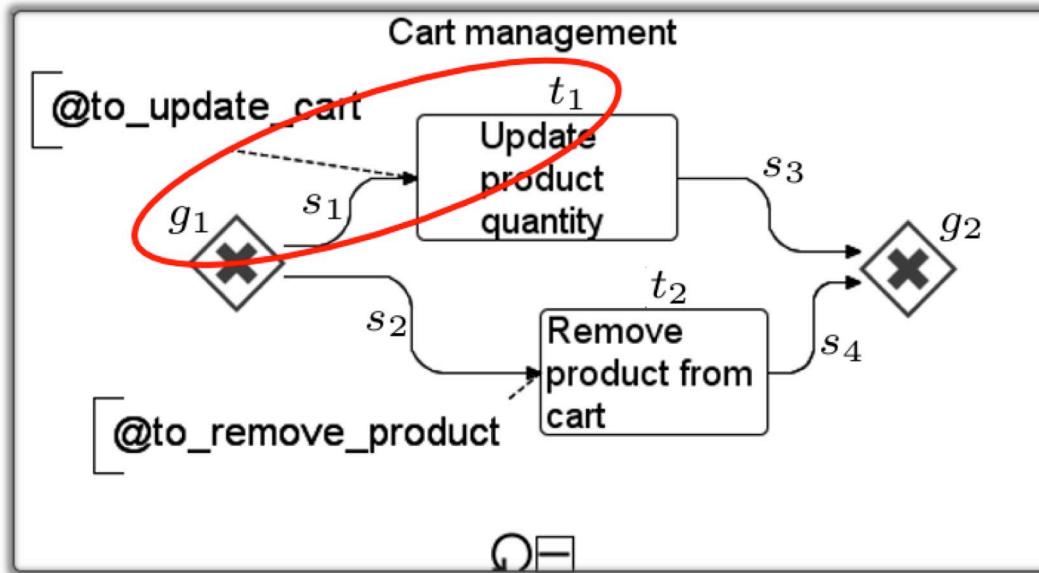
**BPMN-type assertions**: for every graphical element  $g$  of BPMN type  $T$  occurring in the process, we add the assertions  $T(g)$ .

sequence\_flow( $s_4$ )

# BPD Instances



Represents the specific annotated business process diagram.

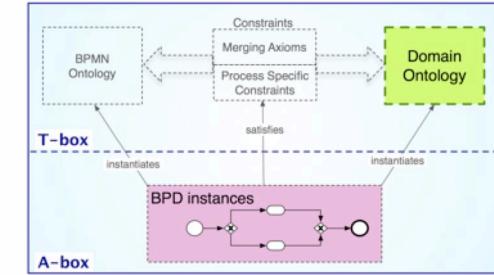


**BPMN-structural assertions:** For every connecting object  $c$ , going from  $a$  to  $b$ , we add assertions of the form  $\text{source}(c,a)$  and  $\text{target}(c,b)$ .

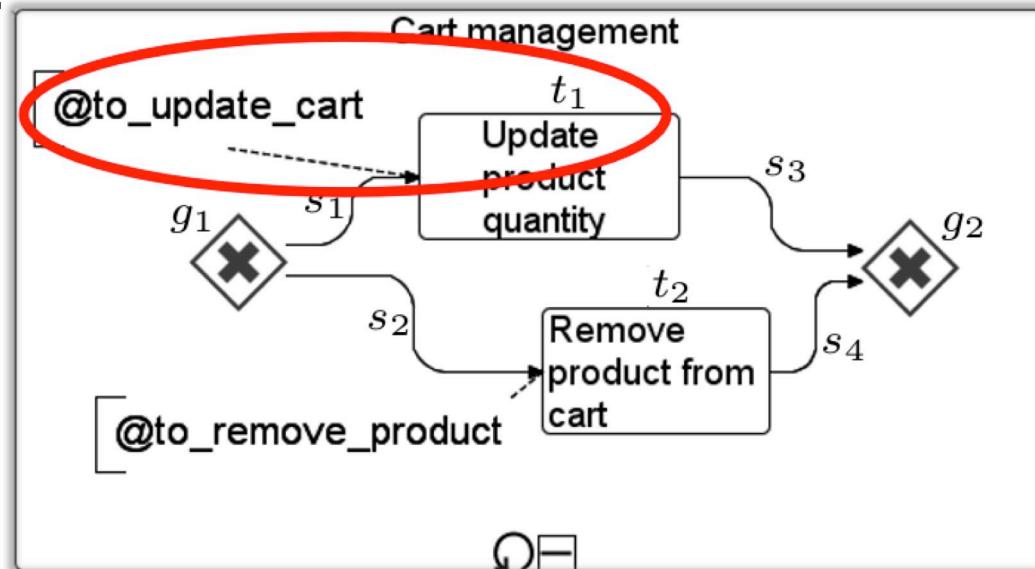
$\text{has\_sequence\_flow\_source\_ref}(s_1, g_1)$

