



An Ontology for Classification Criteria

Mónica Martínez , Regina Motz
{mmartine,rmotz}@fing.edu.uy

Instituto de Computación
Universidad de la República
Uruguay



Motivation

- Classify elements of a domain
- To obtain....
 - Behaviour of the elements in terms of a criterion
 - Compare behaviour of different elements
- Use of an Ontology allows
 - Consistency of definitions
 - Classify instances of the domain



Goals

- Guidelines for the construction of the ontology
- Discuss ontology design alternatives
 - Define an ontology DL (computability)
 - Use of reasoner
 - Modeling with Classes (criteria) and instances (domain elements)



Organization

- Classification criteria
- Ontology Design
- Example
- Conclusions and Future Work



Classification Criteria – Metrics

Fenton 1991 – Software Metrics: A Rigorous Approach

- Nominal Form
 - Attribute value – Disjoint categories
 - Eg. Marital status
- Ordinal Form
 - Comparable categories
 - Eg. Very High, High, Low, Very Low

WOMSDE 2006 - An Ontology for Classification Criteria

5



Classification Criteria – Metrics

- Interval Form
 - Degree of fulfillment of a condition
 - Eg. Bibliographic references in documents
- Functional Form
 - Values in a set of properties
 - Eg. Combinations of functions versus individual functions

WOMSDE 2006 - An Ontology for Classification Criteria

6



Classification Criteria

Metrics

Criteria

- Nominal Form
 - Ordinal Form
- } → Value Criteria
- Interval Form → Affinity Criteria
 - Functional Form → Functionality Criteria

Global Criteria

WOMSDE 2006 - An Ontology for Classification Criteria

7



Ontology Design

- Priorities:
 - OWL – DL (computability)
 - Model simplicity
- DOMAIN Class – set of elements to classify
- Properties for each element characteristic

WOMSDE 2006 - An Ontology for Classification Criteria

8



Ontology Design

- Classes for each criterion
 - Subclasses – Element partition
- Global classification class – DomGlobal
 - Subclasses – Possible global results



Affinity Criteria

- Fulfillment of a property percentage
- 1st Proposal:
 - Degree of property of an individual to a class
 - FUZZY ONTOLOGIES
 - **Problem:** Fuzzy in class hierarchy, not in the membership of individuals to classes



Affinity Criteria

2nd Proposal

Percentages $\longrightarrow$ Mathematical calculations over relationship corresponding

Problem:

Not expressible in OWL – DL

Extensions – Concrete Domains

Concrete types predicates (Eg. Sums, divisions)

WOMSDE 2006 - An Ontology for Classification Criteria

11



Affinity Criteria

o 3rd Proposal

- Partition range of the base property in subsets (discrete)
- Element in a subclass if all the corresponding are of the same range
- $\text{DomRange}_i \equiv \text{Domain} \sqcap \forall \text{Prop Range}_i \sqcap \exists \text{Prop Range}_i$

WOMSDE 2006 - An Ontology for Classification Criteria

12



Affinity Criteria

○ Problem:

- Closed world assumption / Open world assumption
 - Universal restrictions
 - Relationship elements



Affinity Criteria

○ 4th Proposal

- Eliminate universal restrictions
- Functional relationships
- Range of functions representing the “percentages”
- External functions for calculations



Affinity Criteria

- DomAC Class
- Ranges Class –
 - Individuals : high, tendsToHigh, ..., low, null
- ACProp : Dominio $\rightarrow$ Ranges (functional)



Affinity Criteria

- DomAC subclasses:
 - ValueAC-high $\equiv$ Domain $\sqcap$ ACProp $\exists$ high
 - ValueAC-tHigh $\equiv$ Domain $\sqcap$ ACProp $\exists$ tendsToHigh
 -
 - ValueAC-low $\equiv$ Domain $\sqcap$ ACProp $\exists$ low



Value Criteria

- Property value classification
- Idem affinity criteria development
- Discriminator Class - Property range
 - Discrete
 - Individuals – elements of the range ($v_1, v_2 \dots$)

WOMSDE 2006 - An Ontology for Classification Criteria

17



Value Criteria

- $VCProp : Domain \rightarrow Discriminator$ (functional)
- DomVC Class
- DomVC Subclasses– each Discriminator value:

$$ValorVC-v_i \equiv Domain \sqcap VCProp \ni v_i$$

WOMSDE 2006 - An Ontology for Classification Criteria

18



Functionality Criteria

- Combination of property values classification
- Each property – Value criteria
 - RangeProp_i-FC
 - Prop_i-FC : Domain → RangeProp_i-CF (functional)



Functionality Criteria

- Levels – property values combination
- DomFC Class
- DomFC Subclasses – each level:

$$\text{FC-Level}_i \equiv \text{Domain} \sqcap \text{Prop1FC} \exists vi_1 \sqcap \\ \text{Prop2FC} \exists vi_2 \sqcap \dots \sqcap \text{PropNFC} \exists vi_n$$



Global Criteria

Classification based on ALL the defined criteria

Categories: High, Intermediate and Low for each criteria

Global Criteria: Good, Intermediate, Bad



Global Criteria

$\text{DomAC_High} \equiv \text{ValueAC-high} \sqcup \text{ValueAC-Thigh}$

$\text{DomAC_Intermediate} \equiv \text{ValueAC-InHi} \sqcup \text{ValueAC-InLo}$

$\text{DomAC_Low} \equiv \text{ValueAC-low} \sqcup \text{ValueAC-null}$

$\text{DomAC} \equiv \text{DomAC_High} \sqcup \text{DomAC_Intermediate} \sqcup \text{DomAC_Low}$



