# Ontology Consumer Analysis Tool Onto*CAT*

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# Agenda

- Motivation
- Perspectives on Ontology Evaluation
- Some Current Approaches
- Ontology Consumer Analysis Tool
- Some Evaluations Using OntoCAT
- Summary
- Future Plans

### Motivation

- Ontologies the "backbone of the Semantic Web"
- Development and deployment of ontology-based software solutions requires considerable time and effort
- Numerous existing ontologies in libraries available on the WWW
- Why reinvent the wheel? Reuse of ontologies important to SW success

# What is ontology evaluation?

- Ontology evaluation key problem in the field of ontology development and reuse.
- Selection vs. Evaluation
  - Two separate tasks?
  - How related?
  - When does it occur?
  - Selection → Evaluation?
     Evaluation→Selection?
  - Ontology Selection: Ontology Evaluation on the Real Semantic Web (Sabou, Lopez, Motta, Uren EON 2006)

# What kinds of selection criteria?

### Popularity

- metrics account solely for the links between different ontologies.
- same principle as Web search engines, often use a modified version of the PageRank algorithm.
- Semantic data richness
  - determine richness of the ontology's conceptualization
- Topic coverage
  - level to which ontology covers a certain topic.
  - ontology concept labels compared to a set of query terms representing the domain.

### What are we evaluating?

- From U.S. National Center for Ontology Research (NCOR) position paper at EON 2006:
  - well-defined ontology design techniques, i.e.,
    - quality of design
  - principled measurement methods, i.e.,
    - quality of evaluation
  - higher quality ontologies, i.e.,
    - quality of content

### **Earlier Approaches to Evaluating Ontologies**

- One-T [Bouillon et al 2002] :
  - Ontology Group at Universidad Politécnica de Madrid (UPM)
  - Content for completeness, consistency and correctness
- OntoClean [Guarino and Welty 2002] :
  - The Ontology Group at the Italian National Research Council (CNR).
  - Methodologies to evaluate during its entire lifetime,
  - Formal analysis of taxonomies

### **Earlier Approaches to Evaluating Ontologies**

- **ONTOMETRIC** [Lozano-Tello & Gómez-Pérez 2004]
  - Ontology Group at Universidad Politécnica de Madrid
  - method to quantify the suitability of ontologies for the users' systems,
    - uses a taxonomy of 160 ontology characteristics,
      - Content, language, development methodology, built by software tool, cost of use.
    - not fully automated, based on AHP (Saaty 1977)
    - drawback is its usability: complicated and time-consuming to specify characteristics of an ontology and assessing some characteristics is subjective.
- Application Use of ontology to assess application's performance, merits of
  - competency questions, use cases, scenarios

### **Consumer Perspective Approach**

- Noy [2004] suggests for ontology re-use need more research from consumer perspective
  - Somewhat analogous to reviewing Table of Contents and Index, number of pages, etc. for the usefulness of book before deciding whether to check out or purchase.
  - ontology summarization, e-pinions for ontologies, views
- AKTiveRank [Alani and Brewster 2005]
  - AKT (Advanced Knowledge Technologies) consortium of British universities: <u>Southampton</u>, Edinburgh, Aberdeen, Sheffield and The Open University.
  - ranks ontologies retrieved by an ontology search engine based on set of query terms and measures
- OntoQA Analysis tool [Tartir 2005]
  - LSDIS (Large Scale Distributed Information Systems) Lab, University of Georgia
  - analyzes ontology schemas and their populations and describes them through a set of metrics.

