

Introduction

A Tutorial/Talk

There are two types of slides in this file:

- A. The slides shown during the presentation
- B. Slides that provide background or additional information. These are designated by a blue band at the top of the slide.

Paging through this PDF file will reproduce the build-up sequentiality of some slides

Re-Imagining
The Bibliographic Universe:
FRBR, Physics & The World Wide Web

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*In Collaboration with
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Washington DC
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Introduction

A Tutorial/Talk

- One – Resources & Resource Description
- Two – Imagery in Scientific, Artistic, and Creative Thought
- Three – Modeling the Bibliographic Universe with FRBR
- Four – Paper Tools & FRBR's Future
- Five – The World Wide Web, The Semantic Web & A Trading Zone

Interesting Times Lie Ahead For Cultural Heritage Institutions

- There have been tremendous increases in types, qualities, and quantities of resources bidding for custodianship by and access through Cultural Heritage institutions
- The scope and flexibility of existing bibliographic resource description and resource management systems is being challenged
- Significant changes in modes of user discovery and access are being demanded by patrons
- There is a continued emergence of effective *and popular* complementary/alternative/competitive resource discovery and access systems

Interesting Times Lie Ahead For Cultural Heritage Institutions

- In the Cultural Heritage community, efforts to update and/or rethink traditional resource description (cataloging, archival, museum) theories are underway
- Coexistence, collaboration, and/or competition in this new information description, discovery, and access environment all require a clearer understanding of the ideas underlying (Cultural Heritage) resource description.
- These ideas inform Cultural Heritage and other varieties of resource description practice, and they guide theory formation, education/training, and information system design

Ideas to Explore During *Interesting Times*

- Functional Requirements for Bibliographic Records (FRBR)
 - a resource description theory
- FRBR theory focuses on describing - *and reasoning about* - bibliographic resources and relationships
- FRBR theory formation involved a technique not previously used for cataloging theory
- The visual imagery generated by FRBR theory – when shaped into a “Paper Tool” – can be employed to better represent and reason about simple and complex bibliographic relationships
- The Paper Tool approach can also be adopted by parties who prefer (or choose to combine) other Cultural Heritage resource description schemes

Figuring Things Out: What is Complicated and What is Practical?

- *About Theory Complexity* - The history of science recounts how physicists and other scientists *were obliged* to develop theories that reflected the complex nature of physical phenomena. They were by definition not more “complicated” than required

Figuring Things Out: What is Complicated and What is Practical?

- *About Theory Complexity* - The history of science recounts how physicists and other scientists **were obliged** to develop theories that reflected the complex nature of physical phenomena. They were by definition not more “complicated” than required

“It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience.” (A. Einstein)

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- ➡ That is: A theory should be as simple as possible - but not simpler!

What is *Complicated* and What is *Practical*?

- We assert that descriptions of Cultural Heritage creative expressions tend to fall into the category of “*not simpler*”
- Society has found these *creative expressions* sufficiently complex in structure, rich in meaning, and influential in the production of other creative expressions to warrant their collection, preservation, and presentation
- *Descriptions* of these resources should therefore be as elaborate as required in order to capture “relevant” attributes and relationships of those resources
- They should also coexist with resource descriptions that are deemed socially relevant - but are not created or managed by Cultural Heritage institutions

What is *Complicated* and What is *Practical*?

About Theory Practicality - Analog and digital media (and the physical facilities that host them) are based on theoretical and applied knowledge from a wide range of professions.

“There are increasing symptoms that leading practitioners in government, in agriculture, in industry, in education, in community life are becoming aware of the fact that a scientific level of understanding is needed, that the statement ‘nothing is as practical as a good theory’ holds also in the field of social management.”

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What is *Complicated* and What is *Practical*?

- *The Practicality of Theory* - World Wide Web researchers have come to appreciate Kurt Lewin's assertion: "*nothing is as practical as a good theory*:"

The Web is an engineered space created through formally specified languages and protocols. However, because humans are the creators of Web pages and links between them, their interactions form emergent patterns in the Web at a macroscopic scale.

These human interactions are, in turn, governed by social conventions and laws. Web science, therefore, must be inherently interdisciplinary; its goal is to both understand the growth of the Web and to create approaches that allow new powerful and more beneficial patterns to occur

What is *Complicated* and What is *Practical*?

*and to create approaches that
allow new powerful and more beneficial patterns to occur*

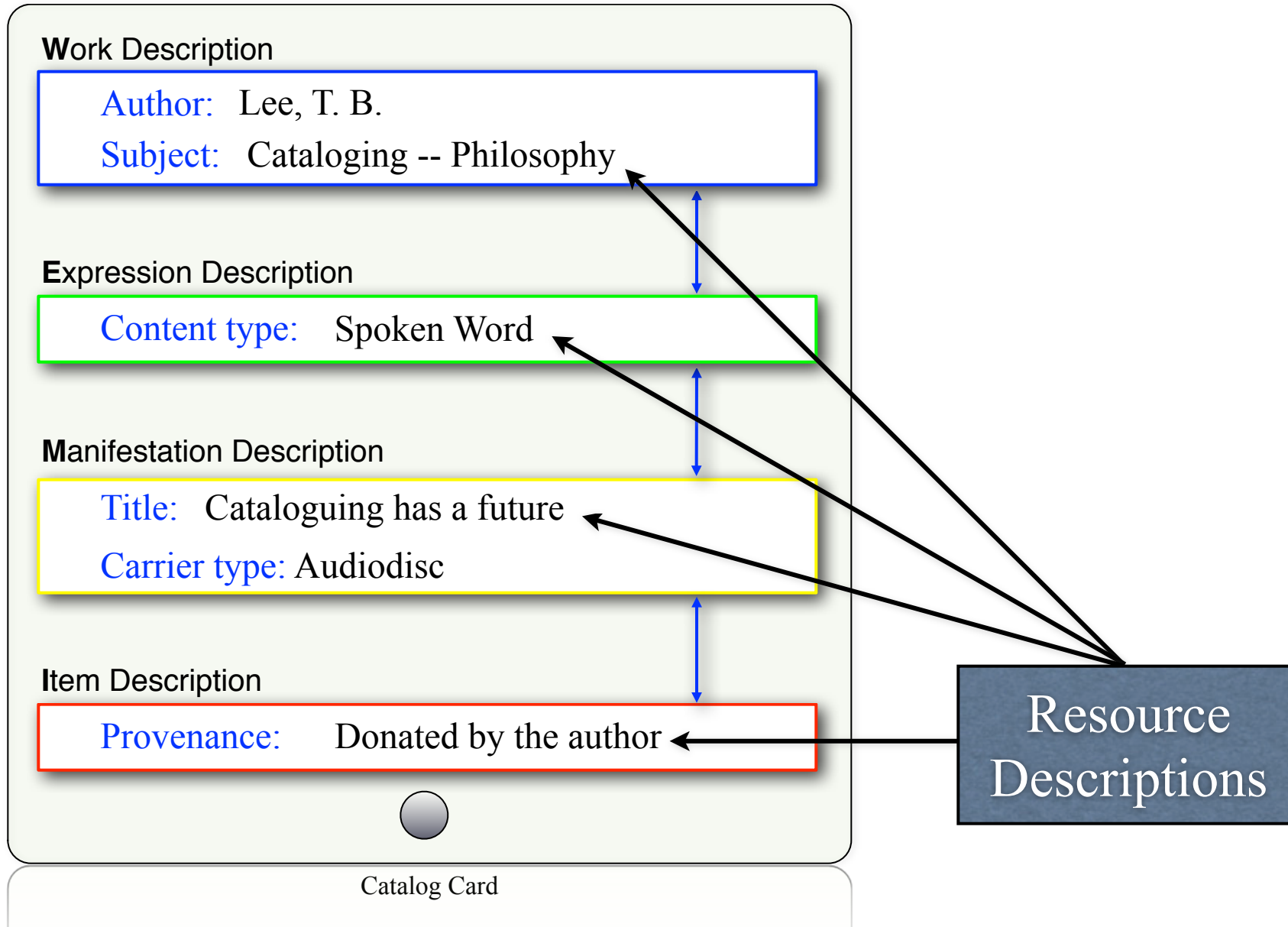
What is *Complicated* and What is *Practical*?

- Many creative expressions are *not* dense in construction and seriously intended - and deserve descriptions appropriate to their status. So as a general principle:
- A Cultural Heritage resource description theory must be flexible enough to encompass the full range of *expressive phenomena* that have appeared so far – and be prepared for extensions
- *Practicality & Complexity* - Creation and analysis of Cultural Heritage resource description theories and practices warrant a multidisciplinary perspective
- This presentation will present results that illustrate that model

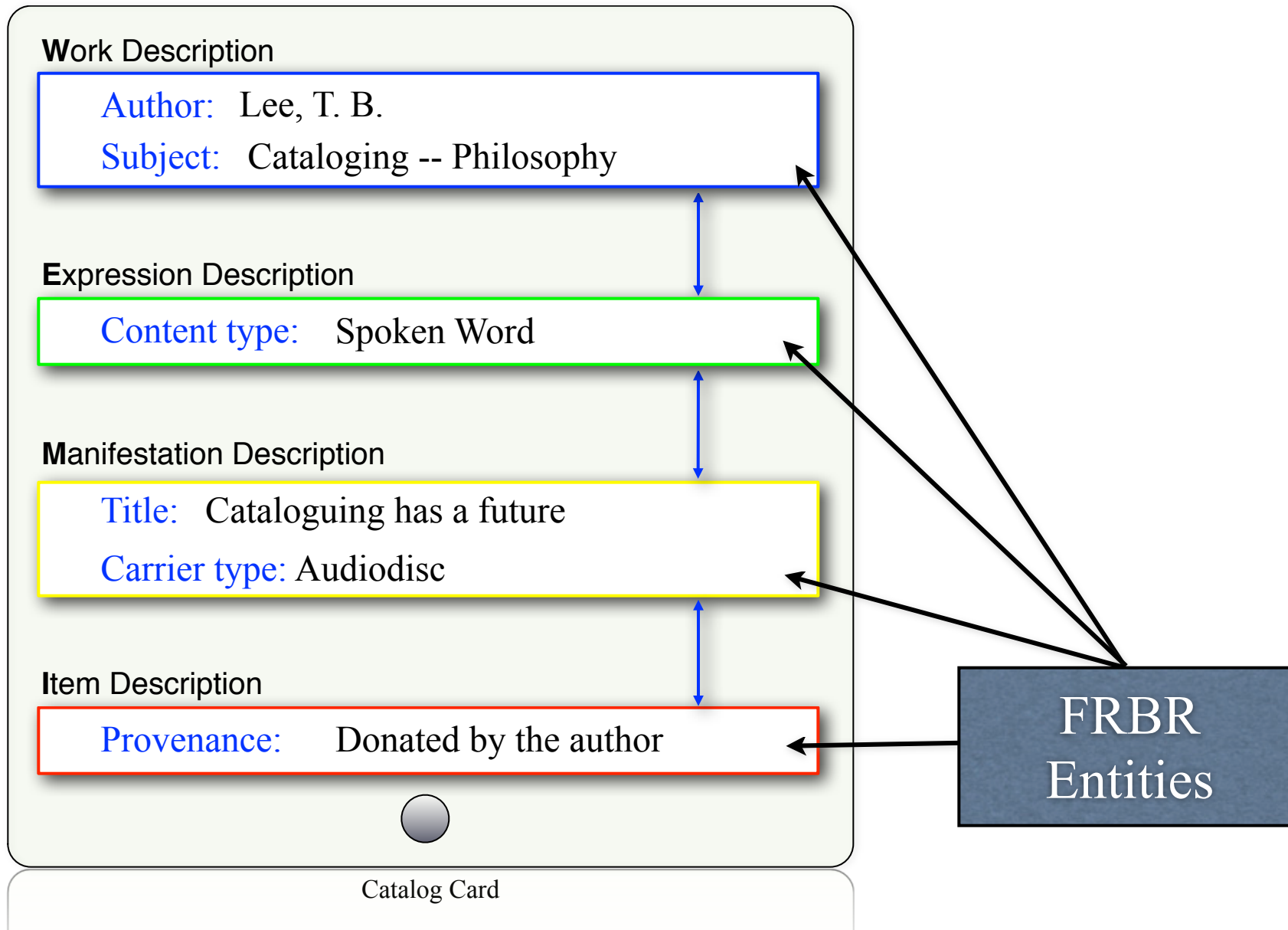
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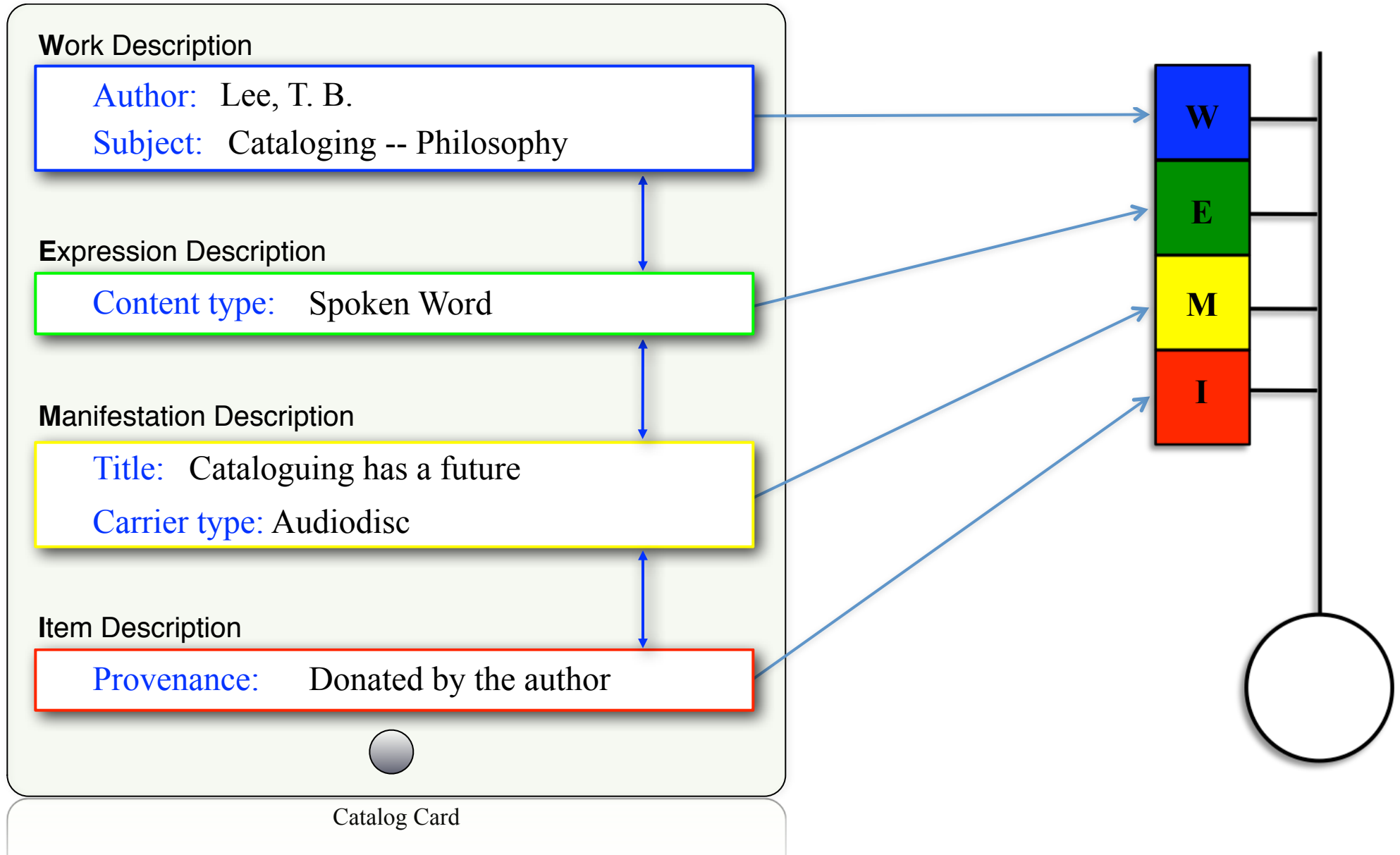
Where This Is Going: Seeing FRBR Theory Work



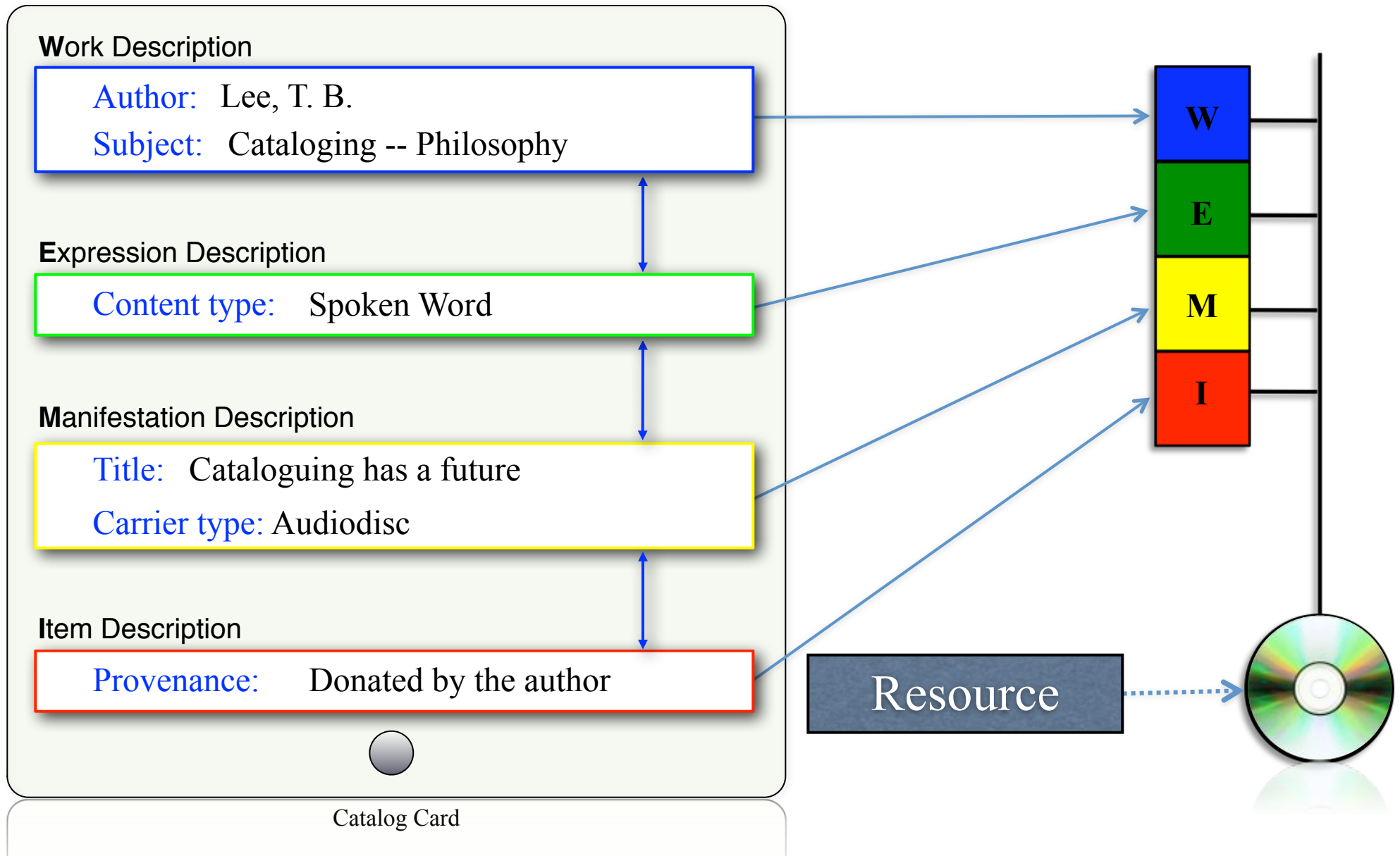
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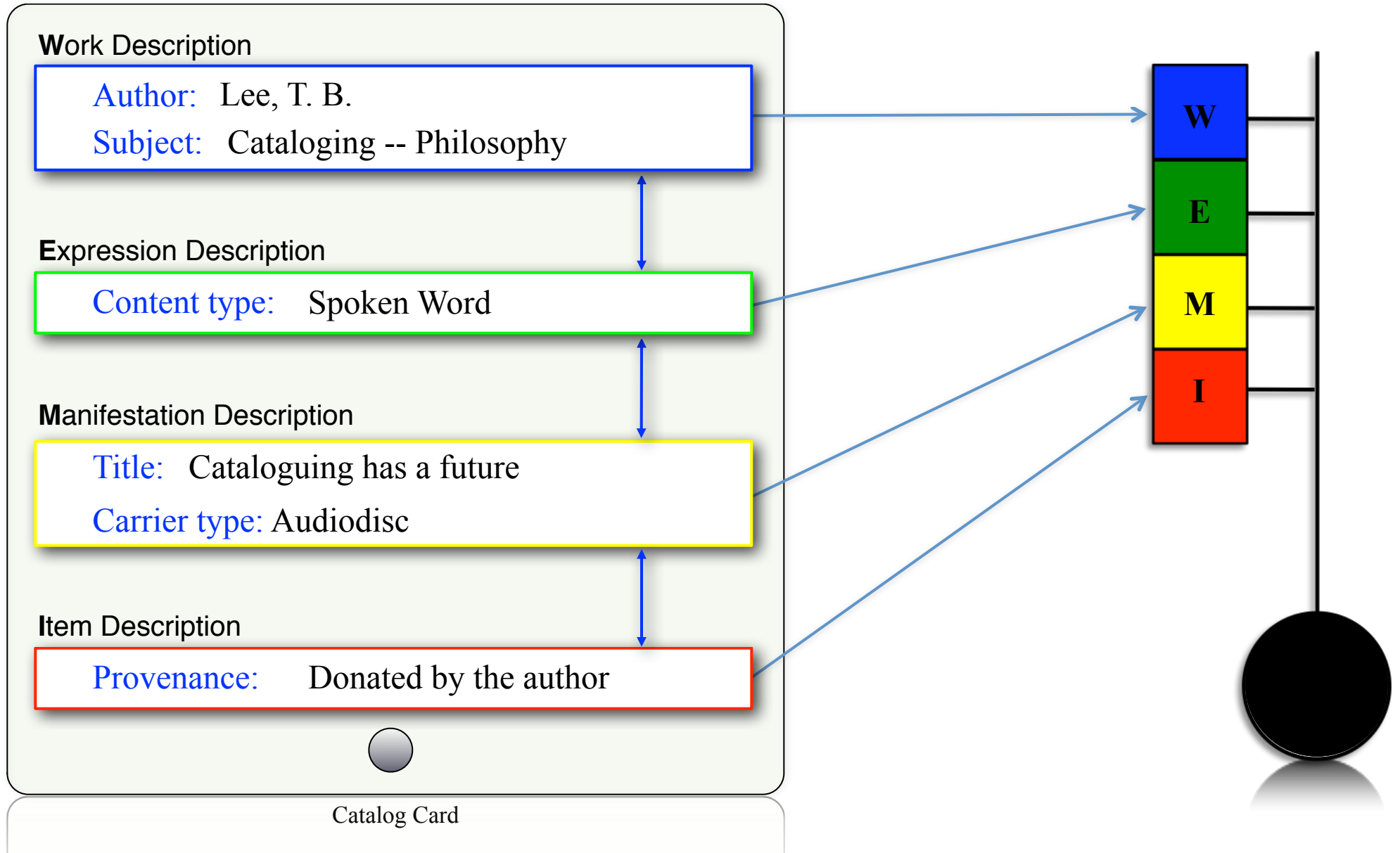
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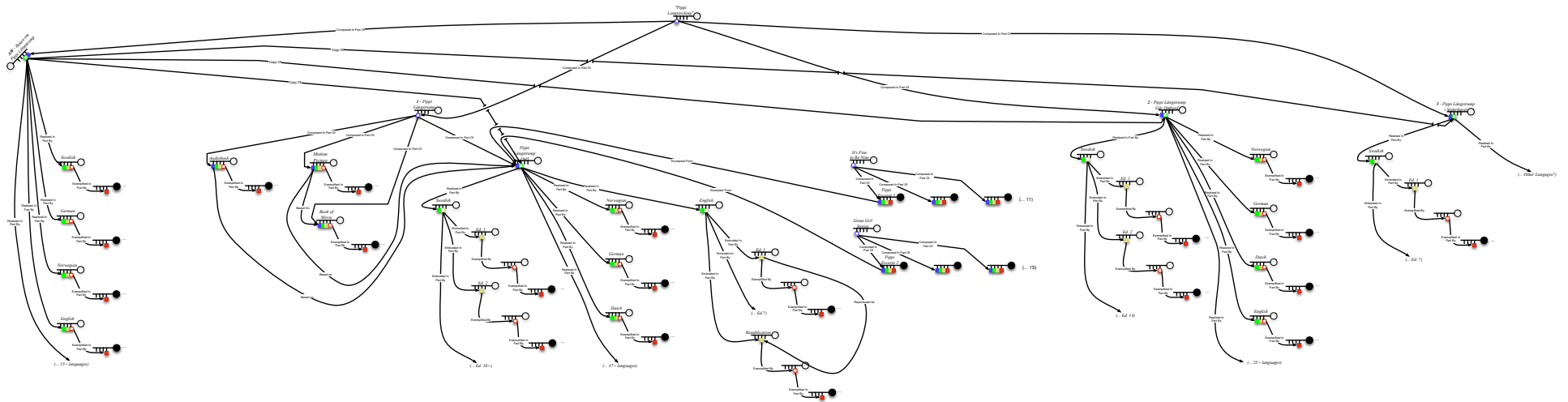
Where This is Going:

Pippi Longstocking

- *Imagine*: Make sense of:
 - 27 Physical resources (*Book, Motion Picture, Audiobook*)
 - 99 Resource description groups (*FRBR Work, etc.*)
 - 76 Relationships between resource description groups
 - Abbreviations for (100+) other known physical resources and resource description Sets

Where This is Going:

Pippi Longstocking



Where This Comes From:

Multidisciplinarity

- *Don't Panic* - We will be introducing and interconnecting topics from three fields outside of cataloging theory. It will be helpful to bring these fields and topics to mind now.
- *Cataloging Theory (just in case...)* - The systematic description of culturally significant resources, following rules and guidelines (and tacit cultural understandings) defined and/or interpreted by one or more responsible parties.
- *History of Science* - The role of mental (in this case, visual) imagery in Classical and Quantum Physical theory formation. The dispersion of Feynman diagrams in Postwar Physics. Tool creation and use in laboratory subcultures

Where This Comes From:

Multidisciplinarity

- ***Don't Panic*** - We will be introducing and interconnecting topics that will be helpful to you. *Speaking Broadly*
Several fields are brought together in this presentation in a way that may be unfamiliar to many. To keep everyone on the right track, basic ideas for each area may be reviewed during the presentation.
A pop-up like this will appear to let you know when fields are being combined or to supply relevant commentary.
- *Catalog* - descriptions of rule definitions and parts of the system (e.g., visual) will be provided.
- *History* - images and forms of the system (e.g., Postwar Physics. Tool creation and use in laboratory subcultures)

Where This Comes From:

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Where This Comes From:

Multidisciplinarity

- *Don't Panic* - More introduction and interconnection
- *Conceptual Data Modeling* - The description of a portion of an enterprise in terms of the fundamental things of interest to it. They are fundamental in that most things seen by business owners are examples of these.
- *Ethnomathematics* - The study of the mathematical practices of specific cultural groups in the course of dealing with their environmental problems and activities.

Where This Is Going: Conclusions

- *Cataloging Theory* - FRBR resource descriptions reflect the complexity of Cultural Heritage resources – as perceived by the describing (cataloging, etc.) parties. Full appreciation of FRBR's necessary complexity benefits from perspectives supplied by other fields of study.
- *History of Science* - Visual imagery – generated by a Cultural Heritage resource description theory – can be employed effectively to represent and explore very complex bibliographic entities.

Where This Is Going: Conclusions

- *Conceptual Data Modeling* - Information system design techniques can successfully identify things and relationships of interest to a Cultural Heritage institution. These techniques can support formation of resource description theories
- *Ethnomathematics* - Mathematical ideas resident in the Cultural Heritage “subculture” can be identified by examining cataloging products and end-user resource discovery activities

Where This Is Going: Conclusions

It is wrong to think that the task of physics is to find out how Nature is

Physics concerns what we can say about Nature

Why: An Evolving Challenge

- In the thirty years since the creation of the World Wide Web, the institutions that comprise the Cultural Heritage community (archives, libraries, and museums) have seen their more traditional approaches to selecting, describing, and presenting culturally relevant resources to the public increasingly challenged by that distributed global information system

Why: An Evolving Challenge

- This technology had a single point of origin
 - The High-Energy Physics community.
 - Design considerations of a Physics-trained(!) programmer working in a distributed, collaborative, scientific research environment
 - He extended the then well-known concept of Hypertext to networked computer systems

Response to the Challenge: Role Reaffirmation

- *Creating a WWW Presence* - Bibliographic data reformatting and sharing; delivery system redesign
- *Cataloging theory extension/reformulation* - internationally coordinated re-conceptualization of bibliographic entities, relationships, and business rules: One example is FRBR
- Tillett (1987) FRBR concepts introduced with a focus on bibliographic relationships, and use of Entity-Relationship (E-R) data modeling technique.
- IFLA (1998) Study group shifts FRBR focus from bibliographic relationships to records
- Smiraglia's (2001) investigations of the nested structure of the FRBR **Work** entity

One

*Resources &
Resource Descriptions*

Why Know About This?

Libraries and other Cultural Heritage institutions have been collecting and describing resources for a long time

Other parties are playing increasingly significant resource collection and description roles. We need to be able to discuss resource description processes and products in a less “culture-bound” fashion

What Is A Resource?

What Is A Resource Description?



What Is A Resource?

What Is A Resource Description?

- **Library**
“Traditionally, collection of books used for reading or study, or the building or room in which such a collection is kept.” *(Britannica Online)*

What Is A Resource?

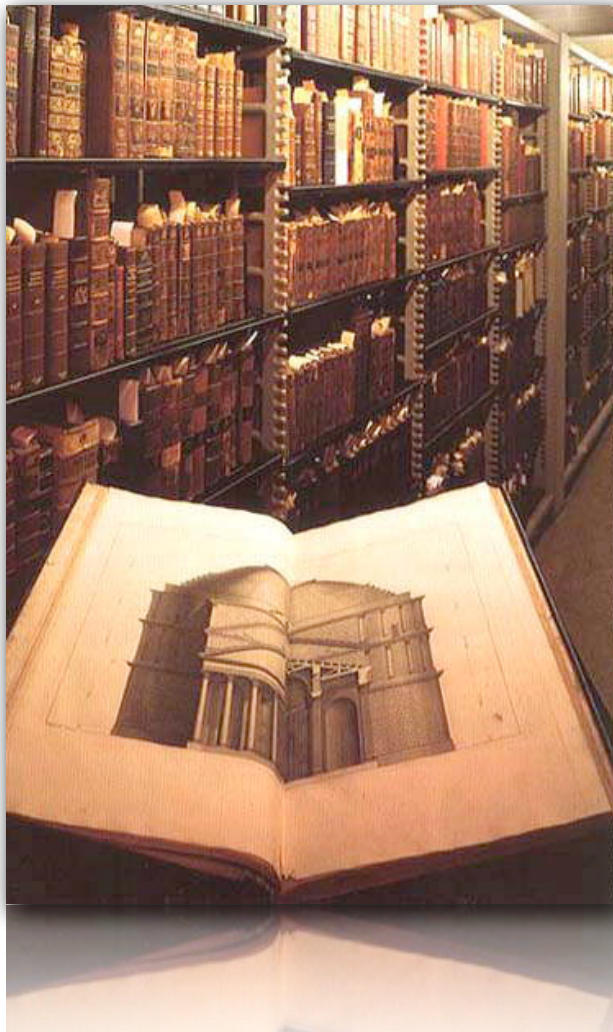
What Is A Resource Description?

- **Library**

“From their historical beginnings as places to keep the business, legal, historical, and religious records of a civilization, libraries have emerged since the middle of the 20th century as a far-reaching body of *information resources* and services that do not even require a building.” *(Britannica Online)*

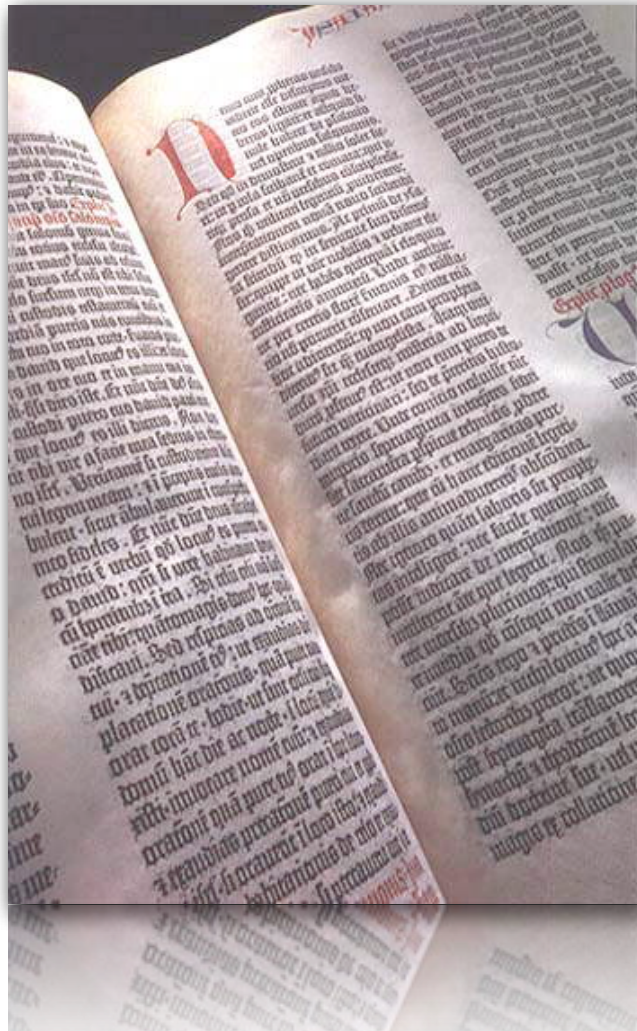
What Is A Resource?

What Is A Resource Description?



What Is A Resource?

What Is A Resource Description?



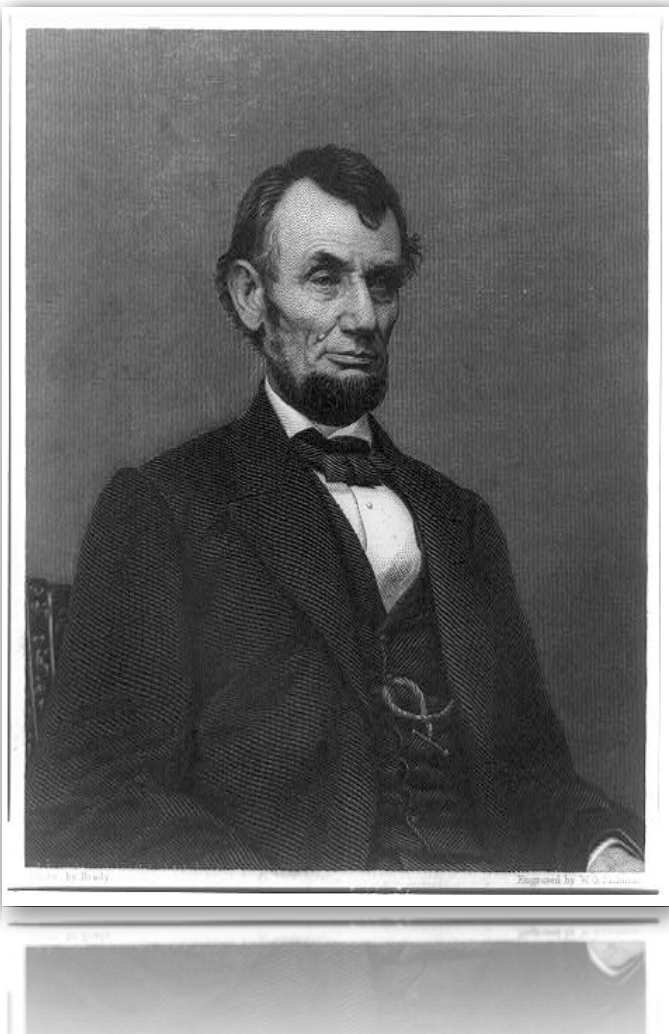
What Is A Resource?

What Is A Resource Description?



What Is A Resource?

What Is A Resource Description?



What Is A Resource?

What Is A Resource Description?



- **Resource** |'rē,sôrs; 'rē'zôrs; ri'sôrs; ri'zôrs|
noun
(Usu. **resources**) a stock or supply of money, materials, staff, and other assets that can be drawn on by a person or organization in order to function effectively: *local authorities complained that they lacked resources.* (OED Online)

What Is A Resource?

What Is A Resource Description?



What Is A Resource?

What Is A Resource Description?

- **Resource Description**

The action of setting forth in words or numbers by mentioning or measuring recognizable features or characteristic marks of a resource; verbal representation or portraiture of a resource.

A statement which describes, sets forth, or portrays a resource; a graphic or detailed account of a person, thing, scene, etc. that is treated as a resource. *(Adapted from OED Online)*

What Is A Resource?

What Is A Resource Description?

- **Presentation of Resource Descriptions**

The way resource descriptions are presented supports and limits our thinking about resource descriptions in general,

FRBR's first goal is to identify the “things of interest” that underlie Cultural Heritage resource descriptions.

A Modern Bibliographic Resource Description Theory

- Cultural things, interact
- Of part and preserved by those institutions

What's Your Theory?

A systematic set of rules or principles regarding the creation and use of resource descriptions by Cultural Heritage Institutions

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those
ese things
cribed

A Modern Bibliographic Resource Description Theory

- Cultural Heritage institutions can be characterized by the *things of interest* to them, by relationships between those things, and by the business rules that specify how these things interact with one another.
- Of particular interest are the resources acquired, described and preserved by those institutions

A Modern Bibliographic Resource Description Theory

- Resource descriptions in a Cultural Heritage institution are derived from examinations/analyses of the resources selected for collection by the institution.
- A party tasked with Cultural Heritage resource description will follow formal and/or informal rules that require the describing party to consider aspects of the resource from one or more points of view

A Modern Bibliographic Resource Description Theory

- After examining a resource, a describing party (e.g. a cataloger) creates or copies the required attribute and relationship information and makes it available to an information system
- The describing party may also supply optional descriptions and establish relationships determined to be useful by the institution or its user population

A Modern Bibliographic Resource

Description Theory: FRBR

- FRBR specifies how a resource is described from up to four *points of view* – labeled **Work**, **Expression**, **Manifestation**, and **Item** – that may be invoked by a party in the course of describing

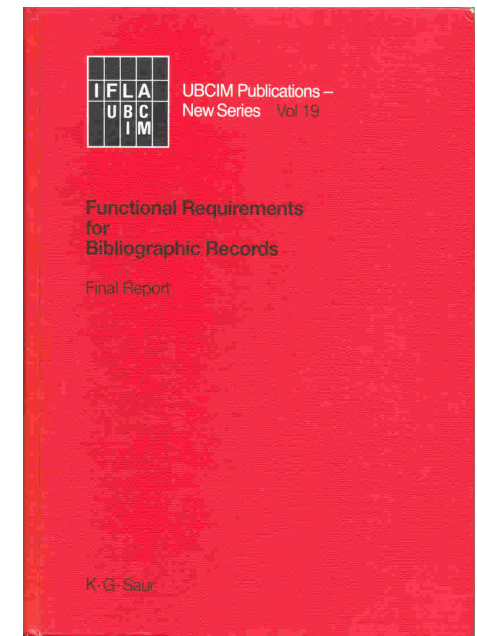
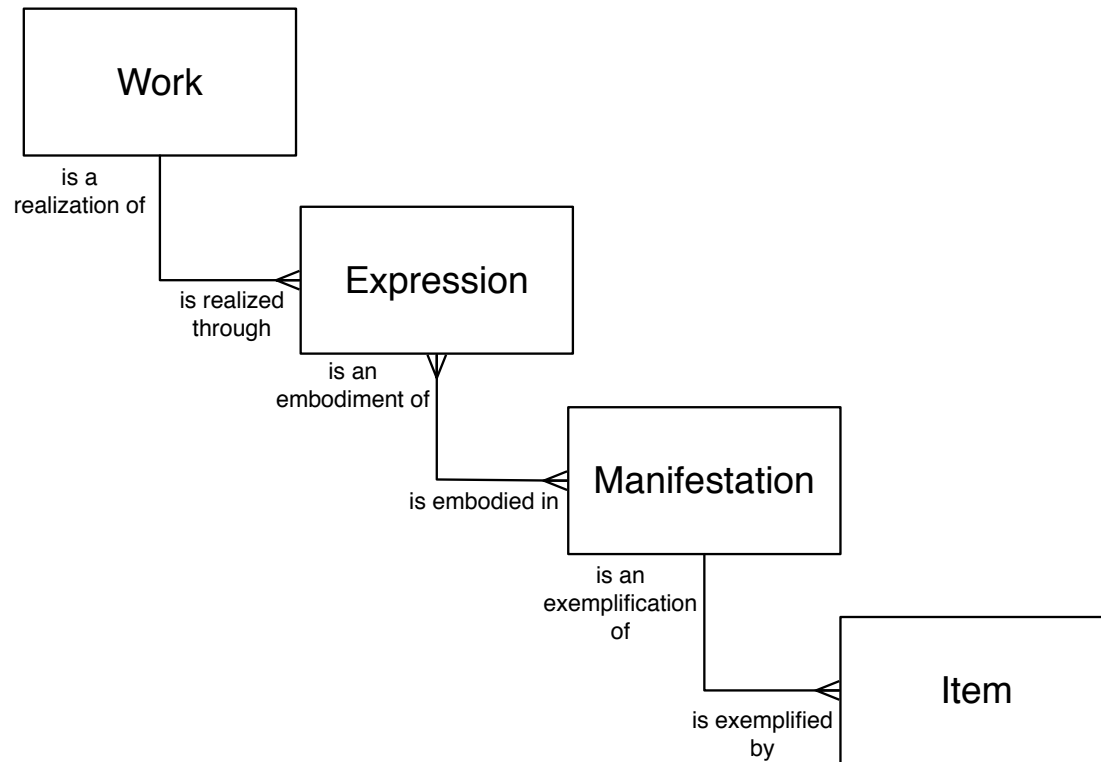
Speaking Broadly

- Each FRBR rule and its relationships to other FRBR rules and its prescribed relationships to other FRBR rules are expressed in a point of view that may or may not be explicitly stated. FRBR defines four of these points of view: user, community, organization, and business. Each point of view is specific to that point of view. We can speak of a **Work**-level resource description and its prescribed relationships to other **Work**- or other FRBR level descriptions

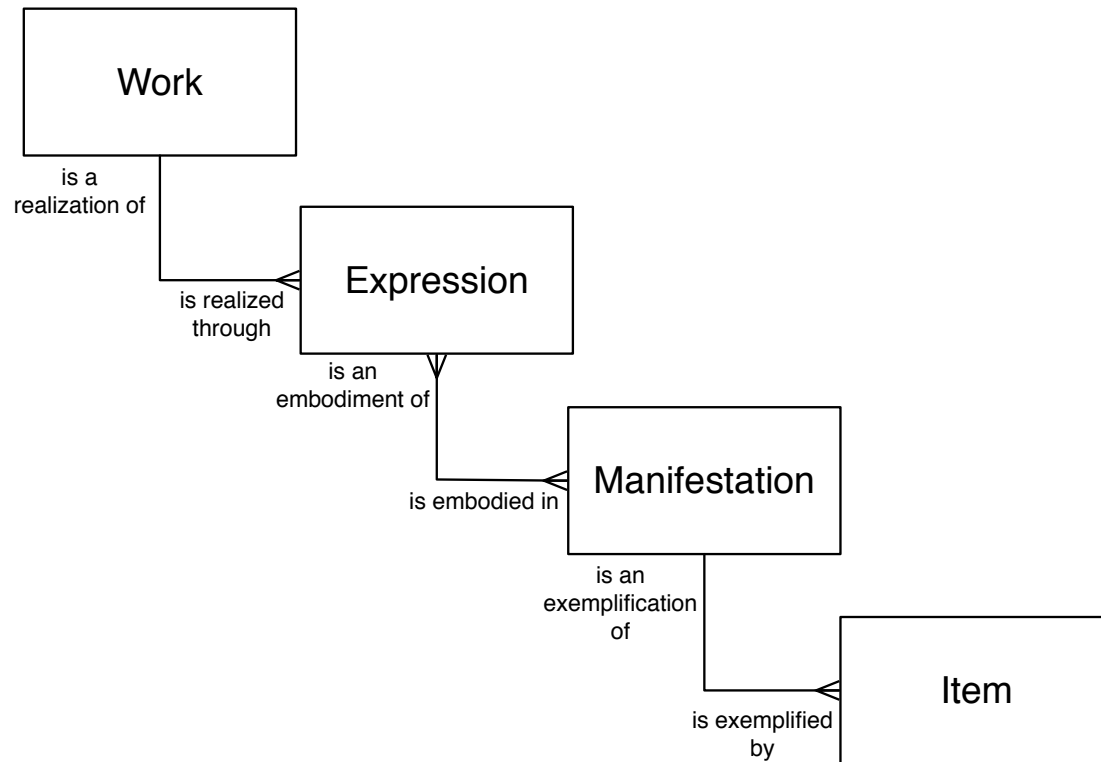
A Modern Bibliographic Resource Description Theory: FRBR

- FRBR specifies how a resource is described from up to four *points of view* – labeled **Work**, **Expression**, **Manifestation**, and **Item** – that may be invoked by a party in the course of describing a resource
- Each FRBR point of view is specified in part by business rules and informal practices, and finds representation in a group of resource attributes that are *complementary* to the other FRBR points of view
- Each point of view may also include relationships specific to that point of view. We can speak of a **Work**-level resource description and its prescribed relationships to other **Work**- or other FRBR level descriptions

Functional Requirements For Bibliographic Records/Relationships



Functional Requirements For Bibliographic Records/Relationships



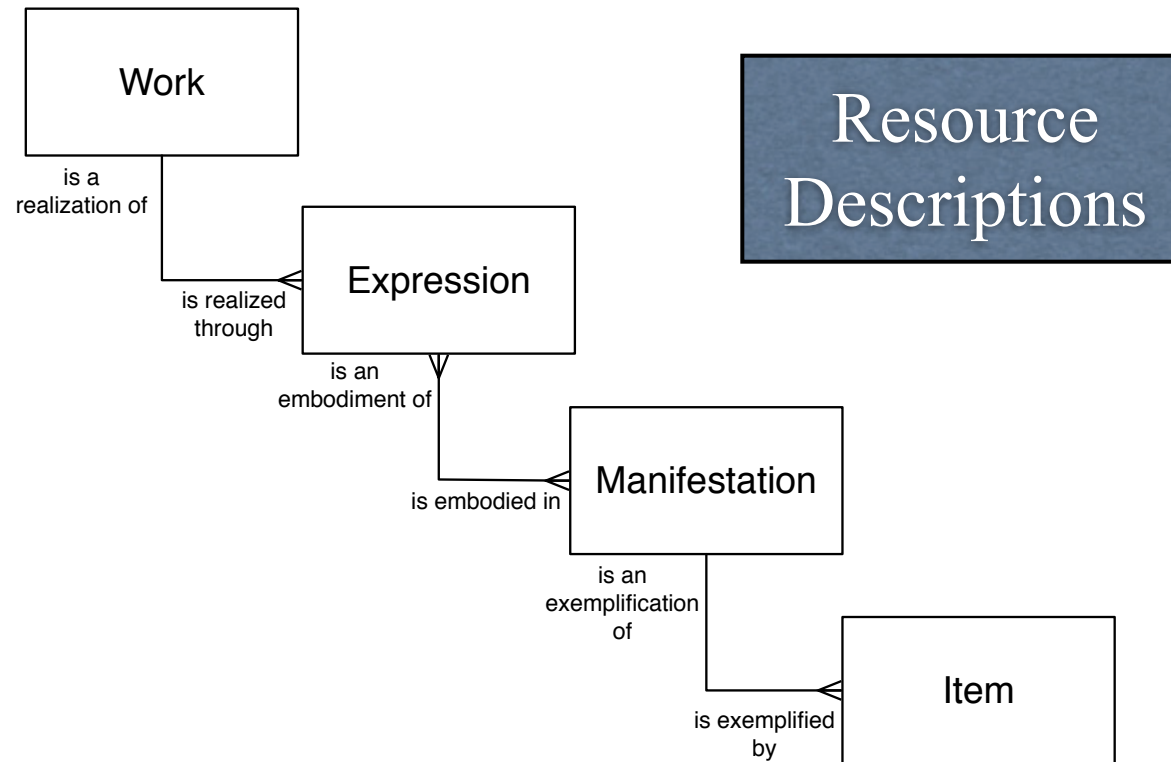
Work Description	
Author:	Lee. T. B.
Subject:	Cataloging -- Philosophy

Expression Description	
Content type:	Spoken Word

Manifestation Description	
Title:	Cataloguing has a future
Carrier type:	Audiocassette

Item Description	
Provenance:	Donated by the author

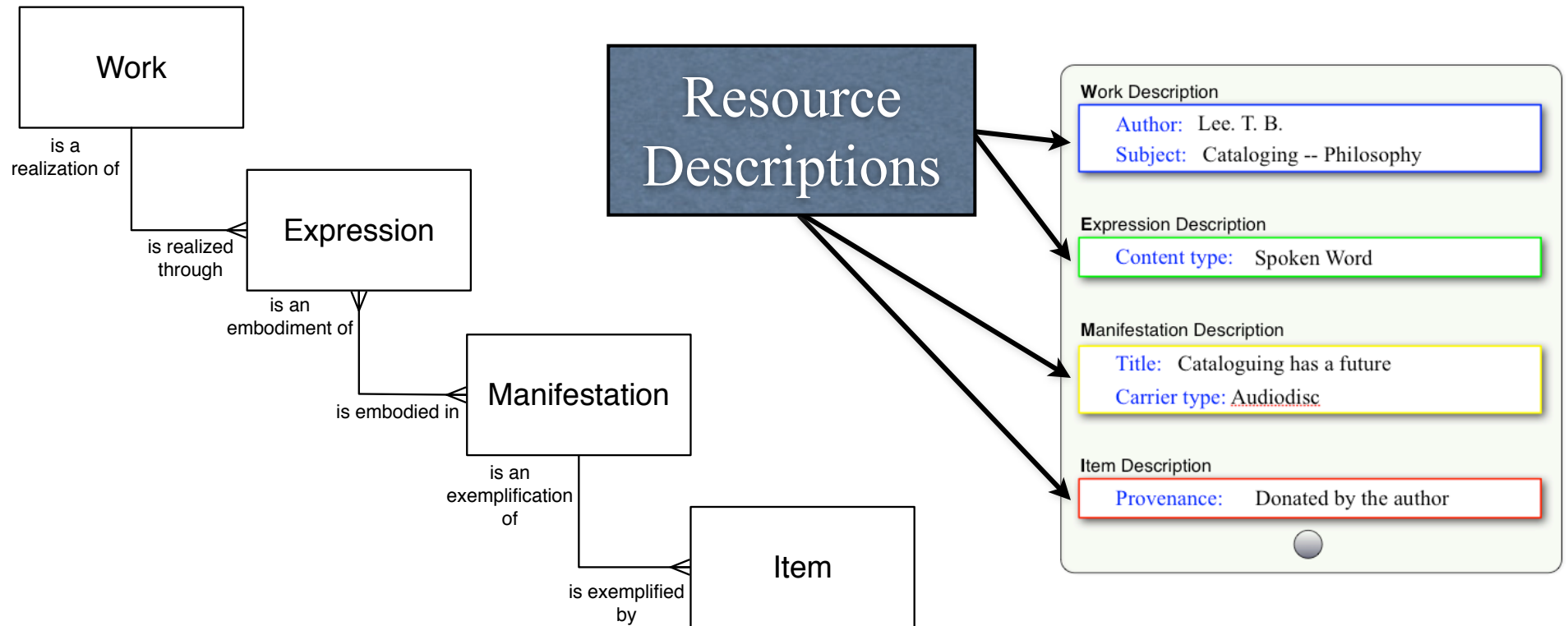
Functional Requirements For Bibliographic Records/Relationships



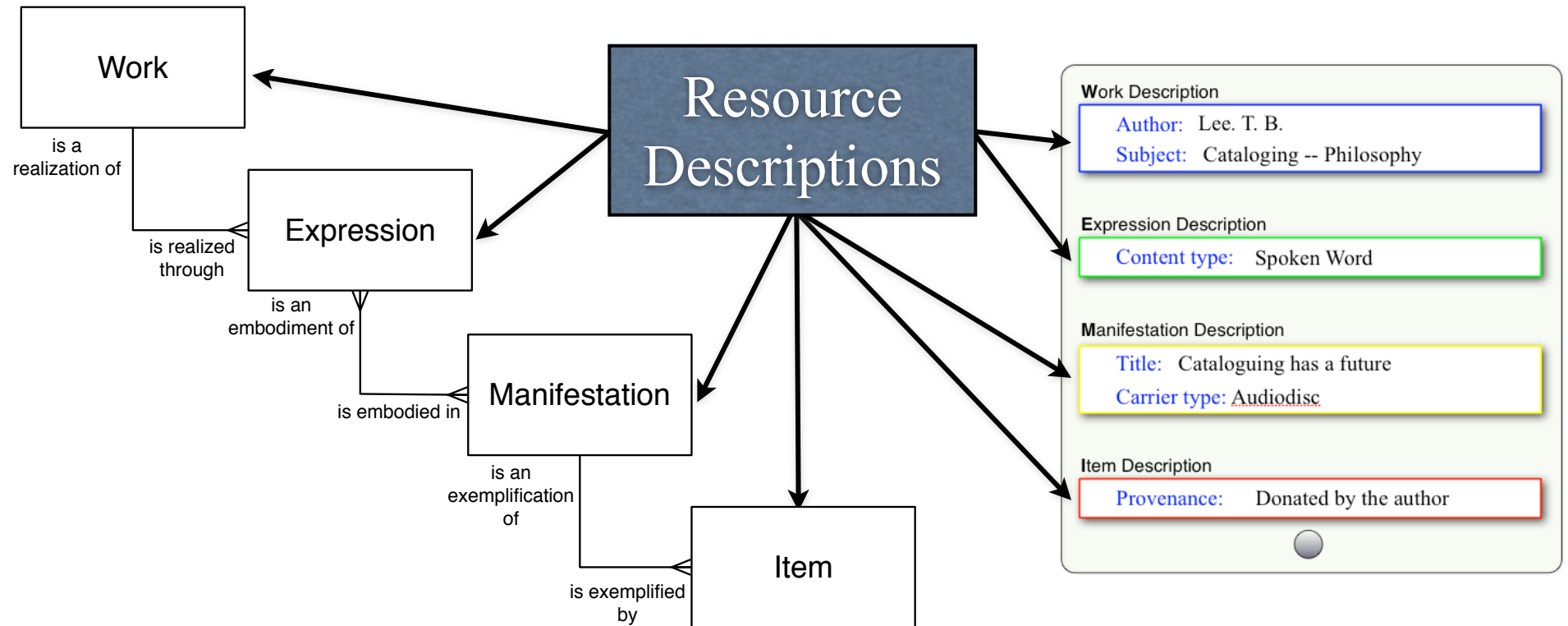
Resource Descriptions

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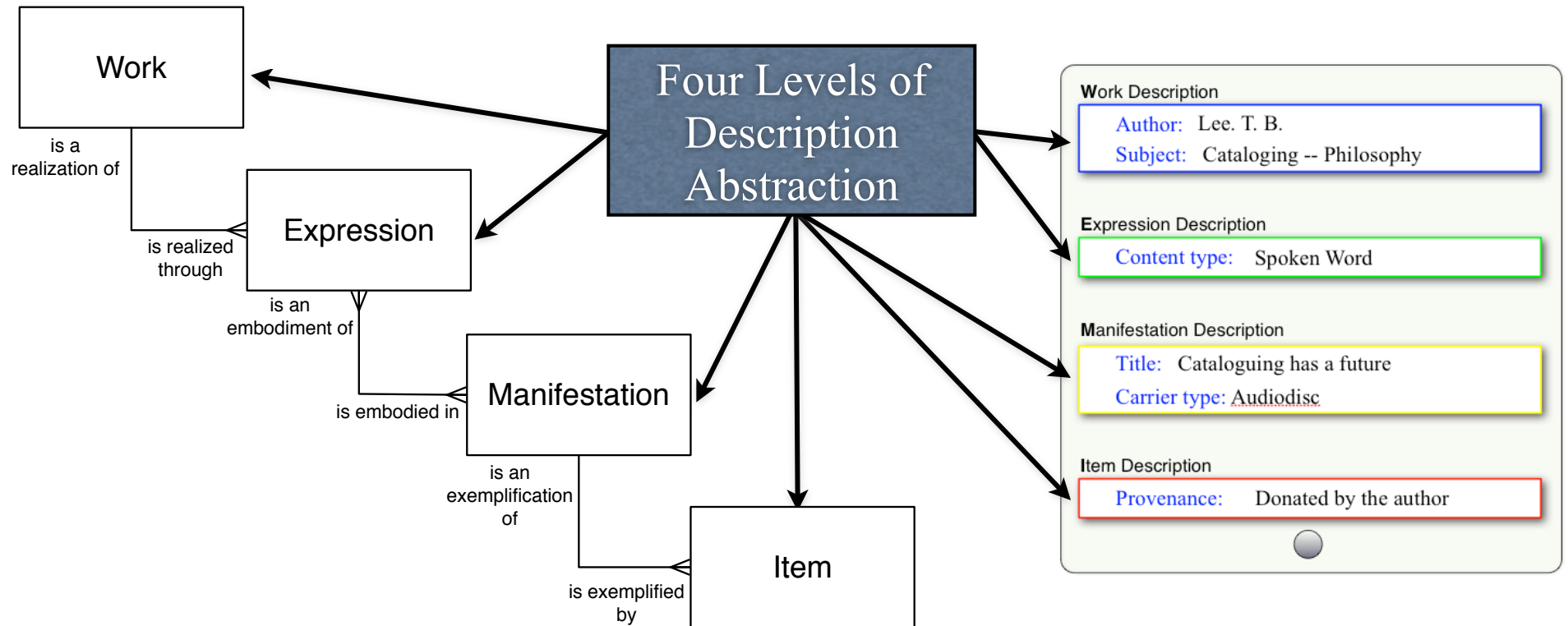
Functional Requirements For Bibliographic Records/Relationships



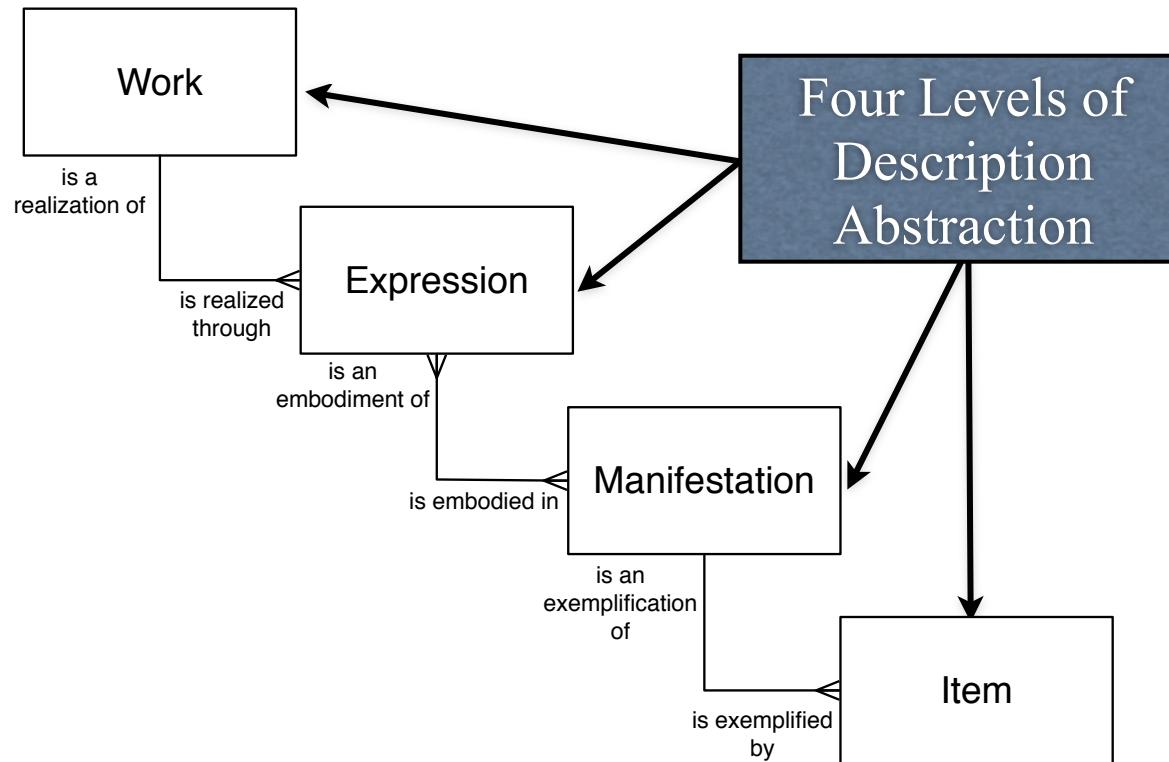
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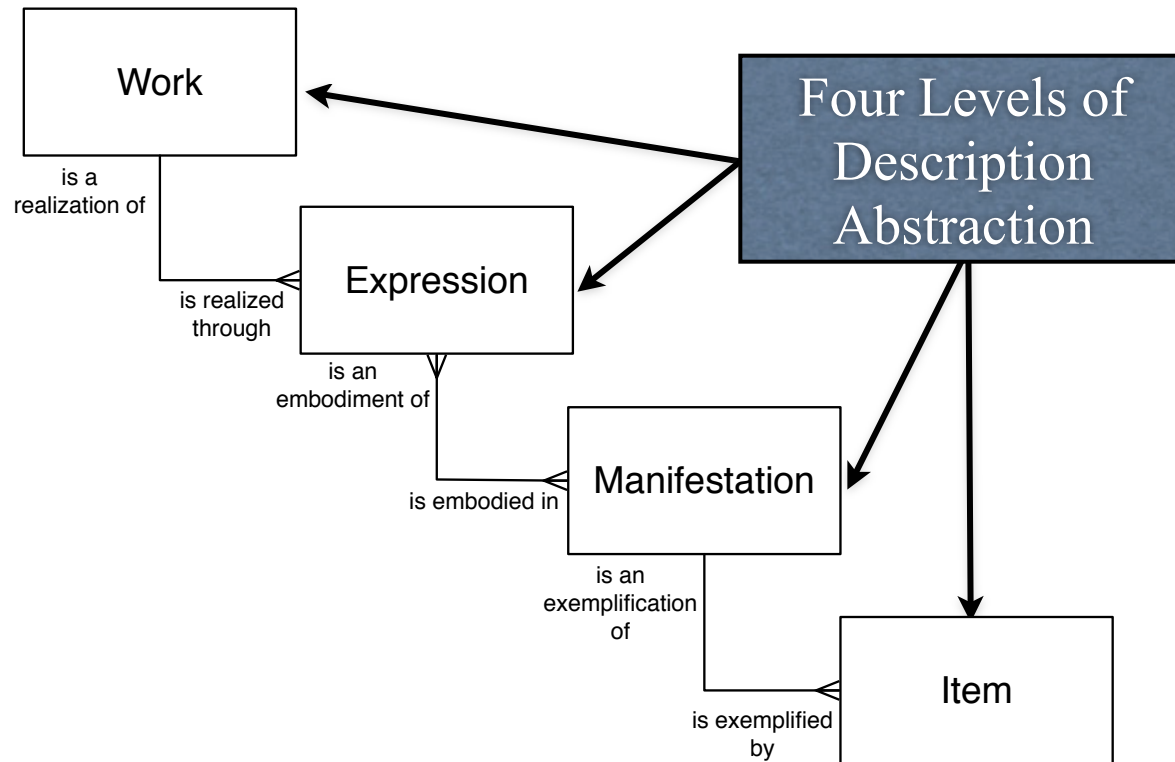
Functional Requirements For Bibliographic Records/Relationships



● Item

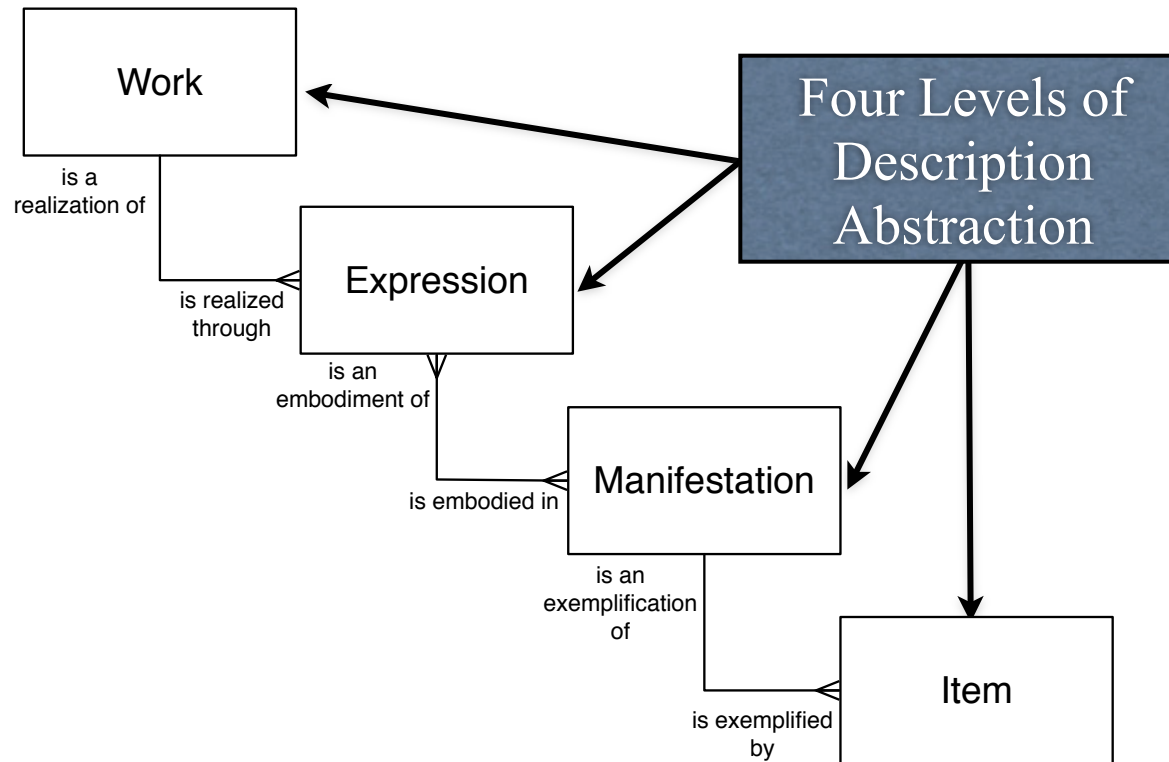
The creative result seen in terms of a concrete entity - in many cases a specific physical object

Functional Requirements For Bibliographic Records/Relationships



Resource Directly Experienced

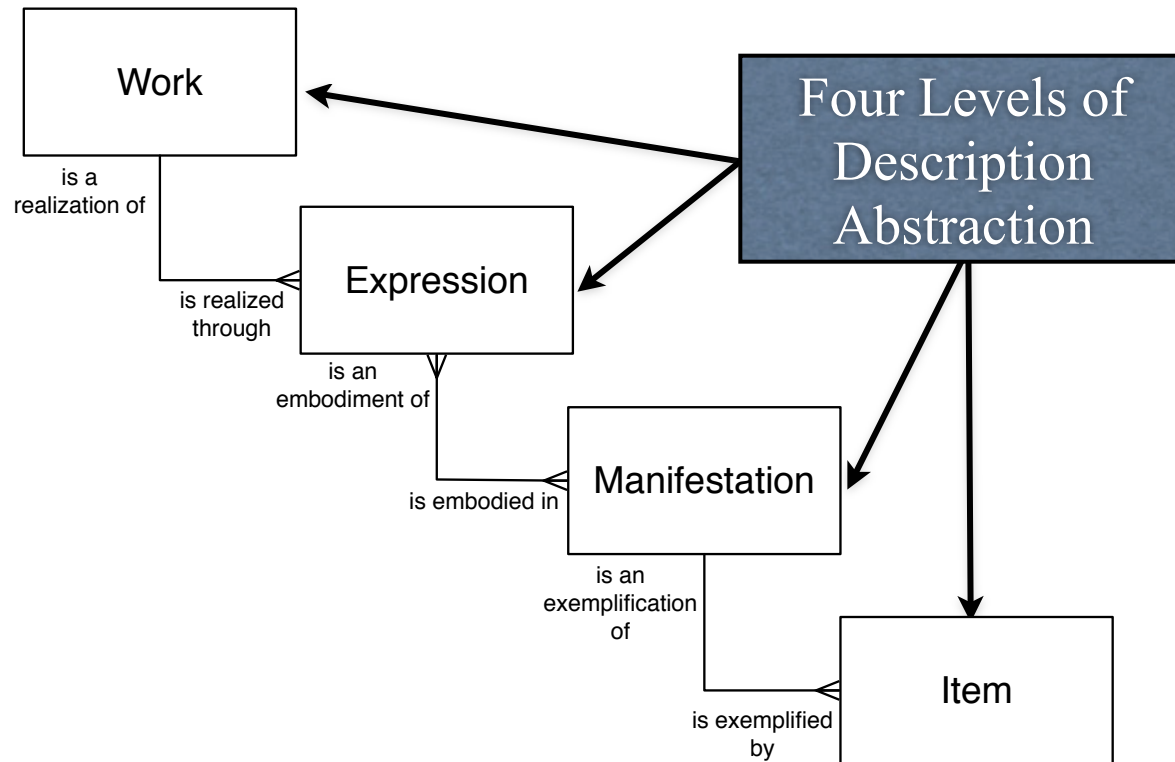
Functional Requirements For Bibliographic Records/Relationships



- **Manifestation**

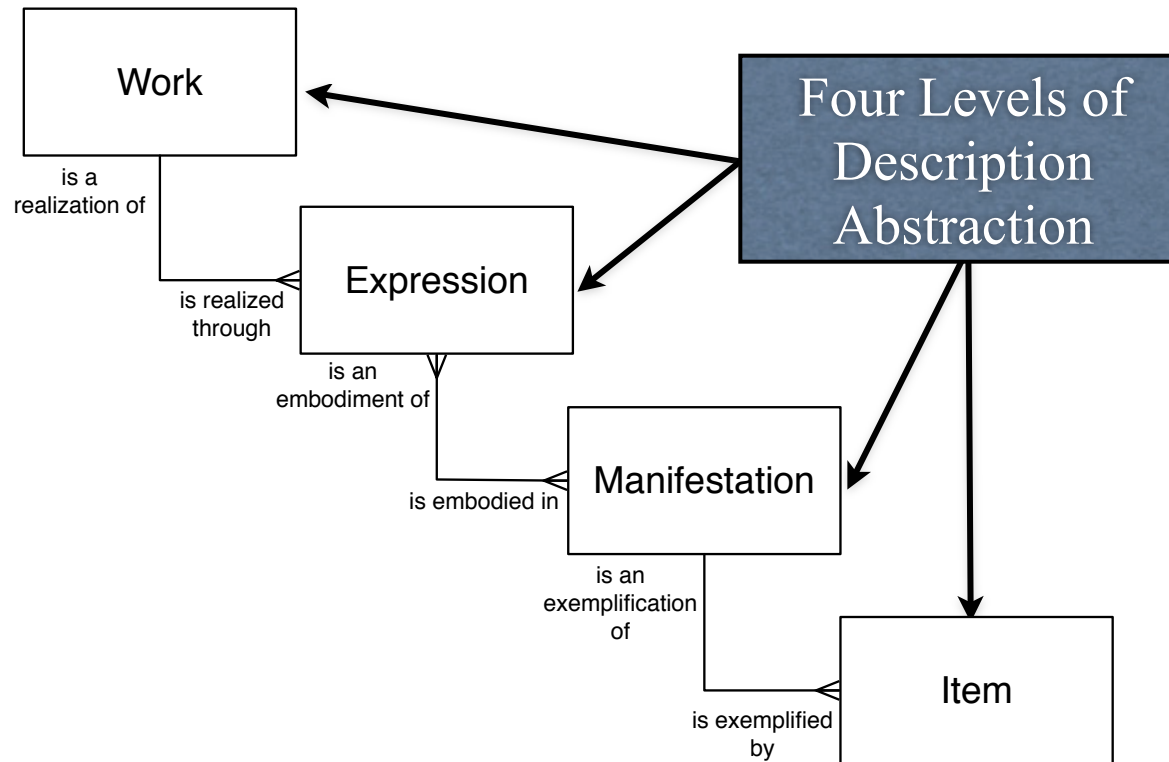
Descriptive of all the physical objects that bear the same characteristics, with respect to both intellectual content and physical form

Functional Requirements For Bibliographic Records/Relationships



Directly
Experienced
(In Principle)

Functional Requirements For Bibliographic Records/Relationships

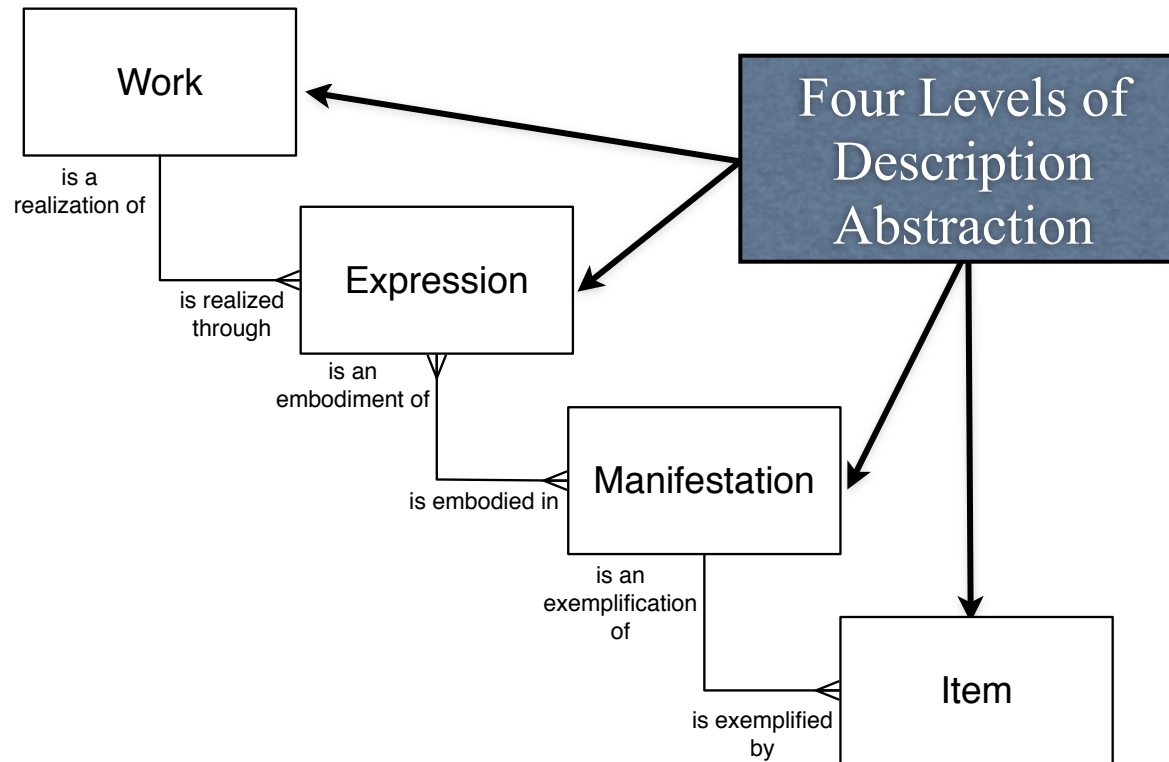


- **Expression**

The creative result seen as a specific intellectual or artistic form the **Work** takes each time it is realized

Experienced as a
Performance or
Recording

Functional Requirements For Bibliographic Records/Relationships

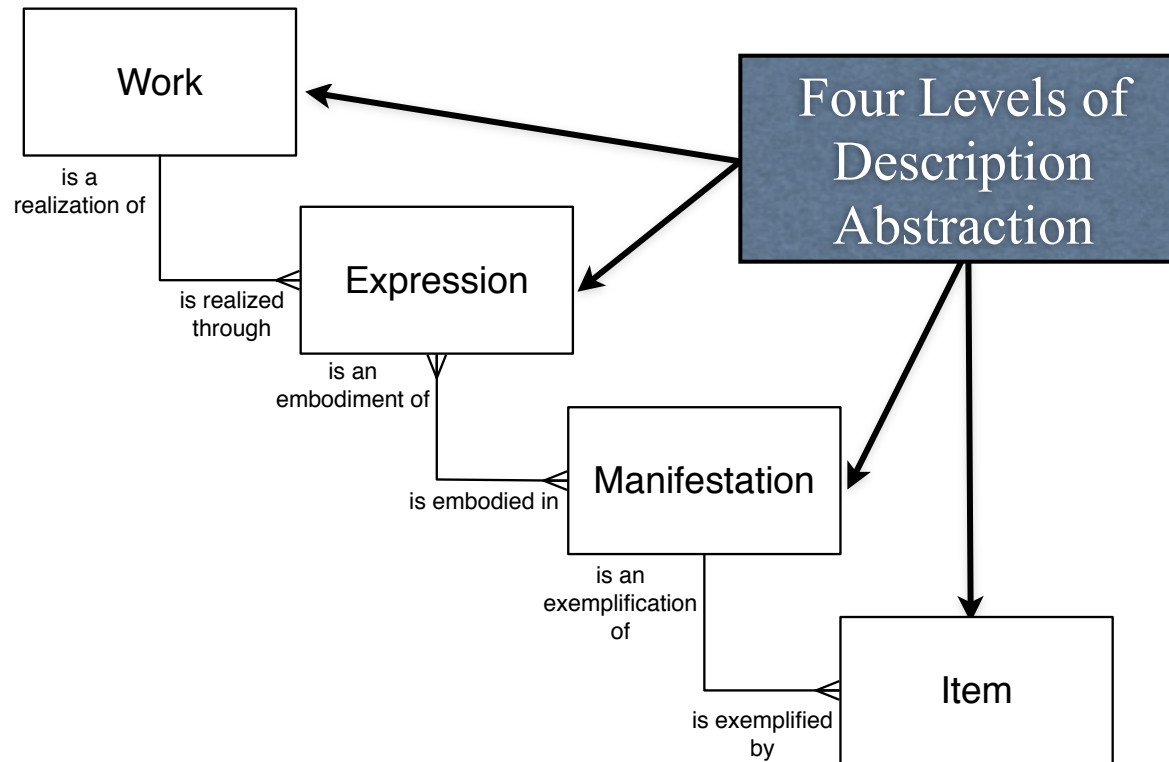


- **Work**

A distinct intellectual
or artistic creation

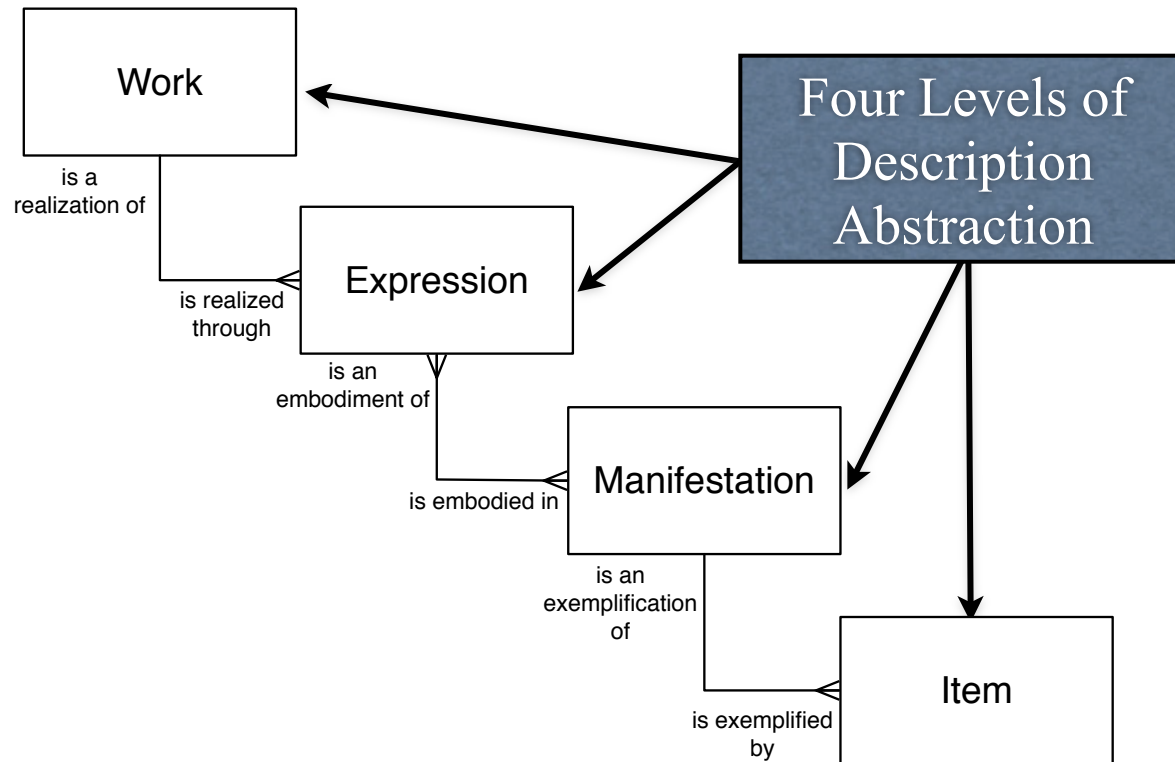
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Functional Requirements For Bibliographic Records/Relationships



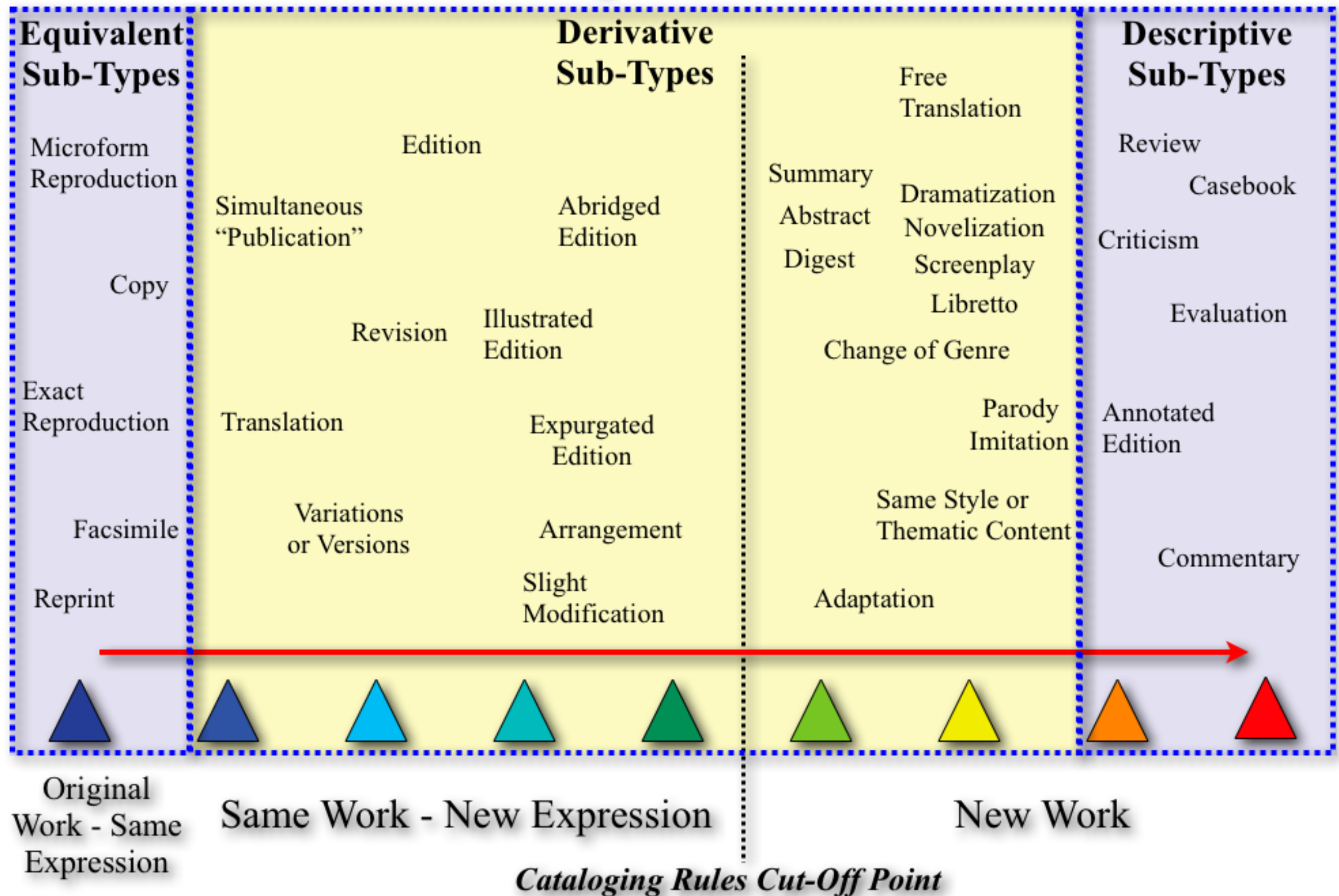
- A standard set of relationships between the four FRBR entities is defined
- Other relationships are defined between similar and different entity types

Functional Requirements For Bibliographic Records/Relationships



- *Example:*
Relationships between **Works**

Family of Works



About FRBR and Entity-Relationship Modeling

- Defining and reasoning about complex FRBR bibliographic entities benefits from the textual descriptions and images introduced by

Speaking Broadly

- An Entity-Relationship Model of mathematical (sets), text proposes a theory of information organization. (Chen)
- Data model is related in a structured manner
- A diagrammatic technique is also introduced as a tool for database design
- Diagram layout corresponds to set definition

About FRBR and Entity-Relationship Modeling

- Defining and reasoning about complex FRBR bibliographic entities benefits from the textual descriptions and images introduced by the data modeling process
 - An Entity-Relationship (E-R) model consists of mathematical (*sets*), textual, and diagrammatic representations (Chen)
 - Data model statements are produced and evaluated in a structured manner
 - A diagrammatic technique is also introduced as a tool for database design
 - Diagram layout corresponds to set definition

FRBR Theory And Implementation

- When E-R modeling is used for FRBR, a set of attributes (descriptions) that are descriptive of each FRBR-theoretic point of view is defined as a FRBR *entity*
- Traditional and potential bibliographic descriptions are then redefined (and extended) in the form of FRBR entities, attributes, relationships and cataloging (business) rules
 - Panizzi's *Work* & cross-reference rules: FRBR entity and relationships
 - Card catalog: Entity groups with relationships implied across cards/*records*

FRBR Theory And Implementation

- Entities, attributes, and relationships derived from FRBR - and institutionally established business rules - can inform database system design
 - IFLA and OCLC research & development
 - Open Source implementation
 - Commercial implementation
 - Scholarly analysis

Seeing Theory at Work: E-R Models and Paper Tools

- *E-R database models are not the only “thinking tools” needed*

- Entity-compa
interes

Speaking Broadly

A FRBR E-R model can play a significant information *management* role – but only a limited theory *formation* role

- An FR
FRBR
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- The IFLA FRBR conceptual model reflects a first approximation of bibliographic things of interest, pending testing of both the theory and a *conceptual data model* against typical or atypical resource description scenarios

Seeing Theory at Work: E-R Models and Paper Tools

- *E-R database models are not the only “thinking tools” needed*
- Entity-Relationship models – especially its diagrams – are compact specifications of things and relationships of interest.
- An FRBR E-R model is only part of a broader process of FRBR theory formation (i.e., deciding what the things of interest are – and why)
- The IFLA FRBR conceptual model reflects a first approximation of bibliographic things of interest, pending testing of both the theory and a *conceptual data model* against typical or atypical resource description scenarios

Seeing Theory at Work: E-R Models and Paper Tools

- *Database models are not the only “thinking tools”*
 - E-R database models – and especially its diagrammatic methods – are not intended to provide detailed views of *specific* FRBR resource/resource description configurations that reflect specific theoretical issues and/or challenge assumptions
 - In particular, exploration of theoretical implications – most efficiently done diagrammatically – becomes constrained by E-R modeling theory itself, and by its attendant imagery
 - For FRBR, E-R modeling technique alone does not provide sufficient *visualizability* – theory-generated imagery – to support resource description theory formation efforts

FRBR, Physics, and Mental Imagery

- *Visualizability* - (Ger. *Anschaulichkeit*[†]) Became a critical issue during the radical shifts in theory in early/mid 20th Century atomic physics. Theorists struggled to represent and reason about visible and invisible things of interest:
 - Heavenly bodies
 - Atomic & sub-atomic particles
- Werner Heisenberg undertook a philosophical reversal that eventually permitted the creative use of mental imagery that played the role of a *Paper Tool*
 - How this came to pass can serve as a guide to improving our understanding of FRBR and its predecessors

[†] Miller, Arthur I. *Imagery in Scientific Thought: Creating 20th Century Physics*. Cambridge MA: The MIT Press. 1987.

