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Knowledge Discovery from Disparate Earth Data Sources

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Motivation: Collaborative and Interdisciplinary e-Science

Available: large amounts of data in many application domains (e.g., global change and terrestrial ecology).

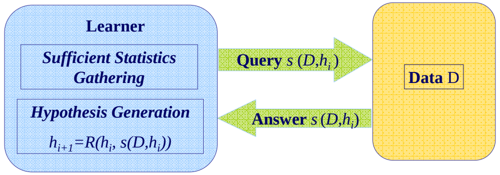
Opportunities: share data and findings between scientists working on related problems.

Challenges: large amounts of data; heterogeneous structure; different ontological commitments; constraints imposed by autonomous data sources.

Needed: knowledge discovery from large, autonomous, distributed and semantically heterogeneous data sources according to a user view.

Traditional Machine Learning Algorithms -- centralized access to data

Learning Classifiers from Data Revisited

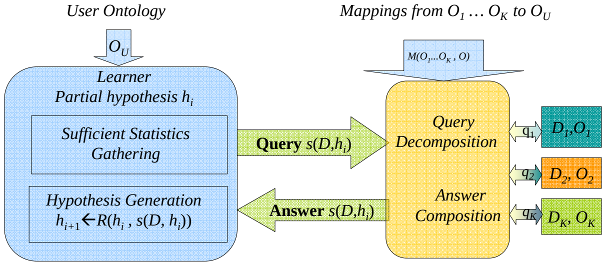


Sufficient Statistics

A statistic $s(D)$ is called a ***sufficient statistic*** for a parameter θ if $s(D)$ provides all the information needed for estimating the parameter θ from data D. We are interested in ***minimal sufficient statistics***.

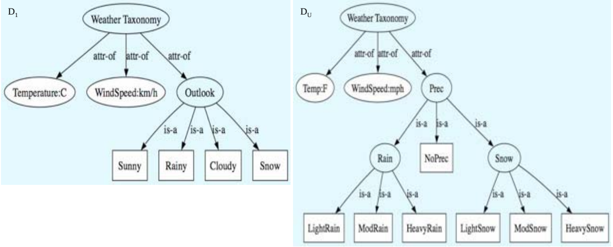
A statistic $s(D,h_i)$ is called a sufficient statistic for the ***refinement*** of a hypothesis h_i into h_{i+1} if there exists a refinement algorithm R that accepts h_i and $s(D,h_i)$ as inputs and outputs h_{i+1}.

Learning from Distributed, Semantically Heterogeneous Data



Ontologies

An ontology is a specification of objects, categories, properties and relationships used to conceptualize a domain of interest. Hierarchies (e.g., *isa* hierarchies) are a common type of ontologies. Hierarchies can be seen as orderings over a set of terms. Types of attributes that describe a data set can be defined as a hierarchical ontology.



Ontology-extended data sources

Let $A_1, A_2, \dots, A_n$ be the attributes of a data source and $\tau_1, \tau_2, \dots, \tau_n$ their types, We say that $\mathbf{D}=(D,S,O)$ is an *ontology-extended data source* if D is a data set, O is an ontology describing the content of the data D, $S=\{A_1{:}\,\tau_1, A_2{:}\,\tau_2, \dots, A_n{:}\,\tau_n\}$ is the data source schema and the following condition is satisfied: $D \subseteq \tau_1 \times \dots \times \tau_n$

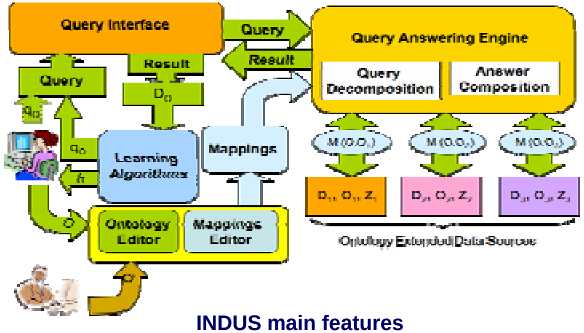
User view

A *user view* with respect to a set of ontology-extended data sources is given by a user schema and ontology and a set of semantic correspondences from data source meta-data to user meta-data.

Semantic correspondences

Schema level:	Ontology level:
Temperature : $D_1 \equiv$ Temp : D_U WindSpeed : $D_1 \equiv$ WindSpeed : D_U Outlook : $D_1 \equiv$ Prec : D_U	Rainy : $D_1 \equiv$ Rain : D_U Sunny : $D_1 \subseteq$ NoPrec : D_U Sunny & Cloudy : $D_1 \equiv$ NoPrec : D_U Rainy : $D_1 \supseteq$ LightRain : D_U Snow : $D_1 \supseteq$ Snow : D_U Etc.

INDUS: An Ontology-Based Approach to Information Integration and Knowledge Discovery from Distributed, Semantically Heterogeneous, Autonomous Data Sources



INDUS main features

- A clear distinction between data and the semantics of the data: makes it easy to define mappings from data source ontologies to user ontologies
- User-specified ontologies: each user can specify his or her ontology and mappings from data source ontologies to the user ontology; there is no single global ontology.
- A user-friendly ontology and mappings editor: this can be easily used to specify ontologies and mappings; however, a predefined set of ontologies and mappings are also available in a repository.
- Knowledge acquisition capabilities: machine learning algorithms can be easily linked to INDUS, making it an appropriate tool for information integration as well as knowledge acquisition tasks.

INDUS prototype: web address

http://www.cild.iastate.edu/software/indus.html

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