$\text{has sequence flow target ref}(s_1, t_1)$

# BPD Instances



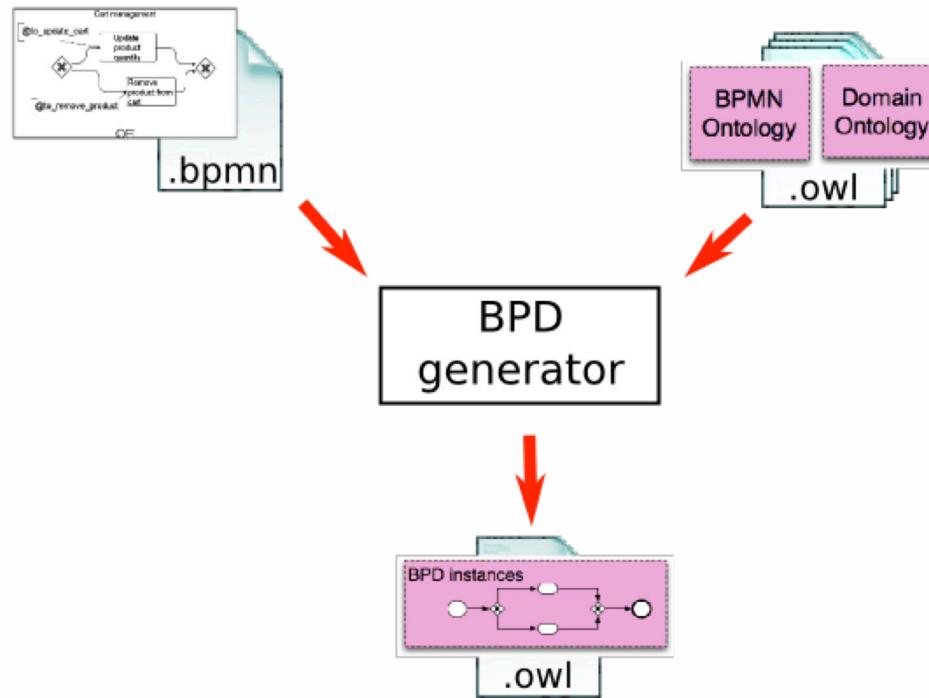
Represents the specific annotated business process diagram.



**Semantic assertions:** For every graphical element  $g$  of the process which is annotated with  $C$  (where  $C$  is a complex concept expression of the domain ontology), we add the assertion  $C(g)$ .

# Automatic OWL A-box generation

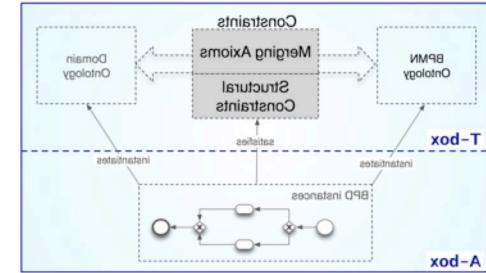
The transformation of an annotated Business Process Diagram into an OWL A-box is performed automatically.



