A Classification of Ontology Change

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Ontology Change Definition

Ontology change is the problem of deciding the modifications to perform upon an ontology in response to a certain need for change, as well as the implementation of these modifications and the management of their effects in depending data, ontologies, services, applications, agents or other elements

Motivation for this Paper

Situation: Due to its complexity, the problem is being addressed by several different, but closely related, interlinked and often overlapping research disciplines; each of these disciplines deals with a certain facet of the problem from a different view or perspective, covering different application needs, change scenarios or needs for change

Problems: Overlapping disciplines; boundaries not clear; confusing use of terms

Purpose of this paper:
❶ Make broad survey and study relationships/boundaries between subfields
❷ Classify ontology change approaches
❸ Propose a terminology; clarify terms; study alternative literature definitions

Ontology Change Subfields

1. Ontology Evolution
2. Ontology Versioning
3. Ontology Mapping
4. Ontology Morphism
5. Ontology Alignment
6. Ontology Articulation
7. Ontology Translation
8. Ontology Integration
9. Ontology Merging

→ Heterogeneity Resolution

Ontology Evolution

Definition
The process of modifying an ontology in response to a certain change in the domain or its conceptualization
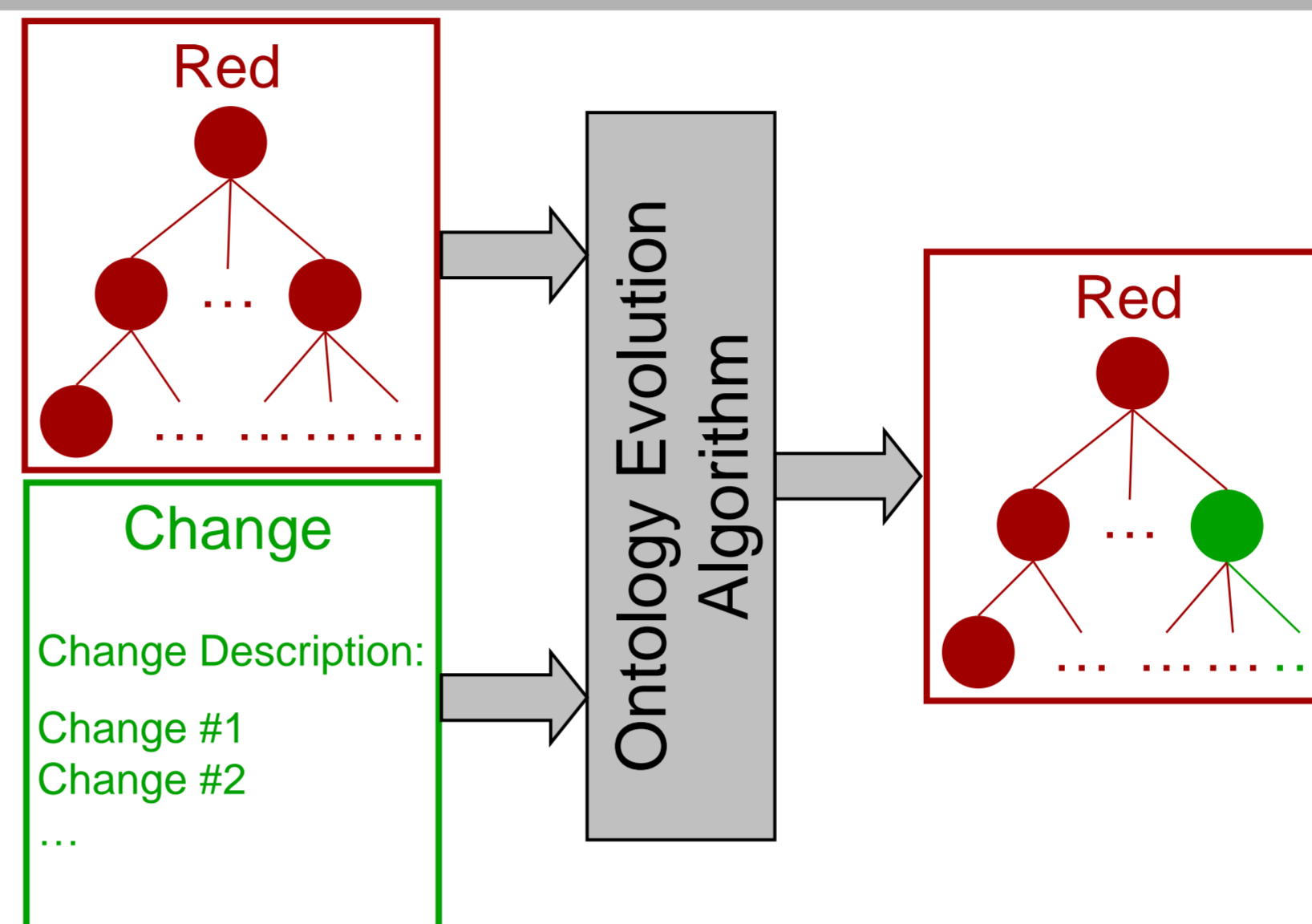
Ontology Evolution at a Glance

