Volgograd State Technical University

Knowledge Based Models and Software Tools for Learning Management in Open Learning Network

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State of the Art

LMDP (Learning Management Design Process) —
8 'learning design based' questions —
3 sequential phases:
Outcomes, Strategy and Evidence

LMS, LCMS — $1.9 billion market (est. 2013)

Open Learning Network approach:
advantages of LMS and Personal Learning Enviroment

Problem: Learning Resources Retrieval

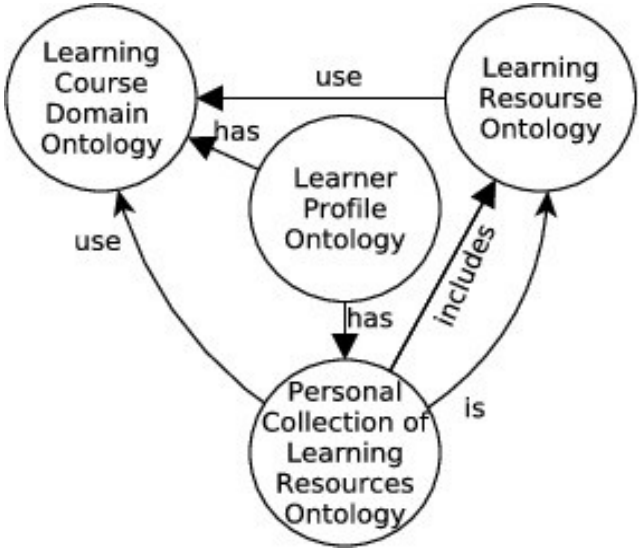
Solutions:

- Web search engines

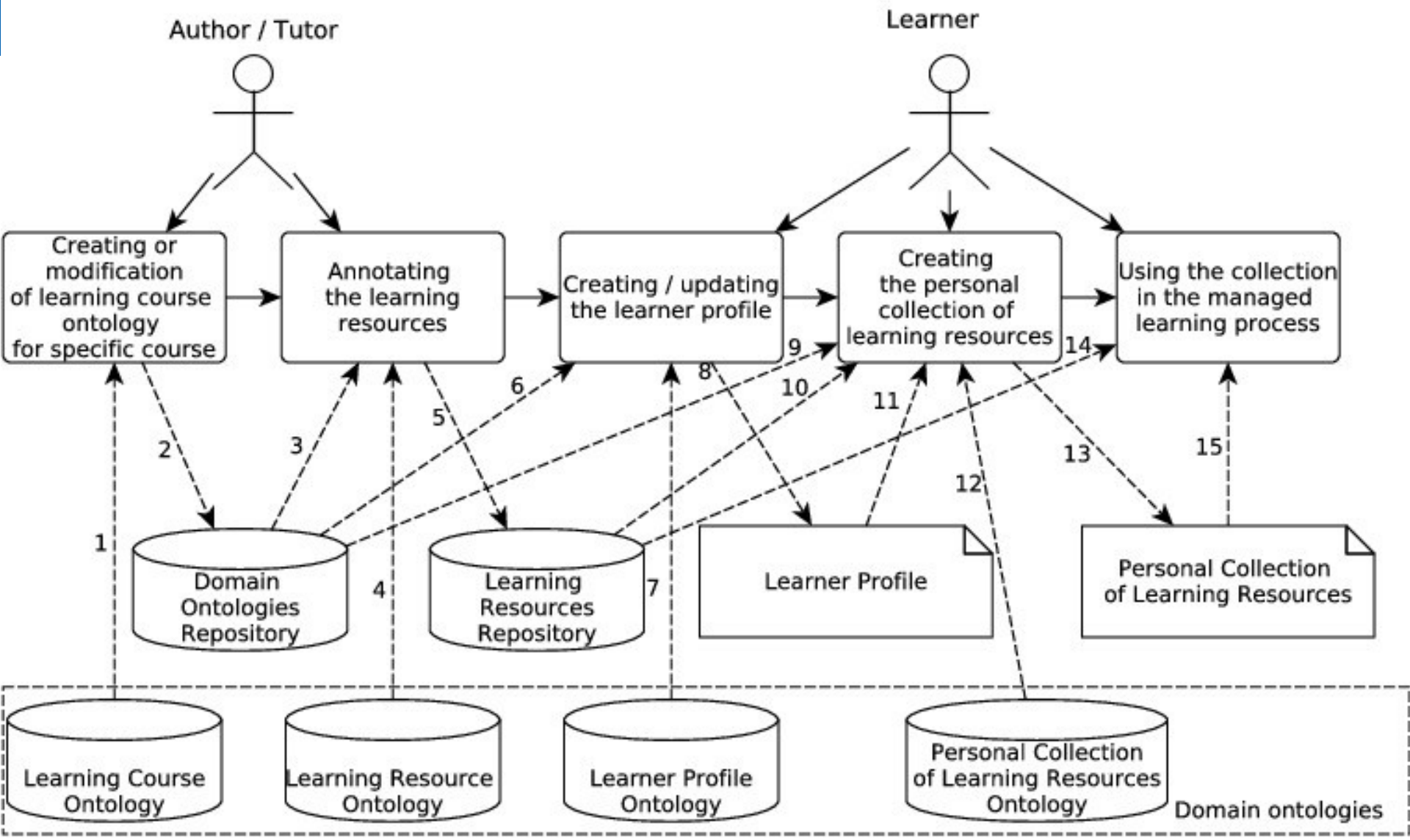
- Metadata annotation (DCMI, LOM...)