Available for download at:

<http://selab.fbk.eu/dfrancescomarino/SemanticBPM/>

# Process Constraints



The framework also enables to define constraints for:

correct/incorrect annotation of business process graphical elements:

- *A BPMN activity is annotatable only with actions of the domain ontology (and not e.g., with documents);*

valid critical patterns:

- **containment constraints:** *the activity of managing a shopping cart is a sub-process which contains an activity of removing products from the cart;*
- **precedence constraints:** *the activity of providing personal data is immediately preceded by an activity of reading the policy of the organization;*
- **exception handling constraint:** *the activity of reserving products in the On-line Shop pool has always to catch a èproduct unavailabilityê error event;*

Using DL-reasoning we can:

Check compatibility of process constraints:

# Integrating processes and ontologies

## Selected publications:

*Semantics based aspect oriented management of exceptional flows in business processes* – C. Ghidini, C. Di Francescomarino, M. Rospocher, P. Tonella, L. Serafini - IEEE Transactions on Systems, Man and Cybernetics. Part C: applications and reviews (to appear)

*A framework for the collaborative specification of semantically annotated business processes* - C. Di Francescomarino, C. Ghidini, M. Rospocher, L. Serafini, P. Tonella - Journal of Software Maintenance and Evolution: Research and Practice

*Semantically-aided business process modeling* - C. Di Francescomarino, C. Ghidini, M. Rospocher, L. Serafini, P. Tonella - International Semantic Web Conference (ISWC'09)

*Reasoning on semantically annotated processes* - C. Di Francescomarino, C. Ghidini, M. Rospocher, L. Serafini, P. Tonella - International Conference on Service Oriented Computing (ICSOC'08)

Next steps: extension to the dynamics of executions

# An architecture for collaborative conceptual modeling in wikis

1. One element  One page

each element of the model is represented by a page in the wiki;

Concept “Mountain” 

Mountain

A **mountain** is a large [landform](#) that stretches above the surrounding land in a limited area usually in the form of a peak. A mountain is generally steeper than a [hill](#).

The highest mountain on earth is the [Mount Everest](#)



# An architecture for collaborative conceptual modeling in wikis

## 2. Unstructured and structured descriptions

each page contains both structured and unstructured content;

### Mountain

A **mountain** is a large [landform](#) that stretches above the surrounding land in a limited area usually in the form of a peak. A mountain is generally steeper than a [hill](#).

The highest mountain on earth is the [Mount Everest](#)



(unstructured content)

$\sqsubseteq Landform$

$\sqsubseteq \neg Hill \sqcap \neg Plain$

$\sqsubseteq \forall madeOf(Earth \sqcup Rock)$

$\sqsubseteq \exists height. \geq 2500$

*Mountain(Mt.Everest)*

*Mountain(Mt.Kilimanjaro)*

(structured content)

# An architecture for collaborative conceptual modeling in wikis

## 3. Different views to access the model:

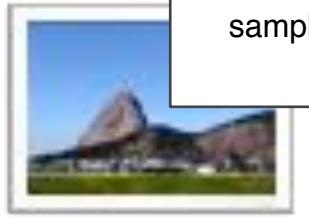
different views to support different modeling actors;

### Mountain

#### Mountain

A **mountain** is a large [landform](#) stretches above the surrounding a limited area usually in the form peak. A mountain is generally steeper than a [hill](#).

The highest mountain on earth is the [Mount Everest](#)



(unstructured view)

is a [landform](#)

different from [hill](#), [plain](#)

made of [earth](#)

made of [rock](#)

height at least 2,500m

samples [Mt. Everest](#)  
[Mt. Kilimanjaro](#)

(semi - structured view)

### Mountain

$\sqsubseteq \text{Landform}$

$\sqsubseteq \neg \text{Hill} \sqcap \neg \text{Plain}$

$\sqsubseteq \forall \text{madeOf}(\text{Earth} \sqcup \text{Rock})$

$\sqsubseteq \exists \text{height}. \geq 2500$

$\text{Mountain}(\text{Mt.Everest})$

$\text{Mountain}(\text{Mt.Kilimanjaro})$

(fully - structured view)

