Organization of knowledge in astronomy

IVOA Interop meeting
ESAC, 2005/10/06
UCD WG

Knowledge & Intelligence

- Astronomers understand each other because they share the same knowledge

IF

Mutual understanding allows intelligence
Challenge for the VO: provide astronomers with intelligent tools
    astronomers can have knowledge of tools
    tools must have knowledge in astronomy
Knowledge must be structured/organized for machines

Existing knowledge bases

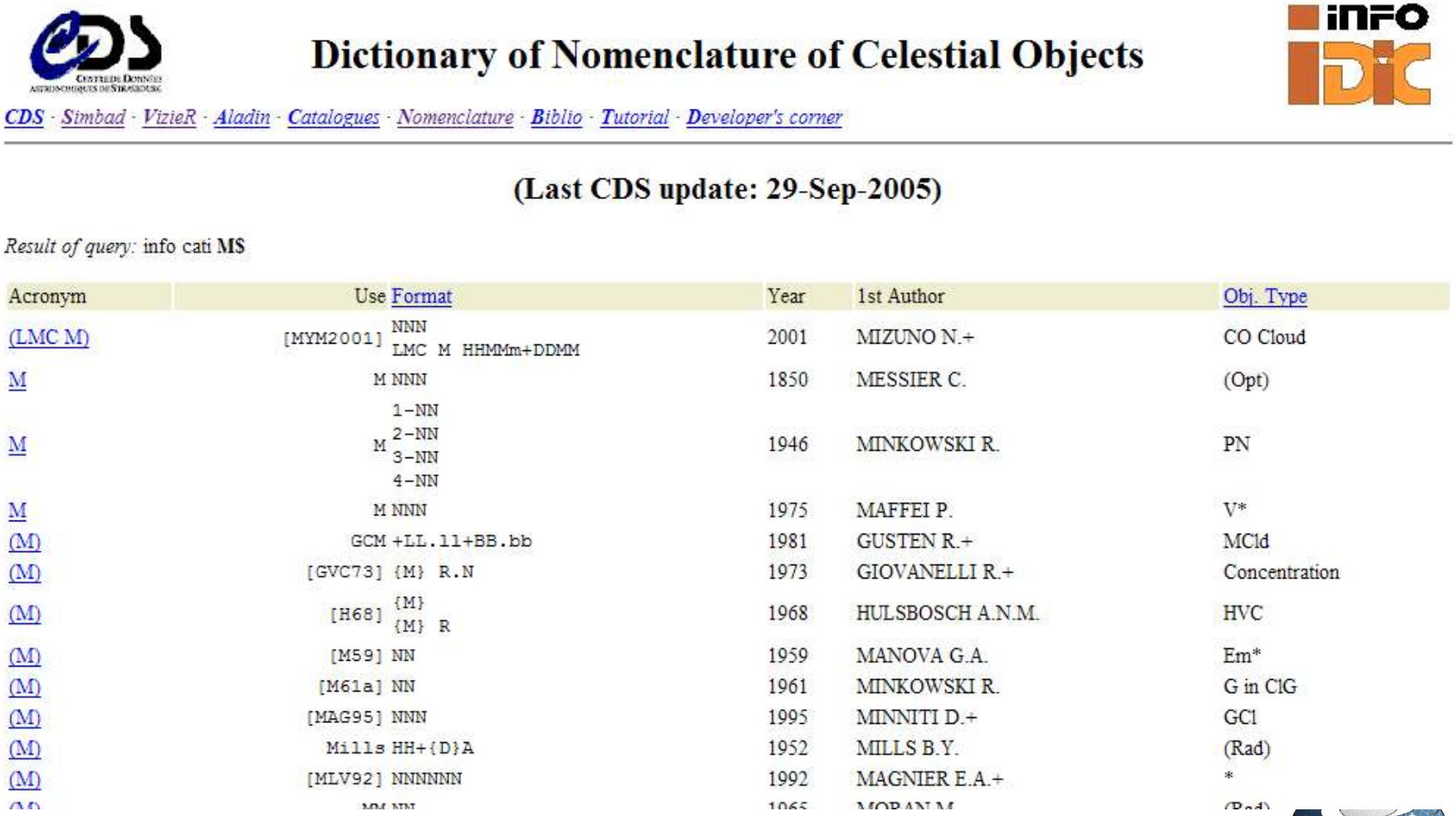
- Don't try to build a virtual astronomer from scratch
- Re-use, structure, combine existing knowledge bases:
  - UCDs
  - Dictionary of nomenclature
  - SIMBAD object types
  - IAU thesaurus
  - VO Registry
  - Data Models

UCDs

- Describe astronomical measurements (quantities): properties
- But some words are related to concepts (S), or can be seen as instances
  - pos.frame (Q)
  - pos.eq (S)
  - pos.galactic (S)

Dictionary of nomenclature

- How to write individual object names: NGC 1234, M101, ...