### **AKTiveRank**

- Ranks ontologies retrieved by search engine (EON 2005)
  - Class match: coverage of query terms
  - Centrality: more central a class
  - Density: degree of details
  - Semantic similarity measure: closeness of classes
  - Produces overall rank
- Extensions (2006 EON, Protégé Conference, ISWC)
  - Collect vocabulary for domain interest
  - Ranking based on number of class labels that match with terminology for domain of interest, parameterized partial vs. exact match
  - New Centrality using JUNG's "betweenness" measure Elinimated original Centrality measure since somewhat redundant with Density

# **Ontology Consumer Analysis Tool**

- Envision as another tool that may be used to further analyze and compare after selecting set of ontologies that are potential candidates
- Currently working on methods to become more "Consumer oriented"
  - summarizations of and combinations of the various metrics
  - Visualization of various metrics to help consumer understand result comparisons

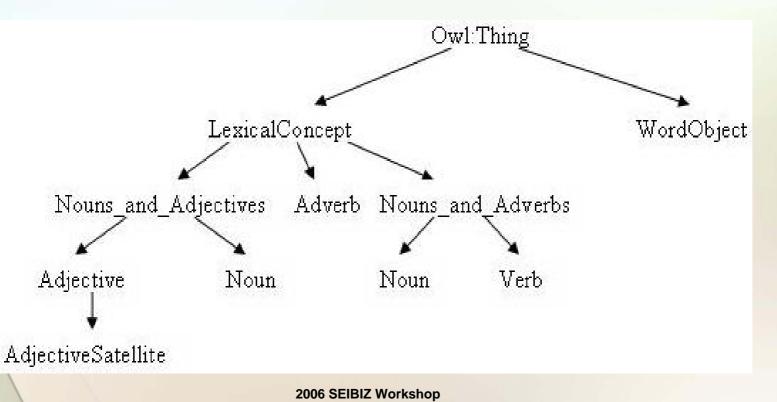
# **Ontology Consumer Analysis Tool**

- plug-in for OWL Protégé
- very parameterized
  - Intensional and extensional
  - View metrics interested in
    - Size
    - Structure
  - User selectable root for analysis
  - User selectable relation for establishing extensional structure

## WordNet

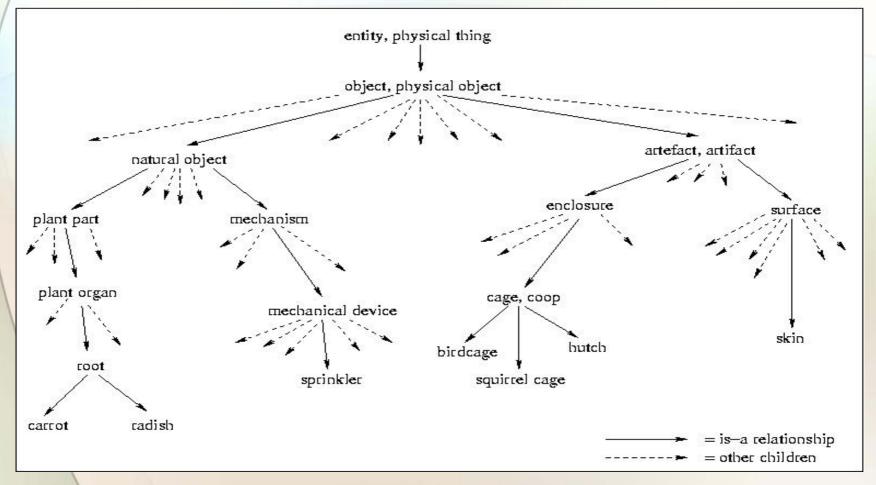
Princeton University
Terminological ontology of English
Organizes nouns, verbs, adjectives and adverbs into synonym sets

•Simple intensional structure: 10 classes



### WordNet

- Complex extensional structure based on hypernymOf /hyponymOf
- Example Root Instance "entity, physical thing", one of the nine noun roots



# **Ontology Consumer Analysis Tool**

- Metrics categorized into
  - Intensional: Measures on definition (classes)
  - Extensional: Measures actual occurrences (instances)
  - Size and Structural
- Summary
  - Hub Concepts
    - Concepts with maximum links in & out
  - Root Concepts