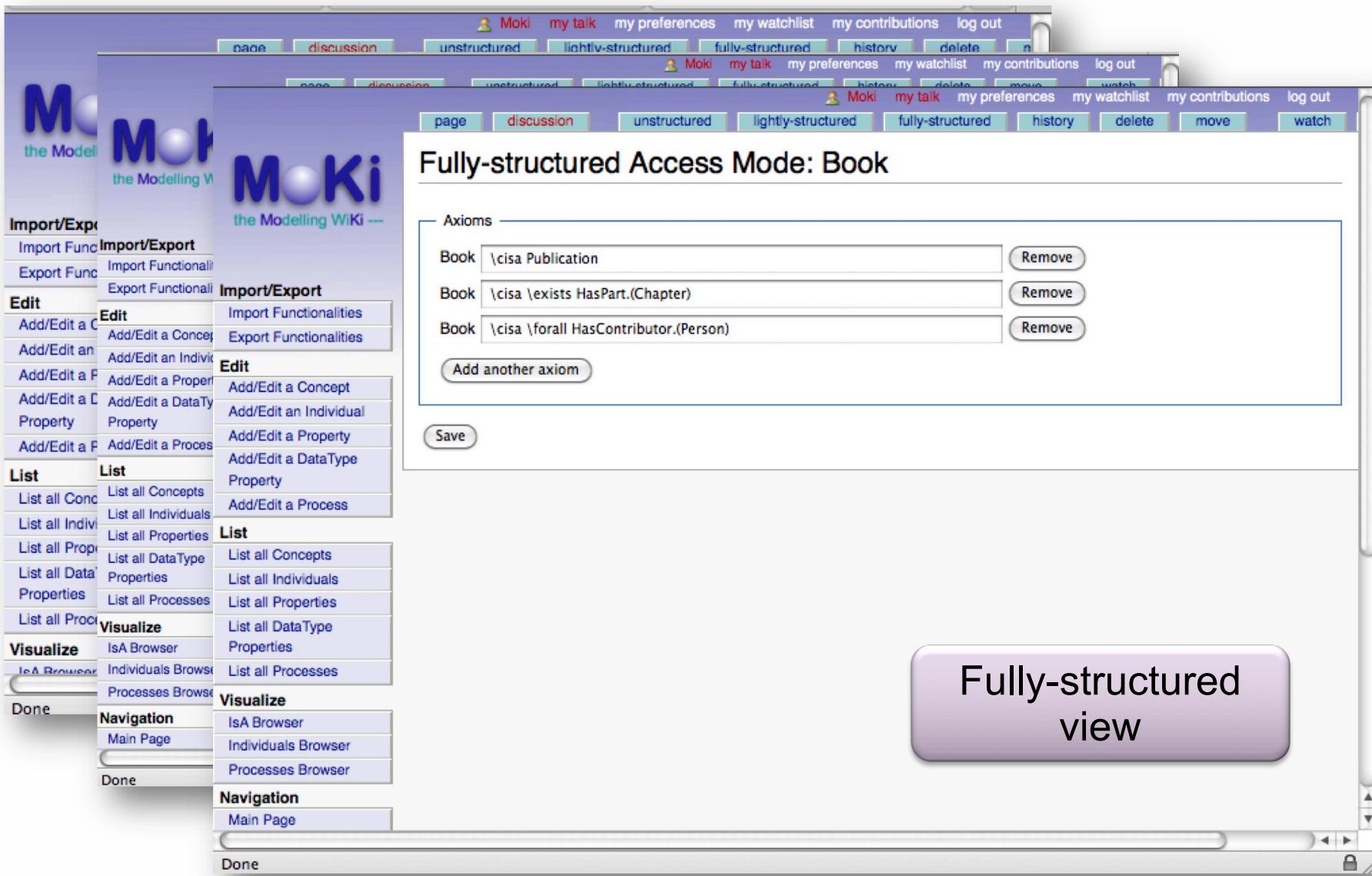
Wiki-based modeling tool;

Supports the integrated modeling of Processes and Ontologies;

Provides modeling support both for domain experts and knowledge engineers, fostering the collaboration between them;

Based on the framework presented so far.

# Different views for different roles



The screenshot shows three identical views of a page titled "Fully-structured Access Mode: Book" from the MOKi platform. Each view includes a header with user navigation links (Moki, my talk, my preferences, my watchlist, my contributions, log out) and a top menu bar with tabs for "page", "discussion", "unstructured", "lightly-structured", "fully-structured", "history", "delete", "move", and "watch".