Purpose: Apply required modifications to an ontology; modifications are initiated due to changes in the domain of the ontology or its conceptualization
Input: An ontology and a (set of) change operation(s)
Output: An ontology

In the figure, a set of Green changes are applied to the Red ontology: the Red ontology is changed accordingly in order to accommodate the changes

Comments on Ontology Evolution

Implements change(s) to the source ontology

Does not provide ontology versioning features

Initiated to handle changes in the domain (i.e., when the modeled world has changed) or to handle changes in the conceptualization (i.e., when the domain should be modeled differently)

Usually performed in six phases

Ontology Versioning

Definition
The ability to handle an evolving ontology by creating and managing different versions of it
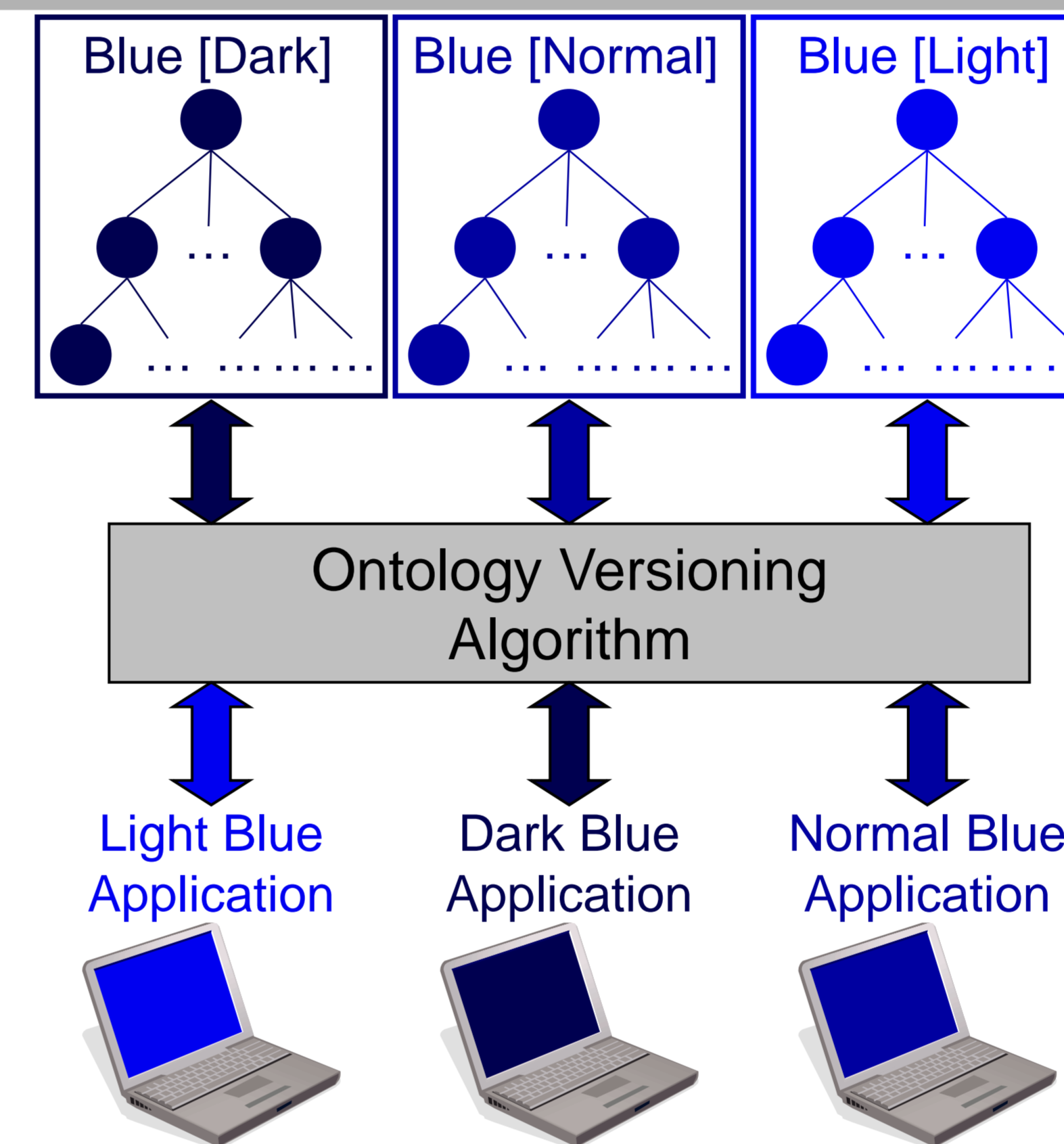
Ontology Versioning at a Glance

