Emergent Knowledge Artifacts for Supporting Trialogical E-Learning

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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.

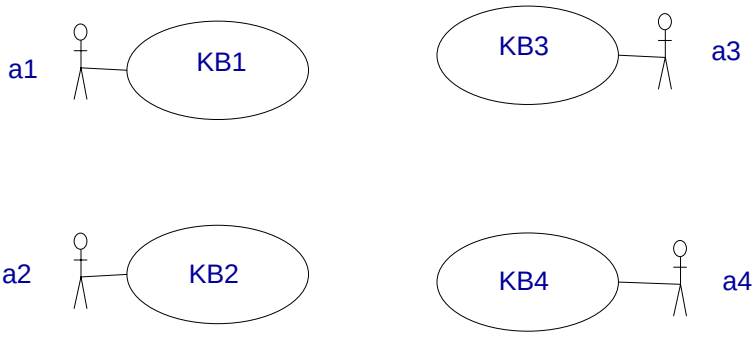
What is a Knowledge Artifact?

- 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*

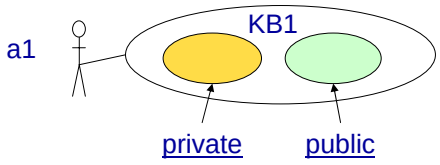
Modeling the Problem

- We model learners as a set of **Actors** A = {a1,… ak}.
- Each actor ai can keep a **personal space** in the form of a knowledge base KBi



Personal Spaces

- Each personal space KBi has a private and a public part.



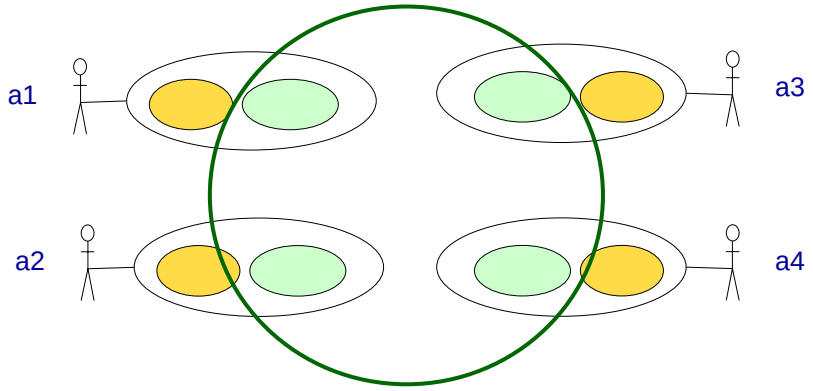
Accessible only by a1 Accessible by all learners

- No restrictions on their relationship. All topologies are acceptable.



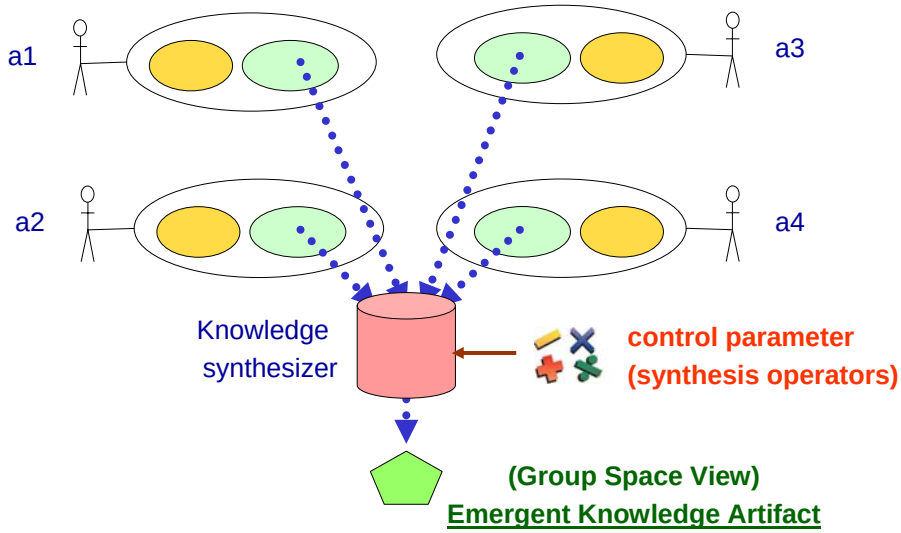
Public is a part of the private | Private is a part of the public | Overlapping | Disjoint