Two

*Imagery In Scientific, Artistic
& Creative Thought*

Why Know About This?

Understanding a Cultural Heritage resource description requires close attention not just to the structure and content of that description, but also to the larger resource/description structures within which any given description fits

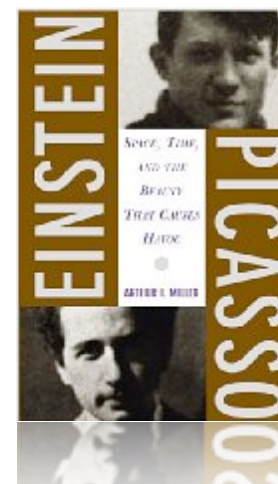
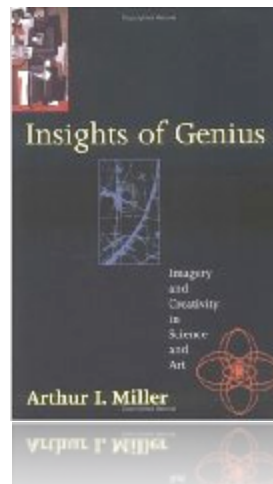
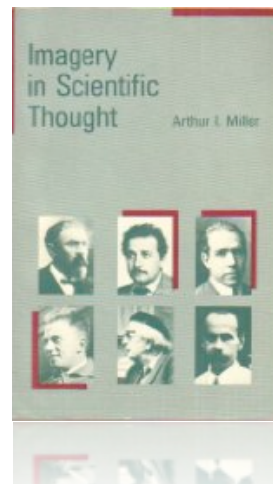
Scientific and artistic approaches to representing and understanding complex phenomena can be instructive in showing how to appreciate the larger, complex, view

Imagery in Scientific Thought

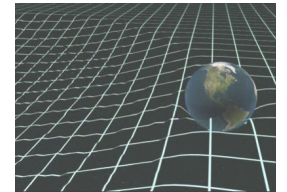
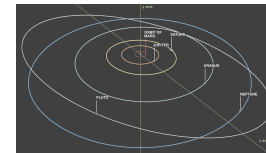
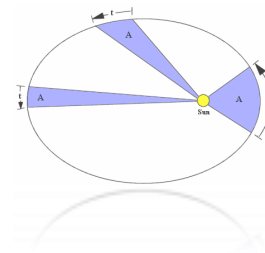
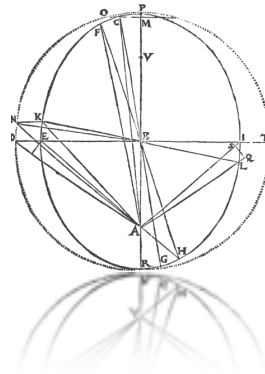
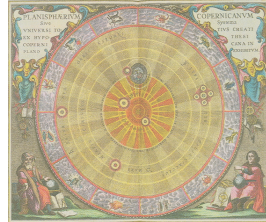
- Finding the Right “Picture” - Historian of science Arthur I. Miller undertook a study of creativity in art and science
 - *Imagery in Scientific Thought: Creating 20th Century Physics, 1986*
 - *Insights of Genius: Imagery and Creativity in Science and Art, 2000*
 - *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc, 2001*

Imagery in Scientific Thought

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Imagery in Scientific Thought: Finding the Right *Picture*



Imagery in Scientific Thought: Finding the Right *Picture*



Imagery in Scientific Thought: Finding the Right *Picture*



- Working with what they could see, imagine, record, and calculate, astronomers tried to make sense of the cosmos

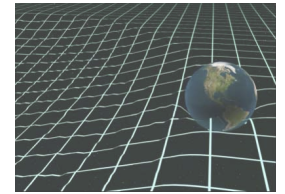
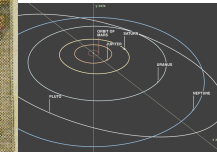
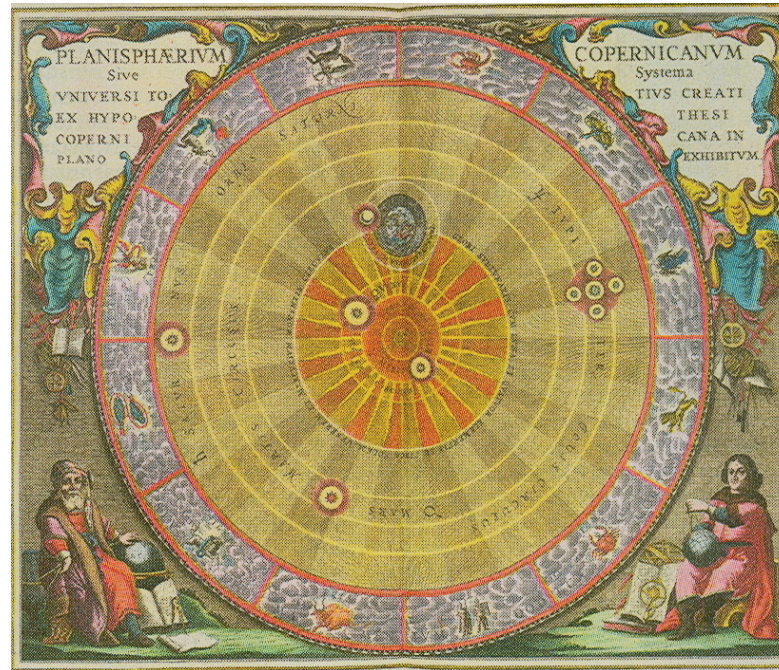
Imagery in Scientific Thought: Finding the Right *Picture*



- Ptolemy (c. 150) - *Hypotheseis ton planomenon* (*Planetary Hypotheses*) Geocentric view of the cosmos. Eccentrics: epicycles, deferents, equants

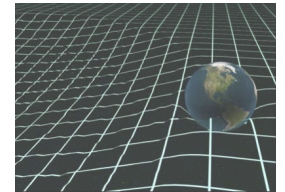
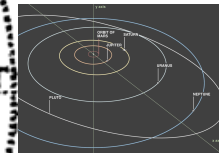
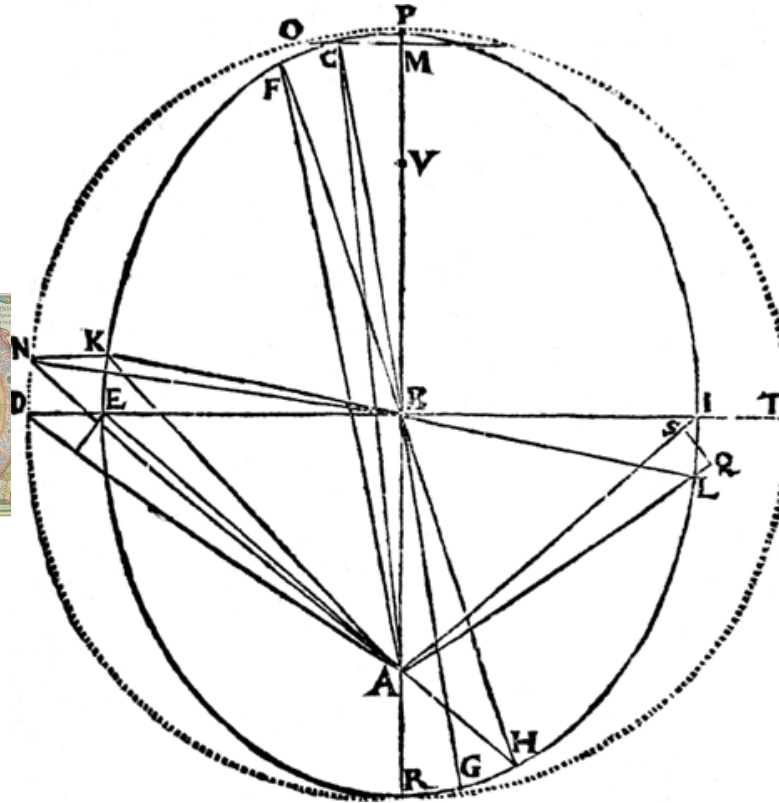
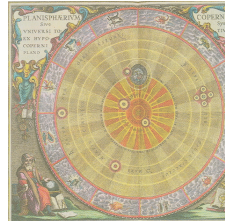
(Norman B. Leventhal Map Center, Boston Public Library; NASA)

Imagery in Scientific Thought: Finding the Right *Picture*



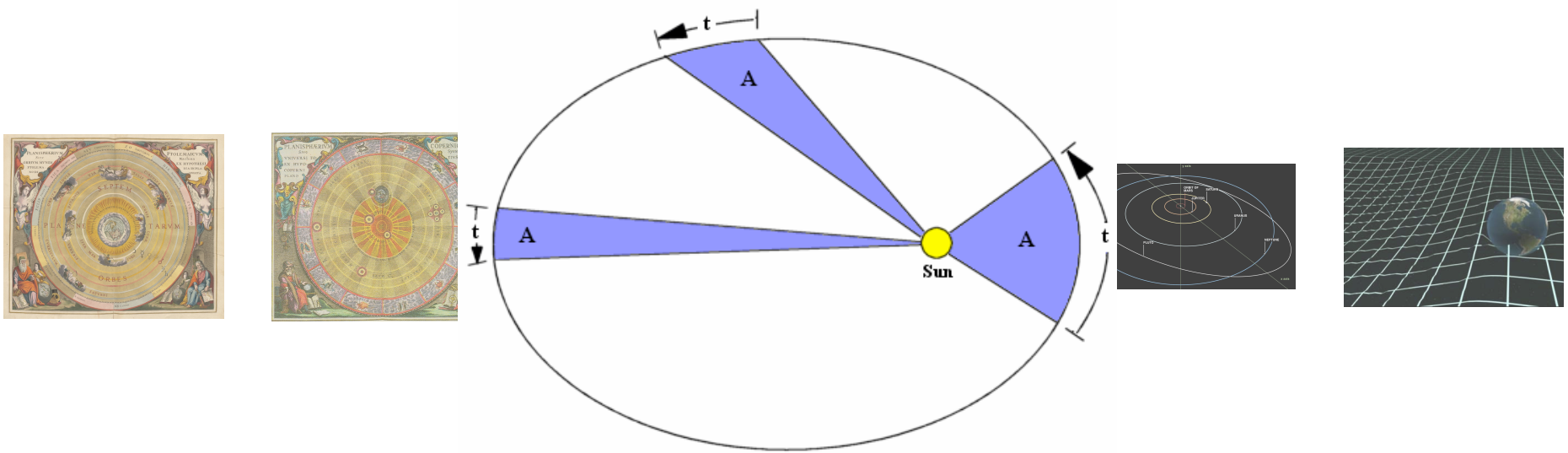
- Copernicus (1543) - Heliocentric view of the cosmos

Imagery in Scientific Thought: Finding the Right *Picture*



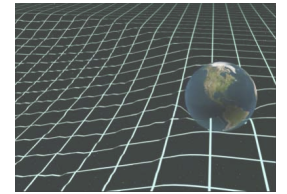
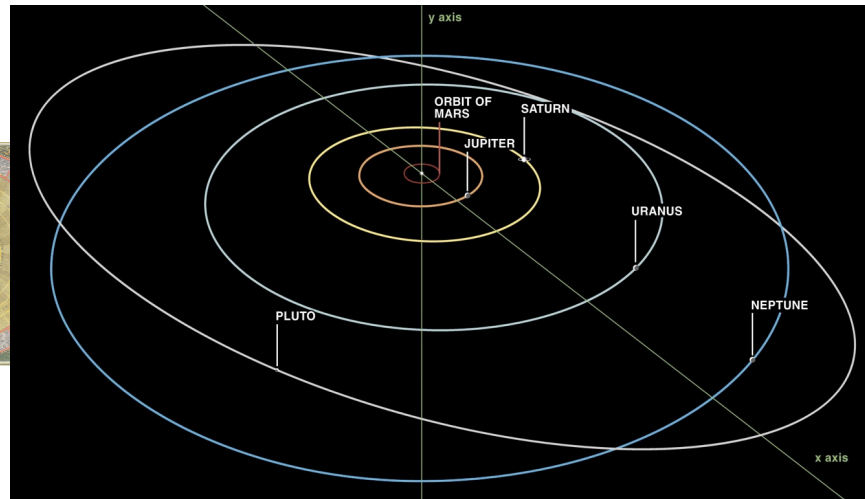
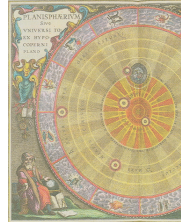
- Kepler (1609) - *Astronomia Nova* (*New Astronomy*)
Heliocentric view of the solar system, elliptical Mars orbit

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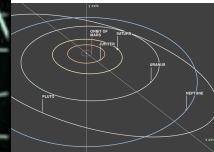
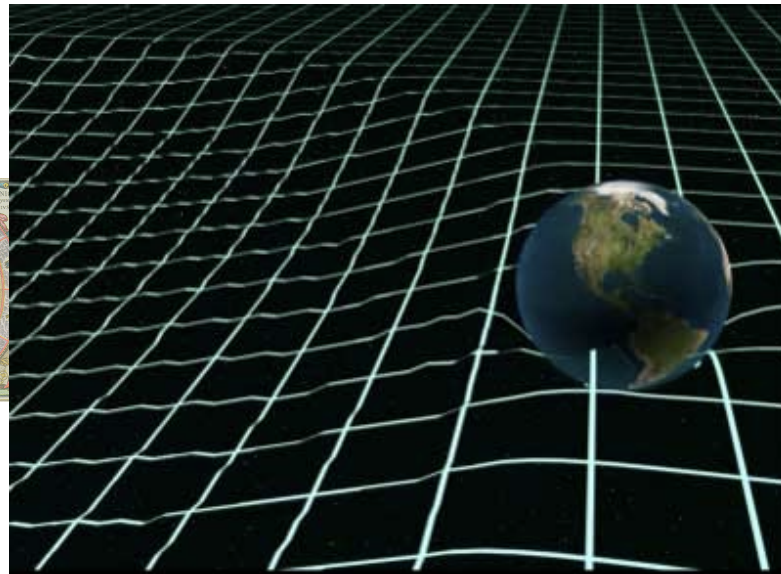
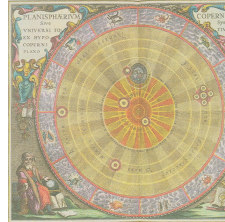
- Kepler - Heliocentric view of the solar system, elliptical orbits imply solar system dynamism

Imagery in Scientific Thought: Finding the Right *Picture*



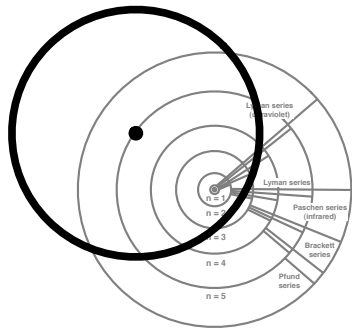
- The Solar System Today -

Imagery in Scientific Thought: Finding the Right *Picture*

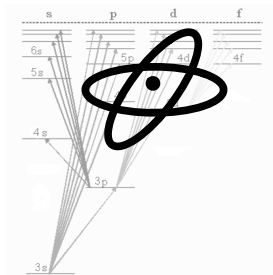


- General Relativity (1917) - Space-time warped by gravitation

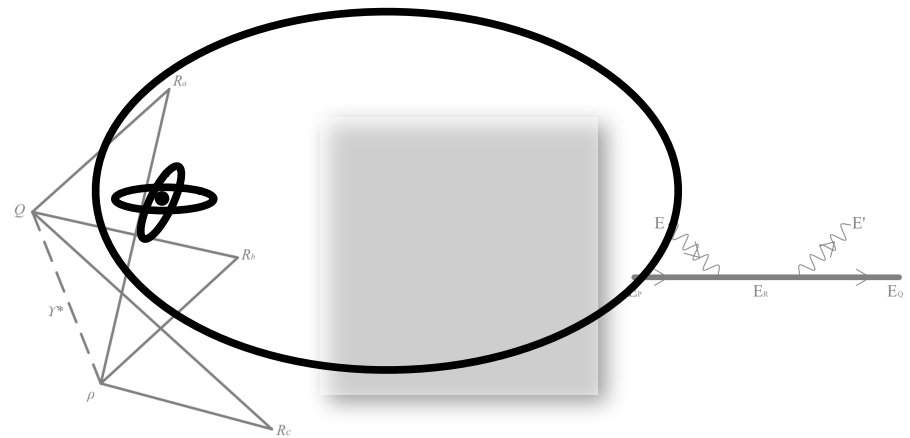
Imagery in Scientific Thought: Finding the Right *Picture*



Hydrogen

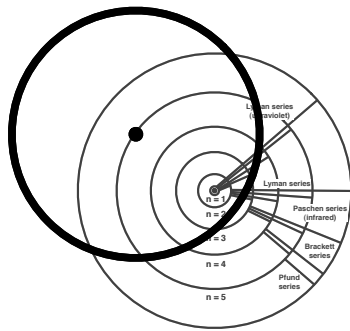


Helium

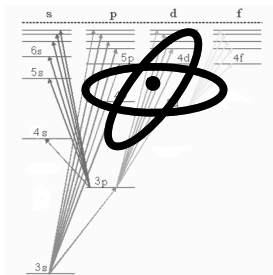


Lithium

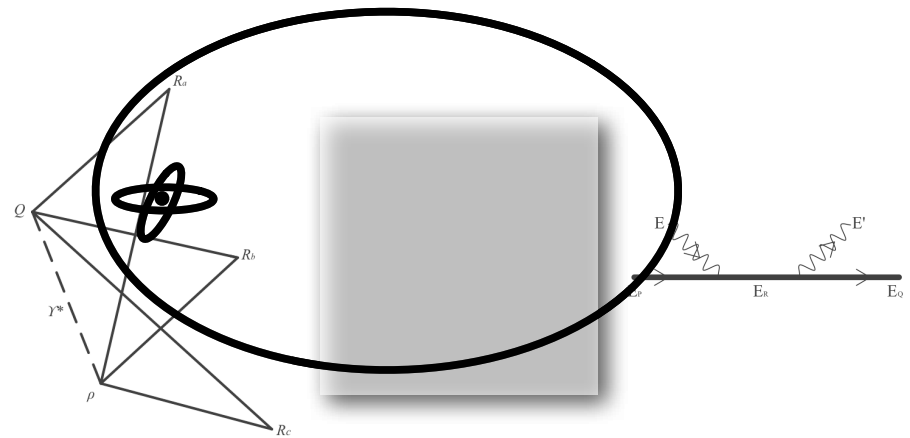
Imagery in Scientific Thought: Finding the Right *Picture*



Hydrogen



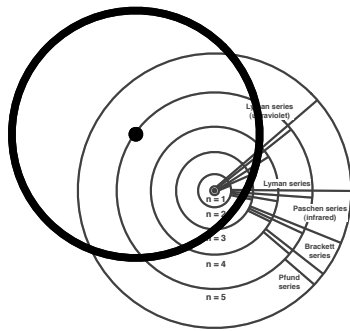
Helium



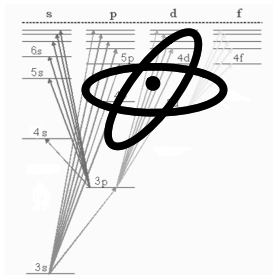
Lithium

- Working with what they could see, imagine, *experiment with*, record, and calculate, atomic physicists tried to make sense of the microworld

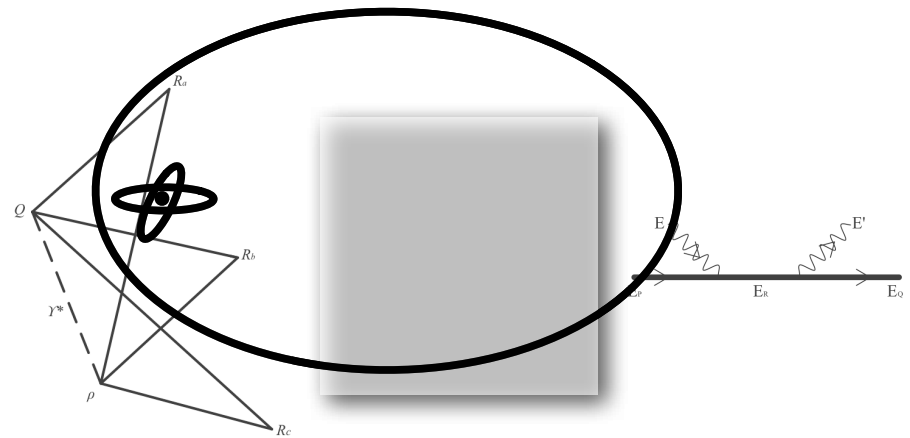
Imagery in Scientific Thought: Finding the Right *Picture*



Hydrogen



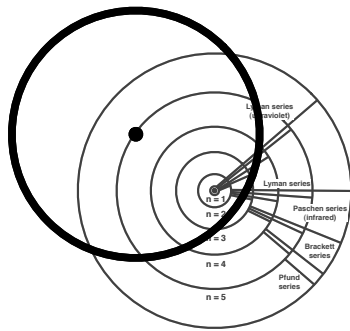
Helium



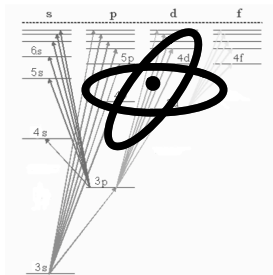
Lithium

- Bohr's Atomic Model - “A remarkable and alluring result of Bohr's atomic theory is the demonstration that the atom is a small planetary system ...”

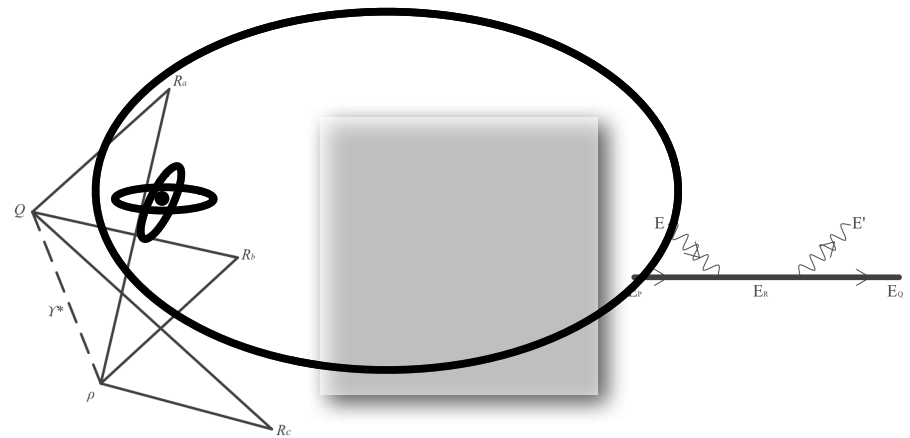
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Hydrogen



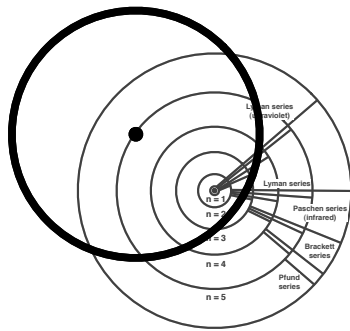
Helium



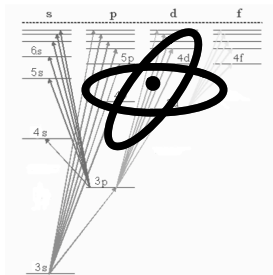
Lithium

- “... the thought that the laws of the macrocosmos in the small reflect the terrestrial world obviously exercises a great magic on mankind’s mind ...”

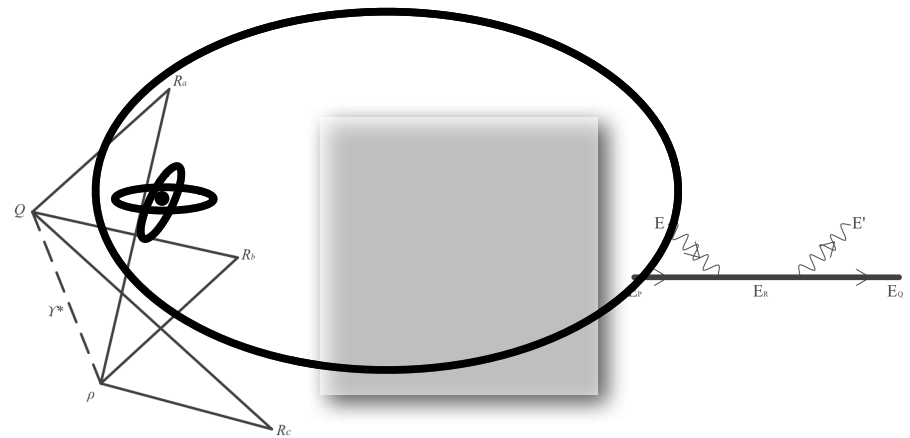
Imagery in Scientific Thought: Finding the Right *Picture*



Hydrogen



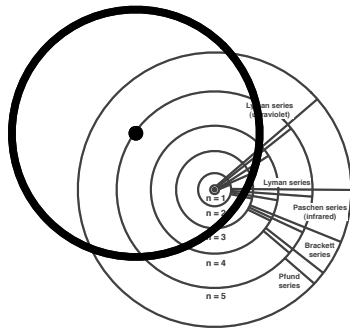
Helium



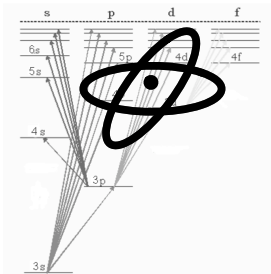
Lithium

- “... indeed its form is rooted in the superstition (which is as old as the history of thought) that the destiny of men can be read from the stars.”

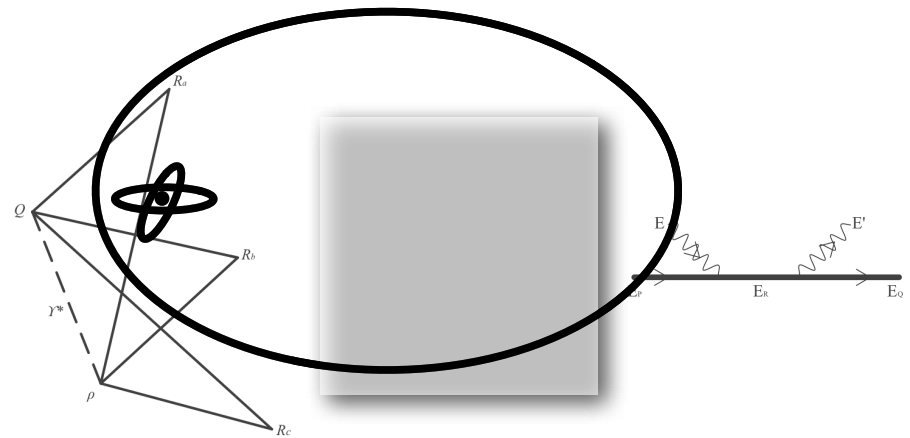
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Hydrogen



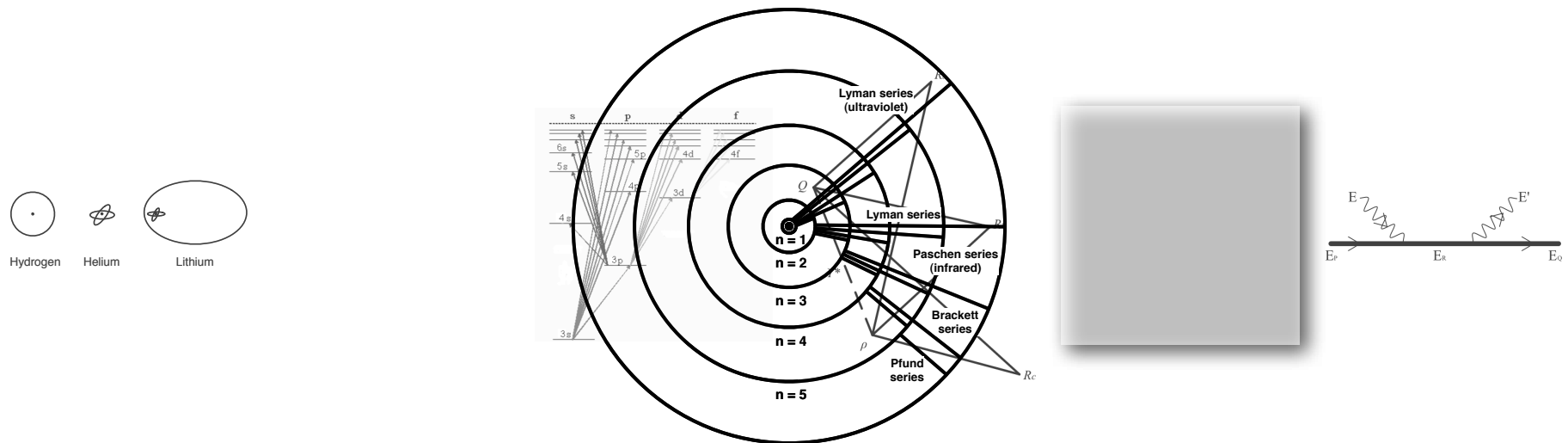
Helium



Lithium

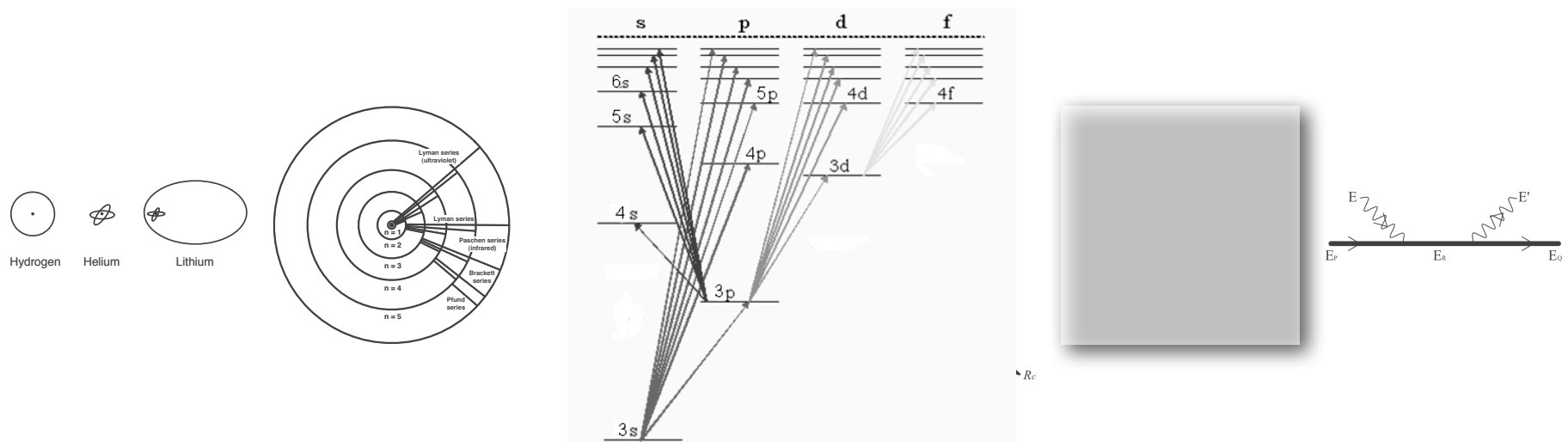
- “The astrological mysticism has disappeared from science, but remains is the endeavor toward the knowledge of the unity of the laws of the world.”

Imagery in Scientific Thought: Finding the Right *Picture*



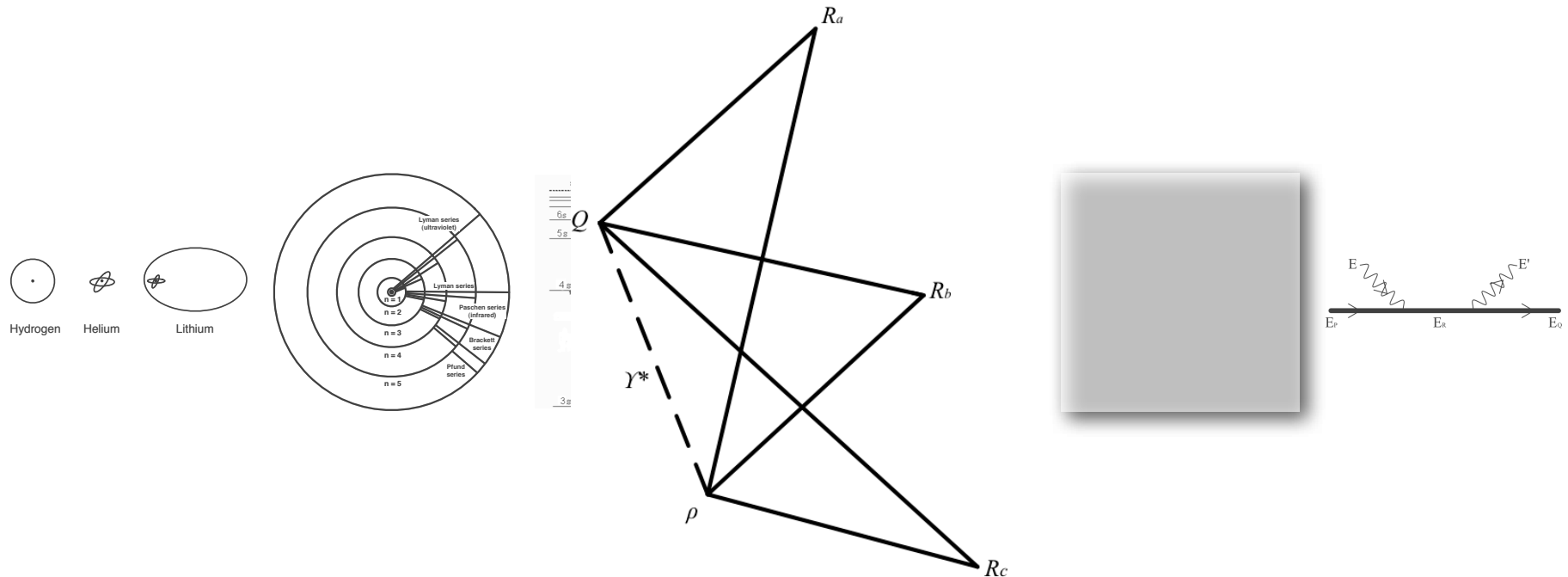
- Bohr Model of the Hydrogen Atom - An explanation for light emission from atoms that avoids Einstein's quantum. Imagery from the world of perceptions

Imagery in Scientific Thought: Finding the Right *Picture*



- Solar System Imagery Departing or Transformed - Imagery from the world of perceptions conflicts with experiment and calculation

Imagery in Scientific Thought: Finding the Right *Picture*



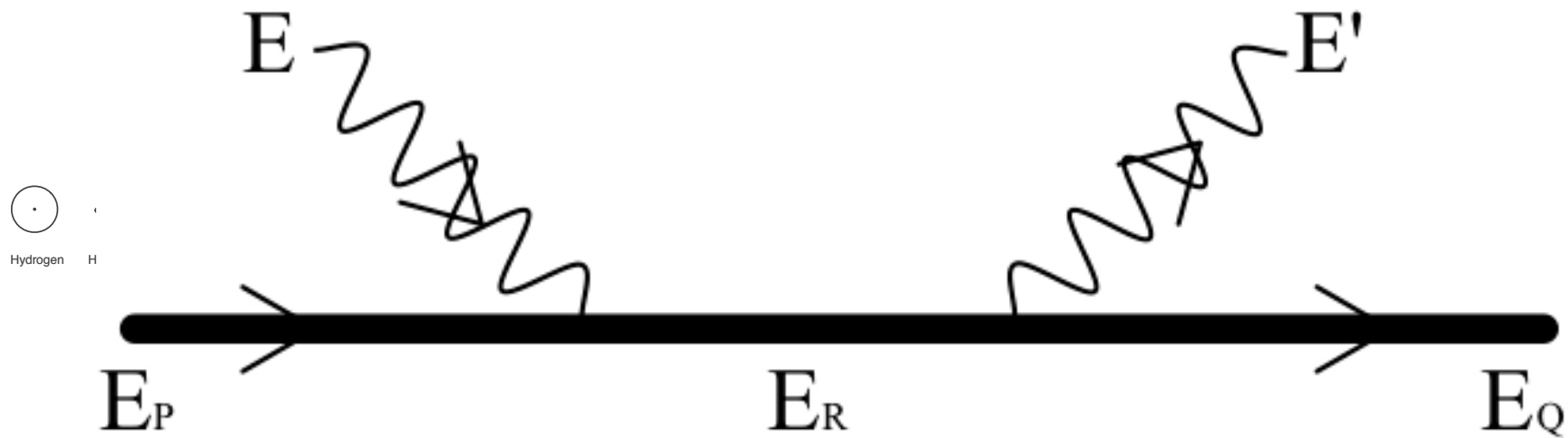
- Kramers-Heisenberg (1925) state diagram - Imagery of the light emission process, but without mathematical underpinnings

Imagery in Scientific Thought: Finding the Right *Picture*



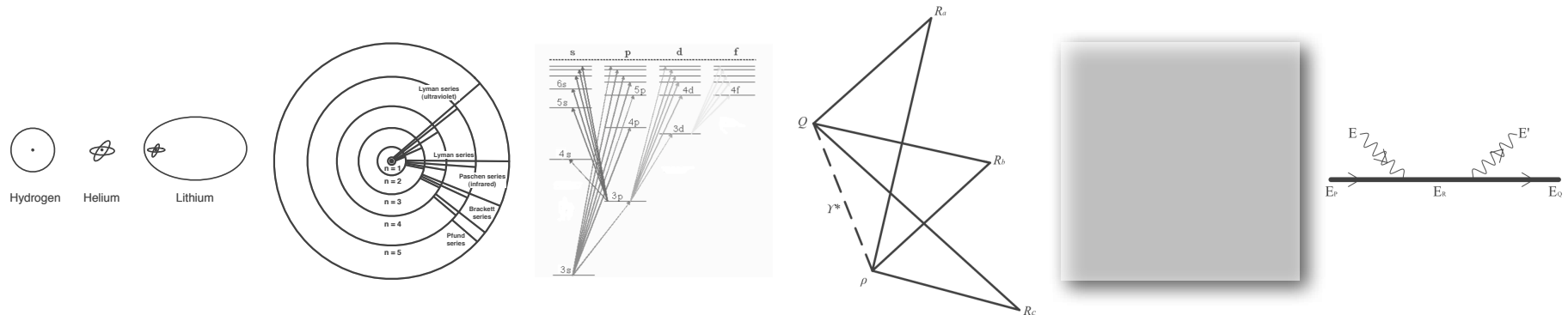
- Imagery Lost (1926-1943) *No* diagrams of electron-photon, neutron-proton particle interactions, though verbal descriptions existed. Much consternation

Imagery in Scientific Thought: Finding the Right *Picture*



- Feynman Diagram (1948) Physical process imagery is now generated by the mathematics of Quantum Theory. (Energy of incident/scattered light)

Imagery in Scientific Thought: Finding the Right *Picture*

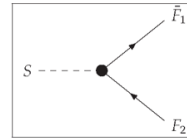


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Imagery in Scientific Thought: Finding the Right *Picture*

Scalar-Fermion-Fermion coupling in the electroweak Standard Model

Reference: A. Denner, Forts. Physik, 41 (1993) 307.



$$= ie(G_{\omega} \omega_- + G_{\omega^+} \omega_+)$$

Generic Level

where for the following combinations of S , \tilde{F}_1 , and F_2

G_{ω_+} and G_{ω_-} take these values:

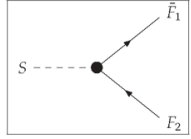
$$\begin{aligned} H\tilde{f}_i f_j &: \begin{cases} G_{\omega_+} = -\frac{1}{2s} \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} + \frac{1}{2} \delta Z^H \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,R} + \delta Z_{ij}^{f,L1} m_{f,j}) \right], \\ G_{\omega_-} = -\frac{1}{2s} \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} + \frac{1}{2} \delta Z^H \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,L} + \delta Z_{ij}^{f,R1} m_{f,j}) \right], \end{cases} \\ \chi\tilde{f}_i f_j &: \begin{cases} G_{\omega_+} = i \frac{1}{2s} 2I_{W,f}^3 \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,R} + \delta Z_{ij}^{f,L1} m_{f,j}) \right], \\ G_{\omega_-} = -i \frac{1}{2s} 2I_{W,f}^3 \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,L} + \delta Z_{ij}^{f,R1} m_{f,j}) \right], \end{cases} \\ \phi^+ \tilde{u}_i d_j &: \begin{cases} G_{\omega_+} = -\frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[V_{ij} m_{d,j} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{d,j}}{m_{d,j}} - \frac{\delta M_W}{M_W} \right) + \delta V_{ij} m_{d,j} \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{ik}^{u,L1} V_{kj} m_{d,j} + V_{ik} m_{d,k} \delta Z_{kj}^{d,R}) \right], \\ G_{\omega_-} = \frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[m_{u,i} V_{ij} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{u,i}}{m_{u,i}} - \frac{\delta M_W}{M_W} \right) + m_{u,i} \delta V_{ij} \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{ik}^{u,R1} m_{u,k} V_{kj} + m_{u,i} V_{ik} \delta Z_{kj}^{d,L}) \right], \end{cases} \\ \phi^- \tilde{d}_j u_i &: \begin{cases} G_{\omega_+} = \frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[V_{ji}^* m_{u,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{u,i}}{m_{u,i}} - \frac{\delta M_W}{M_W} \right) + \delta V_{ji}^* m_{u,i} \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{jk}^{d,L1} V_{ki}^* m_{u,i} + V_{jk}^* m_{u,k} \delta Z_{ki}^{u,R}) \right], \\ G_{\omega_-} = -\frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[m_{d,j} V_{ji}^* \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{d,j}}{m_{d,j}} - \frac{\delta M_W}{M_W} \right) + m_{d,j} \delta V_{ji}^* \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{jk}^{d,R1} m_{d,k} V_{ki}^* + m_{d,j} V_{jk}^* \delta Z_{ki}^{u,L}) \right], \end{cases} \\ \phi^+ \tilde{\nu}_i l_j &: \begin{cases} G_{\omega_+} = -\frac{1}{\sqrt{2}s} \frac{m_{l,j}}{M_W} \delta_{ij} \left[1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{l,j}}{m_{l,j}} - \frac{\delta M_W}{M_W} + \frac{1}{2} (\delta Z_{ii}^{\nu,L1} + \delta Z_{ii}^{\nu,R}) \right], \\ G_{\omega_-} = 0, \end{cases} \\ \phi^- \tilde{l}_j \nu_i &: \begin{cases} G_{\omega_+} = 0, \\ G_{\omega_-} = -\frac{1}{\sqrt{2}s} \frac{m_{l,j}}{M_W} \delta_{ij} \left[1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{l,j}}{m_{l,j}} - \frac{\delta M_W}{M_W} + \frac{1}{2} (\delta Z_{ii}^{\nu,L1} + \delta Z_{ii}^{\nu,R}) \right]. \end{cases} \end{aligned}$$

Classes Level

Particles Level: Insert integers for i and j (1, 2, 3 in this case)

Imagery in Scientific Thought: Finding the Right *Picture*

Scalar-Fermion-Fermion coupling in the electroweak Standard Model
Reference: A. Denner, Forts. Physik, 41 (1993) 307.



Generic Level

$$= ie(G_{\omega} \omega_- + G_{\omega^+} \omega_+)$$

Classes Level

where for the following combinations of S , \bar{F}_1 , and F_2
 G_{ω_+} and G_{ω_-} take these values:

$$H \bar{f}_i f_j : \begin{cases} G_{\omega_+} = -\frac{1}{2s} \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} + \frac{1}{2} \delta Z^H \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,R} + \delta Z_{ij}^{f,L1} m_{f,i}) \right], \\ G_{\omega_-} = -\frac{1}{2s} \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} + \frac{1}{2} \delta Z^H \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,L} + \delta Z_{ij}^{f,R1} m_{f,i}) \right], \end{cases}$$

$$\chi \bar{f}_i f_j : \begin{cases} G_{\omega_+} = i \frac{1}{2s} 2I_{W,f}^3 \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,R} + \delta Z_{ij}^{f,L1} m_{f,i}) \right], \\ G_{\omega_-} = -i \frac{1}{2s} 2I_{W,f}^3 \frac{1}{M_W} \left[\delta_{ij} m_{f,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{f,i}}{m_{f,i}} - \frac{\delta M_W}{M_W} \right) \right. \\ \quad \left. + \frac{1}{2} (m_{f,i} \delta Z_{ij}^{f,L} + \delta Z_{ij}^{f,R1} m_{f,i}) \right], \end{cases}$$

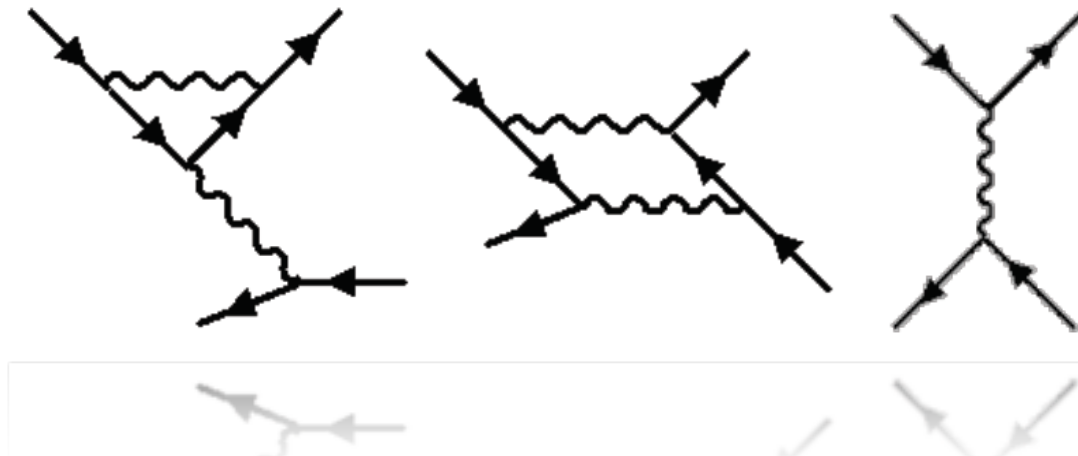
$$\phi^+ \bar{u}_i d_j : \begin{cases} G_{\omega_+} = -\frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[V_{ij} m_{d,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{d,i}}{m_{d,i}} - \frac{\delta M_W}{M_W} \right) + \delta V_{ij} m_{d,i} \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{ik}^{u,L1} V_{kj} m_{d,i} + V_{ik} m_{d,k} \delta Z_{kj}^{d,R}) \right], \\ G_{\omega_-} = \frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[m_{u,i} V_{ij} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{u,i}}{m_{u,i}} - \frac{\delta M_W}{M_W} \right) + m_{u,i} \delta V_{ij} \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{ik}^{u,R1} m_{u,k} V_{kj} + m_{u,i} V_{ik} \delta Z_{kj}^{d,L}) \right], \end{cases}$$

$$\phi^- \bar{d}_j u_i : \begin{cases} G_{\omega_+} = \frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[V_{ji}^* m_{u,i} \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{u,i}}{m_{u,i}} - \frac{\delta M_W}{M_W} \right) + \delta V_{ji}^* m_{u,i} \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{jk}^{d,L1} V_{ki}^* m_{u,i} + V_{jk}^* m_{u,k} \delta Z_{ki}^{u,R}) \right], \\ G_{\omega_-} = -\frac{1}{\sqrt{2}s} \frac{1}{M_W} \left[m_{d,j} V_{ji}^* \left(1 + \delta Z_e - \frac{\delta s}{s} + \frac{\delta m_{d,j}}{m_{d,j}} - \frac{\delta M_W}{M_W} \right) + m_{d,j} \delta V_{ji}^* \right. \\ \quad \left. + \frac{1}{2} \sum_k (\delta Z_{jk}^{d,R1} m_{d,k} V_{ki}^* + m_{d,j} V_{ik}^* \delta Z_{ki}^{u,L}) \right], \end{cases}$$

- Drawing Feynman diagrams (rapid, flexible, creative exploration) now generates the appropriate equations for computation

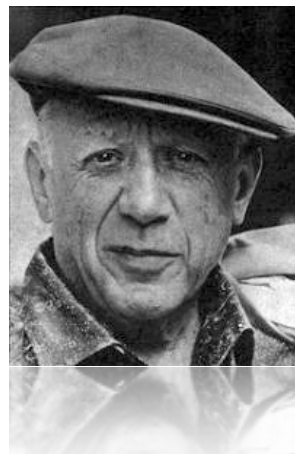
Imagery in Scientific Thought

- The human visual imagery system can generate and operate on image content that has never been perceived.
- Feynman diagrams demonstrated that for physicists, the imagery system can be successfully “programmed” to create and operate on imagery that is *generated by* the mathematics of unobservable physical phenomena



Imagery in Artistic Thought

- The human visual imagery system can generate and operate on image content that has never been perceived
- Picasso's painting *Les Femmes d'Alger* demonstrated that for artists – and for receptive viewers – the imagery system can be made to creatively transform the geometry of customary visual appearances



Imagery in Artistic Thought

- The human mental imagery system can generate and operate on image content that has never been perceived.
 - The creative imagery that led Picasso to cubism was influenced by: his work habits; aloneness and anxiety; Paul Cézanne; cinema, literature, music, and theater; Maurice Princet - “*le mathématicien du cubisme*,” and Henri Poincaré - non-Euclidean geometry and the fourth dimension



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Imagery in Creative Thought

- Final Miller Quotes -

A hallmark of classicism in art and science is a visual imagery abstracted from phenomena and objects we have experienced in the daily world.

There is no such visual imagery in quantum mechanics or in highly abstract art. Artists and scientists had to seek it anew rather than extrapolate it from the everyday world.

Imagery in Creative Thought

In physics, the visual imagery imposed on atomic theories led to inconsistencies and confusions in interpretation.

*It turned out that the proper visual imagery is generated by the mathematics of quantum mechanics, and it consists entirely of **schematic representations of events**, not pictures of objects...*

This transformation in the role of imagery is one of the main distinguishing features of art and science in the twentieth century.

Yu Tsun's Confession

- A Chinese professor of English spies for the Germans during WWI
- Fearing capture, he flees to house in a small town to send a signal to his spymasters
- He encounters a British scholar who has working on a “novel” written by his ancestor, Ts’ui Pên
- Yu Tsun reads Ts’ui Pên: “I leave to various future times, but not to all, my garden of forking paths.”
- The scholar describes his discovery, while Yu Tsun introspects

Yu Tsun's Confession

At that moment I felt within me and around me something invisible and intangible pullulating. It was not the pullation of two divergent, parallel, and finally converging armies, but an agitation more inaccessible, more intimate, prefigured by them in some way ...

Yu Tsun's Confession

“The explanation is obvious. *The Garden of Forking Paths* is a picture, incomplete yet not false, of the universe such as Ts'ui Pên conceived it to be. Differing from Newton and Schopenhauer, your ancestor did not think of time as absolute and uniform.

He believed in an infinite series of times, in a dizzily growing, ever spreading network of diverging, converging and parallel times.

This web of time—the strands of which approach one another, bifurcate, intersect or ignore each other through the centuries—embraces *every* possibility”...

Yu Tsun's Confession

Once again I sensed the pullulation of which I have already spoken. It seemed to me that the dew-damp garden surrounding the house was infinitely saturated with invisible people. All were Albert and myself, secretive, busy and multiform in other dimensions of time ...

Yu Tsun's Confession

He does not know, for no one can, of my infinite
penitence and sickness of the heart.

Imagery in Creative Thought: Relevance for Cultural Heritage Resource Description

- Miller's exploration of imagery-assisted creative expression (with examples from art and science) can inform advanced theories of the *description* of creative expressions
- In the face of increasing knowledge and experimentation, the critical, theory-relevant imagery that formerly elucidated a process can be lost and then regained in a new form
- Building upon E-R modeling – by defining and systematically using appropriate visual imagery in support of Cultural Heritage resource description – will enhance theory formation, education/training, and information system design

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Finding the Right *Picture* With the Help of Conceptual Data Modeling

- The technique involves using existing cataloging theory and bibliographic records to model the resource description process. The resulting model is then drawn upon to create a *Paper Tool* that is used to explore specific – real or imaginary – bibliographic resource/description configurations
- FRBR resource description theory incorporates several *mathematical ideas* for expressing simple and complex relationships between connected elements. These ideas are more easily communicated with the support of a diagrammatic method

Three

Modeling The Bibliographic Universe With FRBR

Three

Why Know About This?

Catalogers have been creating resource description structures that are more complex than even they thought

Full understanding and representation of this complexity requires introducing points of view from outside of the Cultural Heritage arena

Data Modeling: Keeping the Definitions Straight

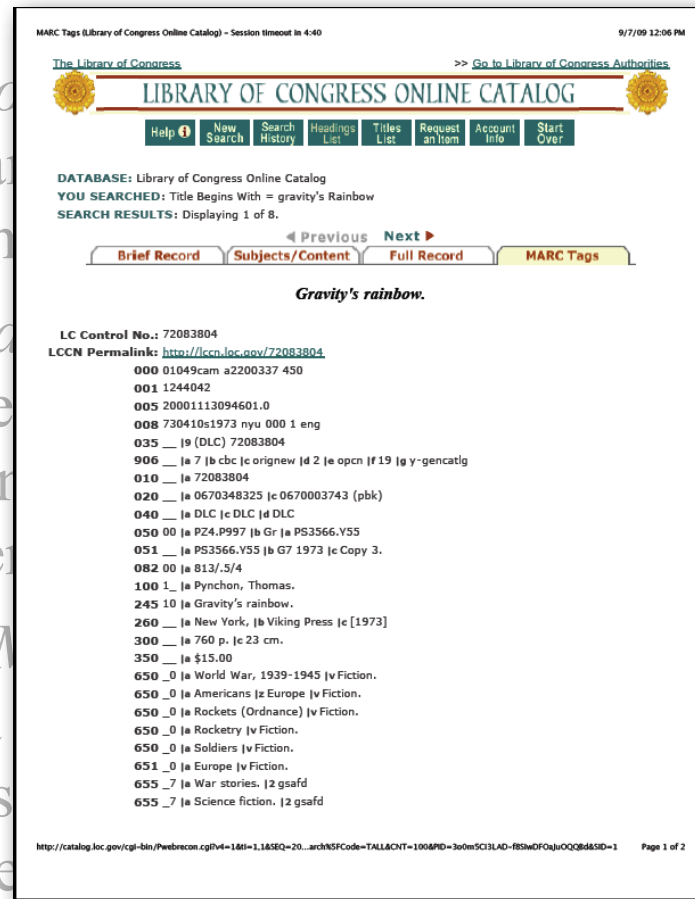
- *General Definition*: The specification of a final conceptual data model and an initial logical data model that together meet business requirements, *prior to performance tuning*
 - *Conceptual Data Model*: A description of a portion of an enterprise in terms of the fundamental things of interest to it. They are fundamental in that most things seen by business owners are examples of these.
 - *Logical Data Model*: The organization of data for use with a particular data management technology. For relational databases, these are tables and columns; for object-oriented databases, object classes and attributes
 - We should not be discussing this kind of model – but we must because they have been hybridized with conceptual data models in the Cultural Heritage realm

Data Modeling: Keeping the Definitions Straight

- *General Definition*: The specification of a final conceptual data model and an initial logical data model that together meet business requirements, *prior to performance tuning*
 - *Physical Data Model*: The organization of data used to place it on specific storage media. This level refers to “tablespaces” and “cylinders”
 - We will not discuss this type of model

Data Modeling: Keeping the Definitions Straight

- *General Definition*
data model and a
business requiremen
- *Conceptual Data*
enterprise in te
it. They are fur
business owner
- *Logical Data Model*
particular data
databases, thes
databases, obje



nal conceptual
that together meet
tuning
a portion of an
ings of interest to
gs seen by
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or relational
or object-oriented

*The MARC bibliographic standard specifies a logical data model that employs **tags** and **delimiters** to structure bibliographic data. The MARC conceptual data model is hybridized with its logical data model*

Conceptual Data Modeling and Theory Formation

- *Conceptual Data Model*: A description of a portion of an enterprise in terms of the fundamental things of interest to it. They are fundamental in that most things seen by business owners are examples of these.
- It assumes that we know what the things of interest are and why they are the way they are
- If modeling is used *to build a theory of what the things of interest are*, a different strategy must be employed
 - Tentative model definitions based on prior art and theoretical considerations
 - Model verification, testing against typical and atypical (but critical) situations, followed by model correction

FRBR Conceptual Data Model

Creation: Relationships

- Specify the set of relationships that exist between the FRBR **Work**, **Expression**, **Manifestation**, and **Item** entities. Statements of each “side” of a relationship are written as *Two Way Statements* to make verification simpler and more reliable
 - A **Work** must be realized through one or more **Expressions**
 - An **Expression** must be a realization of one **Work**
 - An **Expression** must be embodied in one or more **Manifestations**
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- *The Content of Each Statement is Important!* Each statement must indicate whether the relationship is optional (*may/must*), and how many entities are being related to (*zero, one, one or more, etc.*)

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Speaking Broadly

- A **Work** may be described by one or more **Expressions**.
- An **Expression** may be described by one or more **Manifestations**.
- An **Expression** may be described by one or more **Items**.
- A **Manifestation** may be described by one or more **Items**.
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Data Model Quality Assurance

- *The Modeler's Task* - Verify each individual statement. Ensure consistency between all stated combinations of these six FRBR relationships and with any other conclusions drawn from the data model as a whole. This is usually accomplished with the help of knowledgeable users.
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- *A Data Modeling Rule of Thumb* - Examine and characterize the statements that reference the same entities. Look for patterns.
(One-to-Many, Many-to-Many)

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*One-to-Many
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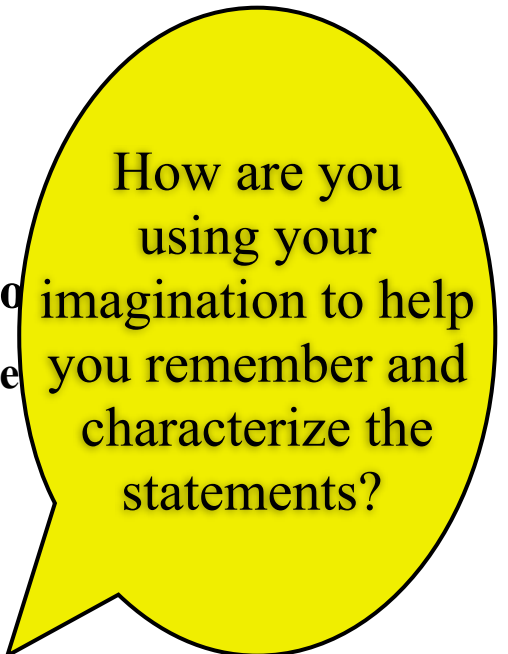
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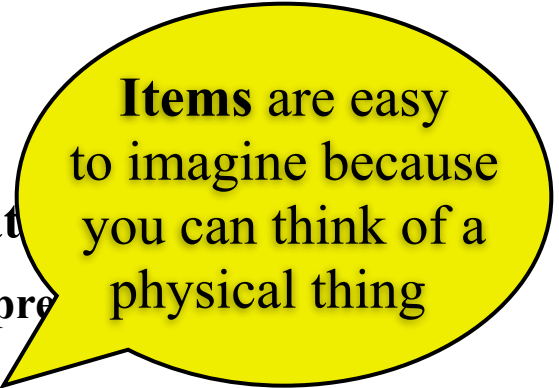


How are you using your imagination to help you remember and characterize the statements?

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Items are easy to imagine because you can think of a physical thing

- *A Data Modeling Rule of Thumb* - Examine and characterize the statements that reference the same entities. Look for patterns.
(One-to-Many, Many-to-Many)

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- *A Data Modeling Rule of Thumb* - Examine and check statements that reference the same entities. Look for (One-to-Many, Many-to-Many)



A **Manifestation**
is the set of all **Items** -
right?

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What about **Works** and **Expressions**?

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Data Model Quality Assurance

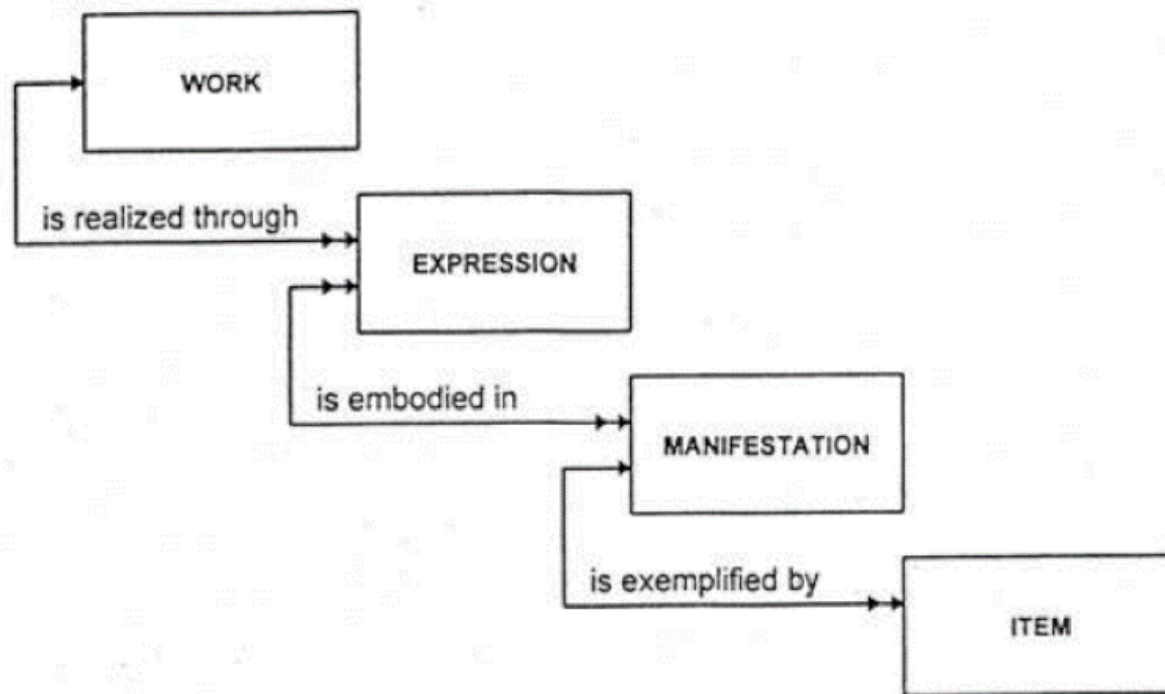
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 - An **Expression** must be a realization of one **Work**
 - An **Expression** must be embodied in one or more **Manifestations** *Many-to-Many Relationship*
 - A **Manifestation** must be an embodiment of one or more **Expressions** *One-to-Many Relationship*
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 - An **Item** must be an exemplification of one **Manifestation** *One-to-Many Relationship*
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Data Model Quality Assurance

- *The Modeler's Task* - Selected FRBR entities and relationships are presented in their published form and in a modified[†] form that shows all six relationship statements

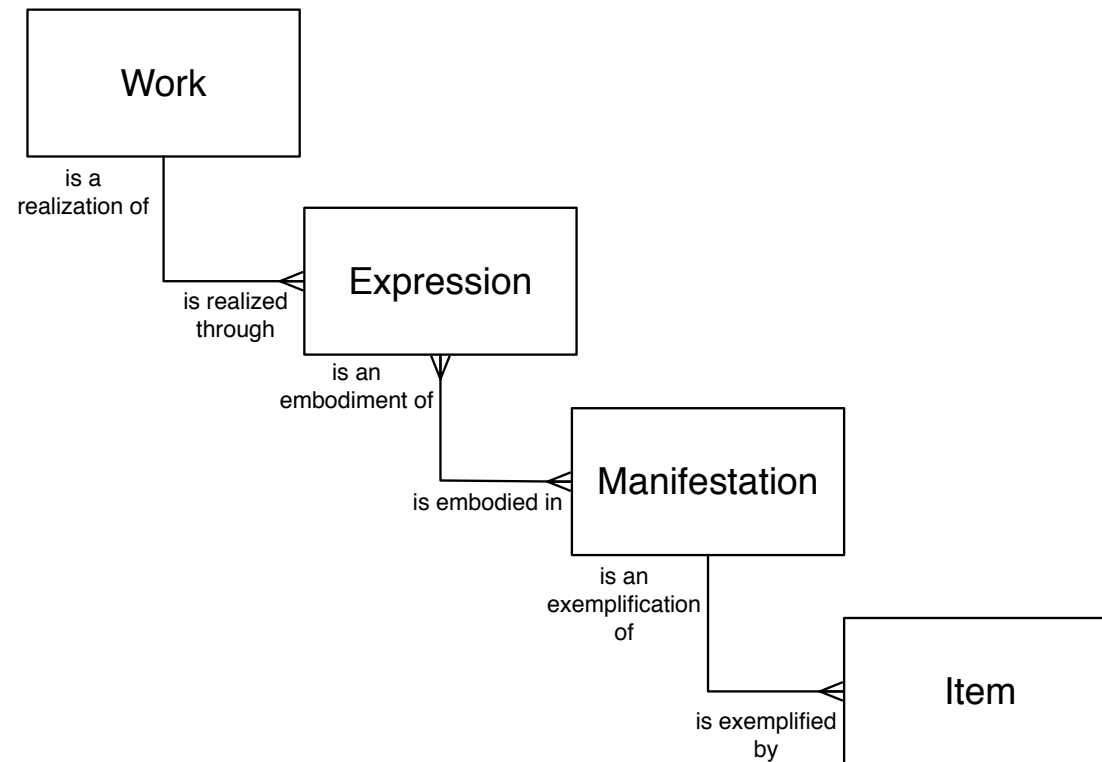
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Data Model Quality Assurance

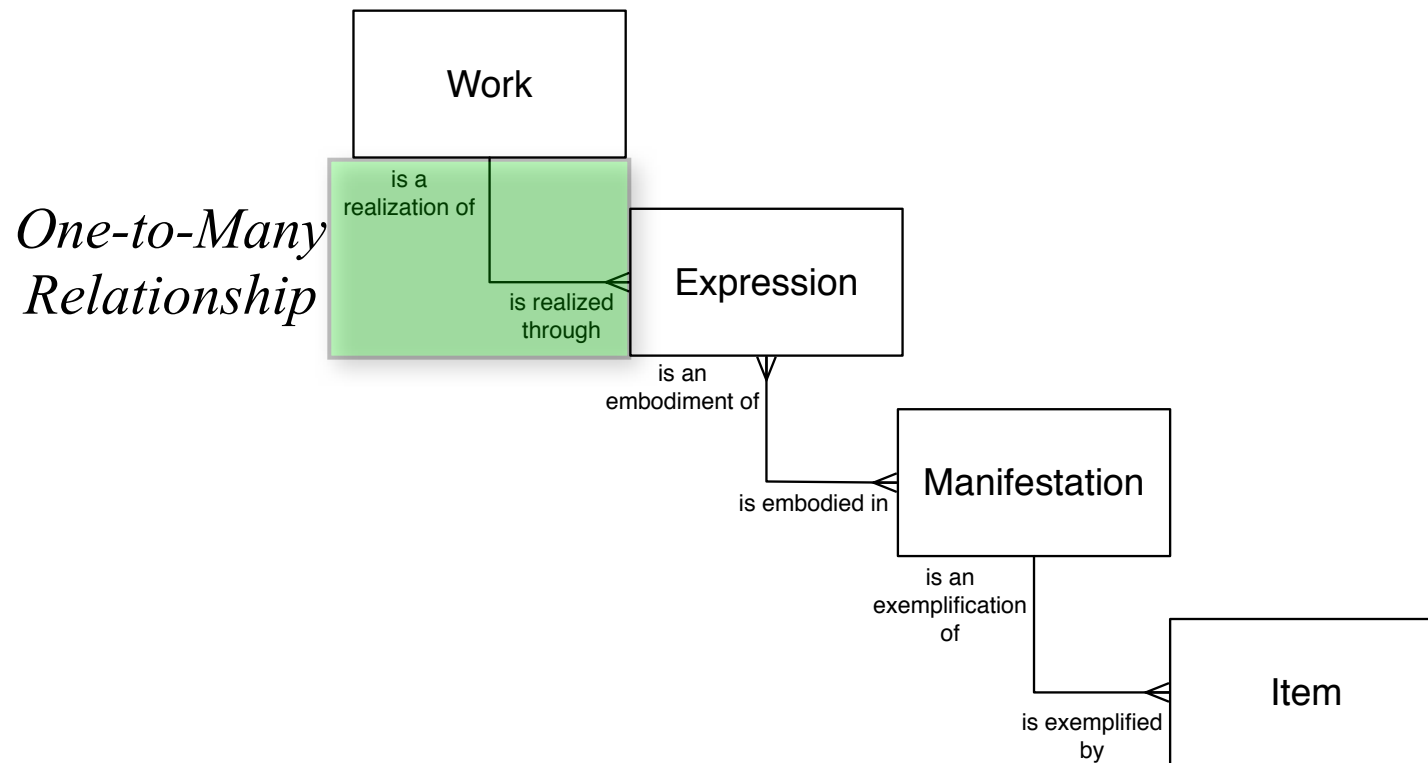
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[†] A 2007 study of professional data modelers indicated that more than 55% used a version of the “crow’s foot” style of notation to solve assigned data modeling problems

Data Model Quality Assurance

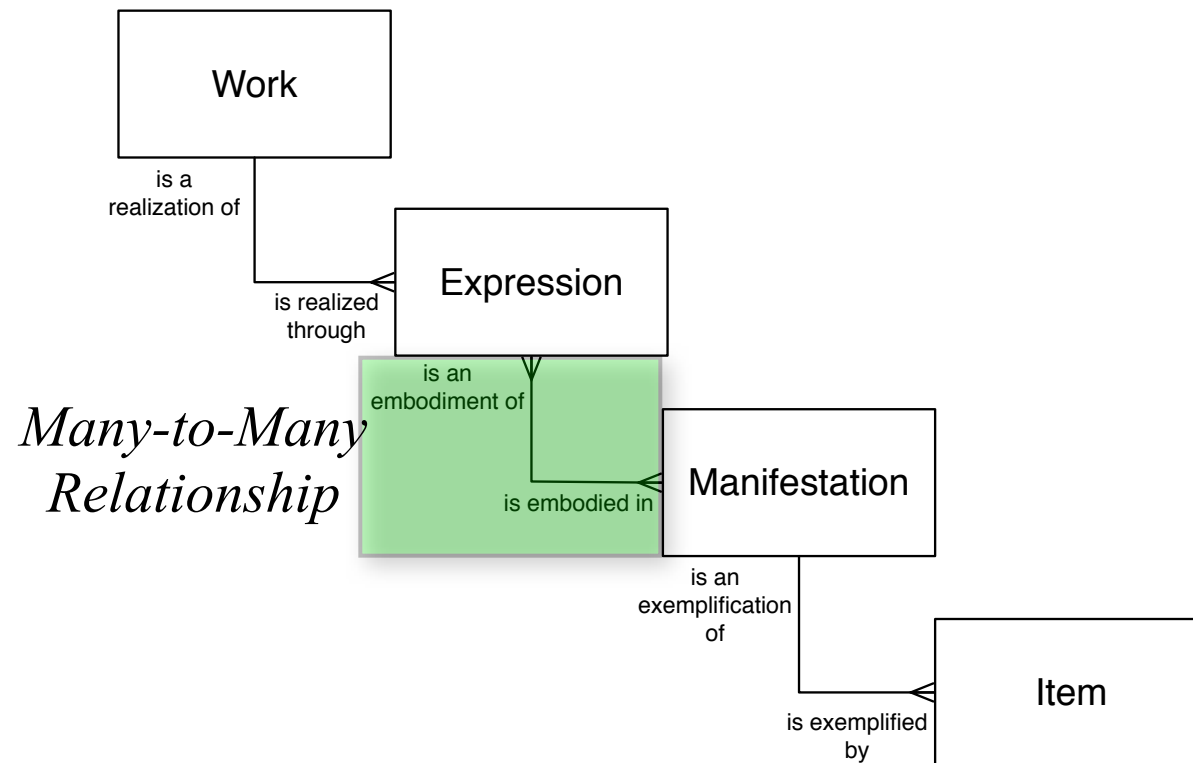
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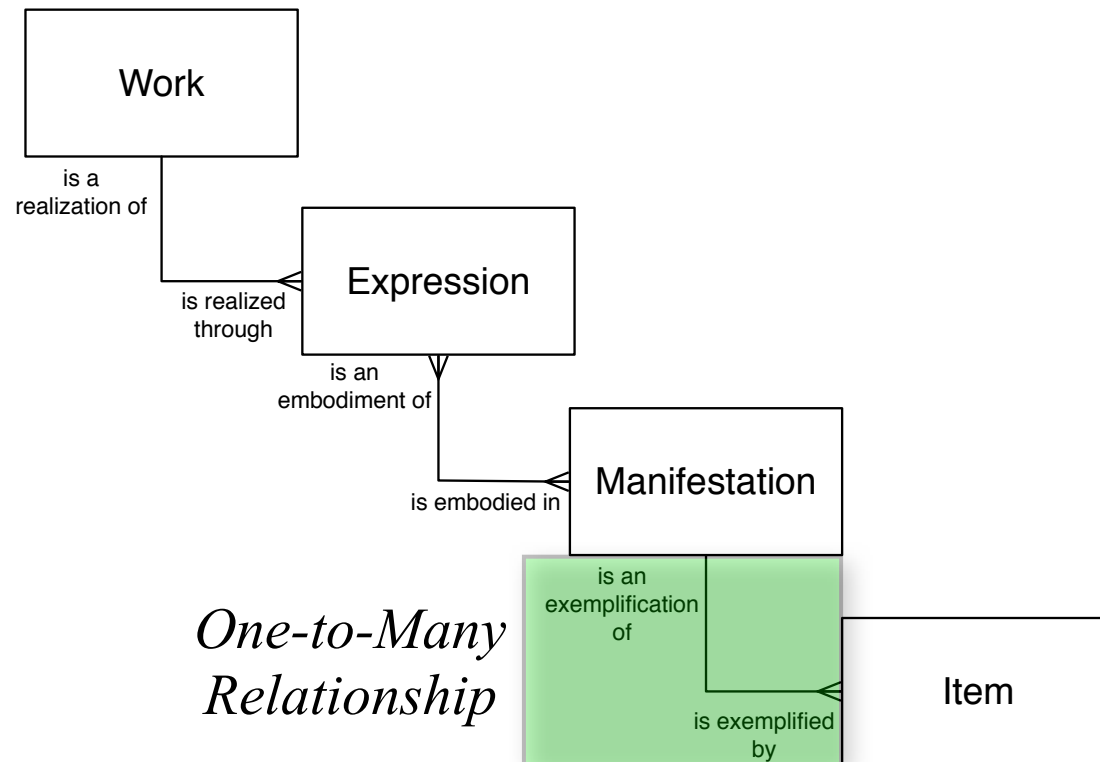
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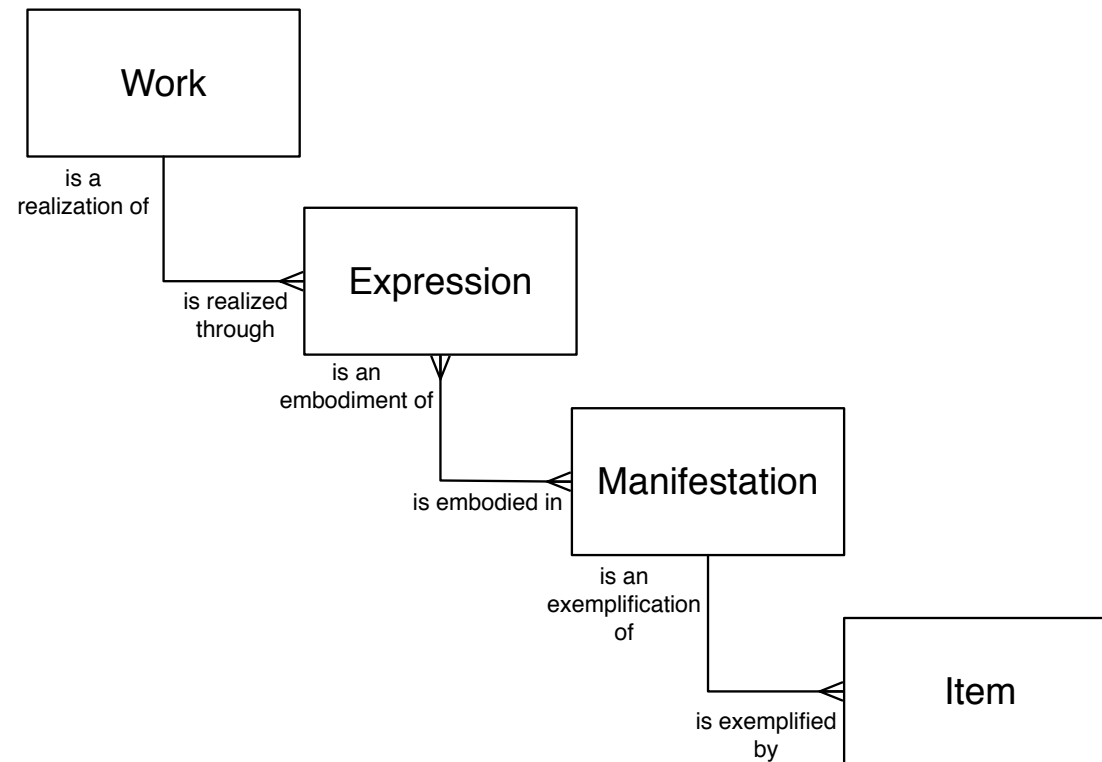
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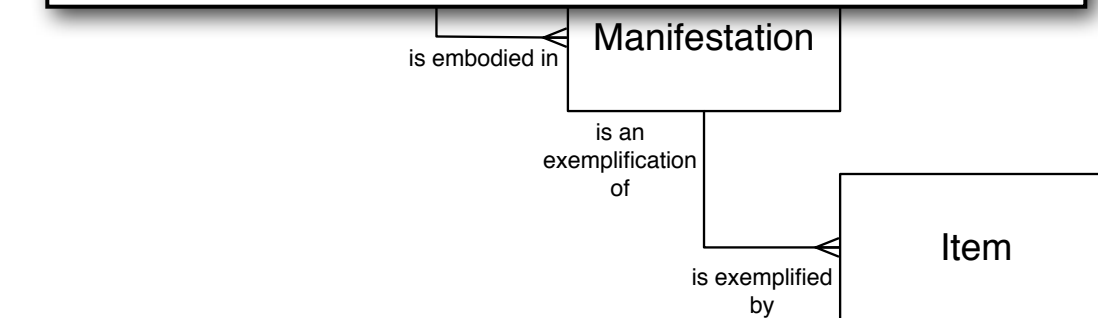


Data Model Quality Assurance

- *The Modeler* presented in shows all six relationships are form that

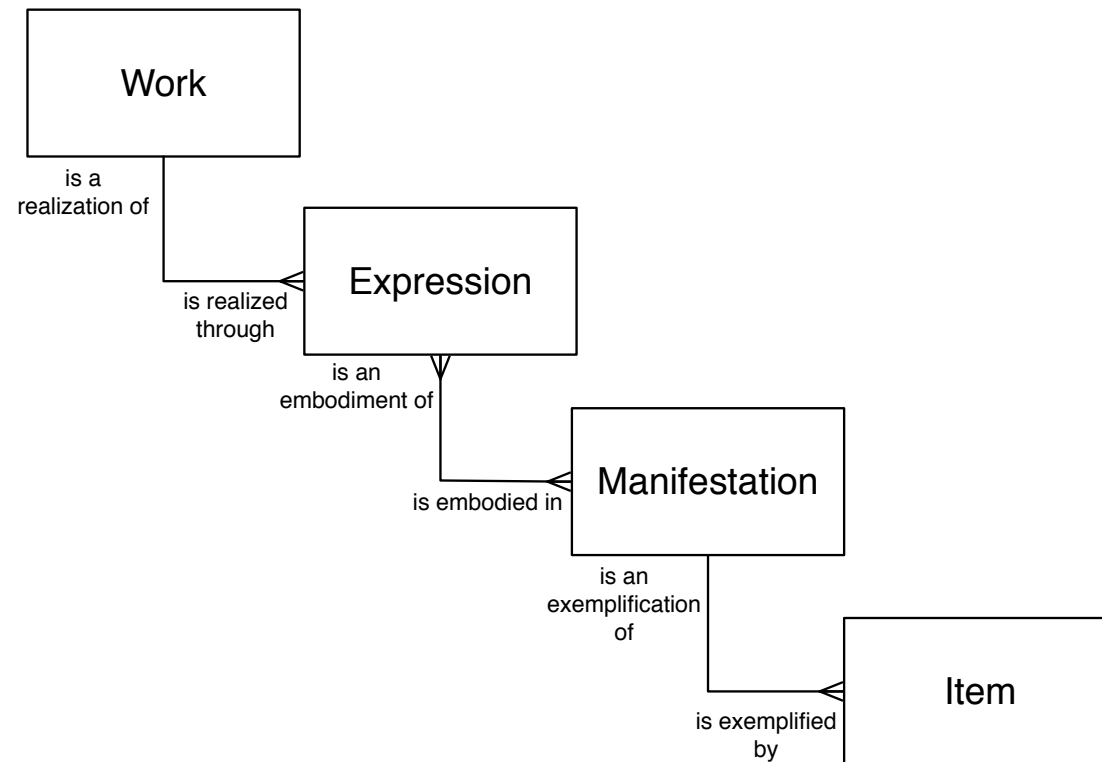
FRBR Optionality is a Theoretical Question

This diagram does not indicate whether the relationships are optional or not. This turns out to be a very significant theoretical question with practical (database design) consequences



Data Model Quality Assurance

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Data Model Quality Assurance: Asking Questions Of The Model

- *Is the FRBR Conceptual Model “Hierarchical?”* - **Execute a logical reasoning task** - Examine the FRBR relationship statements by pairs to determine that only One-to-Many relationships exist (“some” One-to-Ones relationships are OK)
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 - An **Expression** must be embodied in one or more **Manifestations**
 - A **Manifestation** must be an embodiment of one or more **Expressions**
 - A **Manifestation** must be exemplified by one or more **Items**
 - An **Item** must be an exemplification of one or more **Manifestations**

Data Model Quality Assurance: Asking Questions Of The Model

- *Is the FRBR Conceptual Model “Hierarchical?”* - **Execute a logical reasoning task** - Examine the FRBR relationship statements by pairs to determine if they exist (“some” One-to-One relationships exist)
 - A **Work** must be exemplified by one or more **Expressions**
 - An **Expression** must be exemplified by one or more **Manifestations**
 - An **Expression** must be exemplified by one or more **Items**
 - A **Manifestation** must be exemplified by one or more **Items**
 - A **Manifestation** must be exemplified by one or more **Items**
 - An **Item** must be an exemplification of one or more **Manifestations**

Speaking Broadly

A conceptual model may be properly stated and/or drawn, but misunderstood. Verifying conclusions drawn from the model becomes a critical task.