- Semantic Web:
Ontology-based models and reasoning

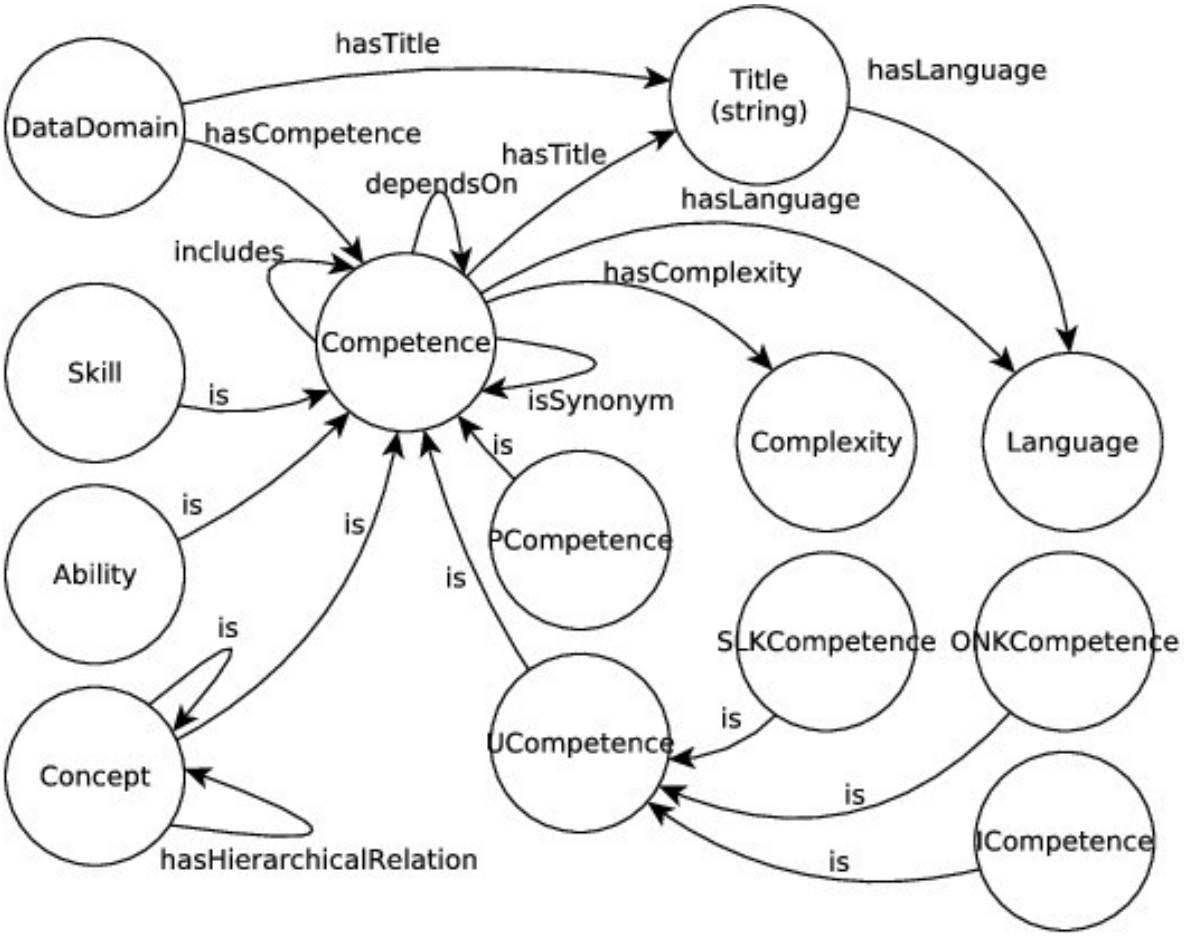
Metaontology for the learning resources retrieval and integration into the personal collections



