Collection/Item Metadata Relationships

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Why collection-level metadata is important

- Collections are designed to support research and scholarship.

- Toward this end collection descriptions indicate such things as:
  - *purpose*
  - *subject*
  - *method of selection*
  - *spatial/temporal coverage*
  - *completeness*
  - *representativeness*
  - *summary statistical features*

    …etc.

- These descriptions enable collections to function as more than simply aggregates of items,
  - as intended by their creators and curators
  - as required by their users

But unfortunately….

Collection-level metadata is poorly understood and accommodated

Most retrieval systems flatten the world, ignoring collection context

Retrieval systems that do use metadata use only item-level metadata

Even simple discovery is impeded:

If the *owner* of a collection is indicated only at the collection-level, then retrieval accessing only item-level metadata…

— cannot usefully process queries constrained by owner

— cannot display the owner of item in the result set

Origins of our focus on this problem: DCC

IMLS Digital Collections and Content

University of Illinois at Urbana-Champaign
Grainger Library &
Graduate School of Library and Information Science
Funded by IMLS, 2003-2007
Timothy Cole, Principal Investigator
Carole L. Palmer, Sarah L. Shreeves, Michael B. Twidale, Co-Investigators

Deliverables…

- a *collection metadata* schema
  Based on RSLP CD and concurrent work on *DC Collection Application Profile*.
- a *collection-level metadata registry*
  for 202 IMLS digital collections.
- an *item-level metadata repository*
  76 collections harvested using OAI-PMH.
- an *experimental portal* for searching aggregated metadata.
  [http://imlsdcc.grainger.uiuc.edu]

Among the research findings:

Users need collection-level information, for discovery and understanding

(Palmer & Knutson, 2004;
Foulonneau et al. 2005;
Palmer, et al. 2006)

But what information?

And how to provide it?

So we included this problem in our next IMLS proposal…

Climax Miners, Leadville, CO. Courtesy Colorado School of Mines

The new project

In 2007 the DCC received a new three year IMLS grant

Carole L. Palmer, Principal Investigator
Timothy Cole, Allen H. Renear, Michael B. Twidale, Co-Investigators

A major deliverable:

> ***show how a formal description of collection/item metadata relationships can help registry users locate and use digital items across multiple collections.***

CIMR: Collection/Item Metadata Relationships

Three phases:

1) Develop a logic-based framework of collection/item metadata relationships and inference rules.
2) Conduct empirical studies to see if the framework matches the behavior of metadata specification designers, metadata creators, and registry users.
3) Implement pilot applications to support searching, browsing, and navigation; including RDF/OWL formulations and inference rules.

Our initial focus is on the *Dublin Core Collections Application Profile (DCCAP).*

Where we are now

Phase 1:

Develop a logic-based framework of collection/item metadata relationships and inference rules.

The next few slides…
three simple examples of collection/item metadata relationships

Attribute/Value Propagation: *marcrel:OWN*

Consider the DCCAP metadata element **marcrel:OWN**…

Plausibly: whoever owns a collection owns each of its items

We say that metadata attributes with this behavior *a/v-propagate*.

Informal definition

an attribute *a/v-propagates* =df
if a collection has some value for the attribute then
each item in the collection has the same value for that attribute.

Or, in first order logic:

An attribute **A** *a/v-propagates* =df

$$\forall x \forall y \forall z\ [(\mathrm{IsGatheredInto}(x,y)\ \&\ \mathrm{A}(y,z)) \supset \mathrm{A}(x,z)\ ]$$

[IsGatheredInto(x,y) is adapted from from the DCMI DCCAP.]

Value Propagation: *cld:itemType / dc:type*

Consider the DCCAP metadata element **cld:itemType**.*

*a refinement, assuming homogeneous collections and no repetition of elements.

cld:itemType* does not a/v-propagate…

However,

if a collection has a value for cld:itemType* then
each of its items has the same value for *dc:type.*

We call this *v-propagation.*

Informal definition

an attribute *v-propagates* =df
if a collection has some value for the attribute then
each item in the collection has that value for some other attribute.