Dictionary of Nomenclature of Celestial Objects

CDS · Simbad · VizieR · Aladin · Catalogues · Nomenclature · Biblio · Tutorial · Developer's corner

(Last CDS update: 29-Sep-2005)

Result of query: info cati **MS**

Acronym	Use	Format	Year	1st Author	Obj. Type
(LMC M)	[MYM2001]	NNN LMC M HHMMm+DDMM	2001	MIZUNO N.+	CO Cloud
M	M	NNN	1850	MESSIER C.	(Opt)
M	M	1-NN 2-NN 3-NN 4-NN	1946	MINKOWSKI R.	PN
M	M	NNN	1975	MAFFEI P.	V*
(M)	GCM	+LL.ll+BB.bb	1981	GUSTEN R.+	MCld
(M)	[GVC73]	{M} R.N	1973	GIOVANELLI R.+	Concentration
(M)	[H68]	{M} {M} R	1968	HULSBOSCH A.N.M.	HVC
(M)	[M59]	NN	1959	MANOVA G.A.	Em*
(M)	[M61a]	NN	1961	MINKOWSKI R.	G in ClG
(M)	[MAG95]	NNN	1995	MINNITI D.+	GCl
(M)	Mills	HH+{D}A	1952	MILLS B.Y.	(Rad)
(M)	[MLV92]	NNNNNN	1992	MAGNIER E.A.+	*

SIMBAD object types

- Hierarchical classification of astronomical object classes
- Few entries (<150) : well focused
- Related to nomenclature

12.13.12.3:	HMXB	HXB	High Mass X-ray Binary
13.00.00.0:	Neb	Neb	Nebula of unknown nature
13.01.00.0:	PartofCloud	PoC	Part of Cloud
13.02.00.0:	PN?	PN?	Possible Planetary Nebula
13.03.00.0:	ComGlob	CGb	Cometary Globule
13.06.00.0:	EmObj	EmO	Emission Object
13.07.00.0:	HH	HH	Herbig-Haro Object
13.08.00.0:	Cloud	Cld	Cloud of unknown nature
13.08.03.0:	GalNeb	GNe	Galactic Nebula
13.08.04.0:	BrNeb	BNe	Bright Nebula
13.08.06.0:	DkNeb	DNe	Dark Nebula
13.08.07.0:	RfNeb	RNe	Reflection Nebula
13.08.11.0:	HI	HI	HI (neutral) region
13.08.12.0:	MolCld	MoC	Molecular Cloud
13.08.13.0:	HVCld	HVC	High-velocity Cloud
13.09.00.0:	HII	HII	HII (ionized) region
13.10.00.0:	PN	PN	Planetary Nebula
13.11.00.0:	HIshell	sh	HI shell
13.12.00.0:	SNR?	SR?	SuperNova Remnant Candidate
13.13.00.0:	SNR	SNR	SuperNova Remnant
14.00.00.0:	Star	*	Star
14.01.00.0:	*inCl	*iC	Star in Cluster
14.02.00.0:	*inNeb	*iN	Star in Nebula
14.03.00.0:	*inAssoc	*iA	Star in Association
14.04.00.0:	*in**	*i*	Star in double system
14.05.00.0:	V*?	V*?	Star suspected of Variability
14.06.00.0:	Pec*	Pe*	Peculiar Star
14.06.01.0:	HB*	HB*	Horizontal Branch Star
14.06.02.0:	YSO	Y*O	Young Stellar Object
14.06.05.0:	Em*	Em*	Emission-line Star
14.06.05.3:	Be*	Be*	Be Star
14.06.12.0:	AGB*	AG*	Asymptotic Giant Branch Star
14.06.15.0:	post-AGB*	pA*	Post-AGB Star
14.06.16.0:	WD*	WD*	White Dwarf