Group Space = all public parts of actors' KBs

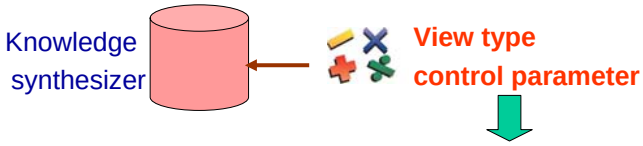


Group Space

Emergent Knowledge Artifacts (EKA)



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

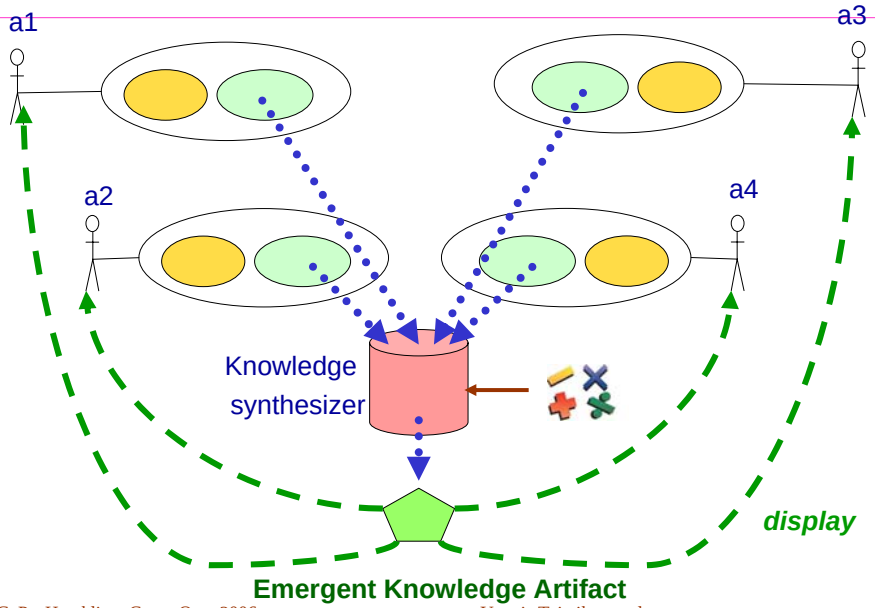


Some basic (and common) operators

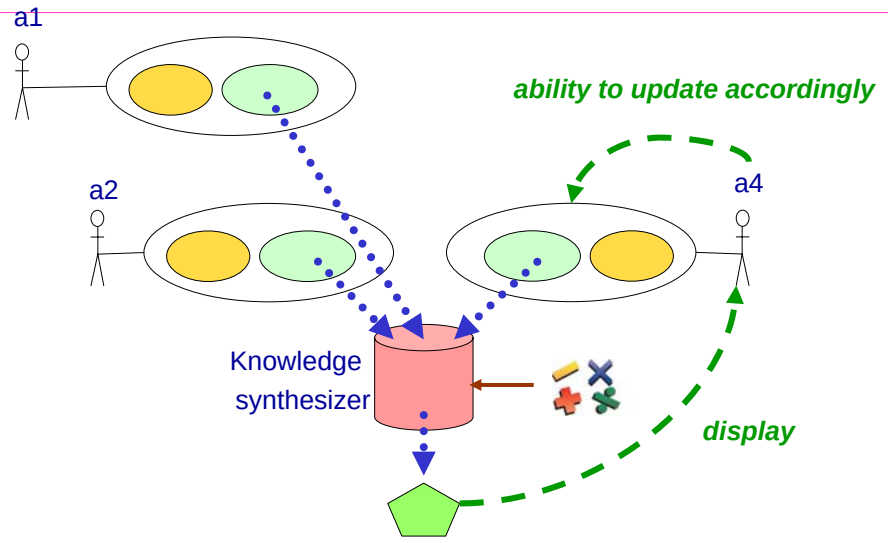
- UNION
  - The result contains all public parts of the participants' KBs.
  - Useful for supporting black board collaboration
- INTERESECTION
  - The result contains only those elements that appear in the public KB of every participant.
- Z-Percent (for identifying trends, etc)
  - The result contains 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