Purpose: Handle multiple versions of an ontology; provide transparent access to the "correct" version, depending on the accessing element
Input: Different versions of an ontology
Output: A versioning system

In the figure, three versions of the Blue ontology (Blue [Dark], Blue [Normal] and Blue [Light]) are managed by a versioning system; each of the three accessing applications, needs access to (is compatible with) a different version of the Blue ontology; it is the job of the versioning system to provide proper (and transparent) access

Comments on Ontology Versioning

Version ids are required to identify versions

Must determine which changes result to a new version (and need a new id)

Needs to determine compatibility between versions

Provides transparent access to versions

Useful feature: "version relations"

Useful feature: "deltas" between ontologies

Heterogeneity Resolution

Definition
The process of relating two ontologies via some kind of translation rules in order to mitigate heterogeneity problems in terms of language, syntax, terminology, modelling conventions etc
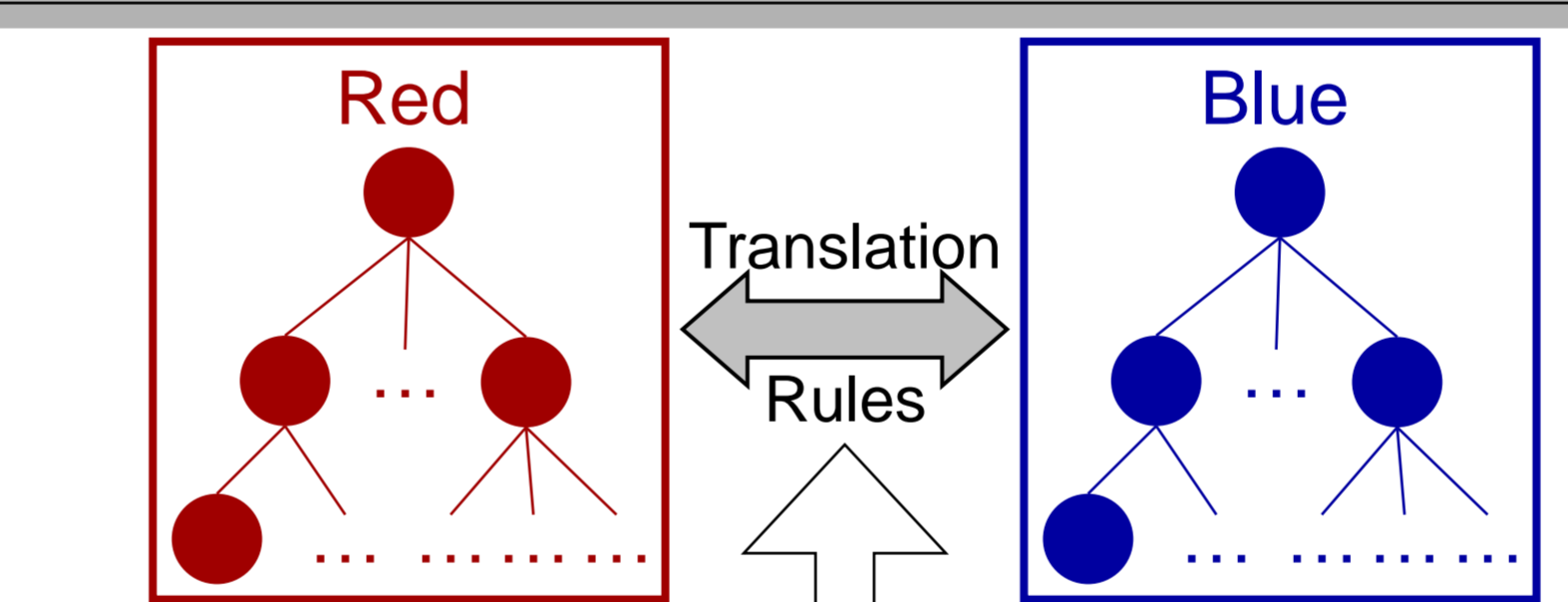
Heterogeneity Resolution at a Glance