**Axioms:**

- Book \cisa Publication Remove
- Book \cisa \exists HasPart.(Chapter) Remove
- Book \cisa \forall HasContributor.(Person) Remove

**Add another axiom**

**Save**

**Left sidebar (Accessible to all users):**

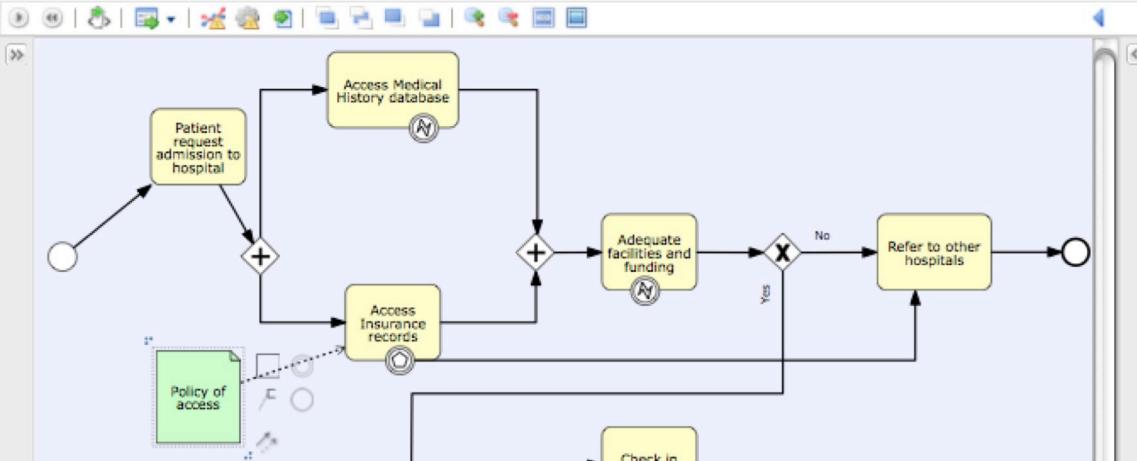
- Import/Export**
  - Import Functions
  - Export Functions
- Edit**
  - Add/Edit a Concept
  - Add/Edit an Individual
  - Add/Edit a Property
  - Add/Edit a DataType
  - Property
  - Add/Edit a Process
- List**
  - List all Concepts
  - List all Individuals
  - List all Properties
  - List all Processes
- Visualize**
  - IsA Browser
  - Individuals Browser
  - Processes Browser
- Navigation**
  - Main Page
- Done**

**Bottom right callout:** Fully-structured view

# Different views for different roles

**Lightly-structured Access Mode: Hospital Administration**

**Fully-structured Access Mode: Hospital Administration**



```

graph TD
    A["Patient request admission to hospital"] --> B["Access Medical History database"]
    B --> C["Access Insurance records"]
    C --> D["Adequate facilities and funding"]
    D -- No --> E["Refer to other hospitals"]
    D -- Yes --> F["Check in Patient"]
    F --> G["Reserve Room for Patient"]
    G --> H["Alert consulting Doctor"]
    H --> I["Update Hospital Admission Records"]
    
```

**Import/Export**

- Import Functionalities
- Export Functionalities

**Edit**

- Add/Edit a Concept
- Add/Edit an Individual
- Add/Edit a Property
- Add/Edit a DataType
- Property
- Add/Edit a Process

**List**

- List all Concepts
- List all Individuals
- List all Properties
- List all DataType Properties
- List all Processes

**Visualize**

- IsA Browser
- Individuals Browser
- Processes Browser

**Navigation**

- Main Page

**Done**

**Import/Export**

- Import Functionalities
- Export Functionalities

**Edit**

- Add/Edit a Concept
- Add/Edit an Individual
- Add/Edit a Property
- Add/Edit a DataType
- Property
- Add/Edit a Process

**List**

- List all Concepts
- List all Individuals
- List all Properties
- List all DataType Properties
- List all Processes