Or, in first order logic:

An attribute **A** *v-propagates* to an attribute **B** =df

$$\forall x \forall y \forall z\ [(\text{IsGatheredInto}(x,y)\ \&\ \mathbf{A}(y,z)) \supset \mathbf{B}(x,z)\ ]$$

Value Constraints: *cld:dateItemsCreated / dcterms:created*

cld:dateItemsCreated* does *not* a/v propagate

nor does it v-propagate to dcterms:created

However,

if a collection has a temporal range for cld:dateItemsCreated*, then its items may not have values for dcterms:created that fall outside that range.

this is a *constraint*: the value of dcterms:created must be *temporally-within* the range given by cld:dateItemsCreated*

Informal Definition

an attribute A *v-constrains* an attribute B with respect to constraint C =df if a collection has the value *z* for A and an item in the collection has the value *w* for B, then *w* is related to *z* by C.

In first order logic:

An attribute **A** *v-constrains* an attribute **B** with respect to a constraint **C** =df

$$\forall x \forall y \forall z \forall w\, [(\mathrm{IsGatheredInto}(x,y)\ \&\ \mathbf{A}(y,z)\ \&\ \mathbf{B}(x,w)) \supset \mathbf{C}(w,z)]$$

How will the framework help?

- *Metadata specification developers* use the framework to classify metadata elements in their specifications.
- *Metadata librarians* use these classifications to confirm their understanding of the metadata elements they are assigning.
- *Software architects* use these classifications to guide the configuration of inferencing features in retrieval systems.

What is missing?

A completed shared framework

... a project for the community

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Prior work? Of course.

- Relationships such as those just described have been studied elsewhere — which is a good thing.
- However as far as we know no one has focused on the *IsGatheredInto* relationship.

Some research questions

- how many relationship categories are there?
- which metadata attributes fall into which categories?
- when does propagation convert information without loss?
- what about propagation from items to collections?
- how expressive a logic is needed for propagation rules?
  - how much of first order logic?
  - what extensions to first order logic? (modal, default, …?)
  - what are the consequences for computational efficiency?

One result: Finishing the job requires modal logic

An attribute A *a/v-propagates* =df

I. a) $\Diamond\, \exists y \exists z\, [\mathrm{Collection}(y) \;\&\; \mathrm{A}(y,z)] \;\&$

b) $\Diamond\, \exists x \exists z\, [\mathrm{Member}(x) \;\&\; {\sim}\mathrm{A}(x,z)] \;\&$

c) $\Diamond\, \exists x \exists y \exists z\, [\mathrm{A}(x,z) \;\&\; {\sim}\mathrm{A}(y,z)] \;\&$

II. $\Box\, \forall x \forall y \forall z\, [(\mathrm{IsGatheredInto}(x,y) \;\&\; \mathrm{A}(y,z)\,) \supset \mathrm{A}(x,z)\,].$

See: The Return of the Trivial: Formalizing collection/item metadata relationships. Renear, A.H., Wickett, K.M., Urban, R.J., and Dubin, D. *Proceedings of the 8th ACM/IEEE-CS Joint Conference on Digital Libraries*. ACM Press, New York 2008.

Most importantly: Non-Reducible Collection Attributes

- Some vital collection-level attributes resist conversion to item-level attributes

- Examples are metadata indicating that a collection

  -- is complete or incomplete
  -- is representative (in some respect)
  -- is heterogeneous with respect to genre or type of object, etc.
  -- was developed according to some particular method
  -- was designed for some particular purpose
  -- has certain summary statistical features

  …. *and so on*.

- These are tightly tied to the distinctive role a collection is intended to play in the support of research and scholarship.

- If this information is inaccessible, the collection cannot be useful, as a collection, in the way originally intended by its creators.

Questions?

We are just getting started and welcome comments and advice.