Data Model Quality Assurance: Asking Questions Of The Model

- *Is the FRBR Conceptual Model “Hierarchical?”* - **Execute a logical reasoning task** - Examine the FRBR relationship statements by pairs to determine that only One-to-Many relationships exist (“some” One-to-Ones relationships are OK)
 - A **Work** must be realized through one or more **Expressions**
 - An **Expression** must be a realization of one **Work**
 - An **Expression** must be embodied in one or more **Manifestations**
 - A **Manifestation** must be an embodiment of one or more **Expressions**
 - A **Manifestation** must be exemplified by one or more **Items**
 - An **Item** must be an exemplification of one or more **Manifestations**

Data Model Quality Assurance: Asking Questions Of The Model

- *Is the FRBR Conceptual Model “Hierarchical?”* - **Execute a logical reasoning task** - Examine the FRBR relationship statements by pairs to determine that only One-to-Many relationships exist (“some” One-to-Ones relationships are OK)

1. **a.** Each of the three divisions of angels, every one comprising three orders, in the system of Dionysius the Areopagite: see note s.v. [CHERUB](#). Also, the collective body of angels, the angelic host.

b. *transf.* of other beings: see quotes.

2. **a.** Rule or dominion in holy things; priestly rule or government; a system of ecclesiastical rule.

†**b.** *gen.* Rule, dominion. *Obs.*

3. *concr.* The collective body of ecclesiastical rulers; an organized body of priests or clergy in successive orders or grades.

4. A body of persons or things ranked in grades, orders, or classes, one above another; *spec.* in *Natural Science* and *Logic*, a system or series of terms of successive rank (as *classes*, *orders*, *genera*, *species*, etc.), used in classification.

Data Model Quality Assurance: Asking Questions Of The Model

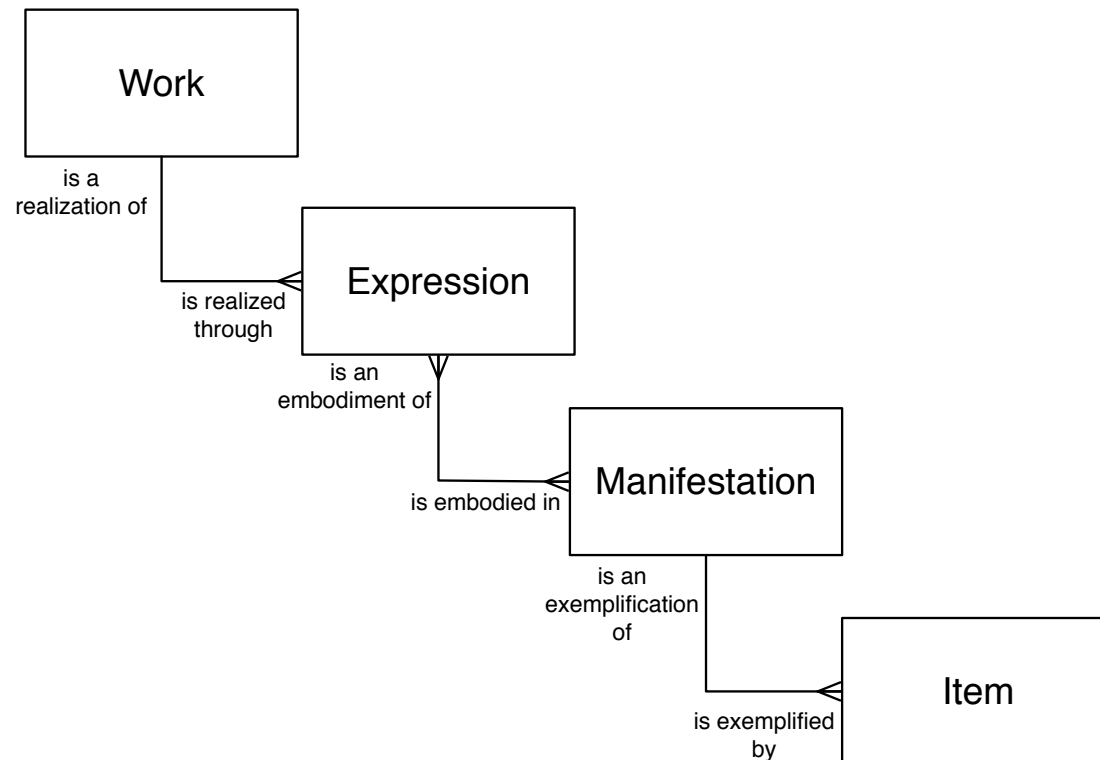
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 - A **Manifestation** must be exemplified by one or more **Items**
 - An **Item** must be an exemplification of one or more **Manifestations**

Data Model Quality Assurance: Asking Questions Of The Model

- *Is the FRBR Conceptual Model “Hierarchical?”* - **Execute a logical reasoning task** - Examine the FRBR relationship statements by pairs to determine that only One-to-Many relationships exist (“some” One-to-Ones relationships are OK)
 - A **Work** must be realized through one or more **Expressions** *One-to-Many Relationship*
 - An **Expression** must be a realization of one **Work**
 - An **Expression** must be embodied in one or more **Manifestations** *Many-to-Many Relationship*
 - A **Manifestation** must be an embodiment of one or more **Expressions**
 - A **Manifestation** must be exemplified by one or more **Items** *One-to-Many Relationship*
 - An **Item** must be an exemplification of one or more **Manifestations**
- The Many-to Many relationship between **Expression** and **Manifestation** makes it easy to answer “no” quickly. Otherwise, the logical relationships between *non-paired* statements are examined

Data Model Quality Assurance: Asking Questions Of The Model

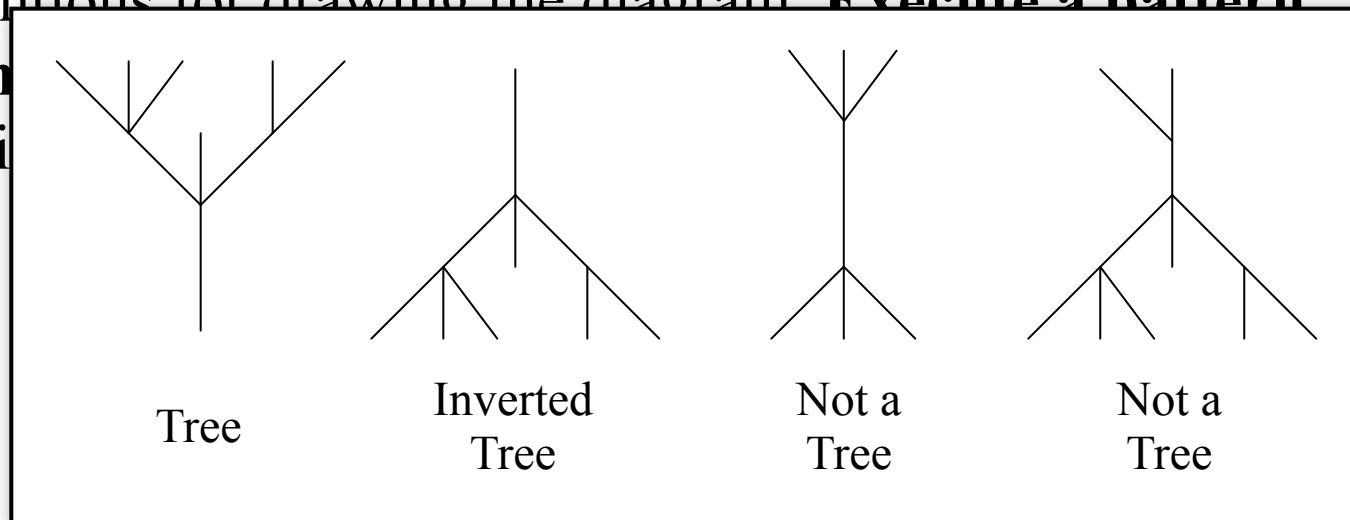
- *Is the FRBR Conceptual Model “Hierarchical?”* - Follow standard conventions for drawing the diagram. **Execute a pattern matching task** - determine whether the “crows feet” or “trees” all point in the same direction (down/right or up/left)



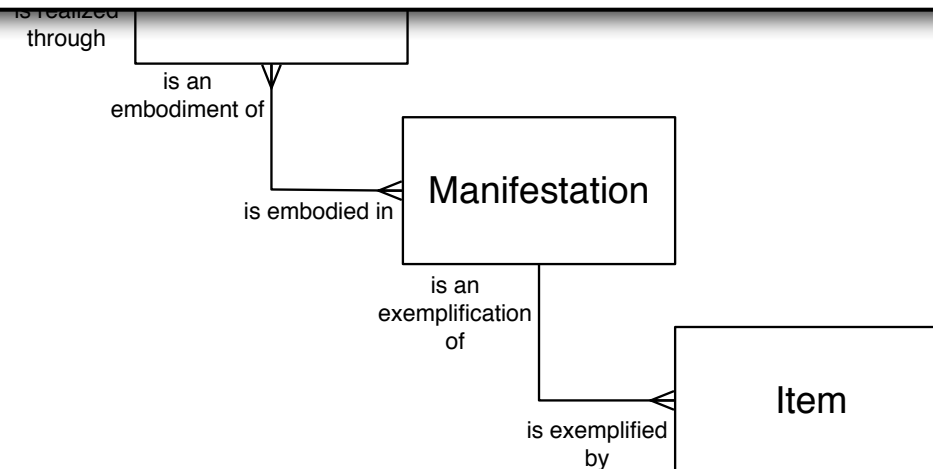
Data Model Quality Assurance: Asking Questions Of The Model

- *Is the FRBR Conceptual Model “Hierarchical?”* - Follow standard conventions for drawing the diagram **Execute a pattern**

match
point i

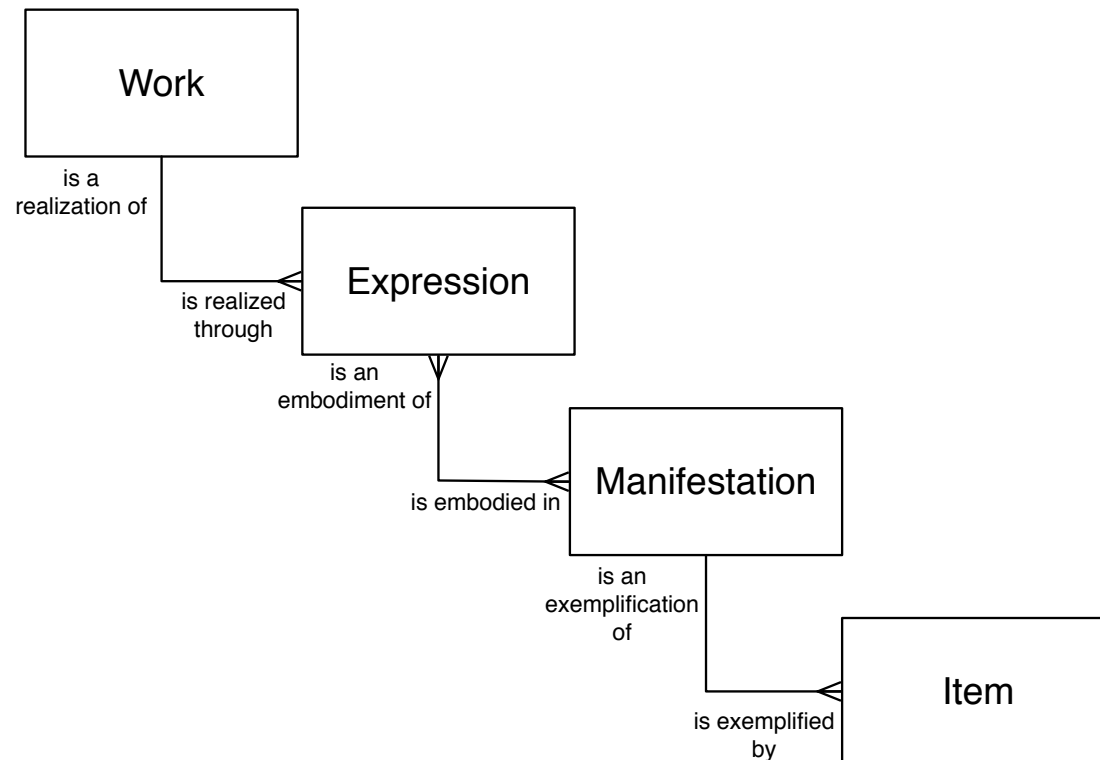


es” all



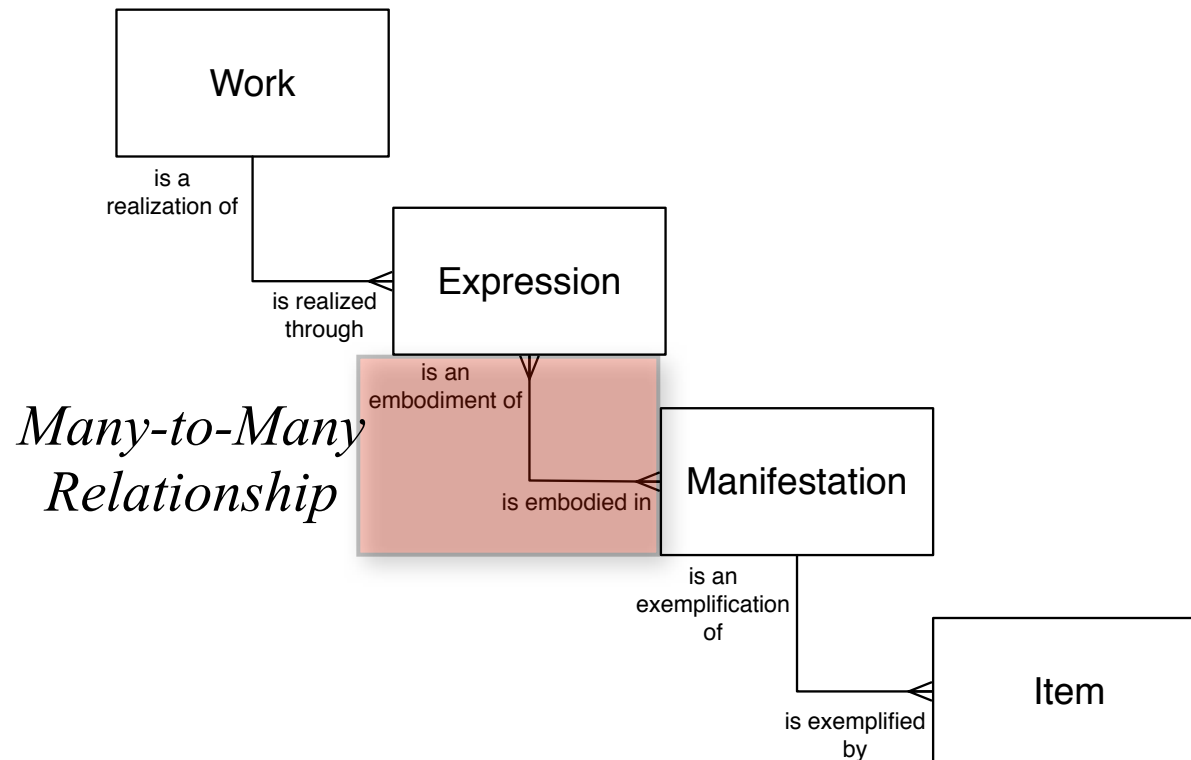
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Data Model Quality Assurance: Asking Questions Of The Model

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Data Model Quality Assurance: From The “Toy Model” To The (Nearly) Full Model

- *The Modeler's Task* - **Execute a logical reasoning task.** Verify the validity of each individual statement. Ensure consistency between all combinations of the following *twenty* FRBR relationships and any other conclusions drawn from the statements.

The (Nearly) Full FRBR Model As Text

- A **Work** must be realized through one or more **Expressions**
- An **Expression** must be a realization of one **Work**
- An **Expression** must be embodied in one or more **Manifestations**
- A **Manifestation** must be an embodiment of one or more **Expressions**
- A **Manifestation** must be exemplified by one or more **Items**
- An **Item** must be an exemplification of one **Manifestation**
- One or more **Works** must be created by one or more **Parties** (**Person** and/or **Organization**)
- One or more **Parties** must be the creator of one or more **Works**
- One or more **Expressions** must be realized by one or more **Parties**
- One or more **Parties** must realize one or more **Expressions**
- One or more **Expressions** must be produced by one or more **Parties**
- One or more **Parties** must produce one or more **Expressions**
- One or more **Items** must be owned by one or more **Parties**
- One or more **Parties** must own one or more **Items**
- One or more **Works** must have as a subject one or more **W|E|M|I** (**Work|Expression|Manifestation|Item**)
- One or more **W|E|M|I** must be the subject of one or more **Works**
- One or more **Works** must have as a subject one or more **Parties**
- One or more **Parties** must be the subject of one or more **Works**
- One or more **Works** must have as a subject one or more **C|O|E|P** (**Concept|Object|Event|Place**)
- One or more **C|O|E|P** must be the subject of one or more **Works**

The (Nearly) Full FRBR Model As Text

- A **Work** must be realized through one or more **Expressions**
- An **Expression** must be a realization of one **Work**
- An **Expression** must be owned by one or more **Manifestations**
- A **Manifestation** must be a realization of one or more **Expressions**
- A **Manifestation** must have as a subject one or more **Items**
- An **Item** must be a realization of one **Manifestation**
- One or more **Works** must be owned by one or more **Parties** (Persons or Organizations)
- One or more **Parties** must realize one or more **Works**
- One or more **Expressions** must be realized by one or more **Parties**
- One or more **Parties** must realize one or more **Expressions**
- One or more **Expressions** must be produced by one or more **Parties**
- One or more **Parties** must produce one or more **Expressions**
- One or more **Expressions** must be owned by one or more **Manifestations**
- One or more **Manifestations** must own one or more **Expressions**
- One or more **Manifestations** must have as a subject one or more **Items**
- One or more **Items** must be the subject of one or more **Manifestations**
- One or more **Parties** must be the subject of one or more **Works**
- One or more **Works** must have as a subject one or more **C|O|E|P** (Concept|Object|Event|Place)
- One or more **C|O|E|P** must be the subject of one or more **Works**

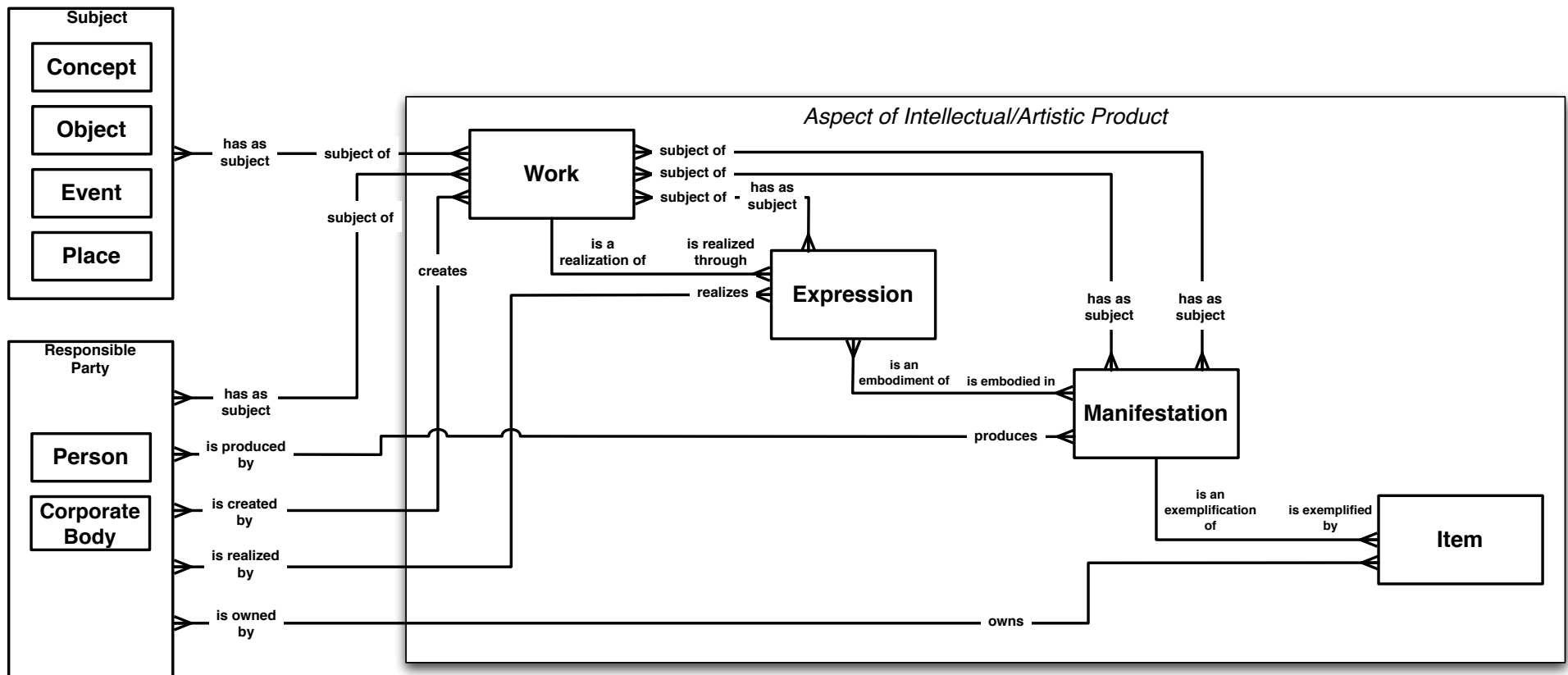
Data Model Statements in Context

When *Two Way Statements* are distributed throughout a specification document, data model quality assurance is much more difficult

Model misinterpretation and poor model specification are possible outcomes

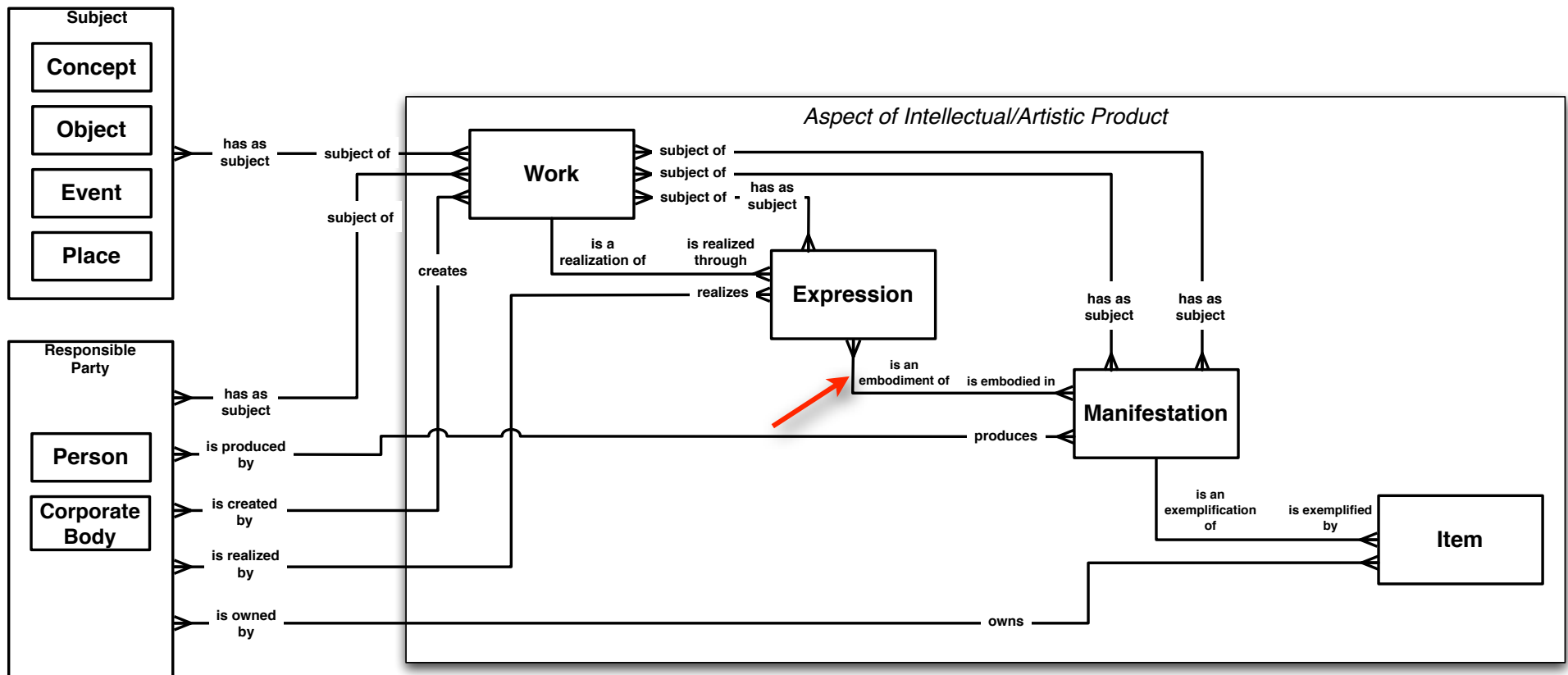
Asking Questions Of The Full* Model Diagram

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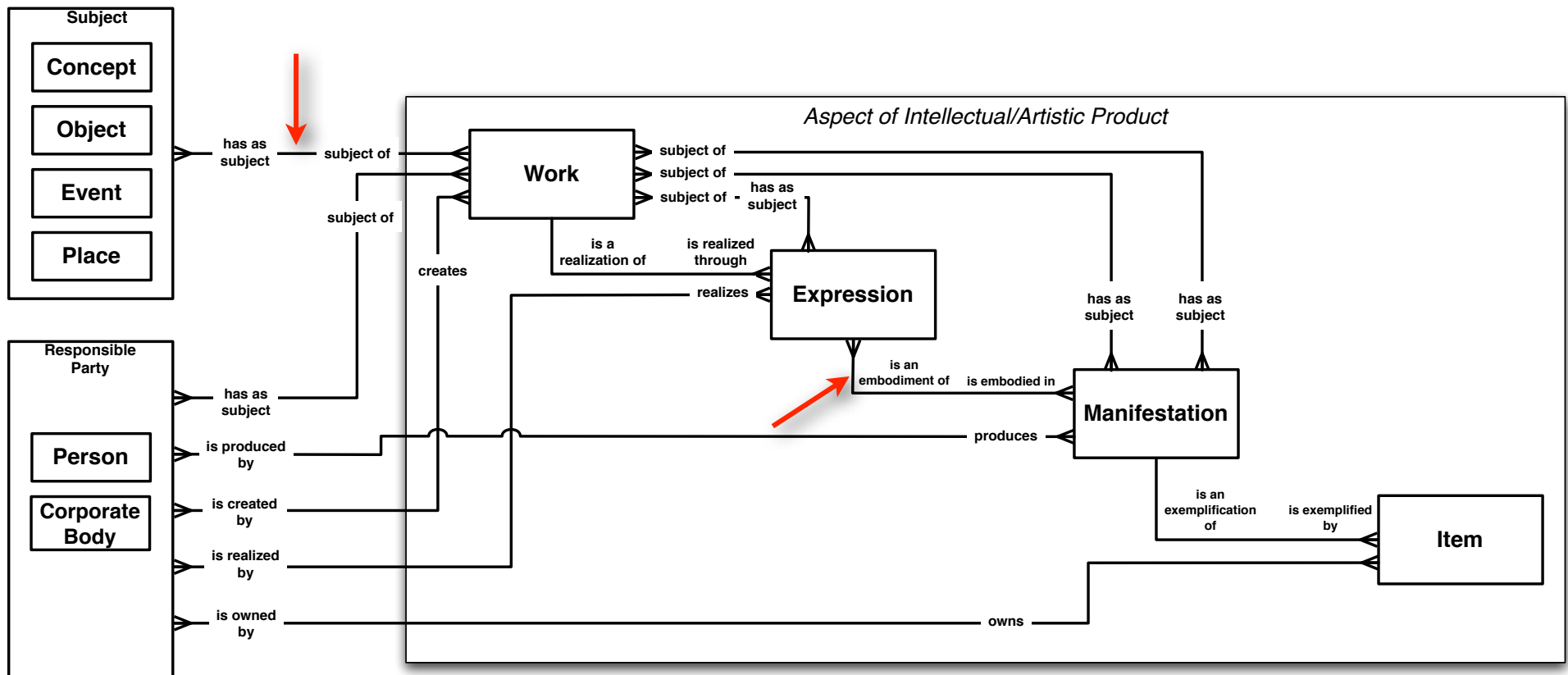
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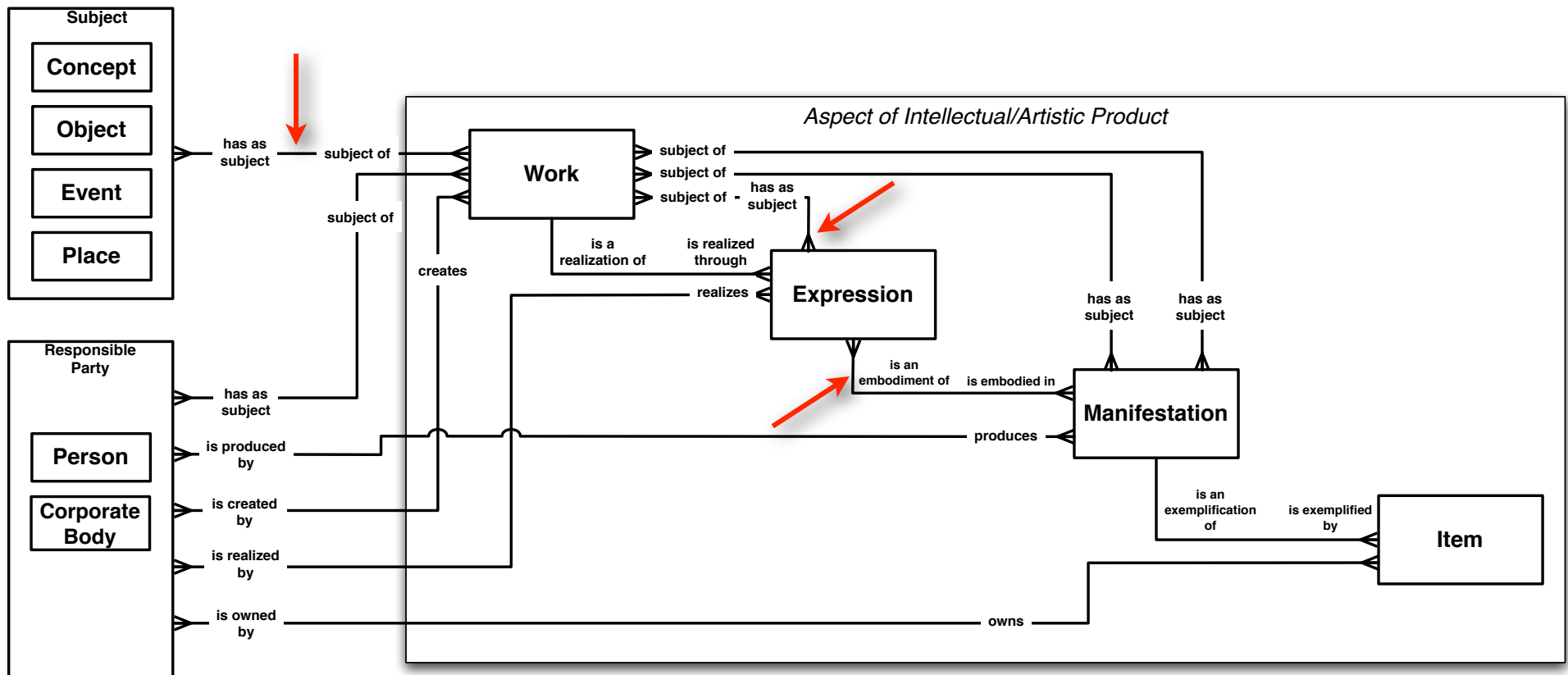
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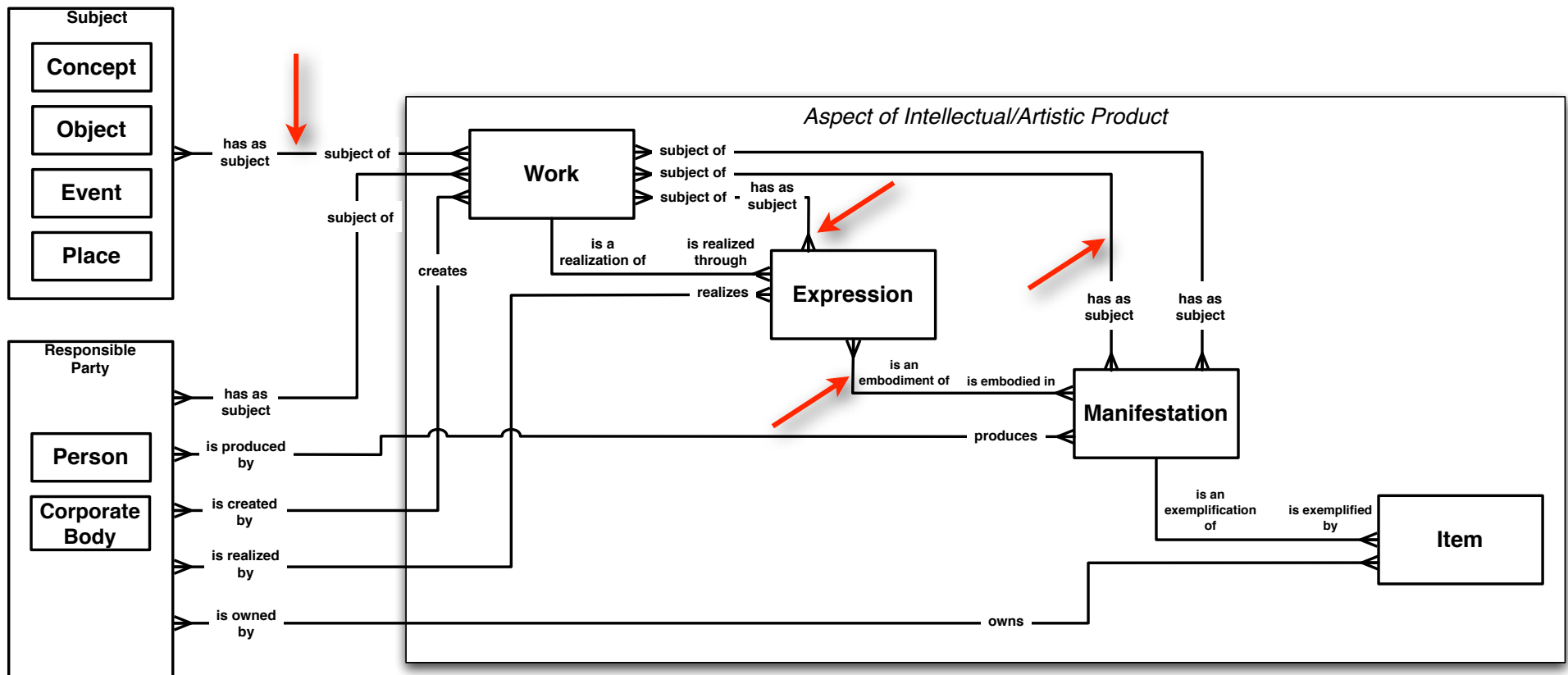
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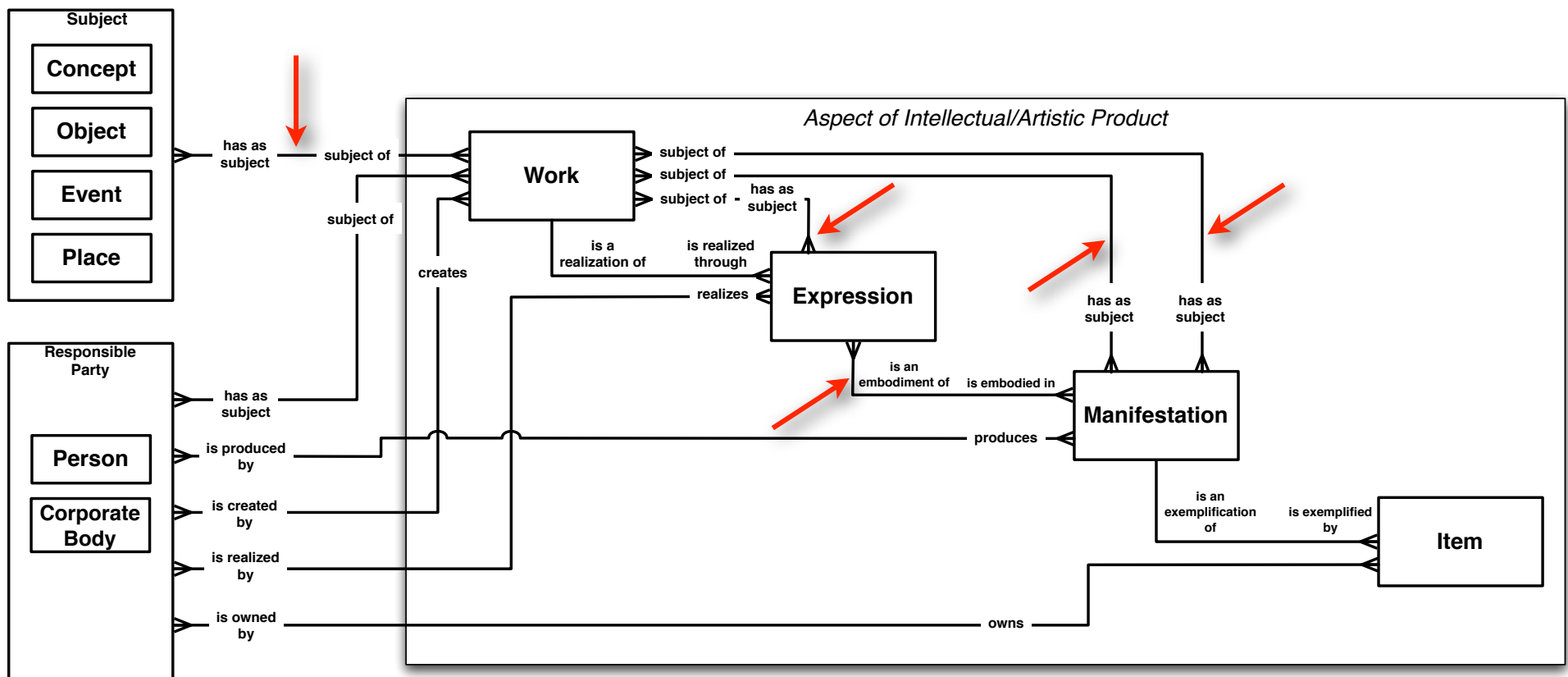
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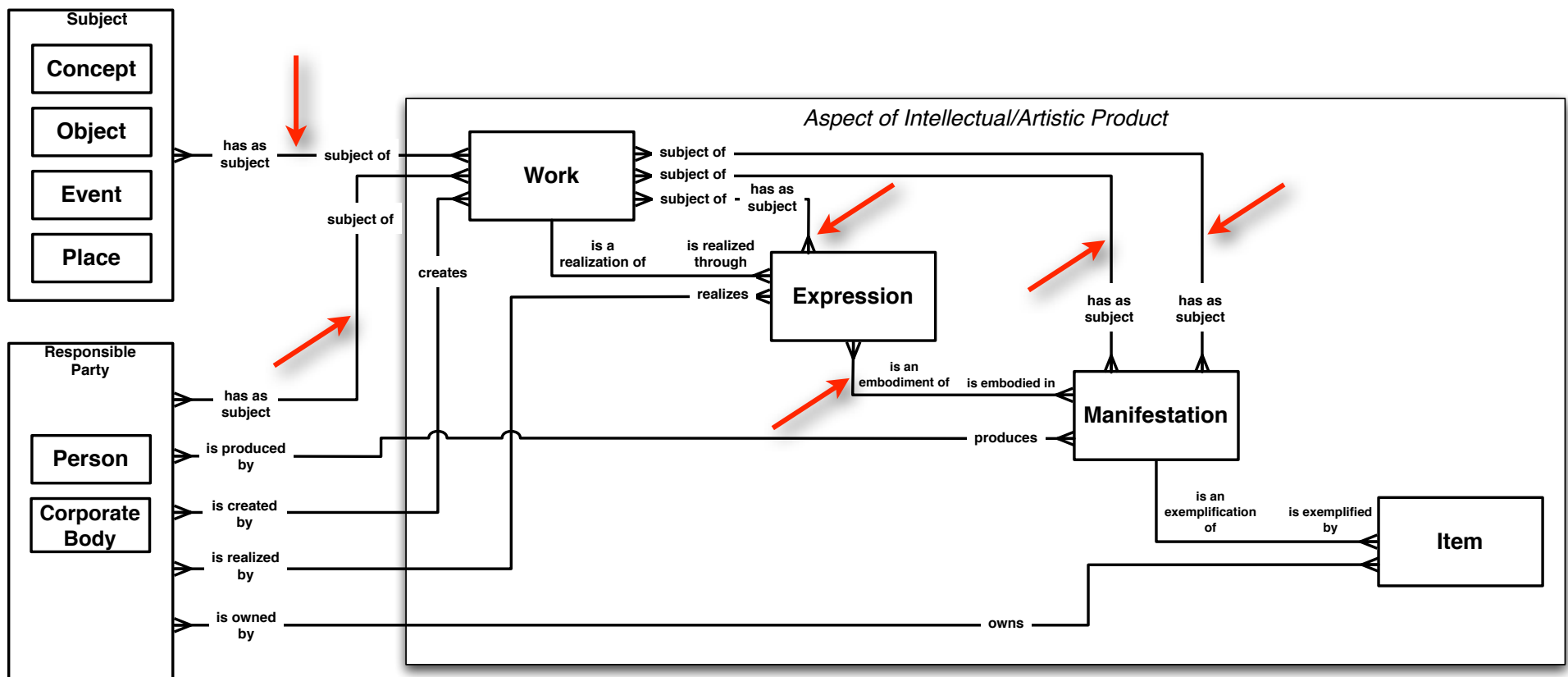
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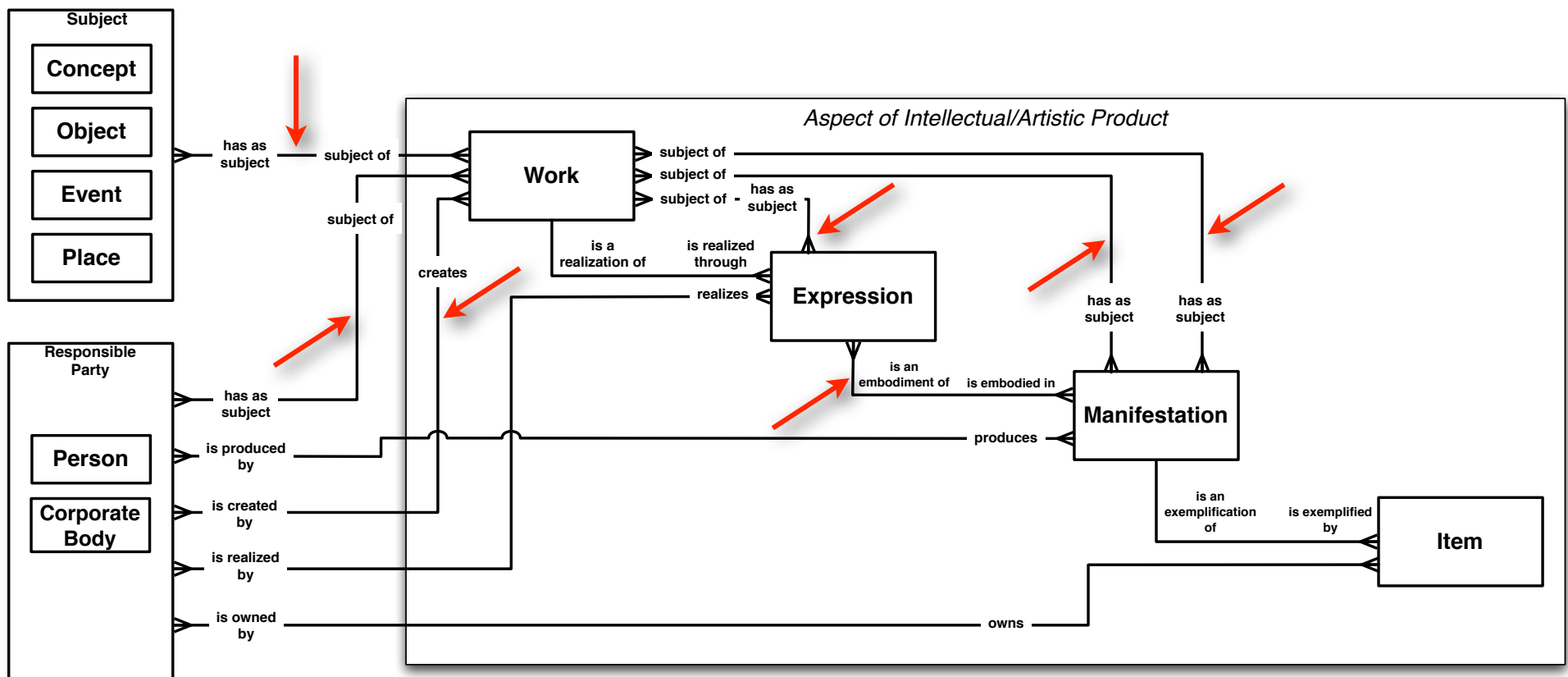
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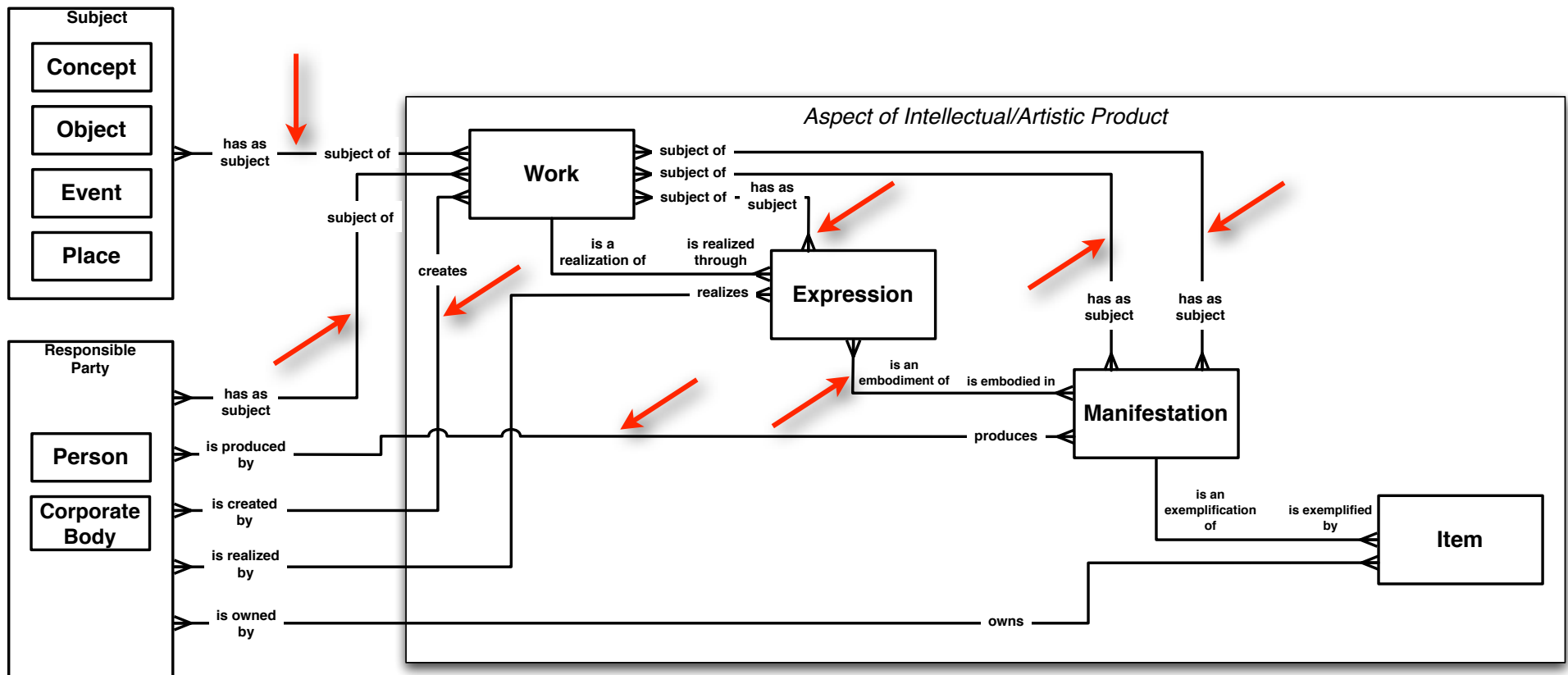
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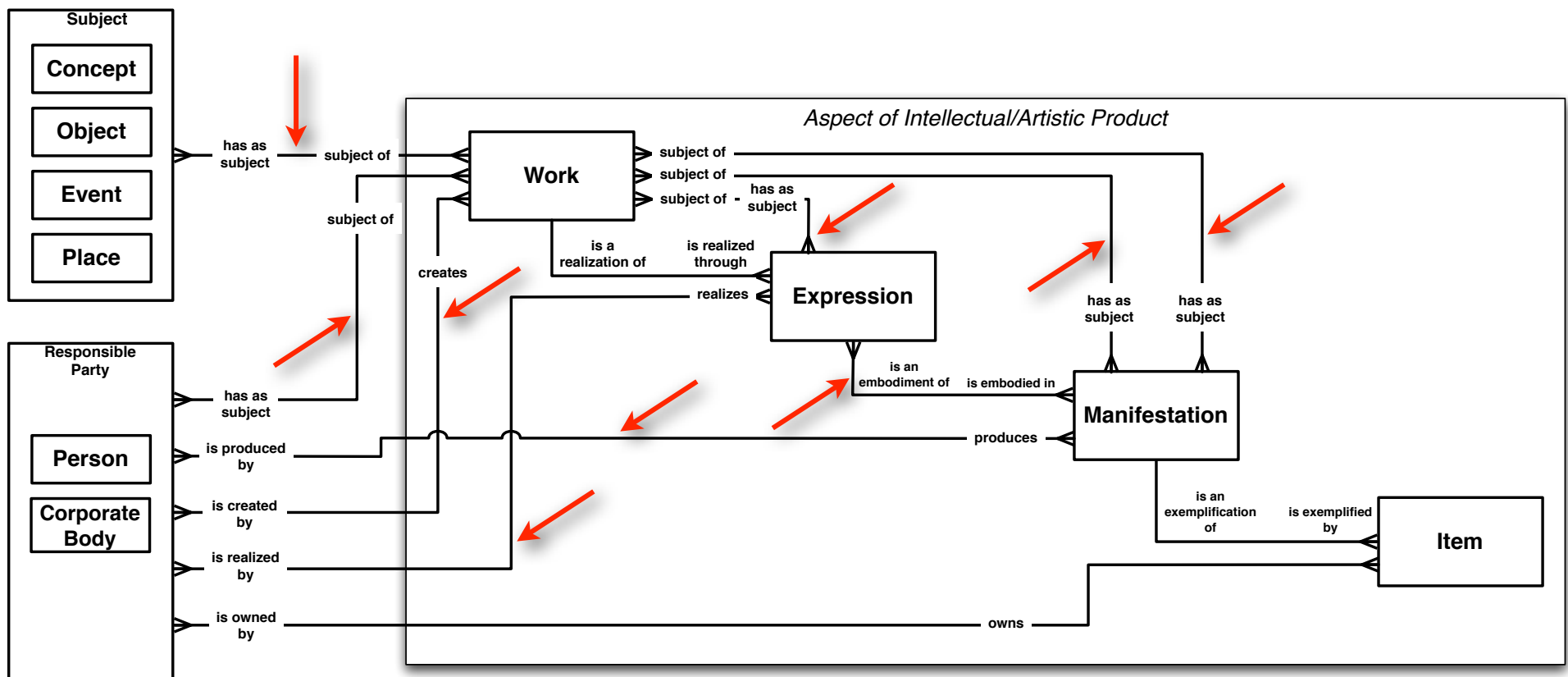
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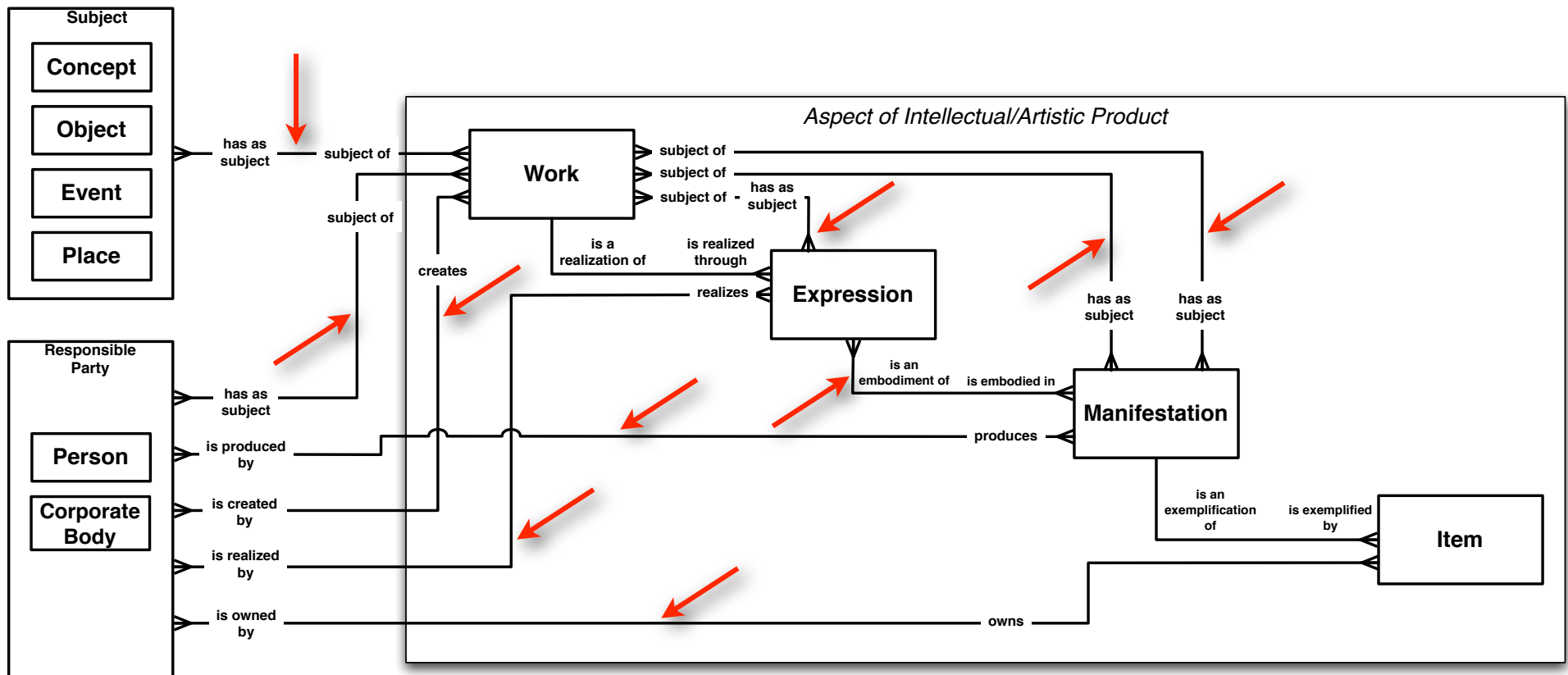
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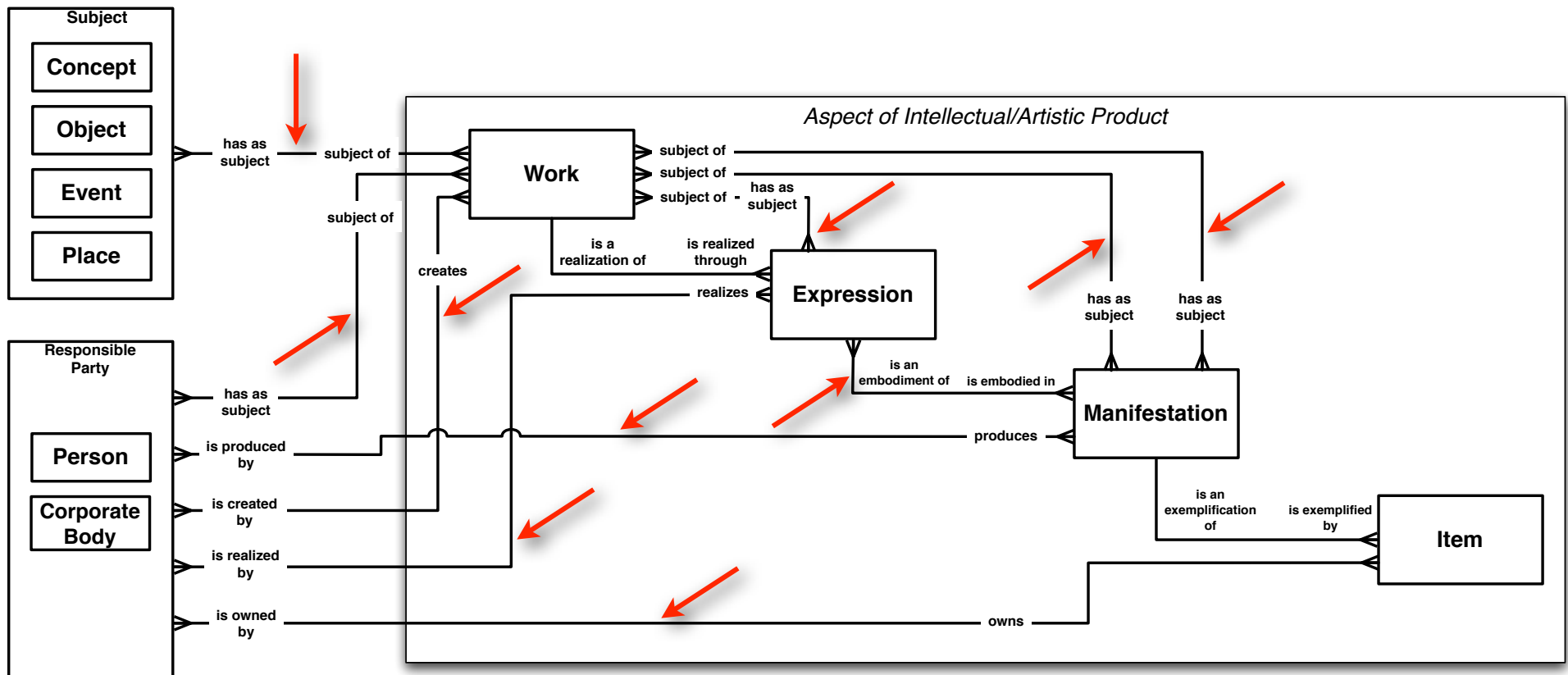
Asking Questions Of The Full* Model Diagram

*This Result is Contrary to Expectation - But **Don't Panic***

- FRBR is simply making visible what has long been the case – especially when multiple names and subjects are involved
- Bibliographic descriptions of any complexity possess a network (*web-like*) structure. Creating and accessing these bibliographic structures incrementally is easier than seeing them whole
 - It is important to distinguish between *authoritative* resource description in general and the structures (historically, inverted trees) used to implement it
- Bibliographic information – however structured – can be managed efficiently by a computer system. *Well-modeled* complexity can be rendered both manageable and visualizable

Asking Questions Of The Full* Model Diagram

- *Is the FRBR Conceptual Model “Hierarchical?”* - Perform a **pattern matching task**. Determine whether the crows feet or trees all point in the same direction (down/right or up/left)



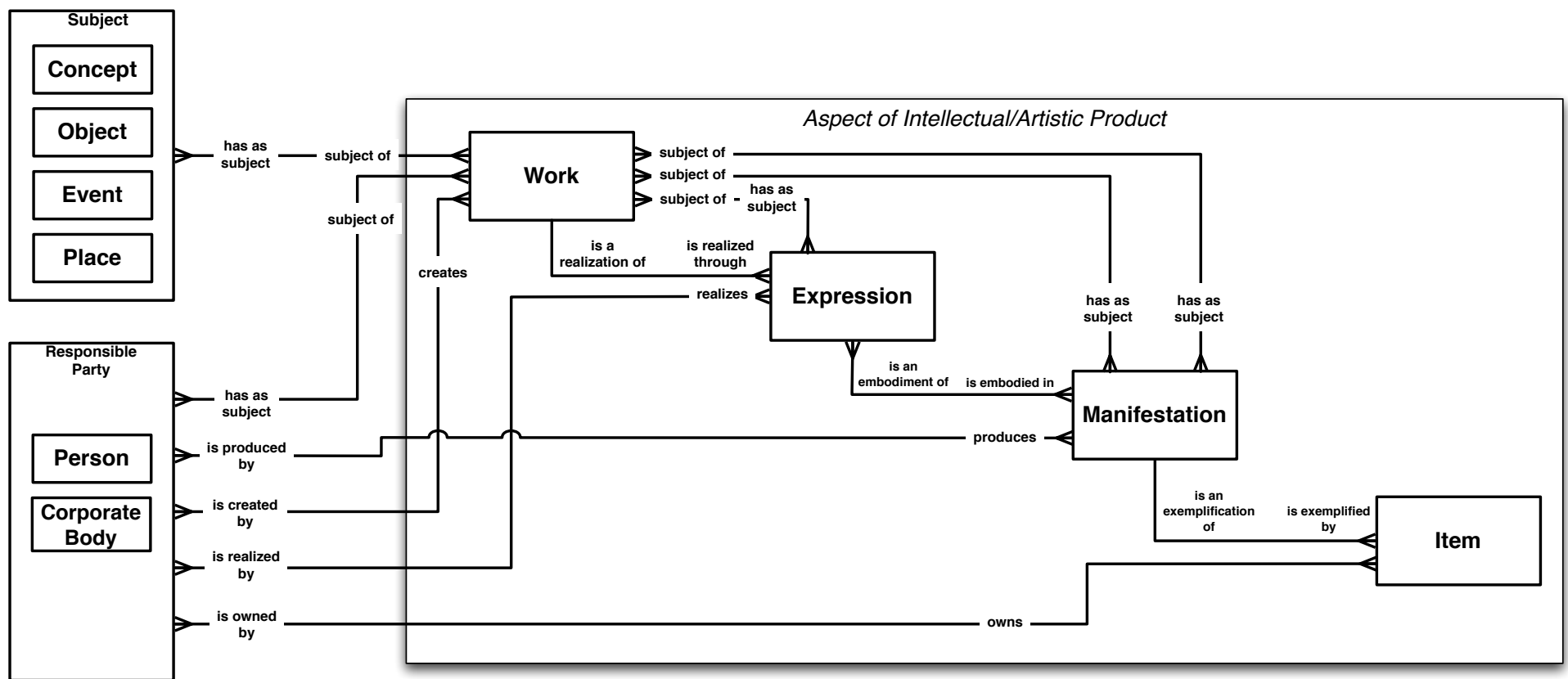
Conceptual Data Modeling: Using *Pictures* and Words

- Modern conceptual data modeling techniques yield textual descriptions (entities, relationship etc. definitions), keyed to an enterprise's “things of interest.”
- With most techniques, each modeled element is also assigned its own “*picture*,” or graphic component. This use of controlled visual imagery is common among professional data modelers.
- When constructed properly, FRBR model imagery and any attendant imagery manipulations are not informal or accidental in nature

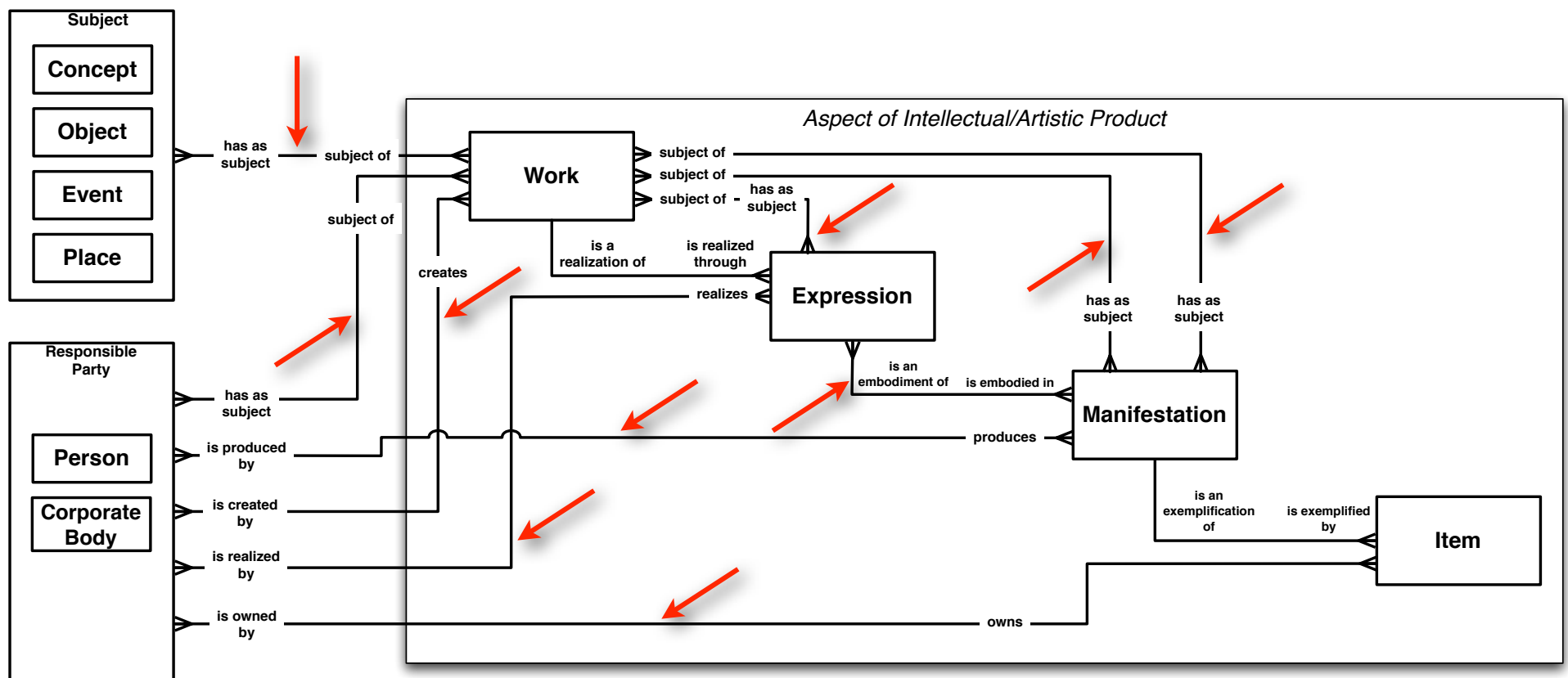
FRBR Conceptual Data Modeling: Using Pictures *and* Words

- Narrative descriptions of bibliographic relationships can overwhelm the reader by requiring a complex, ongoing recollection of – *and comparison of* – data model statements and their intermediate logical conclusions
- If theory and practice in other areas are any indication, graphical representations of FRBR entities, relationships, etc., can greatly improve understanding of bibliographic resource descriptions

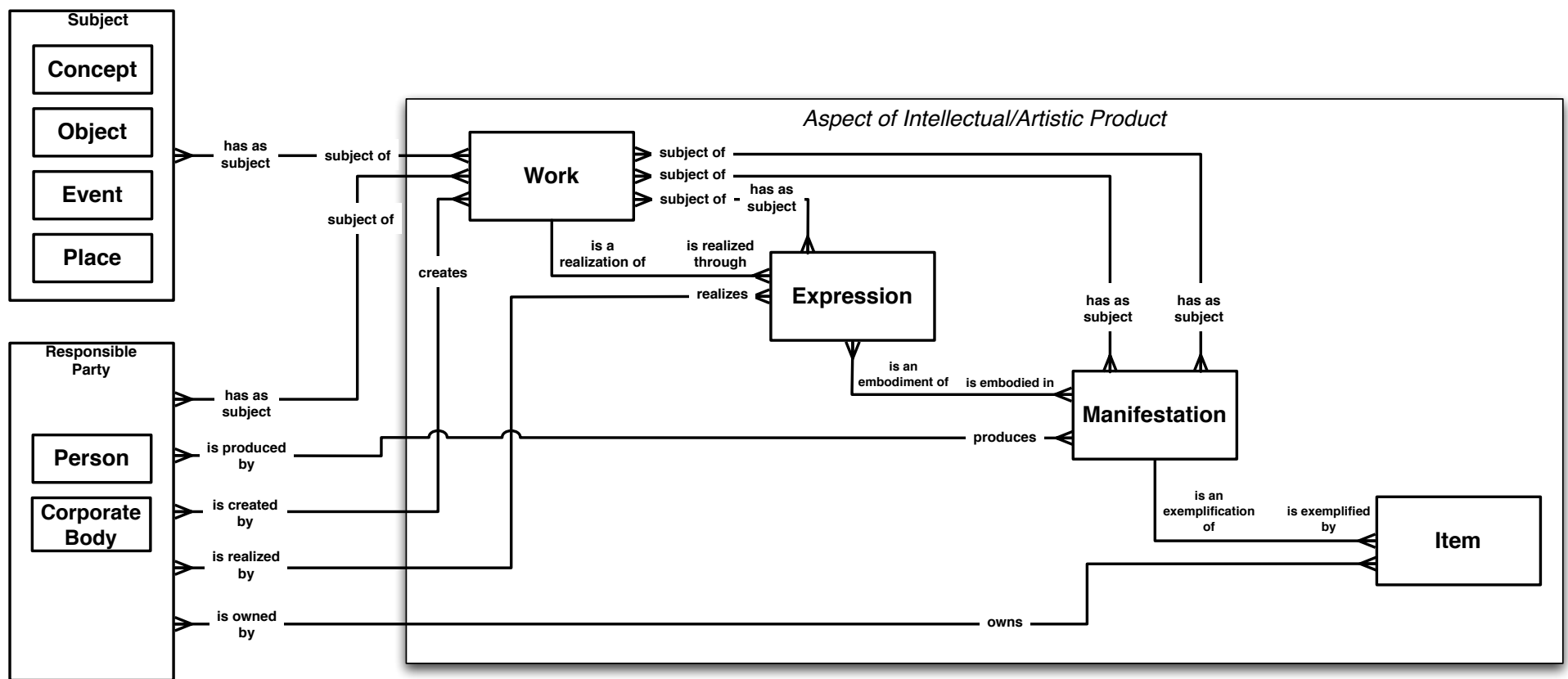
The Full* Data Model Diagram: Why We Need Paper Tools



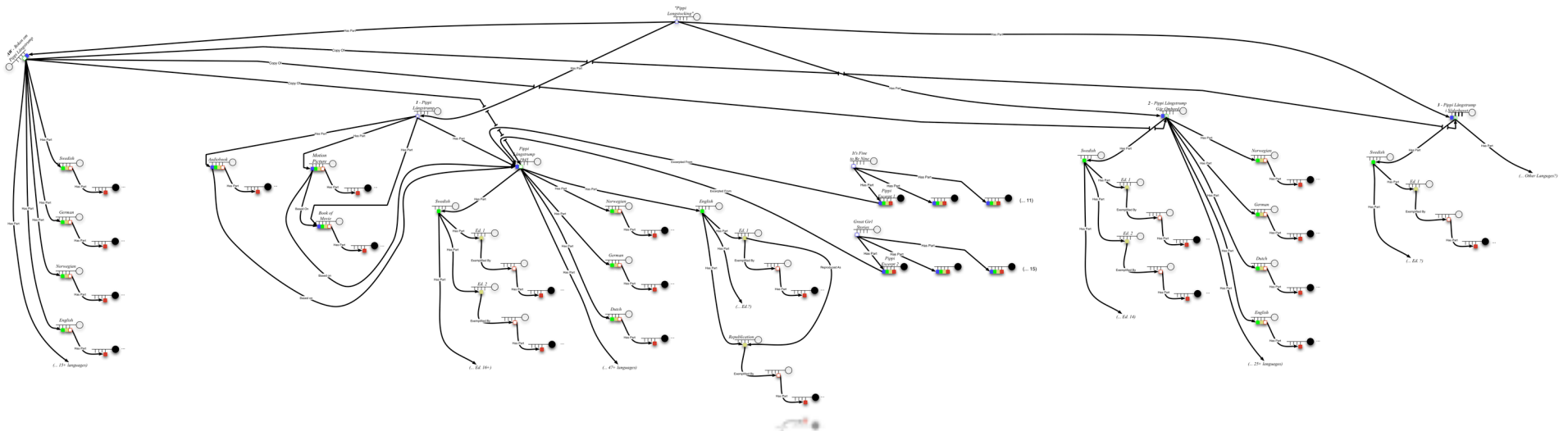
The Full* Data Model Diagram: Why We Need Paper Tools



The Full* Data Model Diagram: Why We Need Paper Tools



The Full* Data Model Diagram: Why We Need Paper Tools



Four

Paper Tools and FRBR's Future

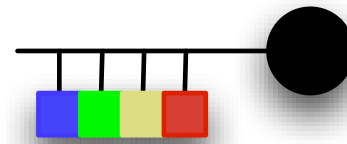
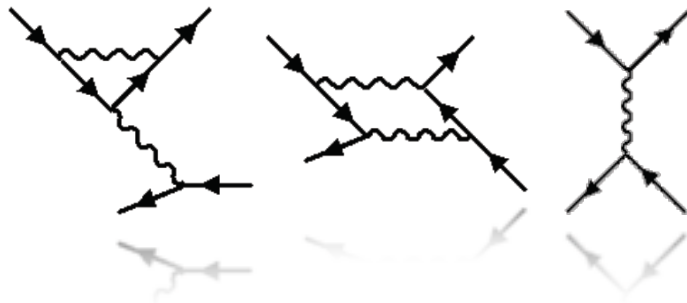
Why Know About This?

