Emergent Knowledge Artifacts for Supporting Trialogical E-Learning

Yannis Tzitzikas¹,², Vassilis Christophides¹,², Giorgos Flouris², Dimitris Kotzinos¹,², Hannu Markkanen³, Dimitris Plexousakis¹,², Nicolas Spyros⁴

¹Computer Science Department, University of Crete, GREECE
²Institute of Computer Science, FORTH-ICS, GREECE
³EVTEK University of Applied Sciences, FINLAND
⁴Laboratoire de Recherche en Informatique, Universite de Paris-Sud, FRANCE

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Outline

• Trialogical Learning (vs Classical Learning Theories)
• Trialogical Learning: Knowledge Artifacts
• An approach for Trialogical E-Learning
  – Personal and Group Spaces
  – Emergent Knowledge Artifacts
  – Learner’s Interaction through Emergent Knowledge Artifacts
  – Case Studies
• Further issues
• Concluding remarks
Classical Learning Theories
The knowledge acquisition metaphor

- A learner individually internalizes a body of knowledge.

Classical Learning Theories
The social participation metaphor

- A group of learners collaboratively appropriate a body of knowledge.
Trialogical Learning (TL)

- A group of learners are collaboratively developing shared objects of activity.

Trialogical Learning (TL)

- **TL** focuses on the social processes by which learners collectively enrich/transform their individual and shared cognition.
- Knowledge creation activities rely heavily on the use, manipulation and evolution of **shared knowledge artifacts** externalizing a body of (tacit or explicit) knowledge.

Trialogical Learning and CoPs (Communities of Practice):
- Trialogical E-Learning can facilitate the negotiation of meaning and the development of **explicit and innovative knowledge** inside a CoP.
What is a **Knowledge Artifact**?

- The term "knowledge artifact" is used to refer to what is being created and/or shared by a group of learners

- Examples of knowledge artifacts:
  - A video that records how group members carry out their tasks which the group could then annotate (e.g. with free text or with respect to an ontology)
    - (this is an example of a knowledge artifact that captures *implicit knowledge*)
  - Documents
  - Designs
  - Concept maps
  - Ontologies
  - Databases
  - Annotations
  - Software
  - …

An Approach for Supporting **Trialogical E-Learning**
Modeling the Problem

- We model learners as a set of **Actors** \( A = \{a_1, \ldots, a_k\} \).
- Each actor \( a_i \) can keep a **personal space** in the form of a knowledge base \( KB_i \).

![Diagram showing personal spaces for different actors]

### Personal Spaces

- Each personal space \( KB_i \) has a **private** and a **public** part.

![Diagram showing private and public parts of knowledge bases]

- No restrictions on their relationship. All topologies are acceptable.
Group Space = all public parts of actors’ KBs

Emergent Knowledge Artifacts (EKA)
Some basic (and common) synthesis operators for deriving Emergent Knowledge Artifacts

Some basic (and common) operators

- **UNION**
  - The result contains all public parts of the participants’ KBs.
  - Useful for supporting blackboard collaboration

- **INTERSECTION**
  - The result contains only those elements that appear in the public KB of every participant.

- **Z-Percent (for identifying trends, etc)**
  - The result contains only those elements that appear in the public KB of Z% of the participants.

Of course more complex operators can be defined by combining the above

Interaction through Emergent Knowledge Artifacts

Emergent Knowledge Artifact
Interaction through Emergent Knowledge Artifacts

Each learner can define and access EKAs on demand
Interaction Through EKA: A possible UI

For editing the personal (private) space

For moving elements from the private to the public part of the personal view and the vice versa.

For moving (copying) elements from a group space view to the personal space.
A UI for Trialogical E-Learning should also support a number of auxiliary services

Grading and Progress Assessment

We need to be able to access the progress of both individual and collaborative work.

Assessment by an external party
There is a set of admissible solutions (that learners do not know). The progress is measured by measuring the distance between the produced artifacts (individual or collaborative) and the solution artifact(s).

No external party (nor known solution set).
This case occurs frequently in innovative tasks. The progress could be measured by the degree of agreement among the group. An artifact of a learner can be also graded w.r.t. a specific group space view.
On Applicability

- The above abstract framework is very general and it can capture a plethora of application scenarios.
- We have started investigating its applicability on various cases of knowledge representation frameworks.

- Depending on the framework, different synthesis operators can be employed and different issues arise.

