Multimedia and Semantic Web

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Outline

- Semantic web and MPEG-7
- Multimedia ontology
- Semantic analysis
- Ontology learning

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Semantic web (in one slide!)

- Annotated resources on the web
- Machine interpretable resources
- Semantic web jargon
  - Resource Description Framework (RDF)
  - RDF Schema, Web Ontology Language (OWL)

MPEG-7

- Metadata standard for multimedia documents
- Comprehensive suite of metadata descriptors
  - Low-level features
  - Structural aspects
  - Semantic aspects
  - Storage format, encoding
  - ...
- Goals
  - Machine interpretable resources
  - Efficient search and retrieval

Problems with MPEG-7

- Emphasis on low-level and structural features
- Not rich in semantics (objects, relationships, events)
- Lack of interoperability with semantic web standards
  - Uses XML Schema as the description language

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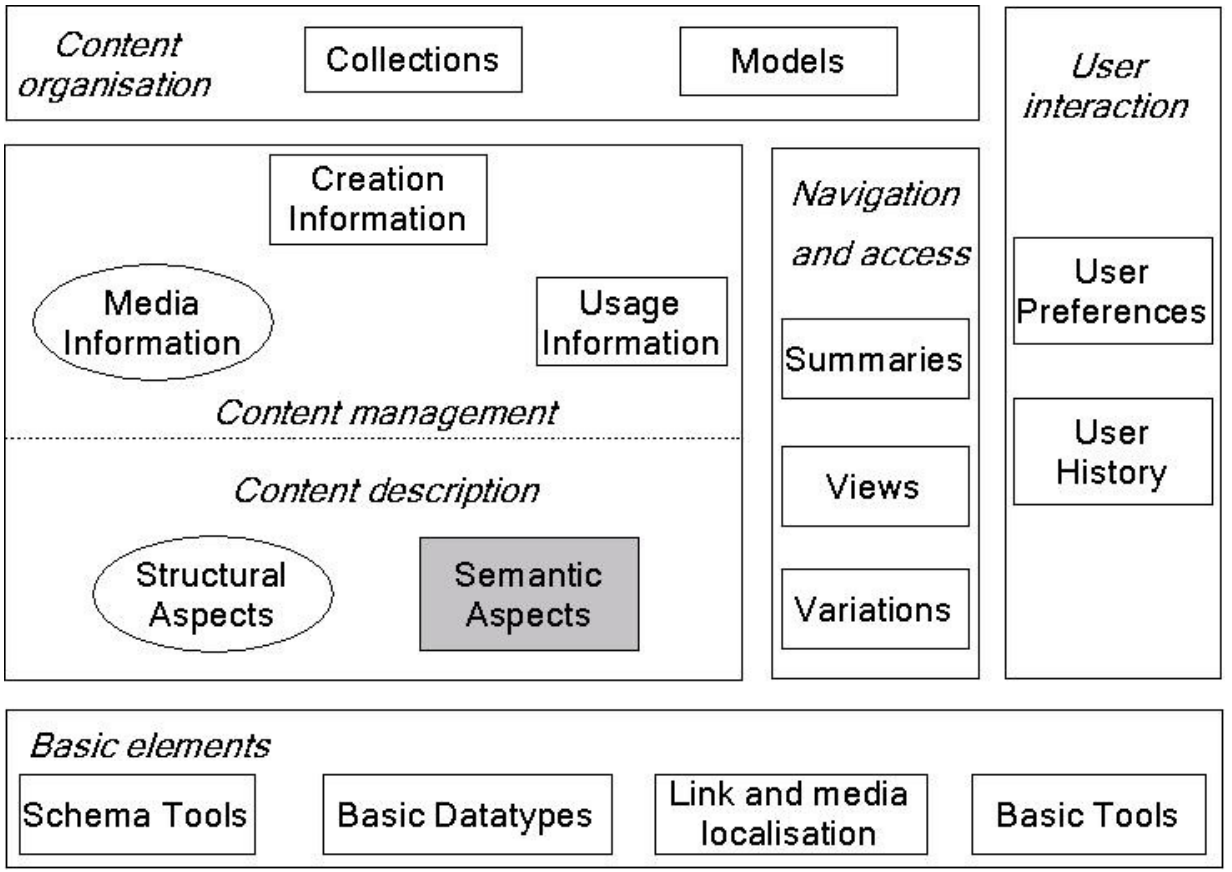
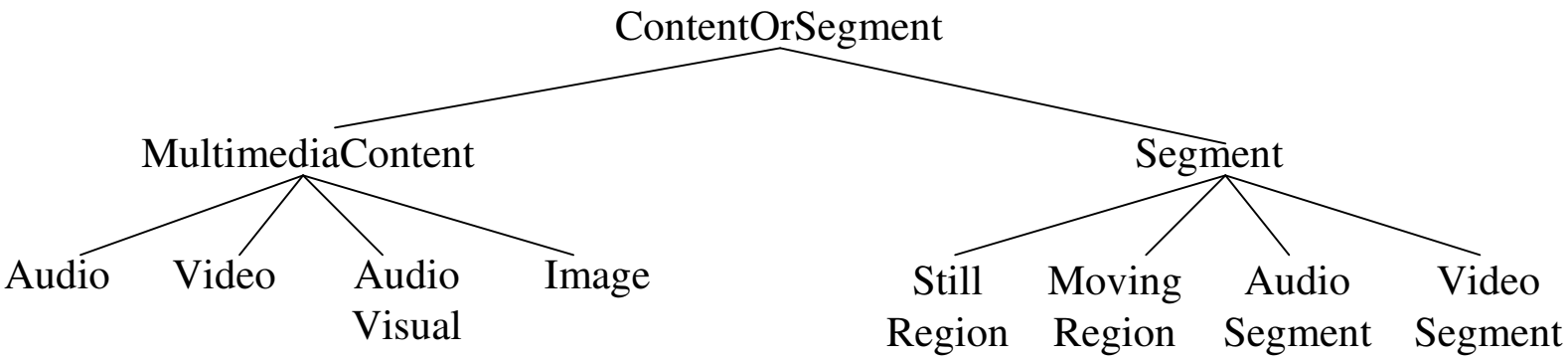
Design approaches (Vembu *et al.* 2006)

