

**Interoperability among Distributed Overlapping Ontologies**  
**– A Fuzzy Ontology Framework**  
Muhammad Abulaish and Lipika Dey

Presented by: Bryant (Du Zhibin)



- Introduction
- Related work
- Mathematical definition
  - Ontology
  - Fuzzy Ontology
- Compute concept consistencies
- Conclusion



More and more people get involved in semantic web



Many individual ontologies are created



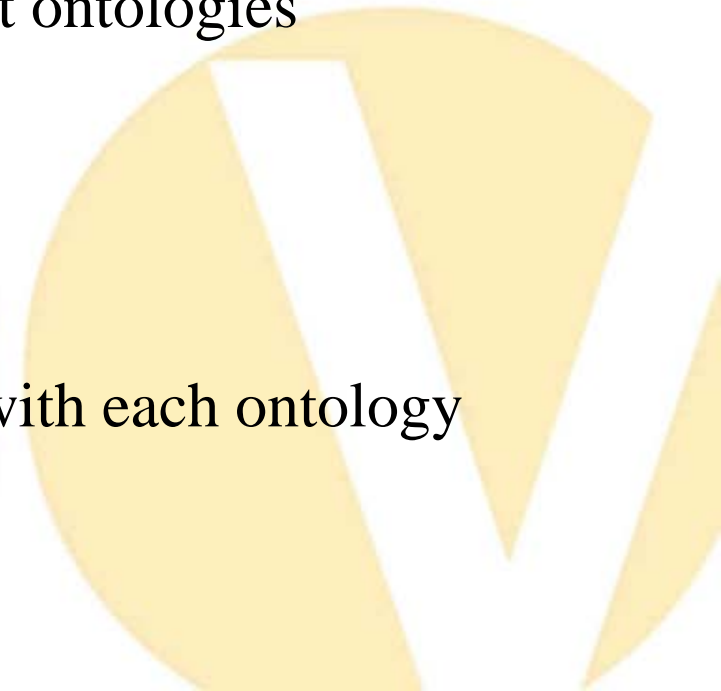
Interoperability among different ontologies



Ontology matching



Provide dissimilarities in definitions with each ontology



- Ontology Integration System
- GLUE
- KAON
- H-MATCH algorithm



$\Theta$  is defined as  $\Theta = (C, P, \mathfrak{R})$

Where

C: A set of concepts defined for the domain

P: A set of concept properties

For  $p \in P$ ,  $p(c, v, f)$  f can be type (ft), cardinality (fc), range (fr)

$\mathfrak{R}: \mathfrak{R} \subseteq C \times C \times R_T$

$R_T = \{\text{one-to-one, one-to-many, many-to-many}\}$

$\mathfrak{R}$  is recursively defined as:

a.  $\mathfrak{R}_a = \{\approx, \uparrow, \downarrow, \nabla, \Delta\}$

eg:  $C_i \approx C_j, C_i \uparrow C_j = C_j \downarrow C_i, C_i \nabla C_j = C_j \Delta C_i$

b. If  $\mathfrak{R}_1, \mathfrak{R}_2 \in \mathfrak{R}$  be any two relations defined between concept-pairs in  $\Theta$  and  $\circ$  denotes a composition operation,  $\mathfrak{R}_1 \circ \mathfrak{R}_2$  is a valid relation.