Creating the personal collections of learning resources using ontologies

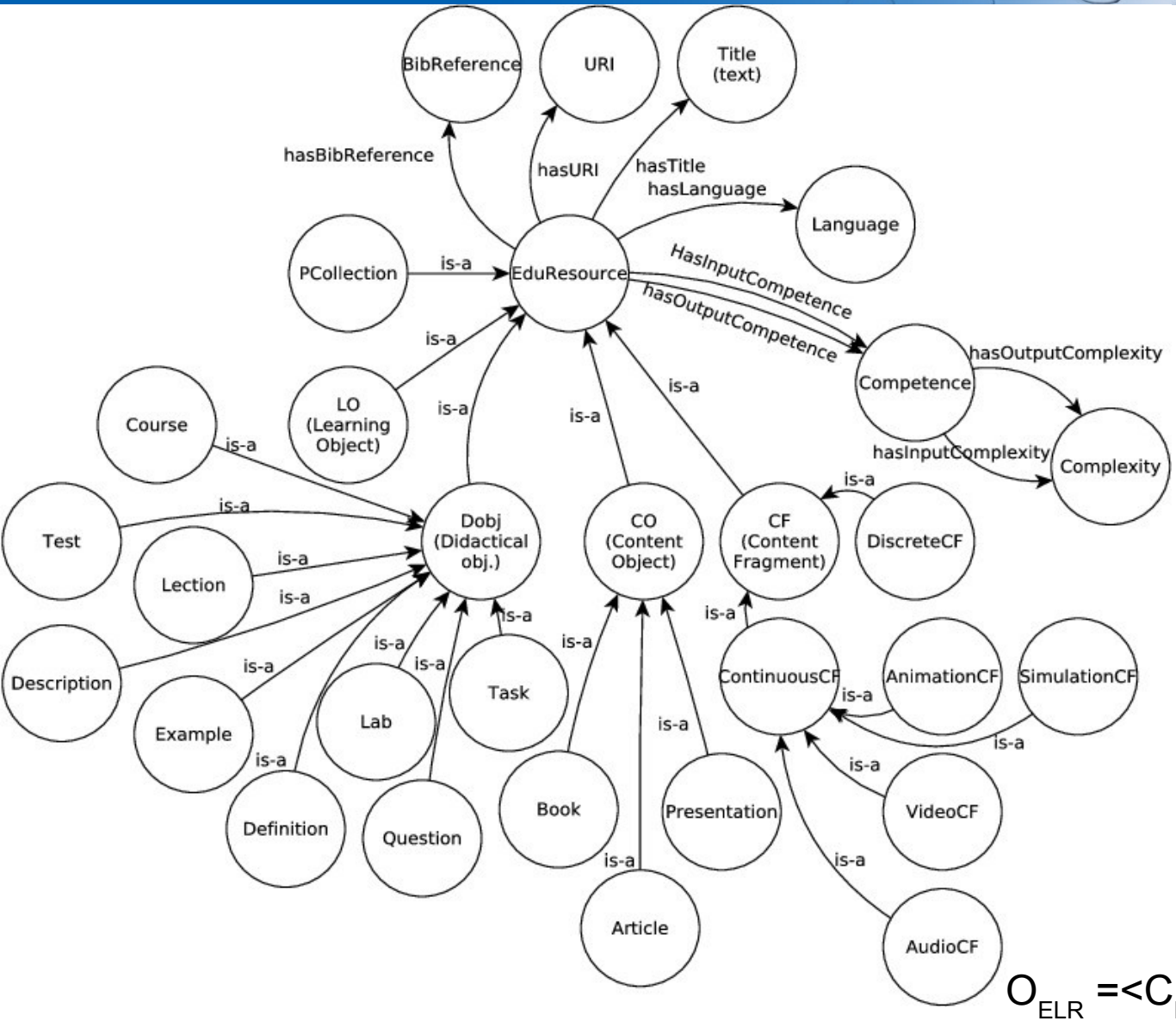


Learning course domain ontology



