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Application of Ontologies in Imaging Past and Present

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Disclosures

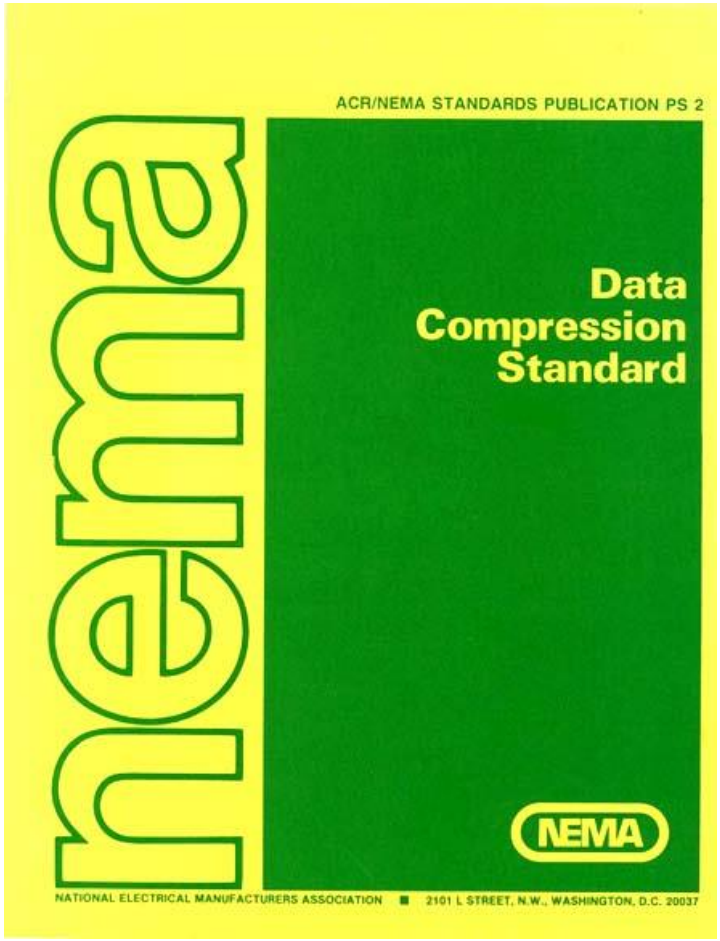
- Most of my work is funded by NCI/NIH and NSF through a variety of grants and contracts
- I periodically consult with other organizations (principally academic) on setting up research image repositories.
- I occasionally get reimbursed for travel expenses when doing AAPM business (e.g. in the DICOM Standards Committee)

Is DICOM an Ontology?

- In a way, but
- To understand, we need a bit of history

ACR-NEMA Standard

- Work starting in 1982 at the request of ACR
- Vendors were reluctant at first
- First edition published in 1985
  - prior to the publication of TIFF
  - Ethernet was just coming out of the labs
  - “The web” did not exist
  - “Semantic Integration” was not a buzz word
- Minor updates in later half of 1980s



Issues With the ACR-NEMA Standard

- Very CT and MR centric
- Non-standard interface (50 pin connector)
- Limited services – essentially just a transfer format
- Versioning was an issue – limited backwards compatibility
- Inconsistent use of data dictionaries and structures led to issues with interoperability

Birth of DICOM

- Work began late 1980s culminating with first publication end of 1992
  - Early work on the World Wide Web had begun
  - “Object Oriented Programming” was just starting to appear
- Focus was
  - Interoperability - data structuring
  - Data object exchange (i.e. still just for transferring data)
  - Tying objects (bundles of info) with services (what to do with the info)
- Real World & Virtual Models, beginnings of terminology lists