$\Theta_F$  is defined as  $\Theta_F = (C, P_F, \mathcal{R}_F, M)$

Where

C: A set of concepts defined for the domain

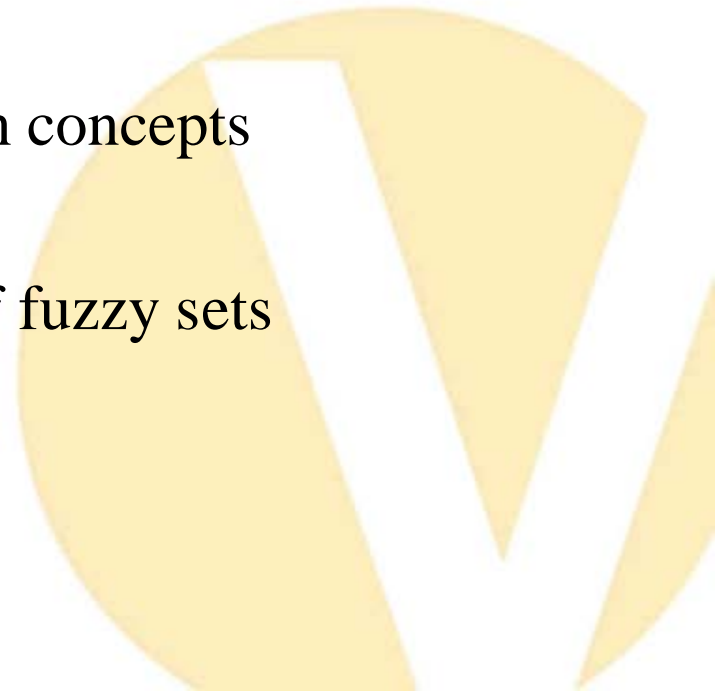
$P_F$ : A set of fuzzy concept properties

For  $p_f \in P_F$ ,  $p_f(c, v_f, q_f, f)$

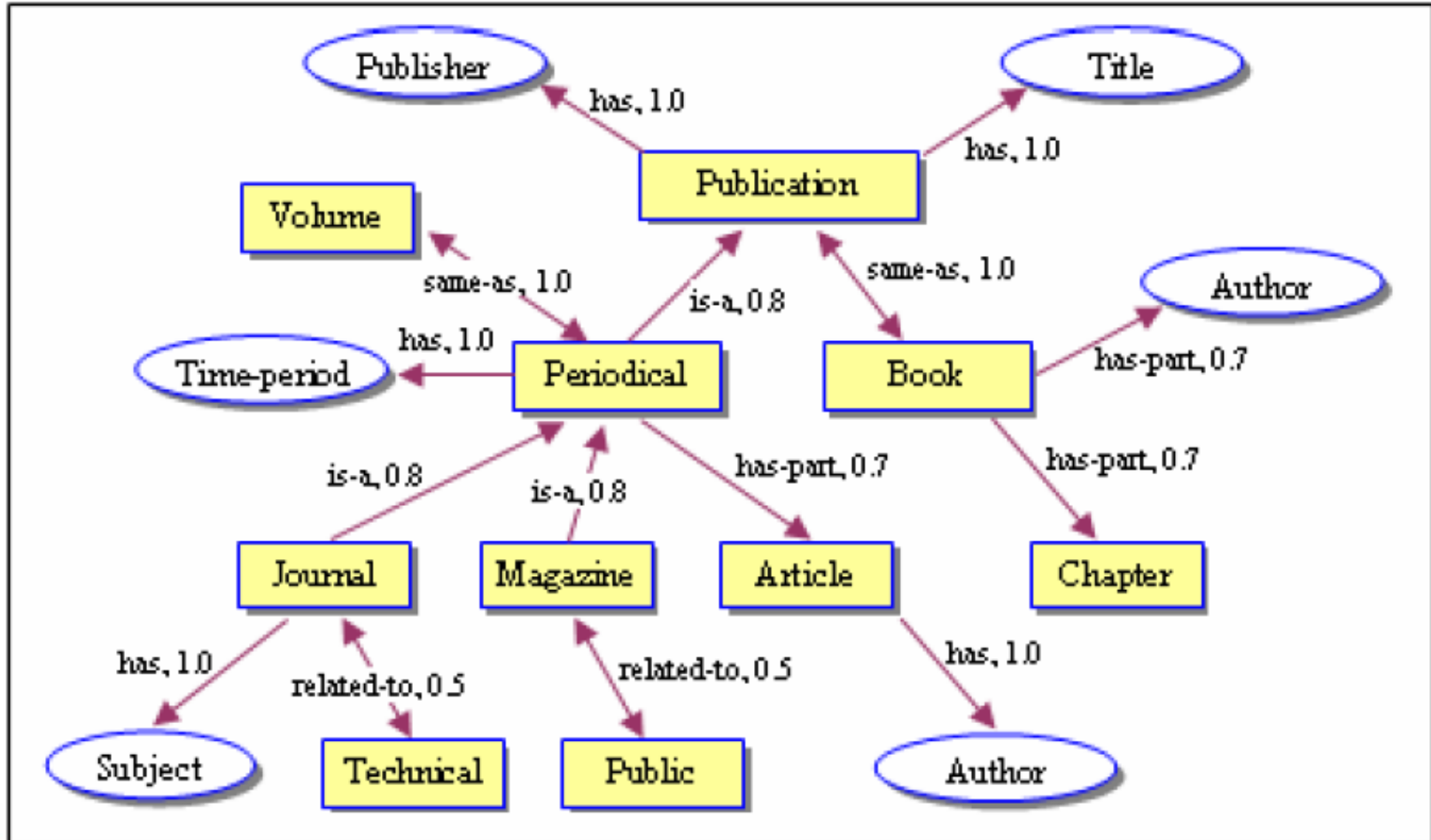
$\mathcal{R}_F$ : A set of inter-concept relations between concepts