Cases of KB

- Set of words
- Binary Relation
- Binary Relation + Second Order Properties
- RDF-based Repository
Case: KB = A Set of Words

**Set of words**

Indicative Application Scenario:
- **Collaborative Construction of Terminology**
  - A set of learners have to define a terminology to be used for annotating a set of objects (e.g. a set of research papers)

- For each word \( w \), we can define the **support** of \( w \) as follows:
  - \( \text{support}(w) = \{ a_i | (w, a_i) \text{ exists in KB} \} \)

- **Emergent Knowledge Artifacts**
  - **Union**: \( \text{KB}(A, \cup) = \{ w | \text{support}(w) \subseteq A \} \)
  - **Intersection**: \( \text{KB}(A, \cap) = \{ w | \text{support}(w) \supseteq A \} \)
  - **Z-Percent**: \( \text{KB}(A, \%z) = \{ w | |\text{support}(w) \cap A|/|A| \geq z \} \)

- **Metrics for measuring the distance of two KBs**
  - Symmetric difference, Dice coefficient, ...

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Case: KB = A Binary Relation

**Binary Relation**

Indicative Application Scenario:
- **Collaborative Graph Construction**
  - A set of learners have to define a graph of keywords (e.g. a conceptual map) for describing a set of objects

- Each KB is a binary relation \( R \) over a set of elements \( T \) (i.e. \( R \subseteq T^2 \)).
- We can define the **support** of each \( r \in R \) as before.
- If \( T \) is considered part of the created knowledge then we can define EKA based on \( T \) and EKA based on \( R \).
Case: KB = A Binary Relation with Second Order Properties

**Taxonomy**

- Each KB is a binary relation $R$ over a set of elements $T$ (i.e. $R \subseteq T^2$) with the extra constraint that this relation satisfies a property (e.g. that $R$ is reflexive, symmetric, antisymmetric, transitive, etc).
  - For example if $R$ is a preorder (reflexive and transitive) captures the case of taxonomies.

*These extra properties can be seen as derivation rules or as constraints.*

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Case: KB = A Binary Relation with Second Order Properties

- Let $\text{Cons}(KB_i)$ denote the knowledge base that contains the elements of $KB_i$ plus the inferred ones.
- EKAs can be defined either on $KB_i$ or on $\text{Cons}(KB_i)$. The resulting EKAs can be different.

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Case: KB = A Binary Relation with Second Order Properties
A Total Order

- Indicative Applications
  - A set of learners have to rank a set of available options \( T \) in order to come up with some decision.

- EKAs can be computed by applying rank aggregation techniques
  - Borda, Condorcet, Kemeny Optimal Aggregation

- CSF (Collaborative Selection and Filtering) is also related

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Case: KB = An RDF-based Repository

- A KB can be seen as a graph with 3 kinds of edges: Risa (which is transitive), Rproperty, Rinstance.
- More complex issues of consistency arise here.
Further Issues

- As we step up the **expressive power** of the representation framework additional issues arise:
  - **Knowledge Evolution** (distinction between update and revision)
  - **Measuring the Distance** between KBs (deltas over RDF graphs)

- As the **number of actors** scales up
  - **Social Network Analysis**
    - The Web is a primitive form of trialogical learning
      - The actors of the web can only create and update their own KBi (interlinked pages) and the only method to combine the KBS of different actors is to add one-way links between them.
  - **Personalized services**

Conclusions

- Trialogical e-learning requires **advanced knowledge management services**, probably more advanced than those that have emerged in the database and KR area (including the Semantic Web).

- Database and KR technologies have provided stable solutions mainly for the case where there is a commonly accepted conceptualization and world view. Methodologies and technologies that **allow diversification and flexible amalgamation of different world views** are still in their infancy.

Thank you for your attention.
Related Work

- **Composing Ontologies and Information Bases**
  - [G. Wiederhold, 1994]: An Algebra for Ontology Composition
  - [J. Euzenat, KAW’96]: Corporate Memory through Cooperative Creation of Knowledge.
  - [M. Theodorakis et al, Information Systems, 2002]: A Theory of Contexts in Information Bases
  - [Z.Kaoudi et al, ESWC05]: RDFSculpt: Managing RDF Schemas Under Set-Like Semantics.

- **Related Areas and Trends**
  - Collaborative Selection and Filtering (~case: total orders)
  - Folksonomies (~case: KB is a subset of Obj x A x L where Obj is a set of objects, A the set of actors and L is a set of words)

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Long-Term Vision: Towards the MetaWeb
We are going to investigate and implement the above issues scenarios in the context of the Semantic Web.

There are no stable tools for managing RDF Named Graphs. We are currently extending the ICS-FORTH RDFSuite with named graphs management.