Lawful construction of a conceptual data model does not necessarily mean that the results are accurate or useful

Inaccurate theoretical assumptions and carryovers from prior implementations can be identified and corrected by testing the resource description model against typical and atypical resource description scenarios

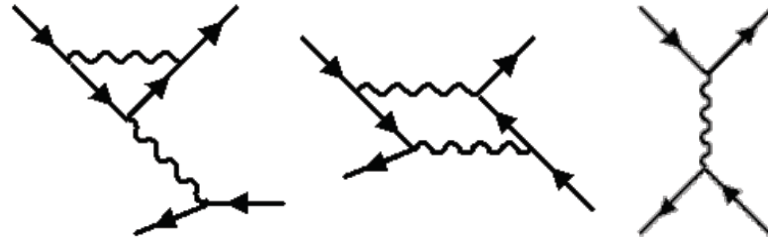
A Paper Tool: Resource Description Using a Diagrammatic Method

- *What is a Paper Tool?*
- *Who uses diagrammatic methods like this?*
- *Why use a Paper Tool to reason about bibliographic (etc.) relationships among resources?*
- *How do we create and use it?*



A Precedent From Physics

Feynman Diagrams & Diagramming Rules[†]



	An electron emits a photon
	An electron absorbs a photon
	A positron emits a photon
	A positron absorbs a photon
	A photon produces an electron and a positron (an electron-positron pair)
	An electron and a positron meet and annihilate (disappear), producing a photon

[†] <http://www2.slac.stanford.edu/vvc/theory/feynman.html>. Kaiser, David. *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics*. Chicago, IL: University of Chicago Press. 2005.

Working With A *Paper Tool*

- *Paper Tool*[†] - A collection of symbolic elements (diagrams, characters, etc.), whose construction and manipulation follow rules and constraints of one or more guiding theories
 - Paper tool manipulation permits rapid, flexible, and creative exploration of phenomena of interest
 - Paper tool/user dialogs can generate unprecedented manipulations, and change the interests and goals of a modeling effort
 - Theoretical and practical work can be performed with paper tools
 - Paper tools used for FRBR theory formation and testing
 - Paper tools used as bookkeeping devices during resource description (cataloging)
 - During information system design, paper tool use validates the specification of data structures that meet user requirements for discovery and access

[†] Klein, Ursula (2001) 'Paper Tools in Experimental Cultures', *Studies in History and Philosophy of Science* 32: 265–302.

Working With Paper Tools

- *Why use a Paper Tool for reasoning about bibliographic (or any other) relationships among resources?*
 - Efficient presentation of entities, attributes, relationships, and business rules
 - Diagram construction can be heavily constrained by (e.g. FRBR) theory
 - What levels of description are appropriate?
 - What relationships exist between **Resources** and/or descriptions?
 - What structural properties emerge from a given **Resource**/description?
 - Can validate obvious and non-obvious aspects of resource descriptions and relationships by creating and validating simple and complex diagrams

Creating and Using a FRBR Paper Tool

- *How do we get there from here?*
 - Begin with imagery generated by the FRBR conceptual data modeling process
 - Create FRBR element combination/connection rules based on business rules
 - Use the resulting FRBR Paper Tool to create and study typical and unusual resource description examples (*exemplars*)

Creating and Using a FRBR Paper Tool

- *Details: From catalog card, to FRBR/XML data model elements, to a Paper Tool*
 - Cataloging “record” evolution
 - FRBR-based groupings of bibliographic descriptions and their graphical representation
 - FRBR diagram creation and graphic modeling shortcuts
 - Construction of a large-scale FRBR resource description structure

Representing Bibliographic Information: Prior Art & New Approaches



University of
Strathclyde

The Semantic Web and expert metadata:
pull apart then bring together

Presented at 12.seminar Arhivi, Knjižnice, Muzeji

26-28 Nov 2008, Poreč, Croatia

Gordon Dunsire



Representing Bibliographic Information: Prior Art & New Approaches

- *Simplifying abstractions begin with the catalog card*
 - The catalog card becomes a catalog data “*record*”
 - Some card text becomes **Resource** attributes
 - Some card text becomes **Resource** relationships
- *Catalog record structure and evolution reflects theoretical & pragmatic concerns*
 - More diverse record types to reduce redundancy
 - Bibliographic, responsible party, subject
 - Cross-referencing employed as a pragmatic access strategy
 - Names and subjects to signal preferred usage
 - An *assumption* of hierarchical structuring
 - XML **should** be used for data storage and interchange: *Zeitgeist*

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

- The selection of XML for the representation and/or description of creative expressions has not occurred without complications

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

- The selection of XML for the representation and/or description of creative expressions has not occurred without complications

Def. - The organization
of data for use with a
particular data
management
technology

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

- The selection of XML for the representation and/or description of creative expressions has not occurred without complications

XML employs a strongly hierarchical document model. At various points, these Guidelines discuss problems that arise when using XML to encode textual features that either do not naturally lend themselves to representation in a strictly hierarchical form or conflict with other hierarchies represented in the markup. Examples of such situations include:

- *Conflict between the hierarchy established by the physical structure of a document ... and its rhetorical or linguistic structure*

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

- The selection of XML for the representation and/or description of creative expressions has not occurred without complications
 - *Conflict between a verse text's metrical structure ... and its rhetorical or linguistic structure ...*
 - *Conflict between metrical, rhetorical, or linguistic structure and the representation of direct speech, especially if the quoted speech is interrupted by other elements ... or crosses metrical, rhetorical, or linguistic boundaries.*
 - *Conflict between different analytical views or descriptions of a text or document...*

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

- The selection of XML for the representation and/or description of creative expressions has not occurred without complications

Non-nesting information poses fundamental problems for any XML-based encoding scheme, and it must be stated at the outset that no current solution combines all the desirable attributes of formal simplicity, capacity to represent all occurring or imaginable kinds of structures, suitability for formal or mechanical validation.

The representation of non-hierarchical information is thus necessarily a matter of trade-offs among various sets of advantages and disadvantages.

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

- The selection of XML for the description of creative expressions

*Non-nesting
XML-based
that no current
formal simplification
imaginable
mechanical*

Using XML for Theory Formation

The limitations and trade-offs discussed in the Text Encoding Initiative specification appear to make theory formation – and visualizability – based on an unalloyed XML logical data model problematic

*for any
at the outset
tributes of
or
or*

The representation of non-hierarchical information is thus necessarily a matter of trade-offs among various sets of advantages and disadvantages.

XML and Its Discontents:

Limitations of the XML *Logical Data Model*

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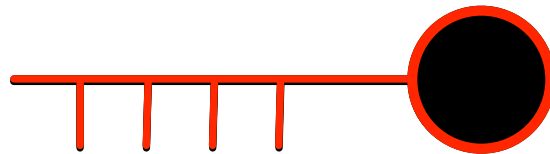
A Resource Description Theory and Diagrammatic Method

- *Things of interest in the world can be treated as Resources*
 - Resources are represented by circles
- *Resources must be described in order to be found, navigated, and accessed*
 - Resource descriptions (defined collections of attributes and relationships, with some minimum specified by theory) are represented by color-etc. coded boxes
- *Different **types** of Resource descriptions can be defined for the same Resource*
 - Co-occurring Resource description boxes are attached to a common carrier/frame element for organizational clarity

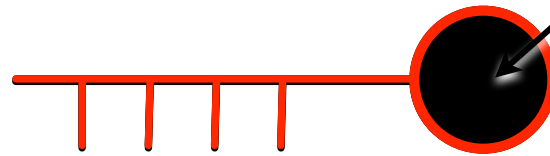
A Resource Description Theory and Diagrammatic Method

- *Relationships can be defined between Resources*
 - Labeled lines can be drawn between Resource description diagram elements
- *Diagram drawing and manipulation rules can reflect relevant attributes of real world Resources and their relationships*
 - Only certain kinds of entities and relationships can be defined
- *Application of business/drawing rules can reveal unexpected Resource attributes and relationships*
 - Ensuring logical consistency of written statements can be more difficult than looking for patterns in appropriately drawn diagrams.
 - Overlooked entities, attributes, and relationships may suggest themselves as “missing” diagrammatic elements

A Simplifying Abstraction: Resource Diagram Drawing Conventions

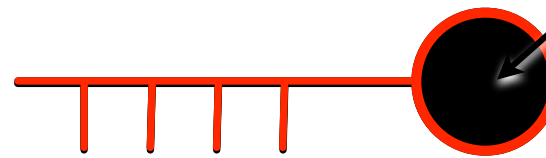


A Simplifying Abstraction: Resource Diagram Drawing Conventions



A Resource
*Not observable
because not identified
or described*

A Simplifying Abstraction: Resource Diagram Drawing Conventions



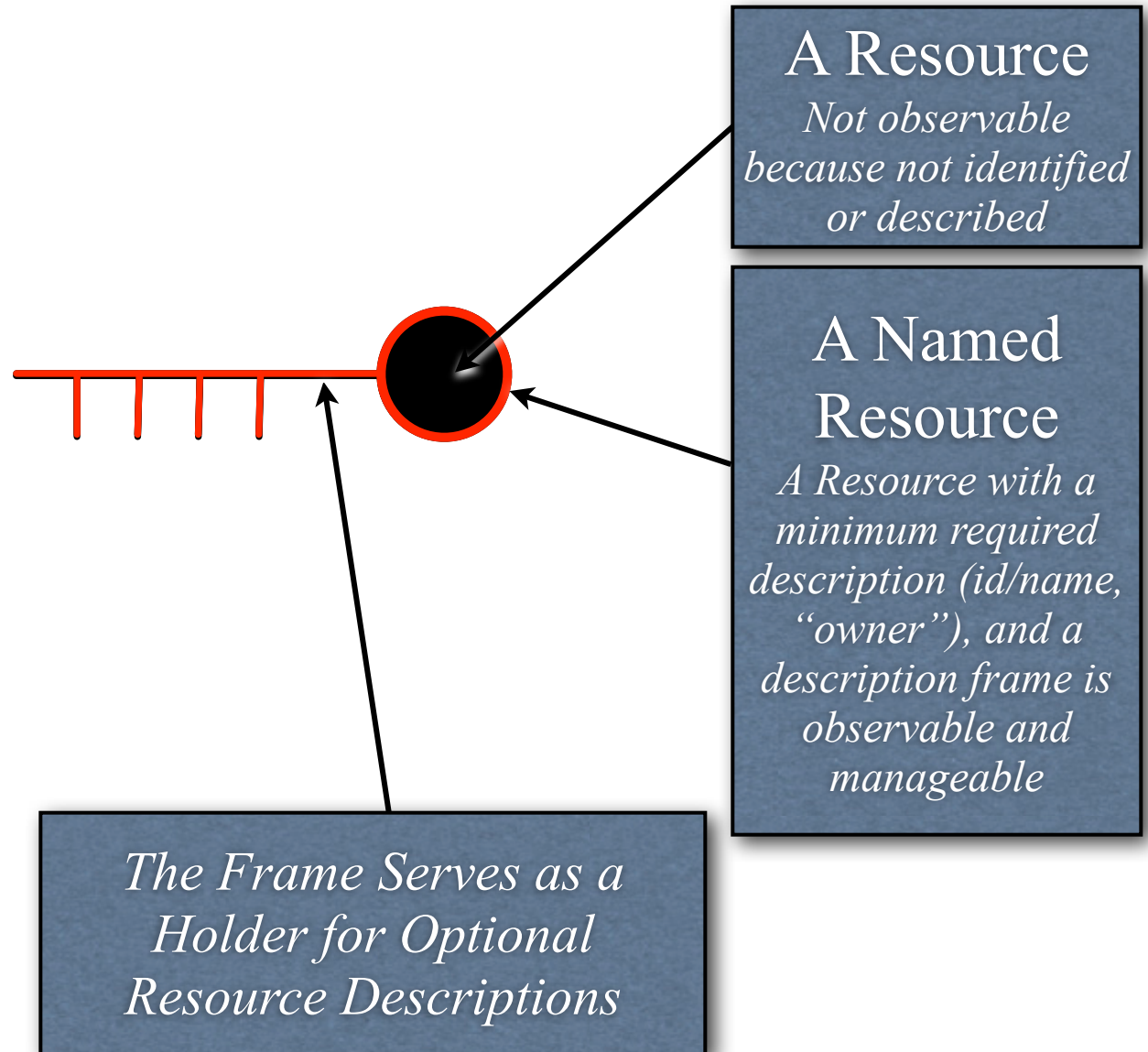
A Resource

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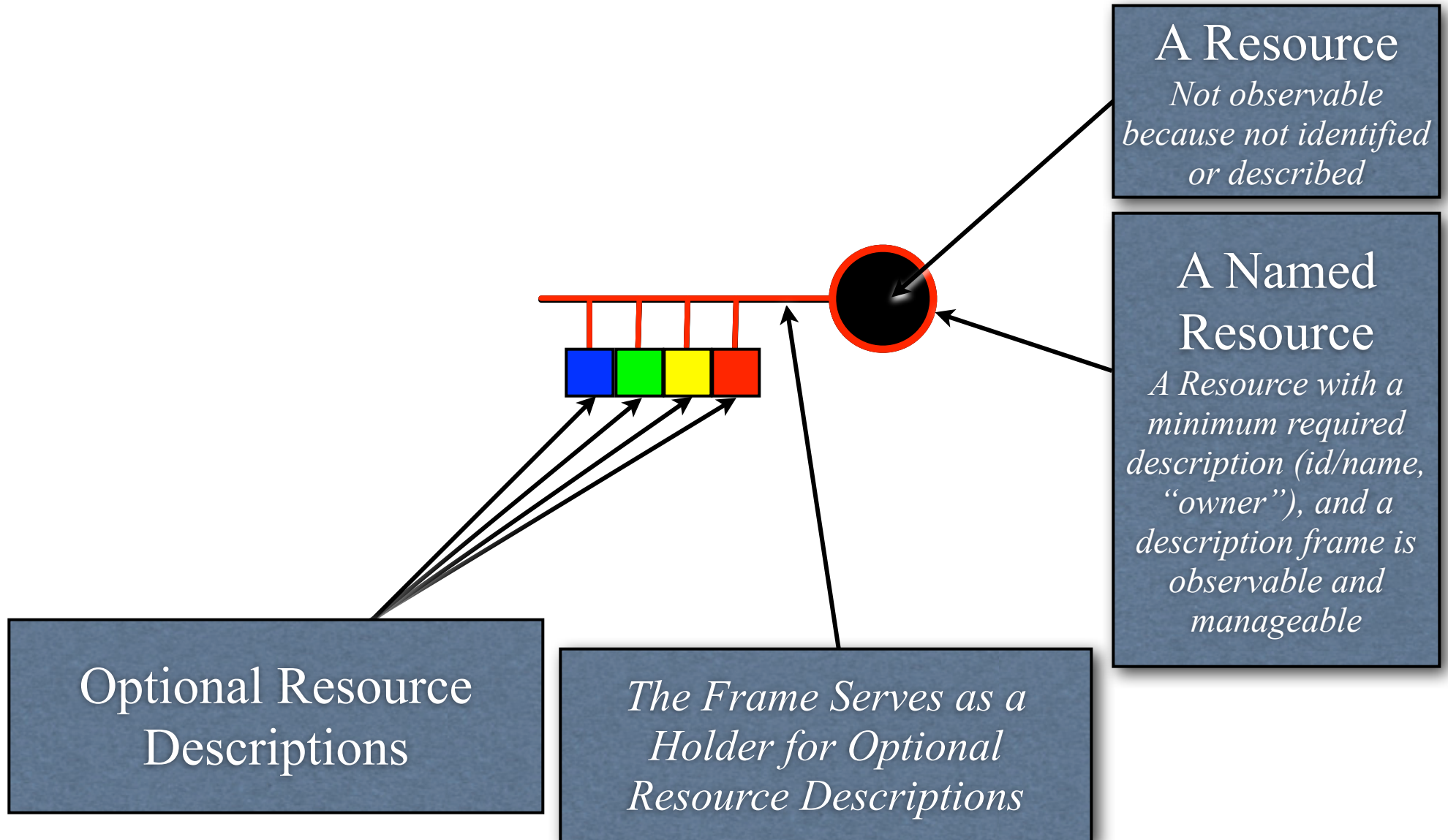
A Named
Resource

*A Resource with a
minimum required
description (id/name,
“owner”), and a
description frame is
observable and
manageable*

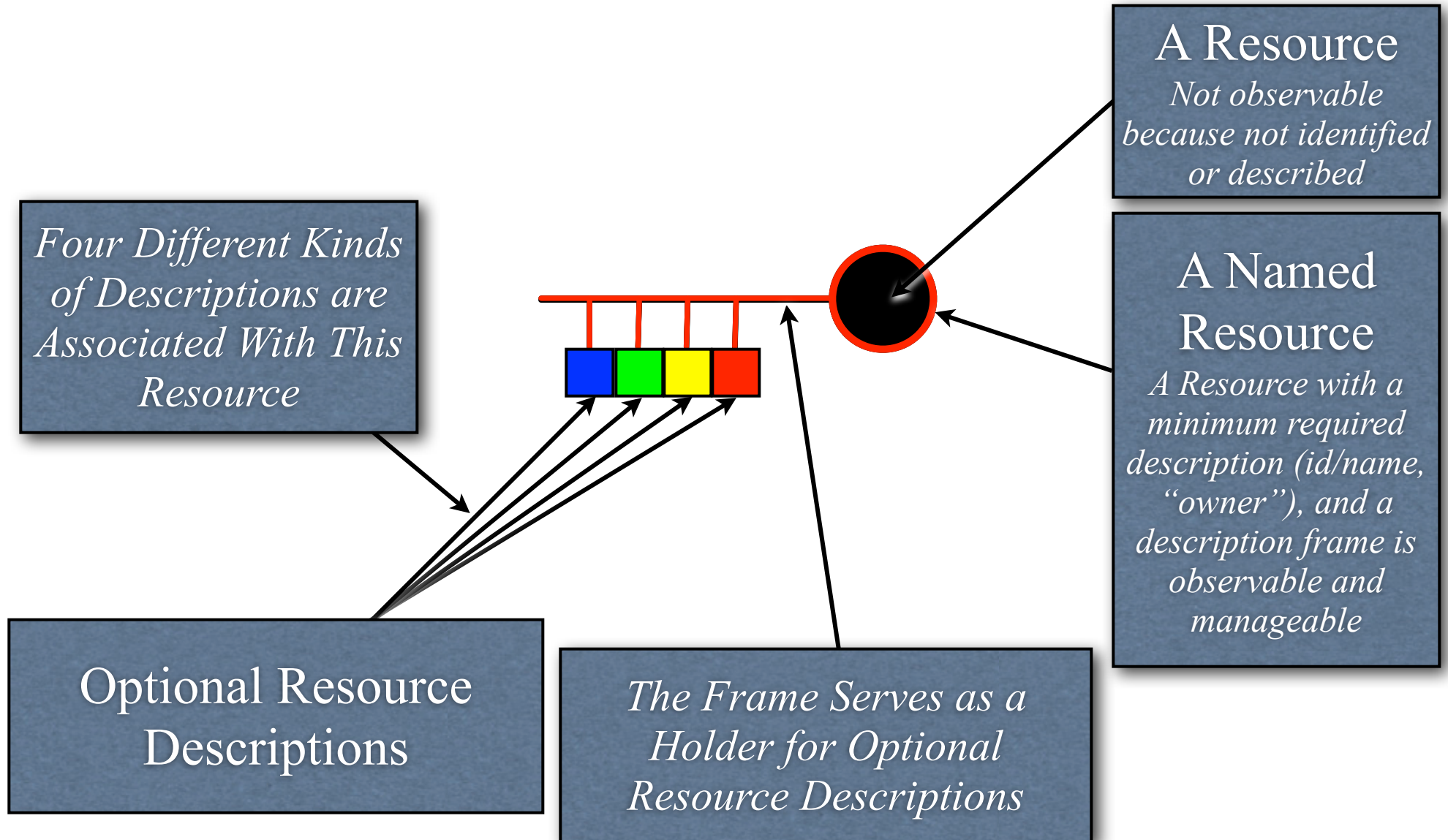
A Simplifying Abstraction: Resource Diagram Drawing Conventions



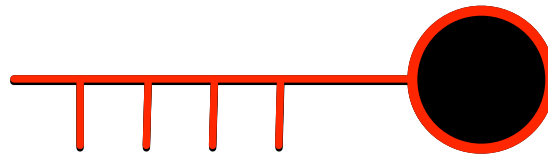
A Simplifying Abstraction: Resource Diagram Drawing Conventions



A Simplifying Abstraction: Resource Diagram Drawing Conventions



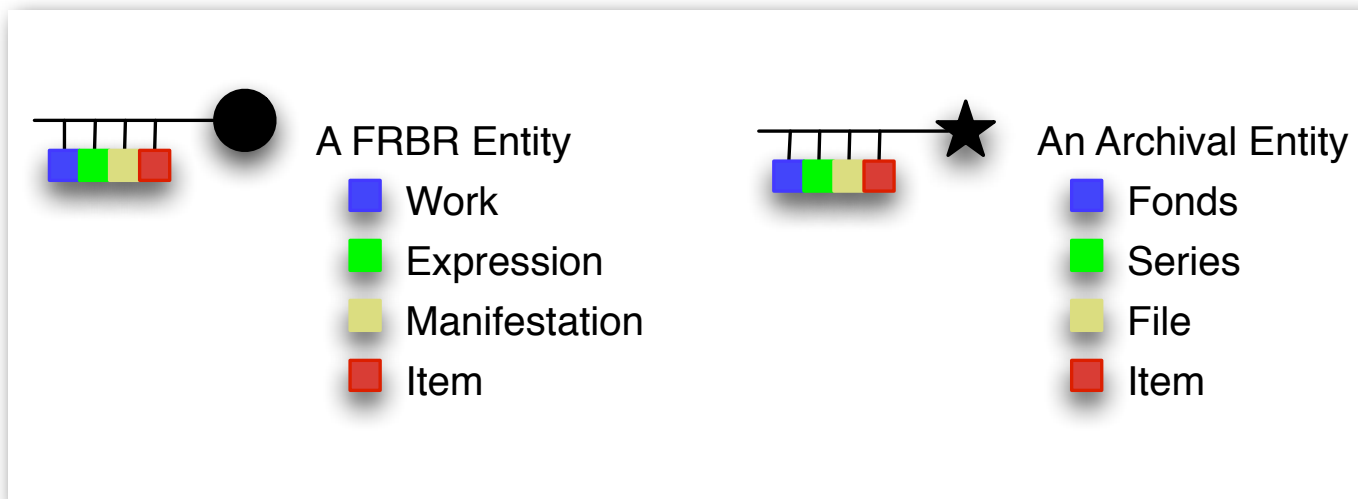
A Simplifying Abstraction: Resource Diagram Drawing Conventions



*It's Convenient to Distinguish
Resource Description Types by
Changing the Shape of the Resource
Holder*

*(e.g., library vs. archive vs. museum institution
descriptions)*

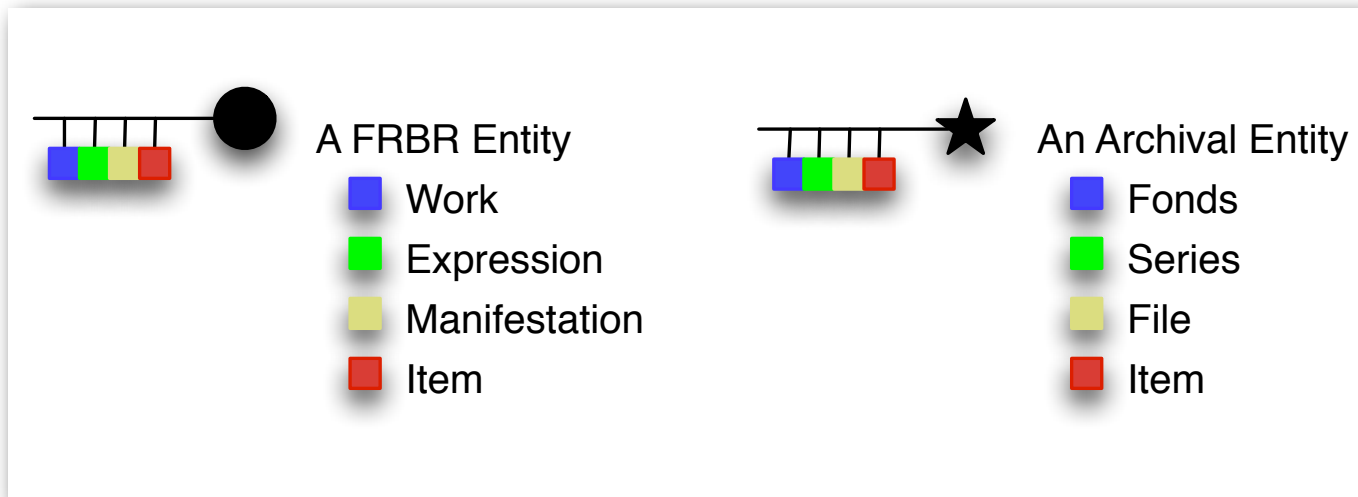
A Simplifying Abstraction: Resource Diagram Drawing Conventions



*It's Convenient to Distinguish
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Holder*

*(e.g., library vs. archive vs. museum institution
descriptions)*

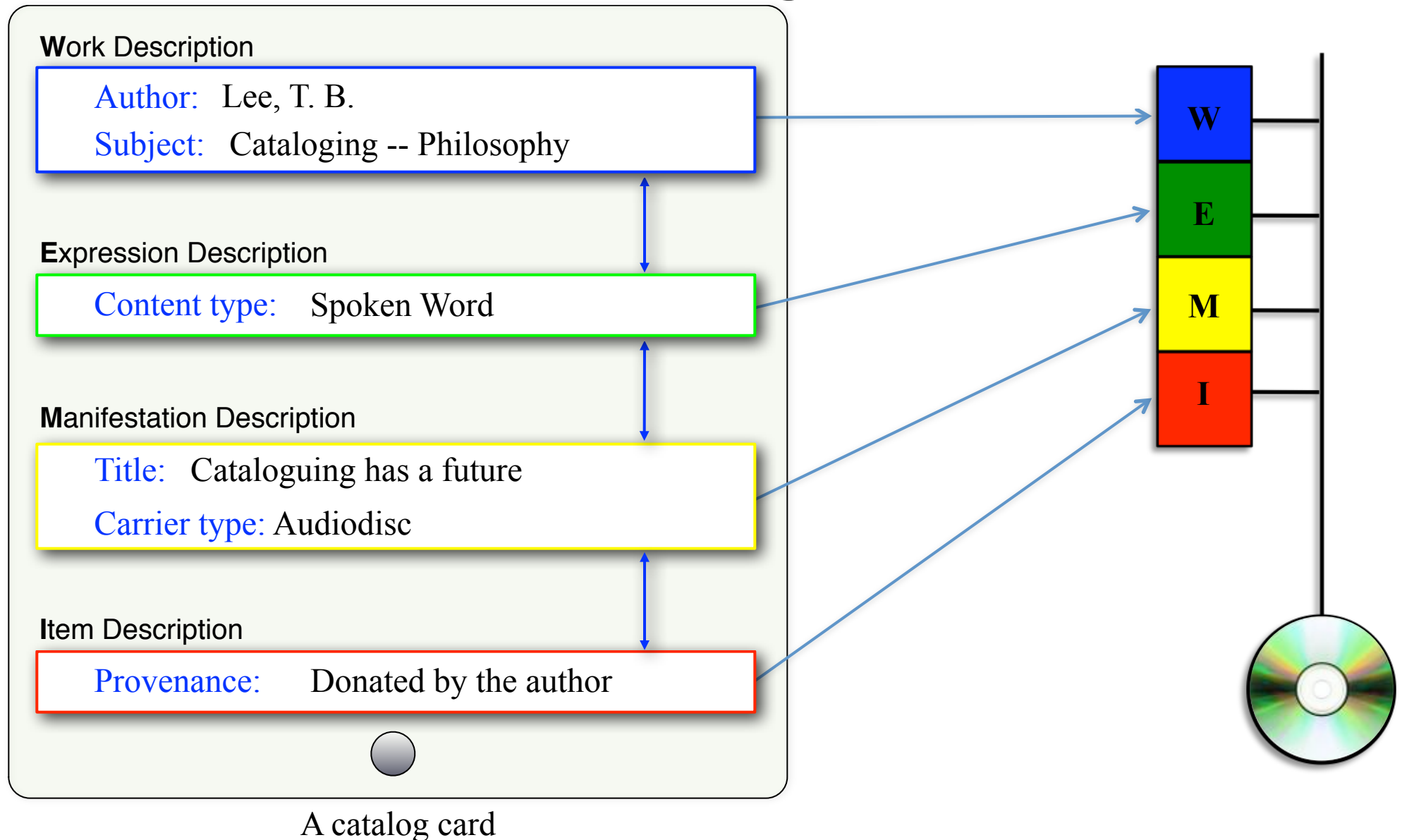
A Simplifying Abstraction: Resource Diagram Drawing Conventions



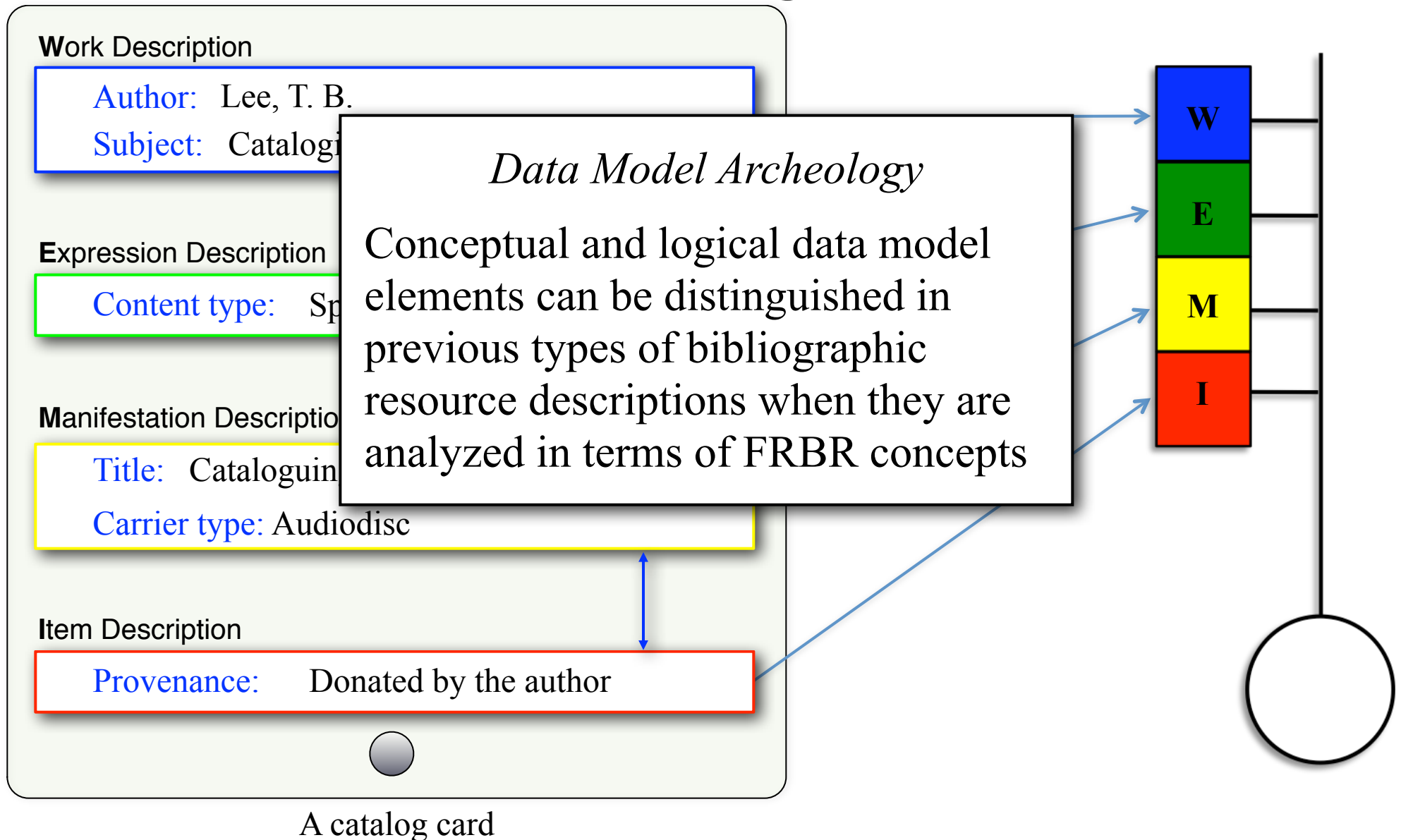
Coexisting Resource Description Schemes

This approach to resource description assumes that other description schemes may be applied to the same set of resources. Depending on business rules, the diagrams can coexist, and can link to the same resources and to each other

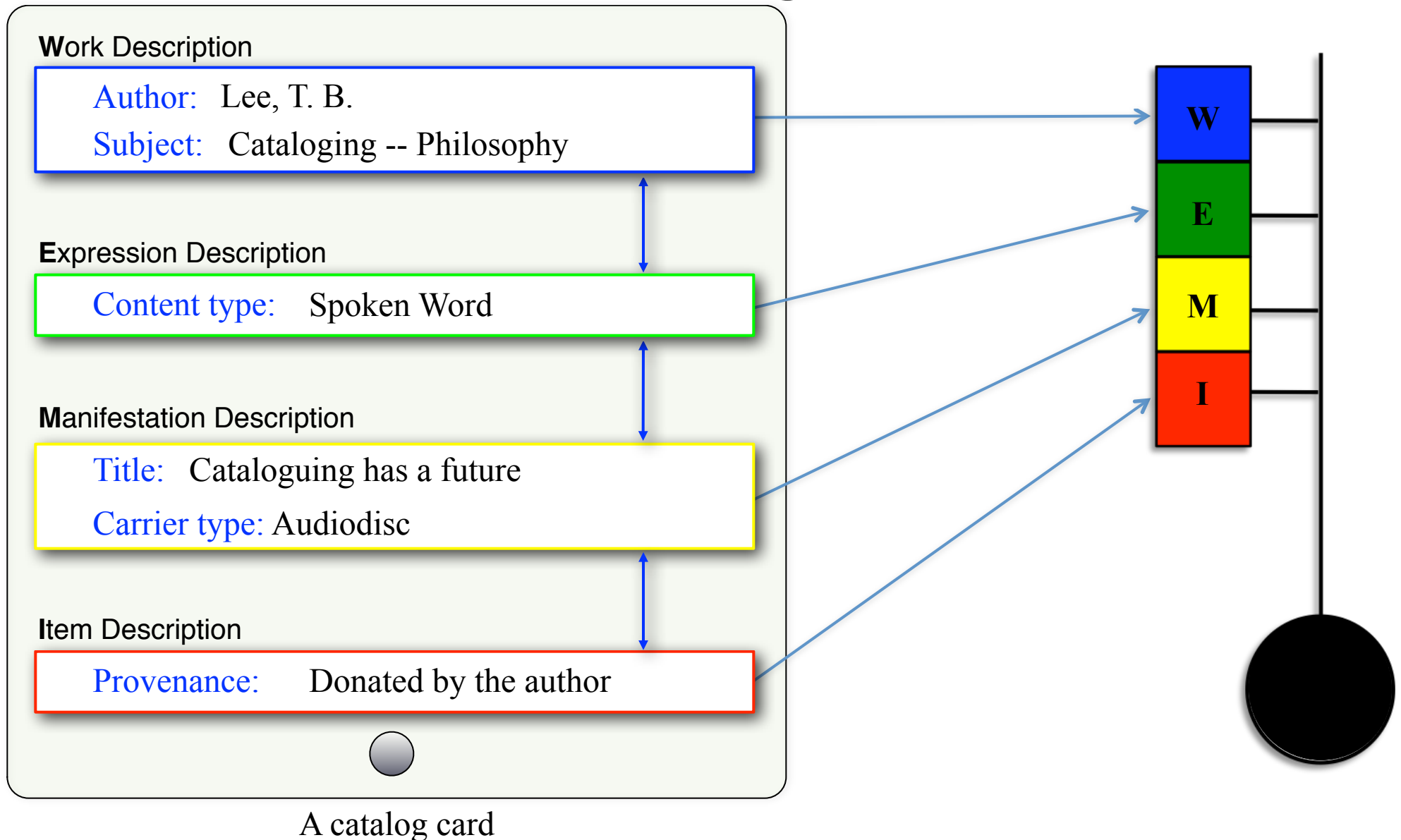
Representing Bibliographic Information: Catalog Card to FRBR



Representing Bibliographic Information: Catalog Card to FRBR



Representing Bibliographic Information: Catalog Card to FRBR



Representing Bibliographic Information: MARC to FRBR

The Library of Congress >> Go to Library of Congress Authorities

LIBRARY OF CONGRESS ONLINE CATALOG

Help New Search Search History Headings List Titles List Request an Item Account Info Logoff Start Over

DATABASE: Library of Congress Online Catalog
YOU SEARCHED: Title Begins With
SEARCH RESULTS: Displaying 1

Brief Record

LC Control No.: 72083804
LCCN Permalink: <http://lccn.loc.gov/72083804>
Type of Material: Book (Print, etc.)
Personal Name: Pynchon, Thomas
Main Title: Gravity's rainbow
Published/Created: New York, N.Y. : Viking Press, 1973.
Description: 760 p. : 23 cm.
ISBN: 0670348325
Subjects: [World War, 1939-1945--Fiction](#)
[Americans--Fiction](#)
[Rockets \(Ordnance\)--Fiction](#)
[Rocketry--Fiction](#)
[Soldiers--Fiction](#)
[Europe--Fiction](#)
Form/Genre: [War stories--Fiction](#)
[Science fiction](#)

LC Classification: PZ4.P997 Gr. PS3566.Y55
LC Copy: PS3566.Y55 G7 1973 Copy 3.
Dewey Class No.: 813/.5/4

CALL NUMBER: [PZ4.P997 Gr. FT MEADE](#)
Copy 1
-- Request in: Jefferson or Adams Building Reading Rooms - STORED OFFSITE
-- Status: Not Charged

CALL NUMBER: [PZ4.P997 Gr. FT MEADE](#)
Copy 2
-- Request in: Jefferson or Adams Building Reading Rooms - STORED OFFSITE
-- Status: Not Charged

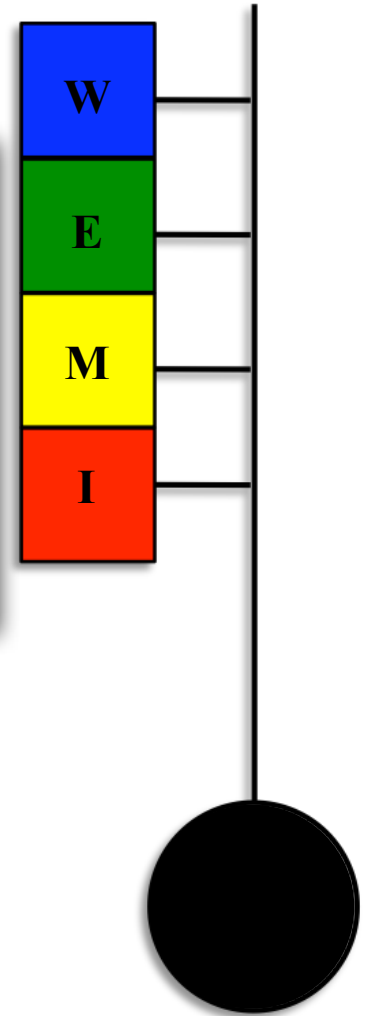
CALL NUMBER: [PS3566.Y55 G7 1973](#)
Copy 1
-- Request in: Rare Book/Special Collections Reading Room (Jefferson LJ239)
-- Status: Not Charged

◀ Previous Next ▶

Save, Print or Email Records (View [Help](#))

Data Model Archeology

An online catalog “record” (in a regular or MARC tag view) contains FRBR attributes plus a great deal of implementation-oriented information



Representing Bibliographic Information: MARC to FRBR

The Library of Congress >> Go to Library of Congress Authorities

LIBRARY OF CONGRESS ONLINE CATALOG

Help New Search Search History Headings List Titles List Request an Item Account Info Logoff Start Over

DATABASE: Library of Congress Online Catalog
YOU SEARCHED: Title Begins With = gravity's rainbow
SEARCH RESULTS: Displaying 1 of 8.

◀ Previous Next ▶

Brief Record Subjects/Content Full Record MARC Tags

Gravity's rainbow.

LC Control No.: 72083804
LCN Permalink: <http://lcn.loc.gov/72083804>
Type of Material: Book (Print, Microform, Electronic, etc.)
Personal Name: [Pynchon, Thomas.](#)
Main Title: Gravity's rainbow.
Published/Created: New York, Viking Press [1973]
Description: 760 p. 23 cm.
ISBN: 0670348325 0670003743 (pbk)
Subjects: [World War, 1939-1945 --Fiction.](#)
[Americans --Europe --Fiction.](#)
[Rockets \(Ordnance\) --Fiction.](#)
[Rocketry --Fiction.](#)
[Soldiers --Fiction.](#)
[Europe --Fiction.](#)
Form/Genre: [War stories, qsafr](#)
[Science fiction, qsafr](#)
LC Classification: PZ4.P997 Gr PS3566.Y55
LC Copy: PS3566.Y55 G7 1973 Copy 3.
Dewey Class No.: 813/.5/4

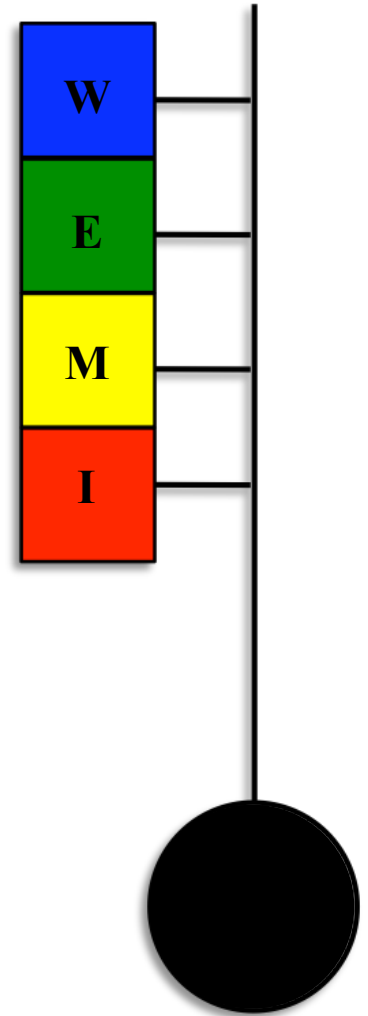
CALL NUMBER: [PZ4.P997 Gr FT MEADE](#)
Copy 1
-- **Request in:** Jefferson or Adams Building Reading Rooms - STORED OFFSITE
-- **Status:** Not Charged

CALL NUMBER: [PZ4.P997 Gr FT MEADE](#)
Copy 2
-- **Request in:** Jefferson or Adams Building Reading Rooms - STORED OFFSITE
-- **Status:** Not Charged

CALL NUMBER: [PS3566.Y55 G7 1973](#)
Copy 1
-- **Request in:** Rare Book/Special Collections Reading Room (Jefferson LJ239)
-- **Status:** Not Charged

◀ Previous Next ▶

Save, Print or Email Records (View [Help](#))



Representing Bibliographic Information: MARC to FRBR

The Library of Congress >> Go to Library of Congress Authorities

LIBRARY OF CONGRESS ONLINE CATALOG

Help New Search Search History Headings List Titles List Request an Item Account Info Logoff Start Over

DATABASE: Library of Congress Online Catalog
YOU SEARCHED: Title Begins With = gravity's rainbow
SEARCH RESULTS: Displaying 1 of 8.

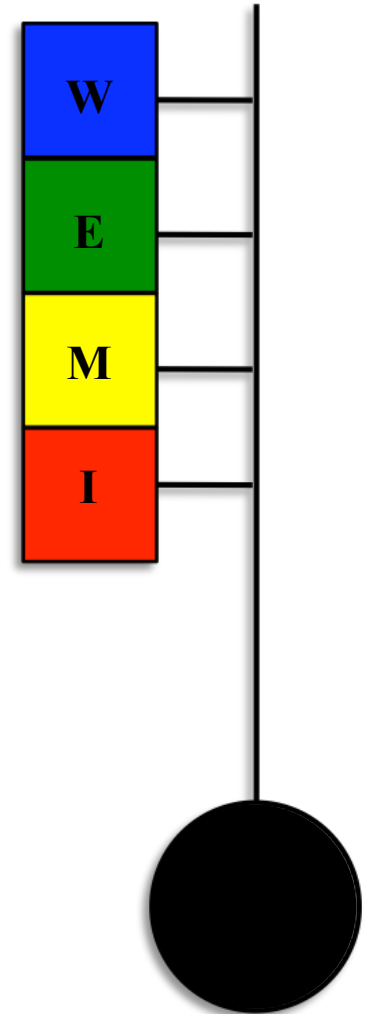
Previous Next

Brief Record Subjects/Content Full Record MARC Tags

Gravity's rainbow.

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LCCN Permalink: <http://lccn.loc.gov/72083804>

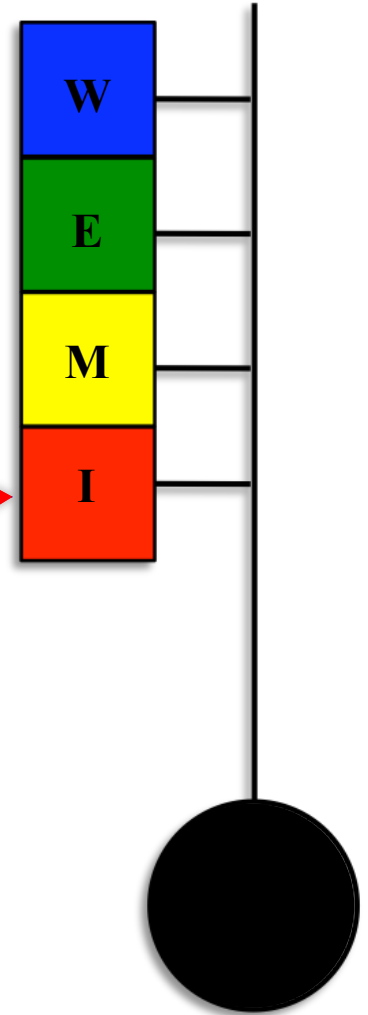
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001 1244042
005 20001113094601.0
008 730410s1973 nyu 000 1 eng
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906 __ |a 7 |b cbc |c orignew |d 2 |e opcn |f 19 |g y-gencatlg
010 __ |a 72083804
020 __ |a 0670348325 |c 0670003743 (pbk)
040 __ |a DLC |c DLC |d DLC
050 00 |a PZ4.P997 |b Gr |a PS3566.Y55
051 __ |a PS3566.Y55 |b G7 1973 |c Copy 3.
082 00 |a 813/.5/4
100 1_ |a Pynchon, Thomas.
245 10 |a Gravity's rainbow.
260 __ |a New York, |b Viking Press |c [1973]
300 __ |a 760 p. |c 23 cm.
350 __ |a \$15.00
650 _0 |a World War, 1939-1945 |v Fiction.
650 _0 |a Americans |z Europe |v Fiction.
650 _0 |a Rockets (Ordnance) |v Fiction.
650 _0 |a Rocketry |v Fiction.
650 _0 |a Soldiers |v Fiction.
651 _0 |a Europe |v Fiction.
655 _7 |a War stories. |z gsafd
655 _7 |a Science fiction. |z gsafd
991 __ |b c-GenColl |h PZ4.P997 |i Gr |p 00001216788 |t Copy 1 |w BOOKS
991 __ |b c-RareBook |h PS3566.Y55 |i G7 1973 |t Copy 1 |w BOOKS



Representing Bibliographic Information: MARC to FRBR

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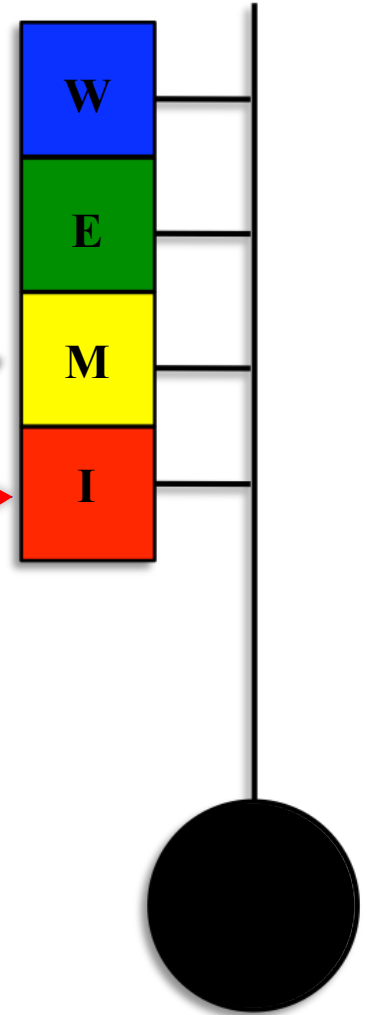
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001 1244042
005 20001113094601.0
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906 __ |a 7 |b cbc |c orignew |d 2 |e opcn |f 19 |g y-gencatlg
010 __ |a 72083804
020 __ |a 0670348325 |c 0670003743 (pbk)
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650 _0 |a Soldiers |v Fiction.
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655 _7 |a War stories. |2 gsafd
655 _7 |a Science fiction. |2 gsafd
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991 __ |b c-RareBook |h PS3566.Y55 |i G7 1973 |t Copy 1 |w BOOKS



Representing Bibliographic Information: MARC to FRBR

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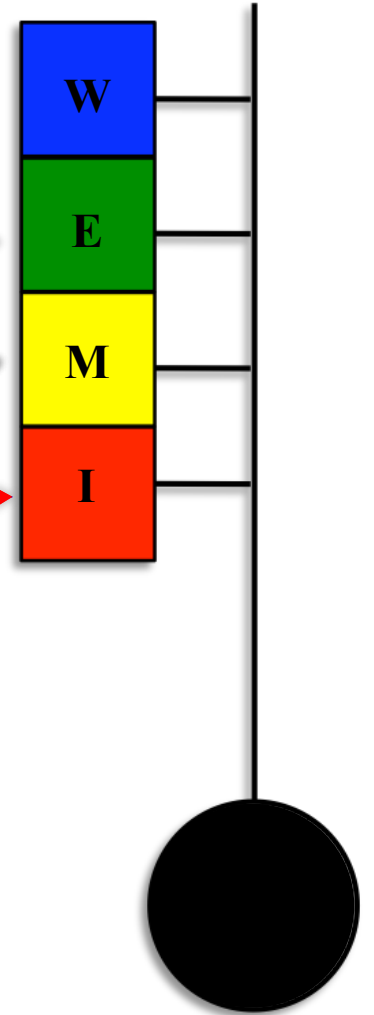
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005 20001113094601.0
008 730410s1973 nyu 000 1 eng
035 __ |9 (DLC) 72083804
906 __ |a 7 |b cbc |c orignew |d 2 |e opcn |f 19 |g y-gencatlg
010 __ |a 72083804
020 __ |a 0670348325 |c 0670003743 (pbk)
040 __ |a DLC |c DLC |d DLC
050 00 |a PZ4.P997 |b Gr |a PS3566.Y55
051 __ |a PS3566.Y55 |b G7 1973 |c Copy 3.
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650 _0 |a Rocketry |v Fiction.
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991 __ |b c-GenColl |h PZ4.P997 |i Gr |p 00001216788 |t Copy 1 |w BOOKS
991 __ |b c-RareBook |h PS3566.Y55 |i G7 1973 |t Copy 1 |w BOOKS



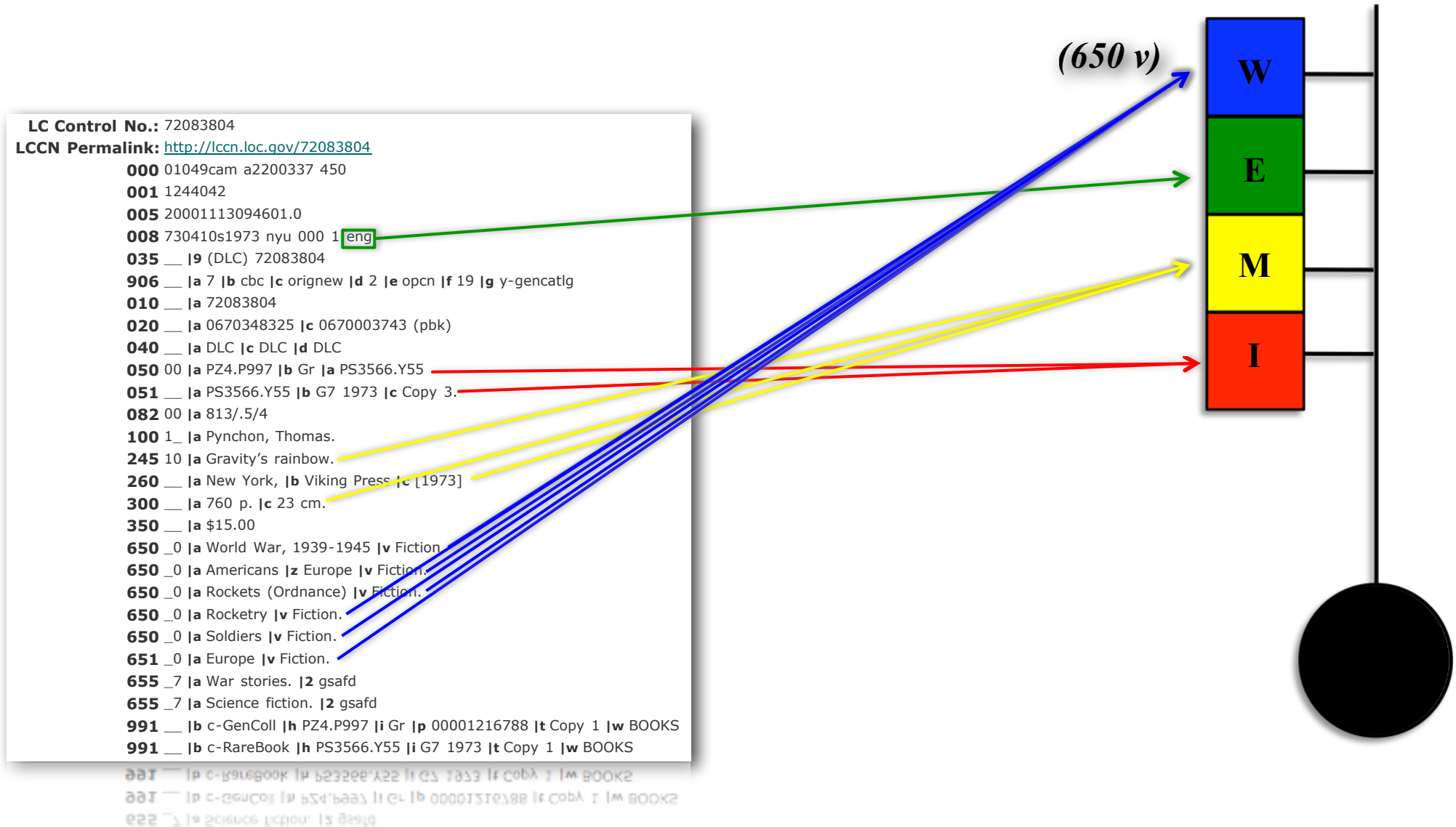
Representing Bibliographic Information: MARC to FRBR

LC Control No.: 72083804
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035 __ |9 (DLC) 72083804
906 __ |a 7 |b cbc |c orignew |d 2 |e opcn |f 19 |g y-gencatlg
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Representing Bibliographic Information: MARC to FRBR



Creating a FRBR Paper Tool: From Cataloging Card to Nodes

Lee, T. B.

**Cataloguing has a future. - Audio disc
(Spoken word). - Donated by the author.**

1. Metadata



Creating a FRBR Paper Tool: From Cataloging Card to Nodes

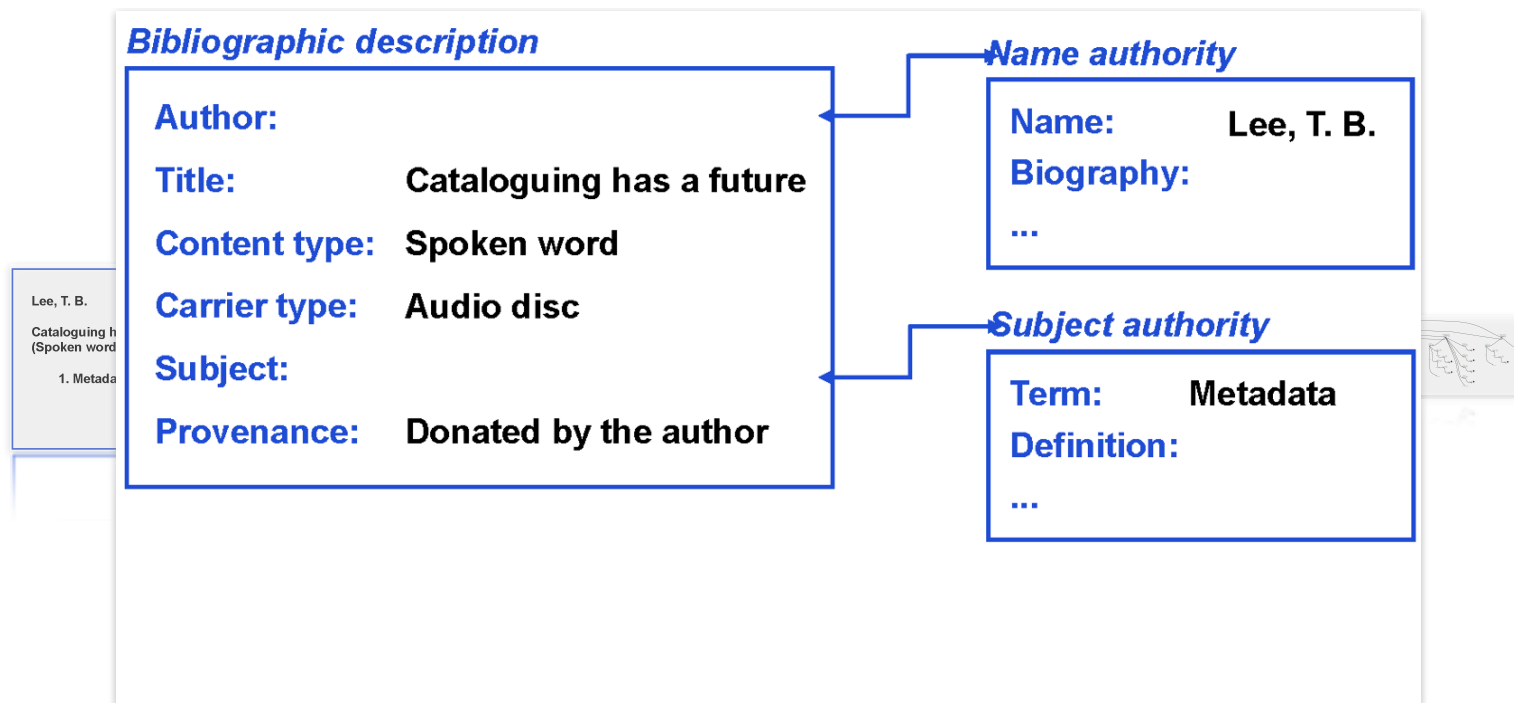
Lee, T. B.

**Cataloguing has a future. - Audio disc
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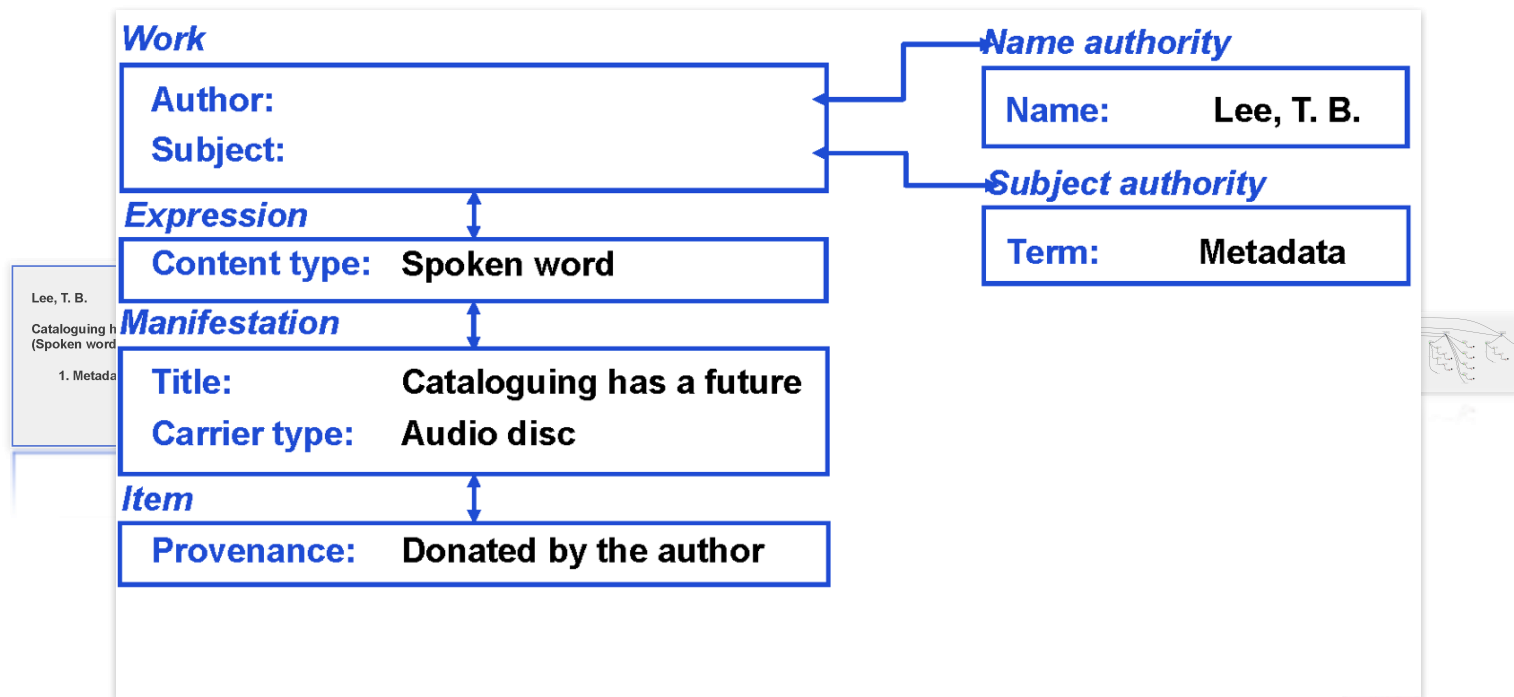
- A Catalog Card – A resource description consists of a limited quantity of attribute text printed on a physical medium

Creating a FRBR Paper Tool: From Cataloging Card to Nodes



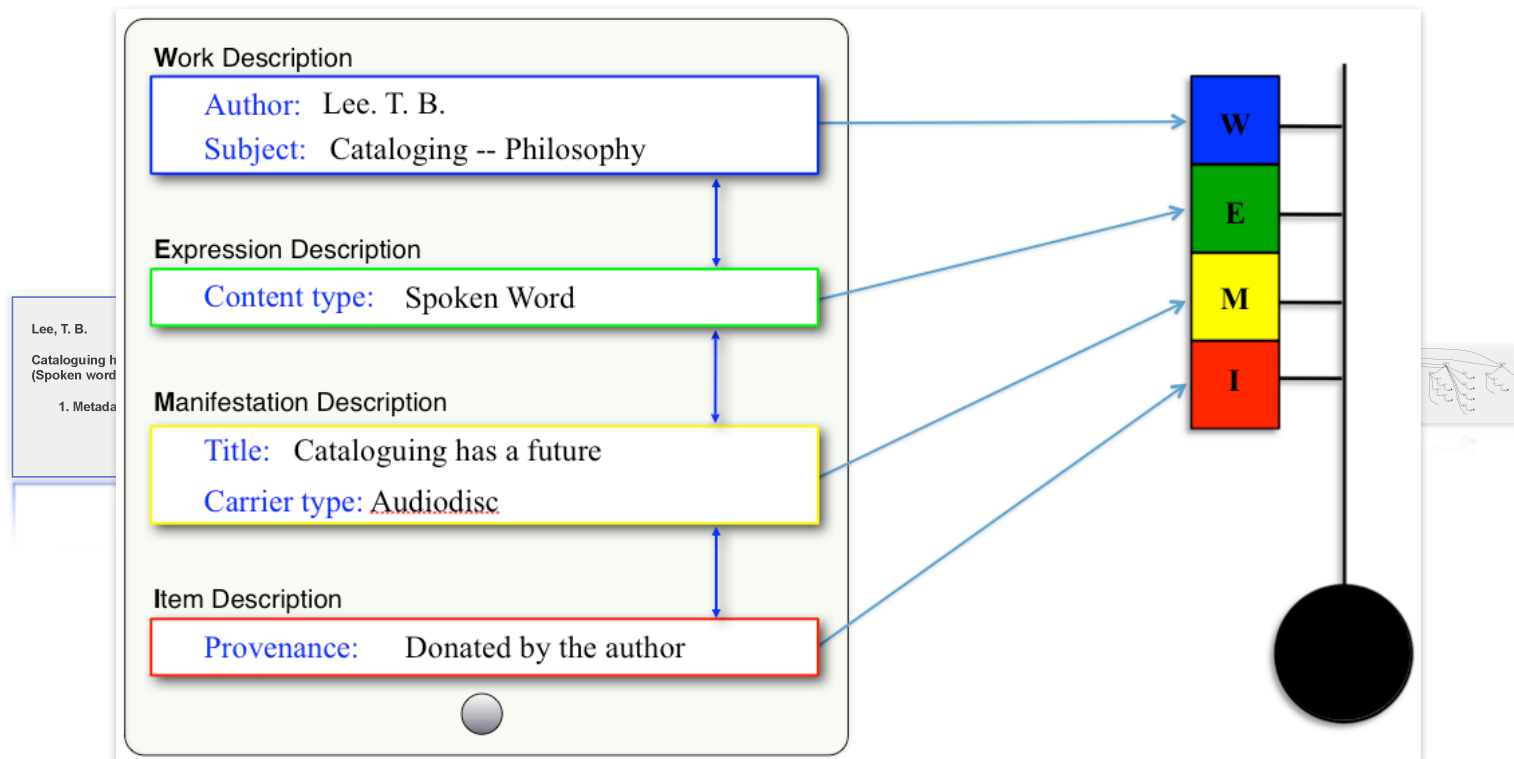
- The resource descriptions on the card are abstracted to three *entities*: three sets of linked, (optimally) non-redundant attributes

Creating a FRBR Paper Tool: From Cataloging Card to Nodes



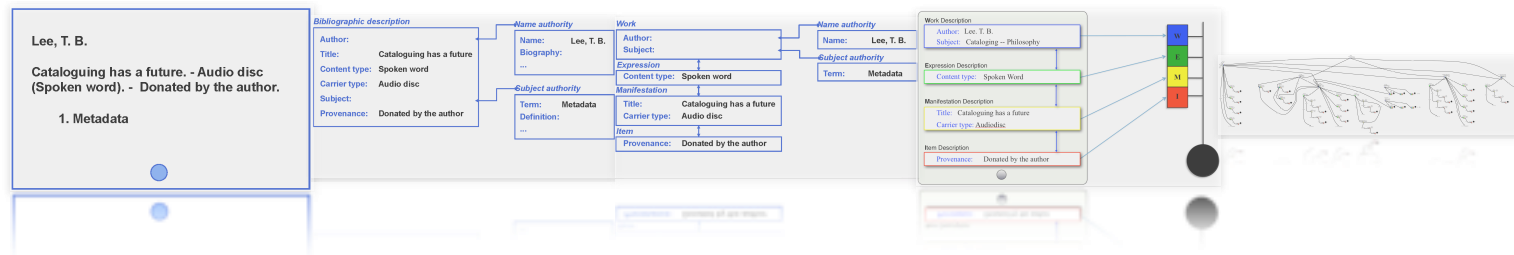
- The remaining bibliographic resource description attributes are separated into FRBR-specific groups

Creating a FRBR Paper Tool: From Cataloging Card to Nodes

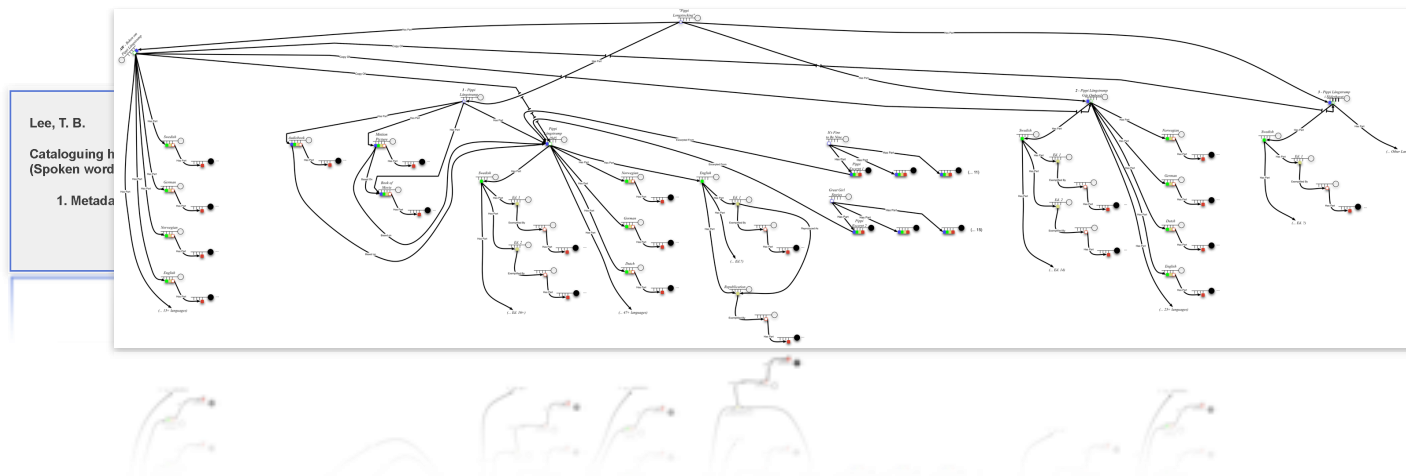


- The FRBR-relevant groups are given diagrammatic form. Additional graphic elements represent the (implied) resource and a “frame”

Creating a FRBR Paper Tool: From Cataloging Card to Nodes

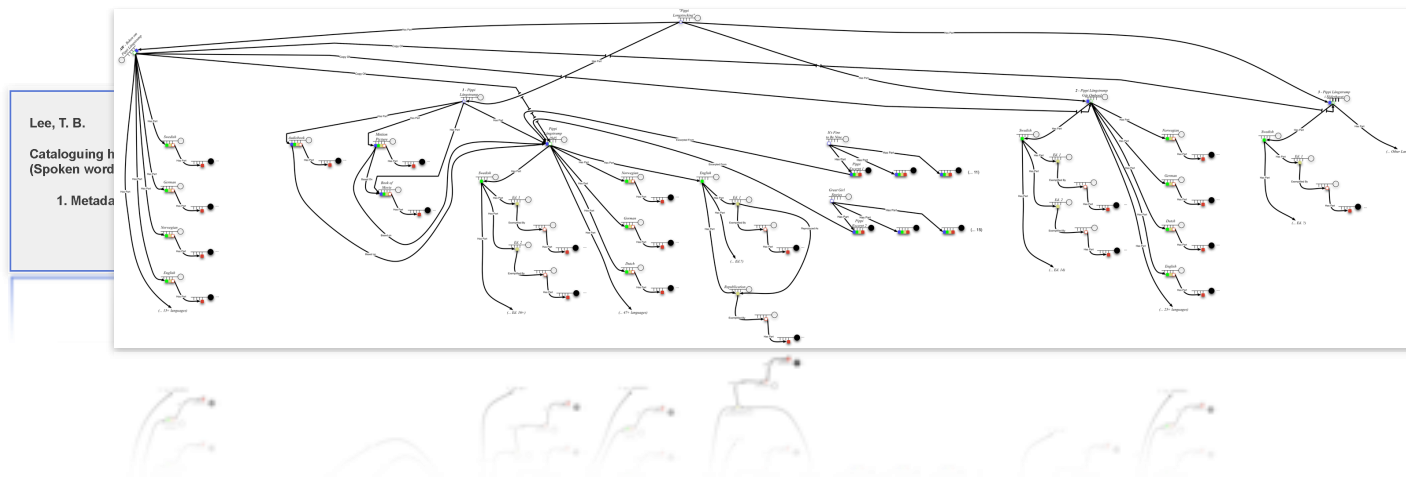


Creating a FRBR Paper Tool: From Cataloging Card to Nodes



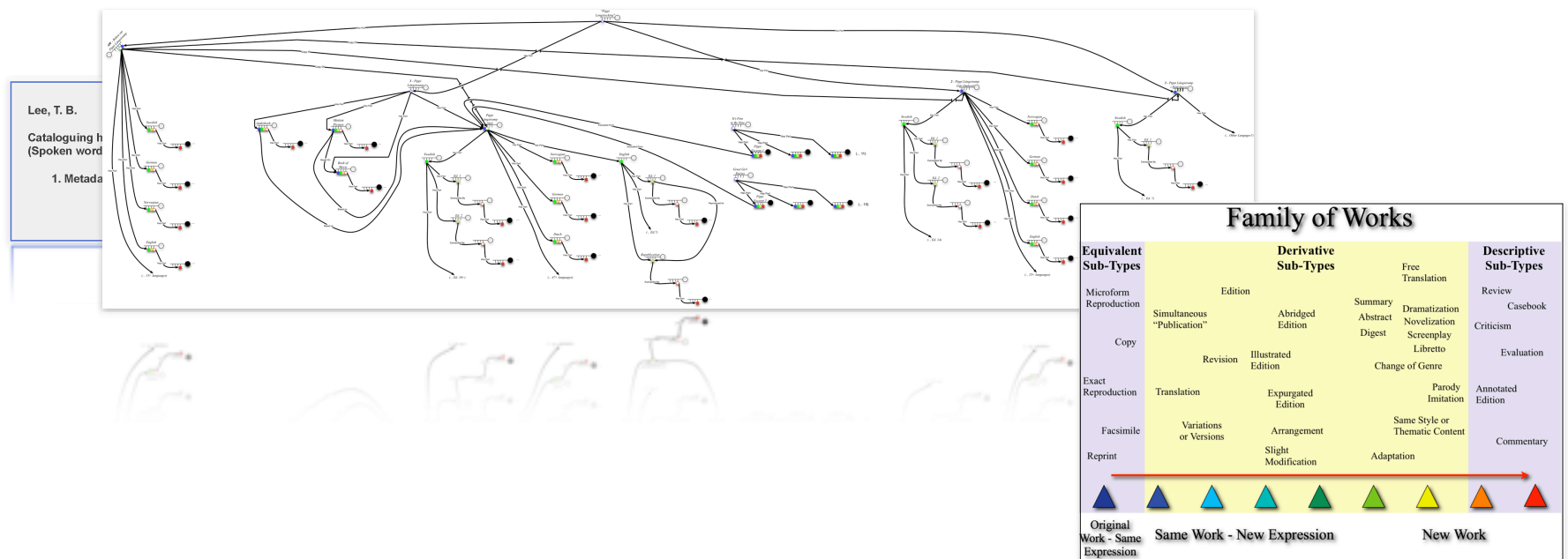
- The FRBR diagram elements are then linked according to business rules that implement FRBR theory and/or local rules of thumb

Creating a FRBR Paper Tool: From Cataloging Card to Nodes



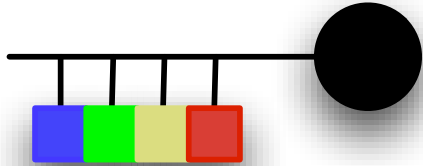
- Each FRBR **Work**, **Expression**, **Manifestation** and **Item** element is treated as a node to/from which bibliographic relationships are linked

Creating a FRBR Paper Tool: From Cataloging Card to Nodes



- Each FRBR **Work, Expression, Manifestation** and **Item** element is treated as a node to/from which bibliographic relationships are linked

Resource Diagram Drawing Conventions



- Work
- Expression
- Manifestation
- Item

Resource Diagram Drawing Conventions

From Records to Relationships

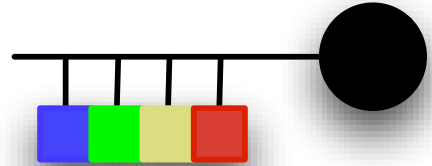
Relationships defined between FRBR resource descriptions complexes are what gives FRBR theory its power – and utility

Proper representation and exploration of these relationships are key to theory formation



- Work
- Expression
- Manifestation
- Item

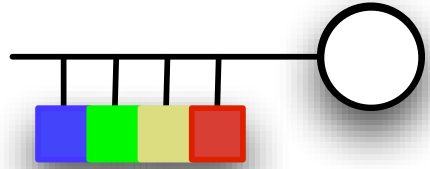
Resource Diagram Drawing Conventions



*The basic FRBR diagram grouping represents a resource and the **combined set of descriptions** of that resource*

-  Work
-  Expression
-  Manifestation
-  Item

Resource Diagram Drawing Conventions

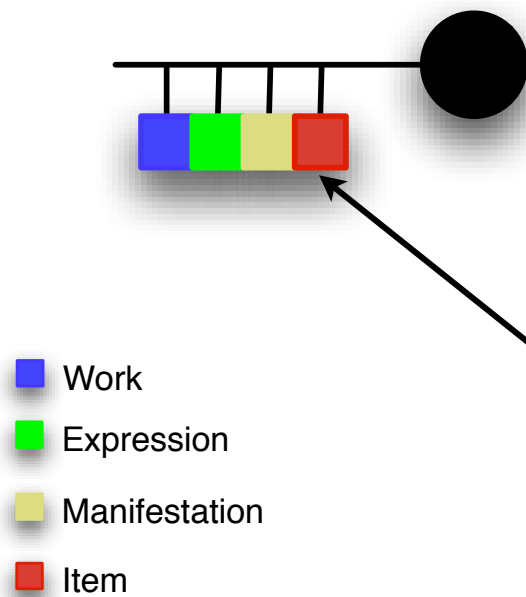


A black-filled circle means that a resource and a resource description are both present.