### **Onto CAT User Interface**

vordnet171 Protégé 3.1.1 (file:\C:\Anindita\OWLProjects\wordnet\wordn	et171.pprj, OWL Files (.owl or .rdf))	
<u>File Edit Project QWL Code Window Tools H</u> elp		
		prote
🥌 OWLClasses 🛛 🔳 Properties 📄 🚍 Forms 🖌 🔶 Individuals 🖌 🔶 Metadata 🖌 Relation Up	dater Ontology Metrics	
Intensional          Intensional         ALL         SIZE         iCnt(Cls)         iCnt(Property)         iCnt(Relation)         iPer(PtoC)         iCnt(Leaf)	Hub Concepts       Intensional       Extensional         Intensional       10       ✓         # of Links       Protege ID       Depth       Width       # of Parents       # of Children       # of Propety	IC
iPer(RtoC)       iPer(RtoP)         Min/Max Property       Depth         Avg       Min/Max         IC @ depth       Avg         Total       Avg         Min/Max       Width         Win/Max       Width		
Extensional  ALL  SIZE Min/Max Occu  eCnt(Root) eAvg(Leaf)	Extensional     10       # of Links     Protege ID       Depth     Width       # of Parents     # of Children	IC
eCht(Occu)     eAvg(Occu(C))     eCht(Ceaf)     Min/Max Leaf     eCht(Ceaf)     Min/Max Cecu(R))     eAvg(Occu(R))     Avg     Min/Max		
IC @ depth     Image: Avg     Min/Max       Total     Avg     Min/Max       Min/Max     Width @     Image: Avg		
Metrics Report 🔀 🔛		
	LexicalConcept # of Links Protege ID Depth Width # of Parents # of Children IC	

### **Ontology Analysis Tool**

wordnet171 Protégé 3.1.1 (file:\C:\Ani	ndita\OWLProjects\wordnet\wordnet171.p
ile <u>E</u> dit <u>P</u> roject <u>O</u> VVL <u>C</u> ode <u>Wi</u> ndow Tool:	s <u>H</u> elp
]CB 488 244	?• • • • • • • • • • • • • •
OWLClasses     Properties     Forms     Intensional     ALL     SIZE     iCnt(Cls) iCnt(Property)     iCnt(Relation) iPer(PtoC)     iPer(RtoC) i Per(RtoP)     Min/Max Property     IC @ depth     Total     Avg     Min/Max	Individuals       Metadata       Relation Updater         Image: Structural structura structural stru
Extensional ALL SIZE Min/Max Occu eCnt(Occu) eAvg(Occu(C)) Cocu(C)) eAvg(Occu(R)) Min/Max Occu(R) IC @ depth	STRUCTURAL eCnt(Root) eAvg(Leaf) eCnt(Leaf) Min/Max Leaf Depth Avg Min/Max Vvidth Avg Min/Max
Total Avg     Min/Max  Metrics Report S	Z Workshop

### **Onto CAT Buttons**

- Metrics Button
  - Display result of selected metrics
- Report Button
  - Report result of selected to file



- Generate tree of hub concept to visualize
- Click hub for individual hub visualization