**Visualize**

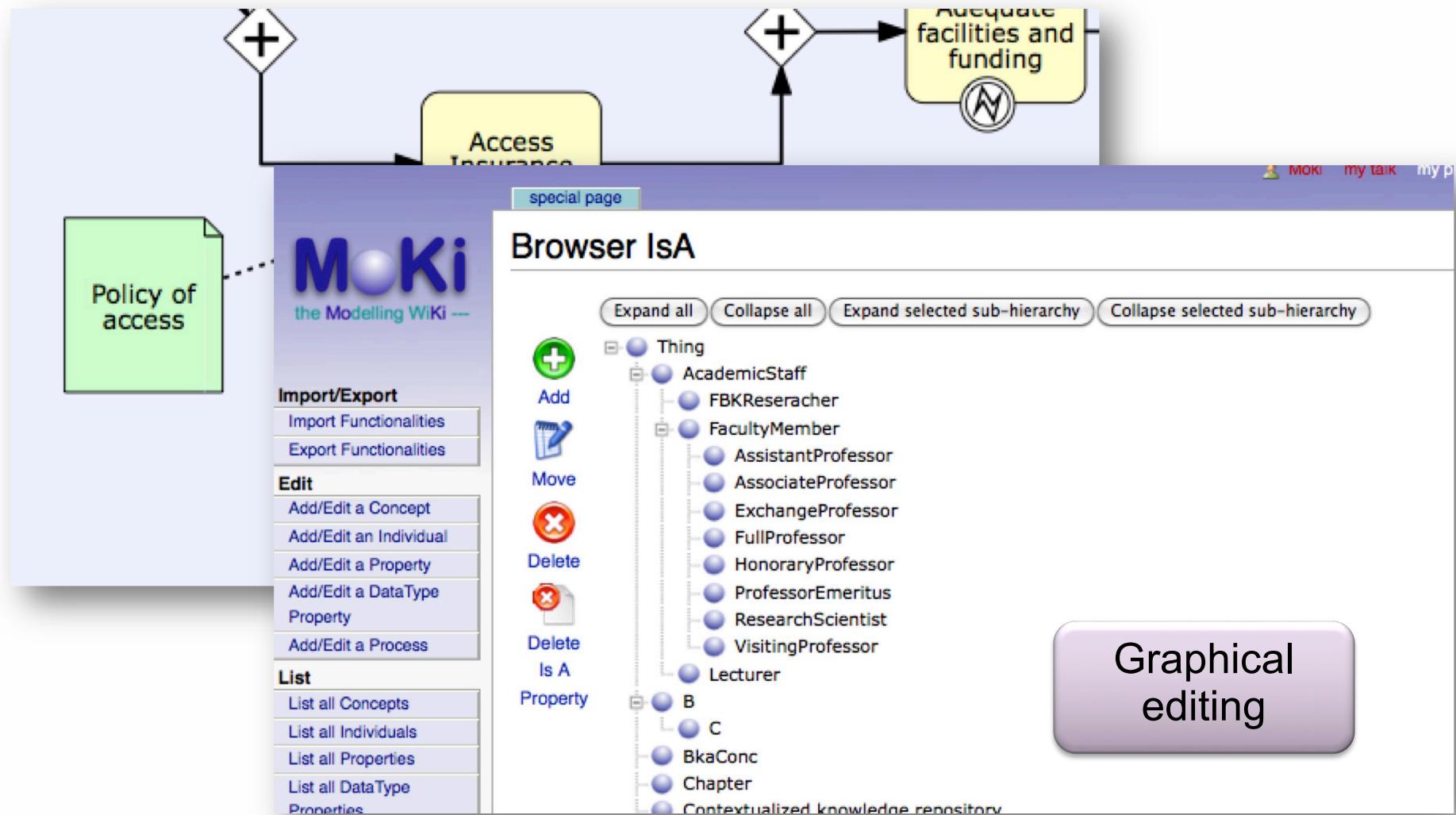
- IsA Browser
- Individuals Browser
- Processes Browser

**Navigation**

- Main Page

**Done**

# Further features



The screenshot shows the MOKi interface with several graphical elements:

- Top Left:** A green box labeled "Policy of access".
- Middle Left:** A purple sidebar with the MOKi logo and navigation links: Import/Export, Edit, List, and Is A.
- Top Center:** A yellow box labeled "Access Insurance".
- Top Right:** A yellow box containing the text "Adequate facilities and funding" with a circular icon containing an 'N'.
- Bottom Right:** A purple button labeled "Graphical editing".
- Bottom Center:** A hierarchical tree view under the heading "Browser IsA" with buttons for expanding/collapsing all hierarchies.

```

graph TD
    Policy[Policy of access] --- Access[Access Insurance]
    Access --- Adequate[Adequate facilities and funding]
    Adequate --- N((N))
    
```

**Browser IsA**

Buttons: Expand all, Collapse all, Expand selected sub-hierarchy, Collapse selected sub-hierarchy

- Thing
  - AcademicStaff
  - FBKReseracher
  - FacultyMember
    - AssistantProfessor
    - AssociateProfessor
    - ExchangeProfessor
    - FullProfessor
    - HonoraryProfessor
    - ProfessorEmeritus
    - ResearchScientist
    - VisitingProfessor
    - Lecturer
  - B
  - C
  - BkaConc
  - Chapter
  - Contextualized\_knowledge\_repository