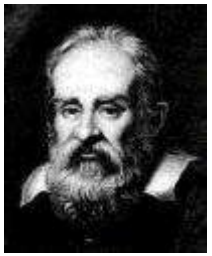
IAU thesaurus

- Many terms, covering astronomical literature
- Vocabulary for: object categorization, phenomenon description, instruments, ...
- Weak relations: RT, BT, NT
- See FG's presentation

VO

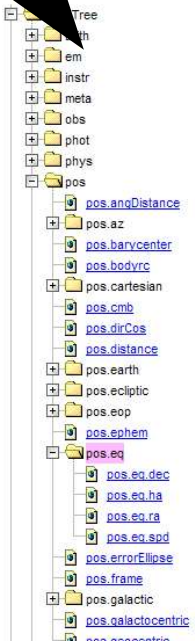
- Registry: structured metadata describing astronomical resources
  - datasets
  - services
- Data Models : definition of concepts and links
  - STC
  - Catalogue
  - Characterization
  - ...

Use cases



Astronomer

« Find proper motions of YSOs in the Lupus cloud »



Knowledge base

Data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      </address>
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  </curation>
 - <content>
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  - <description>
      New Cross Index is constructed on the basis of data analyse
      with HD-number and Bayer-Flamsteed designations with late
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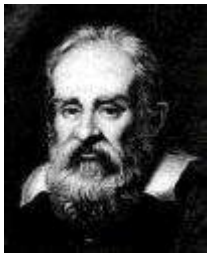
Metadata

Use cases

Intelligent VO tool



Astronomer

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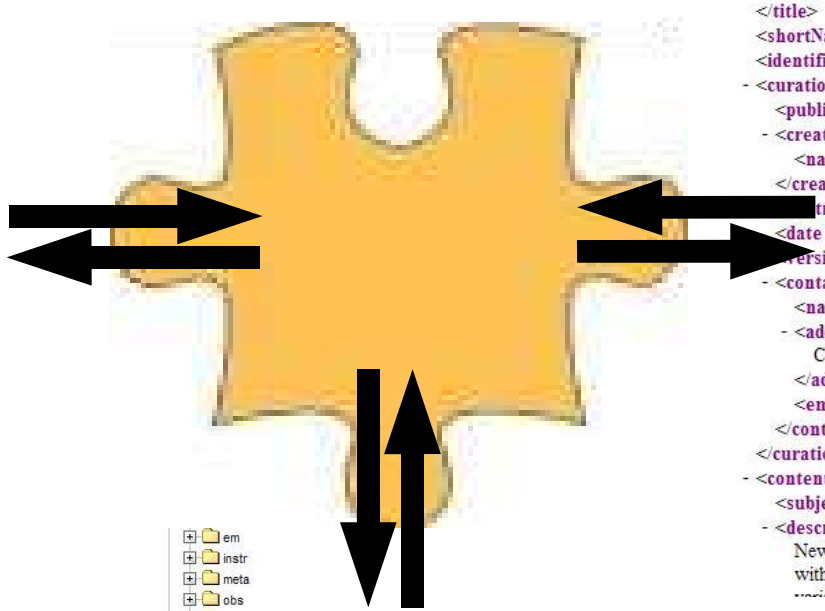
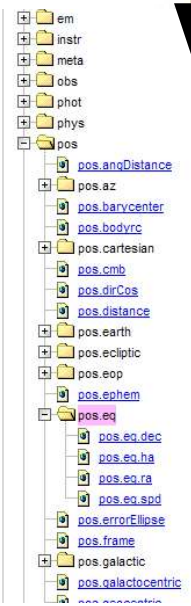
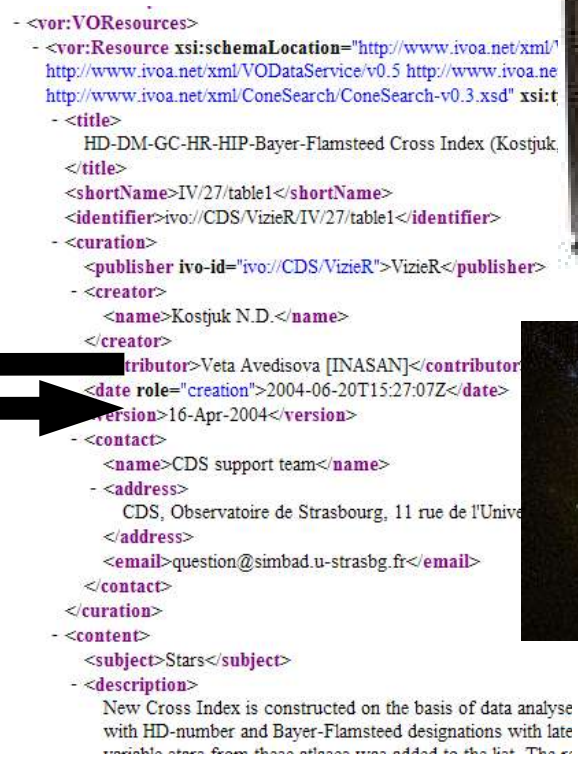