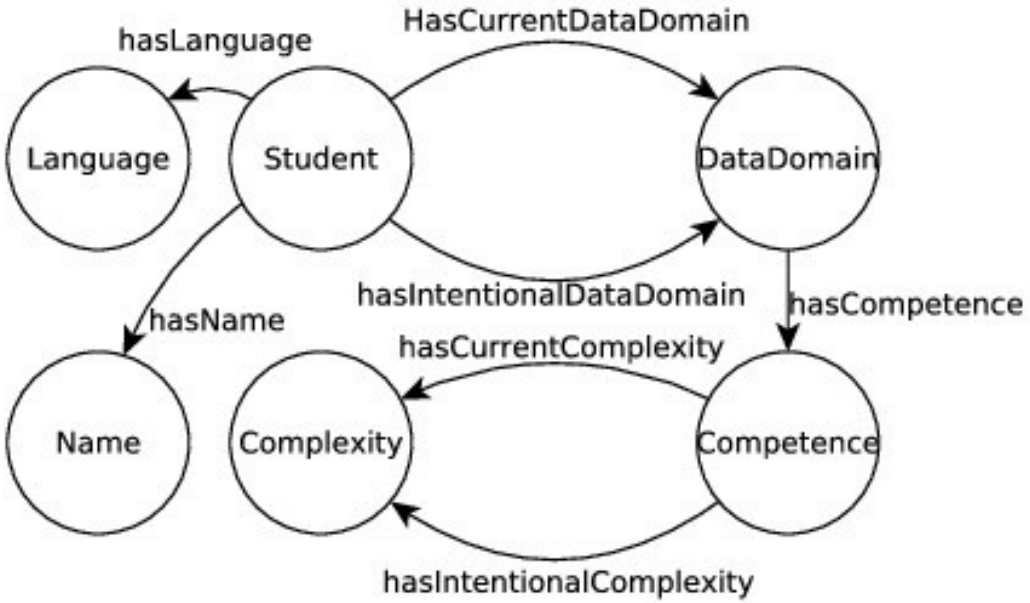
$$O_{DD} =< C_{DD} , Inst_{DD} , R_{DD} , I_{DD} >$$

Learning resource ontology (fragment)



