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# Multimedia Semantics – From MPEG-7 to Web 3.0

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# Agenda

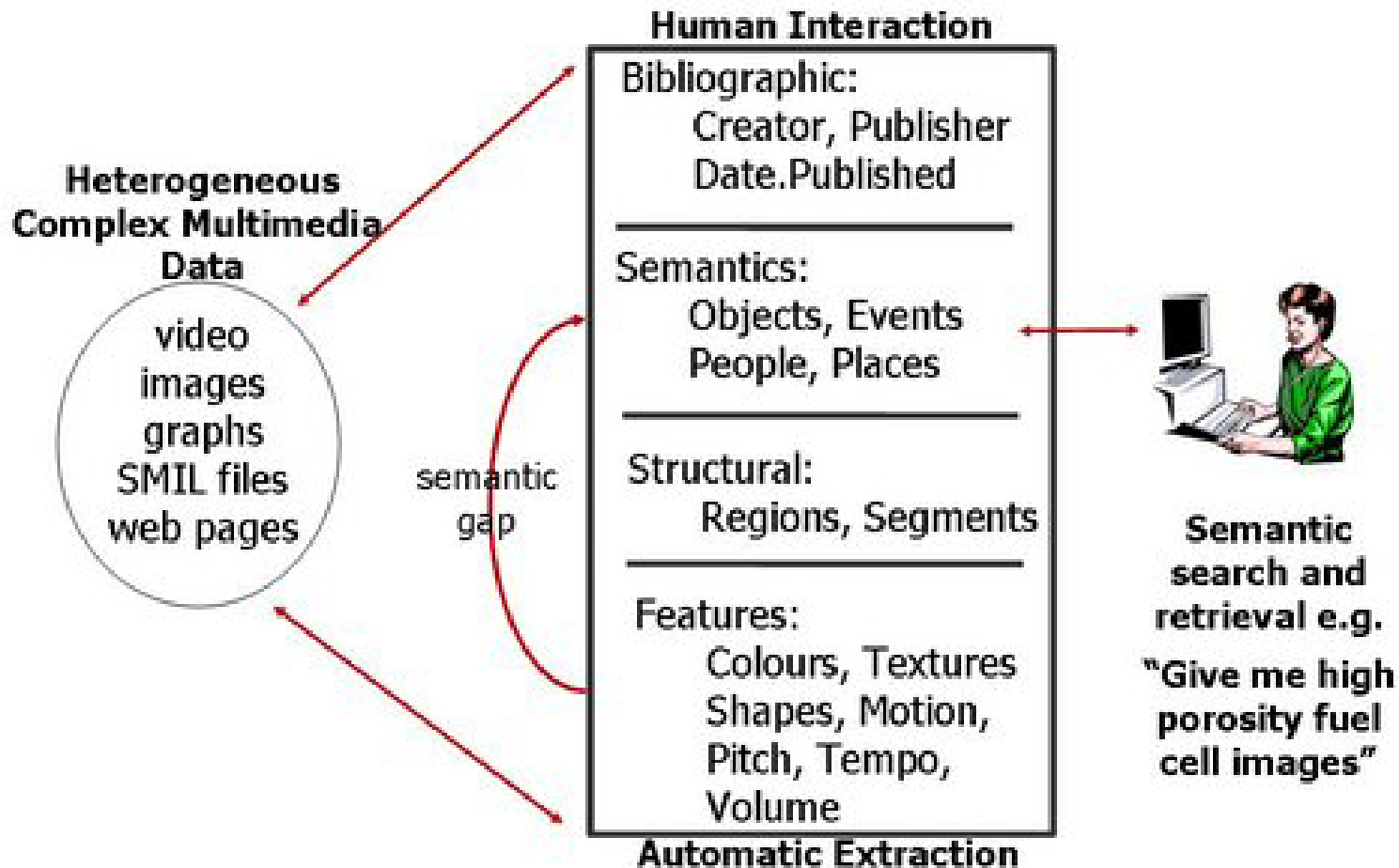
- MPEG-7
- MPEG-7 Ontologies
- Semantic Gap Approaches
- Web 2.0
- Web 3.0
  - New forms of multimedia
  - Hybrid classification
  - Weighted classifications
- Conclusions

# Multimedia Semantics

- How to find user-relevant multimedia
- Using search terms meaningful to the user
- Content-based search
  - Events – tries, coral bleaching
  - People - “Barak Obama”
  - Objects – astrocytoma, cancerous cells
  - Scenes – church scenes in “In Bruges”

(Focus is not on metadata – format, creator, date  
Focus is not on query-by-example)

# The Semantic Gap

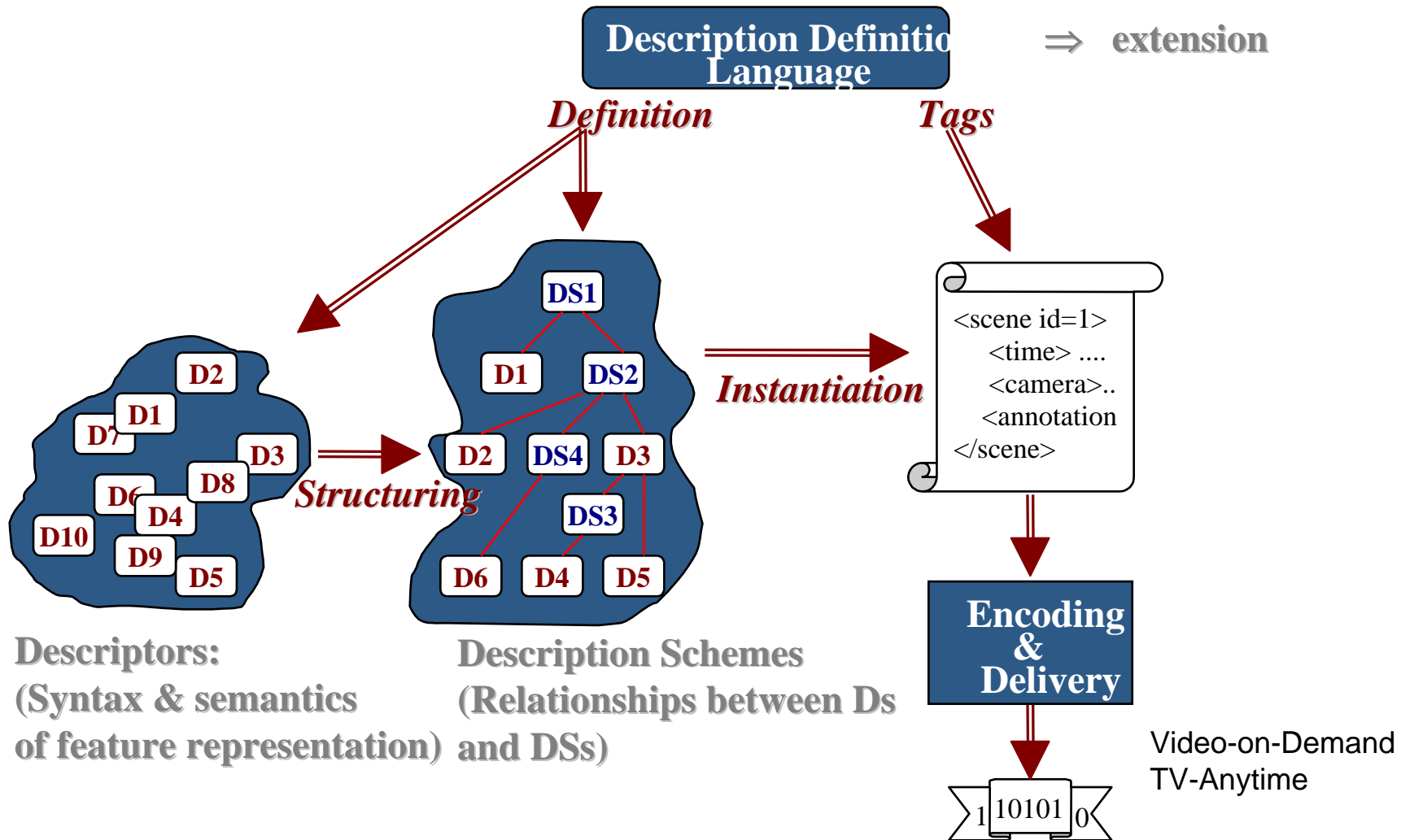


# MPEG-7 Standard

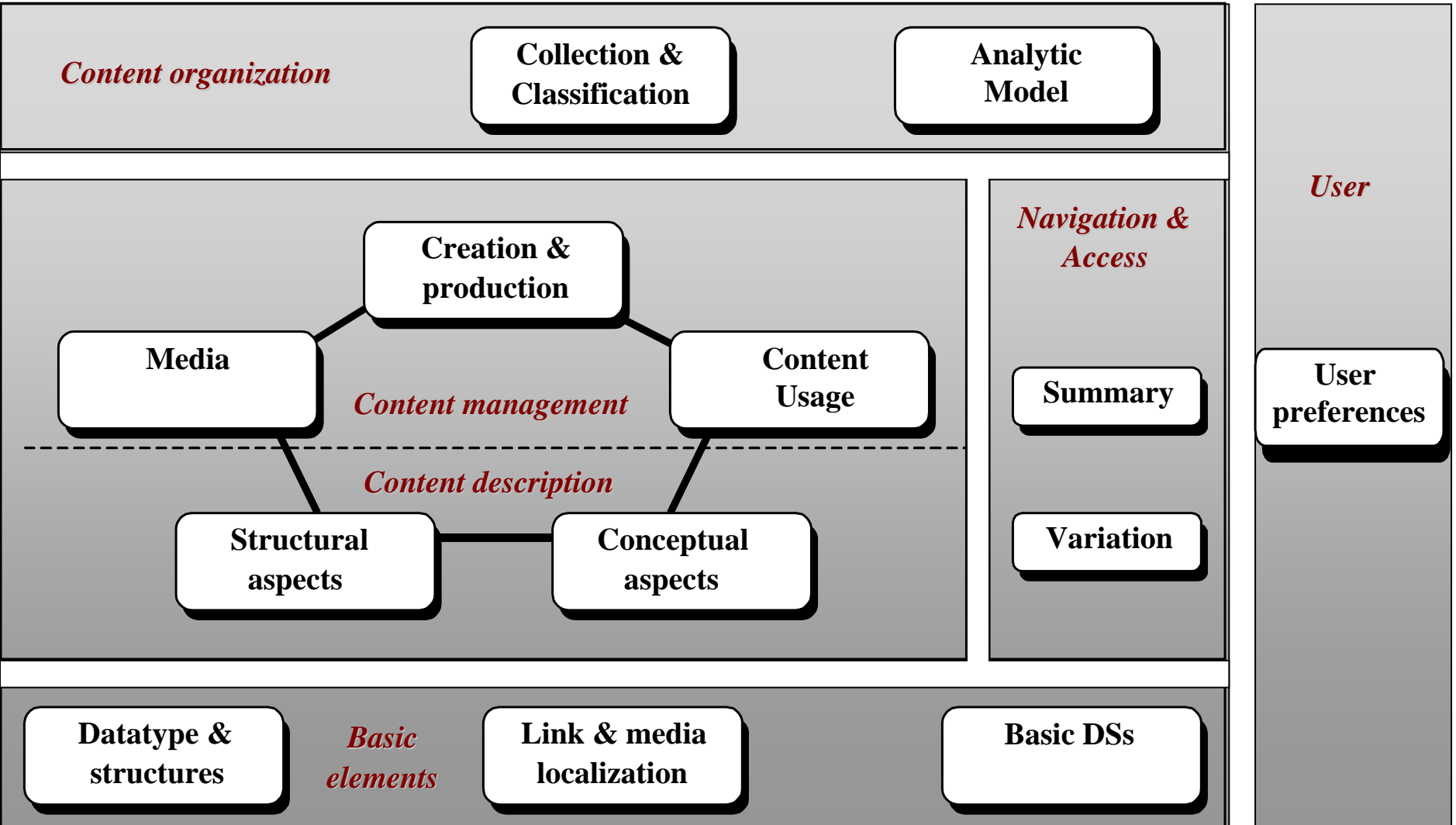
- Multimedia Content Description Interface
- ISO/IEC standard by MPEG
- Objectives are to:
  - Standardize content-based descriptions for audiovisual information
  - Address a wide range of applications
  - Describe images, audio (speech, music), video, graphics, 3D models, compositions
  - Be independent of storage, coding, display, transmission, medium, or technology