A clear circle means that no resource is present.

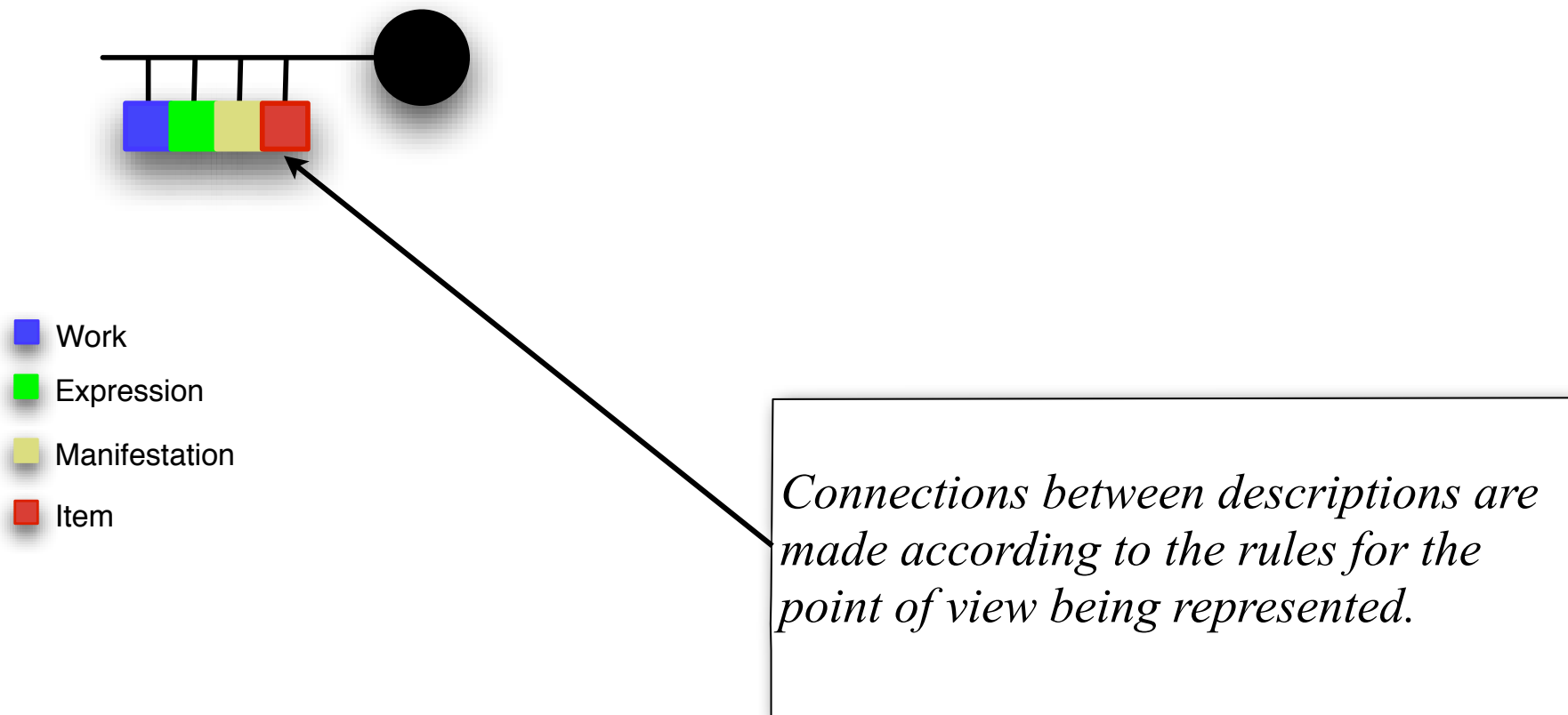
- Work
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- Manifestation
- Item

Resource Diagram Drawing Conventions

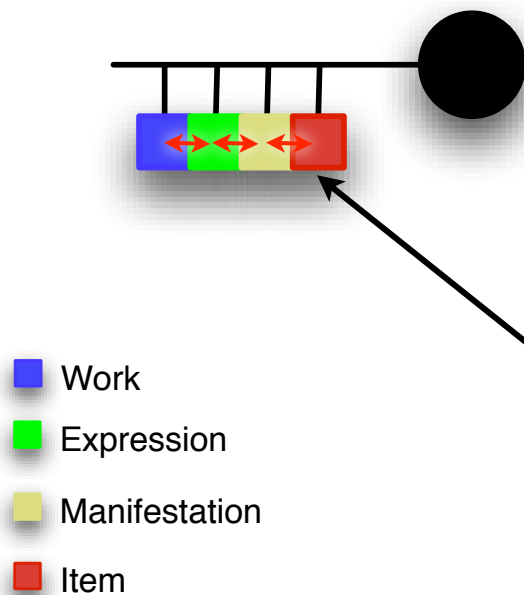


The color squares designate different types of resource descriptions. In this case, the color codes reflect FRBR rules for resource description.

Resource Diagram Drawing Conventions



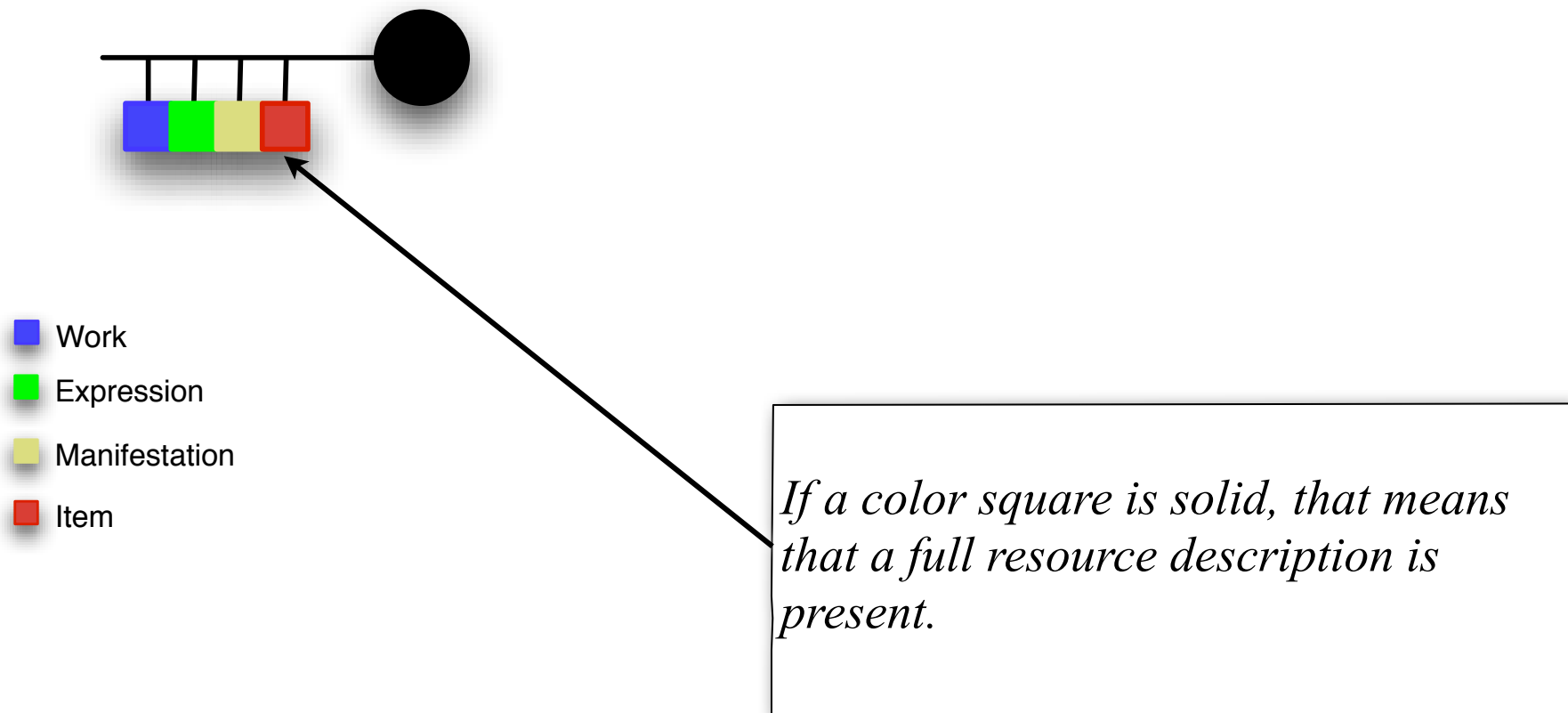
Resource Diagram Drawing Conventions



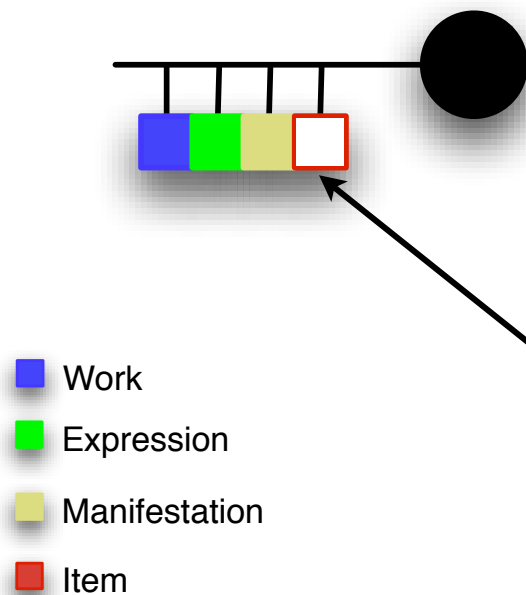
Squares placed next to one another are linked together by the appropriate relationship. No lines are visible.

These placements and links are specific to FRBR theory.

Resource Diagram Drawing Conventions



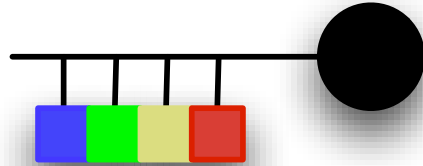
Resource Diagram Drawing Conventions



If a color square is hollow, that means that this description points to one or more descriptions of the same type.

*It acts as a **container**.*

Resource Diagram Drawing Conventions

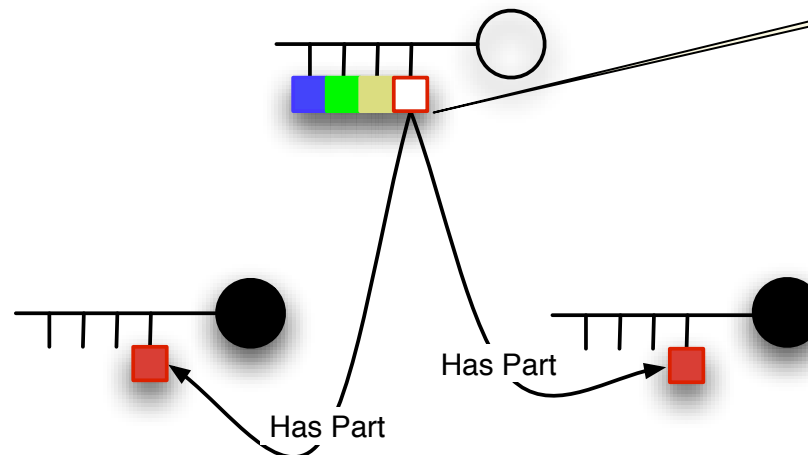


*A **container** description **must** be linked to one or more descriptions of the same **Type**.*

(This is a Business Rule at work.)

*In this example, an **Item** acting as a **container** is composed of two other **Items**.*

- Work
- Expression
- Manifestation
- Item

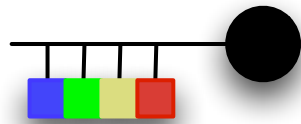


Working With a FRBR Paper Tool: Exemplars

- **Resource Exemplars**[†] - A collection of typical and atypical resources, the description of which builds resource description skills, familiarity with institutional and local business rules, and (if desired) exercise in resource description theory formation

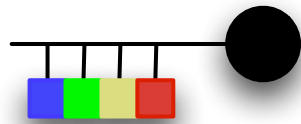
[†] Kaiser, David. *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics*. Chicago, IL: University of Chicago Press. 2005.

Working With a FRBR Paper Tool: Exemplars



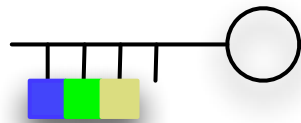
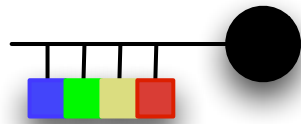
- *Simple FRBR Resource/Description Structures* –

Working With a FRBR Paper Tool: Exemplars



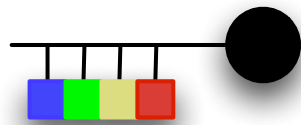
- *Simple FRBR Resource/Description Structures* –
 - An existing work published as a single monograph

Working With a FRBR Paper Tool: Exemplars



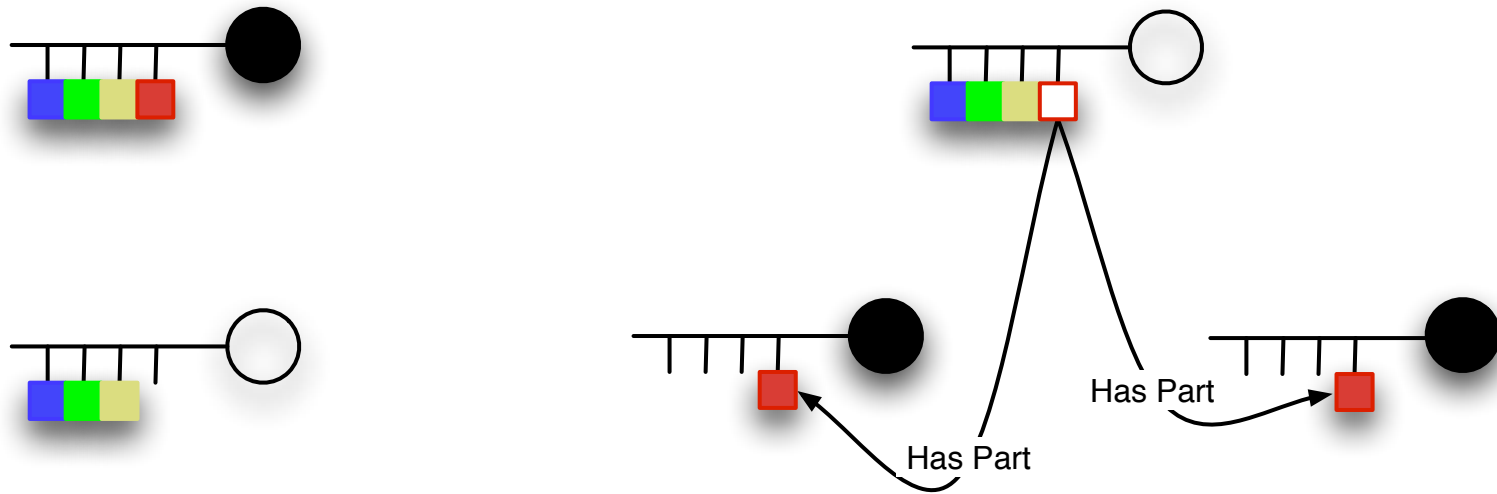
- *Simple FRBR Resource/Description Structures* –
 - An existing work published as a single monograph

Working With a FRBR Paper Tool: Exemplars



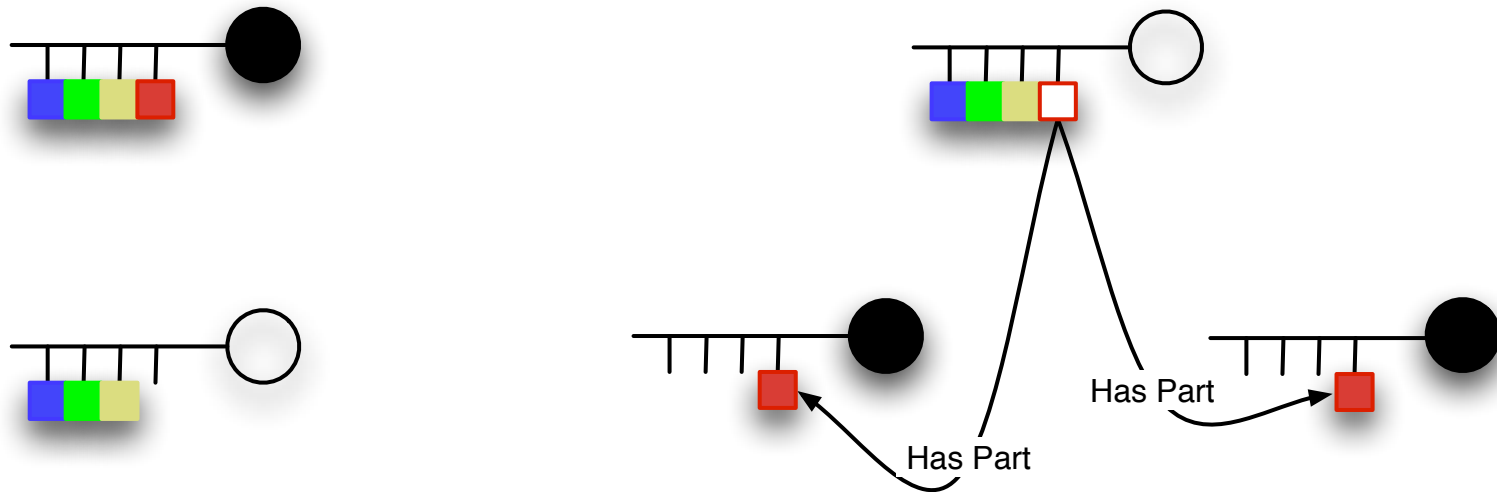
- *Simple FRBR Resource/Description Structures* –
 - An existing work published as a single monograph
 - A work published as a single monograph, but lost to history

Working With a FRBR Paper Tool: Exemplars



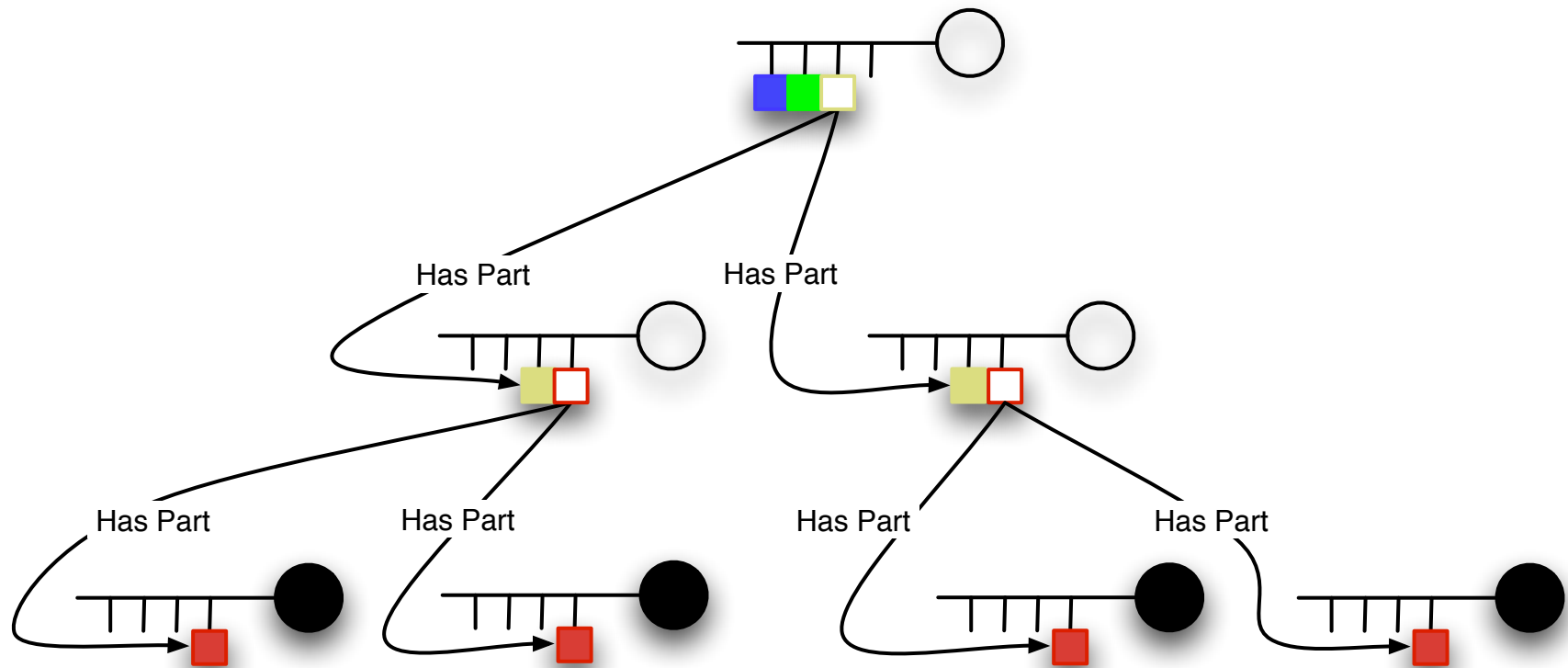
- *Simple FRBR Resource/Description Structures* –
 - An existing work published as a single monograph
 - A work published as a single monograph, but lost to history

Working With a FRBR Paper Tool: Exemplars



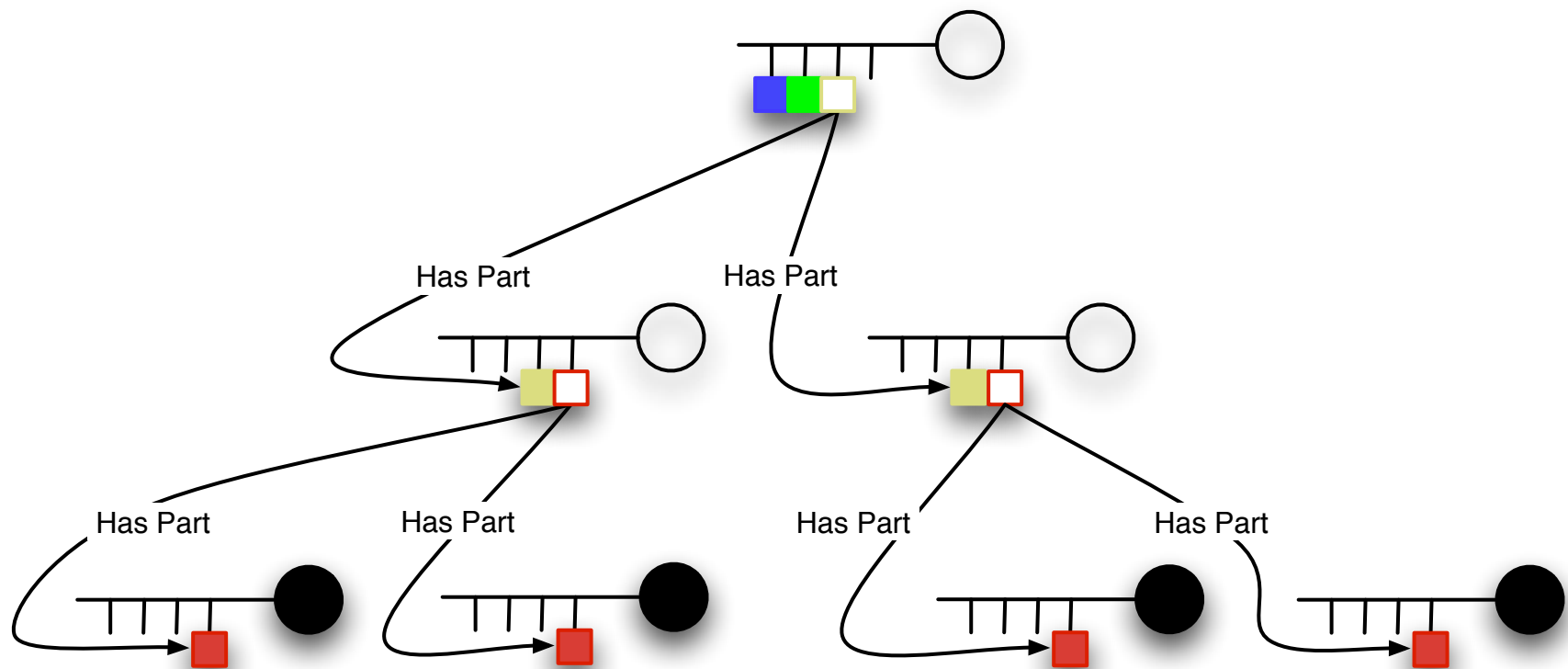
- *Simple FRBR Resource/Description Structures* –
 - An existing work published as a single monograph
 - A work published as a single monograph, but lost to history
 - A work published as a single edition, with two copies printed

Working With a FRBR Paper Tool: Exemplars



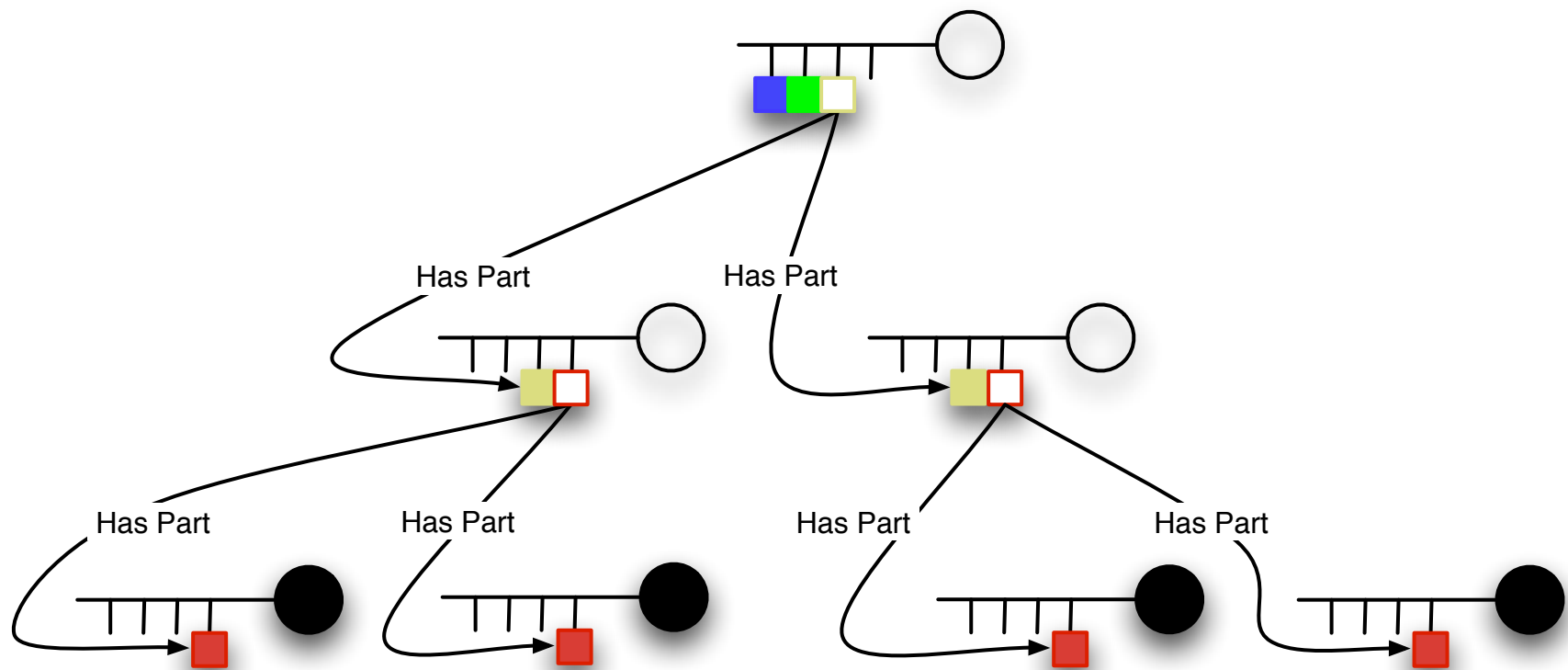
- *A Simple FRBR Resource/Description Structure –*

Working With a FRBR Paper Tool: Exemplars



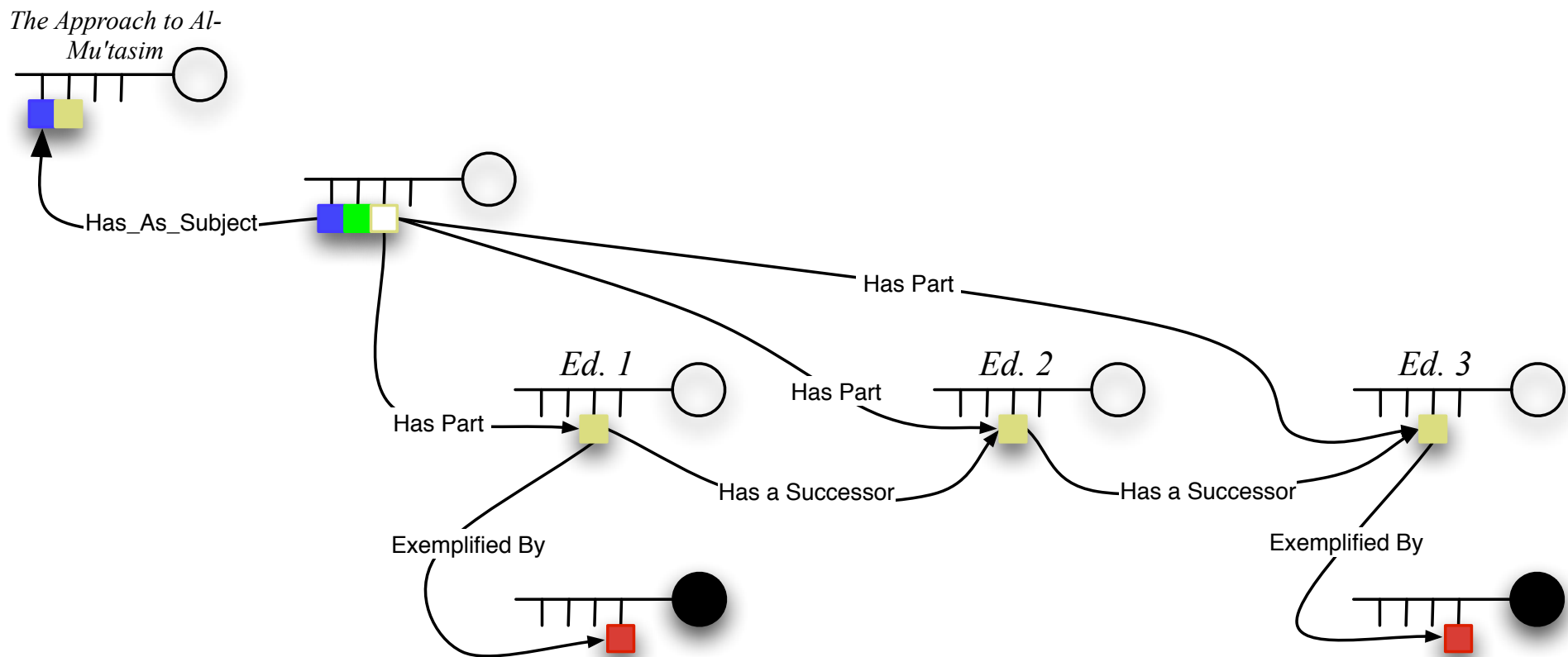
- *A Simple FRBR Resource/Description Structure* –
 - A work published in two editions, with multiple copies printed for each edition

Working With a FRBR Paper Tool: Exemplars



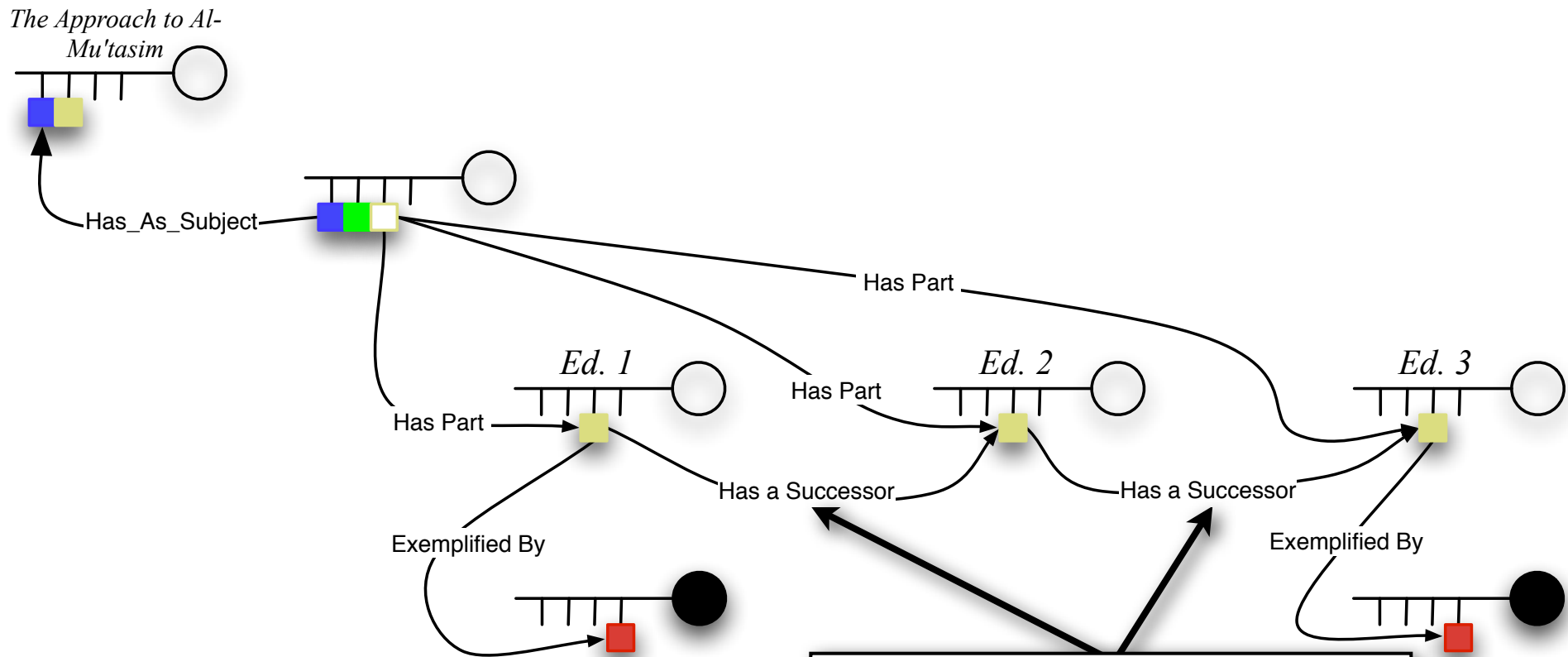
- *A Simple FRBR Resource/Description Structure* –
 - A work published in two editions, with multiple copies printed for each edition
 - Note how the FRBR building blocks are assembled

Working With a FRBR Paper Tool: Exemplars



- ***A Simple FRBR Resource/Description Structure*** – A work, whose subject is the imaginary work *The Approach to Al-Mu'tasim* alluded to by J. L. Borges, is published. One copy of the first and third editions are available, no second copy survives

Working With a FRBR Paper Tool: Exemplars



- ***A Simple FRBR Resource/Description***
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to by J. L. Borges, is published. O
editions are available, no second c

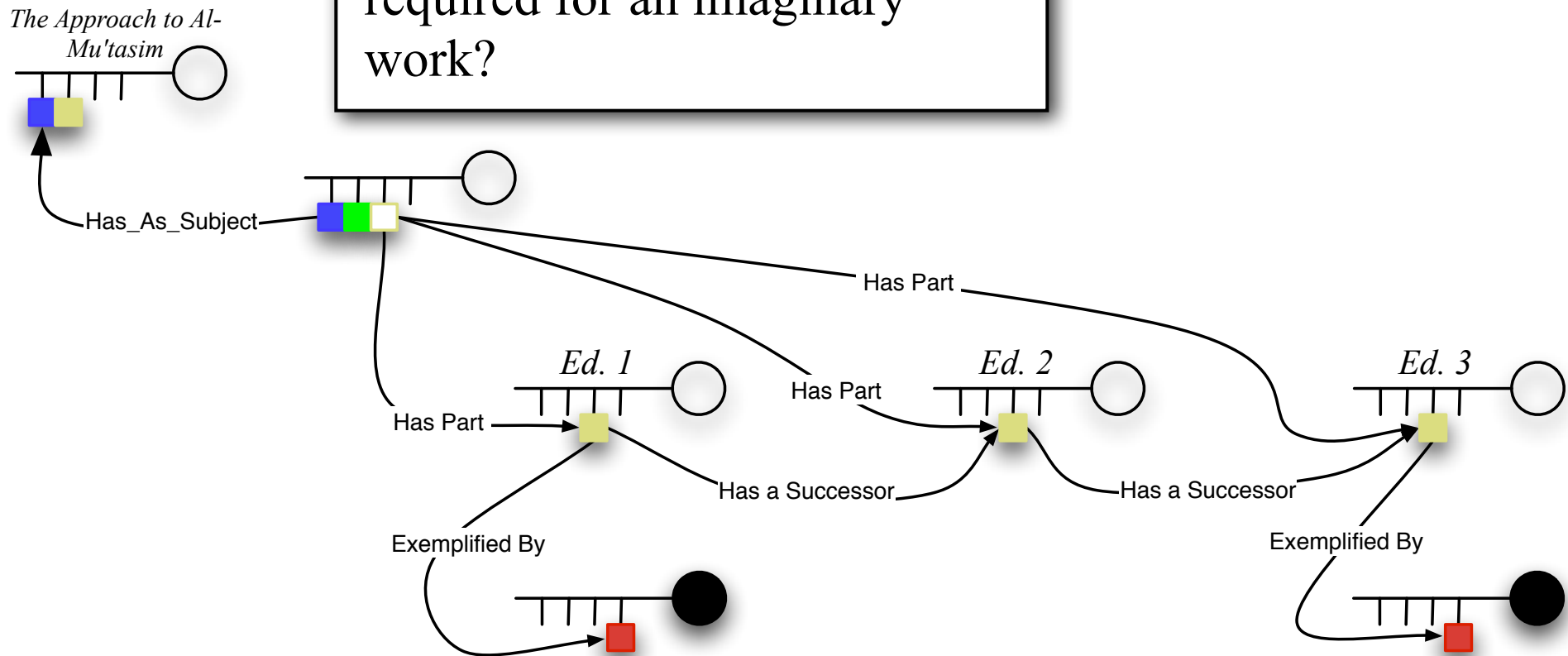
A Modeling Note
“Successor” relationships
between editions are
explicitly declared

those
cluded

Working With a FRBR Paper Tool:

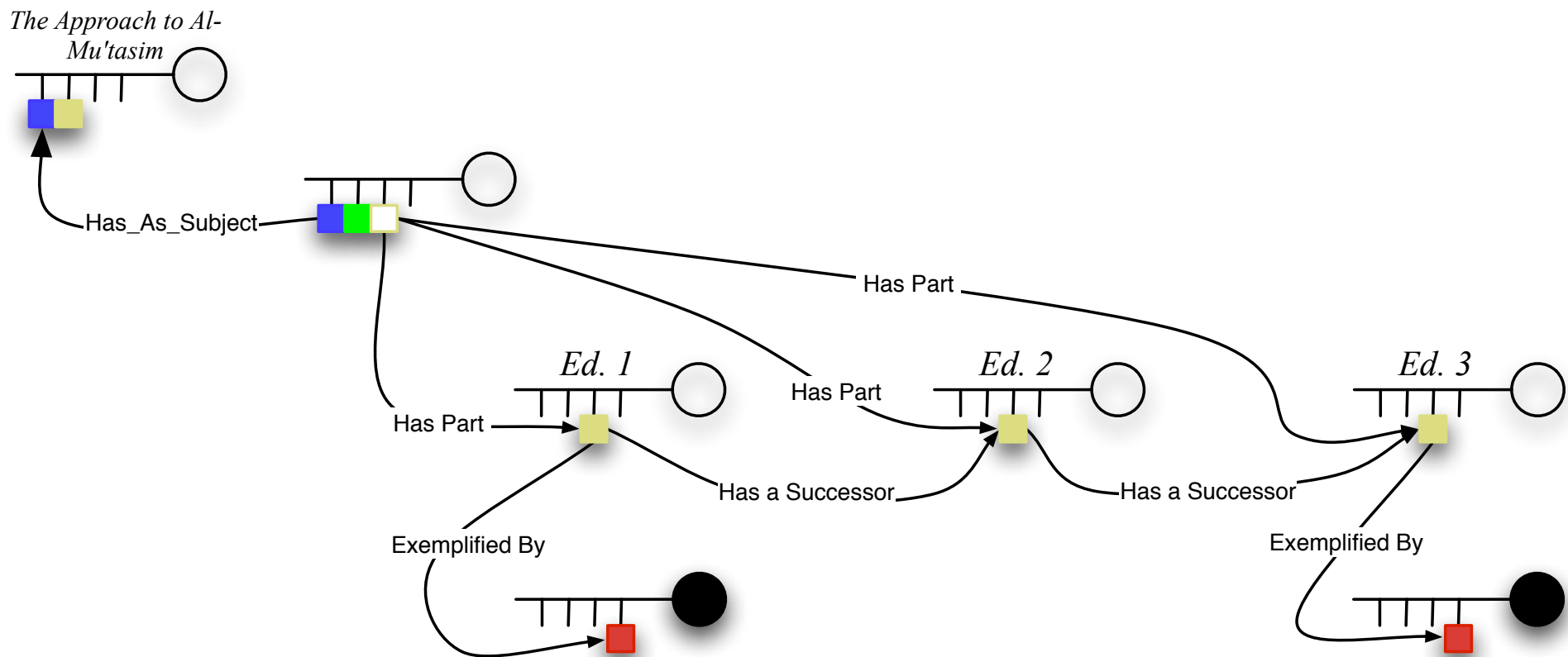
What If? A Question of Theory

How much description is
required for an imaginary
work?



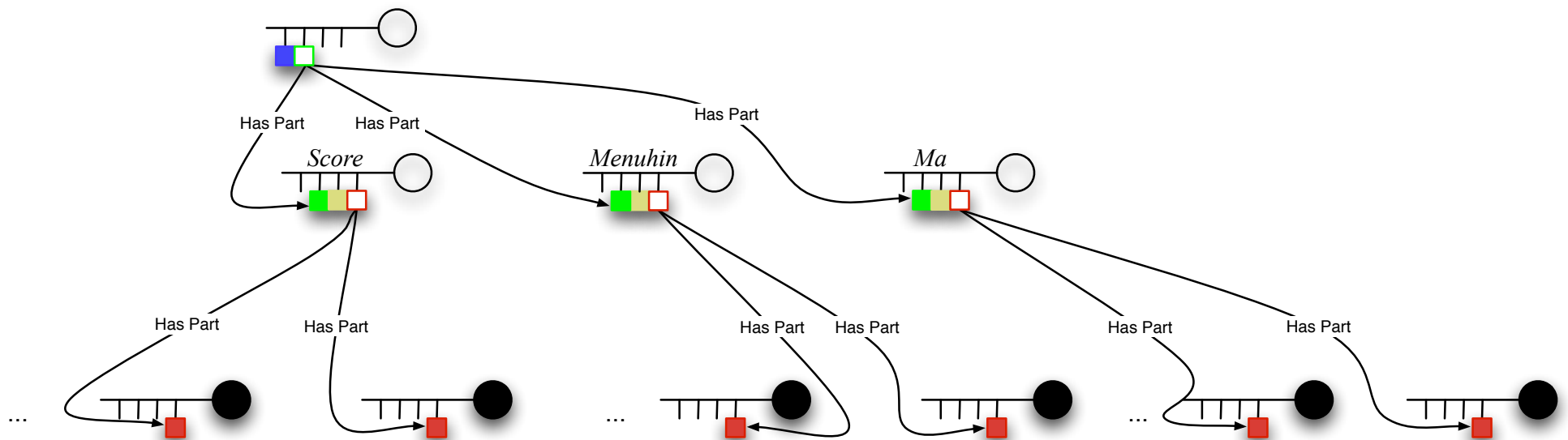
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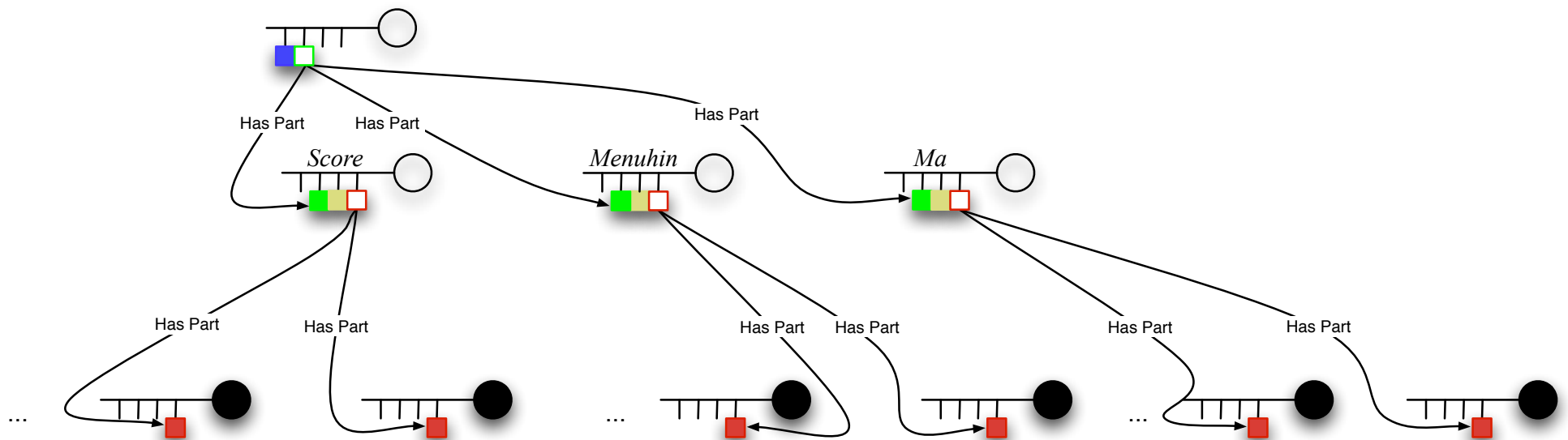


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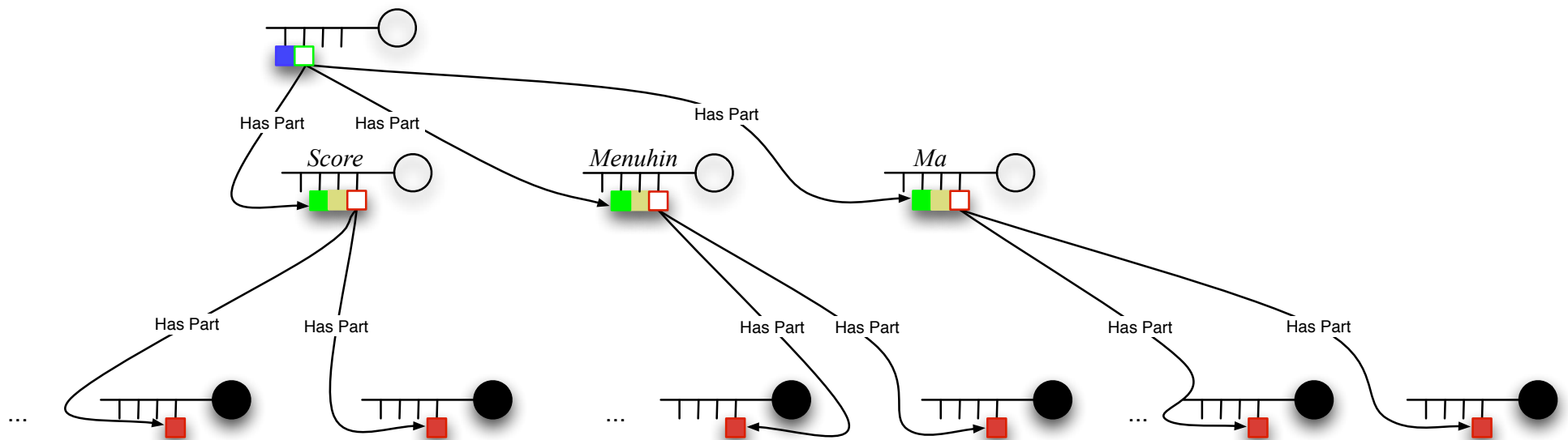


Working With a FRBR Paper Tool: Exemplars

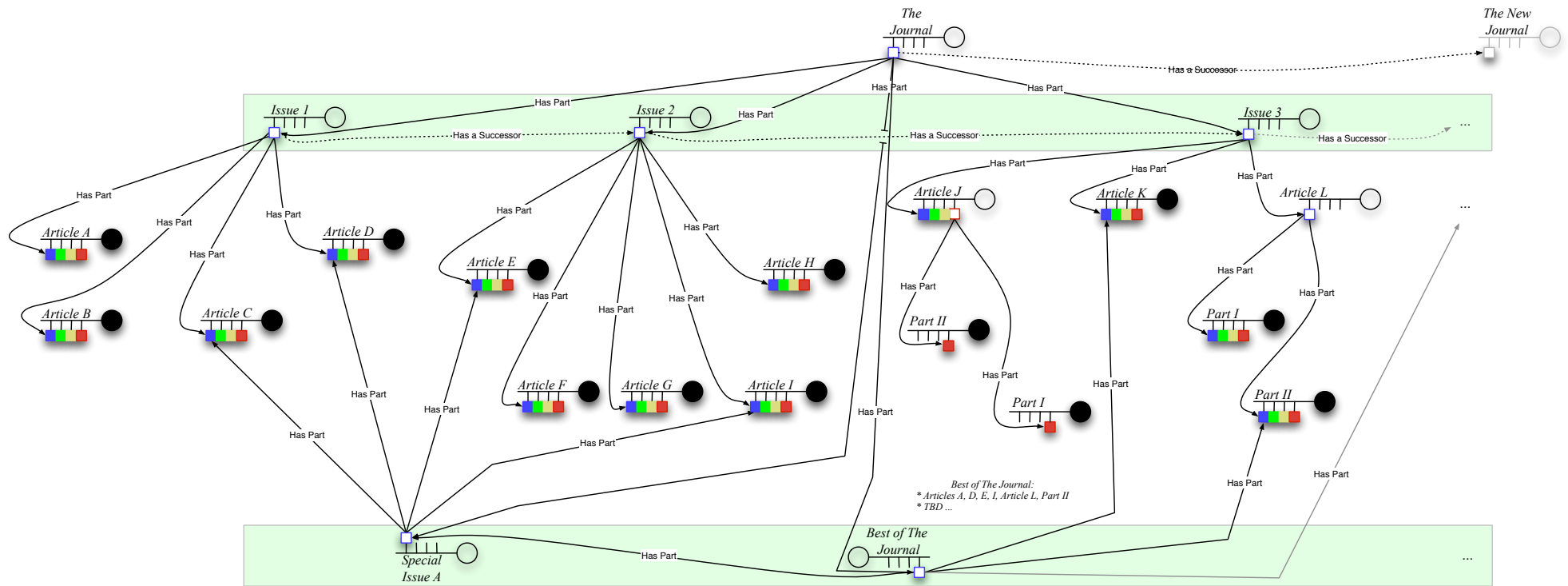


- ***From the FRBR Report:*** A musical work available as the composer's score and as recorded performances by the Amadeus Quartet with Hephzibah Menuhin on piano, and by the Cleveland Quartet with Yo-Yo Ma on the cello. The exact number of recordings produced is not known.

Working With a FRBR Paper Tool: Exemplars

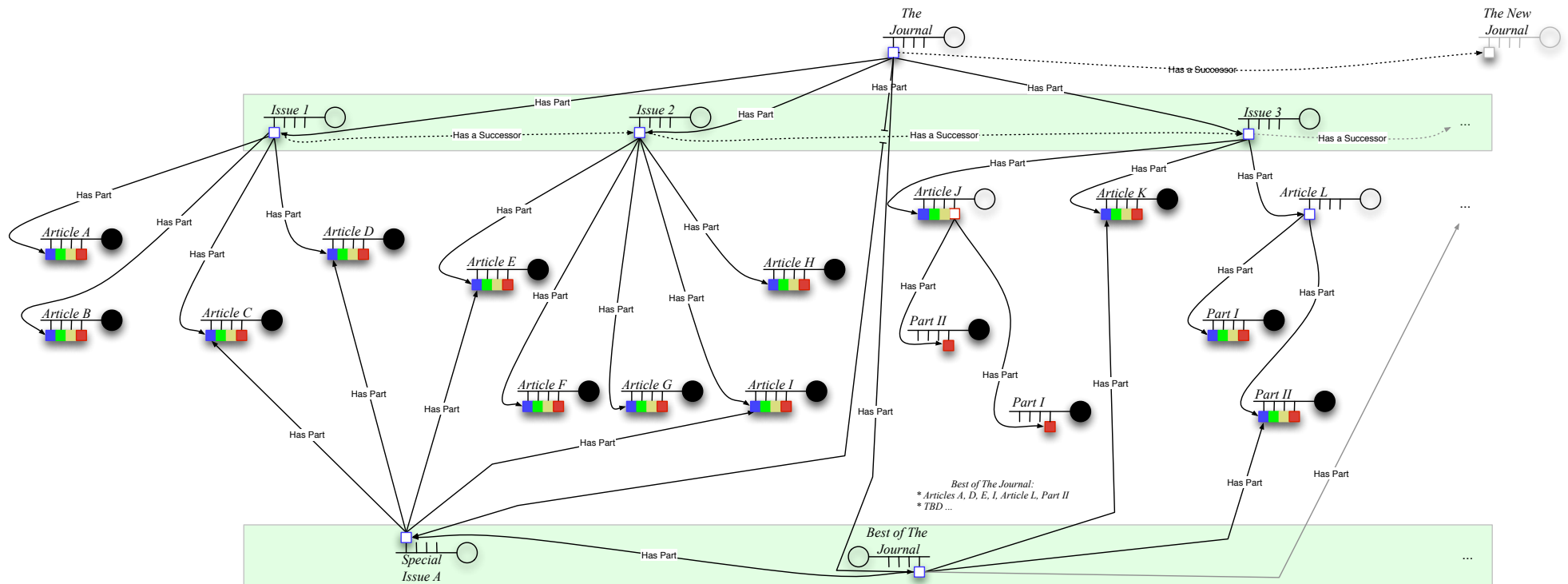


Working With a FRBR Paper Tool: Exemplars



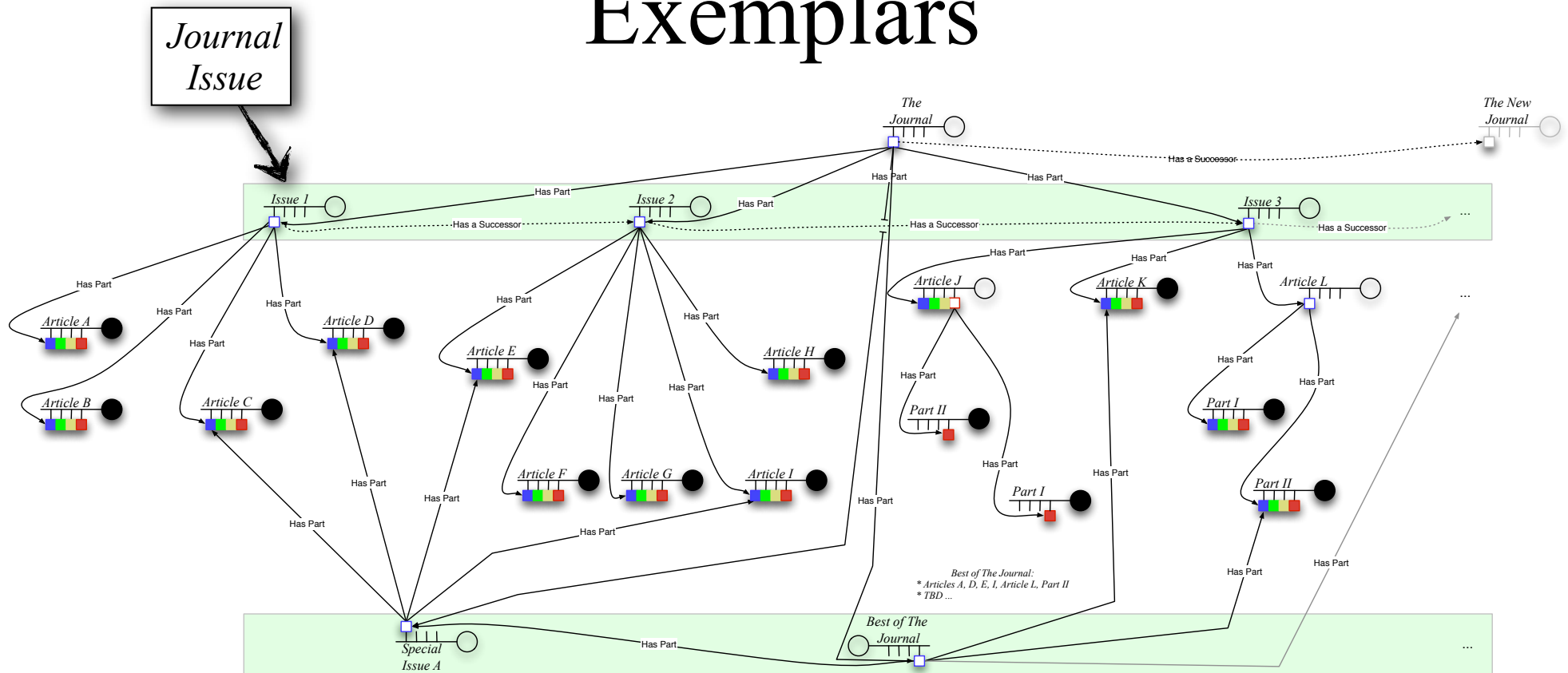
- ***A Nontrivial FRBR Resource/Description Structure*** - A continuing publication

Working With a FRBR Paper Tool: Exemplars



- ***A Nontrivial FRBR Resource/Description Structure*** - A continuing publication
 - Issues composed of articles are produced on a regular schedule

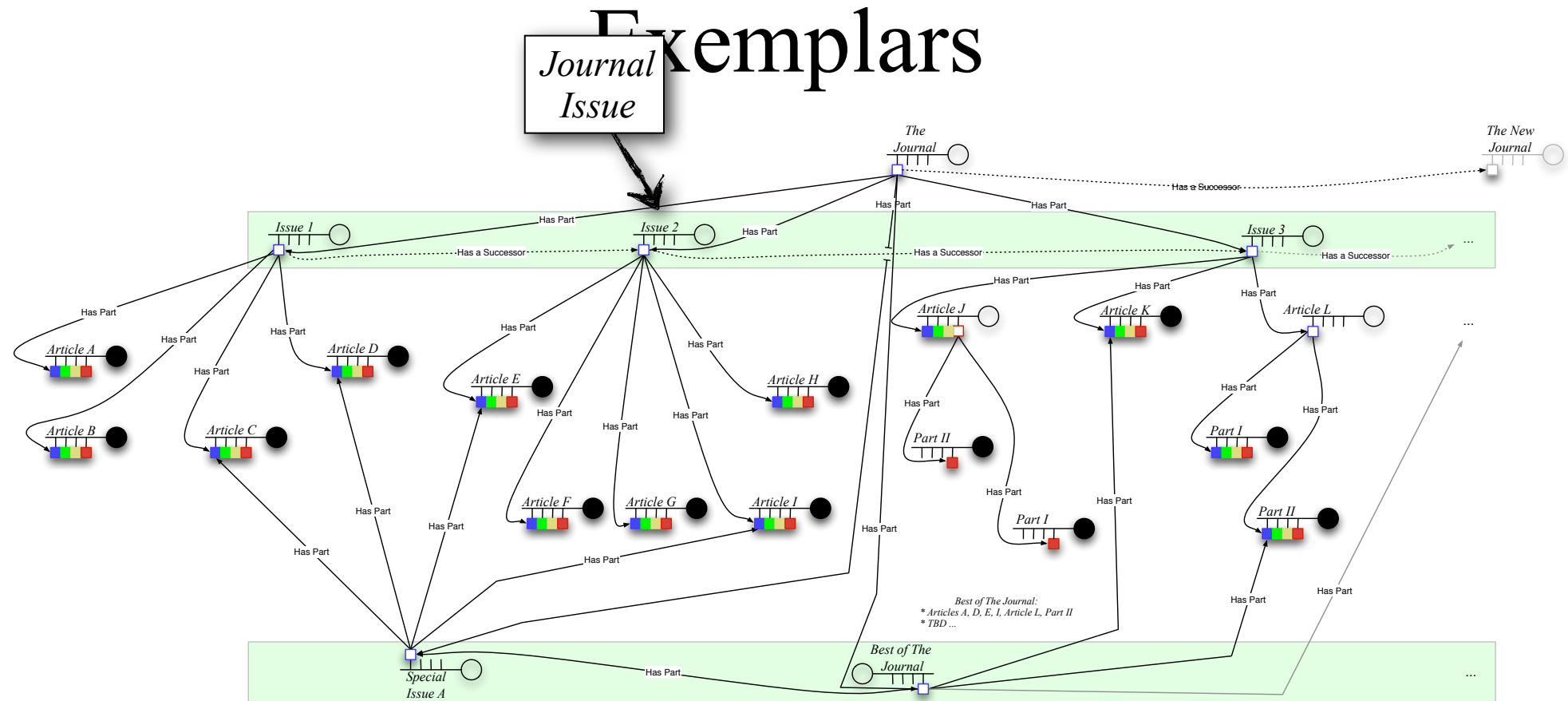
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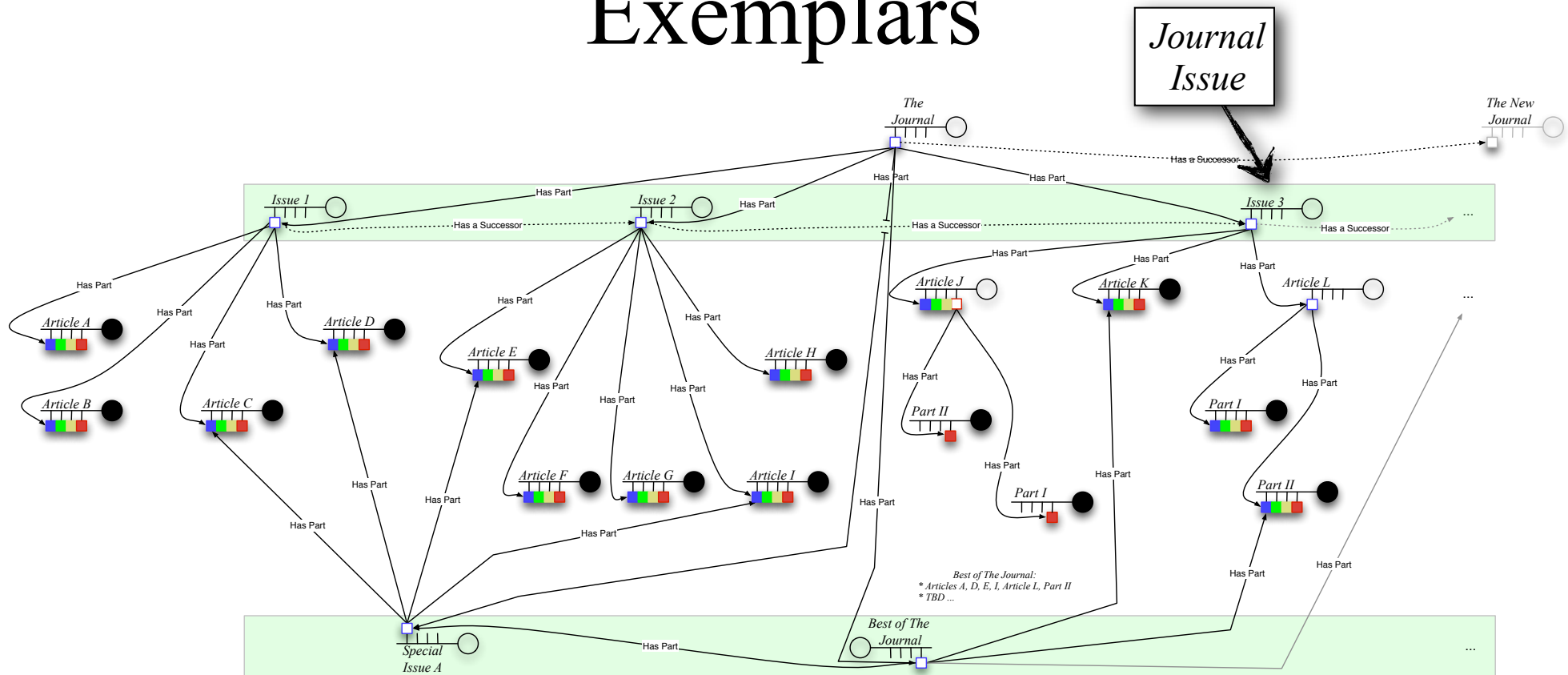
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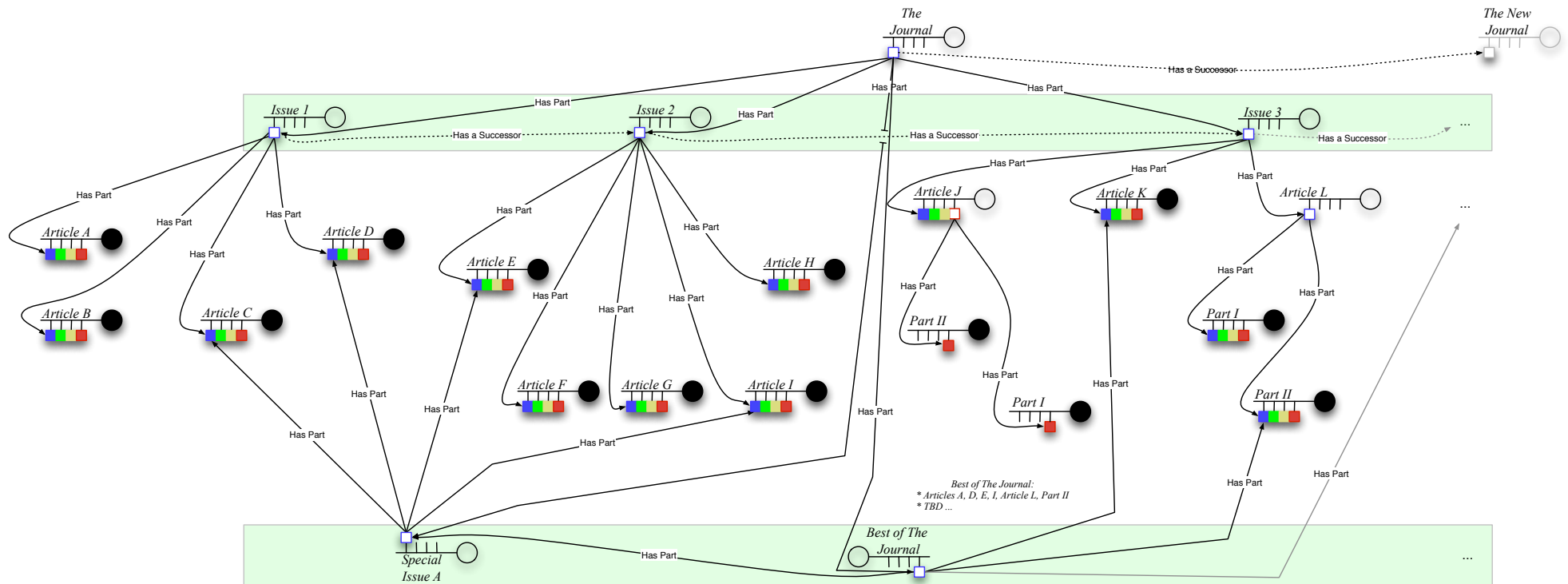
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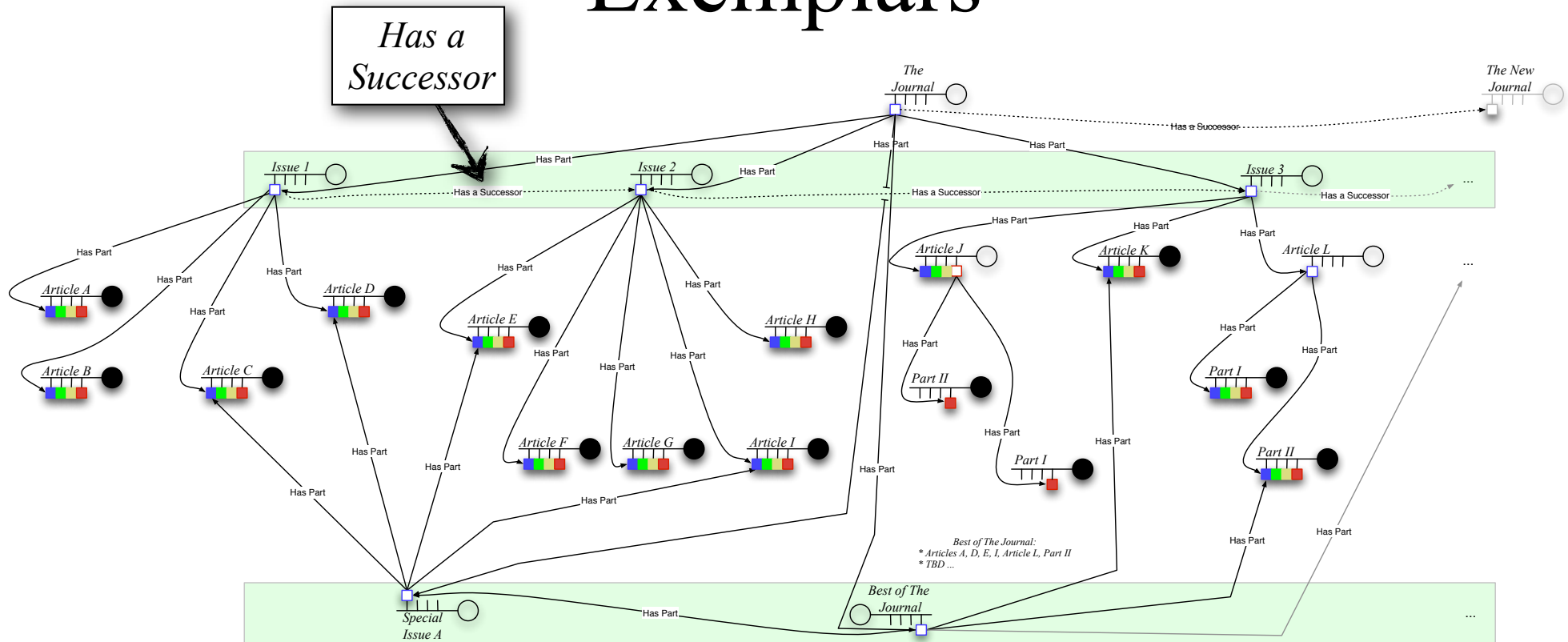
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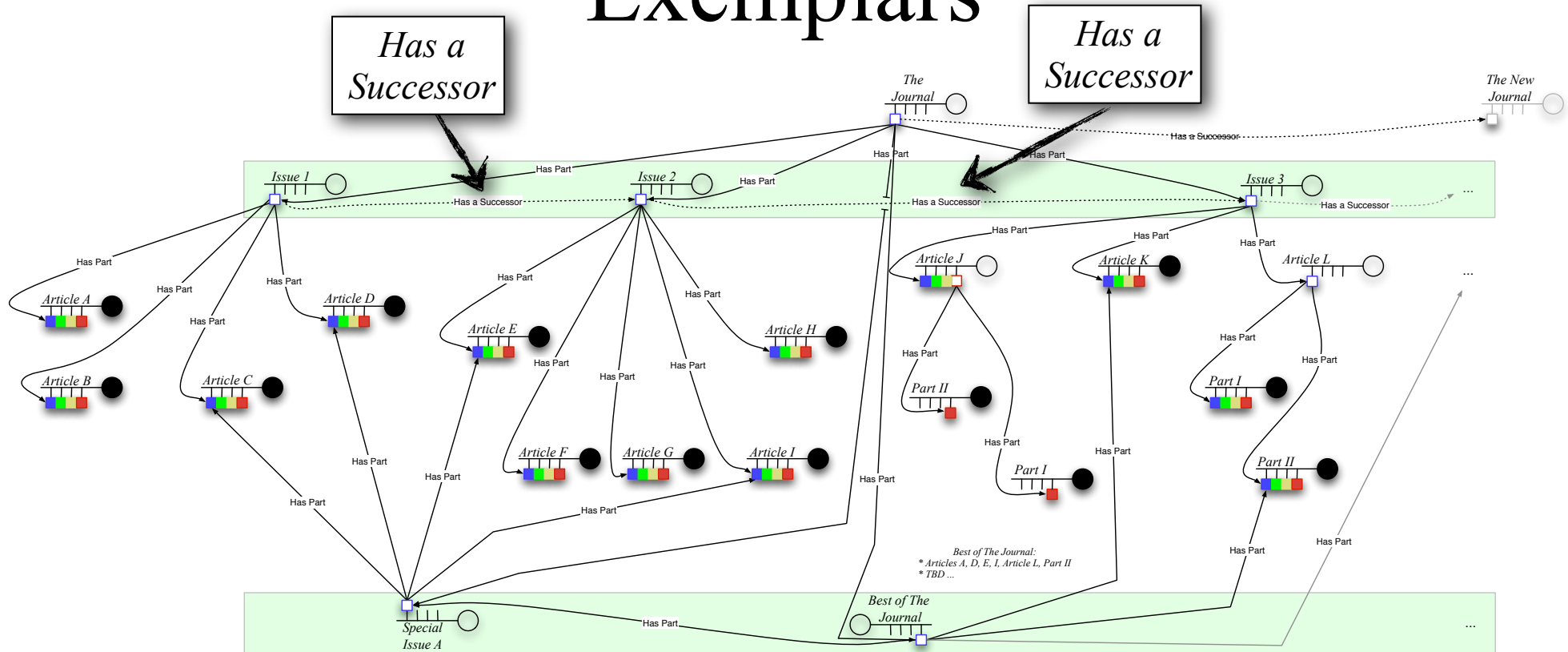
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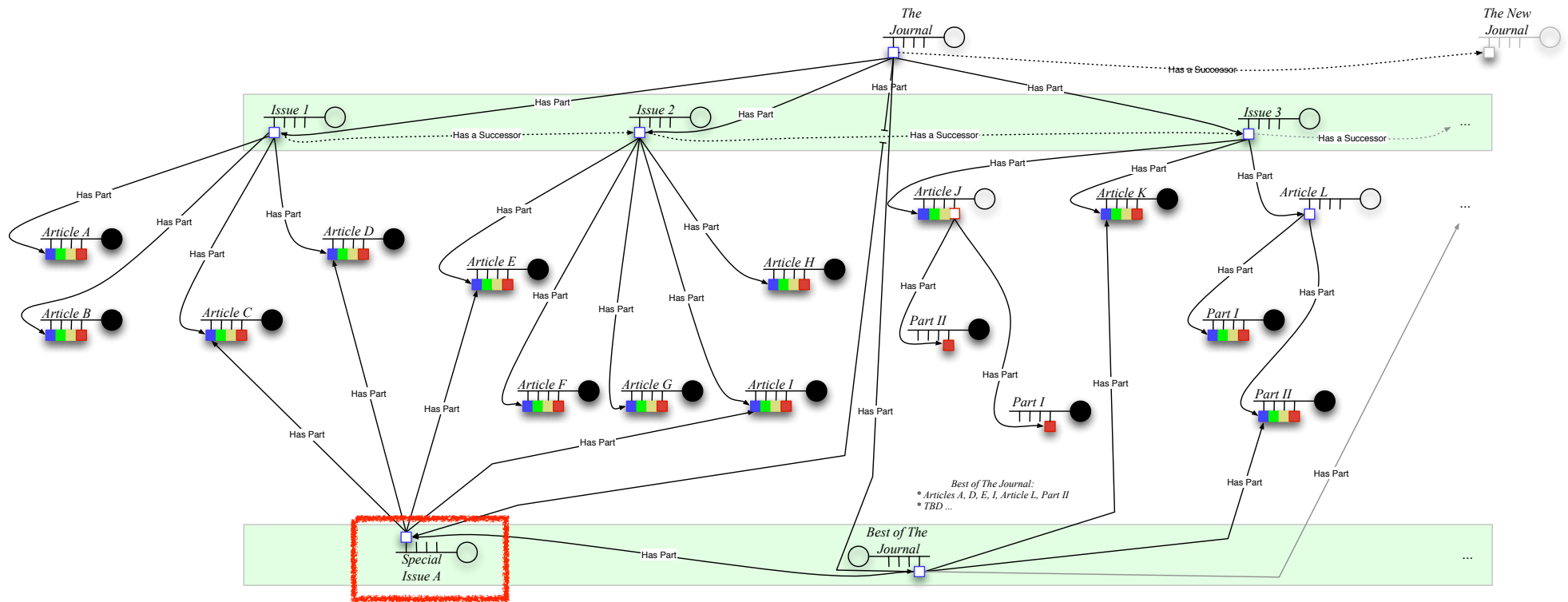
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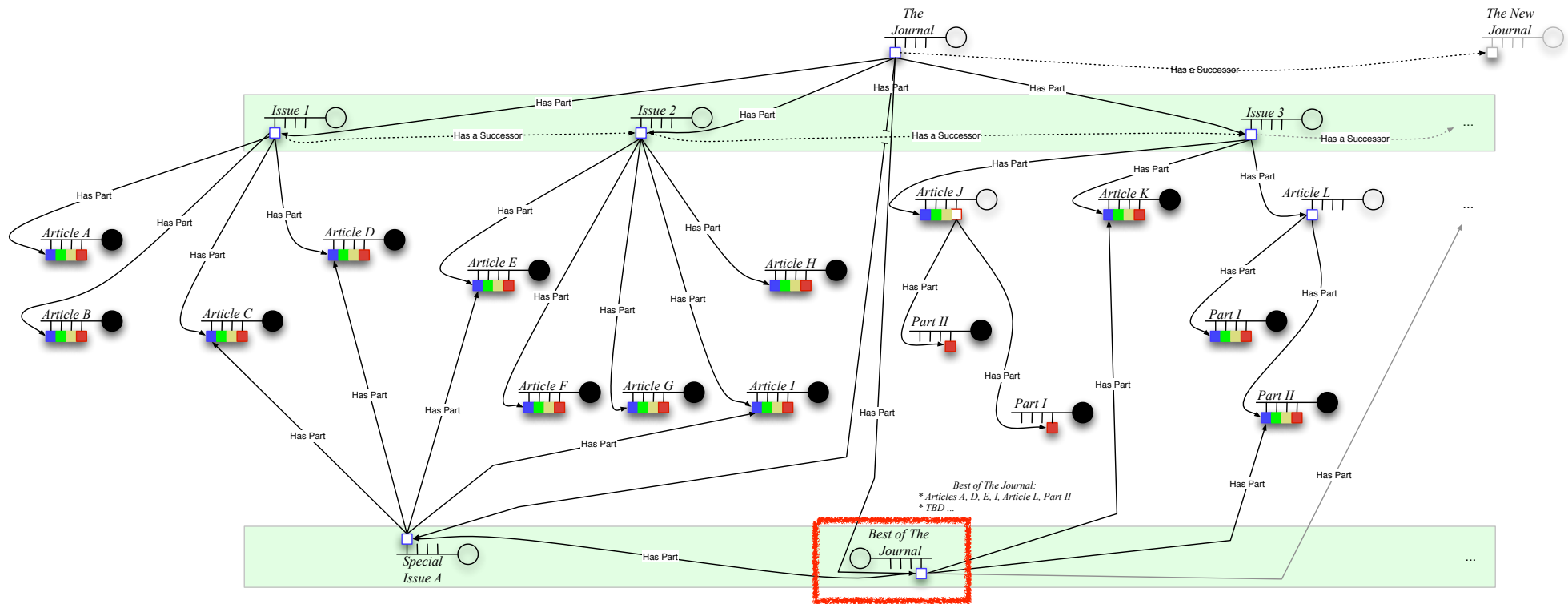
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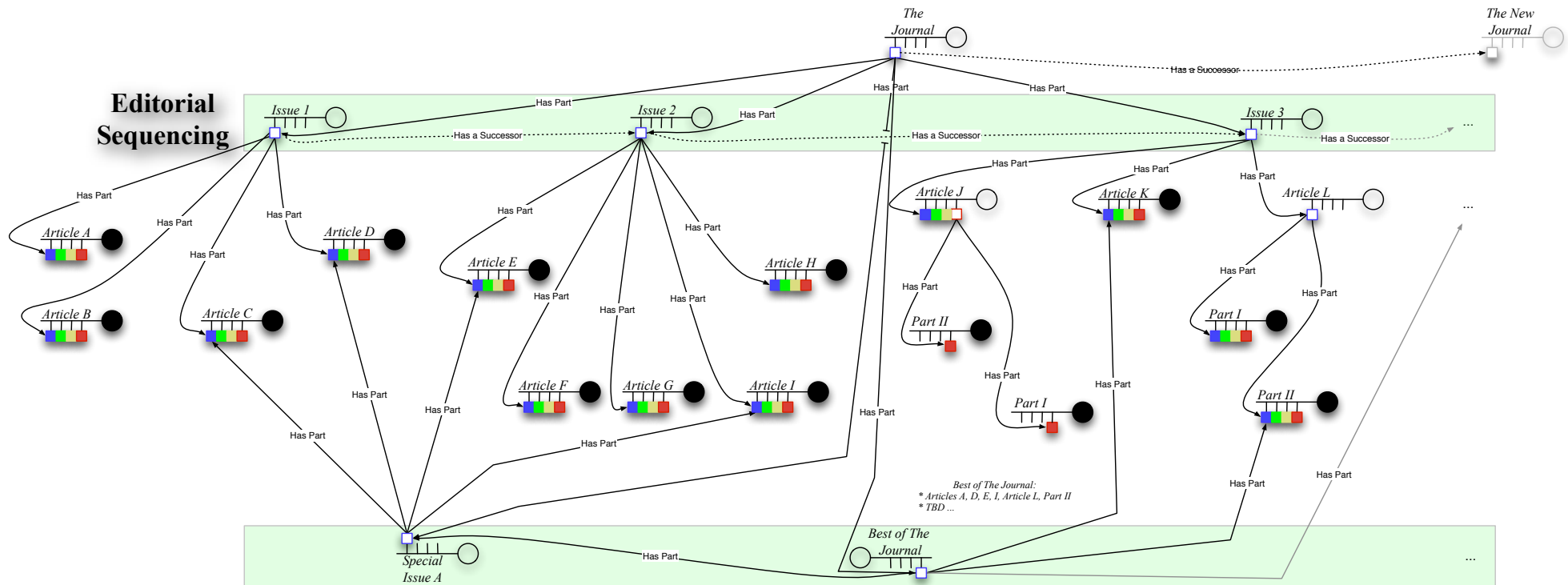
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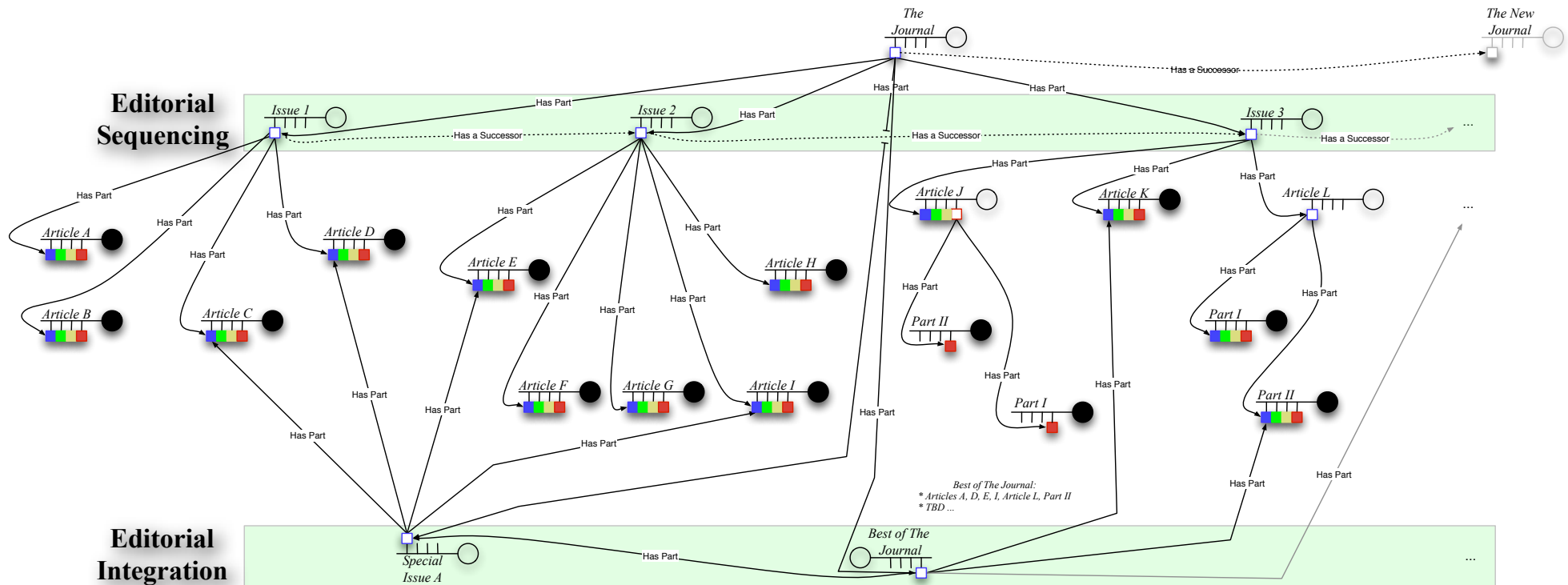
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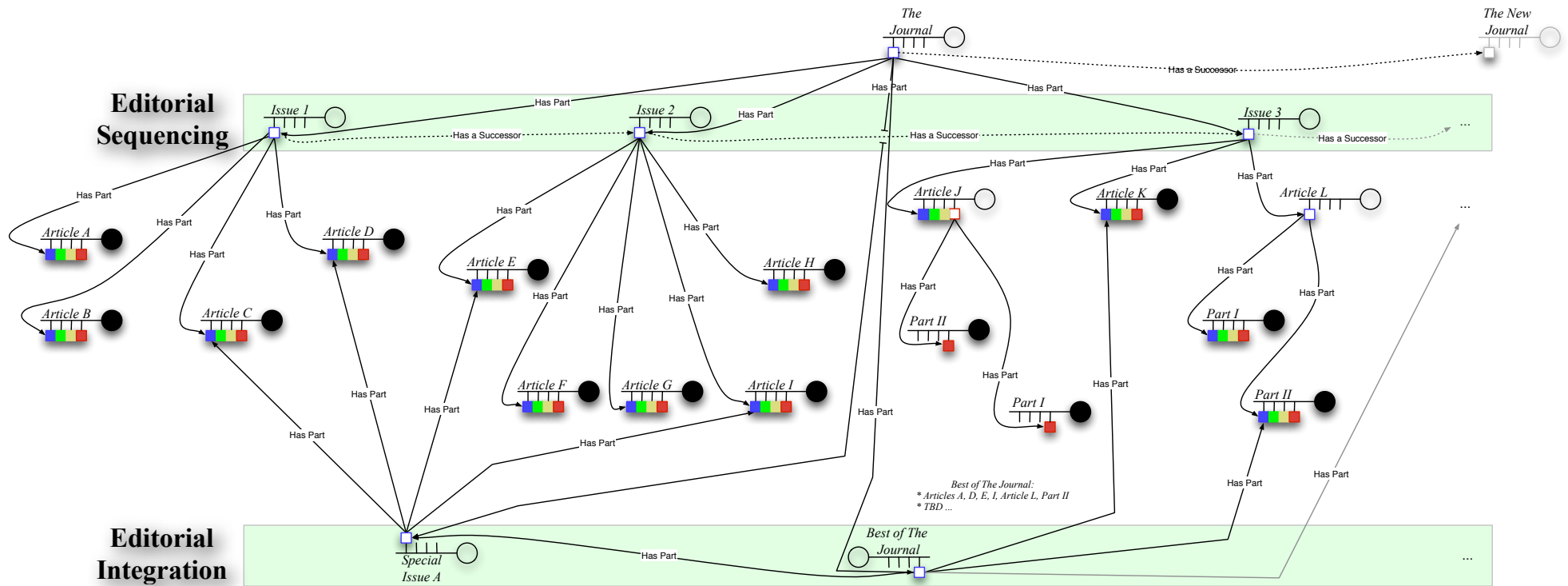
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Working With a FRBR Paper Tool: Exemplars



Depicting A Bibliographic Resource:

Pippi Longstocking

What comes to mind when you think about
Pippi Longstocking?