### **Onto** Cat Selection Class/Extensional Relation

vordnet171 Protégé 3.1.1 (file:\C:\Anir	ndita\OWLProjects\wordnet\wordnet17	'1.pprj, OWL Files (.owl or .rdf))	
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🧶 OWLClasses 🔳 Properties 🗧 Forms 🔶	Individuals 🔶 Metadata Relation Updater	Ontology Metrics	
Intensional ALL SIZE		Hub Concepts Intensional Extensional Intensional 10	
SIZE  iCnt(Cls)  iCnt(Relation)  iPer(PtoC)  iPer(RtoC)  Min/Max  IC @ depth  Cotal  Avg  Min/Max	STRUCTURAL         iCnt(Root)         iCnt(Leaf)         Depth         Avg         Winth         Avg         Winth         Vvidth         Winth @	# of Links       Proteoe ID       Depth         Cls and Relation Selector       SELECT A CLS         Adjective       AdjectiveSatellite         Adverb       LexicalConcept         Noun       Nouns_and_Adjectives	Width       # of Parents       # of Children       # of Propety         1.0       0.052         0.5       0.684         antonymOf       0.684         attributeRel       1.0         causedBy       1.0         entailsTo       1.0         groupWith       1.0         hypernymOf       1.0
Extensional ALL SIZE MinMax Occu eCnt(Occu) eAvg(Occu(C)) Cocu(C)) eAvg(Occu(R)) MinMax Occu(R)	□ STRUCTURAL         ✓ eCnt(Root)       ✓ eAvg(Leaf)         ✓ eCnt(Leaf)       ✓ Min/Max Leaf         □ Depth       □ Avg         □ Avg       Min/Max	Nouns_and_Verbs Verb WordObject	hyponymOf mHolonym pHolonym pMeronym participleOf pertainsTo eHelenum
IC @ depth Total Min/Max	☐ Width ☐ Avg ☐ Min/Max ☐ Width @		

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### **Onto CAT Intensional Report**

cepts

Intensional Extensional

ALL SIZE	
iCnt(Cls)     iCnt(Property)     iCnt(Relation)     iPer(PtoC)     iPer(RtoC)     iPer(RtoP)     Min/Max Property	iCnt(Root) iCnt(Leaf) iPer(LtoC) Depth Avg Min/Max
IC @ depth     2       Total     Avg       Min/Max	Vidth Avg Min/Max Width @ 2
ALL  SIZE  Cont(Occu)  Cont(Occu(C))  Min/Max Occu(C))  Althorematical Avg(Occu(C))  Althorematical Avg(Occu(R))  Cont(Occu(R))  Cont(Occu(R	STRUCTURAL ✓ eCrt(Root) ✓ eAvg(Leaf) ✓ eCrt(Leaf) ✓ Min/Max Leaf Depth Avg Min/Max
C @ depth Total MinMax	Width       Avg       Min/Max       Width @
Metrics Report 🔯 S	3

SIZE METRICS	Entire Ontology	LexicalConcept
Total Class	9	7
Total Properties	19	15
# of Direct Properties	0	3
Total Relations	18	14
Direct # of Relations	0	2
Min # of Property	3	3
Cls with Min Property	LexicalConcept, Adverb	Adverb
Max # of Property	11	11
Cls with Max Property	Noun	Noun
Average Properties	2.11	2.14
Average Relation	2.0	2.0
% R to P	0.94	0.93

STRUCTURAL METRICS	Entire Ontology	LexicalConcept				
Total # of Roots	2	3 AdverbNouns_and_Adjectives Nou				
Roots	LexicalConcept WordObject					
Total # of Leaves	6	5				
% L to C	0.66	0.57				
Min Depth	1	1				
Leaf Cls at Min Depth	WordObject	Adverb				
Max Depth	4	3				
Leaf Cls at Max Depth	AdjectiveSatellite	AdjectiveSatellite				
Average Depth	2.66	2.0				
Width @ 2	3	4				
Min Width	1	1				
Depth of Min Width	4	3				
Max Width	4	4				
Depth of Max Width	3	2				
Average Width	2.5	2.66				
2						
IC @ 2	1.8690	2.6666				
Min IC2	0.3690	0.6666				