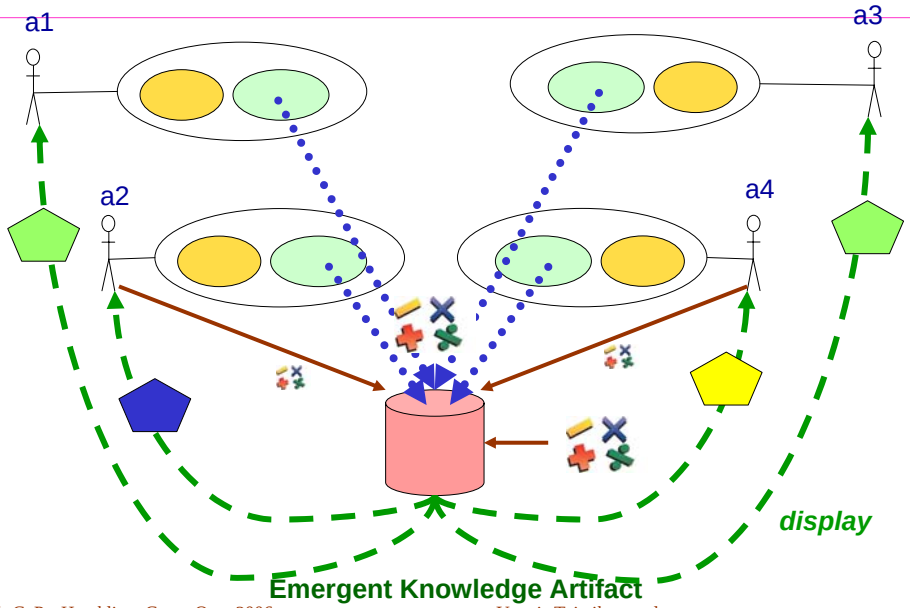
Interaction through Emergent Knowledge Artifacts



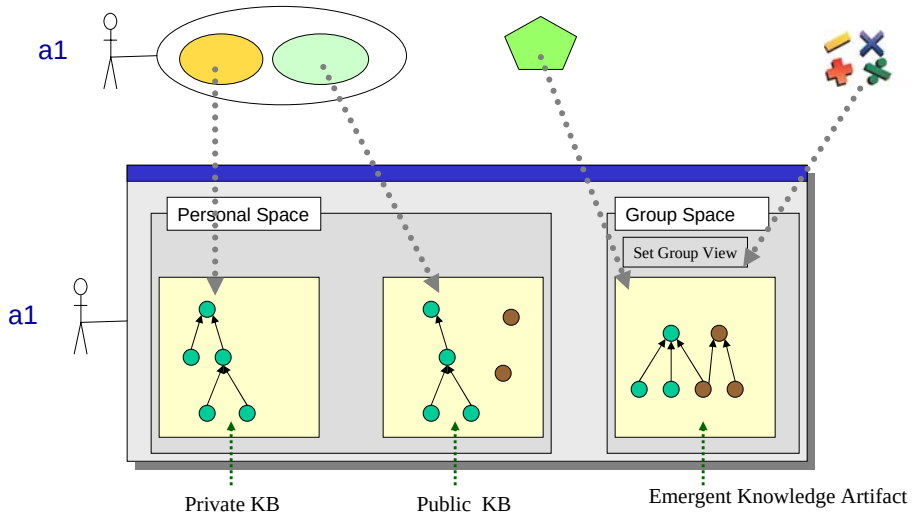
Interaction through Emergent Knowledge Artifacts