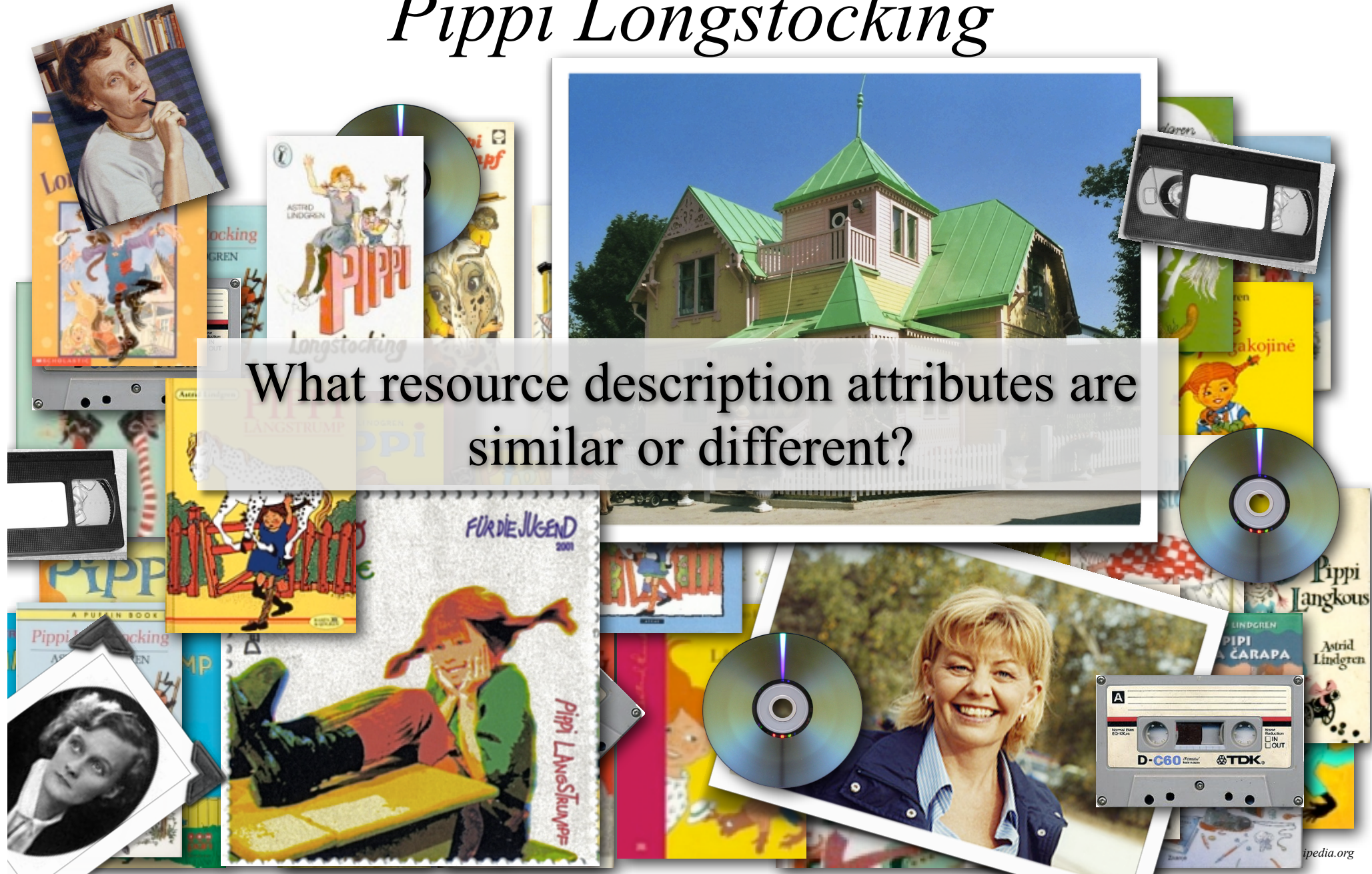
Depicting A Bibliographic Resource: *Pippi Longstocking*

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Depicting A Bibliographic Resource: *Pippi Longstocking*

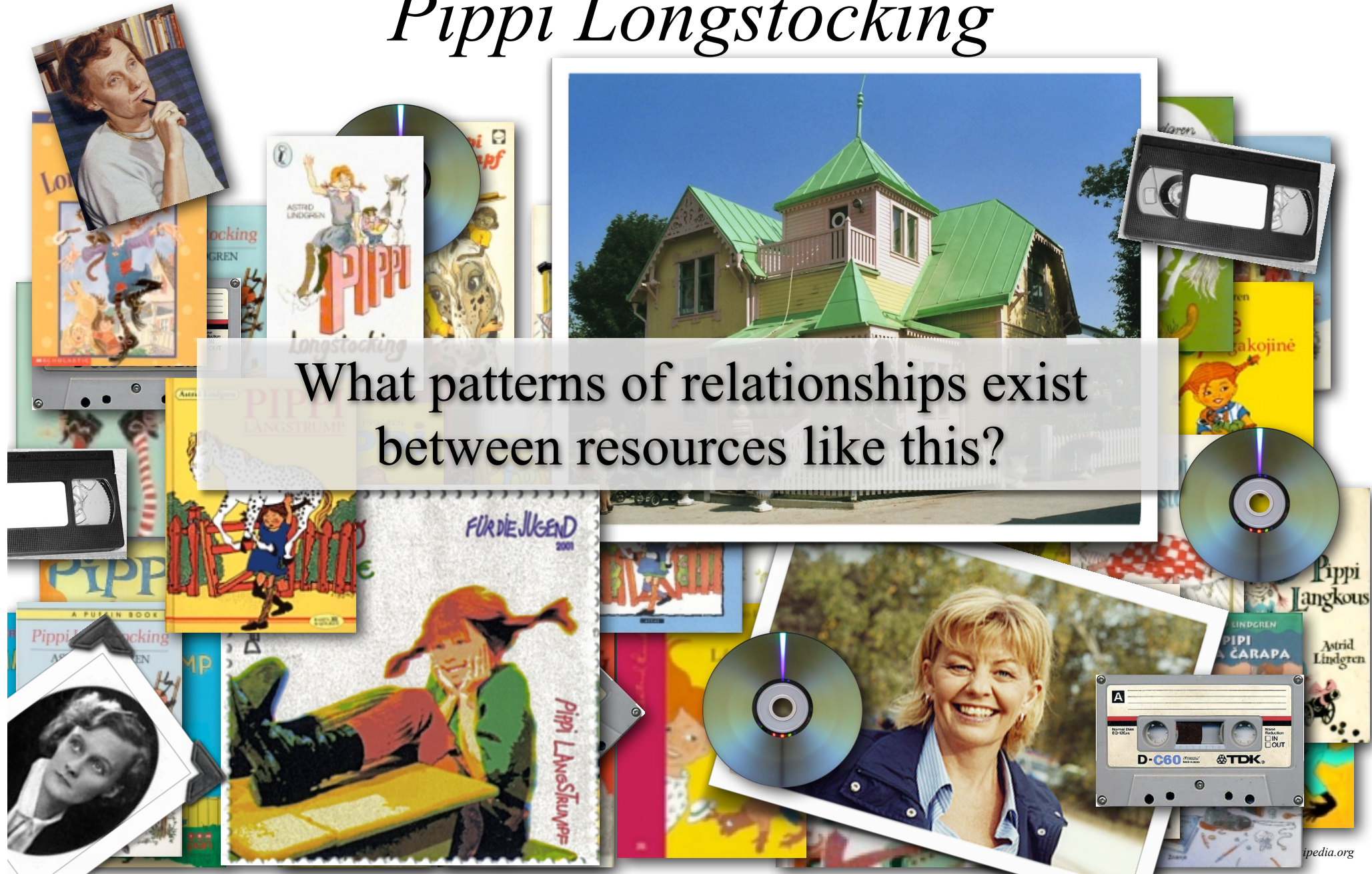
What resource description attributes are similar or different?



Depicting A Bibliographic Resource:

Pippi Longstocking

What patterns of relationships exist between resources like this?

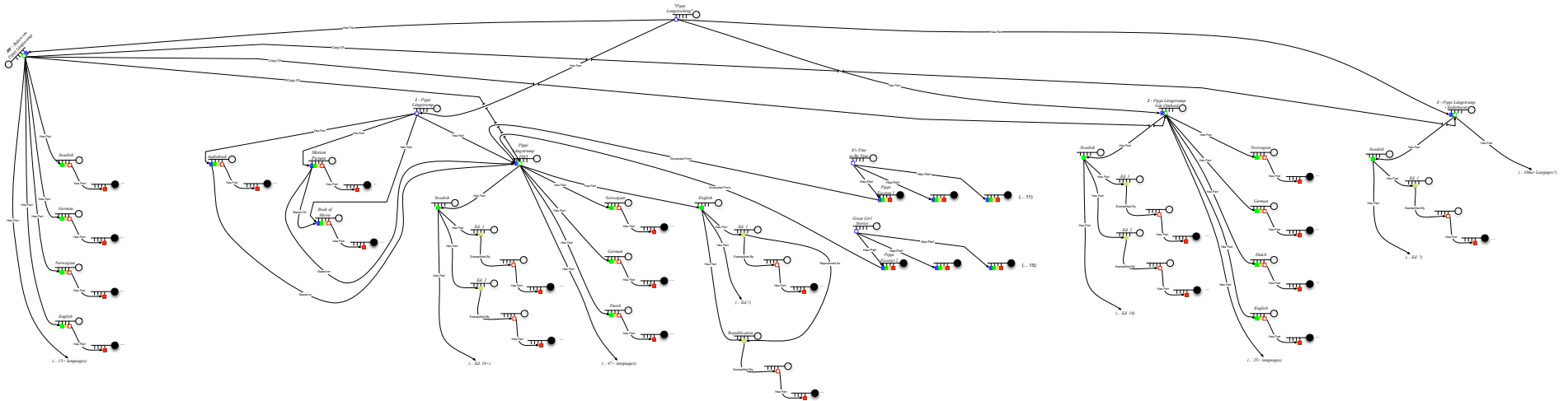


Depicting A Bibliographic Resource:

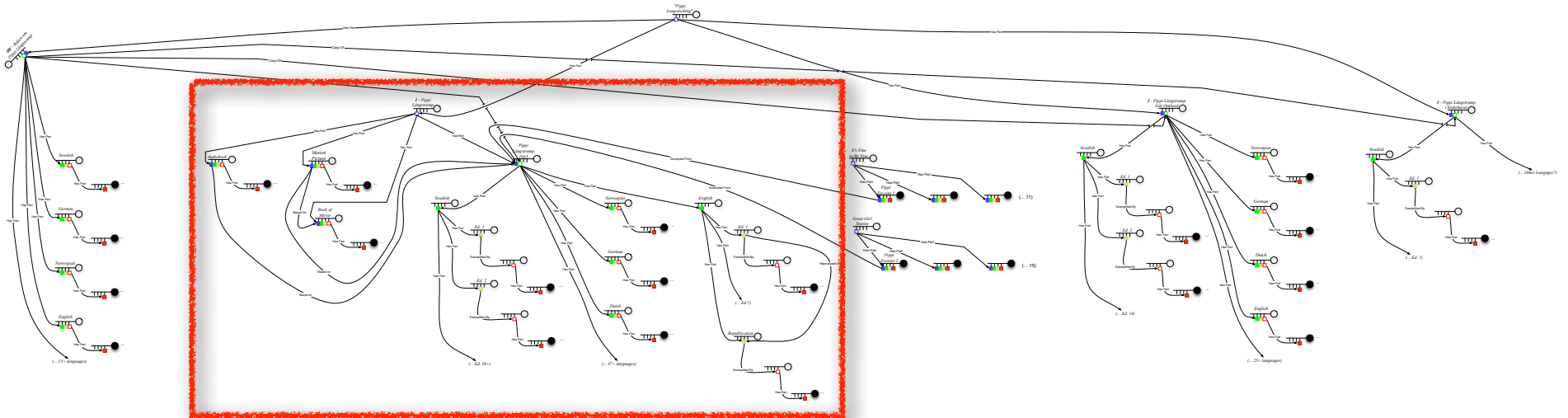
Pippi Longstocking

- Assemble a set of catalog records from national and international sources. Restructure and diagram the data
 - 27 Physical Resources (*Book, Motion Picture, Audiobook, DVD, Photograph, Postage Stamp, etc.*)
 - 99 FRBR Resource Descriptions
 - 13 Work and 4 Compound Work (*“Works of Works”*)
 - 26 Expression and 2 Compound Expression
 - 27 Manifestation
 - 27 Item and 21 Compound Item
 - 81 Relationships
 - Abbreviations for other Resource Descriptions

Pippi Longstocking



Pippi Longstocking



The diagram illustrates a complex semantic network for the entity **Pippi Långstrump** (1945). The central node is **Pippi Långstrump** (1945), which is connected to various other nodes representing different media and languages.

Media and Language Nodes:

- Audiobook** (blue square)
- Motion Picture** (blue square)
- Book of Movie** (blue square)
- Swedish** (green square)
- Norwegian** (green square)
- German** (green square)
- Dutch** (green square)
- English** (green square)

Edition and Exemplification Nodes:

- Ed. 1** (yellow square)
- Ed. 2** (yellow square)
- (... Ed. 16+)** (yellow square)
- (... 47+ languages)** (yellow square)
- (... Ed.?)** (yellow square)
- Republication** (yellow square)

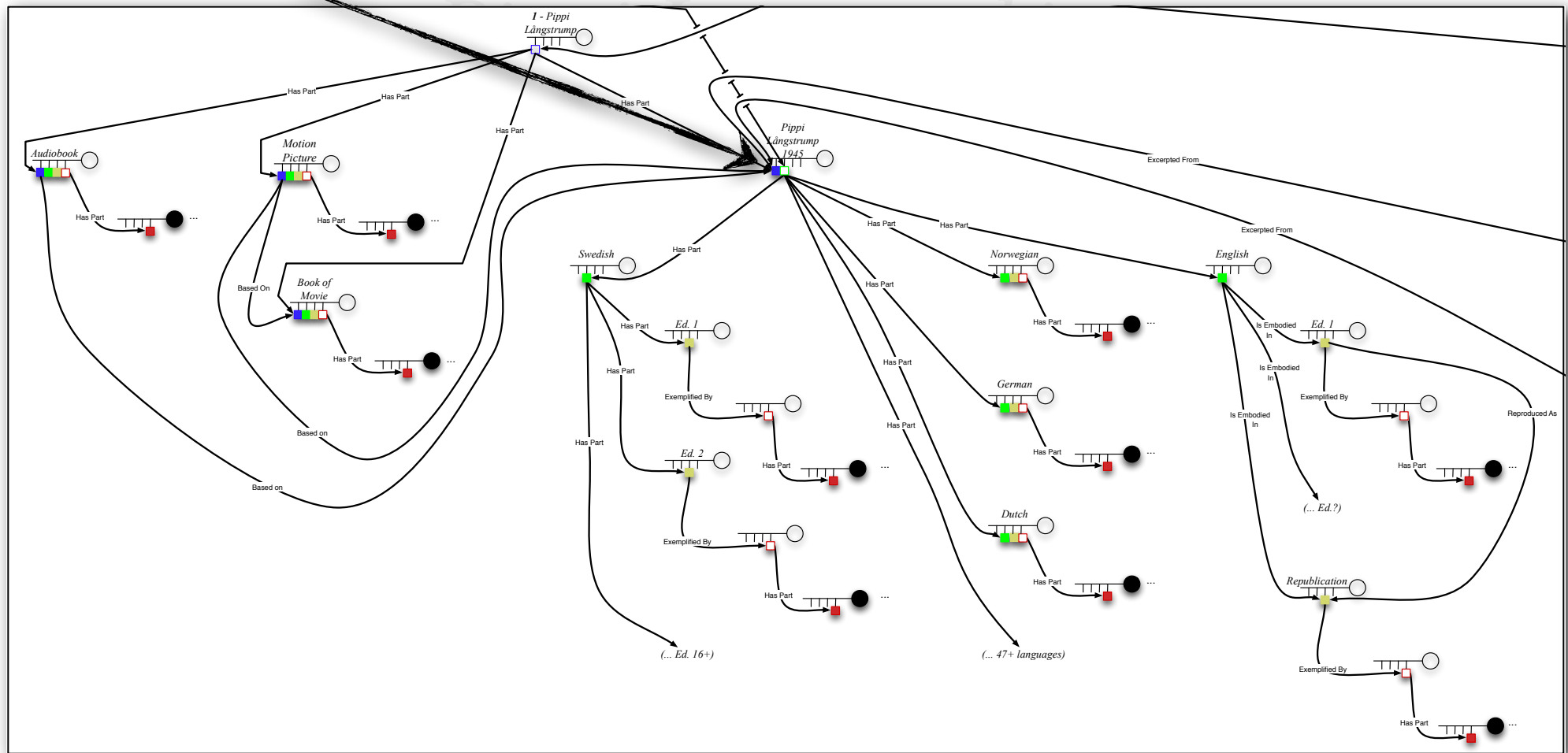
Relationships:

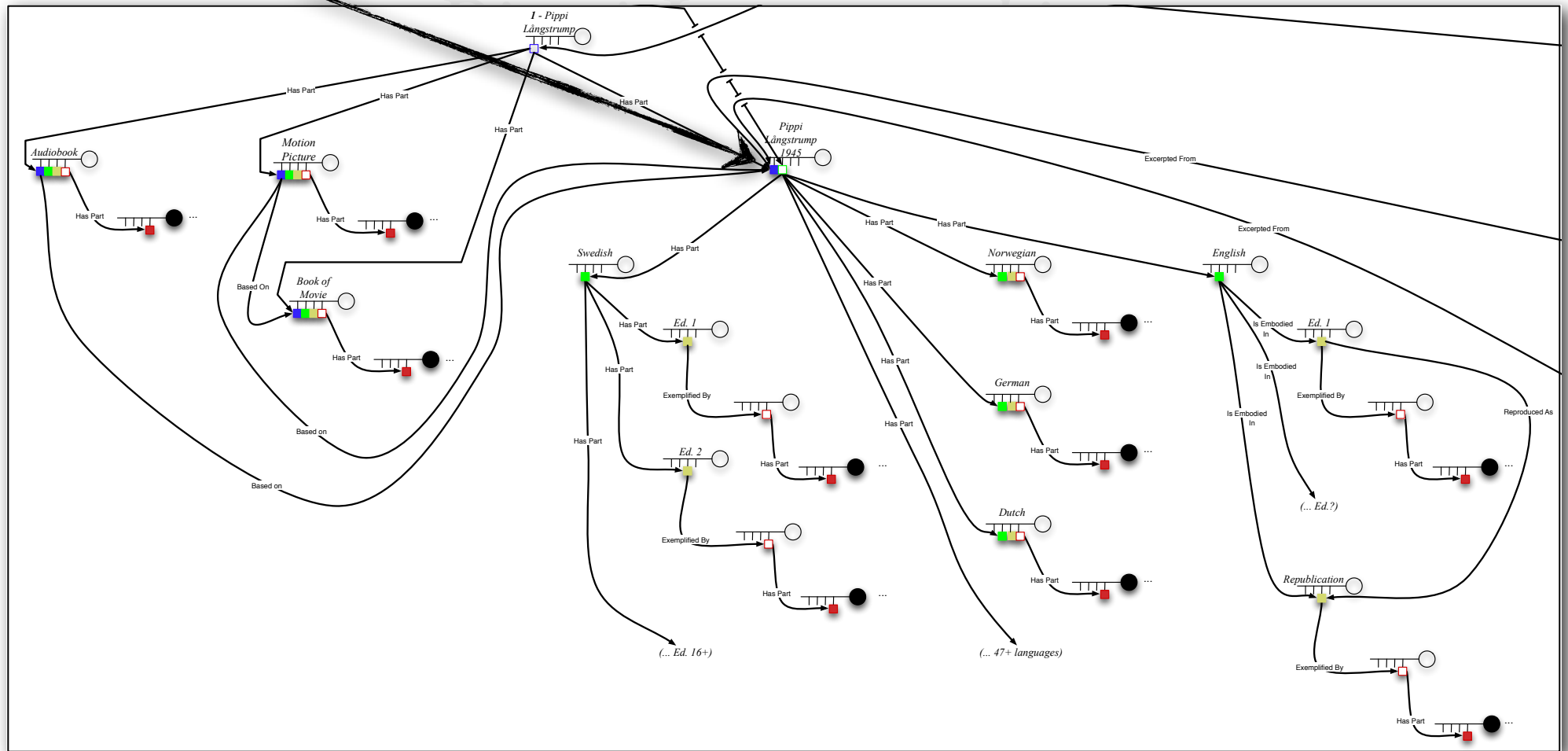
- Has Part:** Connects the main entity to the Audiobook, Motion Picture, Book of Movie, Swedish, Norwegian, German, Dutch, English, and the first edition of each language.
- Based on:** Connects the Audiobook, Motion Picture, and Book of Movie to the first edition of each language.
- Excerpted From:** Connects the main entity to the first edition of each language.
- Is Embodied in:** Connects the first edition of each language to the first edition of each language.
- Exemplified By:** Connects the first edition of each language to the first edition of each language.
- Reproduced As:** Connects the first edition of each language to the first edition of each language.

The diagram shows a hierarchical structure where the main entity is linked to languages, which are then linked to editions, and finally to specific parts or exemplifications. The diagram also shows relationships between different media types and the main entity.

A Work-Level Resource Description

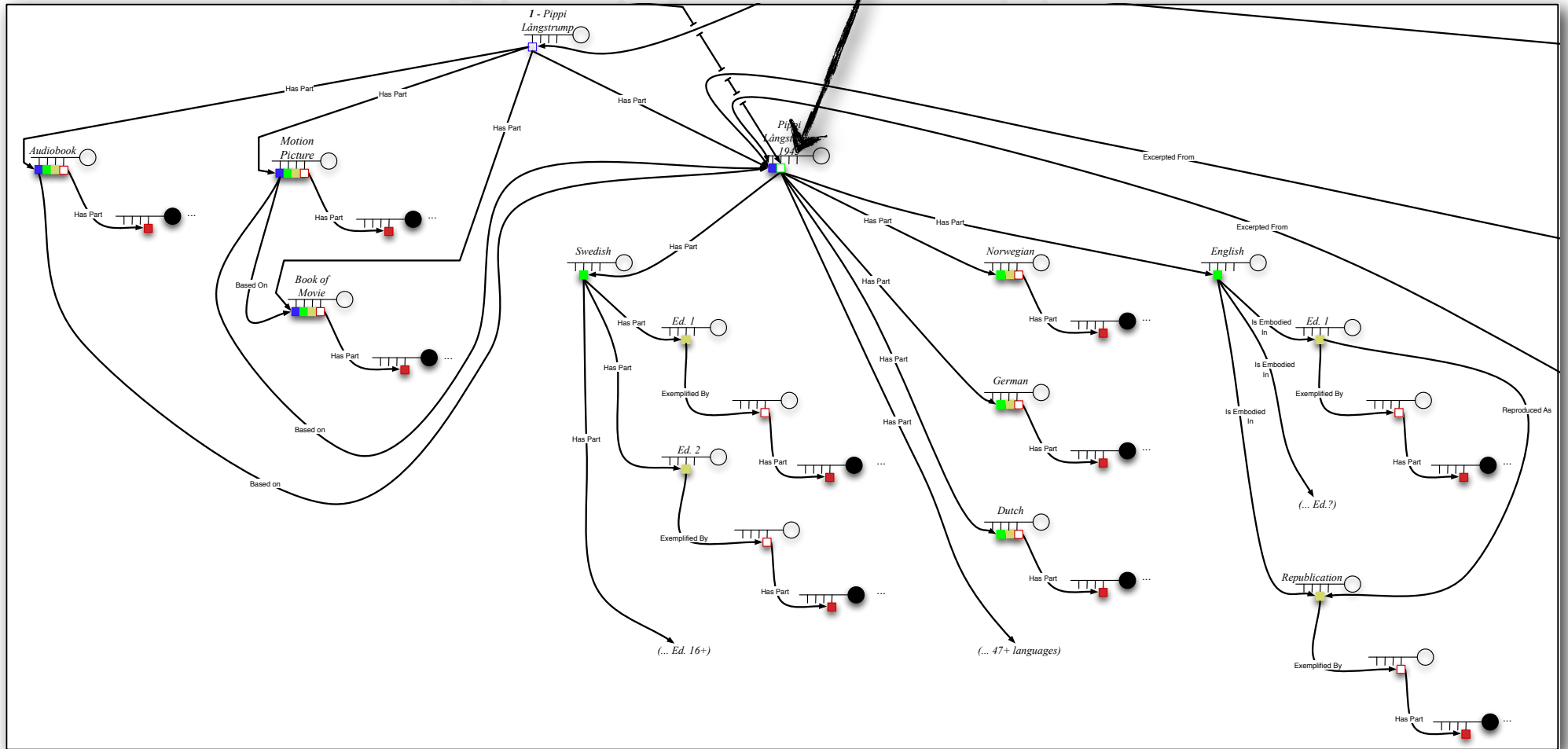
With a FRBR Paper Tool:





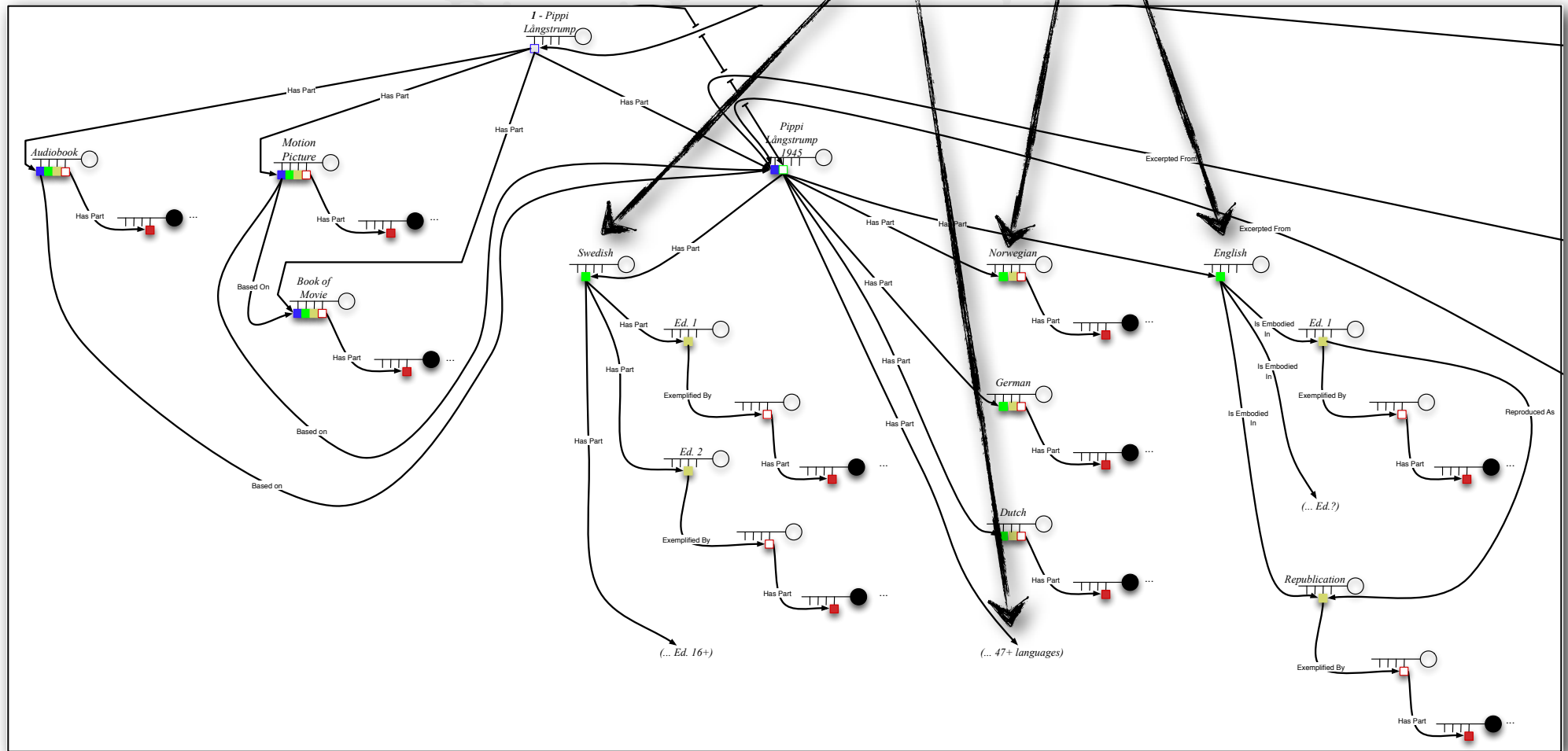
Working With a Flat File Format:

***A Container Expression-Level
Description Holds Links “Only”***

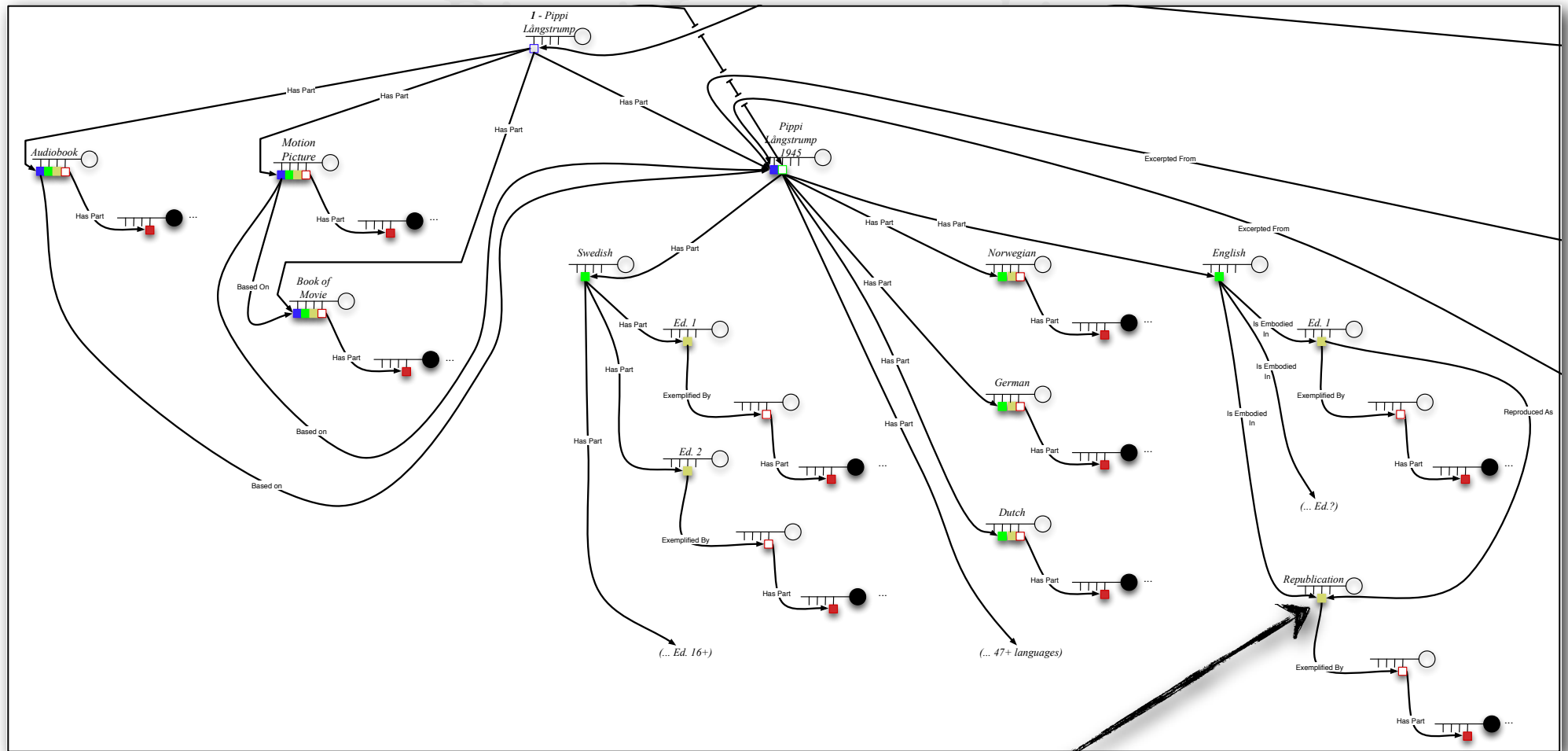


Working With a FL

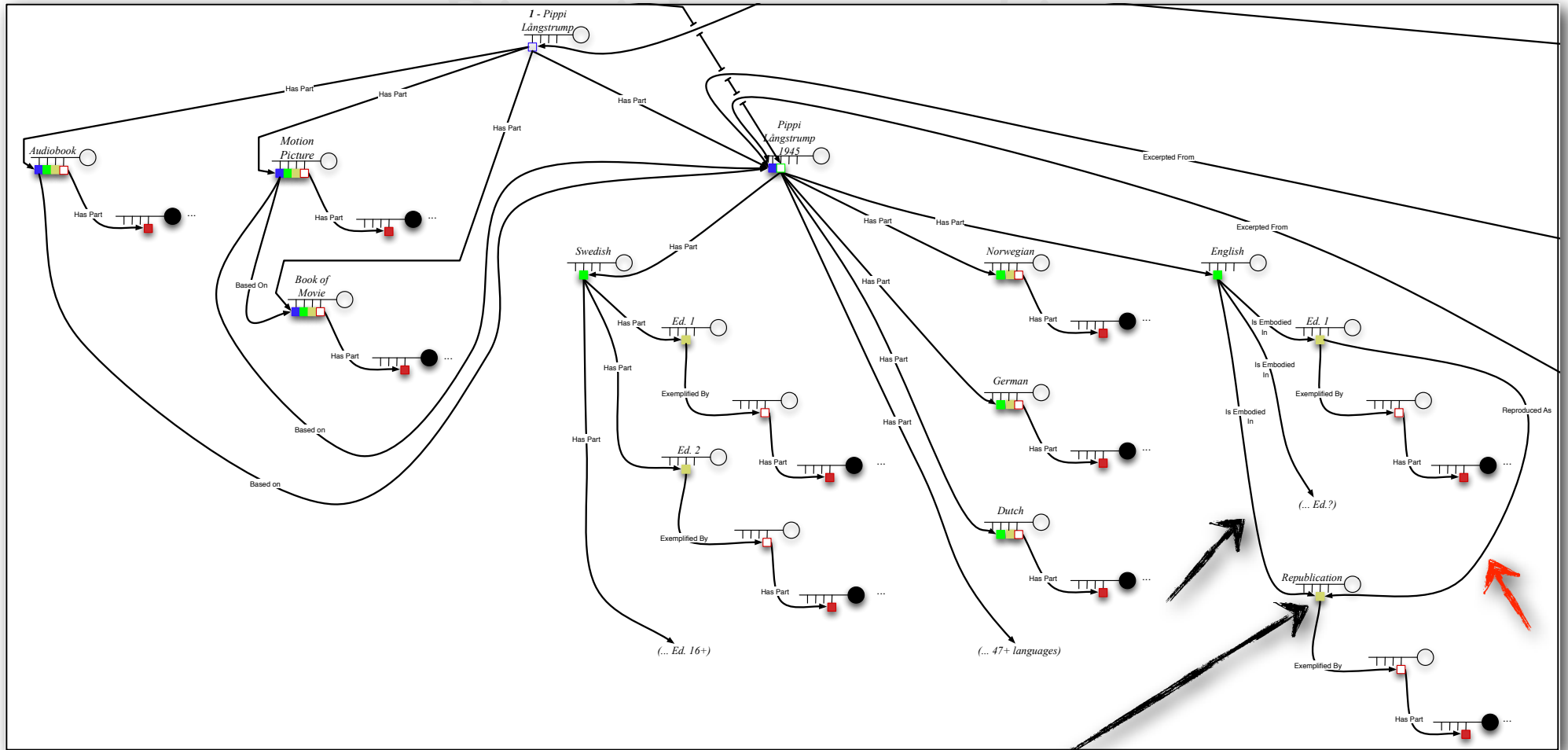
It Collocates **Expression-Level**
Descriptions (Language, etc.) of
the Same Intellectual or
Artistic Creation



Working With a FRBR Paper Tool:

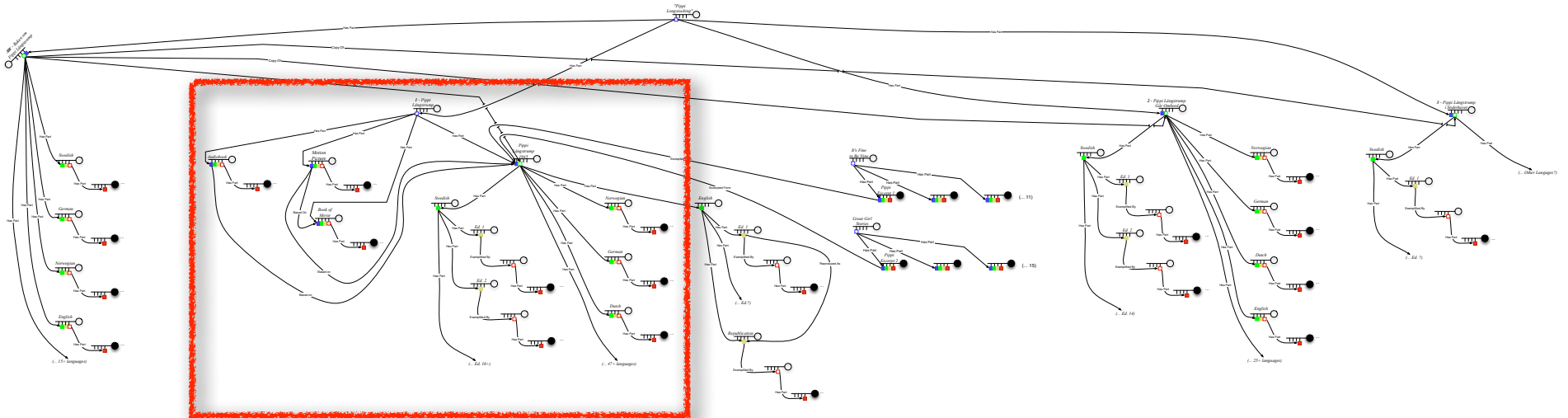


*A **Manifestation-Level** Resource Description and Two Relationships Document the Republication of the First Edition*

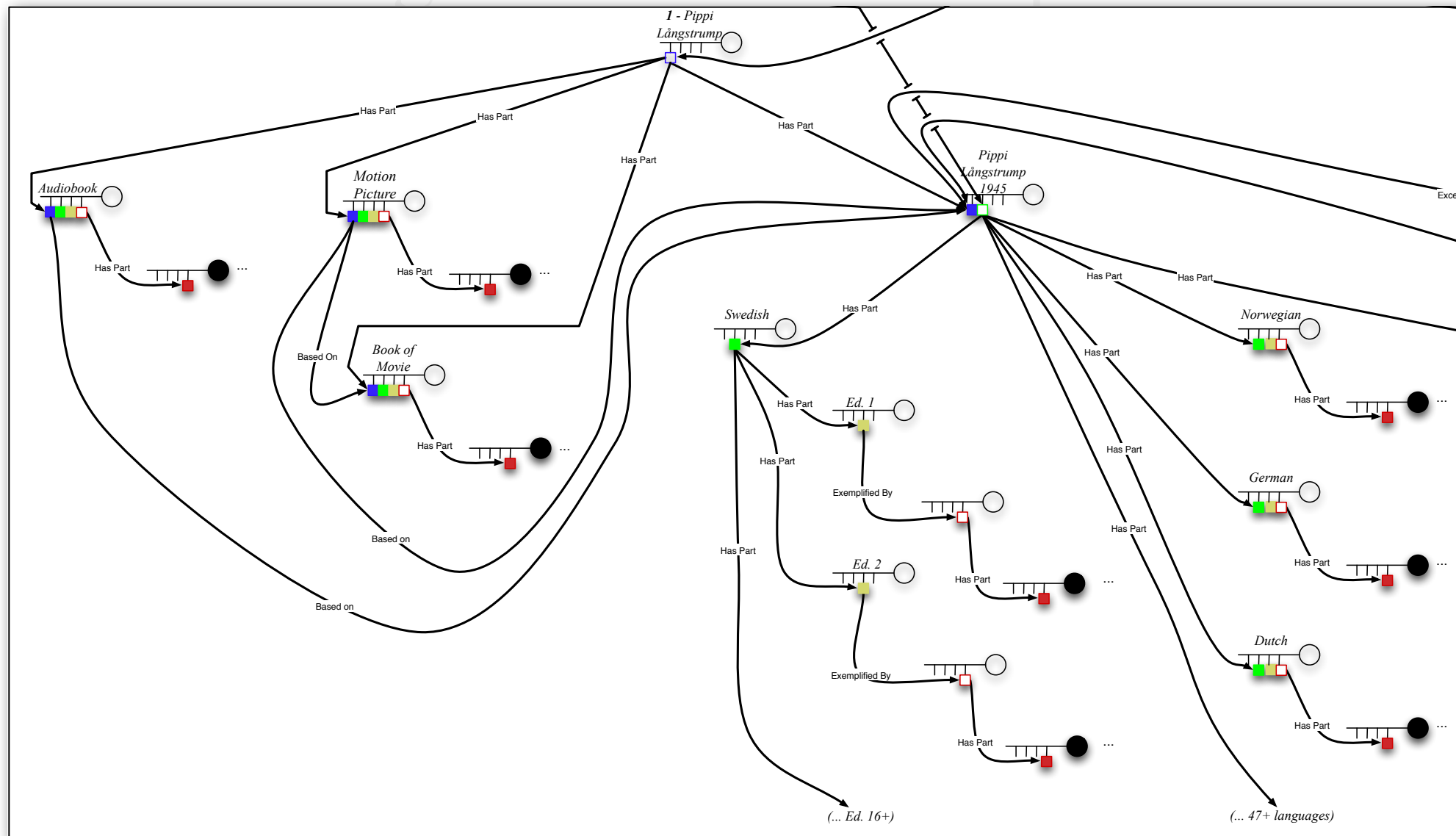


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Description and Two Relationships
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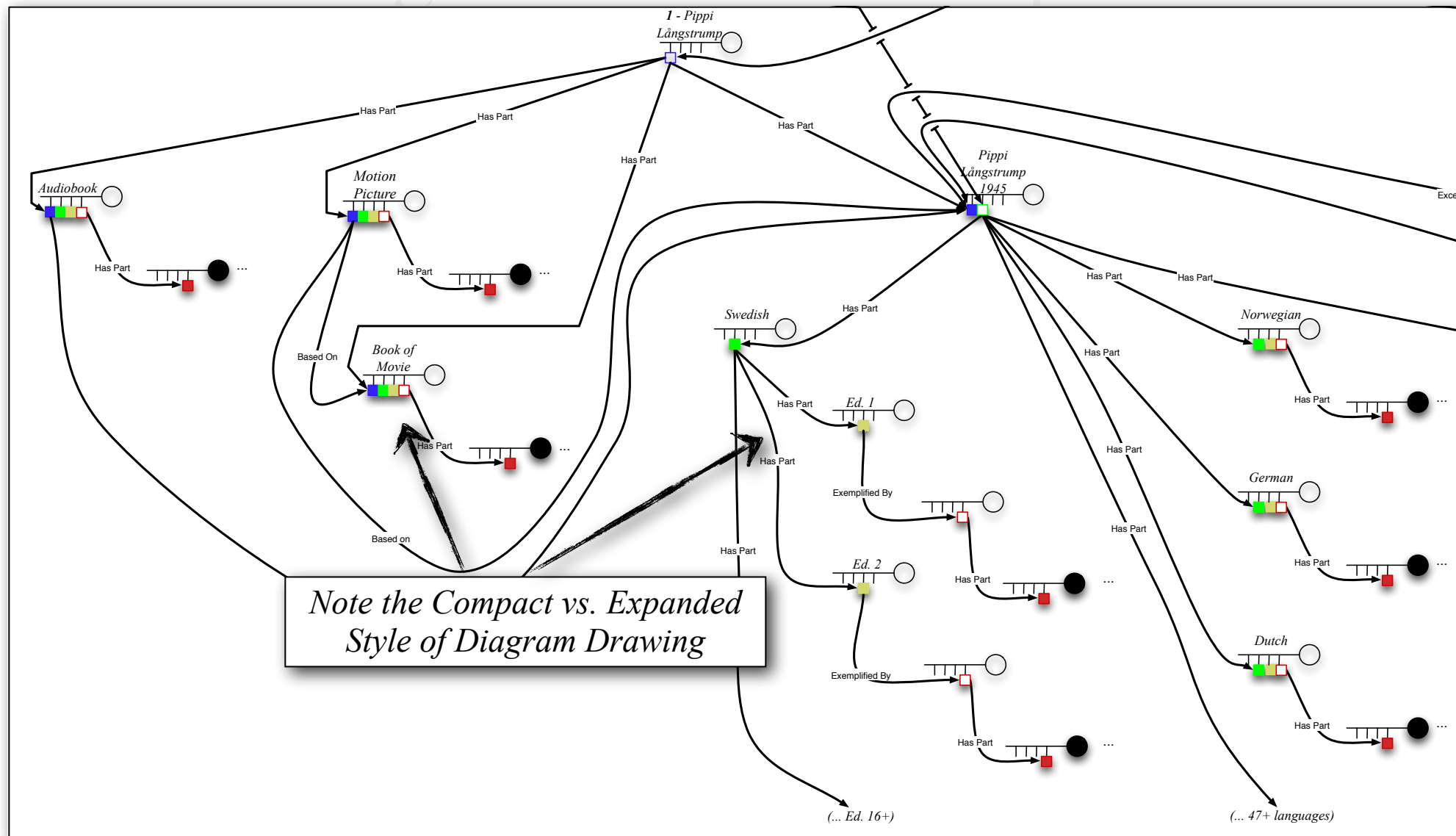
Pippi Longstocking



Working With a FRBR Paper Tool:

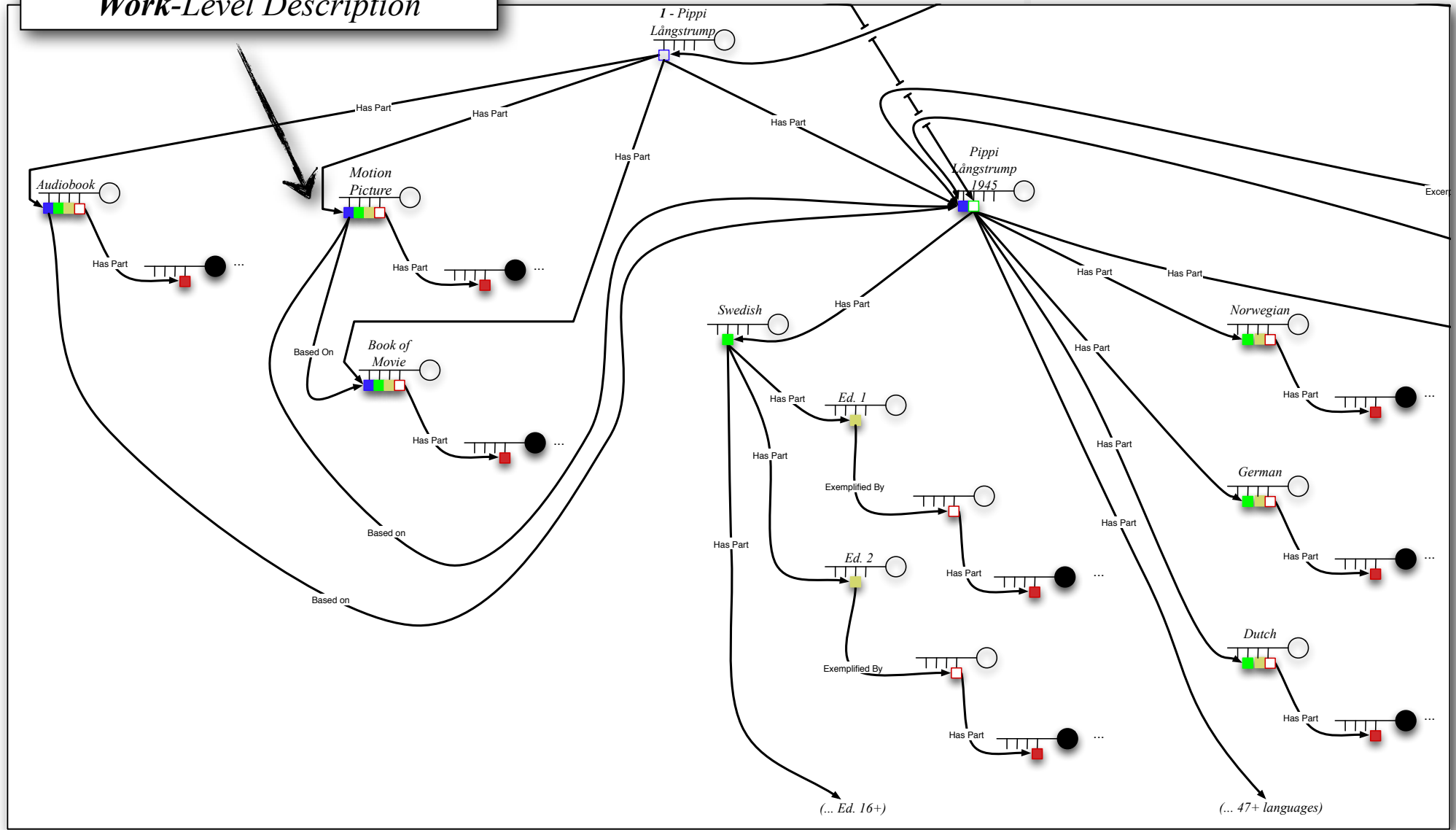


Working With a FRBR Paper Tool:



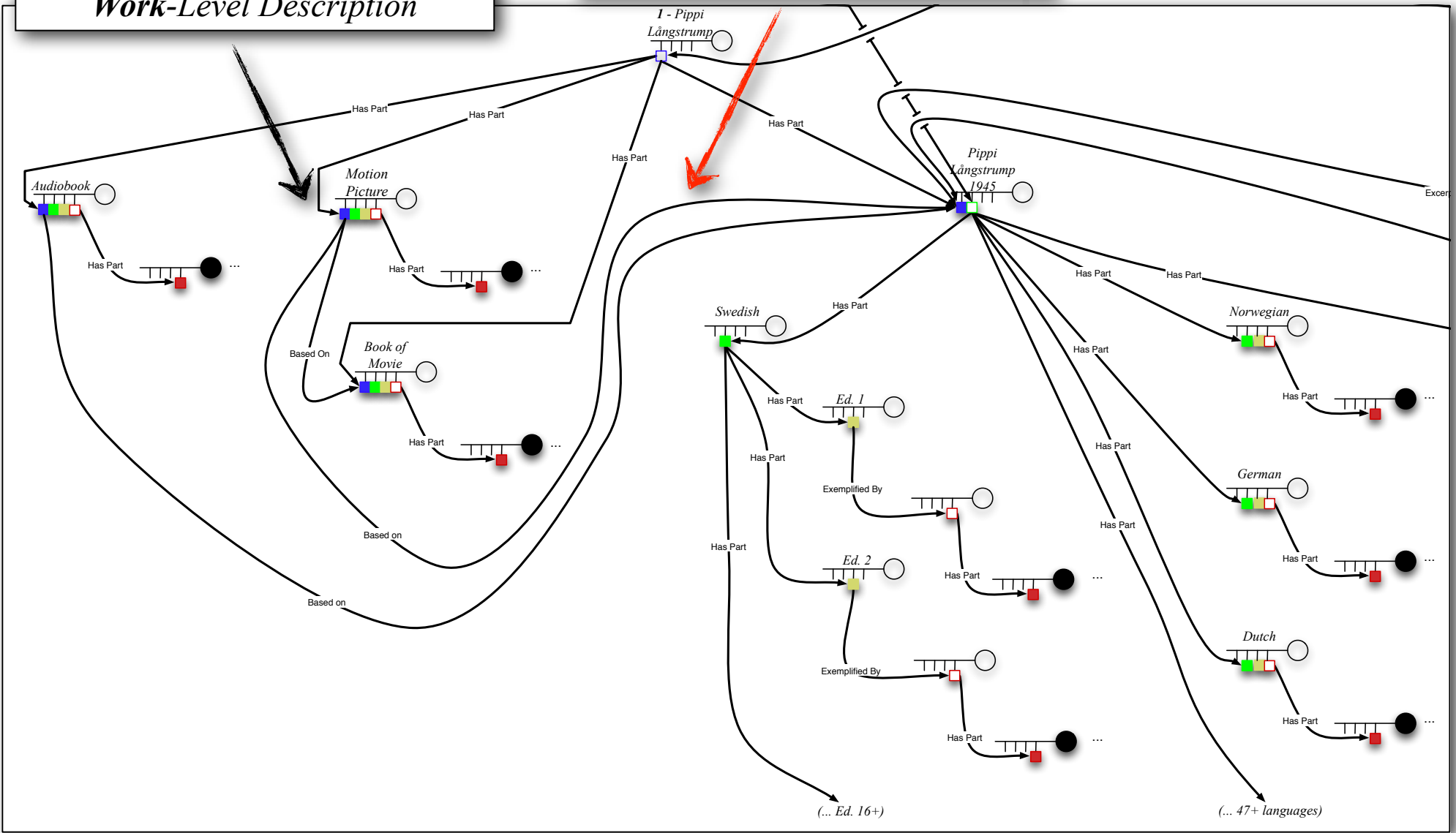
*The Motion Picture Is
Designated as a Distinct
Creation and Receives its Own
Work-Level Description*

With a FRBR Paper Tool:



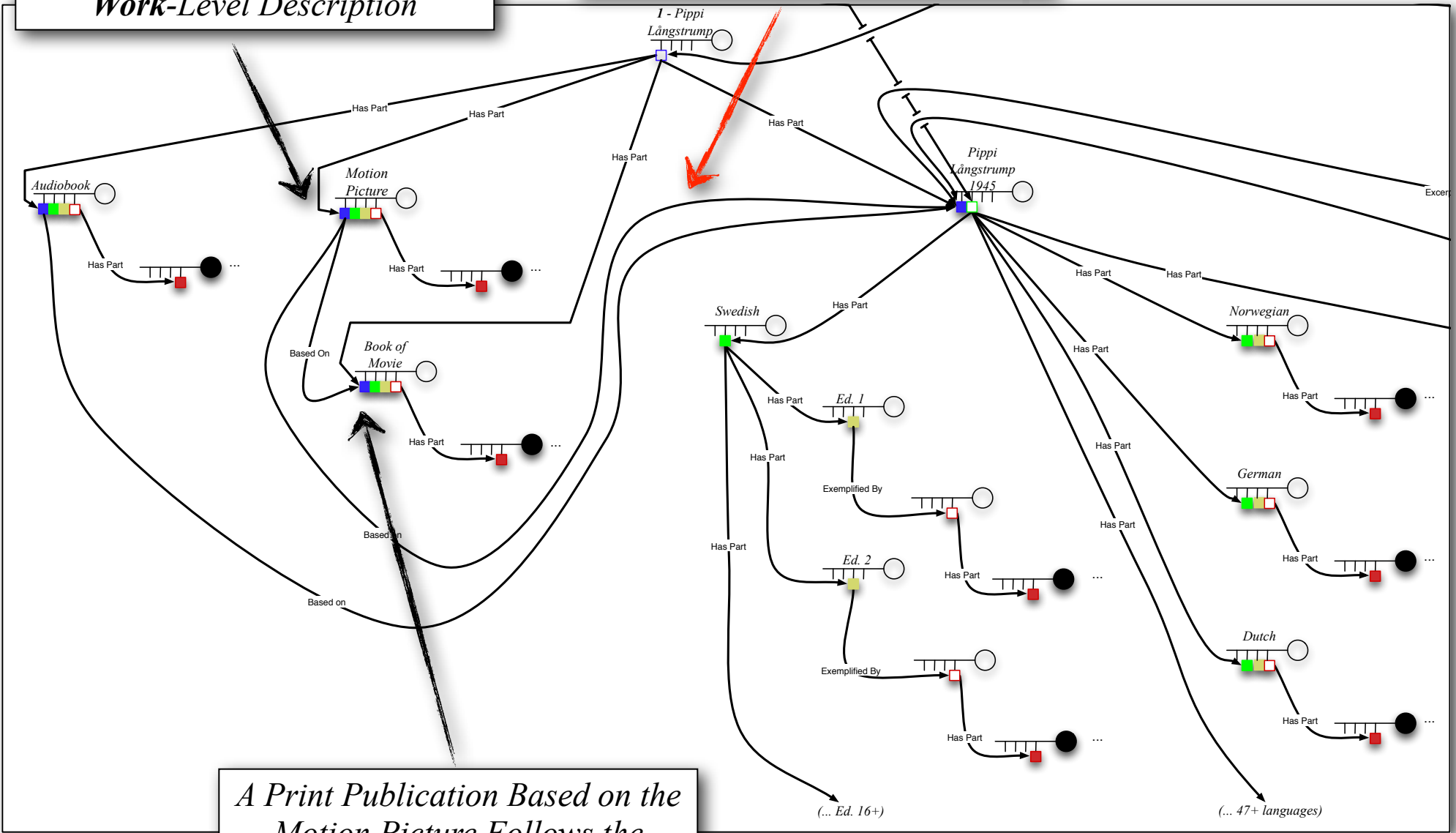
*The Motion Picture Is
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Work-Level Description*

*The Motion Picture Has a Very
Strong (**Based On**) Relationship
to the Print Publication*



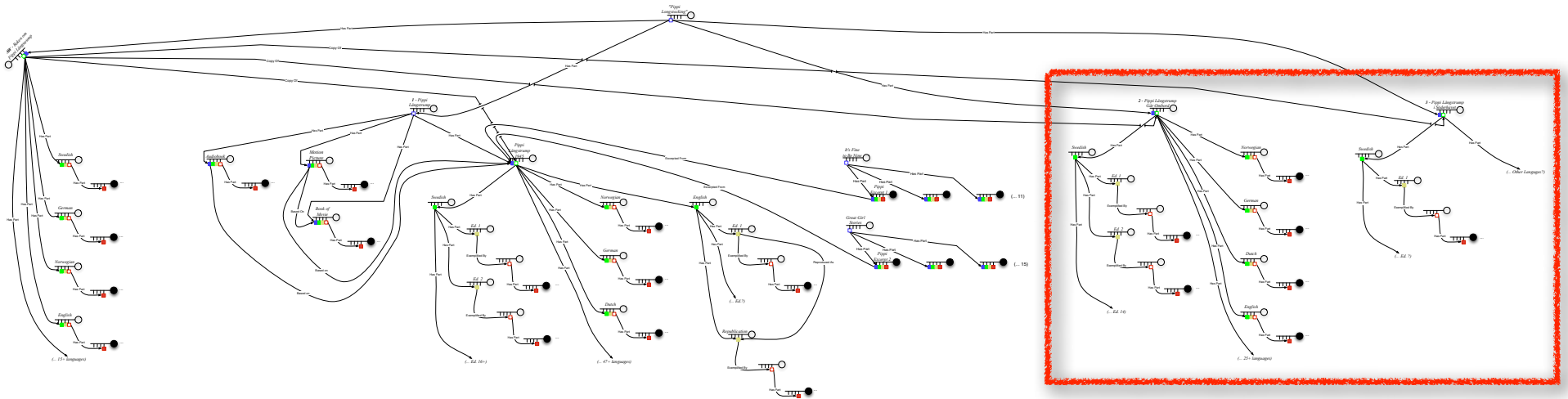
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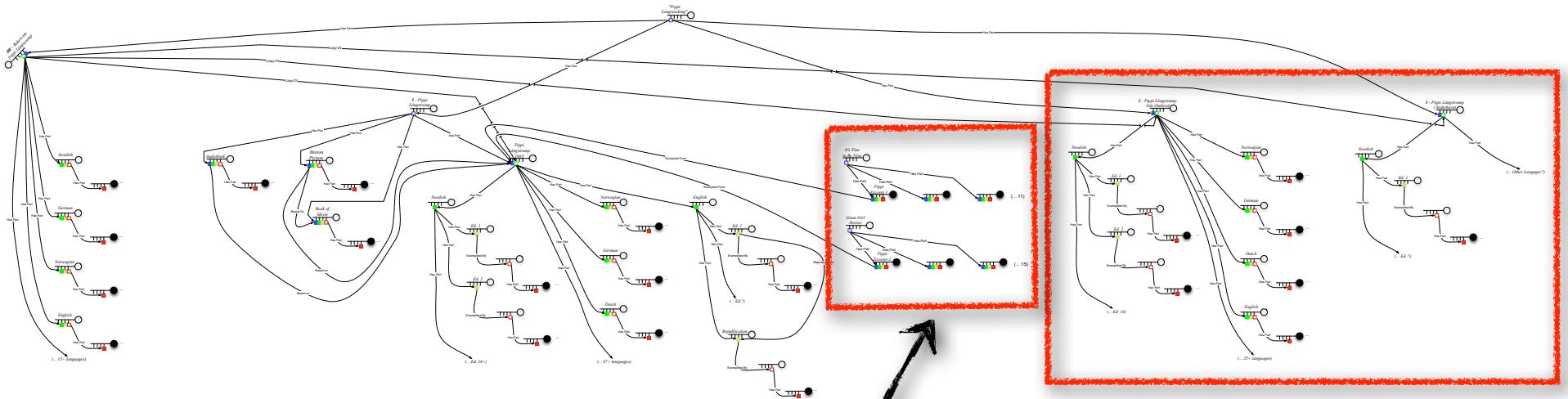
*A Print Publication Based on the
Motion Picture Follows the
Same Pattern*

Working With a FRBR Paper Tool: *Pippi Longstocking*



*Two Subsequent Pippi Publications
Produced in Multiple Languages and
in Multiple Editions*

Working With a FRBR Paper Tool: *Pippi Longstocking*

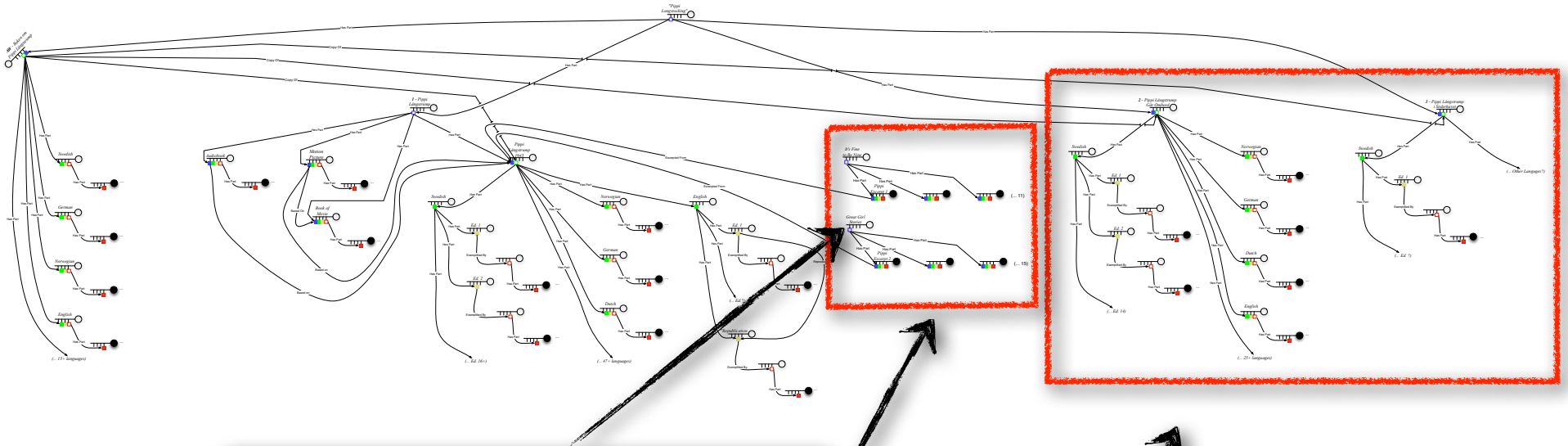


*Excerpts From the First Pippi
Publication Appear With Selections
From Other Authors*

*Two Subsequent Pippi Publications
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Working With a FRBR Paper Tool:

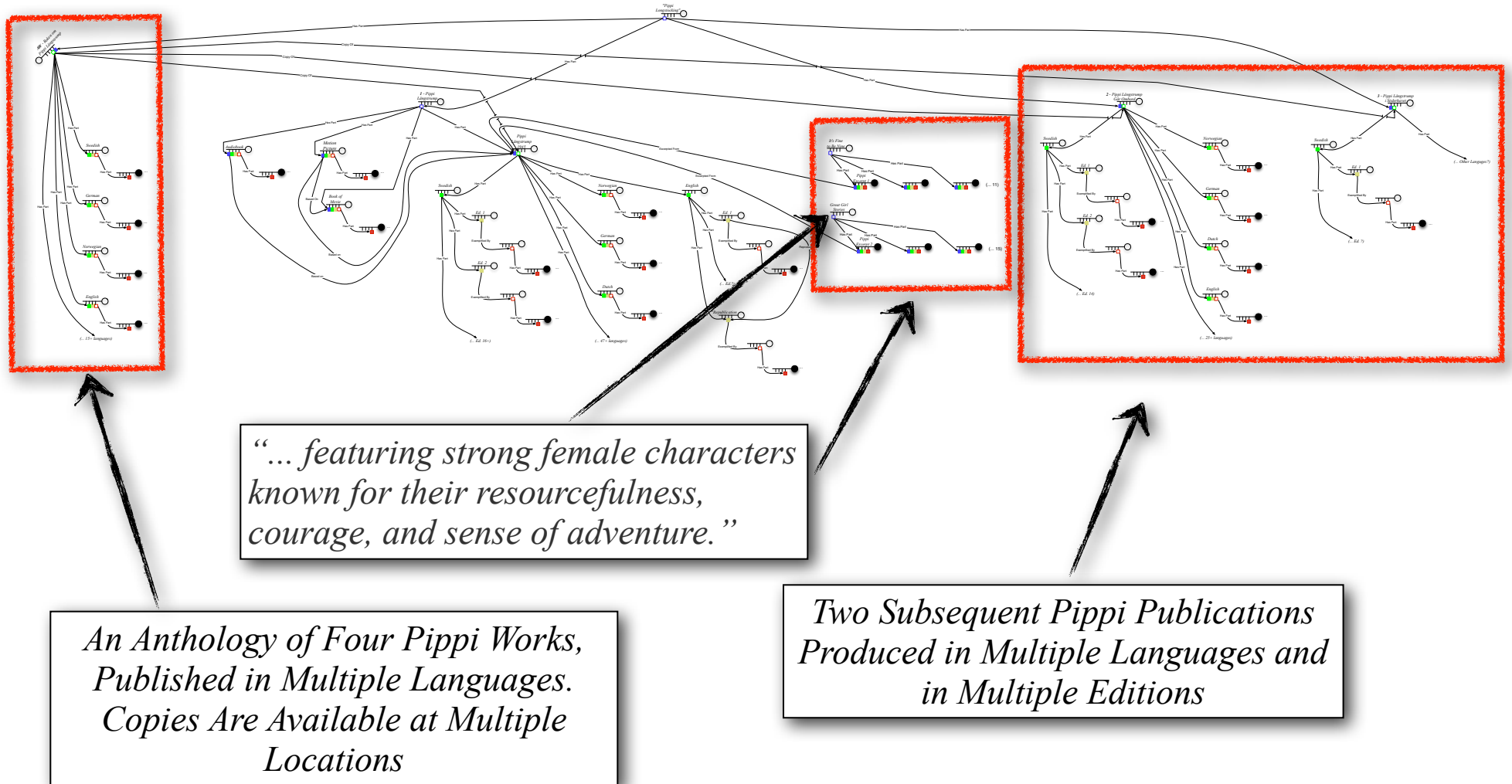
Pippi Longstocking



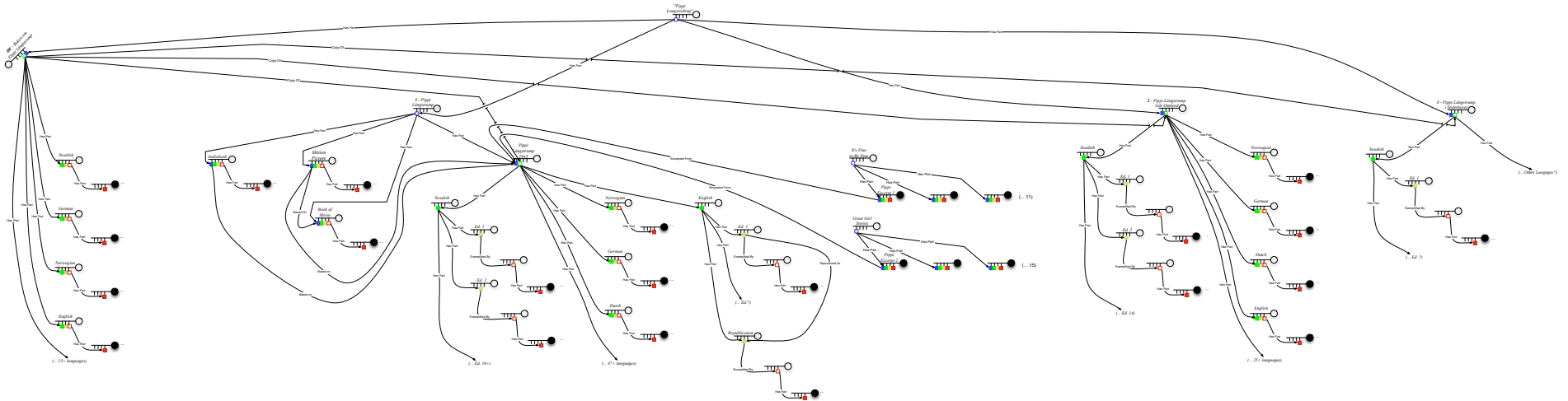
“... featuring strong female characters known for their resourcefulness, courage, and sense of adventure.”