$O_{ELR} = <C_{ELR}, Inst_{ELR}, R_{ELR}, I_{ELR}>$

Learner profile ontology



$O_L =< C_L , Inst_L , R_L , I_L >,$

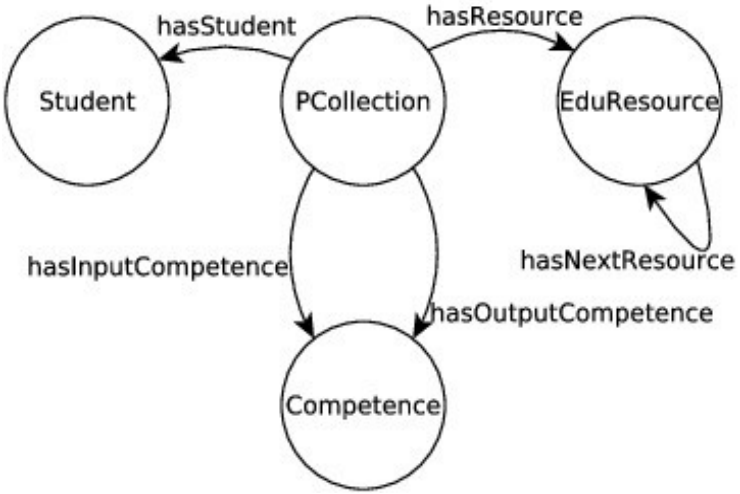
where C_L — finite set of concepts of Learner profile ontology;

$Inst_L$ — set of exemplars of classes C_L of the Learner profile ontology;

R_L — finite set of relations of Learner profile ontology;

$I_L = \varnothing$.

Personal learning collection ontology



$O_{COL} =< C_{COL} , Inst_{COL} , R_{COL} , I_{COL} >,$

where C_{COL} — finite set of concepts of Personal learning collection ontology;
$Inst_{COL}$ — set of exemplars of classes C_{COL} including created personal collections that can be stored in the repository of personal collections;
R_{COL} — finite set of relations of Personal learning collection ontology;
I_{COL} — finite set of reasoning rules for creating the collection.

Ontology Reasoning Rules for Parametric Search of the Learning Resources

The SWRL-rule for learning resources retrieval based on the preferred language and learning resources has the following form:
COL : hasStudent(?c, ?u) ∧ L : hasLanguage(?u, ?l)∧
∧ ELR : hasLanguage(?r, ?l) → COL : hasResourceByLanguage(?c, ?r),
where ?c, ?u, ?l, ?r – SWRL variables,
COL : hasStudent, L : hasLanguage, ELR : hasLanguage,
COL : hasResourceByLanguage — ontology relations with ontology prefixes.

The SWRL-rule for learning resources retrieval based on the outcome competencies and resolving the synonymy problem has the form:
COL : hasStudent(?c, ?u) ∧ L : hasIntentionalDataDomain(?u, ?d)∧
∧DD : hasCompetence(?d, ?cmp1)∧ELR : hasOutputCompetence(?r, ?cmp2)∧
∧ DD : is(?cmp2, ?cmp) ∧ DD : is(?cmp1, ?cmp) →
→ COL : hasResourceByIntentionalcompetencies(?c, ?r).

Ontology Reasoning Rules for the Learning Resources Retrieval Based on the Target Knowledge Field of the Learner

The SWRL-rules for learning resources retrieval based on the target knowledge field of the learner:

COL : hasStudent(?c, ?u)∧
∧ COL : hasResourceByIntentionalcompetencies(?c, ?r)∧
∧ L : hasIntentionalDataDomain(?u, ?d) ∧ DD : hasCompetence(?d, ?cmp1)∧
∧ ELR : hasOutputCompetence(?r, ?cmp2) ∧ DD : is(?cmp2, ?cmp)∧
∧ DD : is(?cmp1, ?cmp) ∧ L : hasIntentionalComplexity(?cmp1, ?level)∧
∧ ELR : hasOutputComplexity(?cmp2, ?level) →
→ COL : hasResourceByOutputDomain(?c, ?r).