$\mathcal{R}_F(c, c, t, q_f)$

M: Universe of discourse—A collection of fuzzy sets

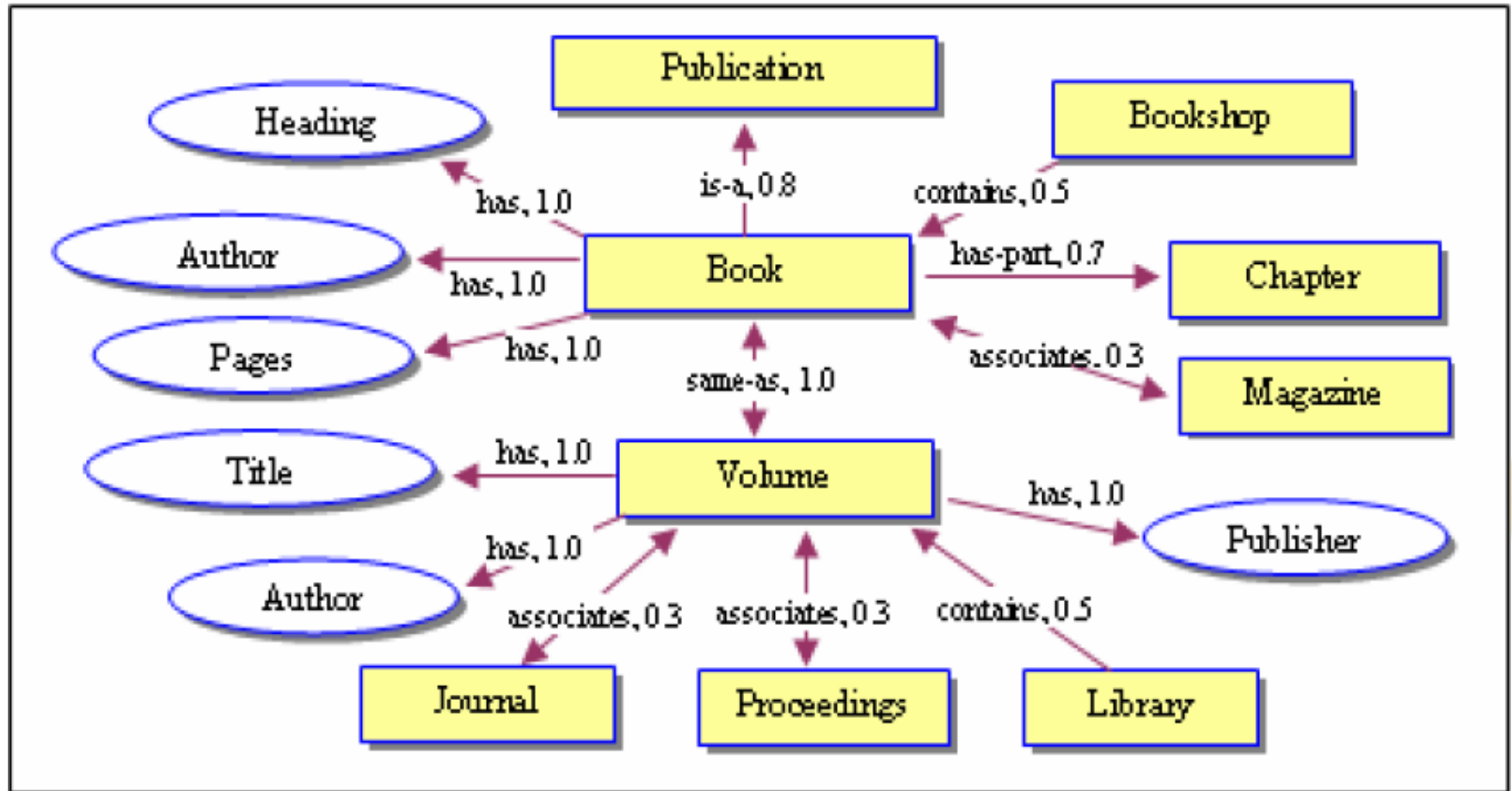


## Example of ontology



An ontology derived through WordNet to represent publication domain

## Example of ontology cont.



An ontology taken from [10] to represent publication domain

## Several interesting observations

- In Ont1 “Book” is described as synonymous to “Publication”, in Ont2 “Book” is described as a specialization of Publication”.
- In Ont1, the descriptor “Volume” is not applicable for describing a “book”, while in Ont2 a volume is defined as an equivalent concept to the concept “book”
- “Pages” is used as a property descriptor in Ont2; however “pages” was not obtained as a meronym when we fed “book” to WordNet 2.0.

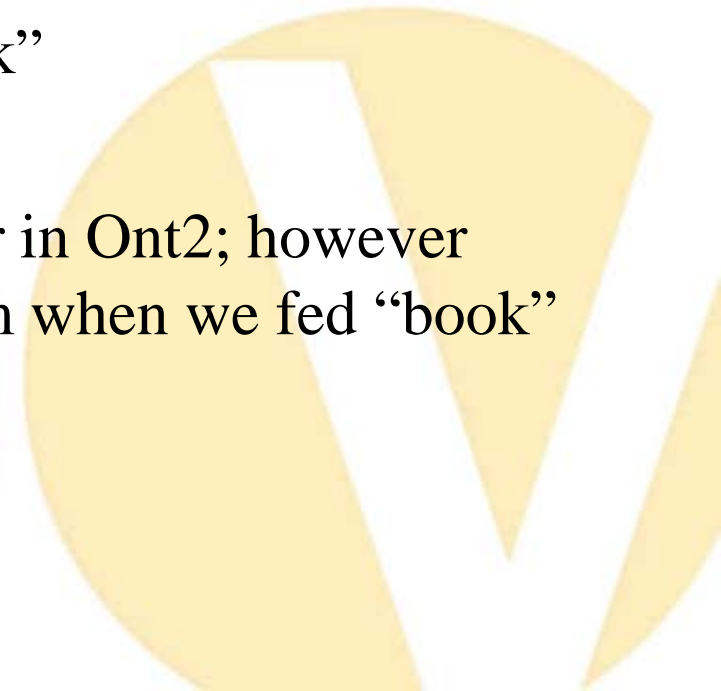


Table 1. Weights associated with linguistic and semantic relations