Purpose: Resolve heterogeneity problems between ontologies; allow interoperability
Input: Two (heterogeneous) ontologies
Output: Some kind of translation rules between the source ontologies; these translation rules identify related signature elements and/or axioms (depending on the algorithm type)

In the figure, a set of translation rules are produced to relate the Blue ontology and the Red ontology; the type of translation rules produced determines the type of the algorithm (mapping, morphism, alignment or articulation)

The various subfields related to heterogeneity resolution are identified based on the type of translation rules produced at the output. More specifically:
Mapping: Function between signatures
Morphism: Function between signatures and axioms
Alignment: Relation between signatures
Articulation: An intermediate ontology, plus functions between this intermediate ontology and each source

Comments on Heterogeneity Resolution

Change is not explicit but is performed at run-time (during interoperability and communication)

Articulation is equivalent to alignment, because a relation can be decomposed into a pair of functions from some intermediate source

Ontology Translation does not produce translation rules; there are two distinct understandings of the term in the literature:
1. Change the representation language of the ontology
2. Implement a signature mapping upon the ontology (produced by an ontology mapping algorithm)

Ontology Integration

Definition
The process of composing the information found in two or more ontologies covering loosely related domains

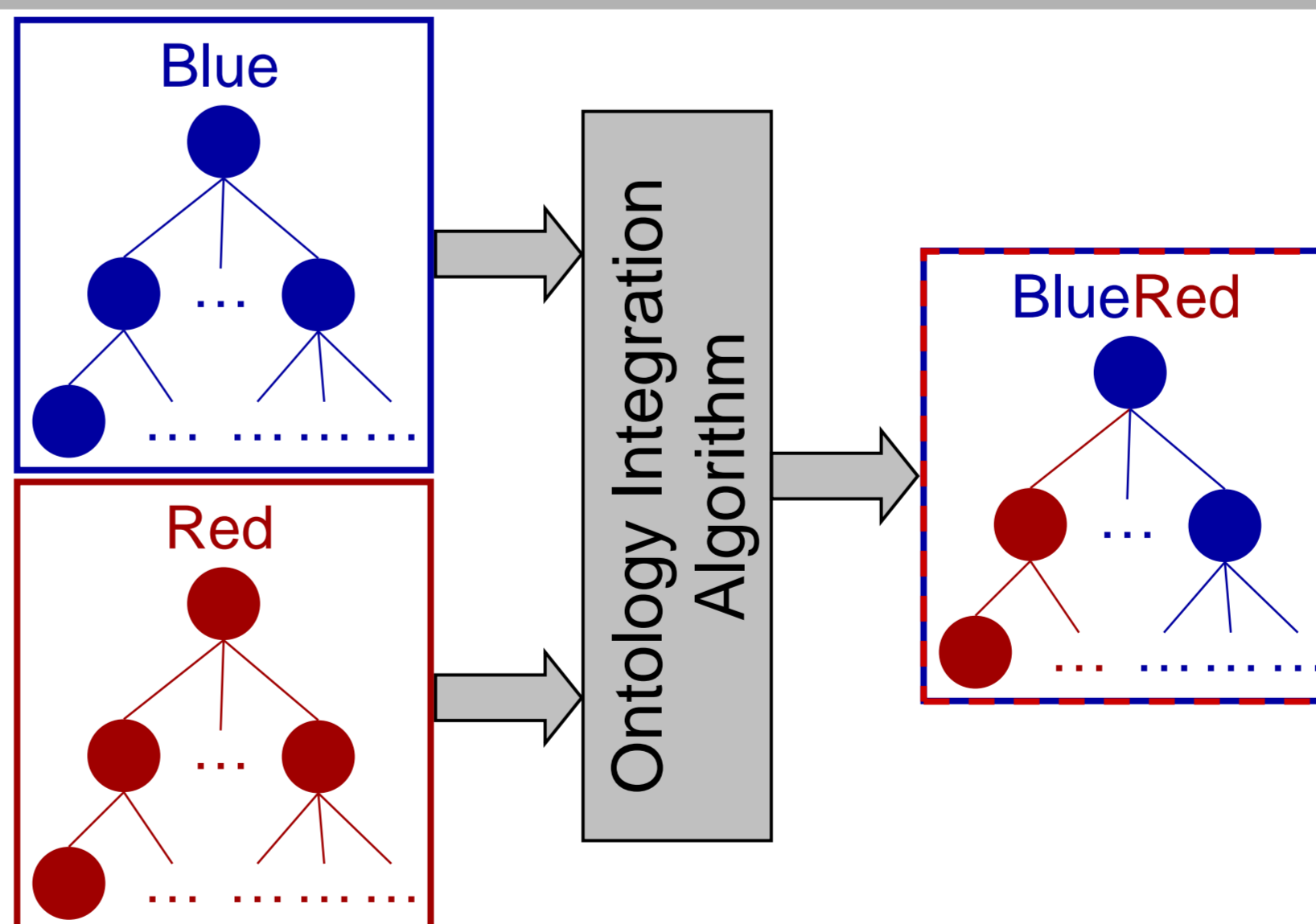### Ontology Integration at a Glance

Purpose: Fuse the information found in two ontologies covering loosely related (i.e., similar) domains
Input: Two ontologies (covering similar domains)
Output: An ontology

In the figure, the Blue ontology is integrated with the Red ontology; the ontologies cover similar domains, so the result (BlueRed ontology) contains each of the sources in loosely related (and easily identifiable) modules

Comments on Ontology Integration

Very similar to ontology merging; the only difference is in the domain of the sources

Mainly applied when the focus is to fuse knowledge from different sources in order to cover a broader domain

Very useful in ontology development (integrating independently developed subontologies makes ontology design more efficient)

Heterogeneity resolution is a major part of the task of integration (but ontology integration is more than that)