# MPEG-7 Components



# Multimedia DSs



# Visual and Audio Descriptors

Feature	Descriptors
Color	DominantColor
	ScalableColor
	ColorLayout
	ColorStructure
	GoFGoPColor
Texture	Homogeneous Texture
	TextureBrowsing
Shape	EdgeHistogram
	RegionShape
	ContourShape
	Shape3D
Motion	CameraMotion
	MotionTrajectory
	ParametricMotion
	MotionActivity

Feature	Descriptors
Silence	Silence
Timbre	InstrumentTimbre
	HarmonicInstrumentTimbre
	PercussiveInstrumentTimbre
Speech	Phoneme
	Articulation
	Language
Musical Structure	MelodicContour, Rhythm
SoundEffects	Reverberation, Contour, Noise, Pitch



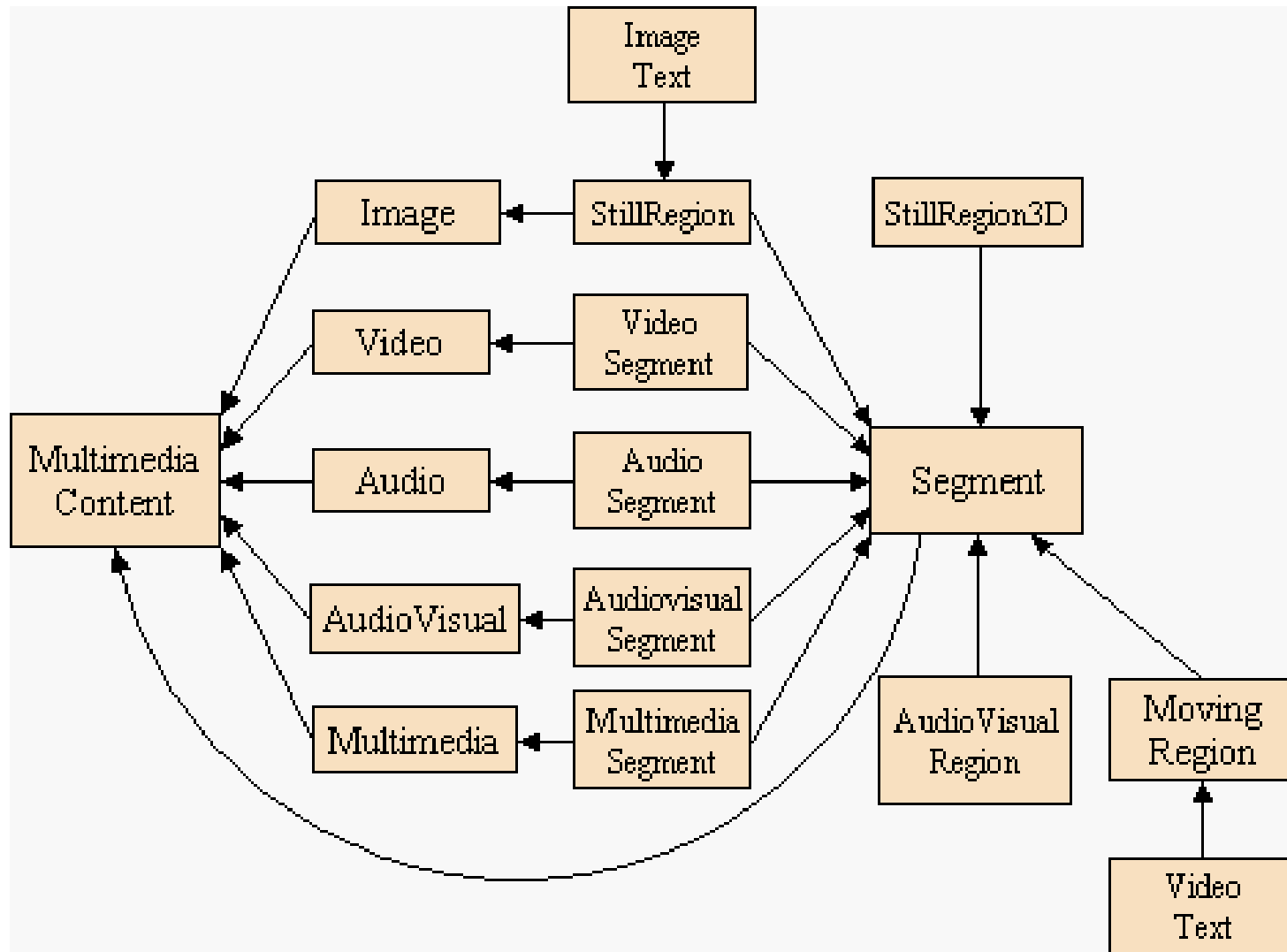


# MPEG-7 Ontology

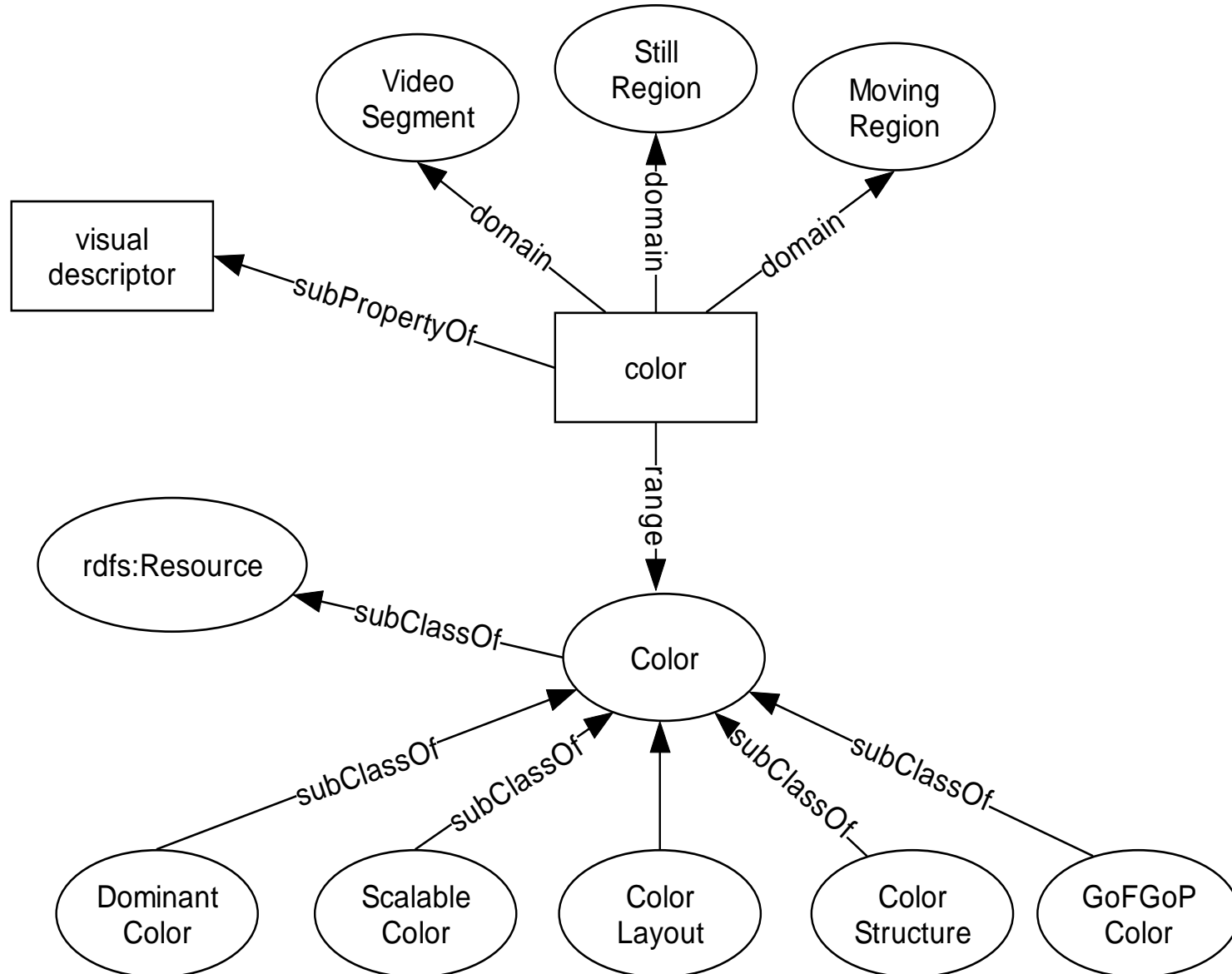
Necessary in order to:

- Bridge the semantic gap
- Enhance discovery
- Add multimedia to the semantic web
- Enable machine reasoning both within and across multimedia content
- Enhance semantic interoperability
- Facilitate integration of multimedia content through common understandings