### **Onto CAT Extensional Report**

Intensional         ✓ ALL         SIZE         iCnt(Cls)       iCnt(Property)         iCnt(Relation)       iPer(PtoC)         iPer(RtoC)       i Per(RtoP)         Min/Max Property       Depth         Avg       Min/Max         Vidth       Avg         Vidth       Q         Min/Max       Vidth         Avg       Min/Max         Vidth       Q	Hub Concepts         Intensional         Extension           Extensional         SIZE METRICS         # of Direct Occurrence           # of Direct Occurrence         Total CIs Occurrence         Total Relation Occurrence           # of Occurrence for         Min CIs Occurrence         Min CIs Occurrence	C Entire Ontology 0 251690 289078 19339	LexicalConcept 0 111223	
<ul> <li>✓ ALL</li> <li>SIZE <ul> <li>iCnt(Cls)</li> <li>iCnt(Relation)</li> <li>iPer(PtoC)</li> <li>iPer(RtoC)</li> <li>iPer(RtoC)</li> <li>iPer(RtoC)</li> <li>iPer(RtoP)</li> <li>Min/Max Property</li> </ul> </li> <li>IC @ depth 2 <ul> <li>Avg</li> <li>Min/Max</li> <li>VMidth</li> <li>Avg</li> <li>Min/Max</li> </ul> </li> <li>Extensional</li> </ul>	SIZE METRICS # of Direct Occurrence Total CIs Occurrence Total Relation Occurrence # of Occurrence for Min CIs Occurrence	0 251690 289078 19339	0	
SIZE         iCnt(Cls)       iCnt(Property)         iCnt(Relation)       iPer(PtoC)         iPer(RtoC)       iPer(RtoP)         Min/Max Property       Depth         IC @ depth       2         Total       Avg         Min/Max       Width         Vvidth       2	SIZE METRICS # of Direct Occurrence Total CIs Occurrence Total Relation Occurrence # of Occurrence for Min CIs Occurrence	0 251690 289078 19339	0	
iCnt(Cls)       iCnt(Property)         iCnt(Relation)       iPer(PtoC)         iPer(RtoC)       iPer(RtoP)         Min/Max Property       Depth         IC @ depth       Avg         IC @ depth       Avg         Min/Max       Width         Avg       Min/Max         Extensional       Extensional	# of Direct Occurrence Total Cls Occurrence Total Relation Occurrence # of Occurrence for Min Cls Occurrence	0 251690 289078 19339	0	
iCnt(Cls)       iCnt(Property)         iCnt(Relation)       iPer(PtoC)         iPer(RtoC)       iPer(RtoP)         Min/Max Property       Depth         IC @ depth       Avg         IC @ depth       Avg         Min/Max       Width         Avg       Min/Max         Extensional       Extensional	Total Cls Occurrence Total Relation Occurrence # of Occurrence for Min Cls Occurrence	0 251690 289078 19339	la la companya da companya	
iCnt(Relation)       iPer(PtoC)         iPer(RtoC)       iPer(RtoP)         Min/Max Property       Depth         IC @ depth       2         Total       Avg         Min/Max         Win/Max         Extensional	Total Cls Occurrence Total Relation Occurrence # of Occurrence for Min Cls Occurrence	289078 19339	111223	
i Crtt(Relation) i Per(PtoC)   i Per(RtoC) i Per(RtoP)   Min/Max Property Depth   IC @ depth 2   Total Avg   Min/Max   Width   Avg   Width   Vidth   Avg   Win/Max	# of Occurrence for Min Cls Occurrence	19339		
iPer(RtoC)       iPer(RtoP)         Min/Max Property       Depth         IC @ depth       Avg         Total       Avg         Min/Max         Win/Max	Min Cls Occurrence		274547	
Min/Max Property Depth Avg Min/Max Ut C @ depth 2 Avg Min/Max Wt Avg Min/Max Min/Max Extensional		0	19339	
Avg Min/Max C @ depth 2 Total Avg Min/Max Width Avg Min/Max Extensional	1995 - \$227.50 % - 87	V	0	
Image: C @ depth       2         Image: C @ depth       2	Cls with Min Occurrence	LexicalConcept, Nouns_and_Verk	Nouns_and_Adjectives,Nouns_ar	
Total Avg Min/Max     Wicth @ 2	CIS WILL WILL OCCUT ENCE	•		
Total Avg     Width @ 2	Max Cls Occurrence	140470	75804	
	Cls with Max Occurrence	WordObject	Noun	
	Average Cls Occurrence	27965.88	15889.0	
	Min Relation Occurrence	0	0	
	Relation with Min Occurrence	pHolonym, sHolonym, mHolonym	antonymOf, pHolonym, sHolonym,	
✓ SIZE Min/Max Occu eCnt(Root) ✓ eAvg(Leaf)	Max Relation Occurrence	140470	140470	
eCnt(Occu)				
eCnt(Occu(C))     eAvg(Occu(R))     Depth	STRUCTURAL METRICS	Entire Ontology	LexicalConcept	
	Total Root	366	366	
	Total Leaf	69410	69410	
Width	Average LeaveshyponymOf	0.78	0.78	
C @ depth	Min Leaves	1	1	
Total Avg     Width @	Root Cls with Min Leaves	c100001742	c100001742	
	Max Leaves	56006	56006	
Metrics Report 🔯 🔛	Root Cls with Max Leaves	c202155096,c201947728,c20135	52 c202155096,c201947728,c201352	