Ontology Merging

Definition
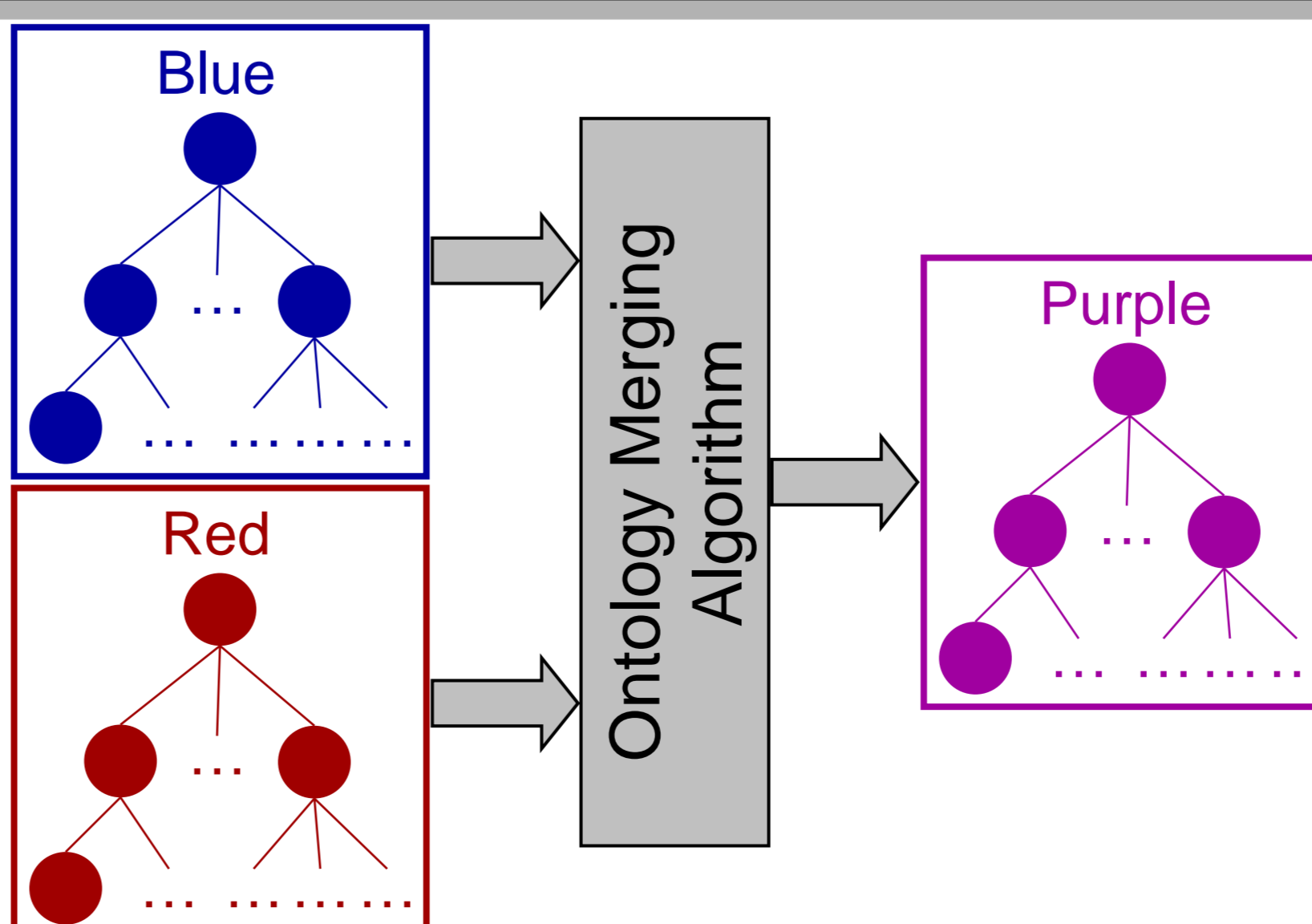*The process of composing the information found in two or more ontologies covering highly overlapping or identical domains*

Ontology Merging at a Glance

Purpose: Fuse the information found in two ontologies covering highly overlapping or identical domains
Input: Two ontologies (covering identical domains)
Output: An ontology

In the figure, the Blue ontology is integrated with the Red ontology; the ontologies cover identical domains, so the information coming from the source ontologies is greatly intermingled (non-identifiable) in the result (Purple ontology)

Comments on Ontology Merging

Very similar to ontology integration; the only difference is in the domain of the sources

Mainly applied when the focus is to fuse knowledge from different sources in order to describe the domain more accurately

Very useful when we have a number of ontologies each partially describing the same domain

Heterogeneity resolution is a major part of the task of merging (but ontology merging is more than that)