# MPEG-7 Class Hierarchy

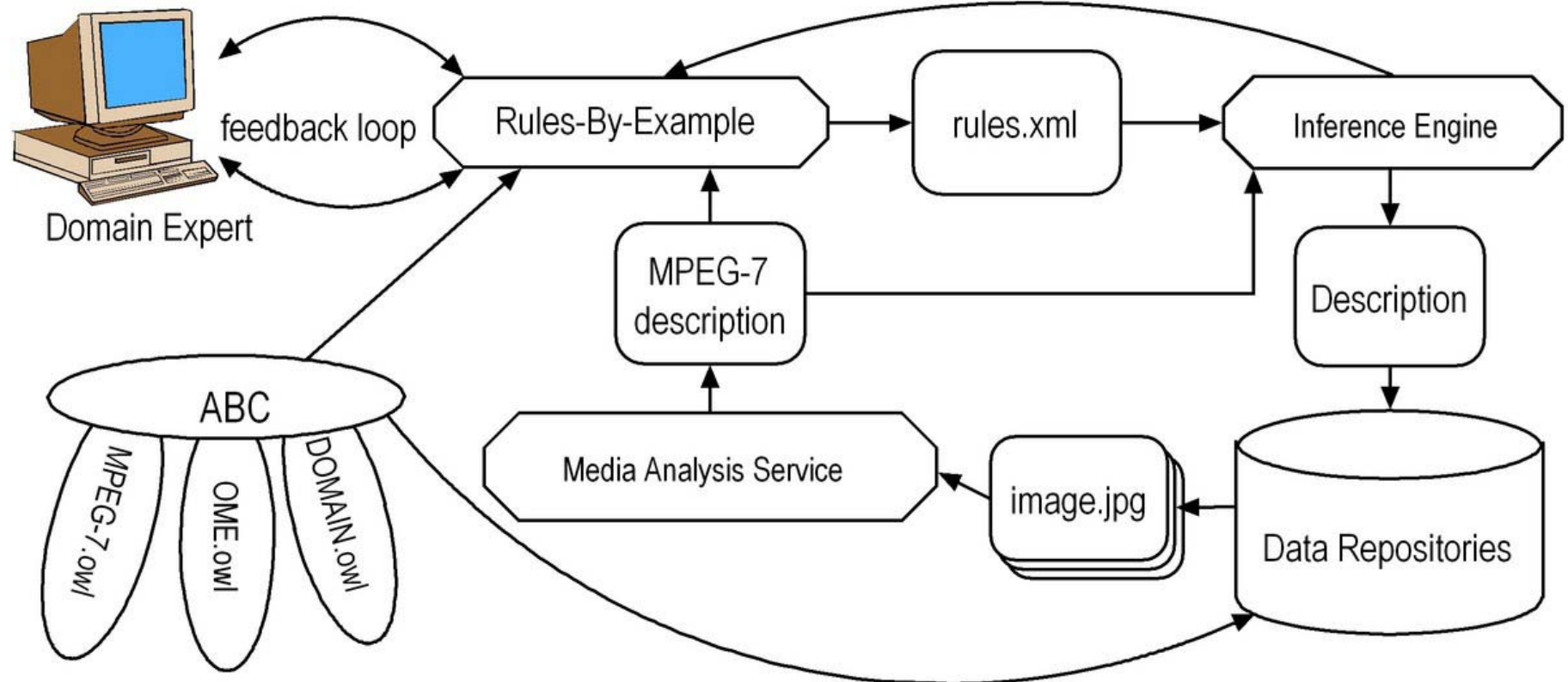


# Colour Descriptors



# Semantic Inferencing Architecture

Define RuleML, SWRL rules



Ontologies – MPEG-7 + Domain-specific

SAMT 2008



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# Rules-By-Example

The screenshot displays the RuleGUI application window. The title bar reads "RuleGUI". The menu bar includes "File", "Rule", and "Image". Below the menu bar are three icons: a mouse cursor, a square, and a circle. The main rule configuration area is as follows:

- Rule Name: **A** (highlighted in a red box)
- Operator: **mpeg7:depicts**
- Target: **fusion:ActiveMetal**

The rule is defined by an "IF" condition with the following clauses:

- B** (highlighted in a red box) **ome:magnification**  $\geq$  50
- mpeg7:color** is **one of** (with a "View Palette" button)
- mpeg7:shape** is **like** (with a red vertical line pointing to a color selection area)  $\pm$  5%
- mpeg7:texture** is **=**

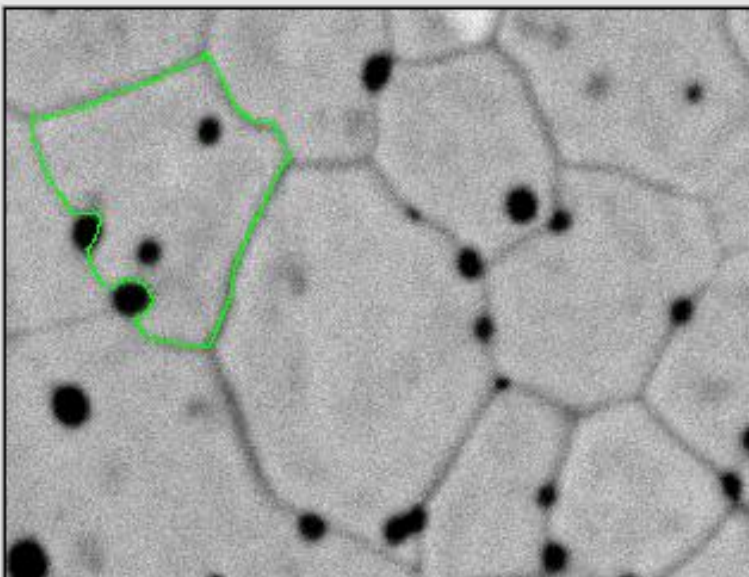
A "Palette" dialog box is open, showing a 4x4 grid of color swatches and buttons for "Add", "Remove", and "Finish".

On the right side, there is a preview window showing an image of a starburst pattern. Below the image is the filename "image012.jp2". A small inset window shows a zoomed-in view of a red spot in the image.

At the bottom left, a status bar indicates "rule not saved".

Rules-By-Example

File Rule Image Help



Attribute Value

Attribute	Value
Image	/local/suzanne/apr28data/
regions	
1	
DominantColorRange	(173,173,173)
DominantColor	(170,170,170)
Orientation	11.6985
Area	64816.0
Color	[(184,184,184),(180,180,1
MinColor	(98,98,98)
StdColor	(14.3042,14.3042,14.3042)
Eccentricity	0.8898
MaxColor	(220,220,220)
coords	((1, 1), (2, 1), (3, 1), (4, 1)
BoundingBox	((0.5, 0.5), (410.5, 0.5), (41
Centroid	(172.3048, 86.706000000000
2	
3	
4	

Show regions

/local/suzanne/apr28data/1.1a 10000x 20deg BC.jpg

Rule

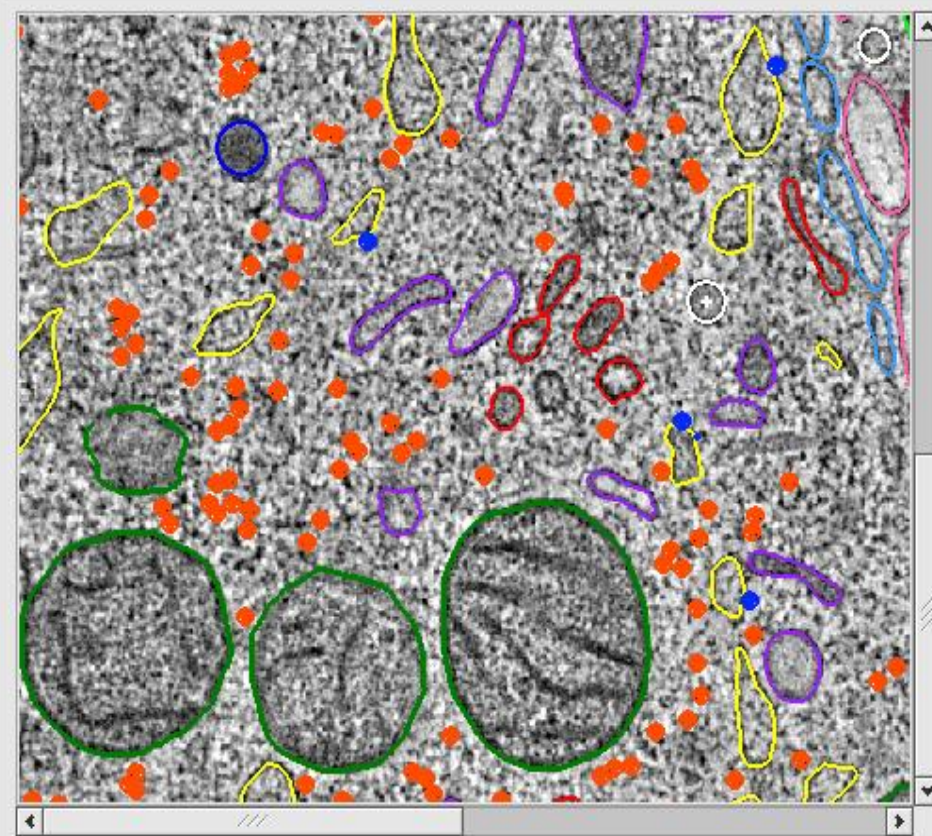
mpeg7:StillRegion **A** / mpeg7:Depicts / fusion:Electrolyte / IF

mpeg7:Color **B** / one of / ColourPalette AND /

Eccentricity / > / 0.5 unit /

Results: 20 View





Show region as  Box  Outline  Show all

/docs/work/sunago/zap/lauralImageAnalysis/Output/zap000.tif

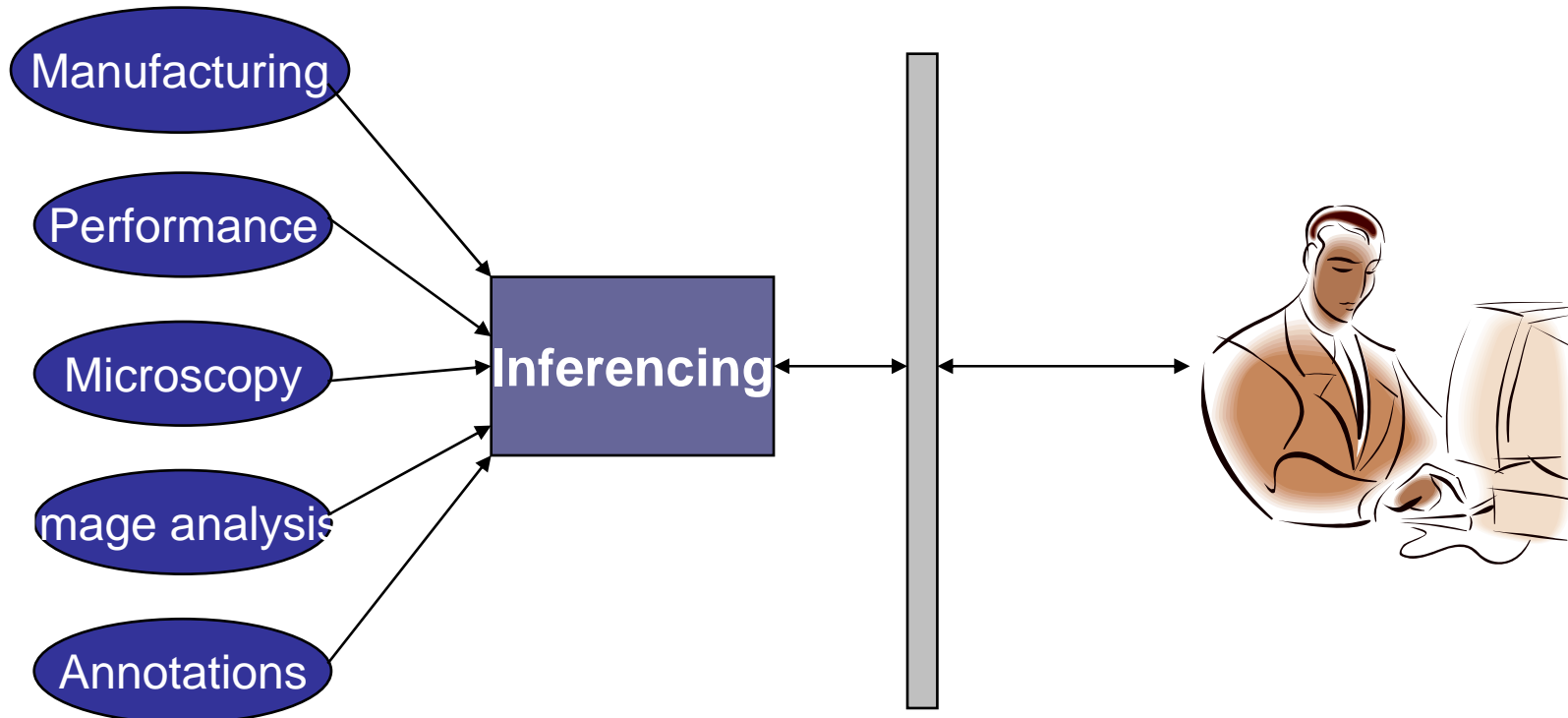
Rule  
 mpeg7:StillRegion ▾ mpeg7:Depicts ▾ Mitochondria ▾ IF  
 Area ▾ >= ▾ 7500 pixels ▾ ANI ▾

