Towards Ontological Context Mediation for Semantic Web Database Integration: Translating COIN Ontologies Into OWL

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Overview I

- **Context Interchange (COIN) is an approach to <u>information integration</u>. It uses <u>ontological mappings</u> and enables powerful <u>context-sensitive query mediation</u> for semantic integration of knowledge across multiple <u>heterogeneous database sources</u>.**

- **Existing COIN applications include:**
  - **<u>financial</u>: reporting and analysis**
  - **<u>travel</u>: airfare and car-rental aggregators**

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Overview II

- **COIN's original development preceded the Semantic Web.**

- **How best to combine COIN's capabilities with those of OWL and RuleML?**
  - **This paper provides a big first step**

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Overview III

- **We present a translation of COIN's ontology representation into OWL Description Logic.**

- **We identify at a high level how to use RuleML LP rules together with ontologies to perform COIN-type reasoning such as mapping of ontologies and mediation of queries.**

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COIN Ontological Model's Translation to OWL I

- Semantic Type → OWL Class
- Attribute → OWL Property
- Source Relation → OWL Class
- Source Relation Column → OWL Property
- is-a inheritance link -> subClassOf axiom

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COIN Ontological Model's Translation to OWL II

- **Context → instance of COINContext Class**
- **Modifier → OWL Property**

Actually, only RDF-Schema features are used:

- **rdfs:class**
- **rdfs:property**
- **rdfs:subClassOf**
- **rdfs:domain**
- **rdfs:range**

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Kinds of Reasoning in COIN

COIN does several kinds of reasoning:

- **Ontological mapping**
- **Query mediation**
  - **Abduction**
  - **Constraint Handling & Equation Solving**

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Use Rules for COIN Reasoning I

- **Description Logic *alone* is not well-suited for COIN reasoning – OWL is not enough**

- **Want Logic Program (LP) Rules – RuleML**

- **RuleML can express the DLP subset of OWL**
  - **DLP = Description Logic Programs knowledge representation**

- **Future Direction for Work: Use RuleML to express rules to do COIN-type reasoning**

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Use Rules for COIN Reasoning II

- **Challenge for Future – how to treat abductive reasoning, constraint handling rules in the context of the Semantic Web**

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MORE ABOUT COIN FOLLOWS

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COIN Motivation

- Distributed databases makes many disparate sources available.
- The web is making even more semi-structured sources available.
  -- With XML and Web Wrapping, these can be treated as databases.
- Schema integration addresses the problem of syntactic inconsistencies.
  -- i.e., differing structures.
- How do we address semantic inconsistencies.
  -- i.e., differing meanings.
  (e.g., what does “price” really mean?)

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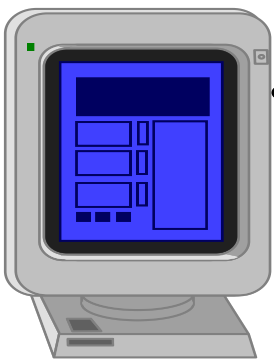
MIT Sloan COntext INterchange (COIN) Project