### Onto CAT Root Summary for WordNet Nouns

#### Root Occurrence in <CIs>

Root ID	# of Leaf	Avg Depth	Max Depth	Min Depth	Avg Width	Max Width	Level at Max	Min Width	Level at Min
c100023182	527	5.63	12	1	55.23	124	4	1	0,12
c100022634	7146	5.12	10	1	711 36	4389	5	1	0
c100020595	2367	5.18	11	1	264.66	518	3	1	0
c100022113	4718	5.15	11	1	535.66	1668	5	1	0
c100021905	B21	4.33	8	1	125.11	448	4	1	0
c100001742	56006	7.33	17	1	3891.61	15406	7	1	0,17
c100016840	3312	6.47	12	2	337.61	1074	7	1	0
c100016993	7993	6.61	13	2	764.92	2163	6	1	0
c100025413	1156	5.16	10	1	141.36	399	4	1	0,10

## **E-COMMERCE ONTOLOGIES**

- Standardized vocabulary of product and services terminology referred to as Product and Service Categorization Standards (PSCS)
- Example PSCS developed into intensional ontologies
  - UNSPSC
    - hierarchical classification of all products and services for use throughout the global marketplace.
    - In between coarse taxonomies for customs purposes and expressive descriptive languages for products and services
  - eCl@ss,
    - offers a standard for information exchange between suppliers and their customers.
  - Both important horizontal standards since cover a broad range of industries

# **Previous Study (Hepp 2005)**

Previous study "to assess the quality and maturity of products and services categorization standard" proposed metrics target four aspects:

- size, growth, and maintenance volume,
- degree of balance among segments, hierarchical order, and the breadth of coverage,
- size and expressiveness of the property library,
- specificity of property assignment in class-wise property lists.

### Example metrics

- "size of segments" corresponds to OntoCAT's iCnt(C)(cj-root), the number of classes for a root class.
- "size" corresponds to OntoCAT's iCnt(C), the number of classes for the entire intensional ontology.
- *"property list size"* corresponds to iCnt(P), the number of properties defined for the entire intensional ontology

# **OntoCAT intensional metrics UNSPSC**

Size	owl:Thing	Apparel_and_ Luggage_and_ Personal_Care_ Products	Building_and_ Construction_and_ Maintenance_ Services
Total #Cls [iCnt(C)]	16500	254	87
Total #Property [iCnt(P)]	2	2	2
Total Roots [iCnt(Roots)]	al Roots [iCnt(Roots)] 56		1
		Clothing, Footwear, Luggage_and_handbags _ and_ packs_and_cases, Personal_ care_products, Sewing_supplies _and_ accessories	Building_ construction_ and_ support_ and_ maintenance_ and_ repair_ services
Total Leaves [iCnt(leaves)]	14317	219	70
Average Leaves [iAv(leaves)]	0.86	0.86	0.80
Max Depth [iMaxDepth]	4	3	3
Max Width [iMaxWidth]	14317	219	70
Depth of iMaxWidth	4	3	3
Average Width [iAvWidth]	4125	84.66	29