Results: 75 (65) of 144 Run All Correct Incorrect Not found Clean highlighting

Attribute	Value
386	
color terms	
ColorVariation	37.33
DarkestColor	(1,1,1)
DominantColor	(66,66,66)
DominantColorF	(121,121,121)-(131,131,131)
LightestColor	(204,204,204)
MeanColor	(92,92,92)
location terms	
BoundingBox	((0.5, 625.5), (23.5, 625.5), (23.5, 697.5), (0.5, 697.5),
Centroid	('15.057895', '654.705263')
shape terms	
Area	190.0
ConvexArea	1127
Eccentricity	0.964554
EulerNumber	1
Extent	0.114734
FilledArea	190.0
MajorAxisLengt	86.5548
MinorAxisLengt	22.8406
Orientation	82.2398
Solidity	0.168589
texture terms	
Dense	no
wellSegmented	yes

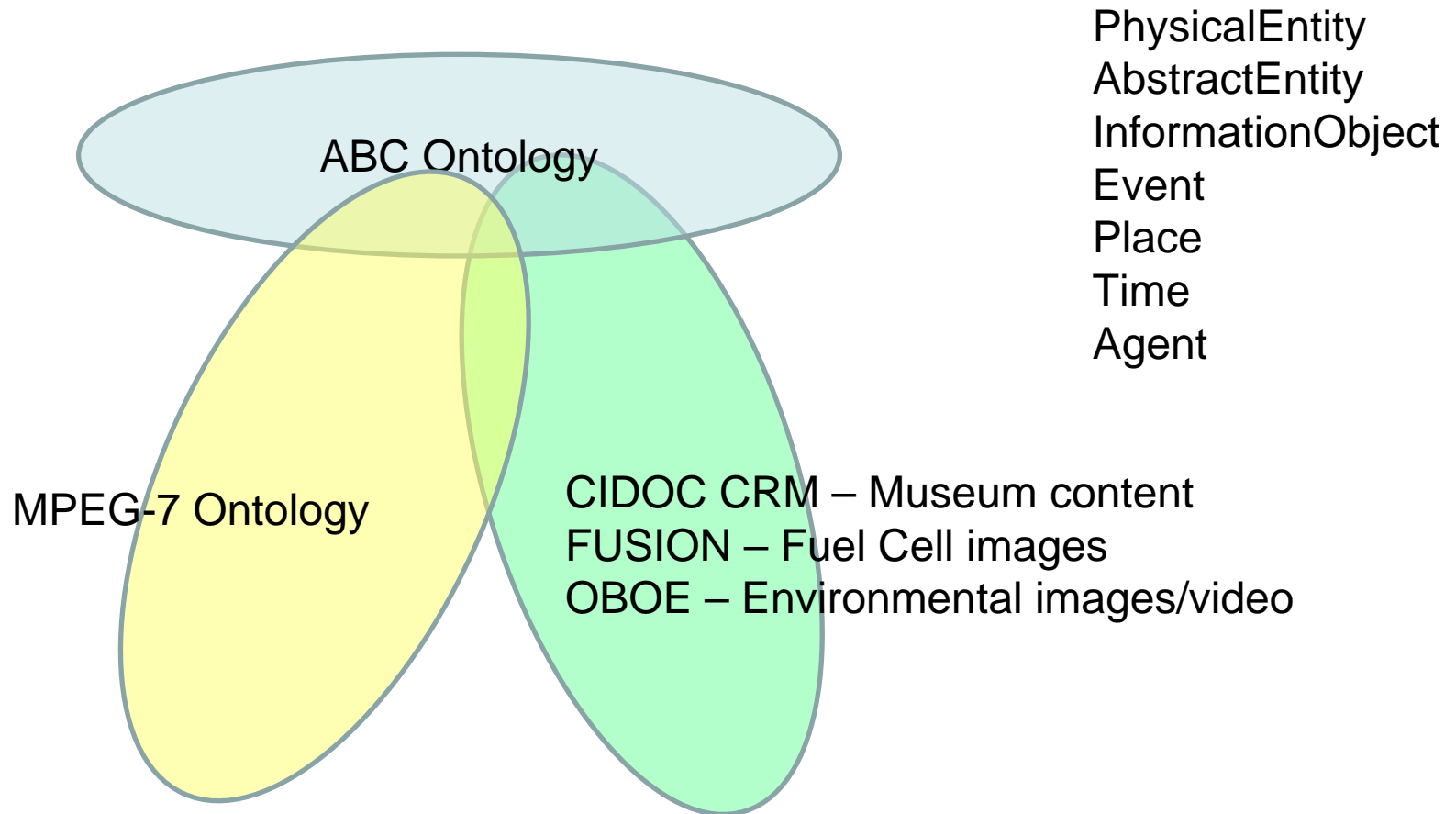
# Richer User-Centred Queries

How does the mean catalyst size in electrodes of width < 20 microns effect electrode conductivity?





# Upper Ontologies



# Related Approaches

- Low level feature extraction – still room for improvement
- Statistical classification methods
  - Cluster multimedia objects based on similarity
- Machine Learning/Black box approaches
  - Bayesian, Probabilistic models
  - Neural networks
  - Genetic algorithms
  - Decision tree learning

# Web 2.0, eScience -> New Content

- 3D – cultural, biomedical, nano-structural
- 4D – Scientific Visualizations
- Compound Objects (Provenance, Learning Objects)
- Access Grid, EVO Sessions
- Multi-sensor networks – webcams, sensors, remote sensing satellite imagery
- YouTube, PodCasts
- Video/Audio Blogs
- FaceBook, MySpace

Search

Fly To  Find Businesses  Directions

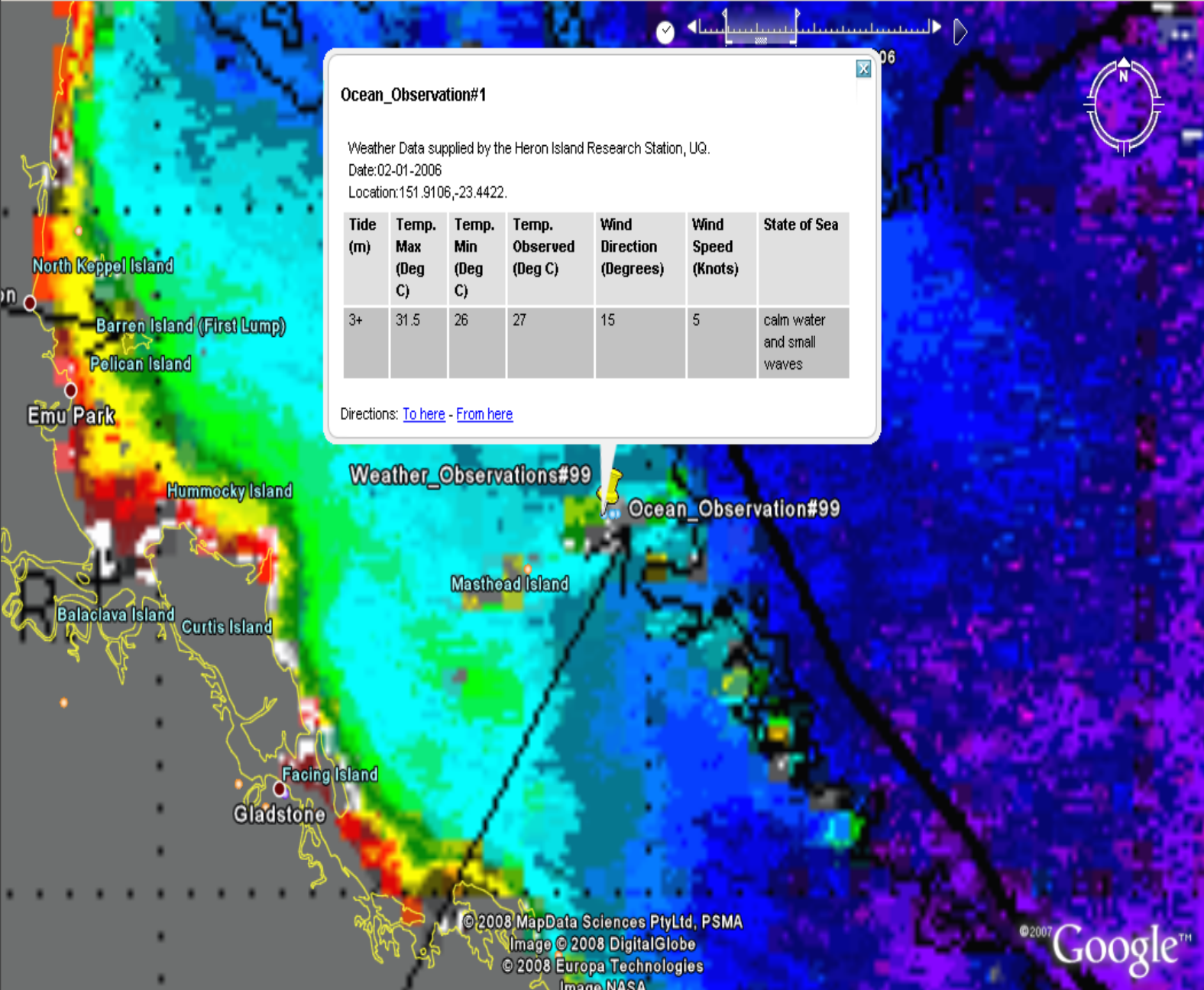
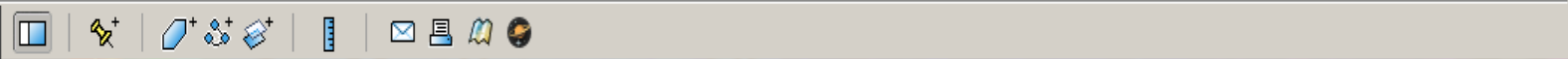
Fly to e.g., 37 25.818' N, 122 05.36' W

Places Add Content

- Heron Island Research Station, Weather Observations D
- Ocean\_Observation#0
- Ocean\_Observation#1
- Ocean\_Observation#2
- Ocean\_Observation#3

Layers

- View:
- Primary Database
  - Terrain
  - Geographic Web
  - Best of Google Earth Comr
  - Panoramic
  - Wikipedia
  - Preview
  - roads



**Ocean\_Observation#1**

Weather Data supplied by the Heron Island Research Station, UQ.  
 Date:02-01-2006  
 Location:151.9106,-23.4422.