Appli-
cations

Receivers



Browsers

OUTPUT PROCESSING

ODBC Driver

Web - Publishing

CONTEXT MEDIATION

* Automatic conflict detection and conversion

- Source selection

TRUSTED AGENTS

INPUT PROCESSING

* Automatic web wrapping

- Semi-structured text

-Multi-source query plan and execution

Web Pages

Sources

Data bases

APPLICATIONS: Financial services, electronic commerce

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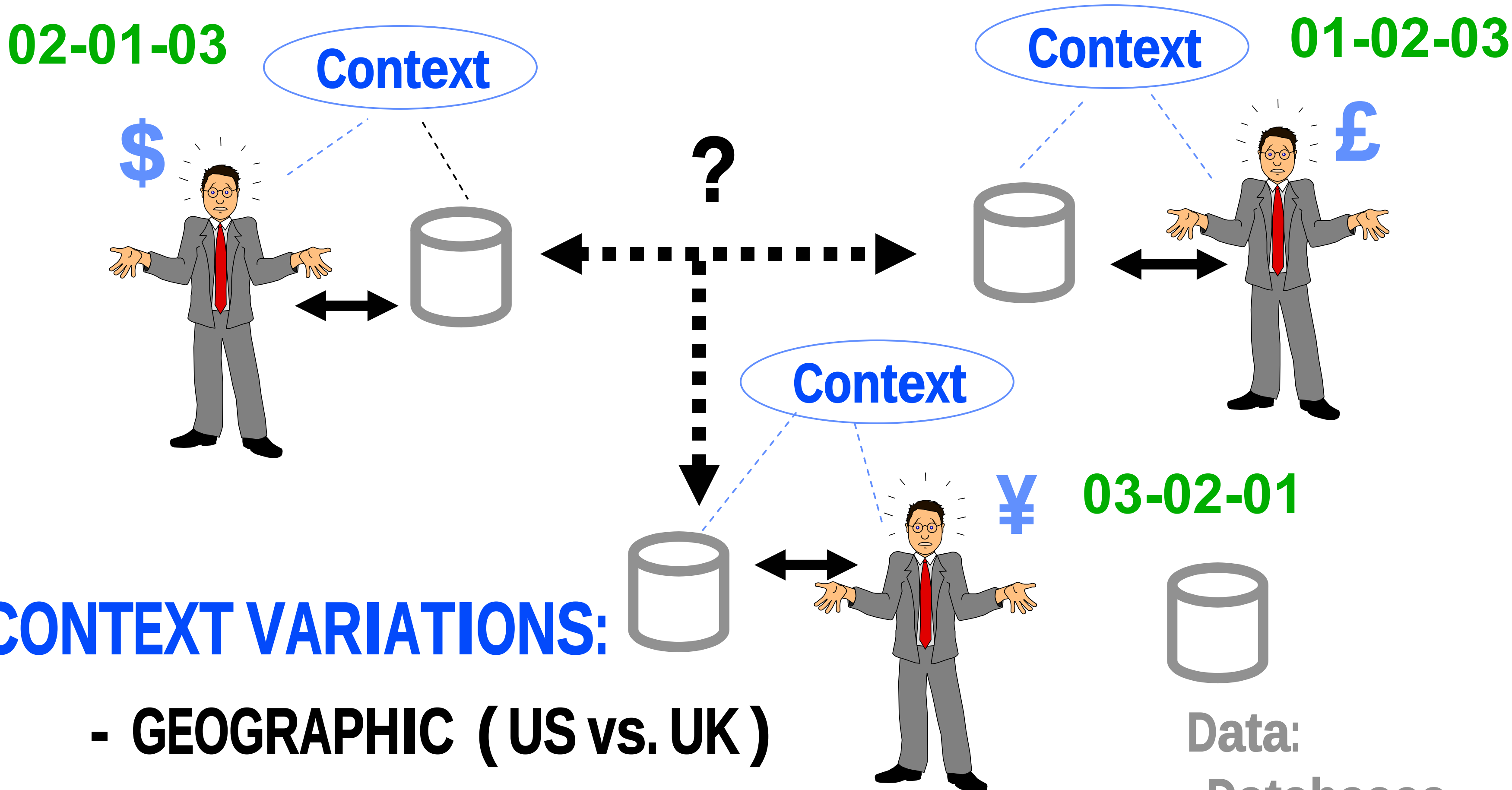
Role Of Context



- **CONTEXT VARIATIONS:**
  - GEOGRAPHIC (US vs. UK)
  - FUNCTIONAL (MARKETING vs. FINANCE)
  - ORGANIZATIONAL (CITIBANK vs. CHASE)

Data:
- Databases
- Web data
- E-mail

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Types of Context

Surface **Ontological**

Temporal

	Example	Temporal
Surface	Currency: $ vs € Scale factor: 1 vs 1000	Francs before 2000, € thereafter
Ontological	Revenue: Includes vs excludes interest	Revenue: Excludes interest before 1994 but incl. thereafter

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COIN - Summary

- Tremendous opportunity to gather and integrate information from many diverse sources
- But … need to overcome many context challenges
- Context-type "metadata" plays a critical role
- COIN technology can be an important aid for semantically meaningful information integration:
  - **- Scalable**
  - **- Extensible**
  - **- Application Domain Merging**
  - **- Reuse and extension of ontologies and contexts**

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COIN ONTOLOGICAL MODEL I

Main components are –

- Semantic Types
- Attributes
- Modifiers
- Contexts
- Conversion Functions
- Elevated Relations

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COIN ONTOLOGICAL MODEL II

Attributes and Modifiers

- **Properties of semantic types specified by attributes and modifiers.**

Attributes define the state of object or relationship between objects.

Example: "city" is an attribute of semantic type "location"

Modifiers are specialized attributes that take on different values in different contexts.