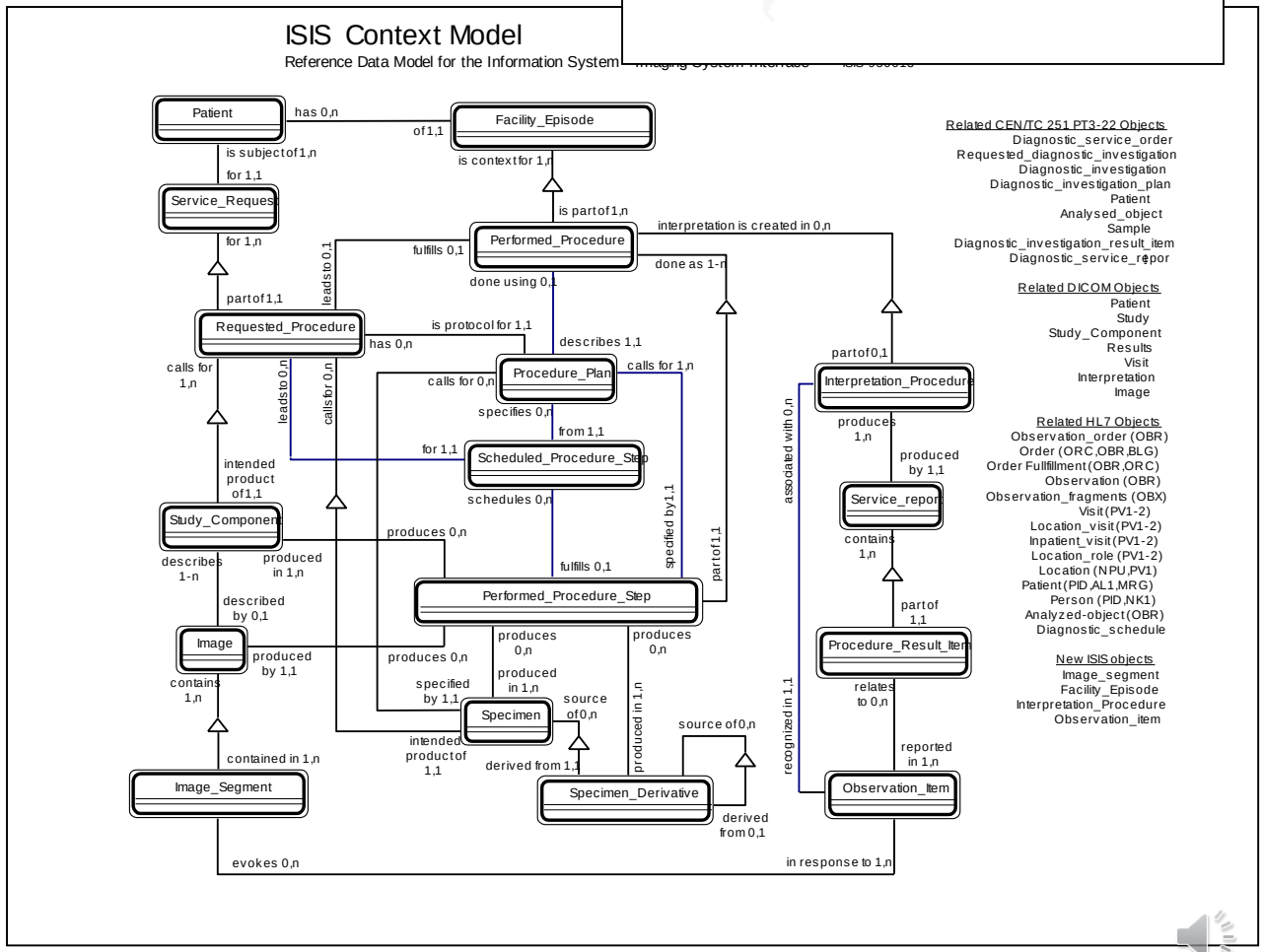
Expanded Modeling

- Mid 1990s
- Dr. Dean Bidgood – Pioneer
- HL7 discussions – RIM (Reference Information Model)
- Led to the concept of “Structured Reporting”

ISIS: Reference Data Model
Information System - Imaging System Interface

W. Dean Bidgood, Jr., M.D.

ANSI HISPP Joint Working Group
for Diagnostic Image Communication



Structured Reporting

- Evolve from hierarchical sets of Attributes (aka Data Elements) to more complex relationships between Attributes
- DICOM Part 16 – “Content Mapping Resource”
  - Defined report templates
  - Incorporated controlled terminologies organized into Context Groups
- Functionally similar to ontologies, but …
  - Does not use modern ontological specifications – the specification is DICOM-specific
  - The DICOM-specific specification hampers interoperability with other ontologies
  - Proposals floating about to remedy this situation

Terminology Use in DICOM

- DICOM organizes terminology into “Context Groups” – sets of terms that are used to fill in the values for Data Attributes
  - Used in Information Object Definitions (IODs – defined in Part 3)
  - Also used in reporting templates (Part 16)
- Terms identified by a code triplet
  - Coding Scheme (with optional version info)
  - Code Value (computer readable)
  - Code Meaning (default human readable)

Coding Schemes Used by DICOM

- Over 60 coding schemes defined for use in DICOM
- Many more included by reference through HL7
- SNOMED CT is the preferred coding scheme in DICOM
- Other coding scheme may be used if
  - no suitable code is found in SNOMED CT
  - the application domain requires a different coding scheme
- DICOM does define its own terminology when needed or deemed desirable

Besides DICOM, what else is out there?

RadLex

- A lexicon of terms developed by RSNA
- Focused on Radiology
- Includes the RadLex Playbook listing radiographic procedures
- Referenced by DICOM

Open Microscopy Environment (OME)

- Describes 5D image data (x, y, z, channel, time), including ROIs and light paths
- Focused on optical microscopy, but branching out
- Extensible to structured annotations
- Expressed in an XML Schema, not as an ontology in a standardized format

Quantitative Imaging Biomarkers Ontology

- An RSNA effort inspired by NIH to define characteristics “that is objectively measured as an indicator of normal biological processes, pathological changes, or pharmacologic responses to a therapeutic intervention.”
- Biomarker data and information not standardized originally
  - Effort started to represent the data as an ontology
  - Effort stalled due to lack of funds

Radiology Gamuts Ontology (RGO)

- 16,000 terms linked by >55,000 relations describing differential diagnosis (gamuts)
- Potential uses include
  - Clinical decision support
  - Medical education
  - Analysis of clinical radiology reports
- Sadly, the ontology itself is not publicly

OntoNeuroLOG

- Targeted towards neuroimaging
- Used for the French NeuroLOG project, which attempted to harmonize heterogeneous data from multiple sources
- Extension of the DOLCE ontology
  - Impacts interoperability since DOLCE is not commonly used

Open Annotation (OA) Core Model

- OAs consist of triples (subject-predicate-object) expressed in Resource Description Framework
- Distinguishes between
  - a resource that identifies the area of interest
  - a resource that describes how to extract it from the original data
- Allows for integration with other ontologies

Ontology for Biomedical Investigations

- Part of the Open Biological and Biomedical Ontologies (OBO) Foundry initiative
- Free distribution (Creative Commons license)
- Assumes 4 investigative steps:
  1. Collecting Specimens
  2. Preparing Specimens
  3. Taking Measurements
  4. Analyzing the Measurements
- Limited terms relevant to medical imaging and pathology

Other Efforts

- Proposal made for the creation of a suite of image ontologies conformant with the principles of the OBO Foundary
  - I have not heard if there is much traction for the proposal
- AAPM Big Data Subcommittee is working on ontologies targeted to medical physics

If interested, get involved!