Tide (m)	Temp. Max (Deg C)	Temp. Min (Deg C)	Temp. Observed (Deg C)	Wind Direction (Degrees)	Wind Speed (Knots)	State of Sea
3+	31.5	26	27	15	5	calm water and small waves

Directions: [To here](#) - [From here](#)

# Indexing and Search for 3D Cultural Artefacts

3d models - Windows Internet Explorer










http://127.0.0.1:8000/3d/index.html

icadl 2008

File Edit View Favorites Tools Help

3d models

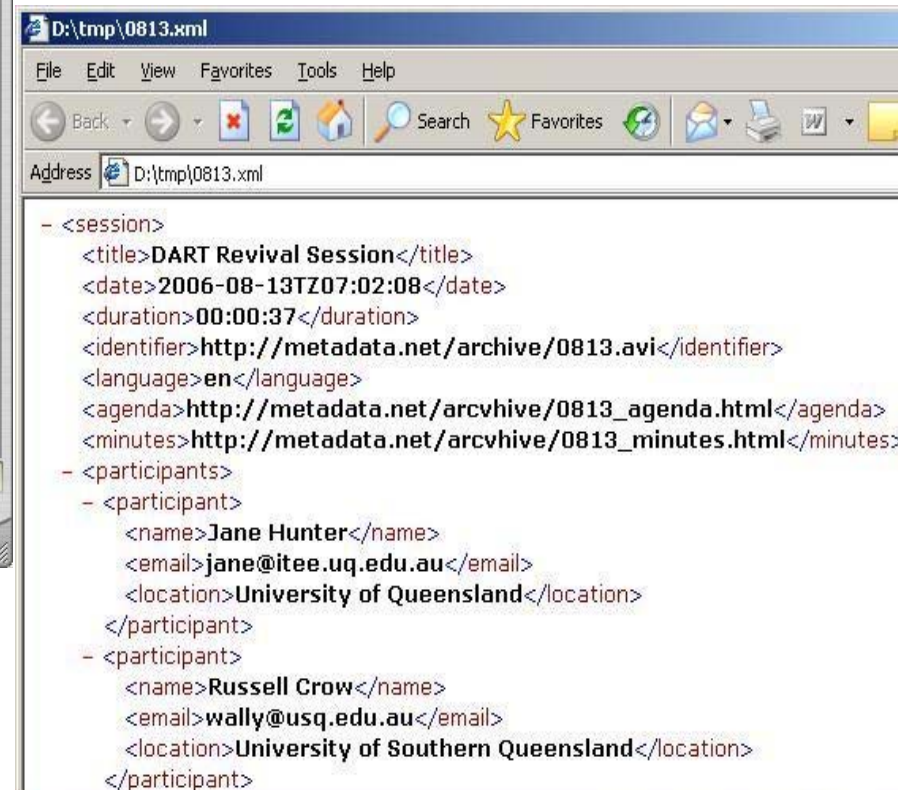
## 3d Object Annotations

		
<u>Inca</u>	<u>Buffle</u>	<u>Buddha</u>
		
<u>Botijo</u>	<u>Pierre 2</u>	<u>Bull</u>
		

Local intranet



# AccessGrid Session Recording & Playback





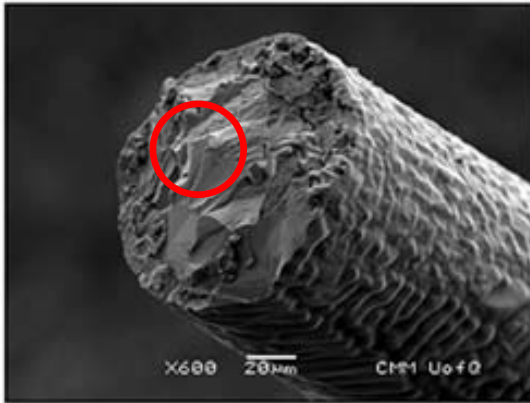
# NANO IMAGE DATABASE

N A N O

Empowering NANO ...

https://www.nidb.nano.org.au - Mozilla Firefox

Image Upload: *W cold fracture tip.tif*



Please Complete the Required Metadata:

SAMPLE:

EXPERIMENT REFERENCE:

PROJECT AFFILIATION:

INSTRUMENT:

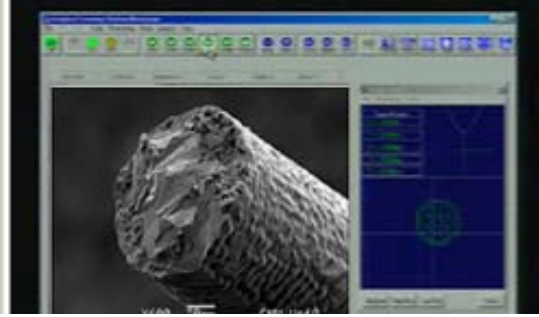
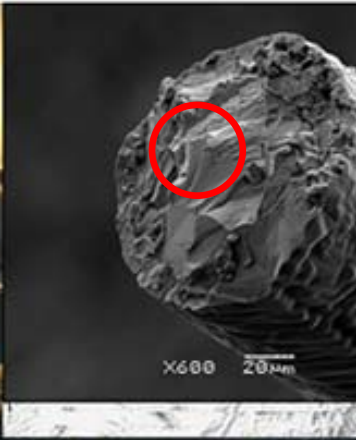
✓ Metadata Value Changed to "UQJSM6460LA"

OK

## CyberSTEM - The University of Queensland

- Video All
- Video 1
- Video 2
- Video 3
- Video 4
- Admin

SEM - Centre for Microscopy and Microanalysis - Phone 33469860



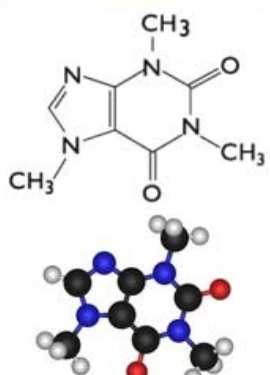
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- List Annotations Policies
- [-] Supercritical carbon dioxide extraction
  - [-] Theophylline
  - [-] C8H10N4O2
  - [-] Wikipedia Reference
  - [-] Molar mass

Body Policy Other Info

(disambiguation).

**Caffeine**



**General**

Systematic name	1,3,7-trimethylxanthine
Other names	trimethylxanthine theine mateine guanine methyltheobromine

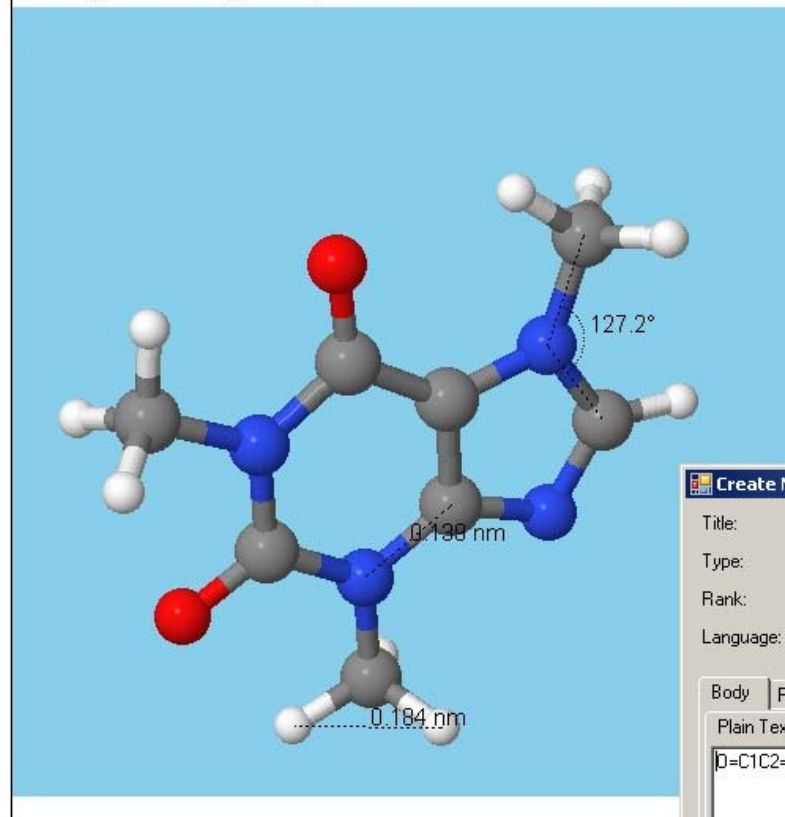


## Annotation of Crystallographic Structures

[View model](#)

[Search publication databases](#),

Viewing models/caffeine.xyz



Selected Atom: { 10 } (O 11 #11)

[Annotate](#)

Show bounding box

Spin the model

[Rotate once about the x axis](#)

**Custom Jmol scripting:**

([what is this?](#))

[Execute](#)

**Create New Annotation**

Title:

Type:

Rank:

Language:

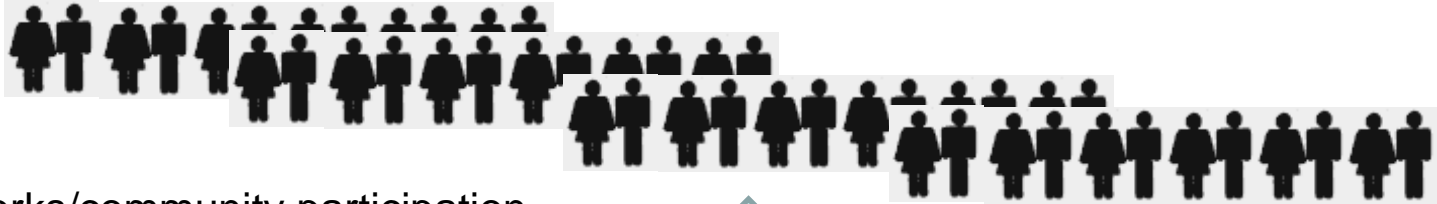
Body Policy

Plain Text URL File

O=C1C2=C(N=CN2C)N(C(=O)N1)C

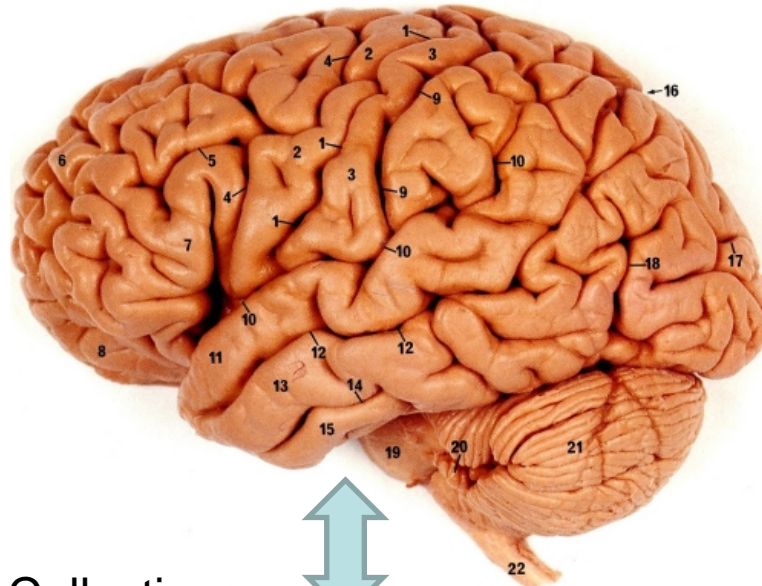


# Web 2.0

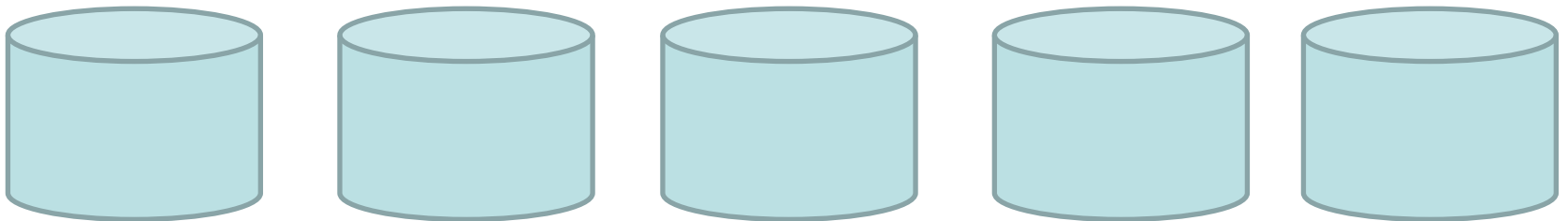


Social networks/community participation

- define information environments
- drive the technologies
- rank information resources
- define own tags (folksonomies)