<b>Interpretation</b>	<b>Relation Name</b>	<b>Weight</b>
Linguistic	Synonym	1.0
	Hypernym/ Holonym	0.8
	Related term	0.5
Semantic	Property	1.0
	Same as	1.0
	Kind-of/ is-a	0.8
	Part-of/ Has-part	0.7
	Contains	0.5
	Associates	0.3

Concept affinity

$$CA(C_i, C_j) = \text{MAX}_{p \in P} \{ \text{Weight}(p) \}$$

Concept affinity for the related concept-pairs

$C_j$  co-occurs with  $C_i$  in more than one ontologies

$$\gamma(C_i, C_j) = \frac{N \times \sum_{p=1}^{N-1} \sum_{q=p+1}^N CA_p(C_i, C_j) \times CA_q(C_i, C_j)}{\binom{N}{2} \times \sum_{p=1}^N CA_p(C_i, C_j)}$$

$C_j$  co-occurs with  $C_i$  in a single ontology

$$\gamma(C_i, C_j) = \frac{CA(C_i, C_j)}{n}$$

Dependence of  $\zeta(C_i)$  on another concept  $C_j$

$$\zeta(C_i) = \frac{1}{|M_{ij}| + |S_{ij}|} \left[ \sum_{C_j \in M_{ij}} \gamma(C_i, C_j) + \sum_{C_j \in S_{ij}} \gamma(C_i, C_j) \right]$$