Knowledge base



Metadata

Data

Ontology / Semantic Web

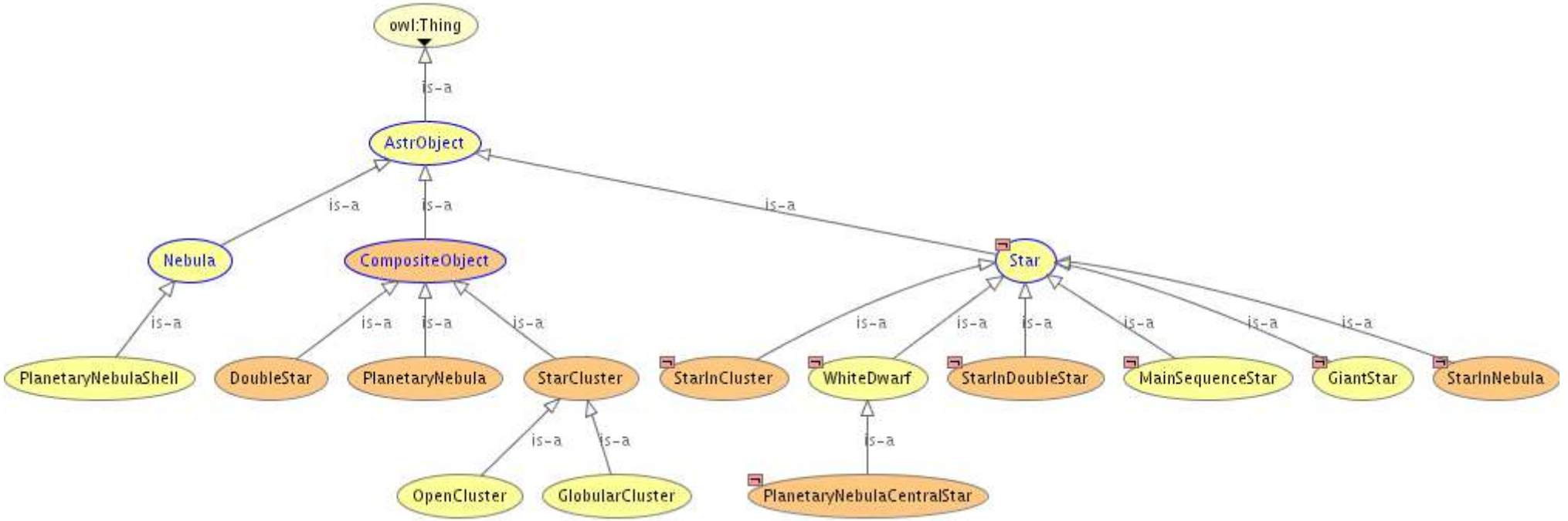
- Ontology
  - formal representation of a domain
    - concepts
    - properties
    - instances
  - common vocabulary for information sharing (between humans, and also machines)
  - attach labels to concepts (link with natural language)
- Semantic Web
  - Data-mining the WWW as a database
  - Heterogeneous, unstructured documents

Ontologies in astronomy

- Don't try to directly model astronomy at large !
- Focus on well-defined problems
  - ontology for UCDs – richer description of relationships between UCD1+ words (collaboration between CDS and LORIA, MDA project)
  - ontology of SIMBAD astronomical object types (VOTech DS5)
  - IAU thesaurus -> ontology (collab. CDS and IRIT)

Ontologies in astronomy

- Astronomical object types
  - Broaden/refine searches in the registry
    - PlanetaryNebulaCentralStar isA WhiteDwarf



Ontologies in astronomy

- Not only useful for astronomers' (users) queries !
- Also useful for data providers, with e.g. metadata validation/enrichment
  - infer new metadata elements from the ones already provided
  - check for inconsistencies in metadata descriptions