Distributed Multimedia Collections



# Metadata vs Tags

## Tags

- Topical, relevant, adaptive, light-weight
- Cheap – generated by masses
- Inconsistent, inaccurate, won't scale, flat structure
- Systems don't interoperate (TagCommons)

## Authoritative metadata

- Complex, fixed, hierarchical structures
- Don't evolve, irrelevant, anachronistic terms
- Very expensive
- High quality

# Annotations vs Tags

- Tags
  - Light-weight, unstructured, organic, folksonomies
- Annotations
  - Structured, schemas, controlled vocabs, ontologies
  - creator, date, type, content/description, context
- Ontology-based tags in RDF enable:
  - machine-processing of annotations
  - resources to become part of semantic web
  - enhanced discovery and reasoning

# Collaborative 3D Object Annotation

The image displays a complex software interface for collaborative 3D object annotation. On the left, a vertical sidebar shows a list of participants from various institutions, including the University of Queensland and the University of Technology Sydney. The main area is divided into three primary sections:

- Top Left (Red Border):** A 'Current Context' window showing a search interface with a 'Search Result' pane displaying a thumbnail of a 3D object.
- Top Center (Yellow Border):** A 3D viewer window displaying a wireframe model of a bird-like object. Below the viewer, a 'Segment Description' panel provides metadata for the object, including its title 'Indigenous Child Dancer' and various attributes.
- Top Right (Blue Border):** A 'Shared Annotation/ Discussion' window titled 'List of Annotations', showing a search interface and a list of annotations.

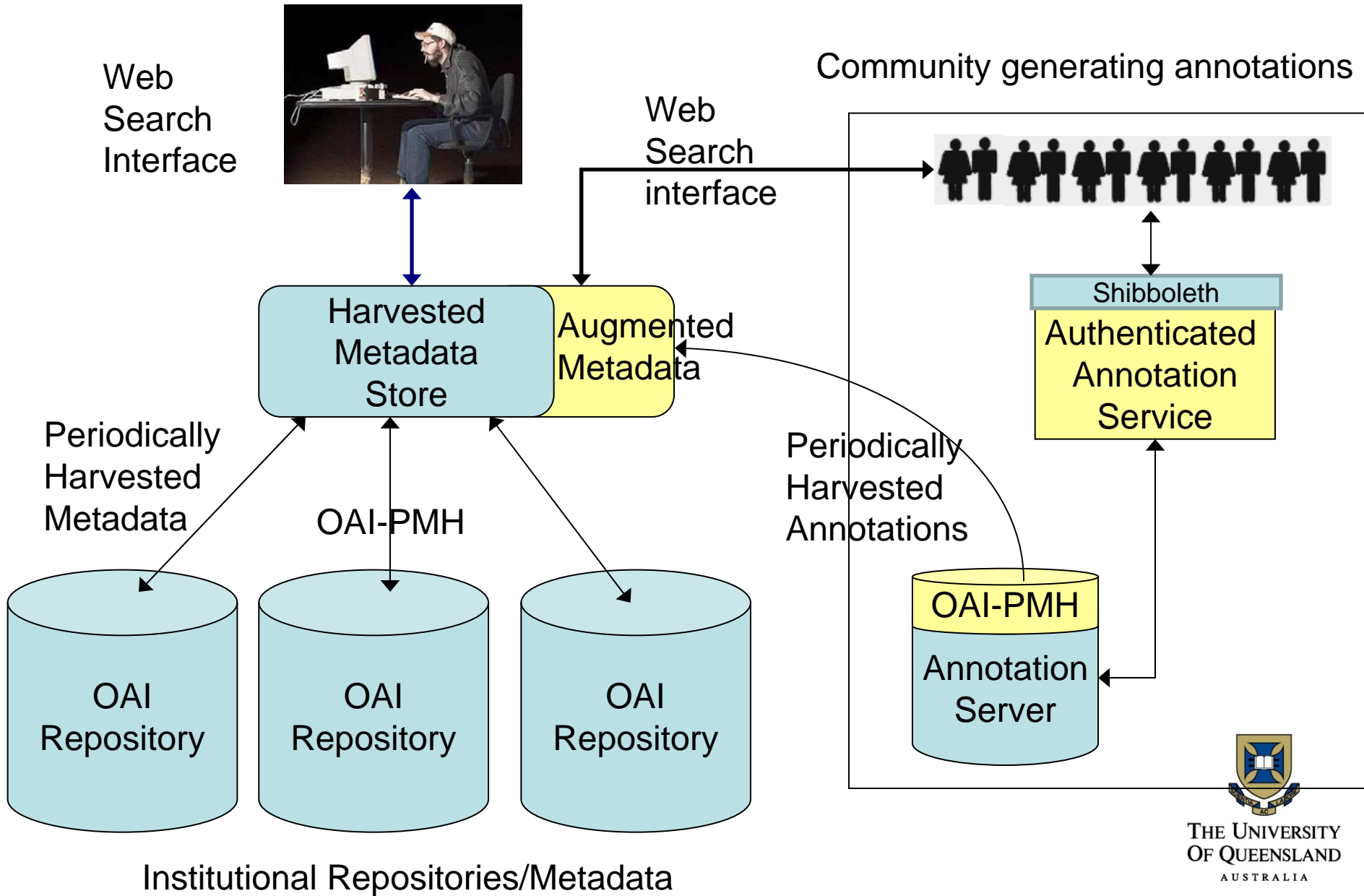
At the bottom, three colored lines point from the labels to their respective interface components: a red line from the 'Semi-Automatic Indexing/Description...' label to the red-bordered window; a yellow line from the 'Content Viewer...' label to the yellow-bordered window; and a blue line from the 'Shared Annotation/ Discussion...' label to the blue-bordered window.

Semi-Automatic  
Indexing/Description (DC/MPEG-7) &  
Access/Rights/Traditional Care

Content Viewer  
(e.g. MPEG-2,  
JPEG2000, 3D objects)

Shared Annotation/  
Discussion (Annotea)

# System Architecture










# Tag Clouds






A access Agriculture **AIDS all** anabolic **and Audio** Best biomass **blog** blogs Blue Body book  
brain **cancer car care** climate data design **Development** diving DIY dmr **energy**  
ethanol ethics **evolution** fitness **for Free** from fuel gardening globalwarming Green Greenhouse  
growth guide **health** health care **history HIV Home** hosting house imaging **in insurance**  
**internet** keyboard law **learning** Logitech memory method **mobile** motor mouse **new news of**  
**online open access** panasonic PET pharmaceutical Power products programming quality **rental**  
**research review RV science** scuba side **Skin** smoking Snowboarding **Social** sports states  
Steroids stock supplements **technology the** tips to **treatment** tutorials vacations Warming **web**  
wiki wireless







 http://localhost:8777/pilin/au.edu.uq.itee.ersearch.pilin.gwt.Main/Main.html#tag
 

 Google
 

 del.icio.us
  TAG




 Page
  Tools

UQ ITEE eResearch

eResearch  
Pictures

Find pictures of

 in **All**  
 Institutional
  Community

## Popular Tags:

[Apartments](#)
[Australian\\_Architect](#)
[Bridge](#)
[Building\\_Other](#)
[Dwellings](#)

[Government](#)
[Heritage\\_Listed](#)
[Houses](#)
[Industrial](#)

[Late\\_Twentieth-Century\\_1960-Units](#)
[Post-War\\_Melbourne\\_Regional](#)
[Structural](#)

[Victorian\\_1840-1890](#)

Search Results for tags of type

'http://metadata.net/pilin/AustralianArchitecture.owl#Victorian\_1840-1890'

1 result  
found.

Government Printing House,  
N/A


[More information](#)

[View image](#)

**Related Tags:**
[Victorian\\_Free\\_Classical](#)
[Victorian\\_Regency](#)
[Victorian\\_Romanesque](#)
[Victorian\\_Mannerist](#)

[Victorian\\_Academic\\_Gothic](#)
[Victorian\\_Georgian](#)
[Victorian\\_Carpenter\\_Gothic](#)
[Victorian\\_Italianate](#)

[Victorian\\_Rustic\\_Gothic](#)
[Victorian\\_Second\\_Empire](#)
[Victorian\\_Egyptian](#)
[Victorian\\_Tudor](#)

[Victorian\\_Academic\\_Classical](#)
[Victorian\\_Filigree](#)

[Tag tree](#)
[Search all](#)
Image data provided by [Picture Australia](#)

# Issues

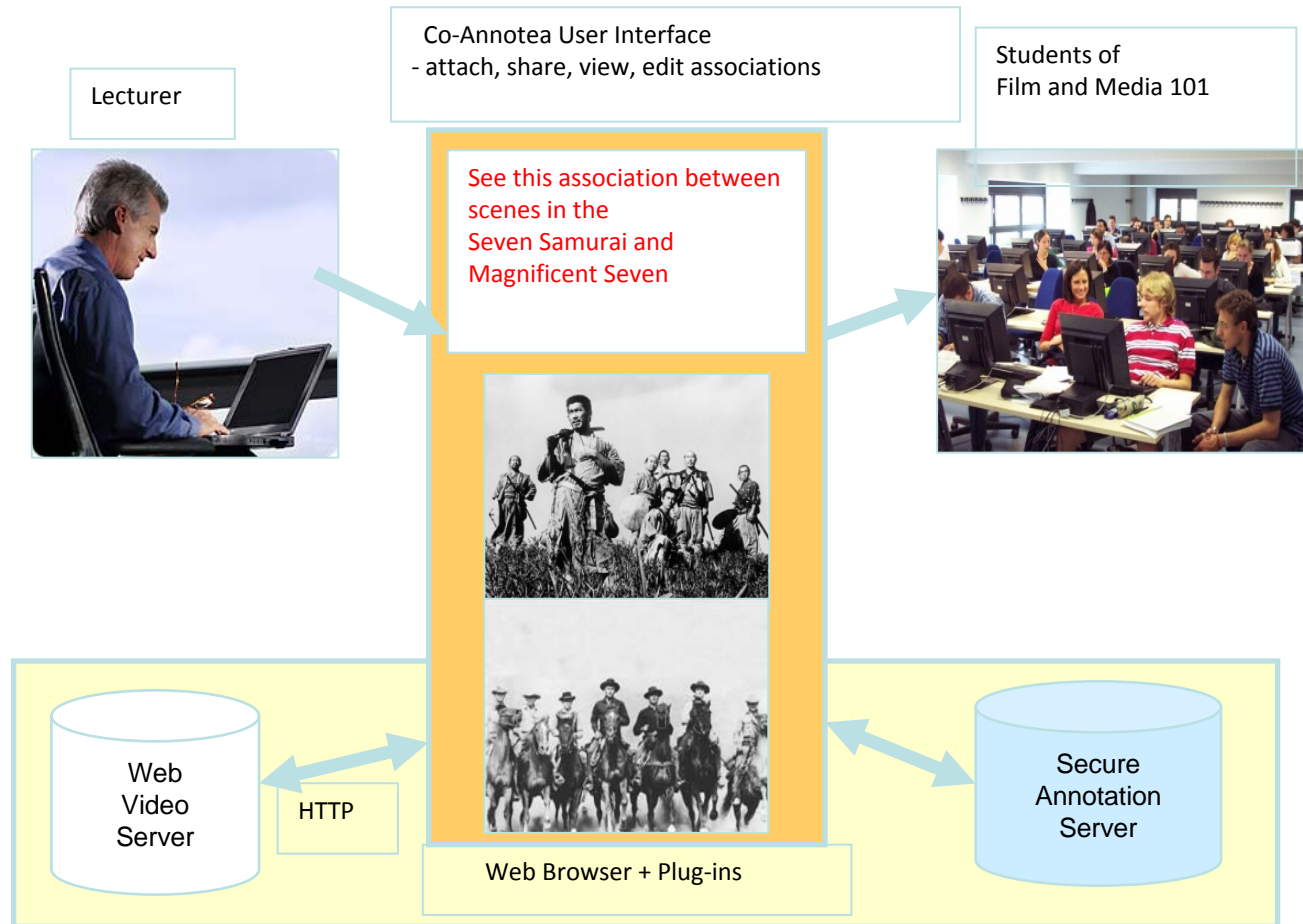
- Quality Control on community-generated data
- Ontology-directed folksonomies
- How to identify tags to add to ontology
  - Tag convergence over time
- When, where to add them?