Global Criteria

- DomGlobal $\equiv$ GIGood $\sqcup$ GIBad $\sqcup$ GIIntermediate
 - GIGood $\equiv$ DomAC_High $\sqcap$ DomVC_High $\sqcap$ DomFC_High
 - GIBad $\equiv$ DomAC_Low $\sqcap$ DomVC_Low $\sqcap$ DomFC_Low
 - GIIntermediate
- Complement Enumeration

WOMSDE 2006 - An Ontology for Classification Criteria

23



Use of the Ontology

- Define individuals in the Domain class (properties)
- Determine element type
- Determine class elements

WOMSDE 2006 - An Ontology for Classification Criteria

24



Example

Document classification

Criteria:

- * Previous Publications (existence and type)
- * Academic level of the author
- * Recent references
- * External references

Domain = Documents

WOMSDE 2006 - An Ontology for Classification Criteria

25



Criteria : Previous Publications

- o Value Criteria
- o $\text{PubType} \equiv \{\text{chapterBook}, \text{magazine}, \text{conf}, \text{other}, \text{notPub}\}$
- o $\text{PubPrev} : \text{Documents} \rightarrow \text{PubType}$ (functional)
- o $\text{AutCBook} \equiv \text{Documents} \sqcap \text{PubType} \ni \text{chapterBook}$
- o $\text{AutMag} \equiv \text{Documents} \sqcap \text{PubType} \ni \text{magazine}$
- o $\text{AutConf} \equiv \text{Documents} \sqcap \text{PubType} \ni \text{conf}$

WOMSDE 2006 - An Ontology for Classification Criteria

26



Criteria : Previous Publications

- $\text{AutOther} \equiv \text{Documents} \sqcap \text{PubType} \sqsupset \text{other}$
- $\text{AutIni} \equiv \text{Documents} \sqcap \text{PubType} \sqsupset \text{notPub}$
- $\text{DocPPHigh} \equiv \text{AutCBook} \sqcup \text{AutMag}$
- $\text{DocPPIntermediate} \equiv \text{AutConf}$
- $\text{DocPPLow} \equiv \text{AutOther} \sqcup \text{AutNull}$
- $\text{DocPP} \equiv \text{DocPPHigh} \sqcup \text{DocPPIntermediate} \sqcup \text{DocPPLow}$

WOMSDE 2006 - An Ontology for Classification Criteria

27



Criteria : Academic Level

- Functionality Criteria (degree, initial, evaluator)
- Classes
 - $\text{Degrees} \equiv \{\text{degree}, \text{graduate}, \text{student}, \text{nothing}\}$
 - $\text{Boolean} \equiv \{\text{Yes}, \text{No}\}$

WOMSDE 2006 - An Ontology for Classification Criteria

28



Criteria : Academic Level

○ Properties

- GrAuthor: Documents → Degrees (functional)
- RfAuthor: Documents → Boolean (functional)
- EvAuthor : Documents → Boolean (functional)

○ Levels – Weighting of the properties

WOMSDE 2006 - An Ontology for Classification Criteria

29



Criteria : Academic Level

GrAuthor	RfAuthor	EvAuthor	Level
Degree	Yes	Yes	1
Graduate	Yes	No	1
Graduate	Yes	Yes	1
Student	Yes	Yes	2
Degree	Yes	No	2
Graduate	No	Yes	2

WOMSDE 2006 - An Ontology for Classification Criteria

30



Criteria : Academic Level

- $\text{AutL1} \equiv \text{AutL11} \sqcup \text{AutL12}$
- $\text{AutL11} \equiv \text{Documents} \sqcap \text{GrAuthor} \wp \text{degree} \sqcap \text{RfAuthor} \wp \text{Yes} \sqcap \text{EvAuthor} \wp \text{Yes}$
- $\text{AutL12} \equiv \text{Documents} \sqcap \text{GrAuthor} \wp \text{graduate} \sqcap \text{RfAuthor} \wp \text{Yes}$
- (5 levels)

WOMSDE 2006 - An Ontology for Classification Criteria

31



Criteria : Academic Level

- $\text{DocALHigh} \equiv \text{AutL1} \sqcup \text{AutL2}$
- $\text{DocALIntermediate} \equiv \text{AutL3}$
- $\text{DocALLow} \equiv \text{AutL4} \sqcup \text{AutL5}$
- $\text{DocAL} \equiv \text{DocALHigh} \sqcup \text{DocALIntermediate} \sqcup \text{DocALLow}$

WOMSDE 2006 - An Ontology for Classification Criteria

32



Criteria: Global

- DocGlobal $\equiv$ GIGood $\sqcup$ GIBad $\sqcup$ GIIntermediate

GIGood $\equiv$ DocPPHigh $\sqcap$ DocALHigh

GIBad $\equiv$ DocPPLow $\sqcap$ DocALLow

GIIntermediate (Enumeration)



Classification of documents

- Creation of individuals of class Documents ($d_1, d_2, \dots, d_p$)
- Function corresponding:
 - PubType, GrAuthor, RfAuthor, EvAuthor
- Determination of individuals type /
Determination of elements in Global classes
and/or each criteria



Conclusions

- Specification different kind of criteria
- Guidelines for the development of the ontology
 - Design alternatives
 - OWL – DL
 - Manipulation of individuals – current reasoners



Future Work

- Experimental validation
 - DocWebQuali Prosul Edital CNPq Project
- Closed world representations
 - Reification
- OWL Extensions