Table 2. Concept affinities between related concept-pairs in Ont1

Concepts & Properties → Concepts ↓	Publication	Publisher	Title	Volume	Periodical	Time Period	Book	Author	Journal	Magazine	Article	Chapter	Subject	Technical	Public
Publication	1.00	1.00	1.00	0	0	0	1.00	1.00	0	0	0	0.70	0	0	0
Volume	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0	0.70	0.70	0	0	0
Periodical	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0	0.70	0	0	0	0
Book	1.00	1.00	1.00	0	0	0	1.00	1.00	0	0	0	0	0	0	0
Journal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0.70	0.70	1.00	0.50	0
Magazine	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	1.00	0.70	0.70	0	0	0.50
Article	0	0	0	0	0	0	0	1.00	0	0	1.00	0	0	0	0
Chapter	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0
Technical	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0	0.35	0.35	0.50	1.00	0
Public	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0	0.50	0.35	0.35	0.50	0	1.00

Table 3. Concept affinities between related concept-pairs in Ont2

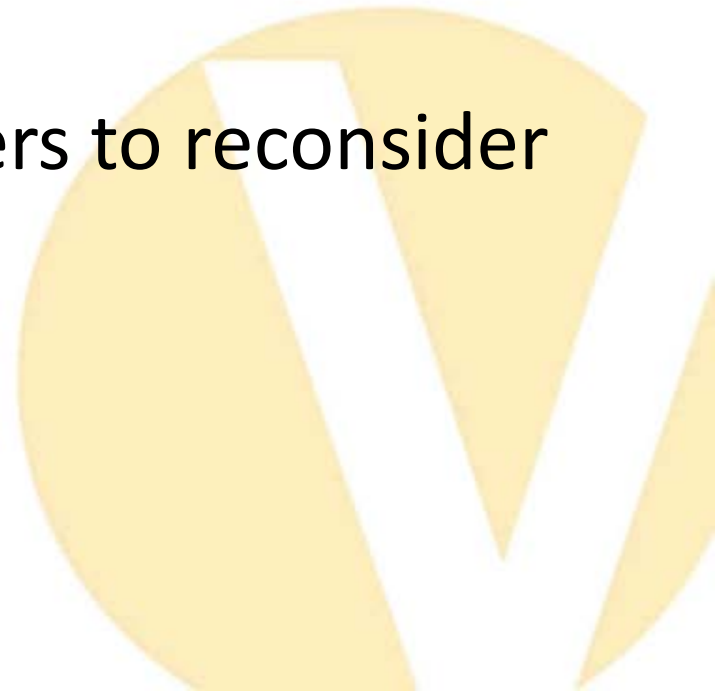
Concepts & Properties → Concepts ↓	Publication	Book	Bookshop	Chapter	Magazine	Heading	Author	Page	Volume	Publisher	Library	Proceedings	Journal	Title
Publication	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0
Book	1.00	1.00	0	0.70	0.30	1.00	1.00	1.00	1.00	1.00	0	0.30	0.30	1.00
Bookshop	0	0.50	1.00	0.35	0.15	0.50	0.50	0.50	0.50	0.50	0	0.15	0.15	0.50
Chapter	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0
Magazine	0.30	0.30	0	0.21	1.00	0.30	0.30	0.30	0.30	0.30	0	0.09	0.09	0.30
Volume	1.00	1.00	0	0.70	0.30	1.00	1.00	1.00	1.00	1.00	0	0.30	0.30	1.00
Library	0.50	0.50	0	0.35	0.15	0.50	0.50	0.50	0.50	0.50	1.00	0.15	0.15	0.50
Proceedings	0.30	0.30	0	0.21	0.09	0.30	0.30	0.30	0.30	0.30	0	1.00	0.09	0.30
Journal	0.30	0.30	0	0.21	0.09	0.30	0.30	0.30	0.30	0.30	0	0.09	1.00	0.30

Table 4. Concept consistency values for the concepts in Ont1 and Ont2

<b>Concept</b>	<b>Consistency Value</b>	<b>Concept</b>	<b>Consistency Value</b>
Publication	0.39	Volume	0.63
Periodical	0.47	Book	0.64
Journal	0.39	Magazine	0.38
Article	0.50	Chapter	1.00
Technical	0.26	Public	0.26
Bookshop	0.22	Library	0.22
Proceedings	0.16		

Every application is free to pursue its own ontology

Have a global idea allows users to reconsider their ontologies



Thank you!