Each learner can define and access EKAs on demand

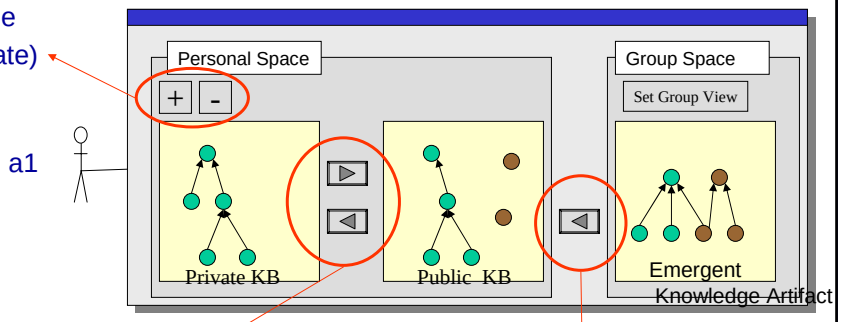


Interaction Through EKA: A possible UI



Interaction Through EKA

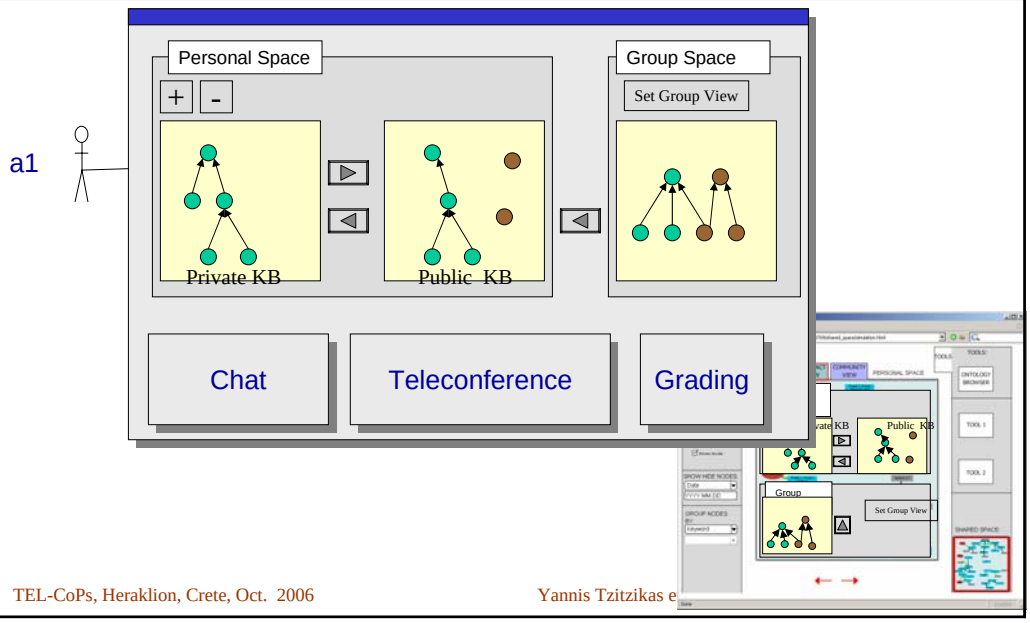
For editing the personal (private) space



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

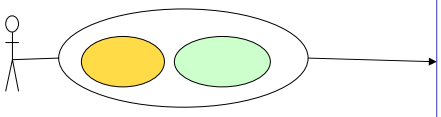
- There is a set of admissible solutions (that learners do not know).
- The progress is measured by measuring the **distance** between the produced artifacts (individual or collaborative) and the solution artifact(s).

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

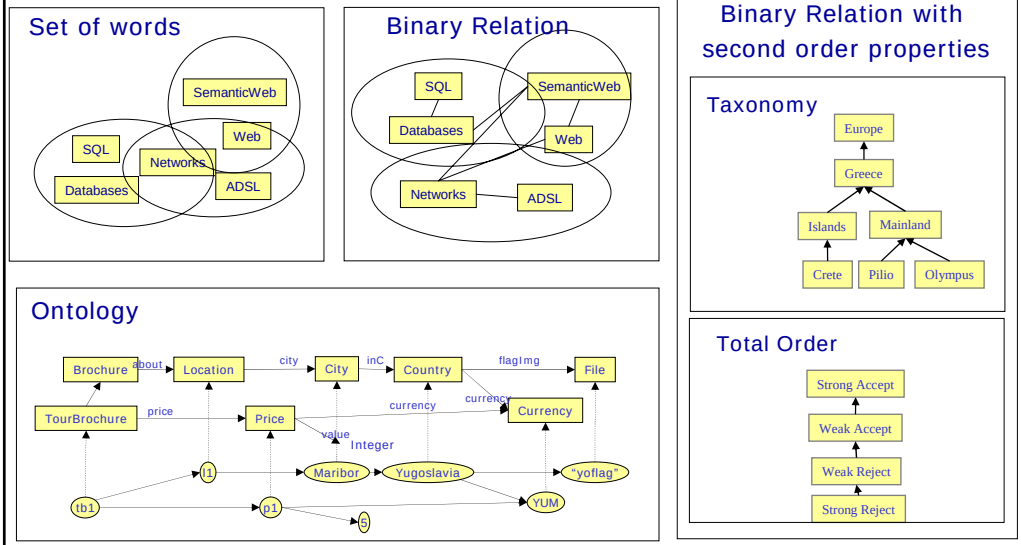
- The above abstract framework is very general and it can capture a plethora of application scenarios.
- We have started investigating its applicability on various cases of knowledge representation frameworks.