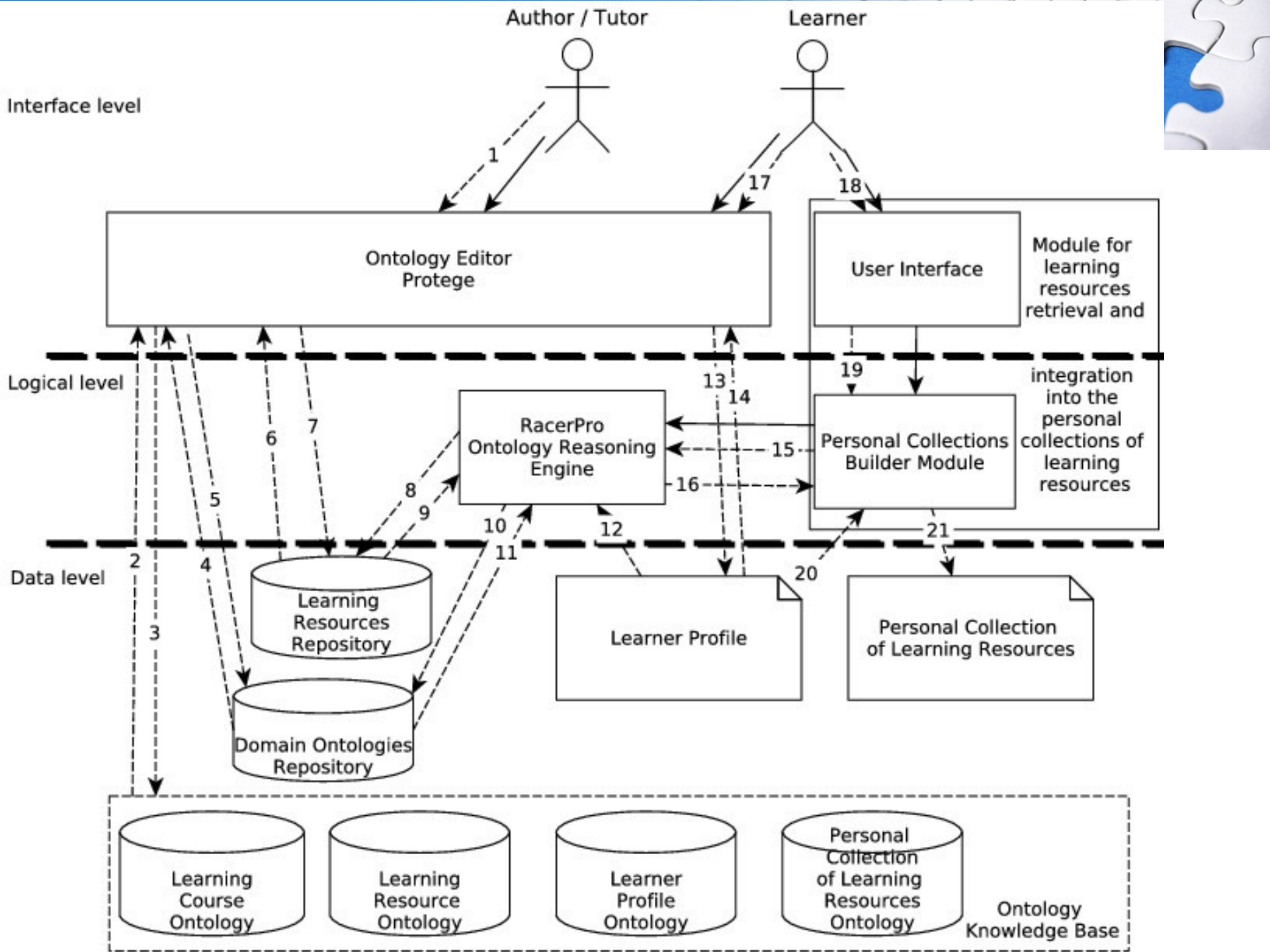
- Additional SWRL rules defined similarly to the rules above

- Algorithm for additional learning resources retrieval based on the current knowledge field of the learner described

Rules for Creating the Personal Collection of Learning Resources

The personal collection of learning resources is the sets R_0 and R_1 (defined with relation COL : hasResource) of learning resources and the set R_2 of auxiliary learning resources with logical relations between the resources defined with the rule:

COL : hasResource(?c, ?r1) ∧ COL:hasResource(?c, ?r2)∧
∧ ELR:hasOutputCompetence(?r1, ?cmp1)∧
∧ ELR:hasInputCompetence(?r2, ?cmp2) ∧ DD:is(?cmp1, ?cmp)∧
∧ DD:is(?cmp2, ?cmp) → COL:hasNextResource(?r1, ?r2).