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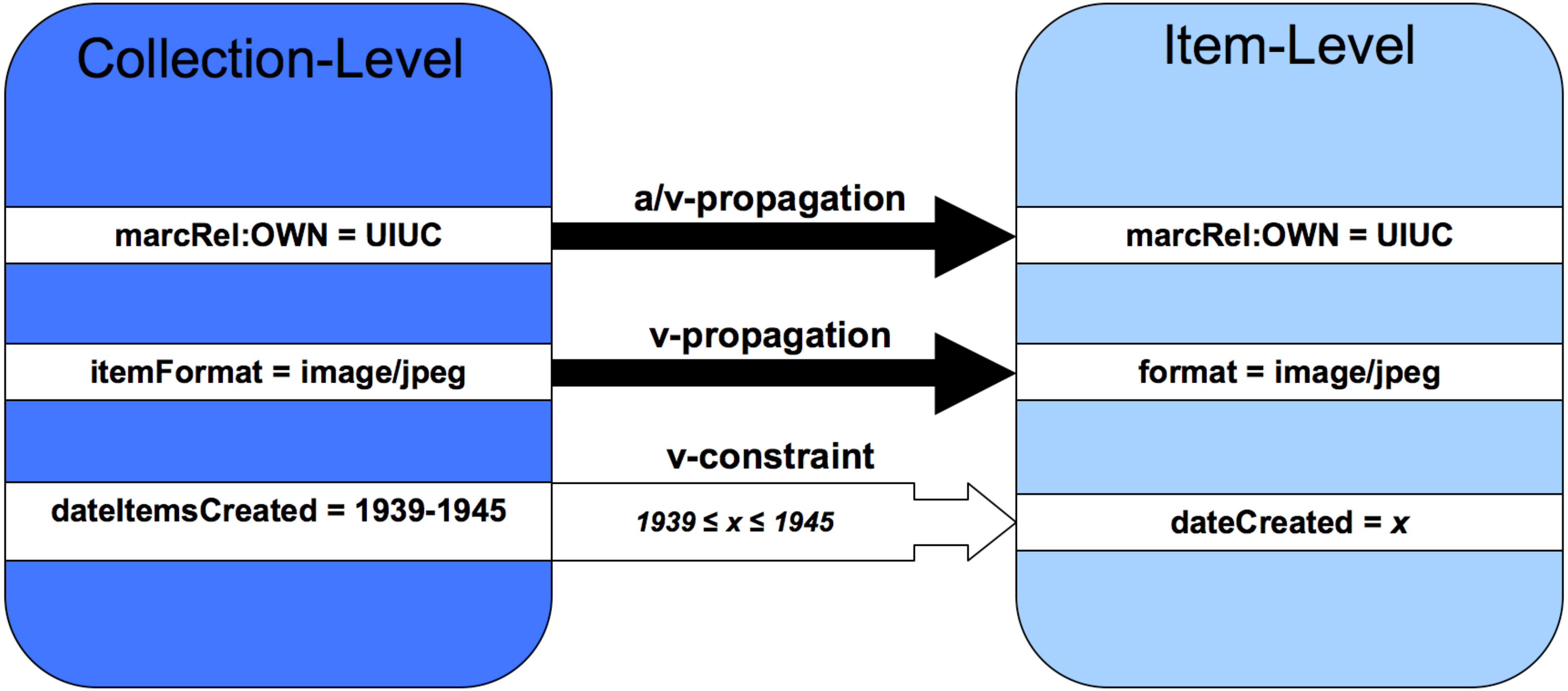
Examples of collection/item metadata relationships



Collection-Level

marcRel:OWN = UIUC

itemFormat = image/jpeg

dateItemsCreated = 1939-1945

a/v-propagation

v-propagation

v-constraint

1939 ≤ x ≤ 1945

Item-Level

marcRel:OWN = UIUC

format = image/jpeg

dateCreated = *x*

But unfortunately….

Collection-level metadata is poorly understood and accommodated

Cabinet Photograph of Lincoln Home Parlor. Courtesy Lincoln Home Historic Site.

NB: Propagation is *not* “inheritance”

IsGatheredInto

is neither

subclassOf

nor

instanceOf

Our use of “propagation” follows Brachman (1991)

Table Showing Contraband Items. Colorado State Penitentiary.
Courtesy Cañon City Public Library