Two Subsequent Pippi Publications Produced in Multiple Languages and in Multiple Editions

Working With a FRBR Paper Tool: *Pippi Longstocking*

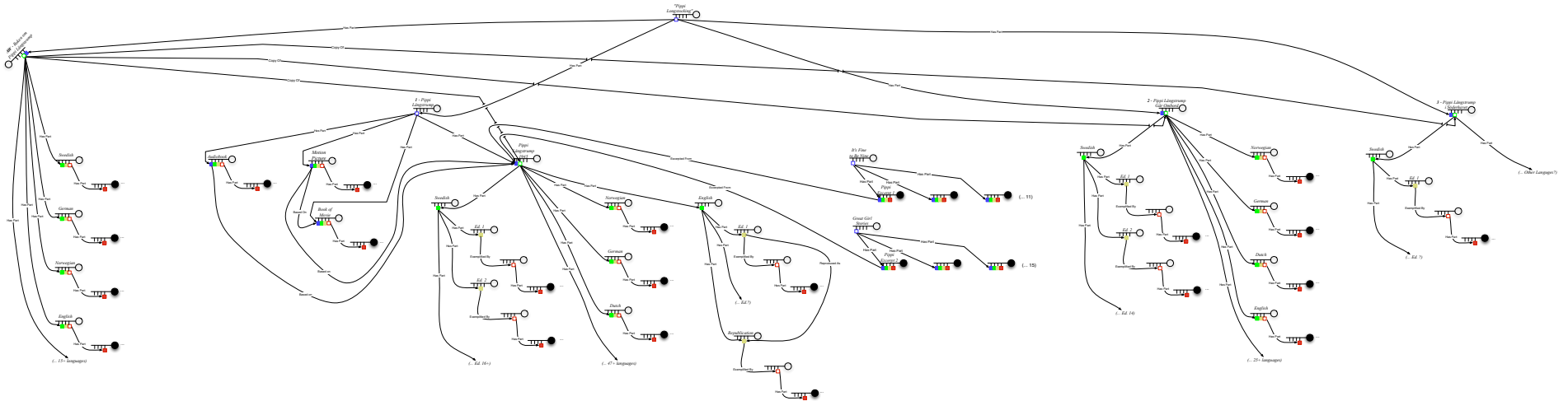


Working With a FRBR Paper Tool: *Pippi Longstocking*



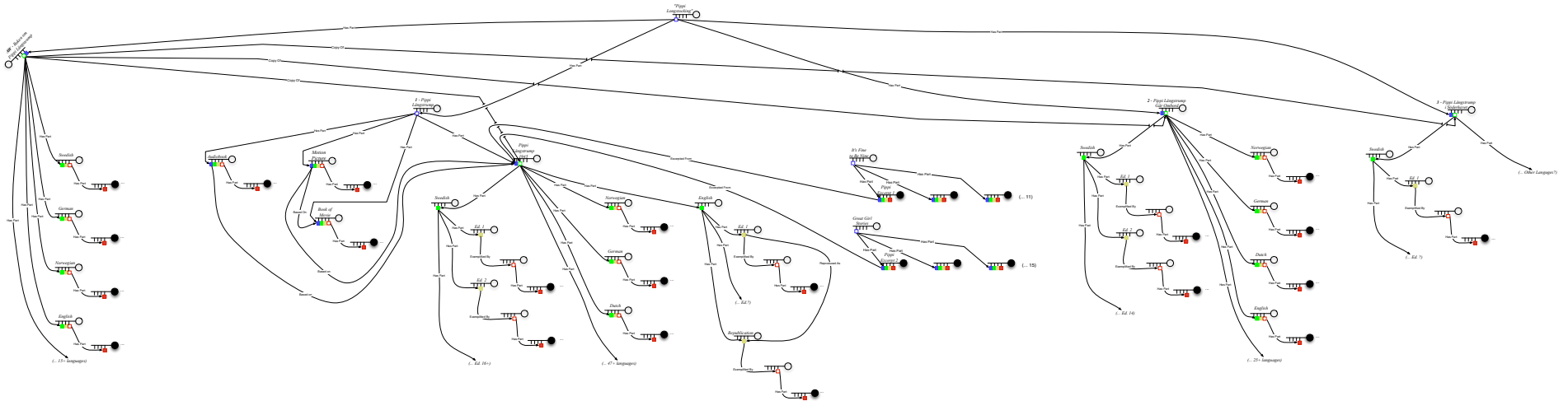
- ***General and Specific*** - The diagrammatic representation helps to clarify FRBR-specific and general resource description issues

Pippi Longstocking



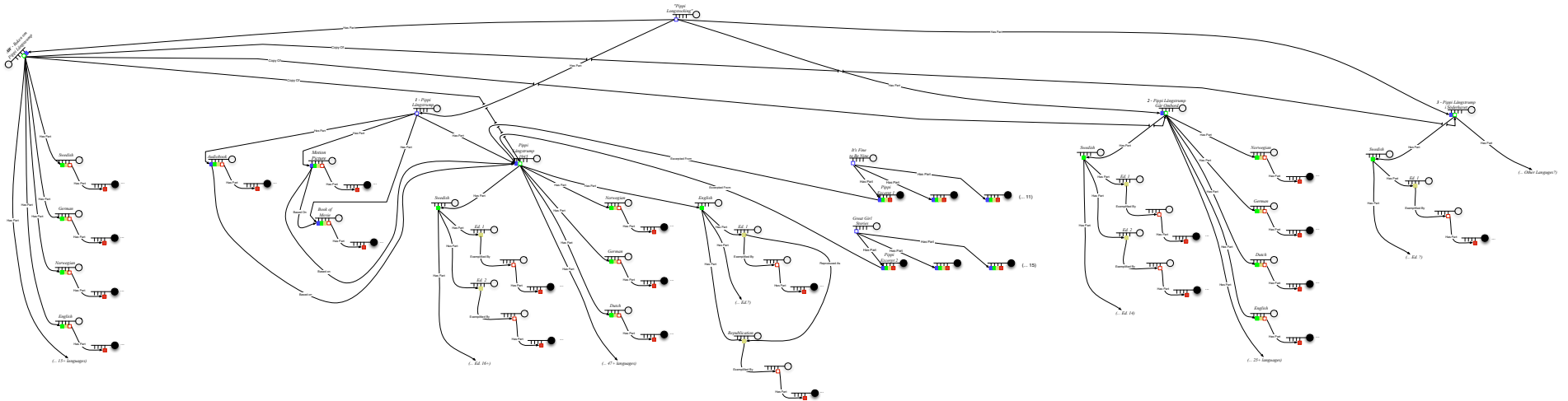
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Pippi Longstocking



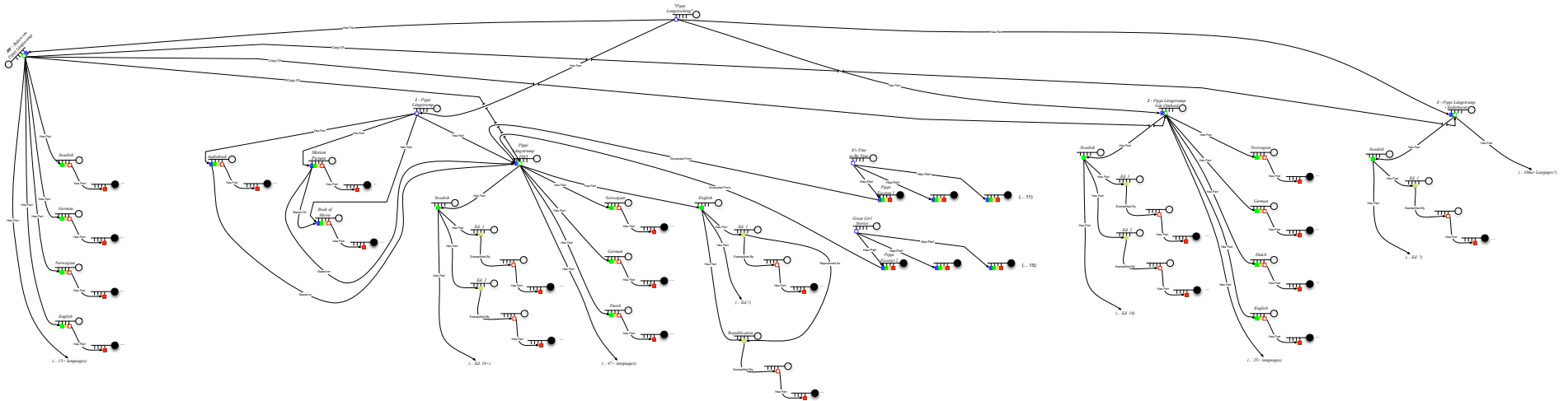
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Working With a FRBR Paper Tool: *Pippi Longstocking*



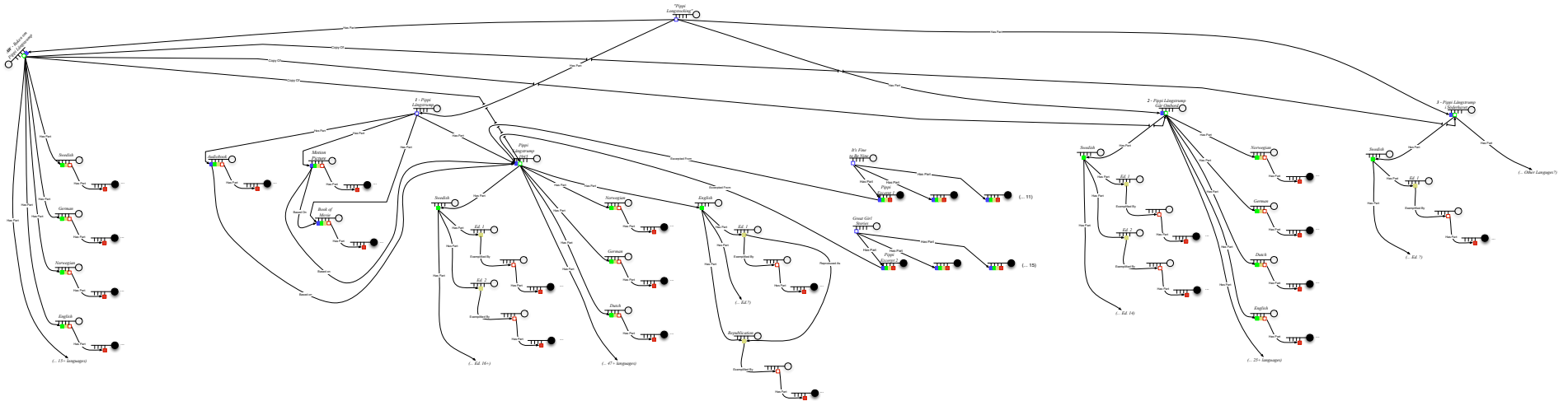
- ***General and Specific*** - The diagrammatic representation helps to clarify FRBR-specific and general resource description issues
 - Resource discovery as *find, identify, navigate, and select* user tasks
 - Collocation as the positioning of resources using their descriptions
 - Resource description structures can in part be represented mathematically

Working With a FRBR Paper Tool: *Pippi Longstocking*



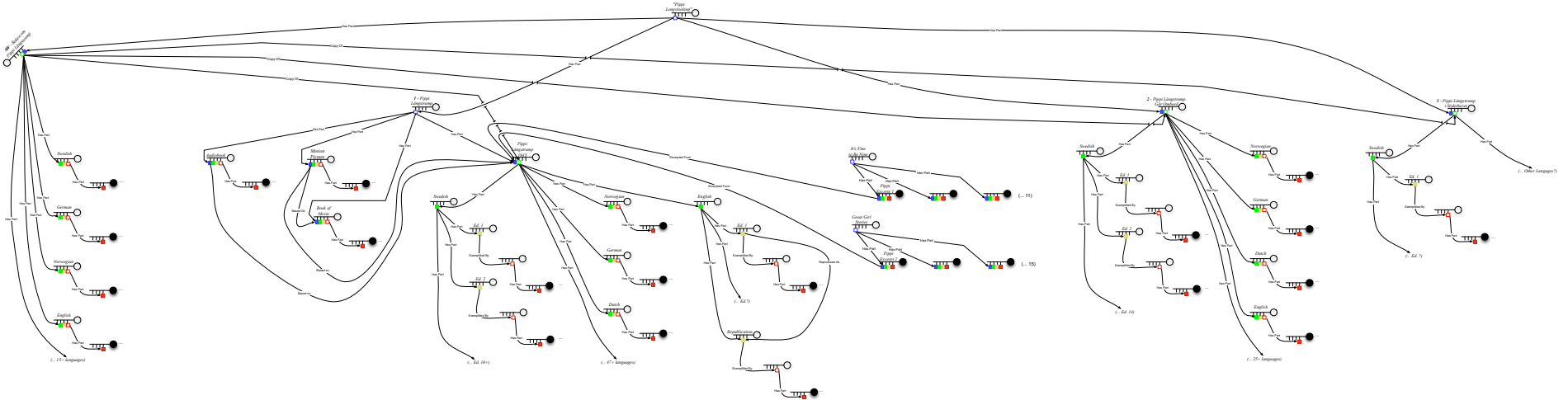
- ***IFLA User Tasks*** - The diagrammatic representation helps to clarify the role of IFLA user tasks

Working With a FRBR Paper Tool: *Pippi Longstocking*



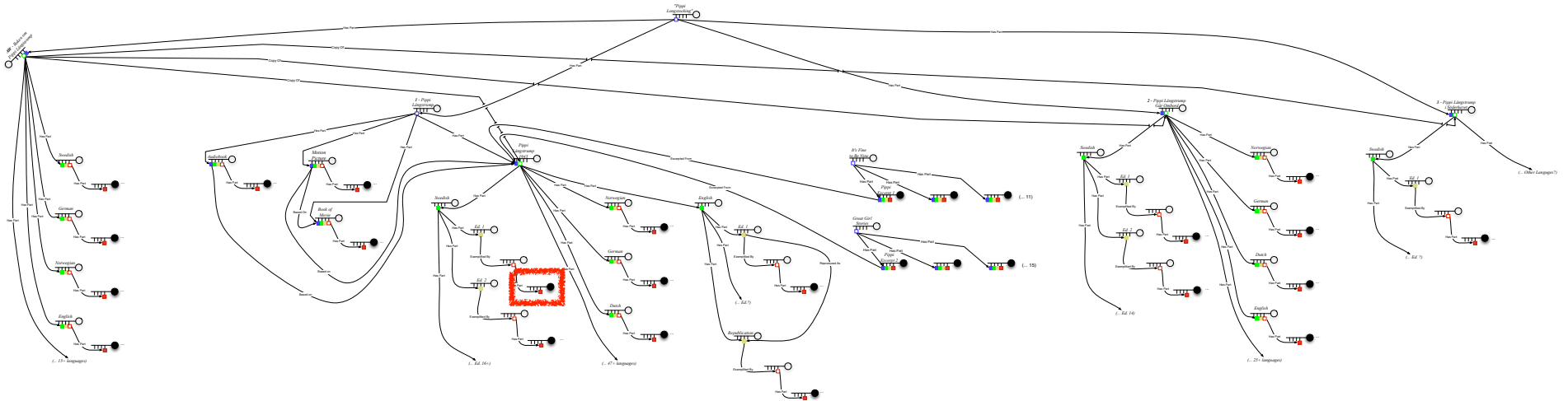
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Working With a FRBR Paper Tool: *Pippi Longstocking*



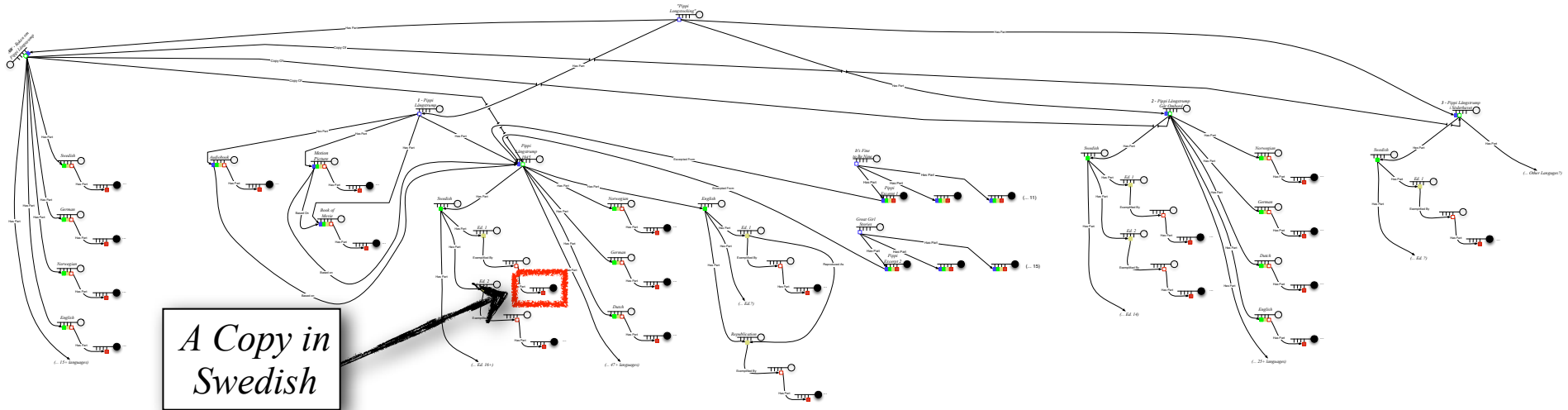
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Working With a FRBR Paper Tool: *Pippi Longstocking*



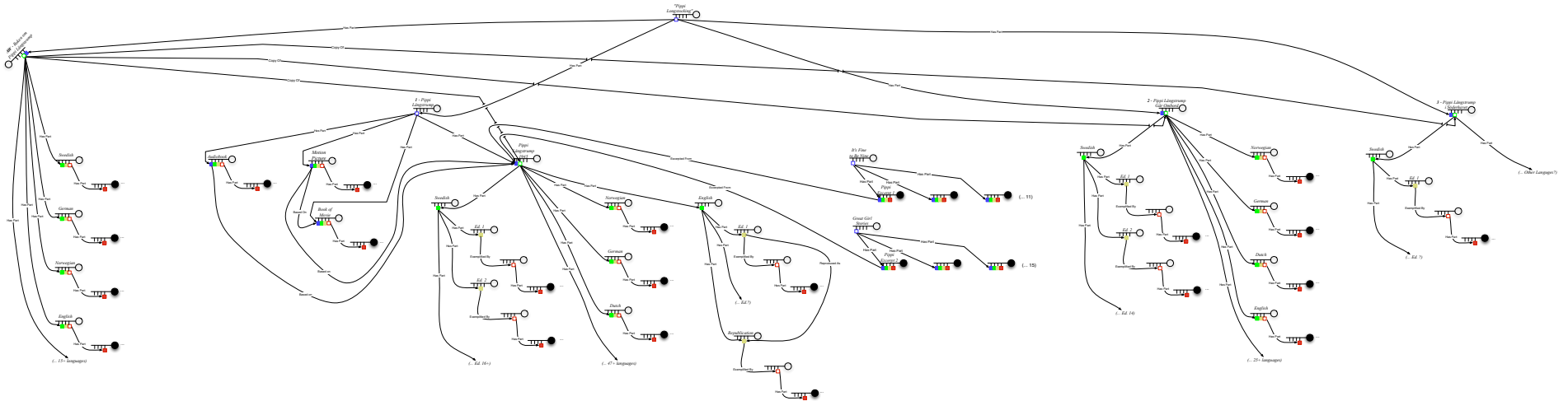
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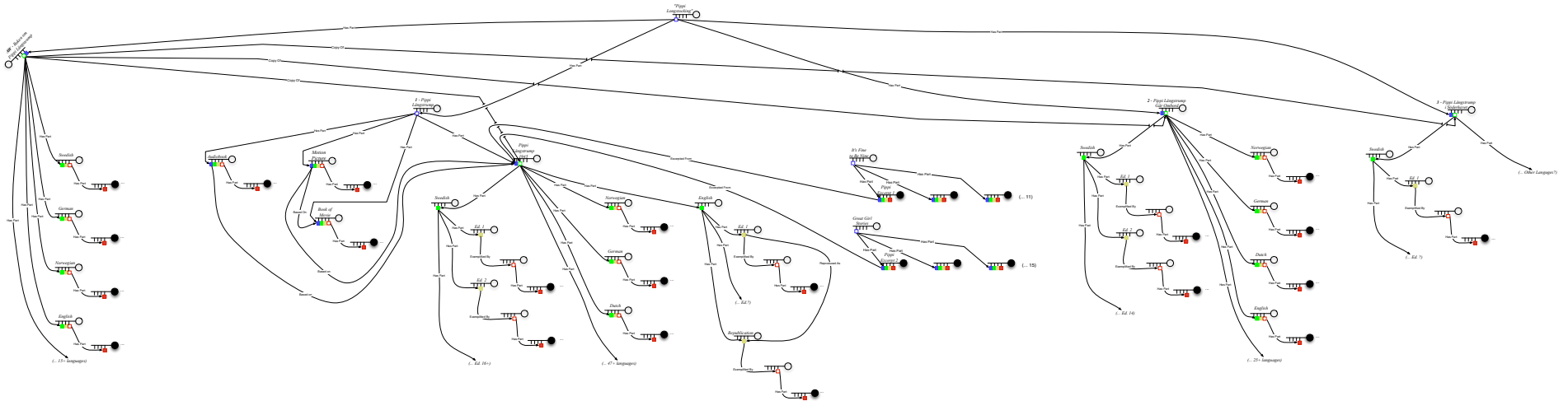
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Pippi Longstocking



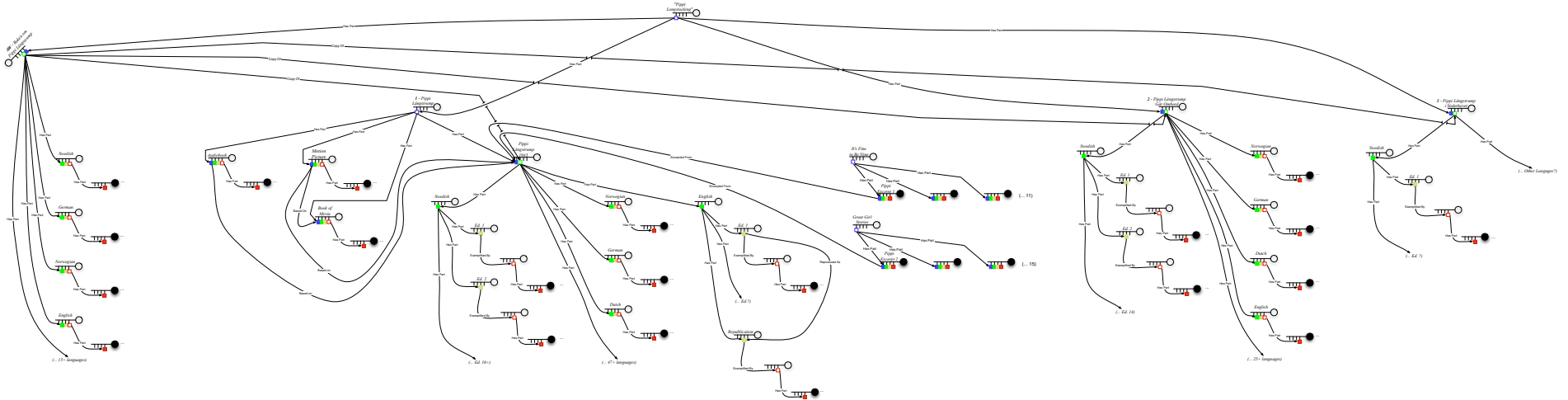
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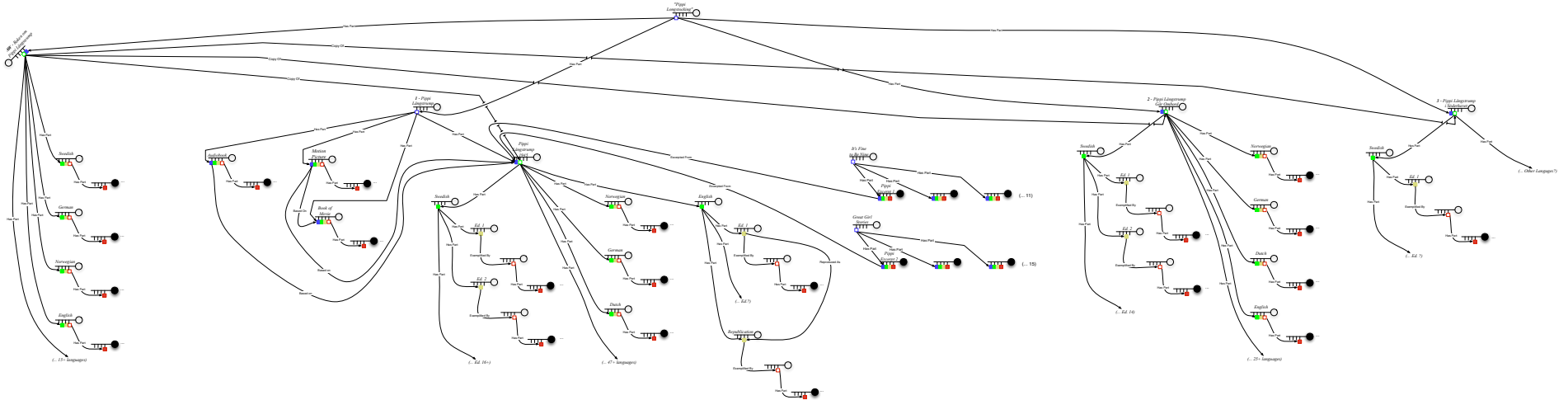
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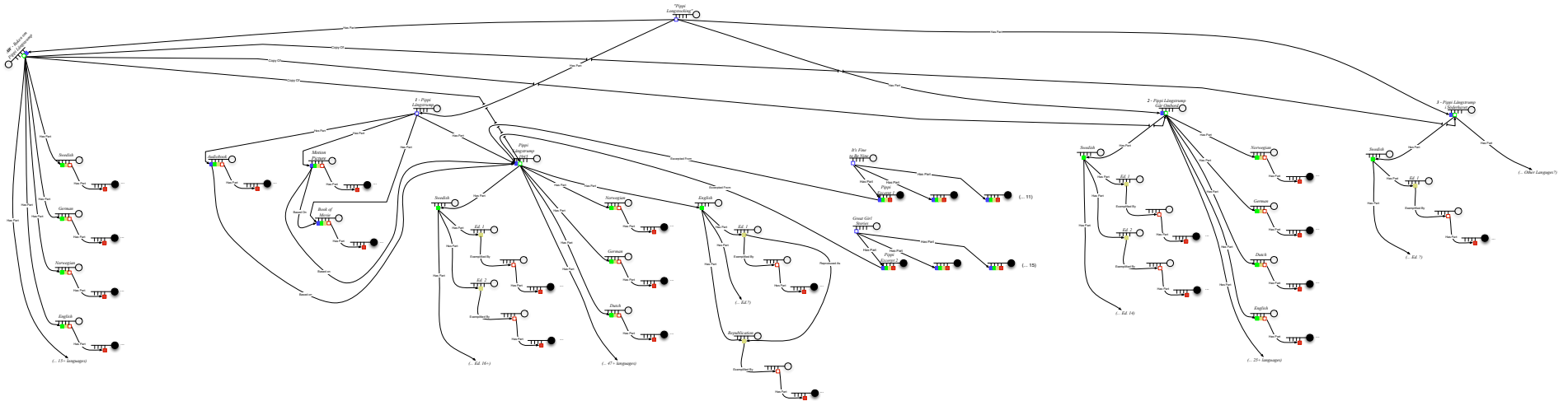
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Working With a FRBR Paper Tool: *Pippi Longstocking*



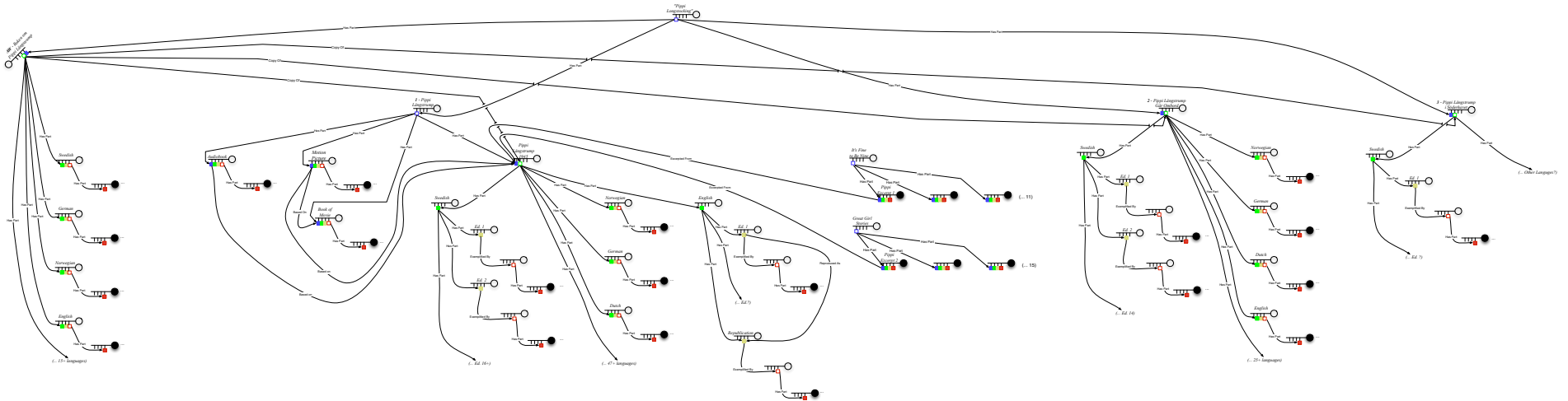
- ***IFLA User Tasks*** - The diagrammatic representation helps to clarify the role of IFLA user tasks
 - To ***Identify*** an entity (i.e., to confirm that the entity described corresponds to the entity sought, or to distinguish between two or more entities)
 - User judgments are based on available resource descriptions and/or on stated or implied relationships

Working With a FRBR Paper Tool: *Pippi Longstocking*



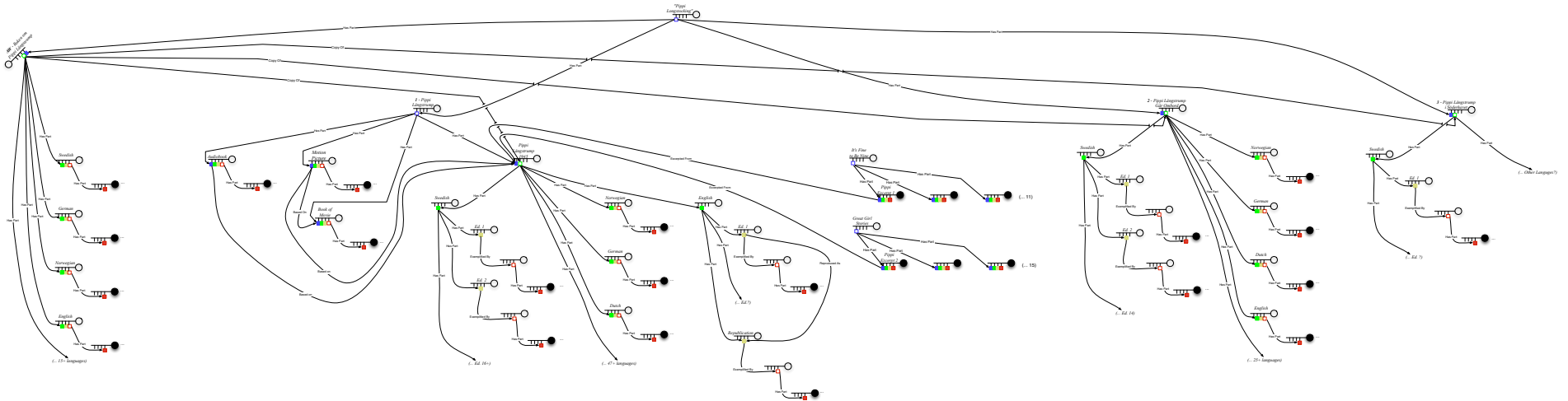
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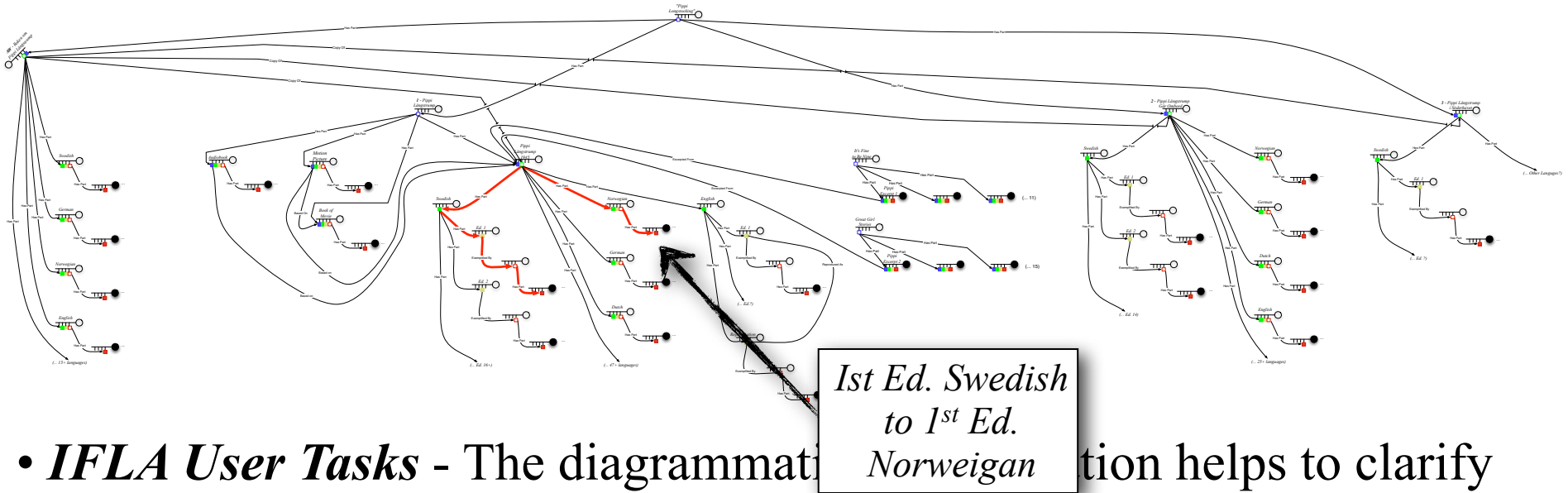
- ***IFLA User Tasks*** - The diagrammatic representation helps to clarify the role of IFLA user tasks
 - To ***Navigate*** the resource description structure based on assessment of descriptions and stated or implied relationships

Working With a FRBR Paper Tool: *Pippi Longstocking*



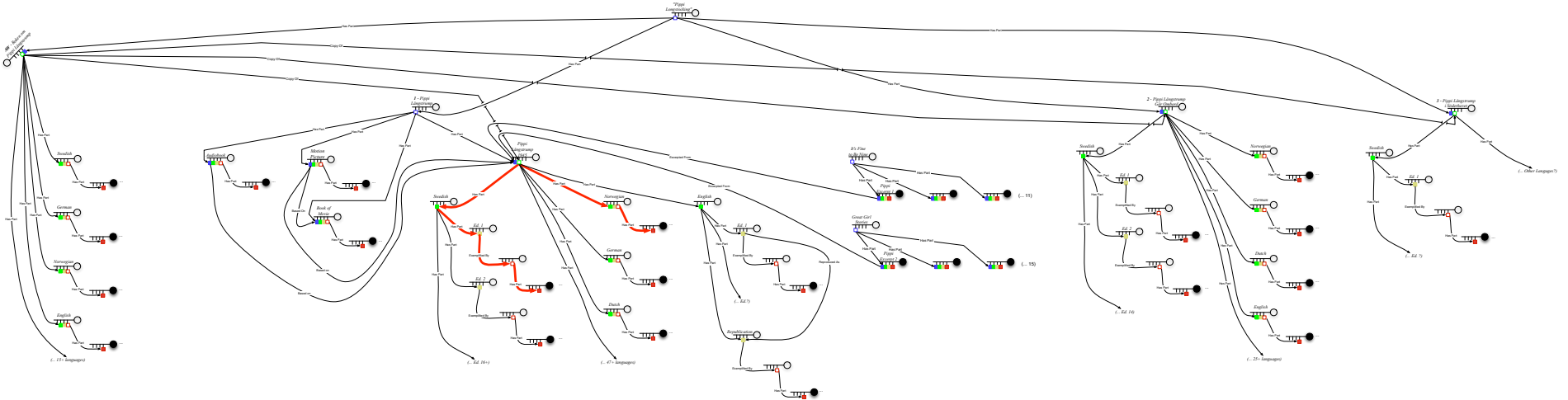
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Working With a FRBR Paper Tool: *Pippi Longstocking*



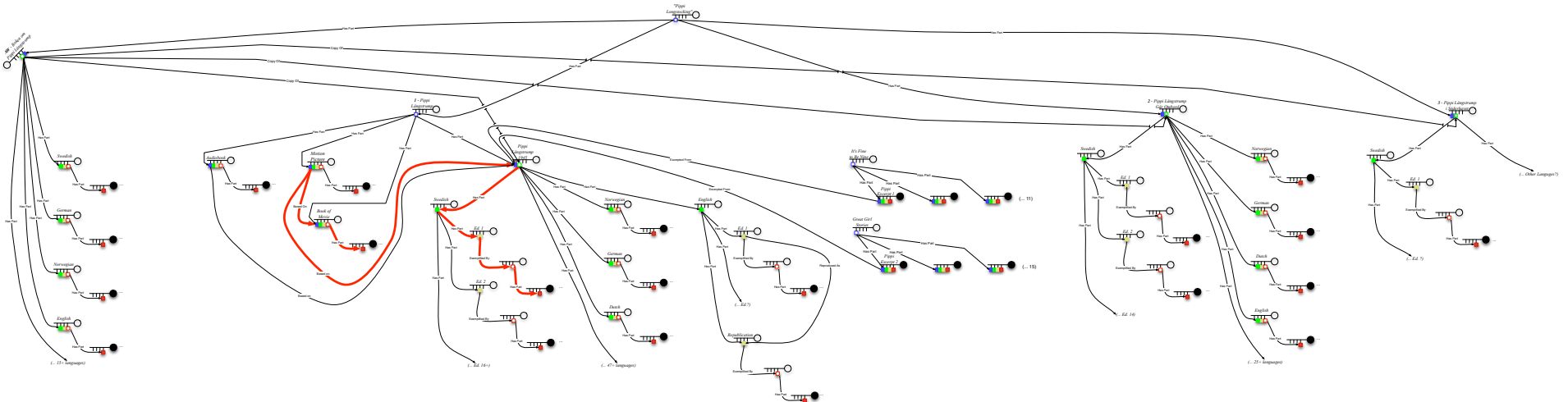
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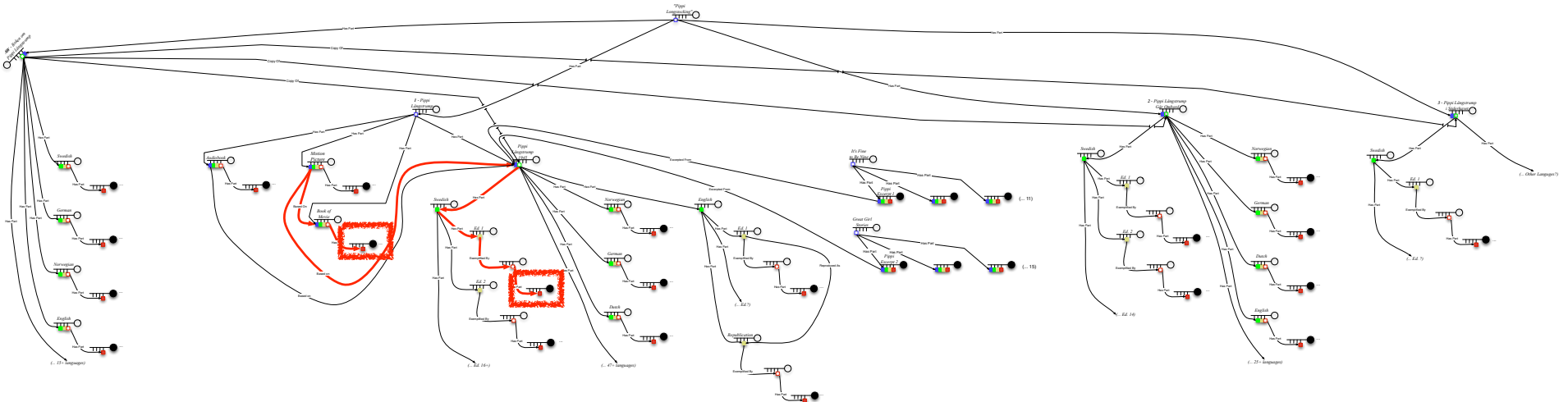
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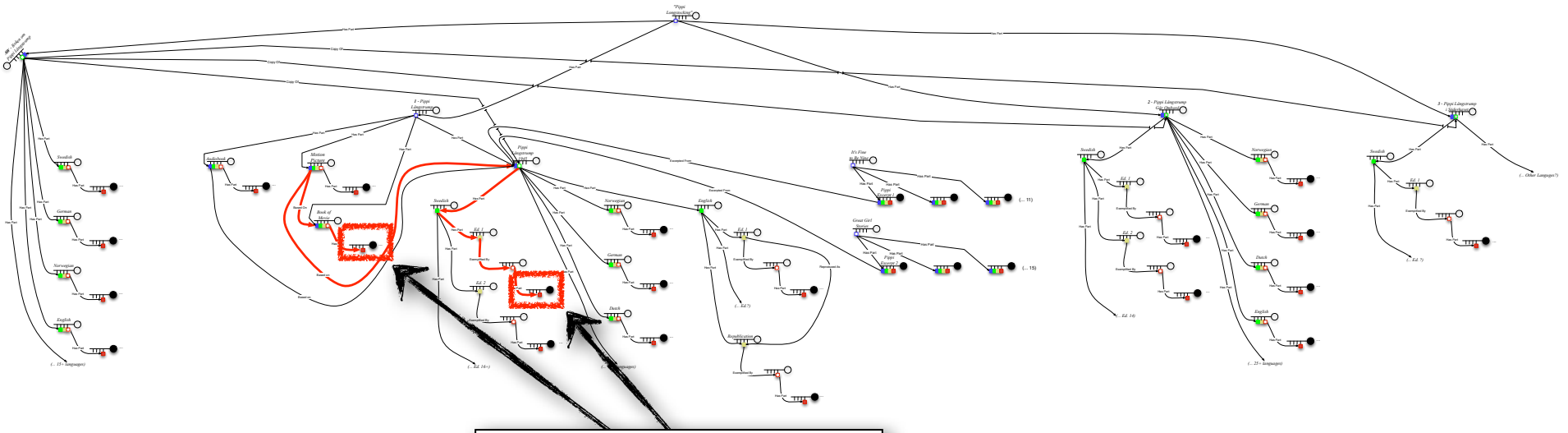
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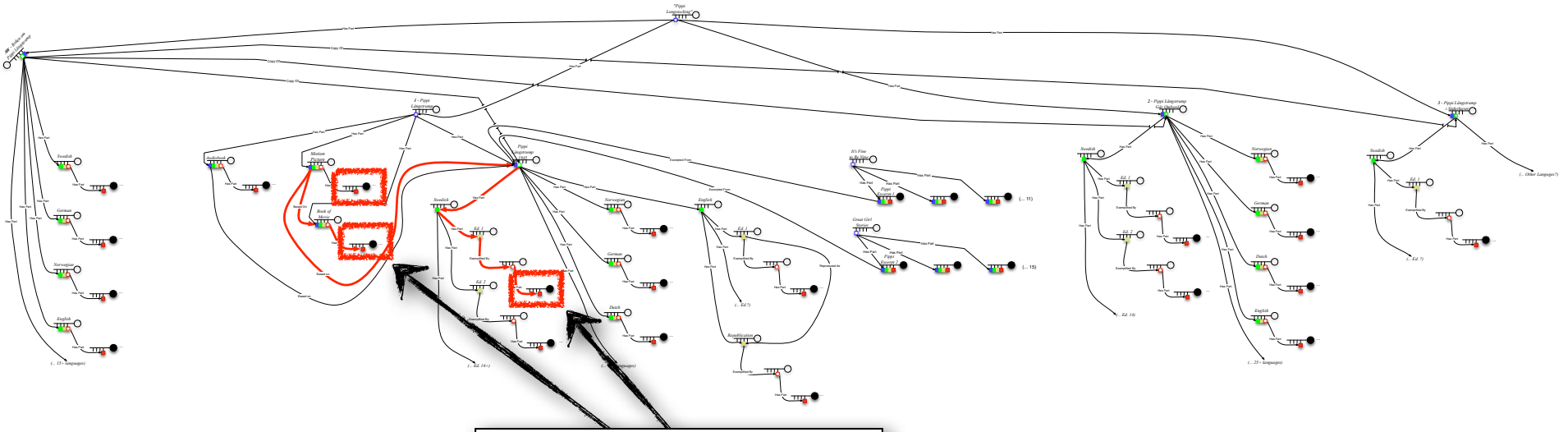
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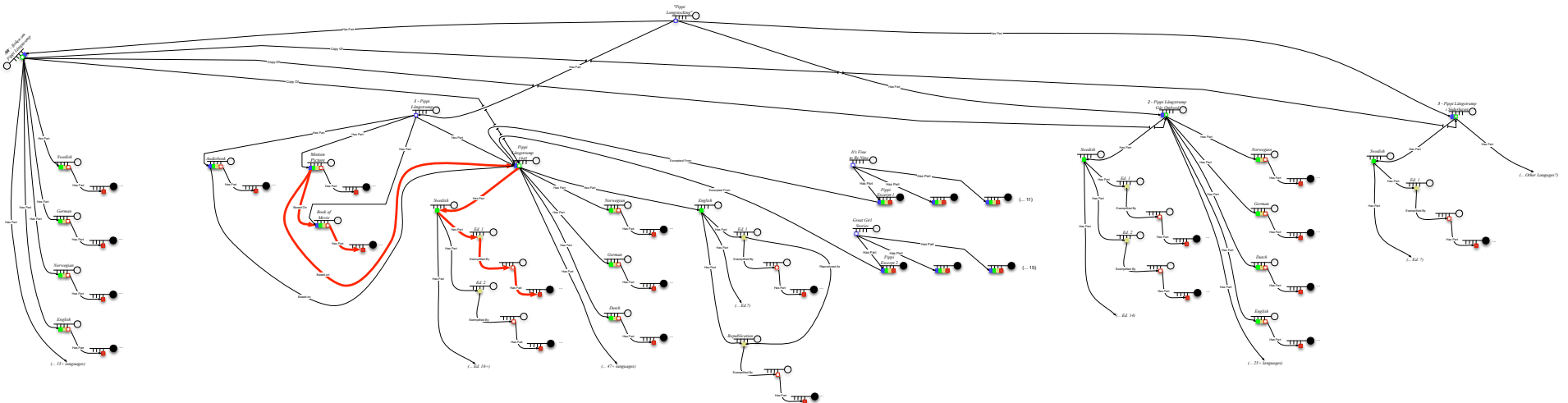
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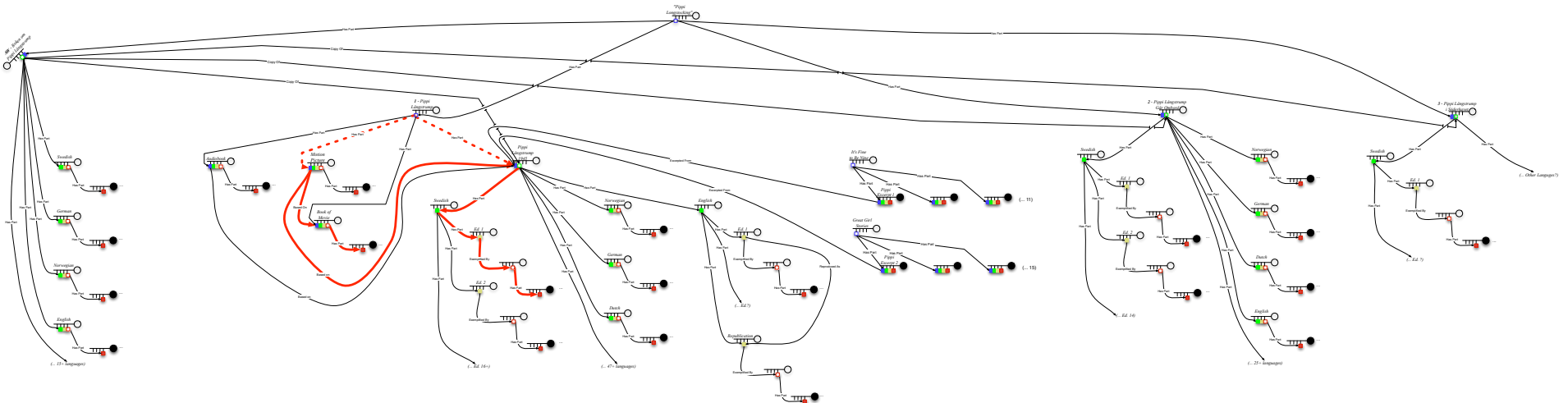
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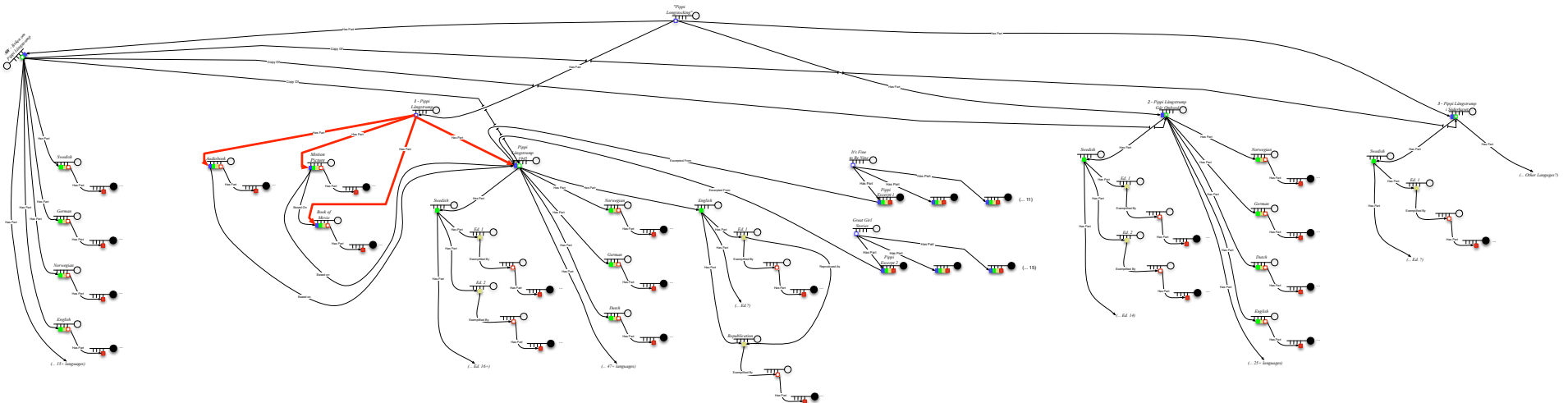
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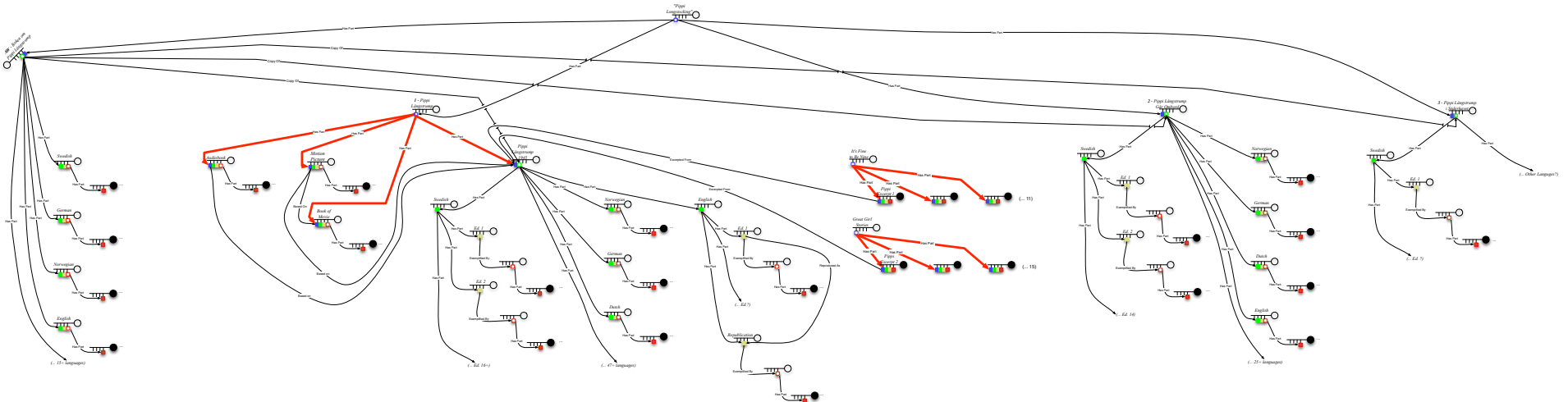
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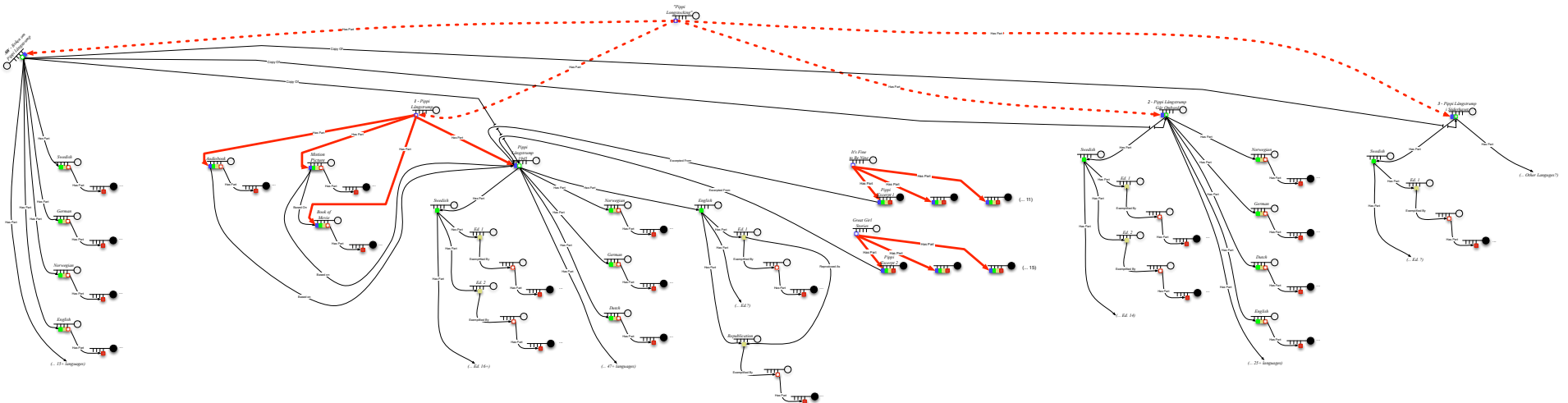
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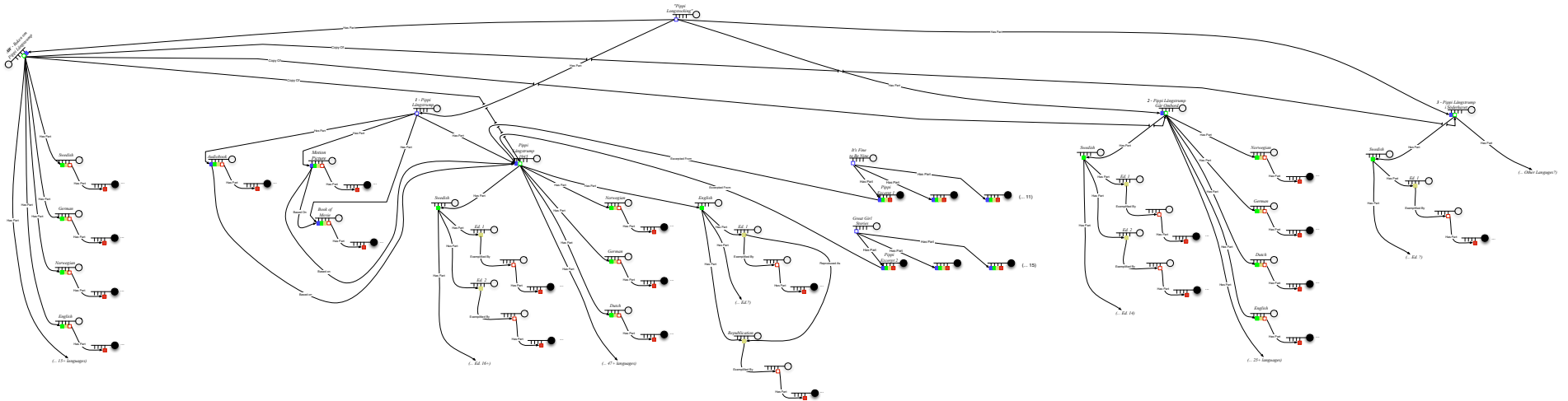
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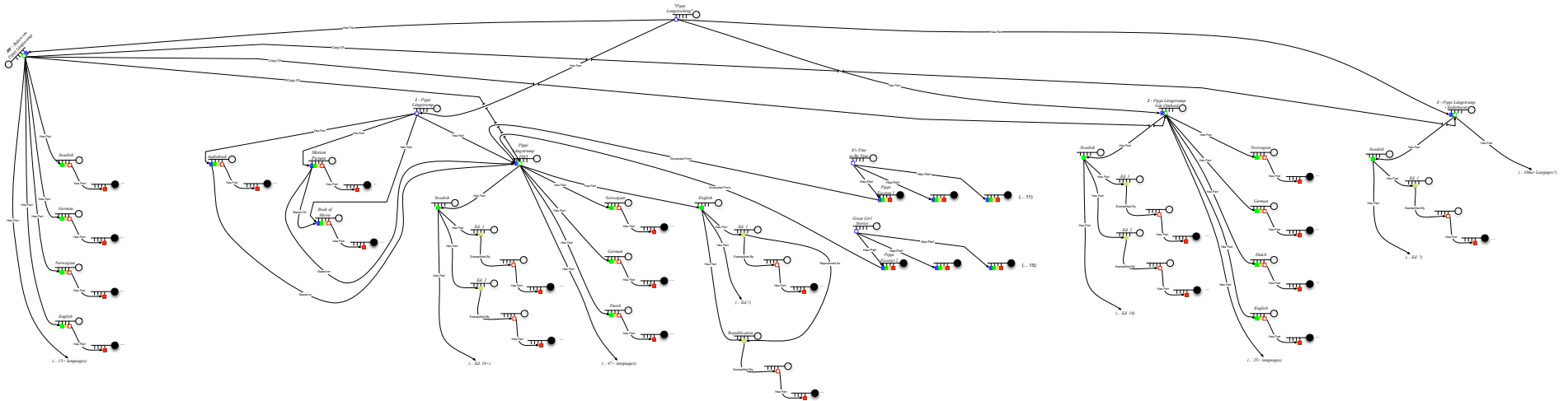
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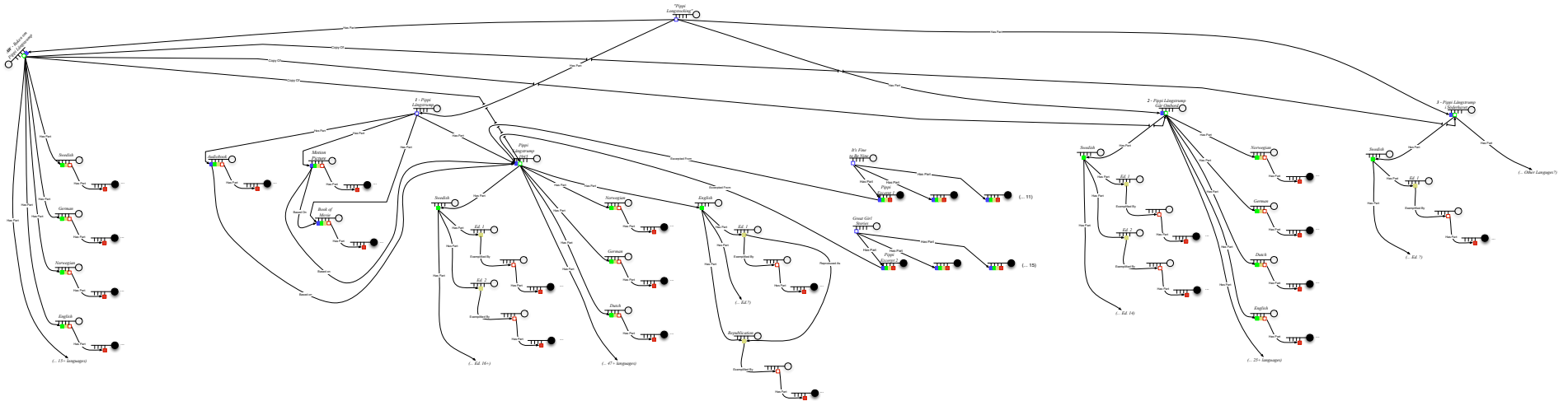
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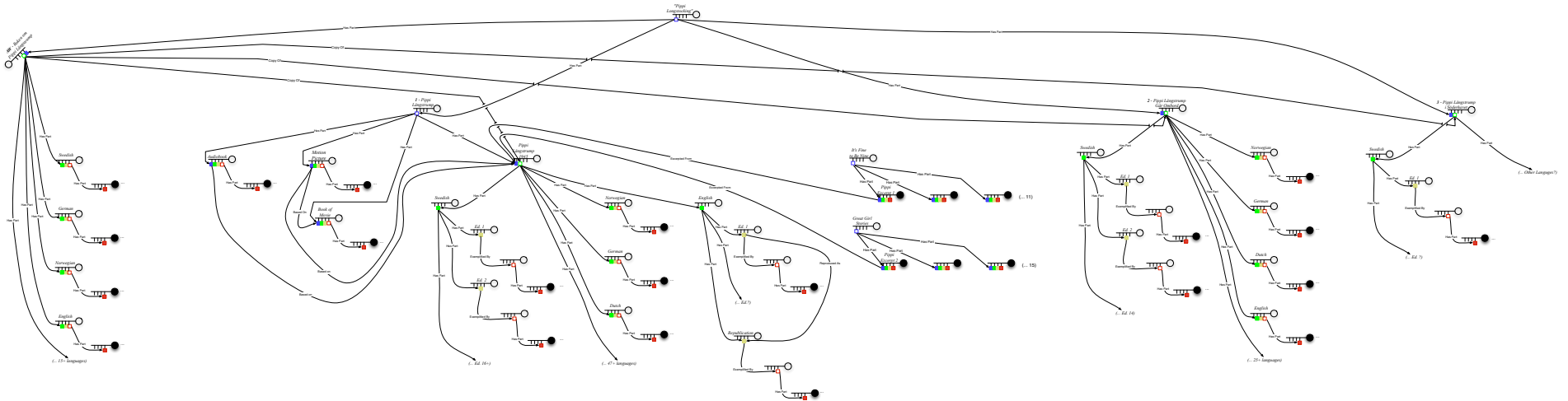
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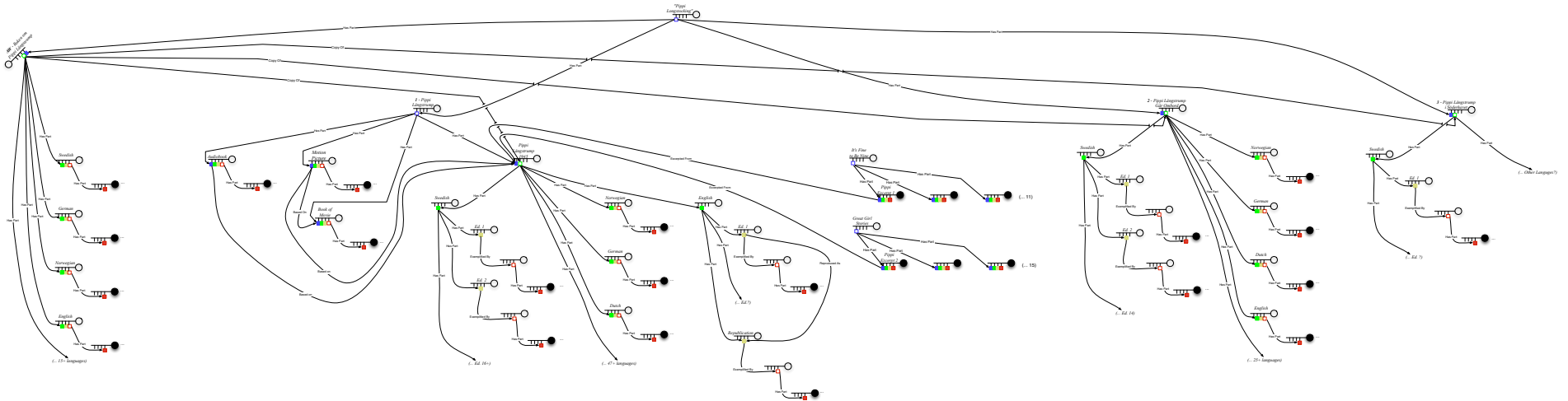
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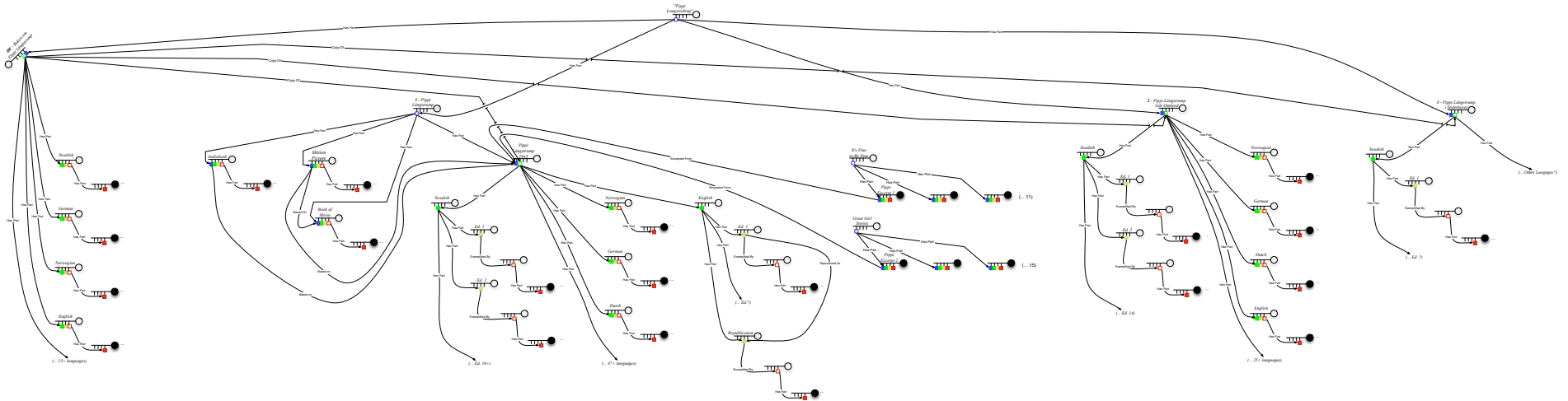
- ***IFLA User Tasks*** - The diagrammatic representation helps to clarify the role of IFLA user tasks
 - To ***Select*** an entity that is appropriate to the user's needs
 - To ***Acquire*** or ***Obtain Access*** to the entity described. Success is dependent on institutional business rules governing resource availability. Possibilities include user redirection to designated (by attribute or relationship) alternatives

Pippi Longstocking



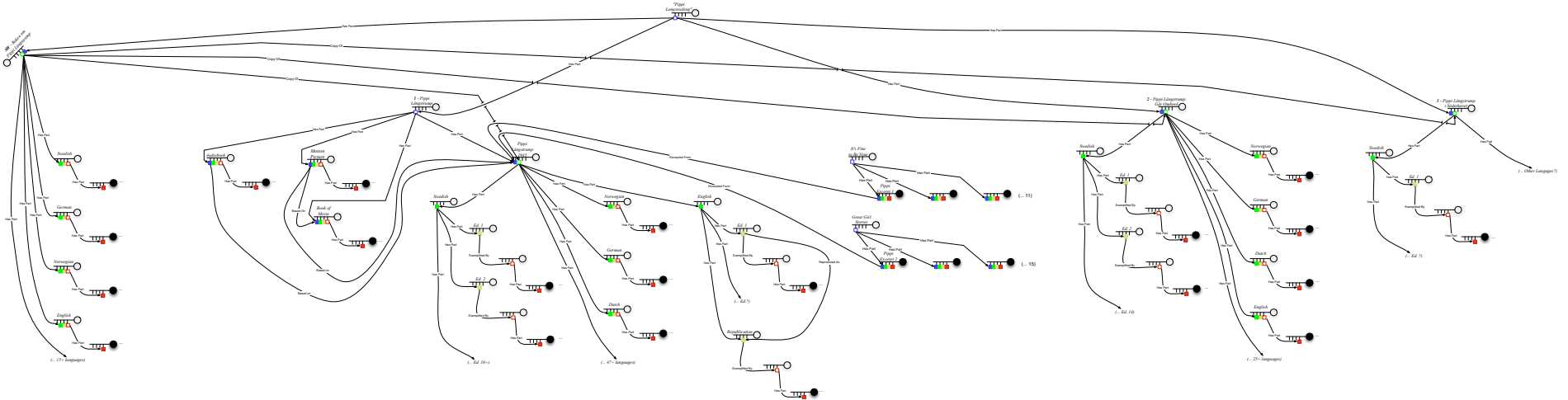
- **Collocation** - The action of setting in a place or position, esp. of placing together with, or side by side with, something else; disposition or arrangement with, or in relation to, others; the state of being so placed

Working With a FRBR Paper Tool: *Pippi Longstocking*



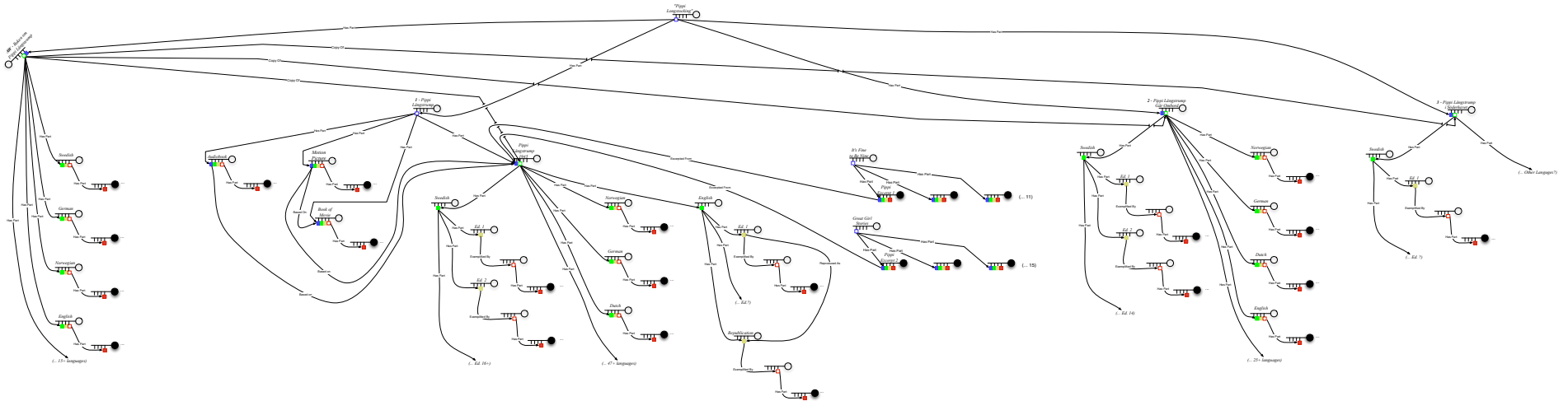
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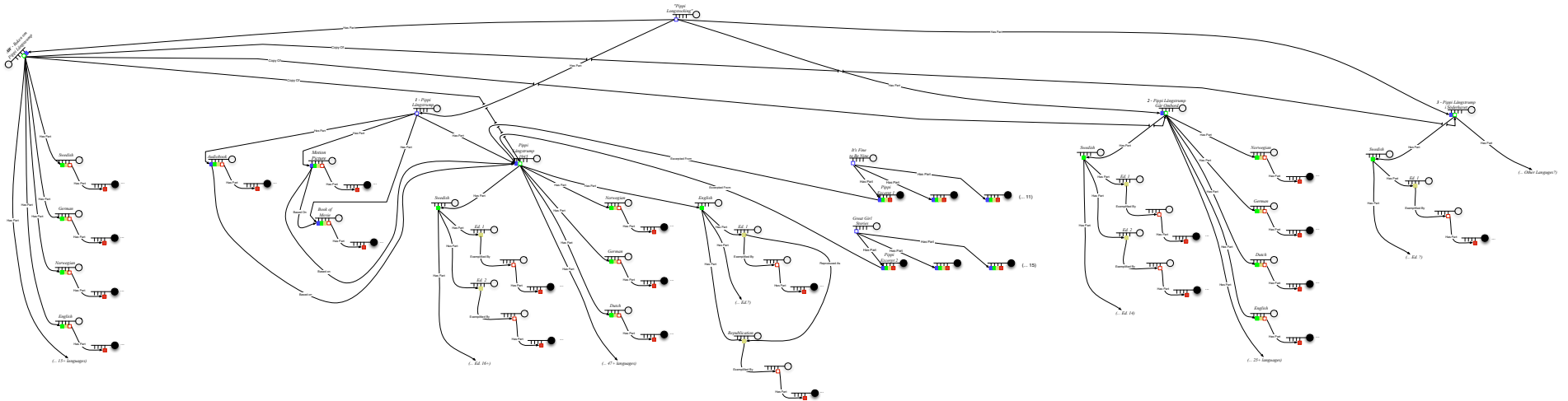
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Working With a FRBR Paper Tool: *Pippi Longstocking*



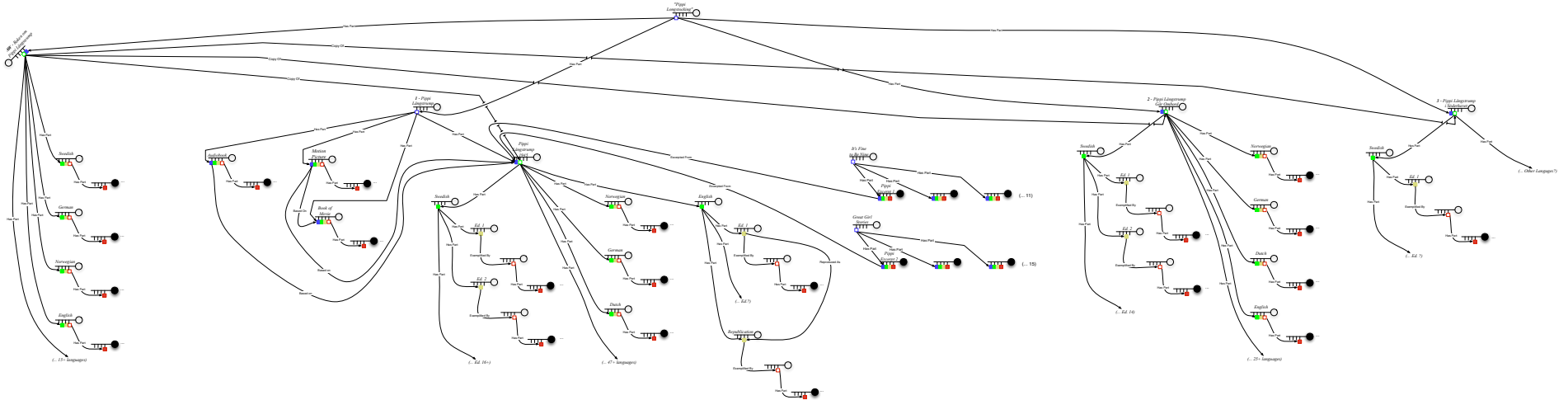
- **Collocation** - Cultural Heritage resource collocation efforts have encountered limitations due to several factors
 - Resource/Description Physicality - Physical characteristics of (analog) recording media
 - Resource Description Theory - Formal and informal organizational principles permit/forbid certain arrangements

Working With a FRBR Paper Tool: *Pippi Longstocking*



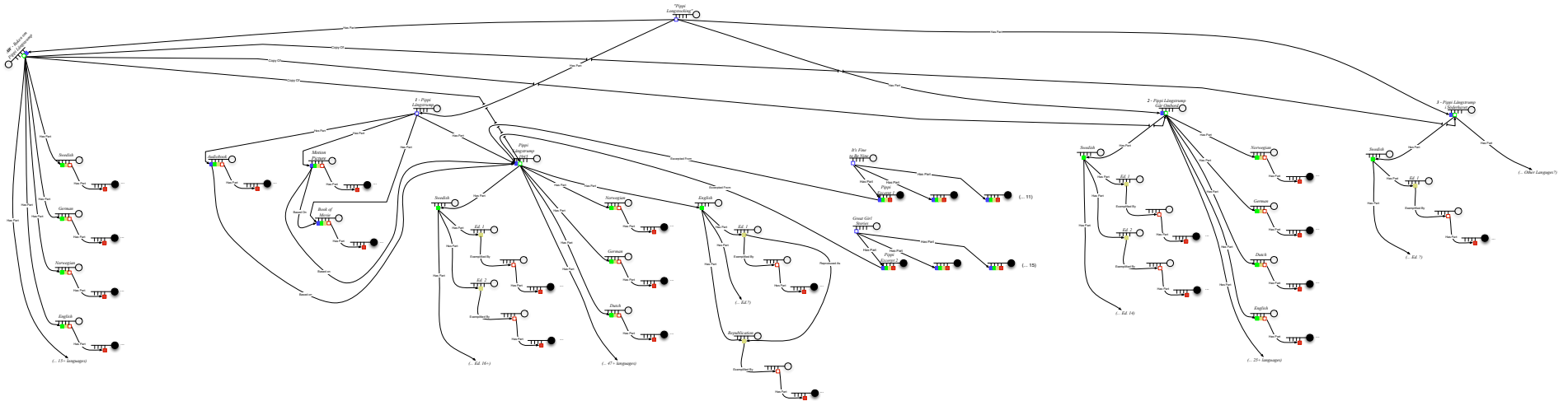
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Pippi Longstocking



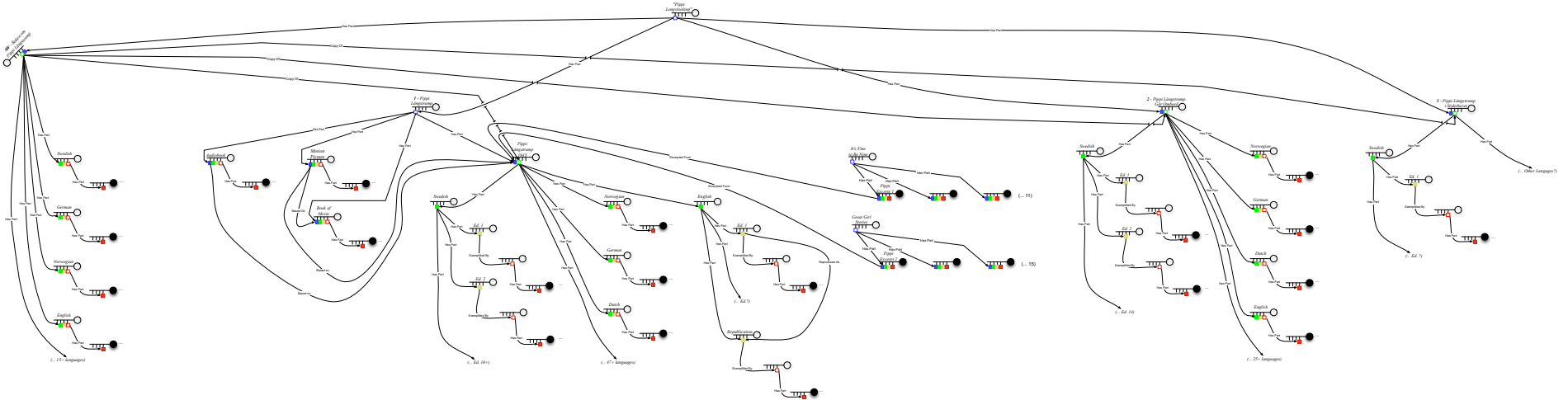
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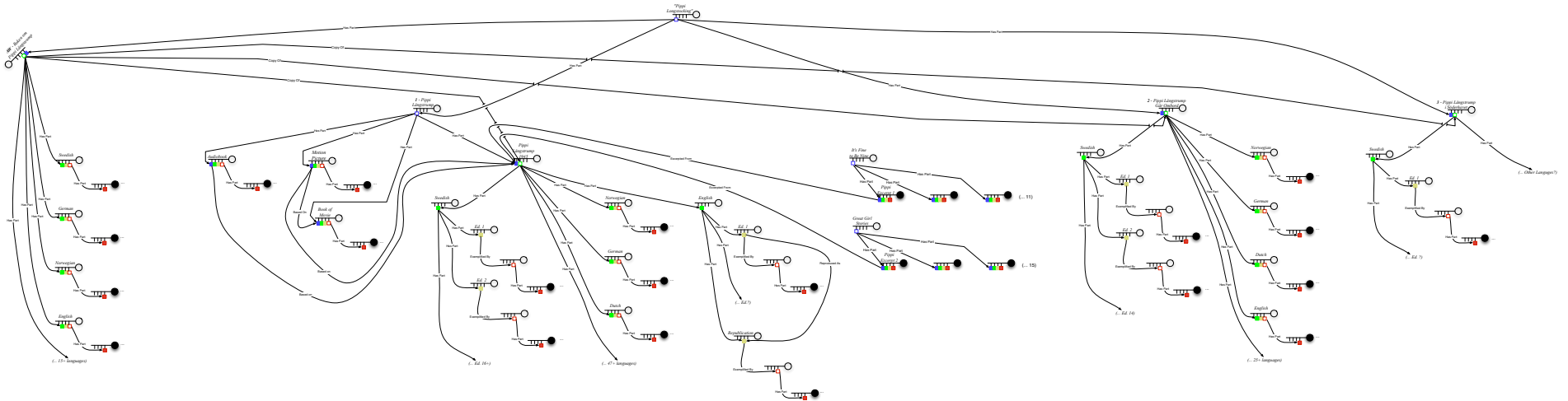
- ***Collocation Redefined*** - Resources and resource descriptions are structured as a *network*. A network consists of organizational structures already familiar to librarians: Sets
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 - *Sets* of resource and resource description relationships that act as “links/edges”

Working With a FRBR Paper Tool: *Pippi Longstocking*



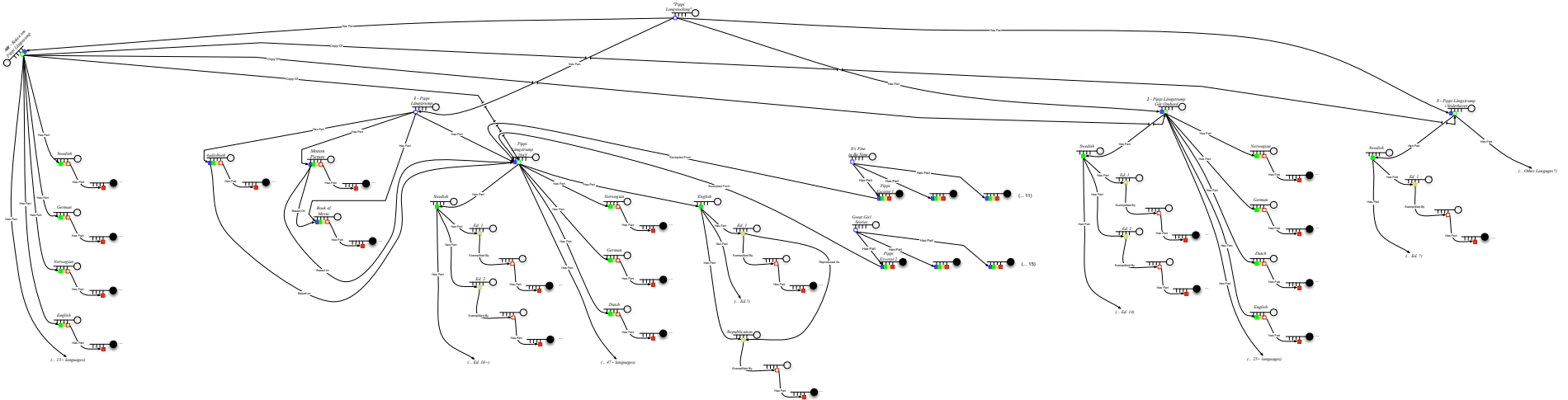
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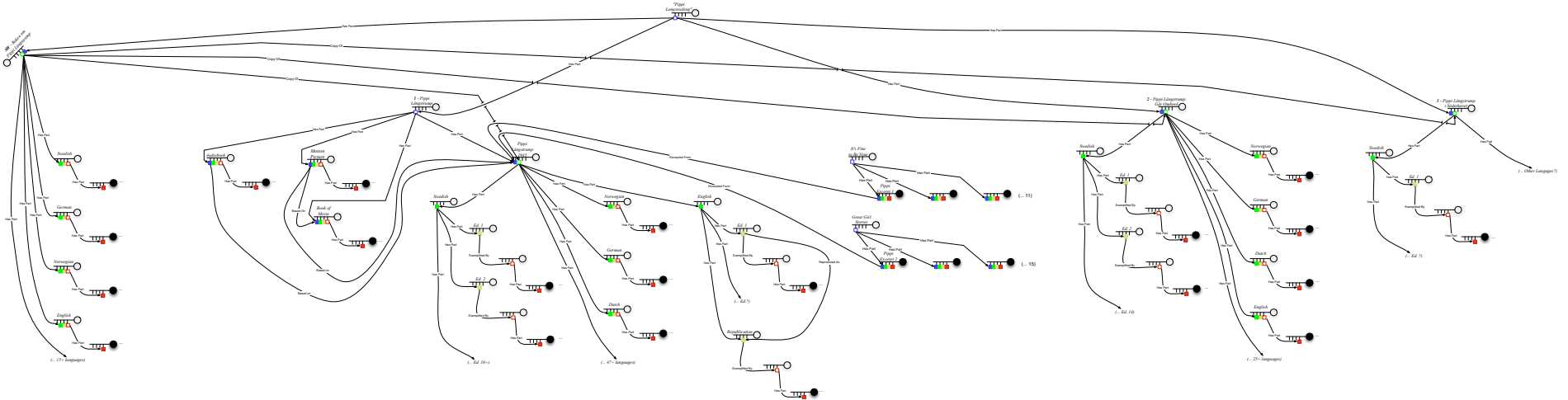
- ***Collocation Redefined*** - Resources and resource descriptions are structured as a network
 - Whole/part relationships support collocation in a “together with” sense
 - Ordered (*has_successor*) or directed (*use_for*) relationships enable side-by-side and jump (“go there”) navigation

Working With a FRBR Paper Tool: *Pippi Longstocking*



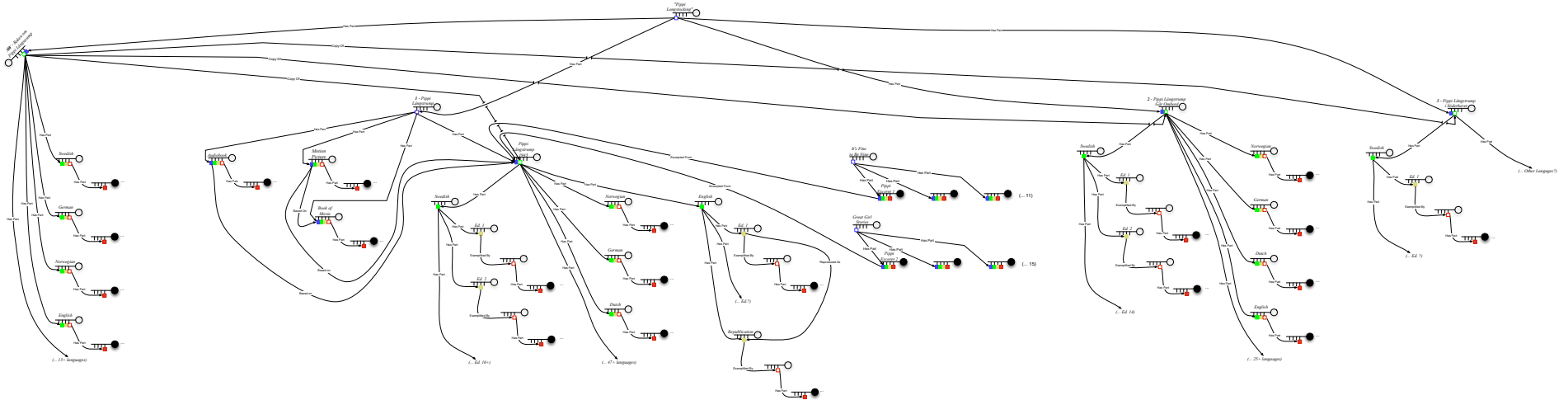
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Working With a FRBR Paper Tool: *Pippi Longstocking*



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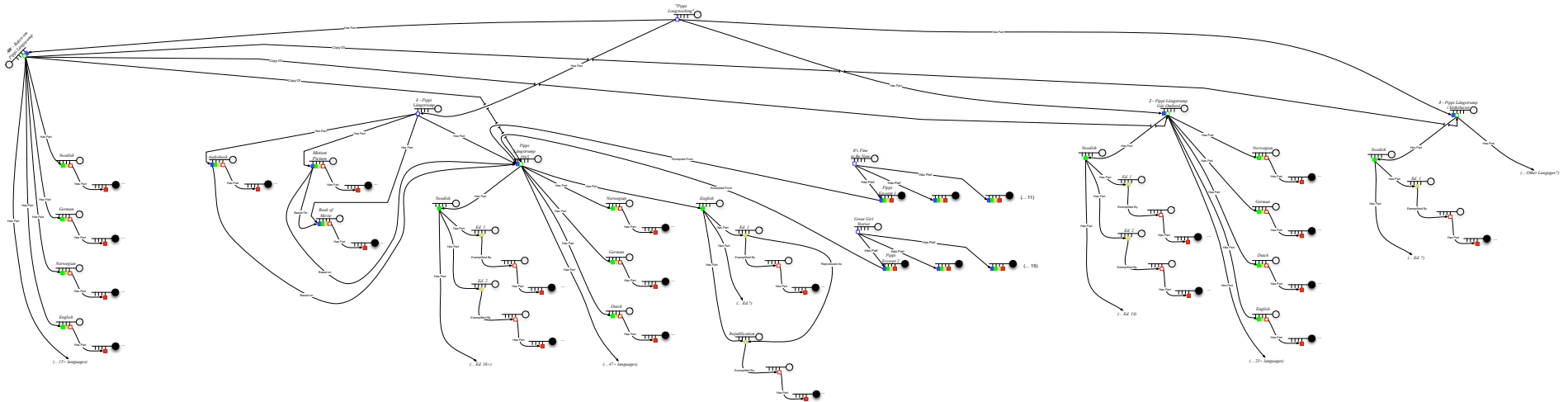
Working With a FRBR Paper Tool: *Pippi Longstocking*



- ***Collocation Redefined*** - The structure consists of sets
 - A network structure can be difficult to describe in words
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 - Sets of this type are known as *graphs*. Diagrammatic representations of graphs aid in perceiving relationships

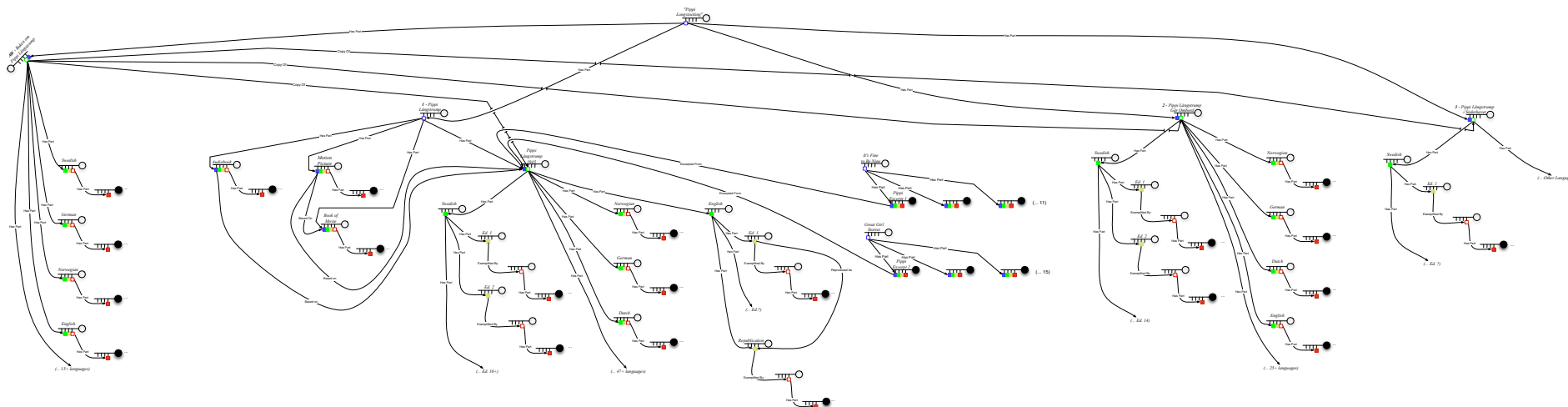
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Working With a FRBR Resource Description Network



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Working With a FRBR Resource Description Network



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- **FRBR Work**-level resource descriptions engage resource attributes and relationships that are of prime interest to scholars, and can guide them to works judged to be conceptually related

Working With a FRBR Resource Description Network

Collocation and Picturing

Do catalogers, scholars, undergrads, and casual users share the same “picture” of a resource or a resource/description network?