Author / Tutor
Learner
Interface level
Logical level
Data level
Ontology Editor
Protege
User Interface
Module for
learning
resources
retrieval and
integration
into the
personal
collections of
learning
resources
RacerPro
Ontology Reasoning
Engine
Personal Collections
Builder Module
Learning
Resources
Repository
Learner Profile
Personal Collection
of Learning Resources
Domain Ontologies
Repository
Learning
Course
Ontology
Learning
Resource
Ontology
Learner
Profile
Ontology
Personal
Collection
of Learning
Resources
Ontology
Ontology
Knowledge Base
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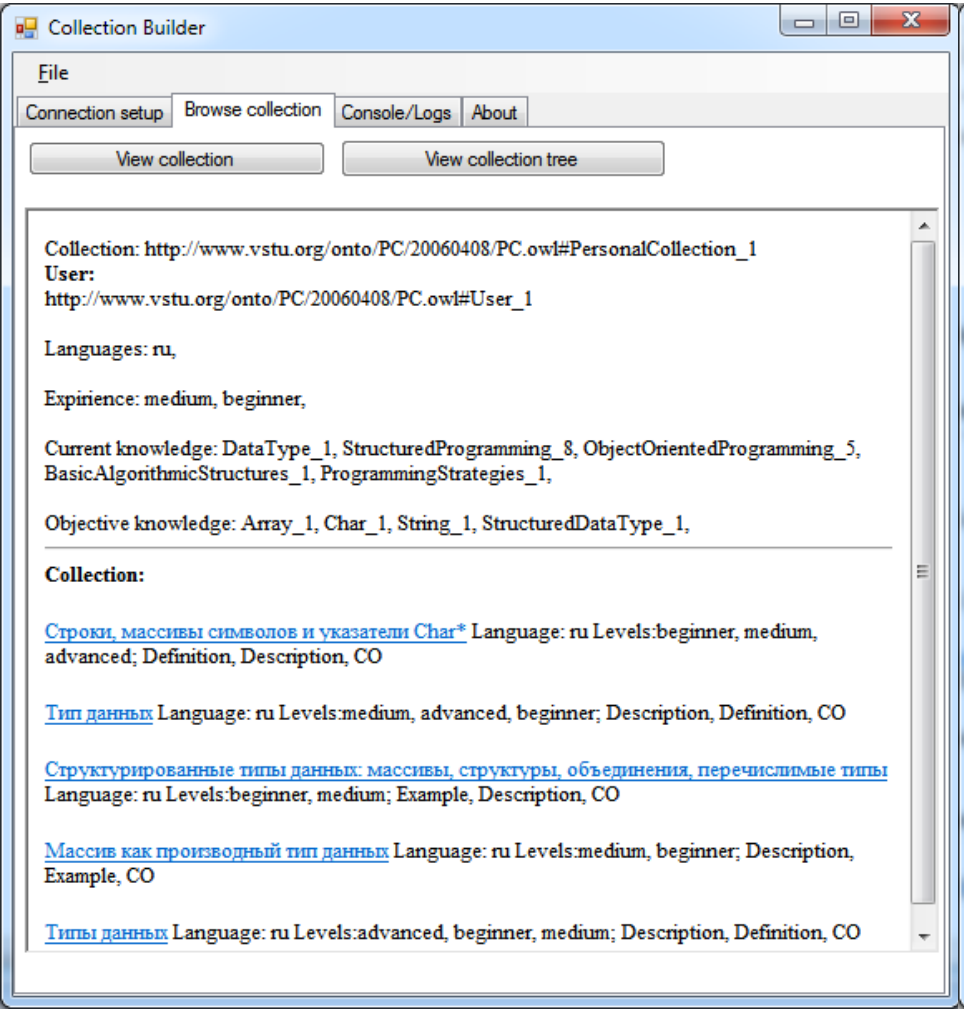
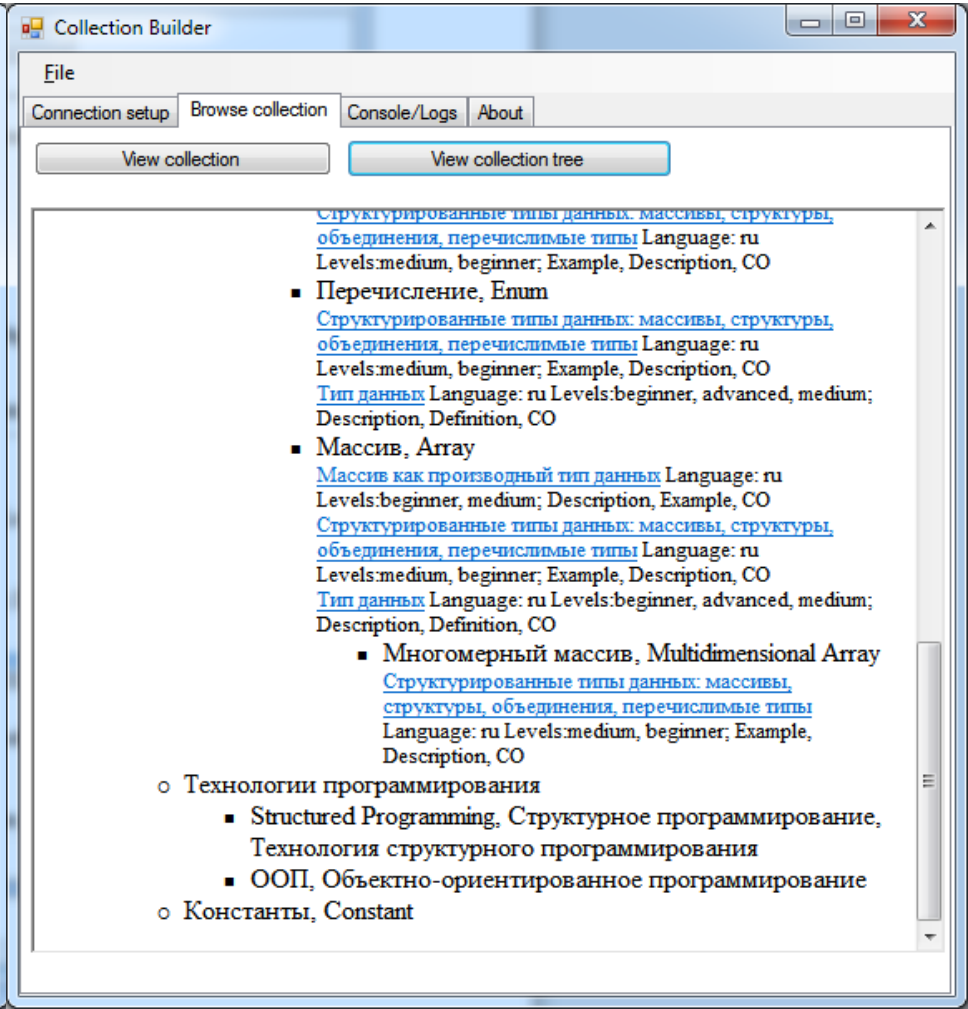
Personal Collection Builder





Conclusion

- The concept of learning management in the open learning network was proposed on the base of learning resources retrieval and creating the personal learning collections using ontology-based approach.

- The ontological model for knowledge representation was developed including ontologies of learning course domain, learning resource, learner's profile and personal learning collection. The last one includes the ontology reasoning rules for creating the personal learning collection.
Also the algorithm for additional learning resources retrieval was proposed.

- The software architecture and tool for creating the personal learning collections were designed and implemented within framework of proposed knowledge-based approach with employment of the object-oriented analysis and C# language.

Future Works

- Developing the software tools for creating the learning course ontologies and annotating the learning resources

- Developing the ontologies for other university courses

- Filling up the repository of learning resources

- Integration with LMS Moodle

¿Questions?