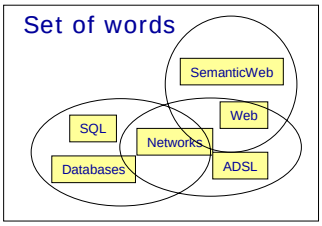
- Set of words
- Binary Relation
- Binary Relation + Second Order Properties
- RDF-based Repository

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

Cases of KB



Case: KB = A Set of Words

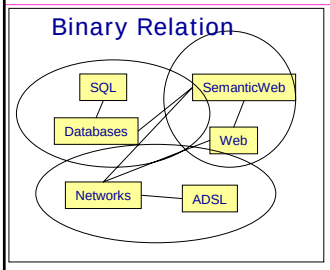


Indicative Application Scenario:

- ***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:
  - support(w) = { a_i | (w, a_i) exists in KB_i }
- **Emergent Knowledge Artifacts**
  - Union: KB(A, $\cup$) = { w | support(w) $\subseteq$ A}
  - Intersection: KB(A, $\cap$) = { w | support (w) $\supseteq$ A}
  - Z-Percent: KB(A, %z) = { w | |support (w) $\cap$A|/|A|$\geq$z }
- Metrics for measuring the distance of two KBs
  - Symmetric difference, Dice coefficient, …

Case: KB = A Binary Relation



Indicative Application Scenario:

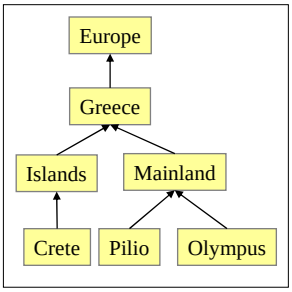
- ***Collaborative Graph Construction***
  - A set of learners have to define a graph of keywords (e.g. a **conceptual map**) for describing a set of objects

- 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 T and EKA based on R.

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

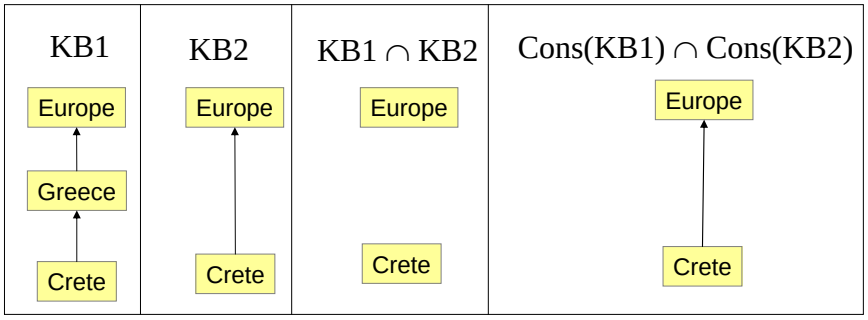
- Each KB is a binary relation R over a set of elements T (i.e. $R \subseteq T^2$) with the extra constraint that this relation satisfies a property (e.g. that R is reflexive, symmetric, antisymmetric, transitive, etc).
  - For example if R is a preorder (reflexive and transitive) captures the case of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



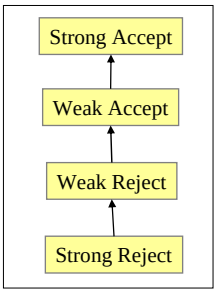
These extra properties can be seen as derivation rules or as constraints.

Case: KB = A Binary Relation with Second Order Properties

- Let **Cons**(KBi) denote the knowledge base that contains the elements of KBi plus the inferred ones.
- EKAs can be defined either on KBi or on **Cons**(KBi). The resulting EKAs can be different.

