



2nd International Conference on Model & Data Engineering (MEDI'2012)



Modular Ontological Warehouse for Adaptive Information Search

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Agenda

Context and main objective
Ontology modularization
Modular Ontology Warehouse
Adaptative Information Retrieval
Conclusion and future works





Main Objective



Proposal Scope



Modular Ontologies

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Modular Ontologies

- Modularization is the process of decomposition of a whole large ontology into smaller modules.
- Domain ontologies: the aggregation of "selfcontained", independent and reusable knowledge components (ontology module)
- An ontology Module: reusable component of ontology, which is self-contained but bears definite relationships to other ontology modules

No agreement on the criteria of ontology decomposition

- absence of ontology modularization framework for Information retrieval
- => Criteria of ontology modularization should be adaptive to search engine = query disambiguation and term distribution on the web

Modular Ontological Warehouse for Adaptive Information Search

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Modular Ontology Warehouse Terminology

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A data warehouse is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process.



An Ontology warehouse is a subject-oriented, integrated, timevariant and non-volatile collection of <u>Ontology modules</u> in support of management's Information Retrieval process.

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Modular Ontology Warehouse





Modular Ontology Warehouse

- 3 levels of knowledge granularity
 Modular Modeling of ontolotgies adapted to IR
- Thematic classification of domain ontologies
- Modular domain Ontology:
 - Static Composition of ontology modules
 - Composition based on semantic relatedness between ontology modules
 - Semantic Links between ontology modules
- Ontological Module : Semantics around a pivotal concept
 - Attributes (definitions)
 - Co-occurring Concepts



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Modular Ontology Warehouse

A Modular Knowledge Warehouse (τ) is defined as:

 $\tau = <\mathcal{T}, Mo_d, \mathcal{M}, \mathcal{R}, \sigma_o, \sigma_d >$

Where:

- \mathcal{T} is the topic ontology definition;
- $-Mo_d$ is the modular ontology definition;
- $-\mathcal{M}$ is the set of module definition composing the modular ontology Mo_d ;
- \mathcal{R} is a set of Resources' URI;
- $-\sigma_o$ is a function associating to each thematic concept of the topic ontology (\mathcal{CT}) , a modular ontology definition (Mo_d) ;
- $-\sigma_d$ is a function providing for each instance of module definition (Mo_d) with a set of resources (\mathcal{R}) (ie. Document URL, Product's URI..).



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(1)

Topic Ontology



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Topic Ontology

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A topic ontology (T) is defined as:

$$\Gamma = < \mathcal{CT}, \mathcal{RT}, \sigma_o >$$

Where : CT = "Medicine", "Sciences", "Arts", "Business", "E-Commerce", Home", "Software", "Tourism", "Health", "Internet", "Notebook", "Employment",

- \mathcal{RT} RT (Medicine, Sciences) and RT (Medicine, Health) cept
- $-\leq^{CT}$: $\mathcal{CT} \times \mathcal{CT}$ it is a partial order on thematic concepts CT which defines the hierarchy of \mathcal{CT} ;

- c o(Medicine)="Medicine.owl"; o(health)="health.owl";
c o(Sciences)="Sciences.owl", etc.

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A modular domain ontology (MO_d) is defined as:

$$MO_{d} = < \mathcal{ID}_{Mo}, \mathcal{M}_{i=1..n}, \mathcal{R}_{o}, \mathcal{H}_{\mathcal{M}}, \mathcal{R}_{\mathcal{M}} >$$
(3)

*ID*_{Mo}="Ontology_ E-Commerce";
The set of modules *M*_{i=1..4}= "person_Module", "customer_Module", "product_Module","
The set *R*_o of pivotal concepts=pivotalConcept_ person, pivotalConcept_ customer, pivotalConcept_ payment;
Taxonomic inter-module relations are defined as followings:

Racine_E - commerce ≤^M person_Module;
Racine_E - commerce ≤^M Product_Module;
Racine_E - commerce ≤^M payment_Module;
Racine_E - commerce ≤^M payment_Module;
Module_Personne ≤^M customer_Module.

Modular Domain Ontology



Ontology Module

$$\mathbf{M} = \langle \mathcal{ID}_{\mathcal{M}}, \sigma_o^{-1}, \mathcal{C}, \mathcal{R}, \mathcal{O} \rangle$$
(4)

where: $\mathcal{ID}_{\mathcal{M}}$ is the identifier of ontology module; σ_o^{-1} is the inverse function de σ_o that provide a set of thematic concepts (\mathcal{CT}) associated to the OM; \mathcal{C} is a set of identifiers of domain concepts making up the OM; $\mathcal{R} : C \times C$ is a set of relations between the internal concepts of the OM; \mathcal{O} is a set of objects described by the OMs. Besides, we define the signature of $(\mathcal{C}, \mathcal{R}, \mathcal{O}) \int (\mathcal{C}, \mathcal{R}, \mathcal{O})$ to be a triple $(\mathcal{CN}, \mathcal{RN}, \mathcal{ON})$ where \mathcal{CN} is a set of all names (terms) of concepts defined in $\mathcal{C}, \mathcal{RN}$ is a set of all names (terms) of relations defined in $\mathcal{R}, \mathcal{ON}$ is a set of objects names.

Graph-Based Framework of Modular Ontologies





Graph-Based Framework of Modular Ontologies



Graph-Based Framework of Modular Ontologies



Adaptive Information Search Based on Modular Ontological Warehouse

Adaptive Information Search

Adaptive Information Search

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Adaptive Information Search

CBR and Modular Ontologies

Conclusions and futur work

 Necessity of introducing modularity to support the partial reuse of ontologies for semantic annotation in knowledge management systems.
 Three-layered ontological warehouse were designed and developed for CBR-based content management

 Ongoing work: modular and semantic indexing in digital libraries by ontology modules.
 Perspective: Modular annotation of structured data and unstructured data

Questions??

Thank You for your attention