RDF/RDF(S) version of UNSPSC is developed by Michel Klein and was obtained from http://www.cs.vu.nl/~mcaklein/unspsc

### **OntoCAT Root summary for the UNSPSC ontology.**

Concept Name	Iotal Class es	Total Leaf	Max Dept h	Min Depth	Avg Depfh	Max Width	Level @ max	Min Width	leve 1@ min	Avg Width
Laboratory_and_Measuring _and_Observing_and_Testin g_Equipment	1103	1008	3.00	3	3	1008	3	3	1	367.66
Structures_and_Building_an d_Construction_and_Manuf acturing_Components_and_ Supplies	596	615	3.00	3	3	615	3	L	1	232
Chemicals_including_Bio_ Chemicals_and_Gas_ Materials	614	508	3.00	3	3	508	3	14	1	204.66
Drugs_and_Phamaceutical_ Products	611	514	3.00	3	3	514	3	15	1	203.66
Commercial_and_Military_a nd_Private_Vekicles_and_th eir_Accessories_and_Comp onents	496	417	3.00	3	3	417	3	10	1	165.33
Communications_and_Com puter_Equipment_and_Perip herals_and_Components_an d_Supplies	416	369	3.00	3	3	369	3	3	1	138.66
Industrial_Manufacturing_a nd_Processing_ Machinery_and_Accessories	395	342	3.00	3	3	342	3	13	1	131.66
Distribution_and_Conditioni ng_Systems_and_Equipmen t_and_Components	340	312	3.00	3	3	312	3	4	1	113.33
Power_Generation_and_Dist ribution_Machinery_and_Ac cessories	305	275	3.00	3	3	275	3	S	1	101.66
Farming_and_Fishing_and_ Forestry_and_Wildlife_Cont racting_Services	280	237	3.00	3	3	237	3	8	1	9333
Industrial_Production_and_ Manufacturing_Services	279	236	3.00	3	3	236	3	9	1	93
Politics_and_Civic_Affairs_ Services	279	241	3.00	3	3	24]	3	8	1	93
Domestic_Appliances_and_ Supplies_and_Consumer_El ectronic_Products	275	246	3.00	3	3	246	3	7	1	91.66

# **OntoCAT intensional metrics ecl@ss**

Size	owl:Thing	Structural	owl:Thing
Total #Cls [iCnt(C)]	76975	Total Roots [iCnt(Roots)]	25684
Total #Property [iCnt(P)]	5527	Total Leaves [iCnt(leaves)]	51317
Total #Relation [iCnt(R)]	2293	Average Leaves [iAv(leaves)]	0.66
% R to P [Per(R of P)]	0.41	Average Depth [iAvDepth]	3.4
Max #Property [iMaxTotal(P to C)]	5527	Width @ 1 [iWidth(depth <sub>k</sub> )]	25684
		Max Depth [iMaxDepth]	5
	-	Min Depth [iMinDepth]	1
		Max Width [iMaxWidth]	26162
	_	Depth of iMaxWidth	2
		Min Width [iMinWidth]	4533
		Depth of iMinWidth	3