# Further features: key concepts extraction

Extract new concepts from textual resources

(Powered by **KX** - a Keyphrase eXtraction system)

## Files

[Upload Files](#)

[Show uploaded files](#)

[Remove all uploaded files](#)

## Configure and Run

[Re-load Default Settings](#)

Language: [english](#) Domain: [environment](#)

Percentage of relevant concepts to return:

Take multiword expressions that occur at least:

- either  times in a document
- or  times in the corpus

Maximum length of multiword expressions:

Prefer key-concepts occuring early in the text:

Prefer specific key-phrases: [Medium Preference](#)

[Extract relevant concepts](#)

## Concepts Extracted

(The lists shown below are limited to the first 500 entries)

### Concepts extracted (Ordered by Relevance)

[hayfever diary](#) (2195.13)

[pollen](#) (1488.32) Already Defined

Wordnet

Synset Num: n#07991785

Wordnet Semfield: Chemistry

Sumo Entry: BodySubstance

Wordnet Definition: a fine powder produced by the anthers of seed-  
Is a: powder

### Additional info

Source: Environmental dictionary

Option Num: 1

Add info entry: FINNISH TRANSLATION: siitepöly

Add info entry: SWEDISH TRANSLATION: pollen n, frömjöl n, ståndan

[oil seed rape pollen](#) (707.85) Already Defined

[birch pollen](#) (693.17) Already Defined

[alternaria-mould spore](#) (460.39)

[flowering of grasses](#) (393.18)

[flowering of mugwort](#) (363.68)

[alder pollen](#) (295.25) Already Defined

[allergic complaints](#) (196.28)

[flowering of hazel](#) (107.44)

[pollen grain](#) (87.5)

[maple pollen](#) (78.65) Already Defined

[tree of heaven pollen](#) (78.65) Already Defined

[cultivated rye pollen](#) (59) Already Defined

[pollen levels](#) (43.47)

[grass flowering](#) (41.94)

[mugwort pollen allergy](#) (25.92)



FP6 EU Project [48 months]

**Purpose: modeling of tasks/processes in an enterprise and of the topics related to that task**

Used by:

4 SMEs

3 Universities

several related summer schools and university courses



STREP FP7 EU project [36 months]

**Purpose: build/revise an environmental ontology**

Developed the new key concepts extraction functionalities

Used to automatically create part of the ontology (pollen)



## Organic.Edunet

eContentplus EU Project [36 months]

**Purpose: build/revise an ontology of organic agriculture and agroecology**

Used to foster collaboration between domain experts (FAO) and knowledge engineers

Follow-up: Organic.Lingua (FP7 Pilot Tipe B EU project [36 months])

Extend MoKi to multilingua models and interface



Italian national project

**Purpose: model processes for analysis/revision and dematerialization**

Used by 5 (out of 7) Italian regions:

Puglia, Liguria 1, Trentino, Emilia Romagna, Liguria 2.

Medium size models produced in around 2 weeks.

eOnco FBK internal project  
modeling of nurse activities in an oncology ward.

OncoCure project  
modeling of clinical protocols for the breast cancer.

Italian private company  
modeling email marketing domain;

# Lessons learned

Wikis can be a powerful way to lower the entrance barrier for modeling tools and to share knowledge;

Real need to integrate processes and ontologies and to include organizational aspects in processes taken from a formal description (ontology);

Collaboration happens and is helpful;

Need to guide domain experts by providing schemata of representations; e.g., what is a document?

# Current & Future Works

Develop ad-hoc templates to guide users in modeling activities

describing an artifact is different than describing a role

Support usage of ontology patterns

to speed up modeling activities, and limit modeling errors

Extend key concepts extraction functionalities

Support extraction / identification of semantic relation (e.g. “isA”) between concepts

Fully implement the formal framework for integrating processes and ontology

Publications and demos:

ESWC2009, SemWiki2009, EKAW2010, ISWC2010,...

Released Open Source in July 2010 (version 1.2 – GPL2)

MoKi WebSite: <http://moki.fbk.eu>

On-line demos, code download, documentation, news, support...

# Thank You!

# Questions?