Example: "tempUnit" is a modifier of semantic type "temperature". It has value "celsius" in metric ctxt and "fahrenheit" in imperial ctxt.

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COIN ONTOLOGICAL MODEL III

Contexts and Elevation Axioms

Elevation Axioms relate the source relations to the domain model. Each primitive source database relation is mapped to a semantic relation.

Semantic Relations are obtained by mapping each primitive column to a semantic type in a particular context.

Example: In the context metric units, the primitive source relation column "city" is mapped to the semantic type "location" in the domain model.

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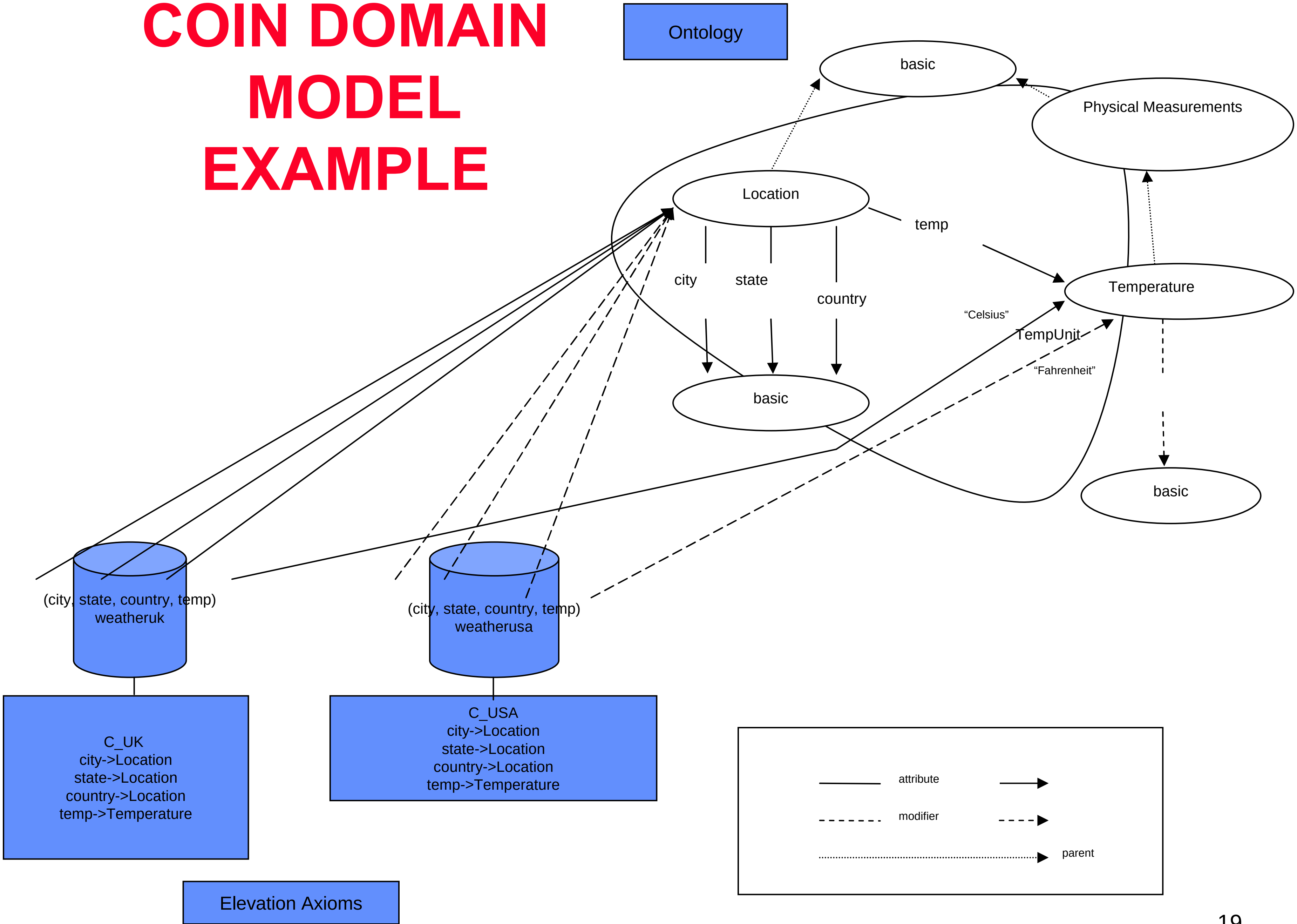
COIN DOMAIN MODEL EXAMPLE



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