# Annotating Relationships

- Tag/Annotate a set of objects (or segments)
- Annotate one multimedia object with another multimedia object
  - Audio description of a photo
- Tag/Annotate relationships between objects or segments – label the relationship
- Kickstart greater semantic inferencing

# Annotating Relationships



# Annotating Relationships

Vannotea2006

File Edit Help

LiverCells\_healthy.jpg  
http://maenad.itee.uq.edu.au/mediaFiles/Medical/LiverC

LiverCells\_sick.jpg  
http://datura/ronalds/LiverCells\_sick.jpg

Media Browser

Share

Browse Annotate Search

- Normal liver stained strongly
- \* Liver with malignant hepatoc
- Healthy Liver (ronalds)

Body Policy Other Info

A normal liver stained strongly for Spry2 can easily be mistaken for a liver with malignant hepatocellular carcinoma (HCC)

Jabber Client

Disconnect Connect Enter Conference Leave Conference

Unfiled

- exodus
- exodus2

Conference Room (drag&drop users to invite them)

Connected

Annotea Timeline Jabber Client Record and Replay Jabber Chat

Annotation Selected

Vannotea2006

File Edit Help

Media Browser

TaraSophieERGcards.mpg

http://maenad.itee.uq.edu.au/mediaFiles/TaraSophieERGcards.mpg

toukelau.mov

http://maenad.itee.uq.edu.au/ethno/toukelau.mov

# Toukelau

Interlinear  
 Translation

s4 ▶ + Malen  
amurin na ka tur  
roat

s5 ▶ + go apo pan  
slat roat, ka fan  
slat roat,

s6 ▶ + A ler mai, ka  
fo pei m\$asel  
roat, a m\$asel  
roat inom

s7 ▶ + Amer p\$el  
ki, ap\$el kin itu.

s8 ▶ + Me apo mer  
pan tai lop. A  
pan tai lop, mai,  
a preg ptaki, tai  
ptaki



s9 ▶ + Ileg nen kin  
ka fo tur roat,  
apreg, aton kin  
rupitkaskei. Lop  
ru pitkaskei

s10 ▶ + Inrik wou  
kin na ka fo  
preg namtampe  
neu ru fitkaskei.  
Inom

s11 ▶ + Amer pei  
taakotkot lop ru  
to m\$it

s12 ▶ + Ka fo mer  
pei mas, mas  
pin, tenen ru  
soso ki 'pin'

s13 ▶ + A mas pin  
ina inom

Annotations Search Rights

Filter

Match (All) ▾

Creator: ▾

Text Contai... ▾

Resource U... ▾

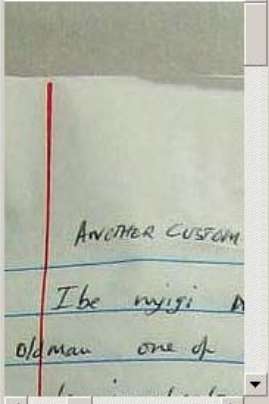
Language: ▾

Created Af... ▾

Created Be... ▾

- Is that a stick?
- Paradisec
- Elderly woman of a South Pacif
- Where is this set?
- What language is this?
  - Question created by ronak
  - Re: What language is this?
    - Reply created by ronak
    - Re: Re: What language is this?
      - Reply created by ronak
      - Re: Re: What language is this?
        - Reply created by ronak
- Hand written transcript
  - Comment created by ronak
- Incorrect context?
- What is this?
- Annotation
- Marilen's Annotation
  - Comment created by marile

Body Policy Other Info



Annotation Selected

Annotea Timeline

00:00:00 00:00:14 00:00:28 00:00:42 00:00:56 00:01:10 00:01:24 00:01:38 00:01:52

michael

marilen

ronalds

imrank

Paused 0 00:00:00:00 00:00:00:00

Paused 55480 00:01:32.46 00:01:52.88

Annotea Timeline Jabber Client Record and Replay Jabber Chat



Microsoft Internet Explorer - cBrowser

File Edit View Favorites Tools Help

Address: http://datura.itee.uq.edu.au/mjh/cBrowser/

Annotations Search Rights

Search: Simple Advanced

Match:  All  Any

Created Between:   
 Language:   
 Resource URL: http://c   
 Text Contains:   
 Creator:

Reset Run

- Wat 1 (N)   
 - Wat2 confirmation   
 - p-octopamine   
 - Overview   
   - Comment created by michael on 2006-03-2   
   - Re: Overview   
   - Re: Overview   
 - B-hydroxyethylamine constriction   
 - p-octopamine annotation   
 - Simulated Annealing   
 - Wat1   
 - p-octopamine comment   
 - human PNMT structures   
 - [R]-p-octopamine   
 - Overview of 2AN3

Body Policy Other Info

We're going to report three crystal structure complexes of human phenylethanolamine N-methyltransferase (PNMT). One bound with substrate that incorporates a flexible ethanolamine side chain (p-octopamine), a second bound with a semirigid analogue substrate [cis-(1R,2S)-2-amino-1-tetralol] and a third with trans-(1S,2S)-2-amino-1-tetralol, that

PDB Search Fedora JMol Annotate Annotations Annotation Graph Debug Licensing FOAF Demo

Layout: Auto Arrange

JMol JMol

JMol: 3D ball-and-stick model of a protein-ligand complex. The protein is shown as a grey ribbon structure, and the ligand is shown as a ball-and-stick model with atoms colored by element (carbon in grey, oxygen in red, nitrogen in blue).

JMol: 3D ball-and-stick model of a protein-ligand complex, showing a different view or zoom of the same structure.

Annotation Graph: A graph showing relationships between annotations. Nodes include "p-octopamine", "Overview", "Re: Overview", and "Re: Re: Overview". Arrows indicate relationships between these nodes.

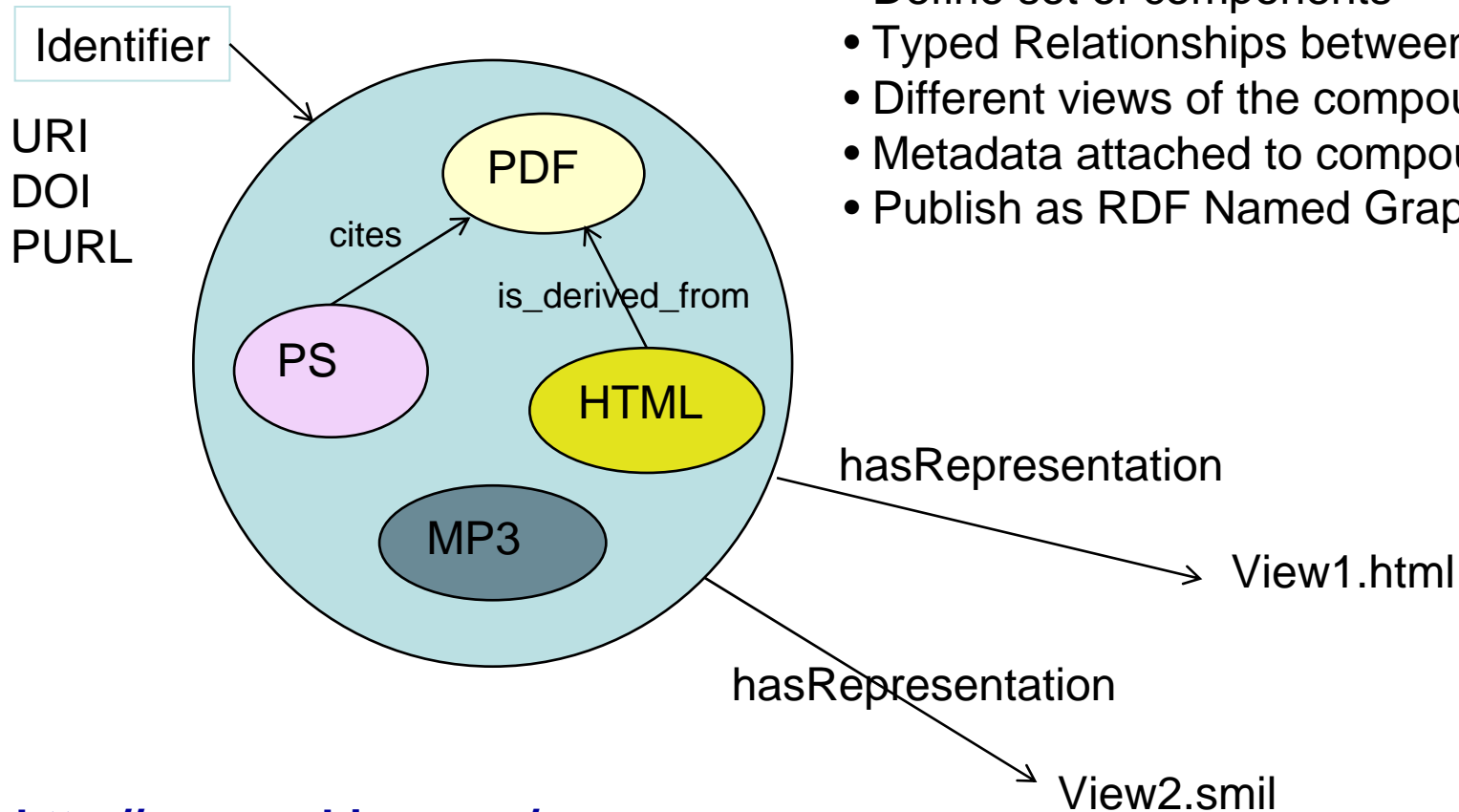
Licensing: Adds descriptive RDF to new annotations, describing how it may be reused.
   
