First Steps Toward a Digital Database of Aristotelian Diagrams

Wouter Termont, Lorenz Demey & Hans Smessaert

KU Leuven, Belgium

ARISTOTELIAN DIAGRAMS

= compact visualizations of a set of concepts or expressions, and certain **logical relations** holding among them

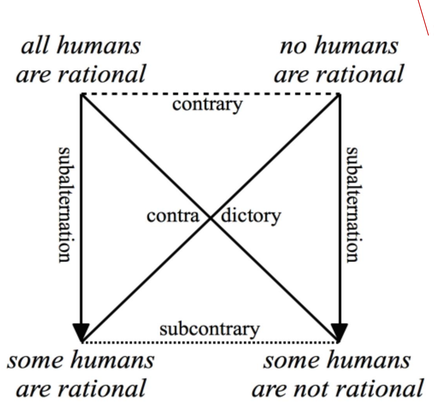
Contradiction ⇔ two terms cannot be true together and cannot be false together

Contrariety ⇔ two terms cannot be true together but can be false together

Subcontrariety ⇔ two terms can be true together but cannot be false together

Subalternation ⇔ one term entails a second, but not vice versa

➔ translate abstract subject matter into concrete visual/aesthetic space



Traditional square of opposition for the categorical statements from syllogistics

Historical importance

- Numerous applications in logic and philosophy
- Popularization of logic and its history.

Frege, Buridan, Reichenbach, Prior, Ockham

Square in Thomas van Zerclaere's epic poem *Der Wälsche Gast* (ca. 1420), as a visual metaphor for the discipline of logic.

Logical geometry

= research into Aristotelian diagrams as independent objects of study:

- *abstract-logical properties*
- *visual-geometrical properties*

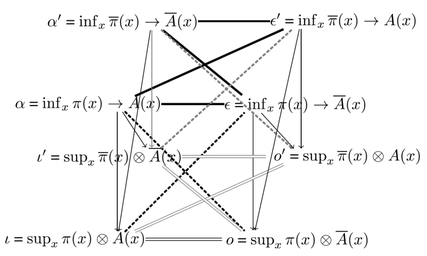
➔ **need for an empirical basis**

Diversifying usage

psychology, linguistics, legal theory, philosophy of religion, computer science

Frequent use in many disciplines concerned with logical reasoning
< ubiquity of logical relations

➔**interdisciplinary potential**



A cube of opposition in AI research on the knowledge representation formalism of graded possibility theory.

A DIGITAL DATABASE

- **Preservation** of cultural heritage
- **Empirical** base for logical geometry
- Interdisciplinary **accessibility**
- Field-specific **extendibility**
- **Comprehensive** range

1 SEMANTIC WEB TRIPLE STORAGE

- World Wide Web Consortium (**W3C**) standards
- Framework of data formats & exchange protocols to share, reuse & integrate structured knowledge in a semantic, machine-readable *Web of Data*

⚠ This "old idea slowly coming of age"(1) provides some advantages over the traditional ***relational database*** approach.

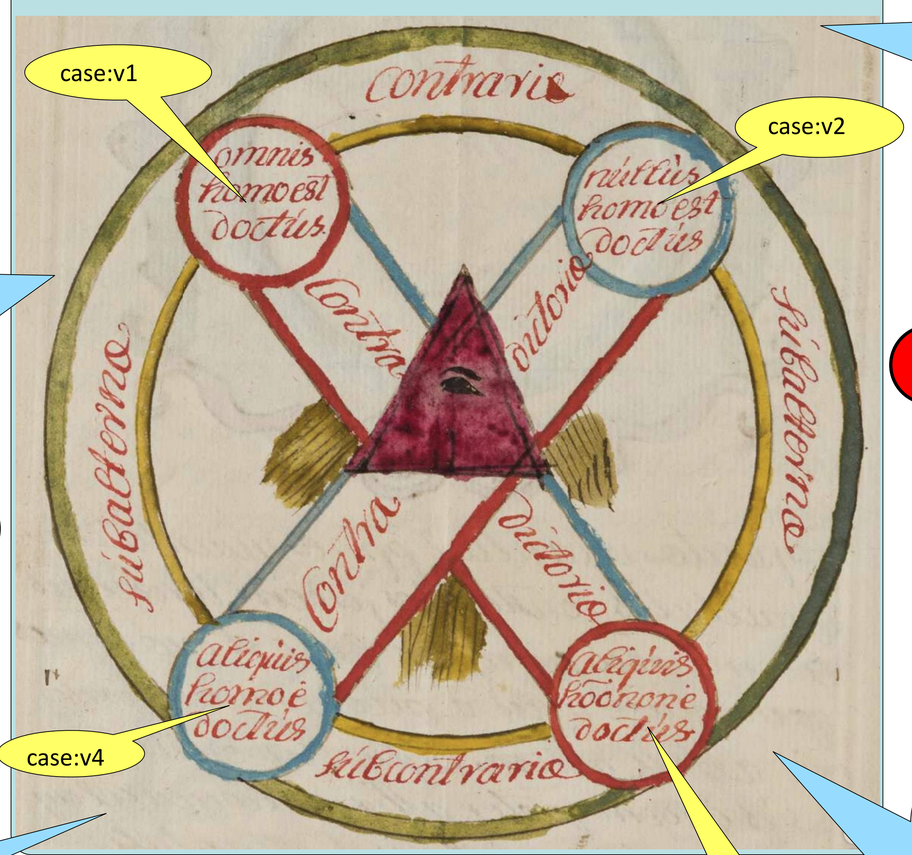
2 Internationalized Resource Identifiers (IRIs)