<u>Used http://www.heppnetz.de/eclassowl as input to OntoCAT</u>

### **OntoCAT ecl@ss Root Summary**

	lotal		Max	Min	Avg		Level @	Min	level @	Avg
Concept Name		Total Leaf		Depth		Width	max	Width	min	Width
C_AAG961003-tax	10623	5038	4	1	3.94	5292	3	20	1	2655.75
C_AAB572002-tax	5317	2181	4	1	3.8	2624	3	35	1	1329.25
C_AAB072002-tax	3983	1669	4	1	3.82	1973	3	19	1	995.75
C_AAD302002-tax	3585	1317	4	1	3.71	1756	3	37	1	896.25
C_AAF876003-tax	2927	1315	4	1	3.88	1444	3	20	1	731.75
C_AAC473002-tax	2653	1186	4	1	3.88	1320	3	7	1	663.25
C_AAC350002-tax	2431	1024	4	1	3.82	1192	3	24	1	607.75
C_AAB315002-tax	2127	850	4	1	3.77	1041	3	23	1	531.75
C_AAA183002-tax	2065	832	4	1	3.79	1019	3	14	1	516.25
C_AAA862002-tax	1927	739	4	1	3.73	932	3	32	1	481.75
C_AAA647002-tax	1603	589	4	1	3.68	763	3	39	1	400.75
C_AAD111002-tax	1519	580	4	1	3.74	750	3	10	1	379.75
C_AAF397003-tax	1451	499	4	1	3.62	680	3	46	1	362.75
C_AAT090003-tax	1239	445	4	1	3.64	577	3	43	1	309.75
C_AAD025002-tax	1041	318	4	1	3.57	502	3	19	1	260.25
C_AAW154003-tax	1007	417	4	1	3.79	490	3	14	1	251.75
C_AKJ313002-tax	977	403	4	1	3.79	477	3	12	1	244.25
C_AAD640002-tax	879	329	4	1	3.7	420	3	20	1	219.75
C_AKK397002-tax	863	286	4	1	3.62	416	3	16	1	215.75
C_AAC286002-tax	701	253	4	1	3.68	339	3	12	1	175.25
C_AAN560003-tax	515	214	4	1	3.8	253	3	5	1	128.75
C_AKJ644002-tax	509	121	4	1	3.41	242	3	13	1	127.25
C_AAE587002-tax	493	189	4	1	3.73	240	3	7	1	123.25
C_AAD170002-tax	451	175	4	1	3.74	221	3	5	1	112.75
C_AAC168002-tax	405	131	4	1	3.58	191	3	12	1	101.25

# Comparisons

Both defined as intensional ontologies

### UNSPSC

- 16500 classes and only two properties.
- 56 root classes and 14317 leaves, Percent leaves 88%
- more wide than deep with an average depth of 4 and average width of 4125
- a uniform maximum and minimum depth of 3.
- root classes have all leaves at the same level
- maximum width occurs at the maximum depth, equivalent to the number of leaves for the root class.

### ecl@ass

- 76975 classes and 5527 properties
- 25684 root classes and 51317 leaves, Percent leaves 66%
- more wide than deep with an average depth of 3.4 and average width of 20526
- Unlike UNSPCS maximum width occurs not at the greatest depth but at depth 3 for all roots.
- Like UNPSCS, the minimum width varies and always occurs at depth 1 for each root.

# Summary

- Many flavors of ontology evaluation or selection
  - Creating "candidate" set of ontologies for reuse with initial evaluation
  - Detailed analysis of "candidate" set using metric analysis
- OntoCat one of numerous tools to address needs of ontology evaluation
  - Structural and size analysis
  - Both intensional and extensional
  - Root selection parameters
  - Root and hub summaries
  - Initial experiment with hub visualizations
- Experiments on numerous domains:
  - WordNet
  - UMLS vocabularies
  - E-commerce ontologies UNSPSC and ecl@ss

### **Possible Future Work**

- Interface with "candidate" selection approaches before perform detailed analysis
- Comparison metrics/charts/visualization for multiple ontologies for "candidates"
- Visualization to help consumers "see" ontology for reuse and comparison
  - Hubs visualization Improvement
  - Individual hub visualization
  - Top-level summary / visualization
  - Bottom-up level summary / visualization
- Combine and aggregate analysis results to provide consumers with summaries characterizing each ontology