 All Rights Reserved
   
 CC By
   
 CC By-NC
   
 Public Domain
   
 Also:
   
 Creative Commons RDES schema

FOAF: Your FOAF Profile:
   
 http://maenad.itee.uq.edu.au/
   
 Creator of current annotations:
   
 todo

Annotate
   
 Current selection
   
 Current camera
   
 Both

# OAI-ORE - Complex Compound Objects

<http://arXiv.org/astro-ph/061175/>



OAI/ORE Named Graphs/Resource Maps:

- Define set of components
- Typed Relationships between components
- Different views of the compound object
- Metadata attached to compound object
- Publish as RDF Named Graph

<http://openarchives.org/ore>

# OAI-ORE Compound Objects

The screenshot displays the OAI-ORE Graph interface, which visualizes a network of resources and their relationships. The main area shows several resource nodes connected by labeled edges. The nodes include:

- A photograph resource: <http://austlit.edu.au/images/austLit/dorispsml.jpg>
- An agent resource: [http://austlit.edu.au/run?ex=ShowAgent&agentId=A\)6h](http://austlit.edu.au/run?ex=ShowAgent&agentId=A)6h)
- A work resource: <http://austlit.edu.au/run?ex=ShowWork&workId=CwVk>
- A Wikipedia article resource: [http://en.wikipedia.org/wiki/Stolen\\_Generations](http://en.wikipedia.org/wiki/Stolen_Generations)
- A YouTube video resource: <http://au.youtube.com/v/AWJNAIqy&vw>
- A metadata resource: <http://nla.gov.au/nla.aus-vn672744-2x-...>

The relationships between these resources are as follows:

- The photograph resource is **is\_image\_of** the agent resource.
- The agent resource **is\_author\_of** the work resource.
- The work resource **is\_dramatization\_of** the Wikipedia article resource.
- The work resource **has\_as\_subject** the YouTube video resource.
- The Wikipedia article resource **has\_as\_sub** the metadata resource.
- The YouTube video resource **is\_excerpt\_from** the Wikipedia article resource.

On the right side, the Properties panel shows a table of metadata for the selected resource:

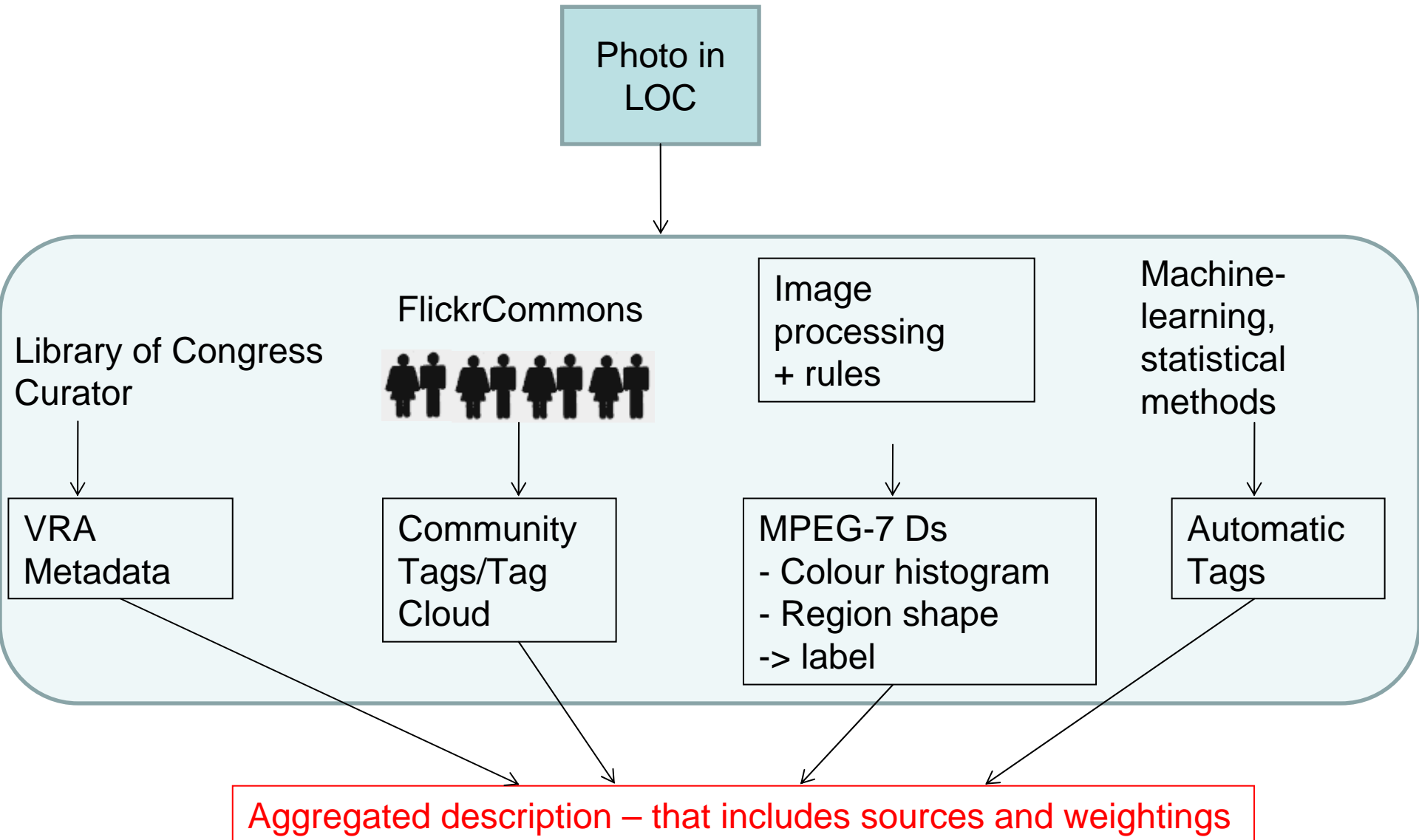
Name	Value
dc:creator	http://tee.uq.edu.au/~agerber
dc:description	Resources relating to the film Rabbit-F
dcterms:created	2008-10-13
dcterms:modified	10/17/2008
ore:describes	#aggregation
rdf:about	http://austlit.edu.au/rem/rpf
rdf:type	http://www.openarchives.org/ore/ter

# Future -> Hybrid Approaches

- Traditional authoritative metadata – high quality, expensive, hierarchical, rigid
- Combine with:
  - automatic low-level feature extraction – colour, texture, shape, pitch
  - social tagging – topical, cheap, flat, non-conformist
  - machine learning/statistical – need corpus
- Assign weightings based on:
  - reliability of source/method
  - social network information - FOAF



# Web 3.0 – Social Web meets Semantic Web





# Weighted Multimedia Metadata

## Source

## Weightings



Manual

### Bibliographic:

Title, Creator, Subject,  
Genre, Date\_created

High

### Formatting:

Format, encoding,  
storage, dimensions,  
hardware/software

High

### Life History/Provenance:

Events, Rights mgt.

Automatic



Manual

### Semantics:

People, place, objects,  
events, concepts

Low-Medium – depends on  
Trust rating

Machine Learning  
Bayesian  
Neural Network  
Statistical

Semi-Automatic

### Structural:

Regions, Segments

Medium

### Content:

Description, Transcript  
Colours, Textures  
Shapes, Motion  
Pitch, Tempo, Volume

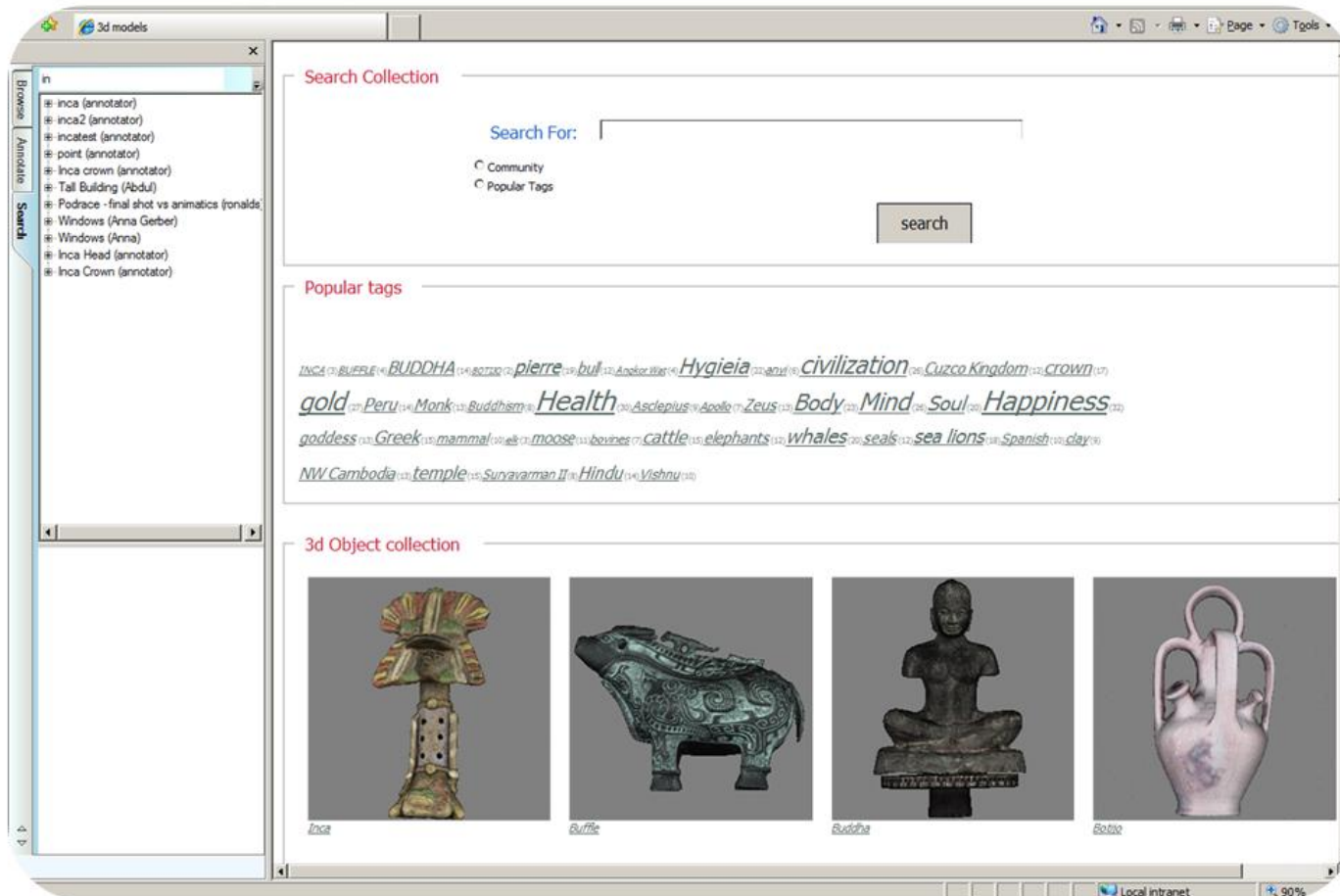
Medium

Automatic

Image Processing  
Audio Processing

# Hybrid Search and Browse Interfaces

- Tag Clouds + Ontology-based querying
- Combined keyword plus descriptor (e.g., shape) searches
- SPARQL + spatio-temporal search interfaces
  - Give me sub-tropical rainforests in S-E Qld above 3000m with reduced rainfall and containing endangered species



# Future Research Challenges I

Increasing volumes of community-generated content +  
community generated metadata/annotations  
in multiple formats



Challenges –

1. Identify relationships between resources on the Web (is\_about)
2. Extract structured information/metadata/tags from unstructured sources (RDFa?)
3. Assign trust or reliability weighting based on the source

- how to crawl blogs and identify discussions around particular videos
- how to extract structured information about the video/image from a blog

# Future Research Challenges II

## Multimedia search engines that support:

- Ontology-based searches
  - Ontology is dynamic – incorporates folksonomies over time
  - Combined with content-based, QBE, spatio-temporal searches
- Dynamic inferencing – rules change over time
- Identification of your social network and trust metrics
- Ranking of results based on:
  - tags assigned by users from same social networks
  - weightings applied to metadata that reflect reliability, precision

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# Questions?

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