- Globally unique identification
  ➔ **fine-grained *external* references** ⚠
  ➔ basis for Linked (Open) Data
- E.g. URLs and URNs (DOI, ISSN …)

Prefixes allow for shorter notation:
let "lg:" stand for logicalgeometry.org/,
"lgd:" for lg:diagrams,
"lgs:" for lg:sources,
"lga:" for lg:authors …

CASE STUDY

Augustinus Vandungen's "circular" square of opposition



Store the case study diagram as lgd:vd1759ad1, shortened as the prefix "case:", the author as lga:vandungen, the source as lgs:vd1759a, the vertices as case:v1, case:v2 etc.

Also create IRIs for **annotation concepts :**
lg:AristotelianDiagram, lg:Circle, lg:Vertex …
and for **annotation properties :**
lg:shape, lg:contains, lg:subcontrary …

3 Resource Description Framework (RDF)

- Abstract language; multiple syntactic formats (2)
- Adds meta-terms rdf:type and rdf:Property
- All data stored as *triples of IRIs* or ***literals***

SUBJECT ===PROPERTY==> OBJECT

➔ Data forms the **computationally interesting** structure of a ***directed labeled graph*** ⚠

SUBJECT	PROPERTY	OBJECT
case:	rdf:type	lg:Arist…Diagram
case:	lg:shape	lg:Circle
case:	lg:complexity	'3'^^xsd:int
case:	lg:directed	false
case:	lg:artistic	true

Booleans, integers and tagged string literals

case:	lg:contains	case:v3
case:v3	lg:subcontrary	case:v4
case:v3	lg:label	'aliquis homo non est doctus'@la

4 RDF Schema (RDFS)

- Additional meta-terms for custom vocabularies and basic ontologies: rdfs:Class, rdfs:subClassOf …
- Meta-terms enhancing property resources: rdfs:domain, rdfs:range …

Promotes **reuse of existing vocabularies** ⚠

E.g. Friend of a Friend FOAF,
Dublin Core Metadata Initiative DCMI,
the Bibliographic Ontology BIBO

lg:Sigma2Diagram	rdfs:subClassOf	lg:Arist…Diagram
lg:Arist…Diagram	rdfs:subClassOf	lg:LogicalDiagram
lg:contains	rdfs:range	lg:Vertex
lg:contrary	rdfs:range	lg:Vertex
lg:contrary	rdfs:domain	lg:Vertex

case:	DCMI:source	lgs:vd1759
lgs:vd1759a	rdf:type	BIBO:Manuscript
lgs:vd1759a	DCMI:title	'Dialectica'@la
lgs:vd1759a	DCMI:created	1759
lgs:vd1759a	BIBO:isPartOf	md:
lgs:vd1759a	BIBO:locator	'ms. II 3212'
lgs:vd1759a	DCMI:creator	lga:vandungen
lga:vandungen	rdf:type	FOAF:person
lga:vandungen	FOAF:firstname	'Augustinus'
lga:vandungen	FOAF:lastname	'Vandungen'
md:	rdf:type	BIBO:Collection
md:	DCMI:title	'Magister Dixit'

5 The Web Ontology Language (OWL)

Additional meta-terms for complex ontologies (2)

- Identity assertions: e.g. owl:sameAs
  ➔ Allows for ***easy combination of information***
- ***Complex class descriptions with restrictions*** ⚠
- Property axioms: e.g. owl:SymmetricProperty
  - Local reuse with owl:import

Individual: case:v1
Fact: lg:contrary case:v2

ObjectProperty: lg:contrary
Characteristic: Symmetric

Individual: case:v2
Fact: lg:contrary case:v1

6 Automated Inference

- Semantic understanding by machine reasoners
  ➔ *semantics for* ***non-trivial inference*** *are* ***integrated in the semantic web approach*** ⚠
- Based on RDFS and OWL
  - Extended with ***rule-based languages*** (2)

case:	lg:contains	case:v1 … *(idem for v2, v3 & v4)*
case:v1	lg:contrary	case:v2
case:v1	lg:contradictory	case:v3
case:v2	lg:contradictory	case:v4

Rule: lg:AristotelianDiagram(?<*D*>),
lg:contains(?<*D*>,?<*a*>),
… *(idem for b, c and d)*
lg:contrary(?<*a*>,?<*b*>),
lg:contradictory(?<*a*>,?<*c*>),
lg:contradictory(?<*b*>,?<*d*>)
-> lg:ClassicalSigma2Diagram(?<*D*>)

case: rdf:type lg:ClassicalSigma2Diagram

(1) A characterization of the Semantic Web by the Pelagios Commons geodata comunity. (2) All basic RDF statements on this poster are simple triples; more complex ones are written in Manchester Notation.

More information? www.logicalgeometry.org; wouter.termont@kuleuven.be; lorenz.demey@kuleuven.be; hans.smessaert@kuleuven.be.

This research is supported through C1 project 3H180236 at KU Leuven and a Postdoctoral Research Fellowship of the Research Foundation - Flanders (FWO)