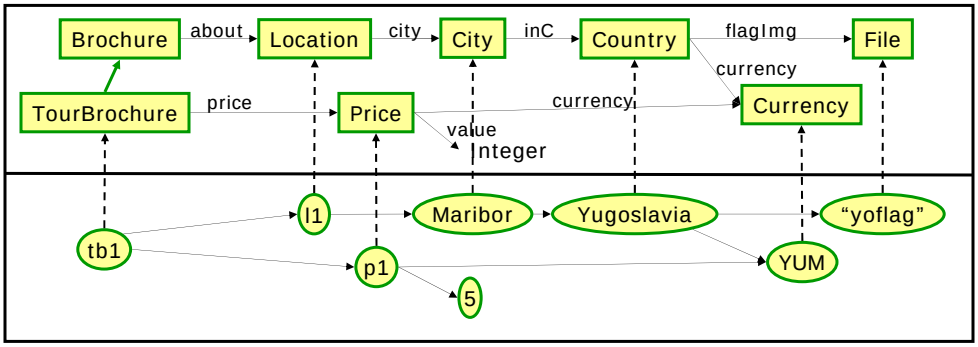


Case: KB = A Binary Relation with Second Order Properties
A Total Order



- 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

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 differencet 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.

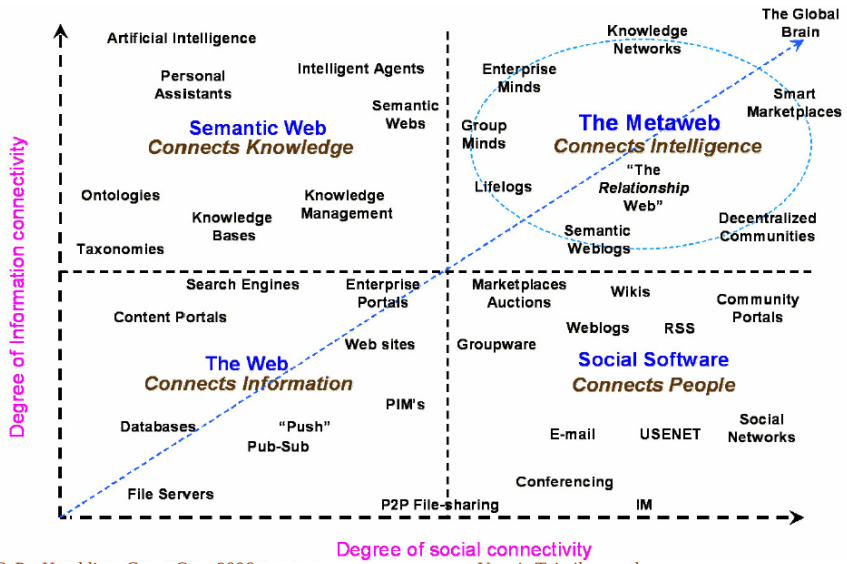
Thank you for your attention.

This research is being contacted in the context of the Knowledge Practices Laboratory (**KP-Lab**) project (co-funded by the IST programme of the EU 6).

Related Work

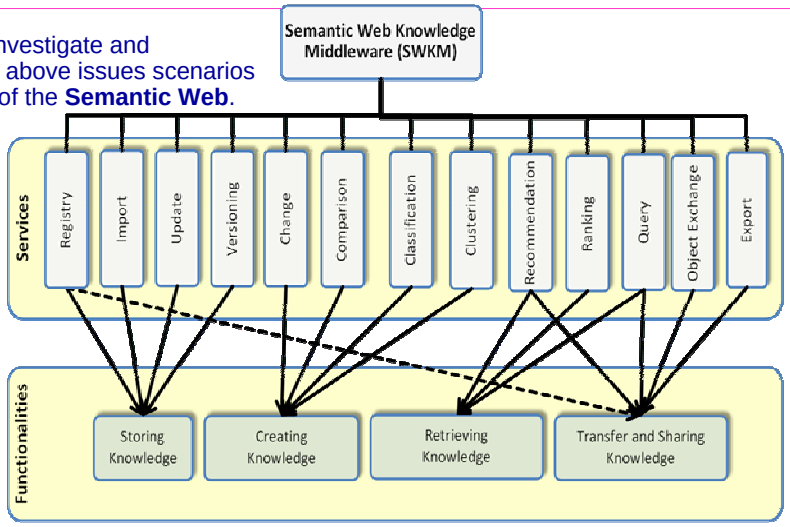
- Composing Ontologies and Information Bases
  - [G. Wiederhold, 1994]: An Algebra for Ontology Composition
  - [J. Euzenat, KAW'96]: Corporate Memory through Cooperative Creation of Knowledge.
  - [M. Theodorakis et al, Information Systems, 2002]: A Theory of Contexts in Information Bases
  - [Z.Kaoudi 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)

Long-Term Vision: Towards the MetaWeb



Implementation Issues

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.