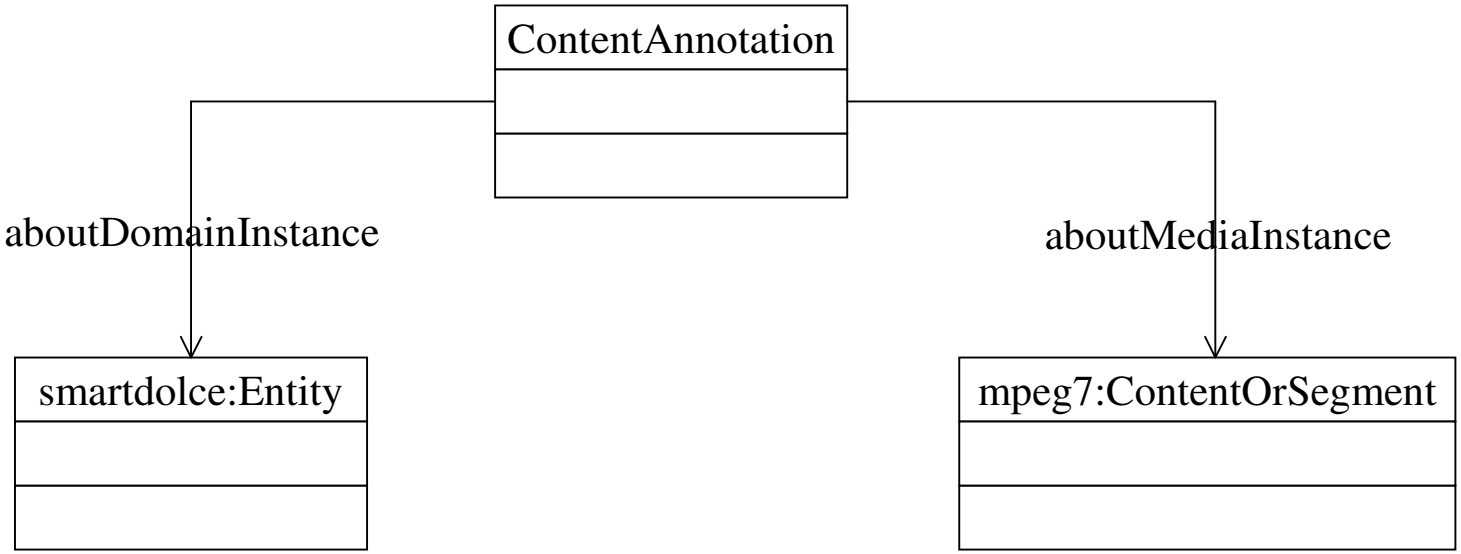
- Semantic web + MPEG-7 = Multimedia ontology
- Map MPEG-7 to RDFS or OWL (Hunter 2001)
- (a) Use MPEG-7 to model low-level and structural aspects of multimedia
- (b) Use domain-specific ontologies to model semantics of the domain (eg: sports)
- Merge (a) and (b)

MPEG-7 MDS (taken from the specs)



SmartMedia ontology





Multimedia plugin for Protege

What next?

- Multimedia ontologies are in place
- Annotation of multimedia content is possible
- (semantic) Web search is possible
  - Text-based queries
- BUT...

What next?

- Who annotates the content?
  - Manual annotation ☹
- Need to (semi)automate the annotation process
  - Using machine learning approaches
  - Using content-based retrieval techniques

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Semantic analysis

- Annotation with low-level MPEG-7 features is possible
- Annotation at a semantic level of abstraction is non-trivial
  - Identify concepts in images
  - Identify events in videos

Probabilistic models (Naphade *et al.* 1998)

- Multijects: Probabilistic multimedia objects
  - Visual concepts: *sky, water, forest* etc.
  - Audio-visual concepts: *explosion, waterfall*
- Multinet: Bayesian network of multijects
  - Models the relationship between concepts

Probabilistic models (Barnard *et al.* 2003)

- Probabilistic models of text and images
  - Uses captions found in image databases
- Uses multi-modal extensions of LDA
  - Latent Dirichlet Allocation: Topic model for semantic analysis of text documents
- Text-based annotation and *querying* is now possible

Concept classifiers (Vogel and Schiele 2006)

- Classifies local image regions into concepts
  - *sky, rocks, flowers* etc.
- No segmentation step
  - Uses a 10*10 grid on the image
  - Classifies each grid point into a concept class
  - Concept-occurrence vector
- Notion of semantic similarity

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Ontology learning

- Why learn ontologies?
  - Knowledge acquisition bottleneck
- Data-driven acquisition of knowledge
- Ontology learning from text
  - Abundance of text data on the web
  - Uses NLP techniques
  - (Tutorial at ECML/PKDD 2005)

Challenges, Open questions

- Multimedia ontology population
- Multimedia ontology learning (Karkaletsis *et al.* 2005)
- To what extent is it possible to extract metadata descriptors from multimedia documents so as to enable their subsequent search and retrieval using semantic web technologies?

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- SmartWeb project
  - http://www.smartweb-project.org
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Are we ready to embrace the semantic web?