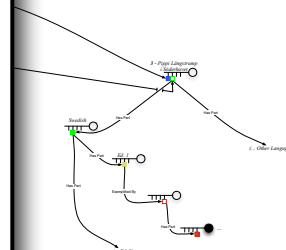
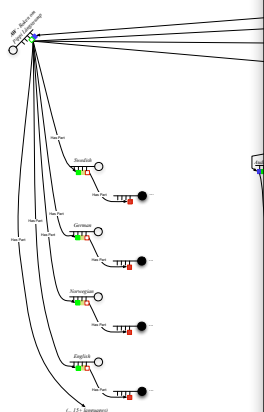
Can this picture be changed by exposure to authoritative/community resource descriptions, resource network navigation, user feedback?

- **Support**
physical

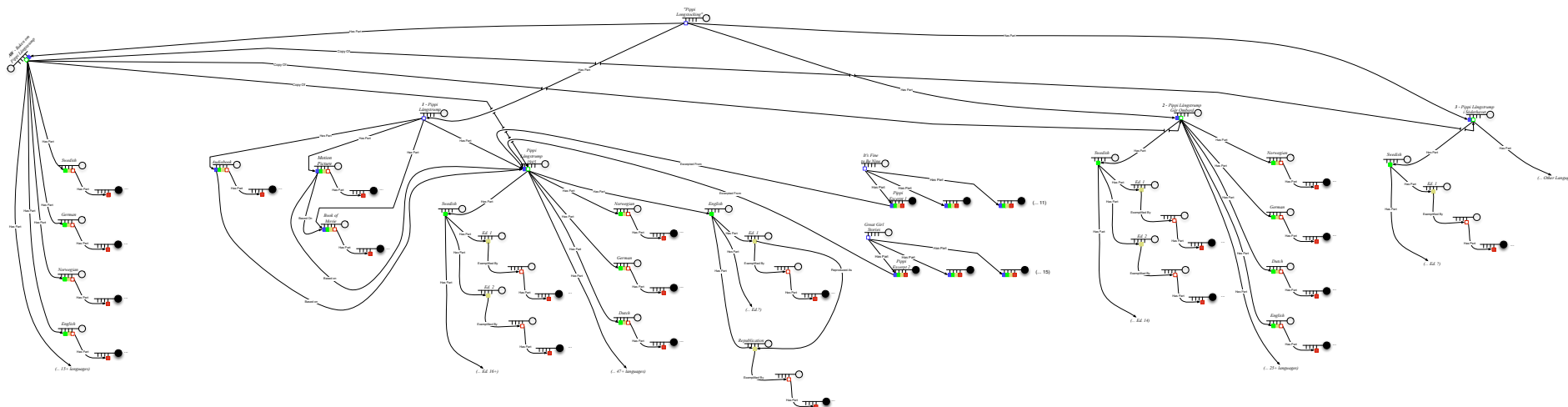
artistic/

intellectual descriptions can play the role of a support structure for a scholarly research and publication network.

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Working With a FRBR Resource Description Network



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Working With A FRBR Paper Tool: Exemplar Creation & Study

- *Resource Exemplars*[†] - A set of typical and atypical resource and description combinations, the mastery of which builds resource description skills: (a.) proper use of a Paper Tool derived from a conceptual data model, (b.) the refinement of conceptual and logical data models that are then used to improve Paper Tool capabilities

[†]Kuhn's *The Structure of Scientific Revolutions* & Kaiser's *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics*

Working With A FRBR Paper Tool: Exemplar Creation & Study

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Resource description expertise is acquired from combinations of education (for theory acquisition & official rules) and experience (for rules of thumb)
 - A manuscript or imaginary
 - A monograph (for rules of thumb)
 - A monograph in multiple editions (individual and related multiples)
 - A publication in multiple media
 - A continuing publication (individual and related multiple publications, special editions) network
 - A library multimedia resource and its resource description network
 - A World Wide Web page and its underlying multimedia resource network

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Working With A FRBR *Paper Tool*: Summary

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 - Redefinition of collocation
 - Identification of some mathematical ideas underlying collocation
 - Exploration of paper tool uses at different levels to suggest data structures for Cultural Heritage resource description, discovery, and access

A Resource Description Theory and Diagrammatic Method: Review

XML and Its Discontents: Limitations of the XML *Logical Data Model*

- The use of XML for the representation and/or description of creative expressions has not come about without complications

XML employs a strongly hierarchical document model. At various points, these Guidelines discuss problems that arise when using XML to encode textual features that either do not naturally lend themselves to representation in a strictly hierarchical form or conflict with other hierarchies represented in the markup. Examples of such situations include:

- *Conflict between the hierarchy established by the physical structure of a document ... and its rhetorical or linguistic structure*

A Resource Description Theory and Diagrammatic Method: Review

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A Resource Description Theory and Diagrammatic Method: Review

Chapter 20

Non-hierarchical Structures

XML employs a strongly hierarchical document model. At various points, these Guidelines discuss problems that arise when using XML to encode textual features that either do not naturally lend themselves to representation in a strictly hierarchical form or conflict with other hierarchies represented in the markup. Examples of such situations include:

- Conflict between the hierarchy established by the physical structure of a document (e.g., volume, page, column, line) and its rhetorical or linguistic structure (e.g., chapters, paragraphs, sentences, acts, scenes, etc.)
- Conflict between a verse text's metrical structure (e.g., its arrangement in stanzas and metrical lines) and its rhetorical or linguistic structure (e.g., phrases, sentences, and, for plays, acts, scenes, and speeches).
- Conflict between metrical, rhetorical, or linguistic structure and the representation of direct speech, especially if the quoted speech is interrupted by other elements (e.g., What, she asked, was that all about) or crosses metrical, rhetorical, or linguistic boundaries.
- Conflict between different analytical views or descriptions of a text or document, e.g., markup intended to encode diplomatic information about a word's appearance in a manuscript with markup intended to describe its morphology or pronunciation.

Non-nesting information poses fundamental problems for any XML-based encoding scheme, and it must be stated at the outset that no current solution combines all the desirable attributes of formal simplicity, capacity to represent all occurring or imaginable kinds of structures, suitability for formal or mechanical validation. The representation of non-hierarchical information is thus necessarily a matter of trade-offs among various sets of advantages and disadvantages.

These Guidelines support several methods for handling non-hierarchical information:

- redundant encoding of information in multiple forms (discussed in 20.1. *Multiple Encodings of the Same Information*)
- the use of empty elements to delimit the boundaries of a non-nesting structure (discussed in 20.2. *Boundary Marking with Empty Elements*)
- the division of a logically single non-nesting element into segments that nest properly in their immediate hierarchical context but can also be reconstituted virtually across these hierarchical boundaries (discussed 20.3. *Fragmentation and Reconstitution of Virtual Elements*)
- stand-off markup: the annotation of information by pointing at it, rather than by placing XML tags within it (discussed in 20.4. *Stand-off Markup*)

Some of these methods can be used in TEI Conformant or Conformable documents. Others require extension.

A Resource Description Theory and Diagrammatic Method: Review

Chapter 19

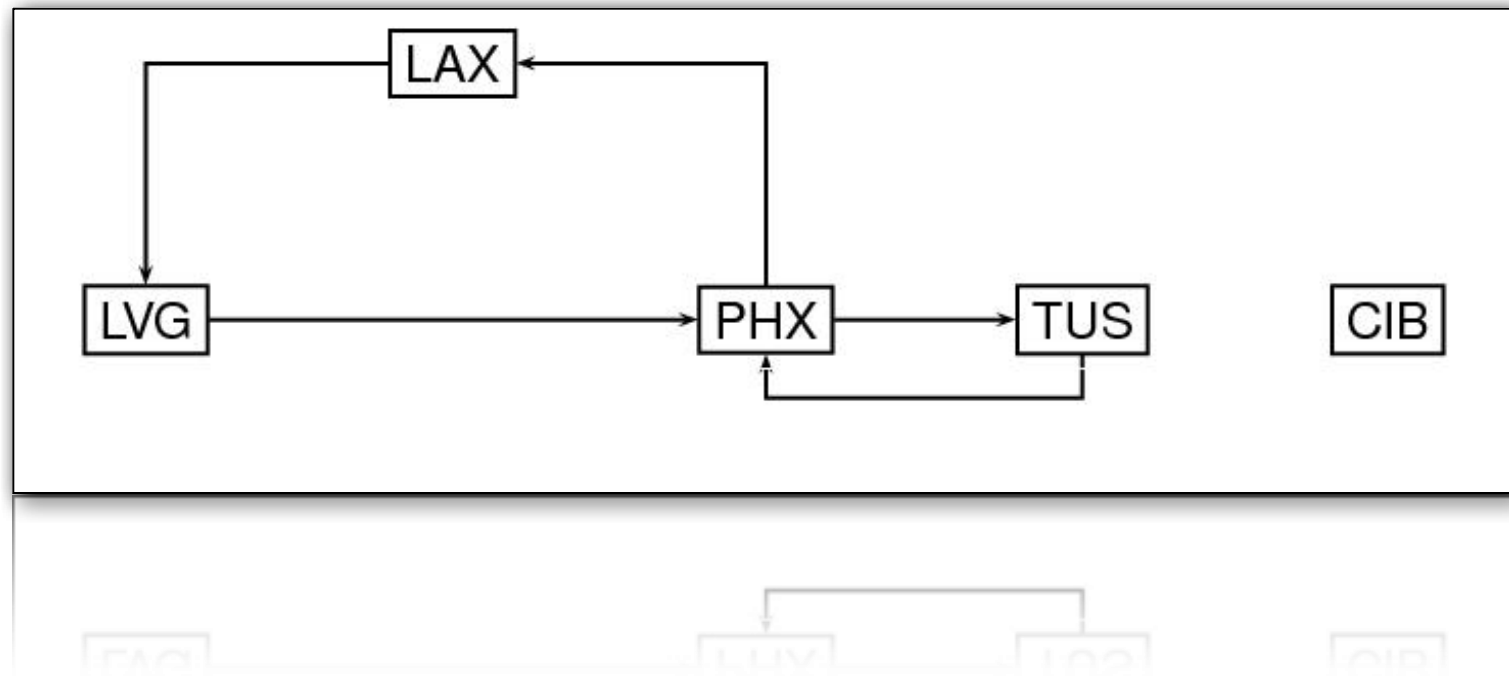
Graphs, Networks, and Trees

Graphical representations are widely used for displaying relations among informational units because they help readers to visualize those relations and hence to understand them better. Two general types of graphical representations may be distinguished.

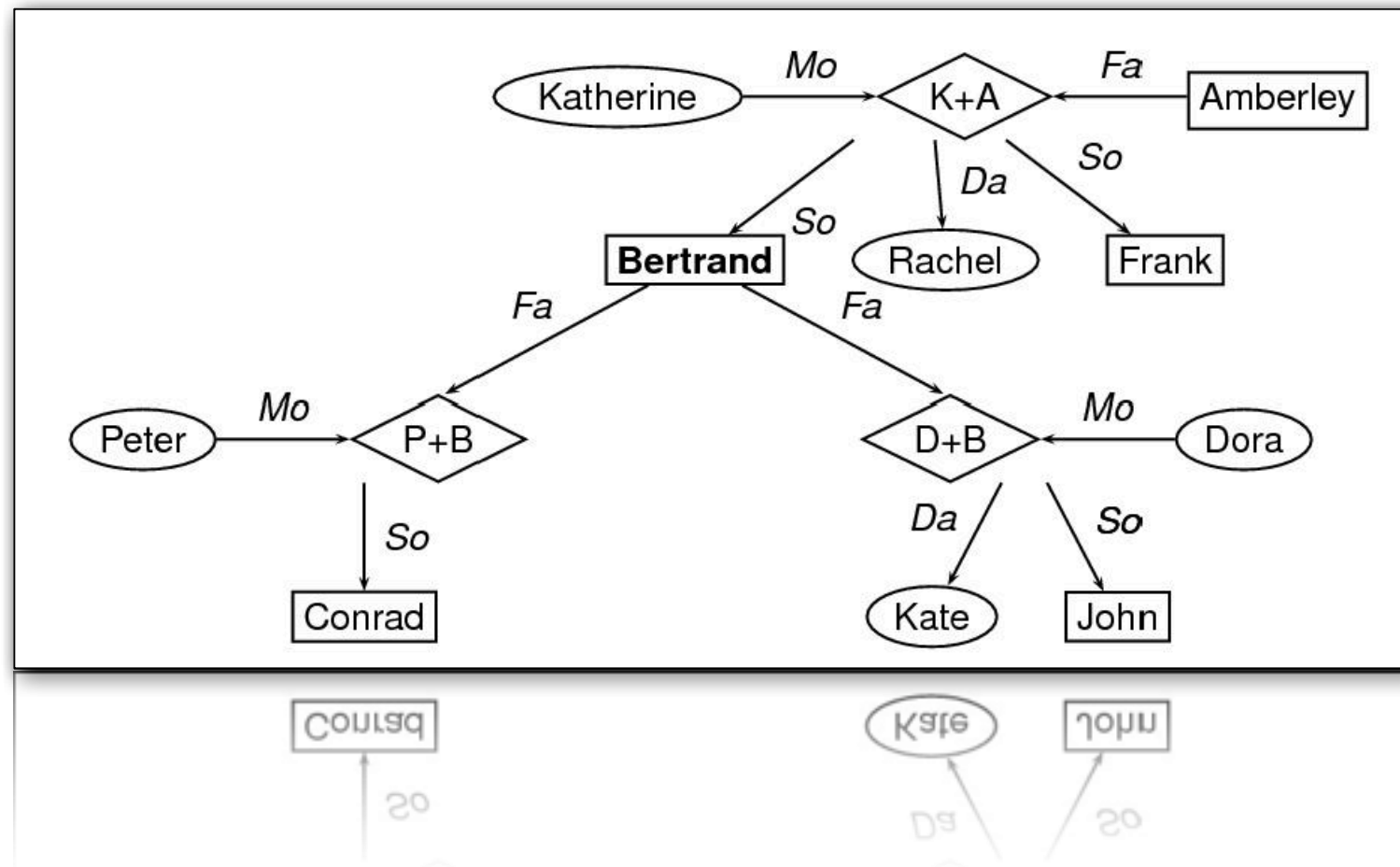
- *Graphs*, in the strictly mathematical sense, consist of points, often called *nodes* or *vertices*, and connections among them, called *arcs*, or under certain conditions, *edges*. Among the various types of graphs are *networks* and *trees*. Graphs generally and networks in particular are dealt with directly below. Trees are dealt with separately in sections 19.2. *Trees* and 19.3. *Another Tree Notation*.¹
- *Charts*, which typically plot data in two or more dimensions, including plots with orthogonal or radial axes, bar charts, pie charts, and the like. These can be described using the elements defined in the module for figures and graphics; see chapter 14. *Tables, Formulae, and Graphics*.

Among the types of qualitative relations often represented by graphs are organizational hierarchies, flow charts, genealogies, semantic networks, transition networks, grammatical relations, tournament schedules, seating plans, and directions to people's houses. In developing recommendations for the encoding of graphs of various types, we have relied on their formal mathematical definitions and on the most common conventions for representing them visually. However, it must be emphasized that these recommendations do not provide for the full range of possible graphical representations, and deal only partially with questions of design, layout, and placement.

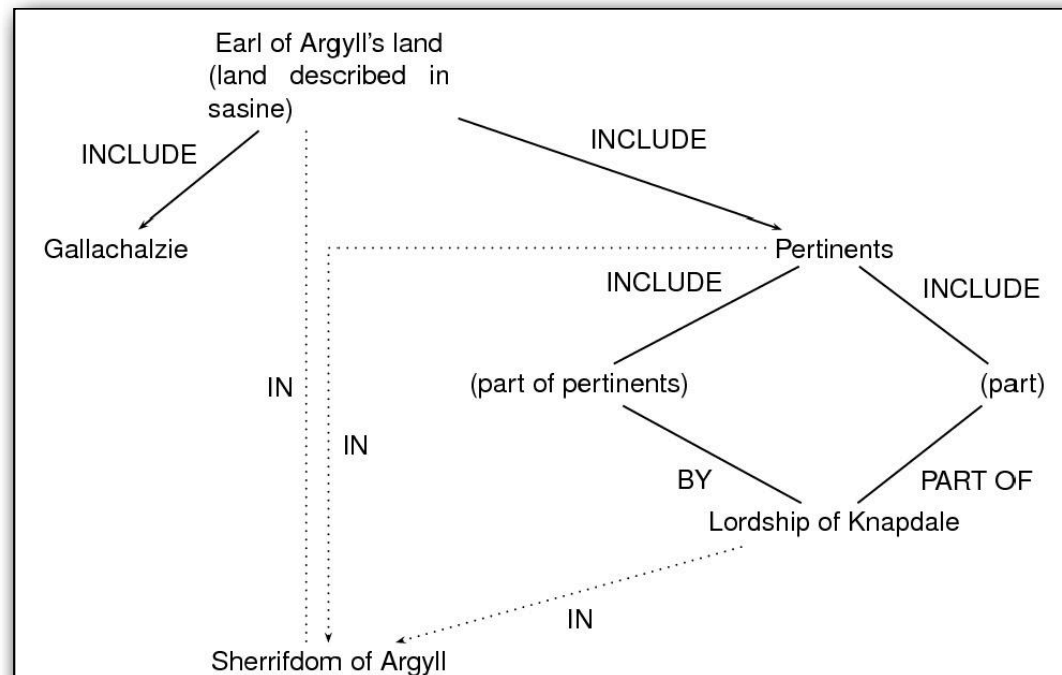
A Resource Description Theory and Diagrammatic Method: Review



A Resource Description Theory and Diagrammatic Method: Review



A Resource Description Theory and Diagrammatic Method: Review



The graph formalizes the following relationships:

the Earl of Argyll's land *includes* (the parcel of land in) Gallachalzie

the Earl of Argyll's land *includes* the pertinents of that parcel

the pertinents are (in part) *by* the Lordship of Knapdale

the pertinents are (in part) *part of* the Lordship of Knapdale

A Resource Description Theory and Diagrammatic Method: Review

The Text Encoding Initiative (TEI) Situation

Non-nesting information poses fundamental problems for any XML-based encoding scheme, and it must be stated at the outset that no current solution combines all the desirable attributes of formal simplicity, capacity to represent all occurring or imaginable kinds of structures, suitability for formal or mechanical validation.

FRBR and Cultural Heritage Resource Description

- FRBR, as a theory, specifies one of many possible views of the *Bibliographic Universe* – as seen by Cultural Heritage institutions
- Complex structure of analog and digital resources and resource descriptions
 - Derived from potentially complex sets of human judgments of resource characteristics and existing resource descriptions
- Constructed (at present) by human descriptive acts

FRBR and Cultural Heritage Resource Description

- FRBR can be *implemented* as a more-or-less visualizable and traversable network of resources and resource descriptions
 - Printed characters on one or several catalog cards
 - Character data in an electronic information system
 - Flat-file, custom, or relational database
 - XML statements – HTML, RDF, Named Graphs, etc.
- But what does the future hold for FRBR as a resource description theory?

FRBR and the Future

The future for FRBR as a theory of bibliographic resource description depends on:

- Whether it provides an comprehensible and actionable “picture” of bibliographic (*and other forms of*) resource description
- Whether that picture can be accepted by a Cultural Heritage community that (a.) is steeped in traditions of textual description, and (b.) has had until recently relatively unchallenged curatorial control of Cultural Heritage resources and their descriptions.

This picture can emerge irrespective of cataloging’s status as art, craft, or scholarship.

FRBR and the Future

Cataloging can be approached as a *rule-governed, institutionally sanctioned resource description creation and management process*.

The *things of interest* to a Cultural Heritage institution – for which data must be collected, stored and retrieved – can be identified using analysis and design techniques adopted from the Information Technology field. The most popular conceptual and logical data modeling techniques generate their own imagery in addition to textual descriptions

FRBR and the Future

Cataloging can also be appreciated as a *creative intellectual activity* that centers on the examination, interpretation, and description of complex creative expressions produced by others

While cataloging is considerably more constrained in its results than scientific research, art practice, or scholarship in general, the history of science and of art at points of high creativity offer strong arguments for paying close attention to cataloging theory's enabling and constraining imagery

FRBR and the Future

- If the generation and use of theory-based resource description imagery is considered to be an essential aspect of FRBR theory formation, the parties creating conceptual data models of bibliographic materials face risks
 - Poor model specification, leading to incomplete understanding of the model by implementers and users
 - Inability to rapidly, creatively, and efficiently explore the model – especially when specific resource description configurations (real and imaginary) are involved
 - Difficulties in extending or reformulating existing resource description theories in the face of challenges presented by new media and information systems

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Five

*The World Wide Web, The
Semantic Web, And
A Trading Zone*

Five

Why Know About This?

Interactions between resource description theories and the information systems that implement them must be understood and exploited.

Ideas should travel in both directions.

A Trading Zone

A New Challenge:

The World Wide Web

A hypertext page has pieces of text which refer to other texts ... That text itself has links to other texts ... The texts are linked together in a way that one can go from one concept to another to find the information one wants. The network of links is called a web ...

The web need not be hierarchical ... The web is also not complete ... The texts are known as nodes ... The process of proceeding from node to node is called navigation ... Nodes can in principle also contain non-text information...

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The World Wide Web

Library of Congress Home

http://www.loc.gov/index.html

GO Google

LIBRARY OF CONGRESS

ASK A LIBRARIAN DIGITAL COLLECTIONS LIBRARY CATALOGS

GO Options

Resources for...

- [Kids, Families](#)
- [Librarians](#)
- [Publishers](#)
- [Researchers](#)
- [Teachers](#)
- [Visitors](#)

General Information

- [About the Library](#)
- [Concerts & Events](#)
- [Jobs/Fellowships](#)
- [Support the Library](#)
- [Shop the Library](#)
- [Inspector General](#)

More Library Resources

- [American Folklife Center](#)
- [Braille, Audio Materials](#)
- [Copyright Office](#)
- [Copyright Royalty Board](#)
- [Kluge Center](#)
- [Law Library of Congress](#)
- [Poetry](#)
- [Research Centers](#)

[RSS](#) | [Blog](#)

[Podcasts](#)

AMERICAN MEMORY EXHIBITIONS THOMAS WORLD DIGITAL LIBRARY VETERANS HISTORY myLOC.gov

AMERICAN MEMORY

American Memory provides free and open access to historic maps, photos, documents, audio and video.

→ GO

Library Highlights

- National Book Festival Sep. 26**
John Grisham, John Irving, Judy Blume among authors
- Wise Guide to loc.gov**
Newspapers, postcards, teachers and more
- Webcasts from the Library**
Stevie Wonder premieres "Sketches of a Life"
- Places in the News**
Headline locations from the Library's map collections
- Today in History** | August 27
Travel back in time through American Memory

News from the Library

- August Film Series at Packard Campus**
Silents, foreign films, John Wayne and more
- Book Festival Lineup Expands**
Patterson, Pelecanos, Grimes, Robinson & Silva added
- 2009-2010 Concert Season Announced**
Art of the Quartet, commissions, Music & the Brain and more
- Library Opens New Storage Facilities**
Modules 3 and 4 at Ft. Meade will hold 33 million items
- Copyright Office Adjusts Fees**
New rate schedule begins August 1
- [More news and upcoming events](#)

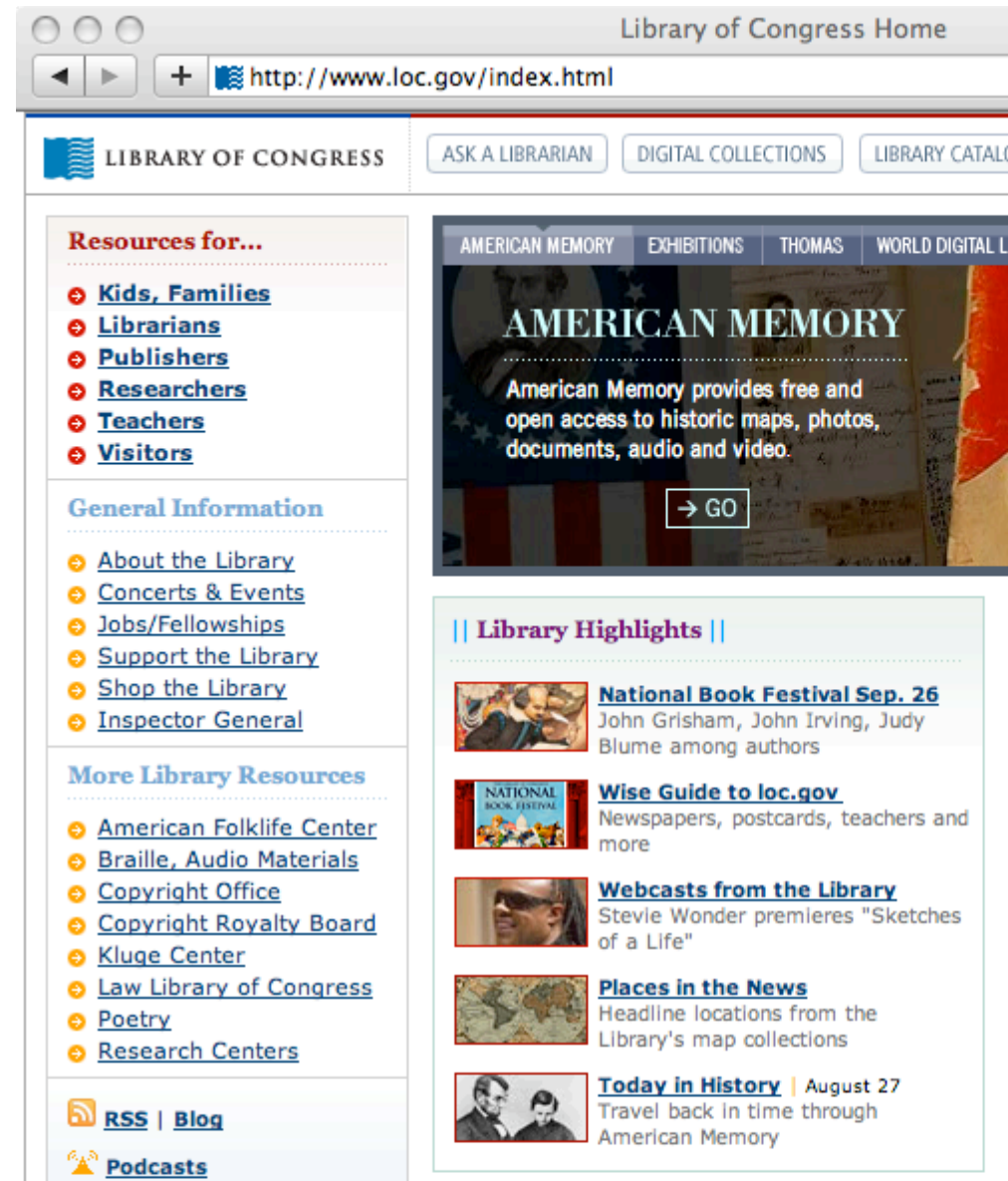
The Library at Work

[Lifelong Literacy](#)

The Next Step: The Semantic Web

Limitations of the World Wide Web Information Retrieval System

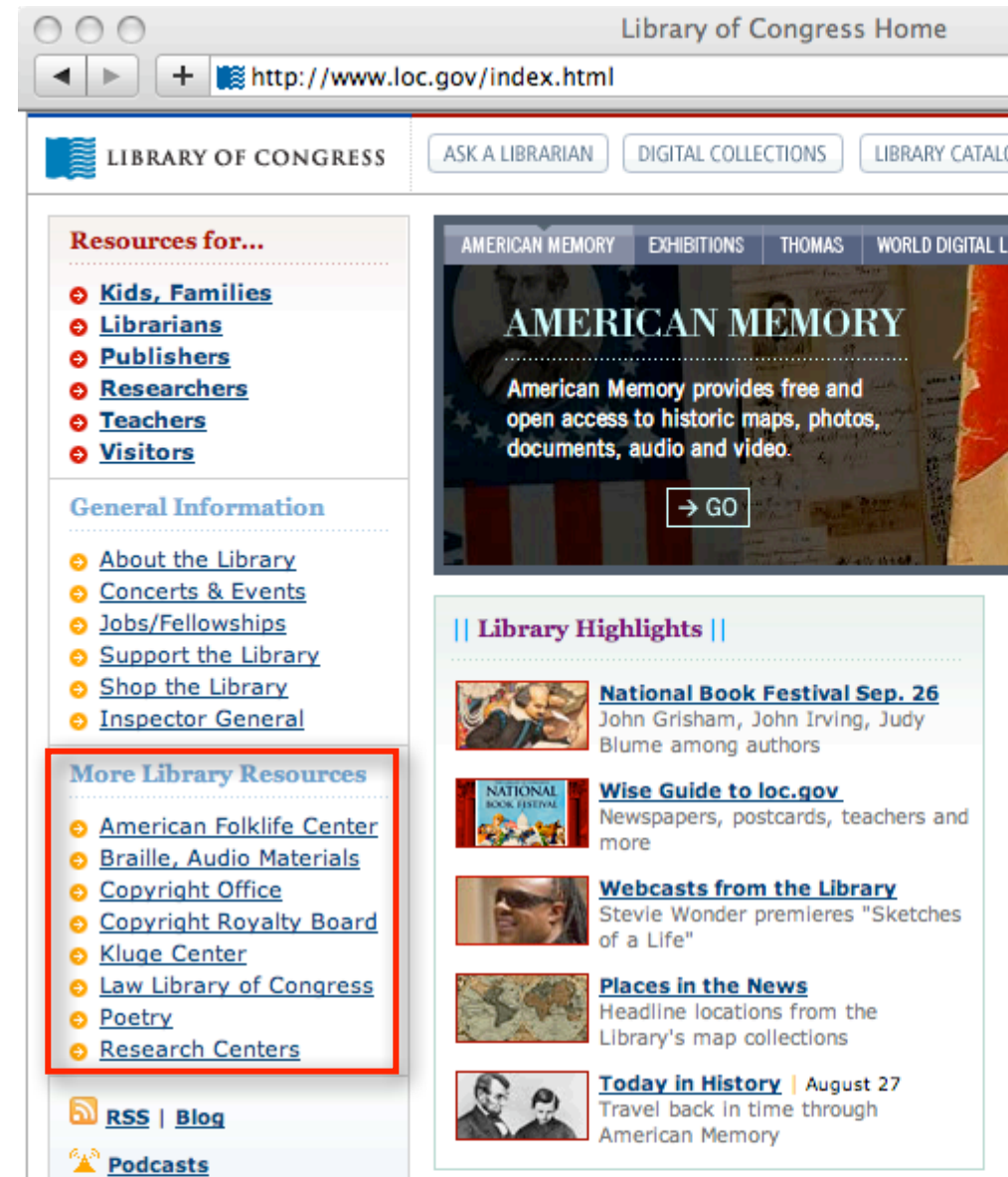
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- Resources composed using HTML did not readily convey their author's "meaning" to programs that process it



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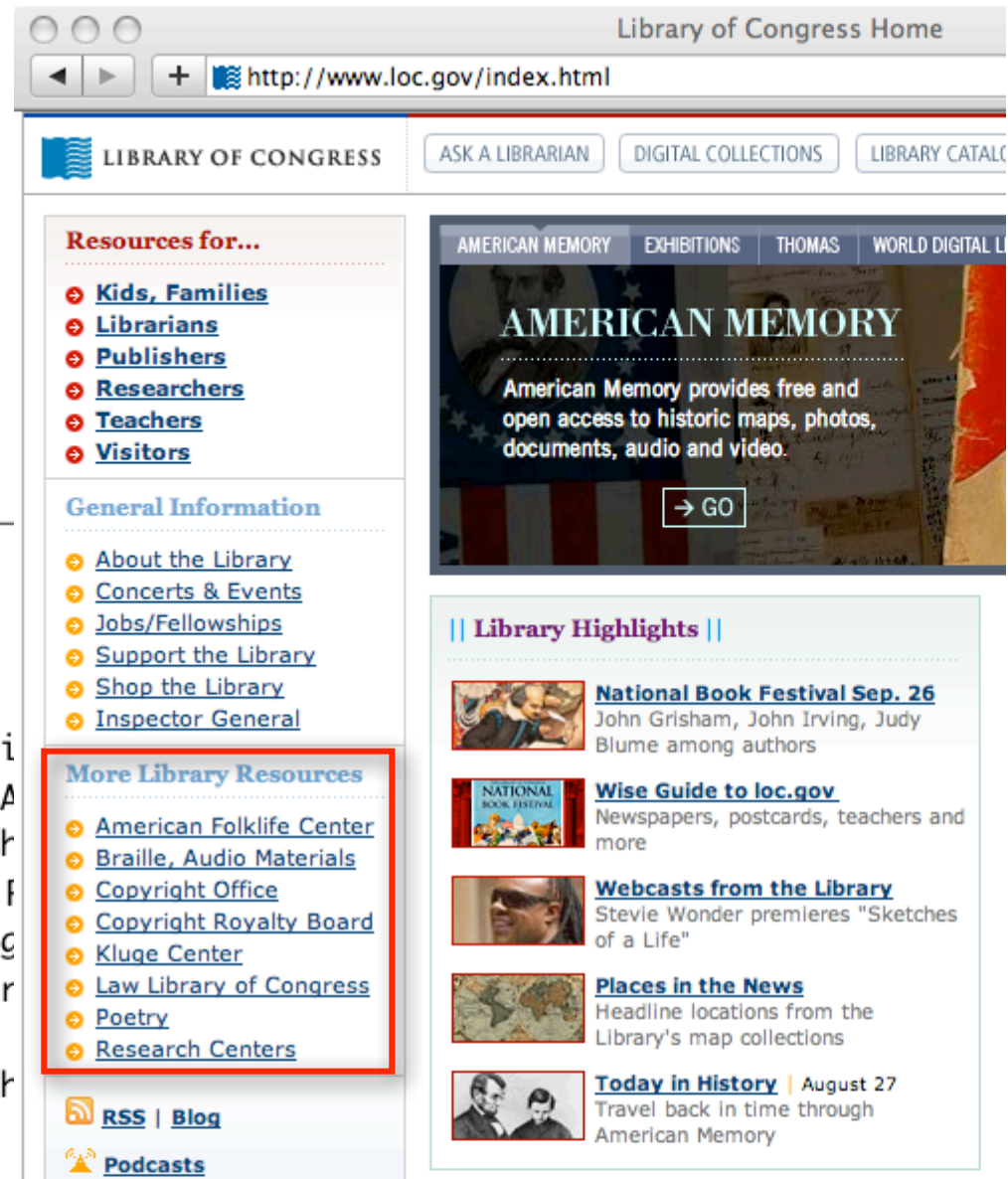
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- Poetry
- Research Centers



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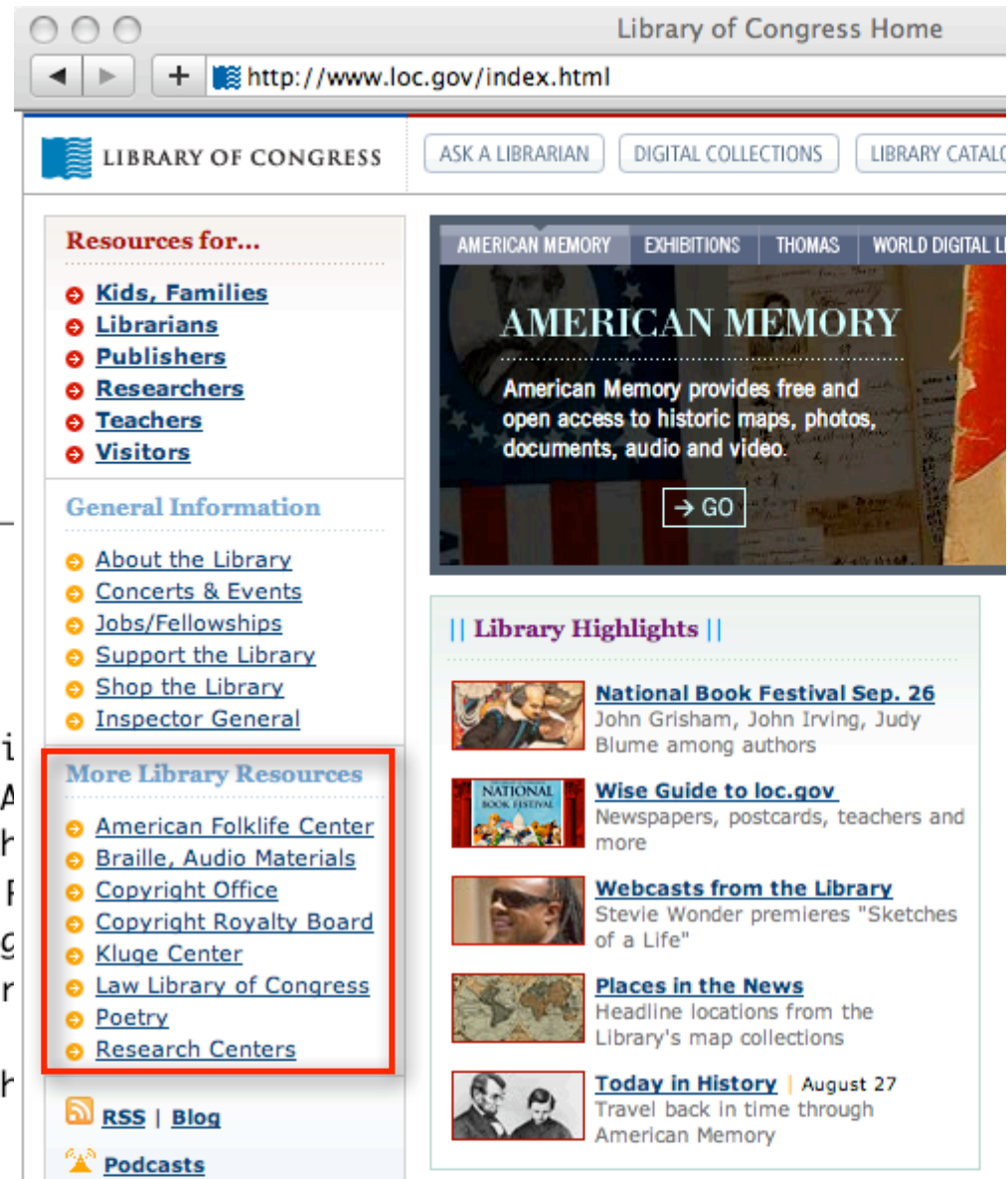
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Institutional Subdivisions?
Subjects?
Media Types?

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  <li><a href="http://www.loc.gov/law/">Law Library of Congress</a>
  <li><a href="/poetry/">Poetry</a></li>
  <li><a href="/rr/research-centers.html">Research Centers</a></li>
</ul>
```



The Next Step: The Semantic Web

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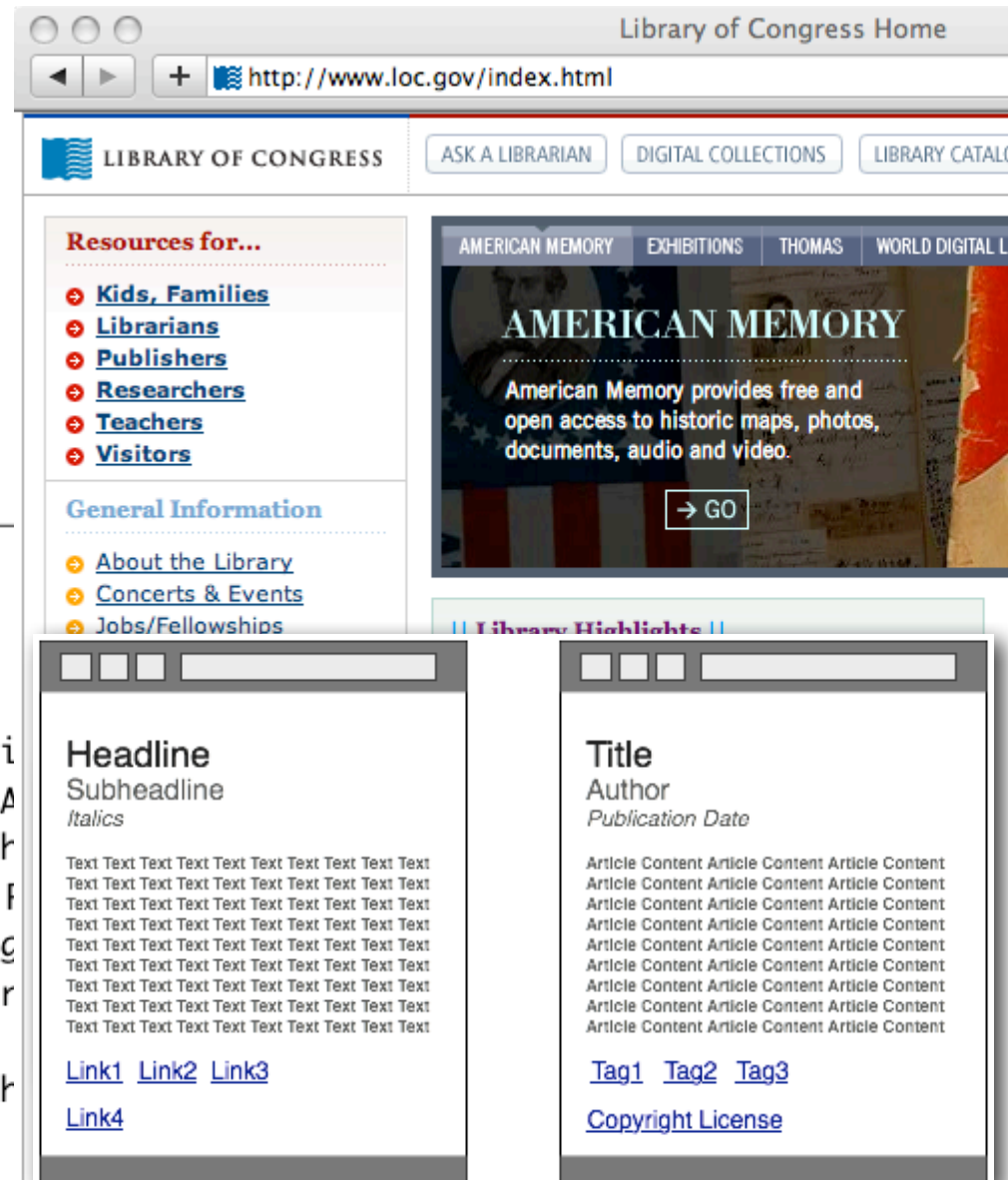
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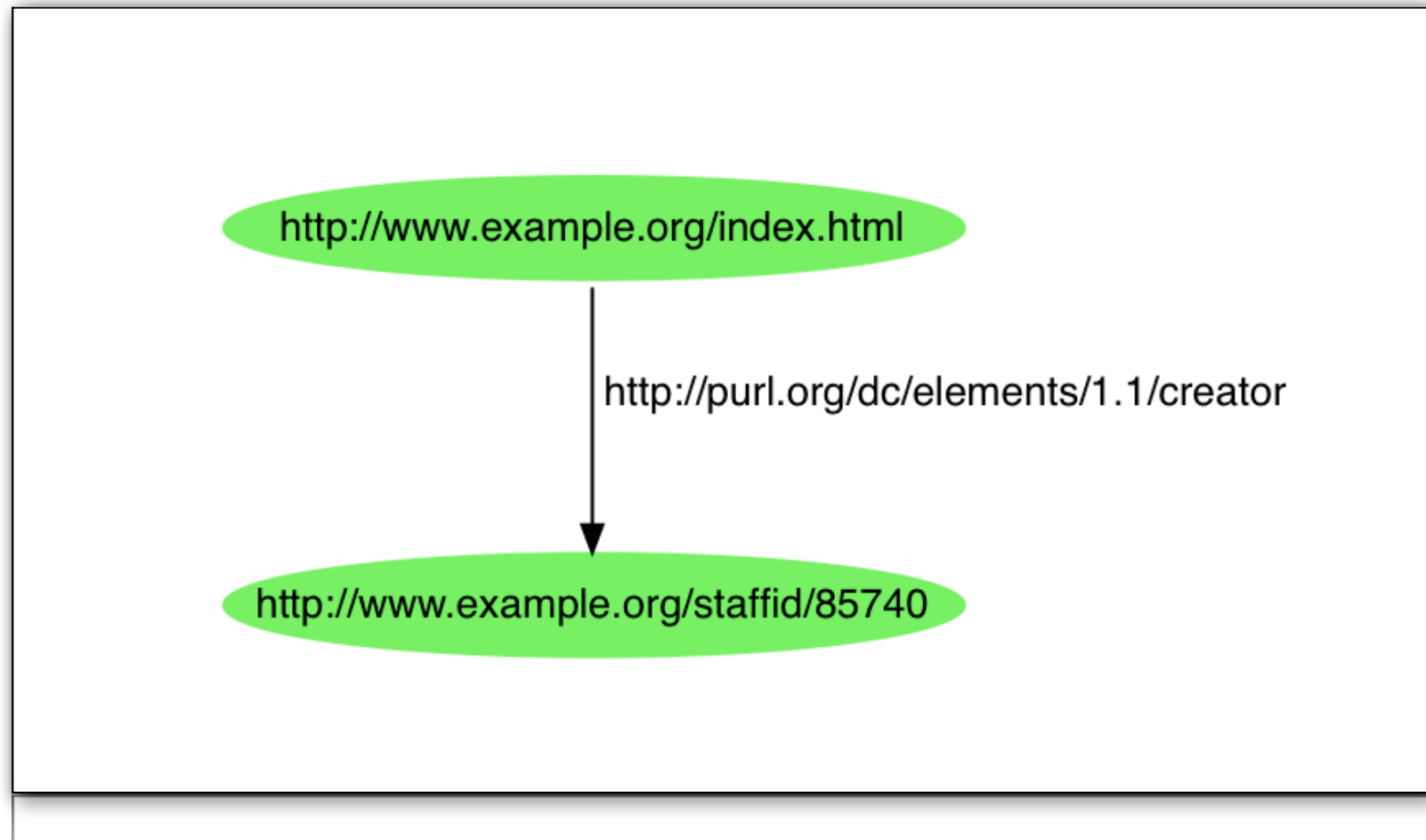
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  <li><a href="http://www.loc.gov/loc/kluge/">Kluge
  <li><a href="http://www.loc.gov/law/">Law Librar
  <li><a href="/poetry/">Poetry</a></li>
  <li><a href="/rr/research-centers.html">Research
</ul>
```

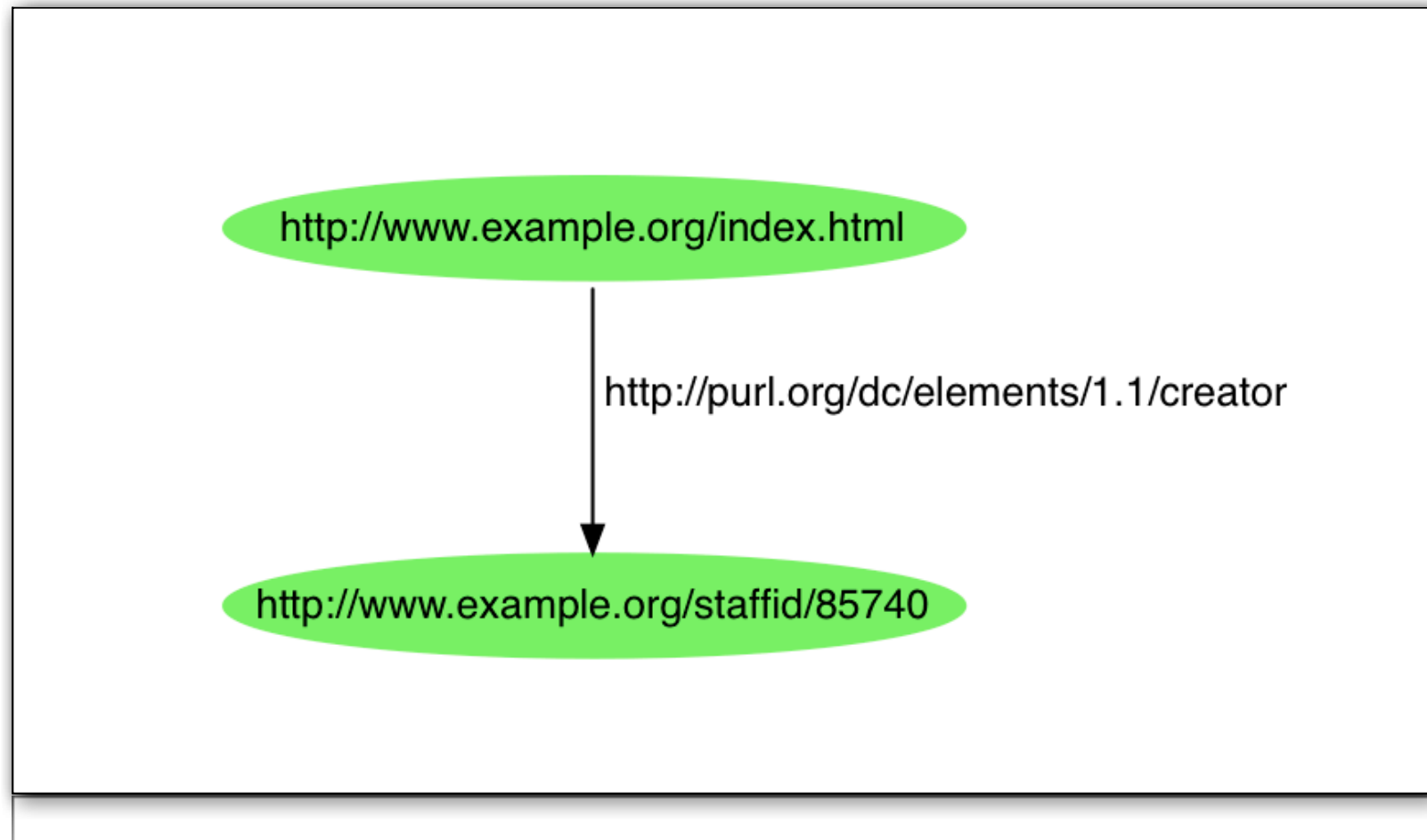


The Next Step: The Semantic Web



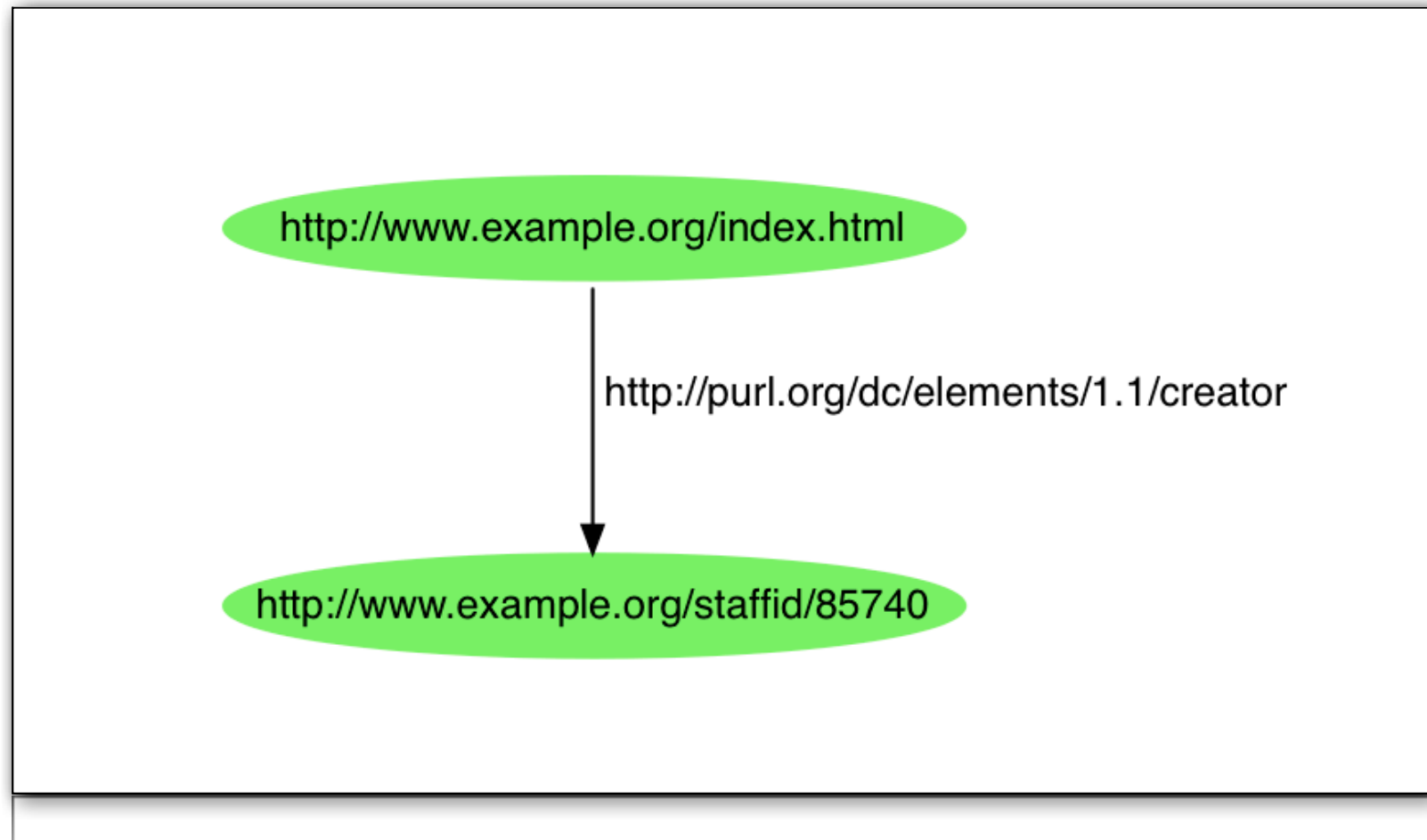
- Semantic Web Theory – Host a bevy of resources, and reduce resource descriptions to elemental Resource Description Framework (RDF) statements

The Next Step: The Semantic Web



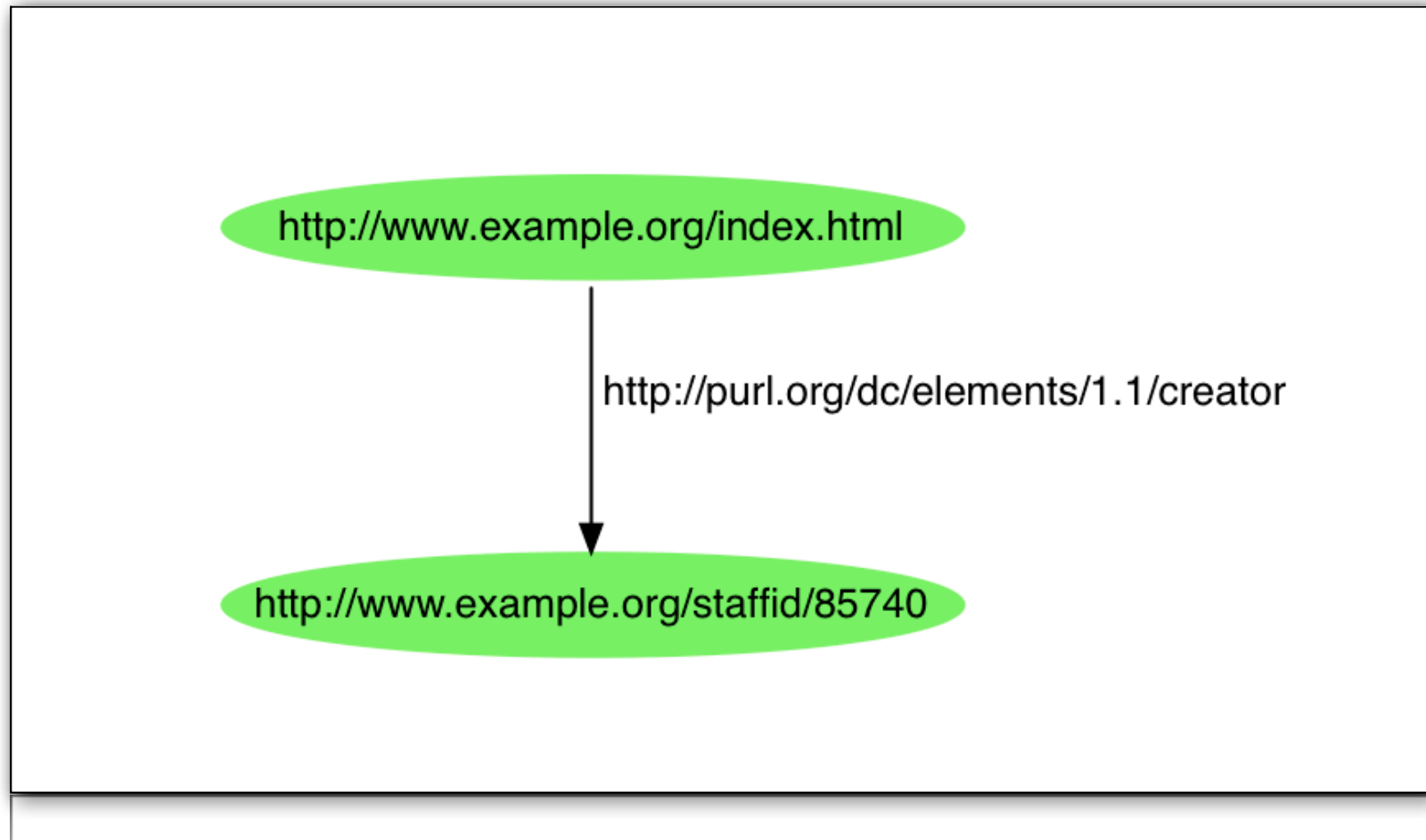
- The simplest level of Resource Description Framework (RDF) statement takes the form of `<subject> <predicate> <object>`

The Next Step: The Semantic Web



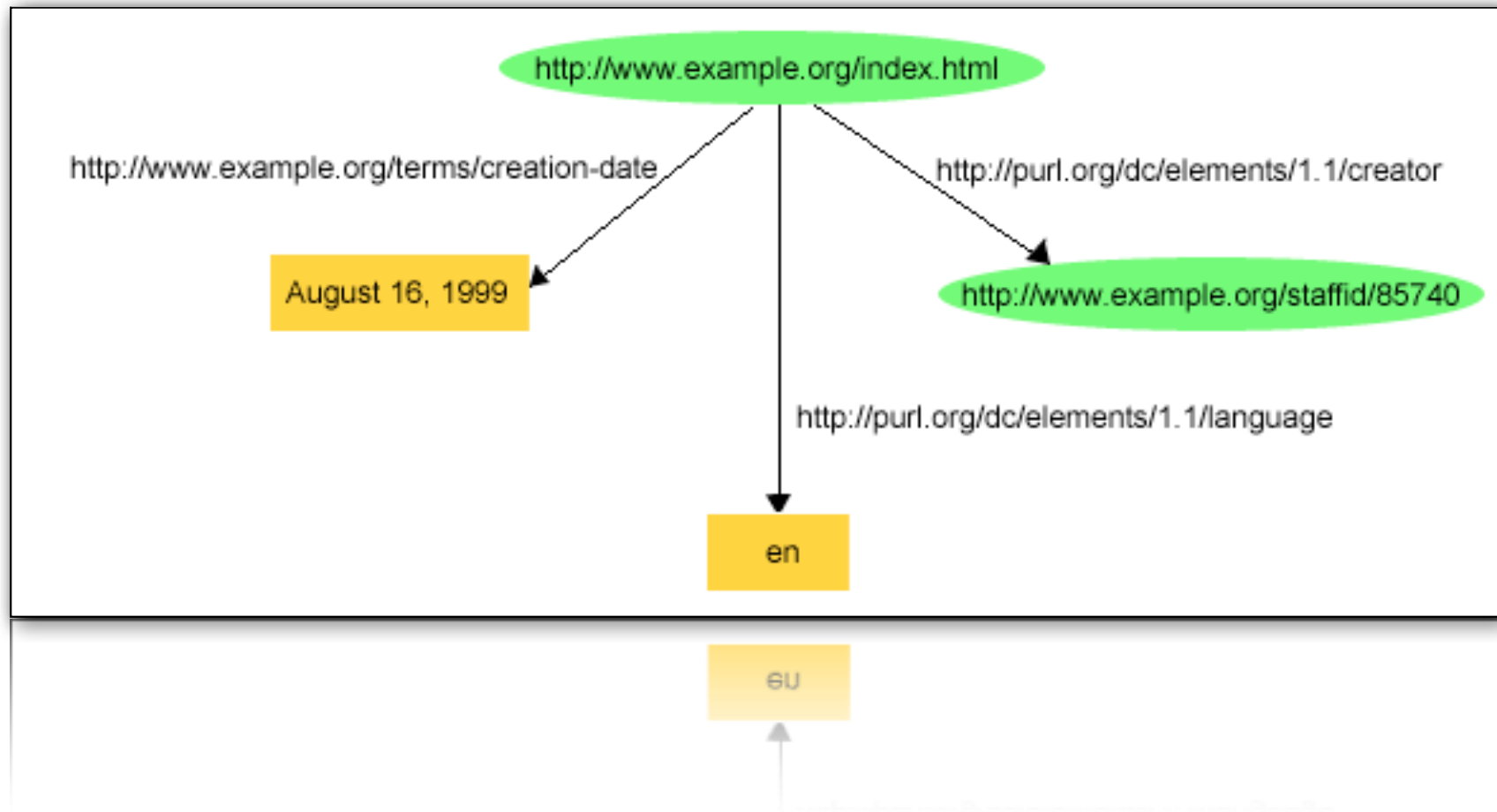
- RDF “triple” statements – when implemented in XML – provide a layer of descriptiveness and structure that is not available in unadorned XML

The Next Step: The Semantic Web

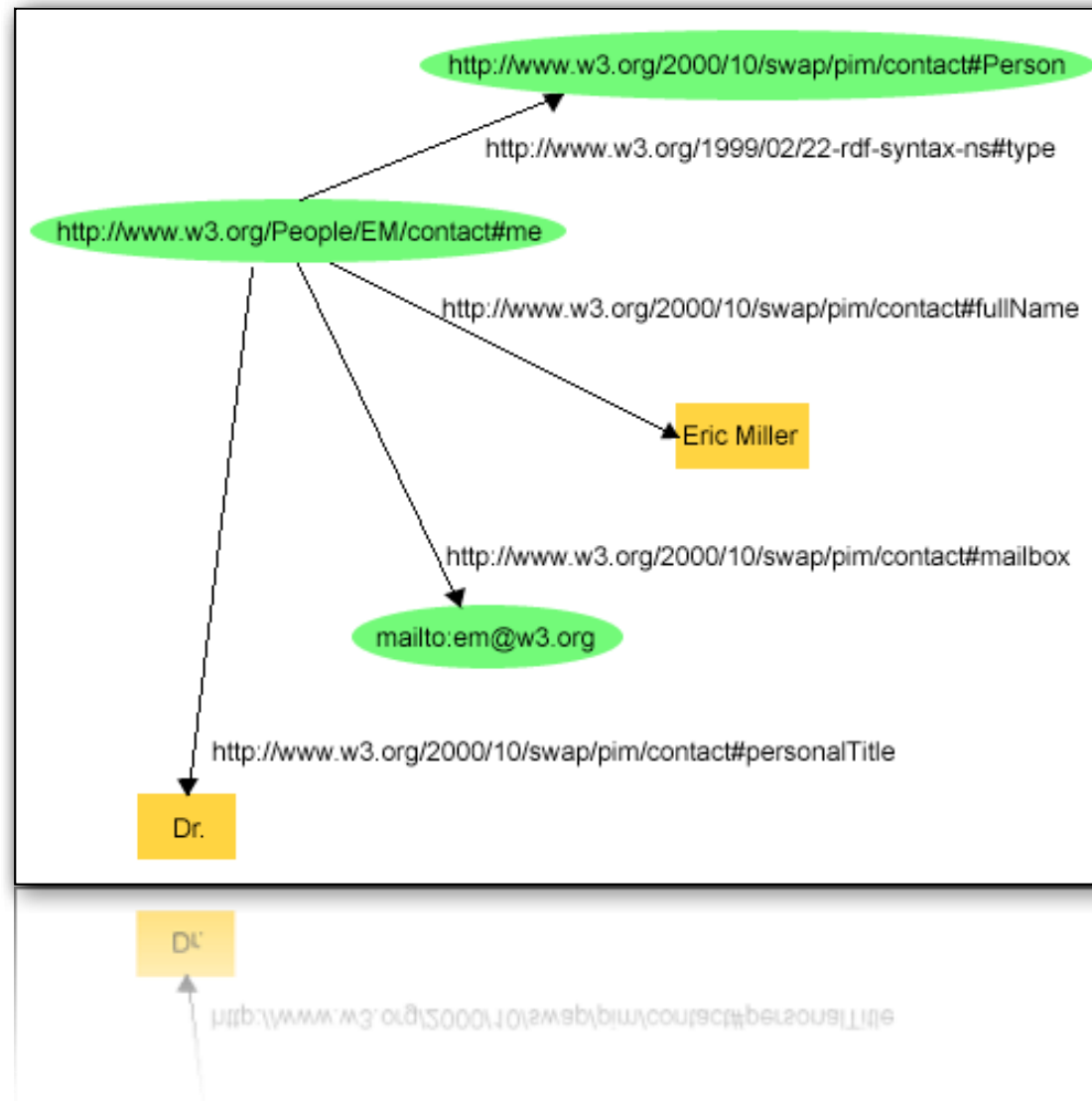


- Construction of simple RDF configurations

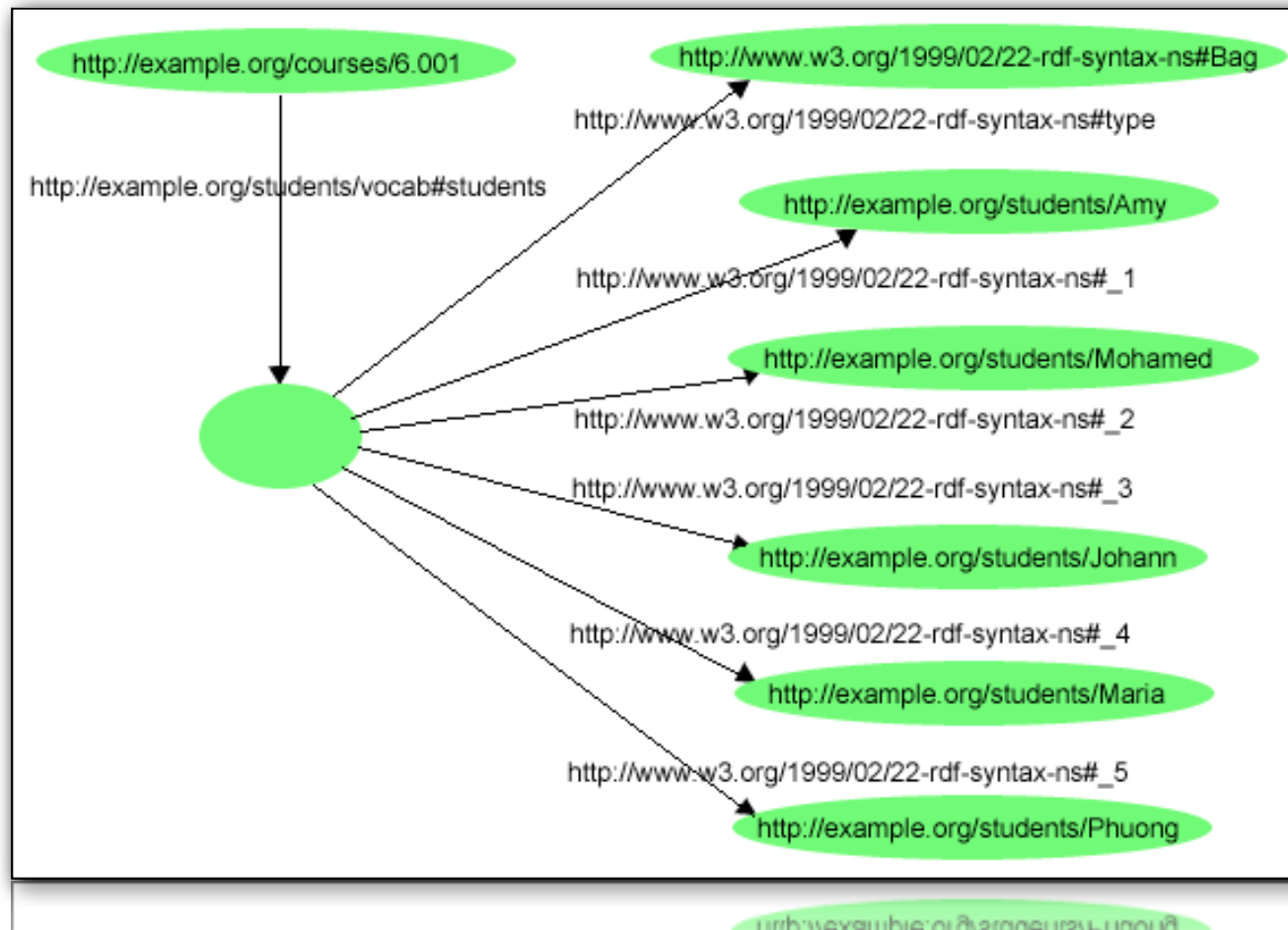
The Next Step: The Semantic Web



The Next Step: The Semantic Web

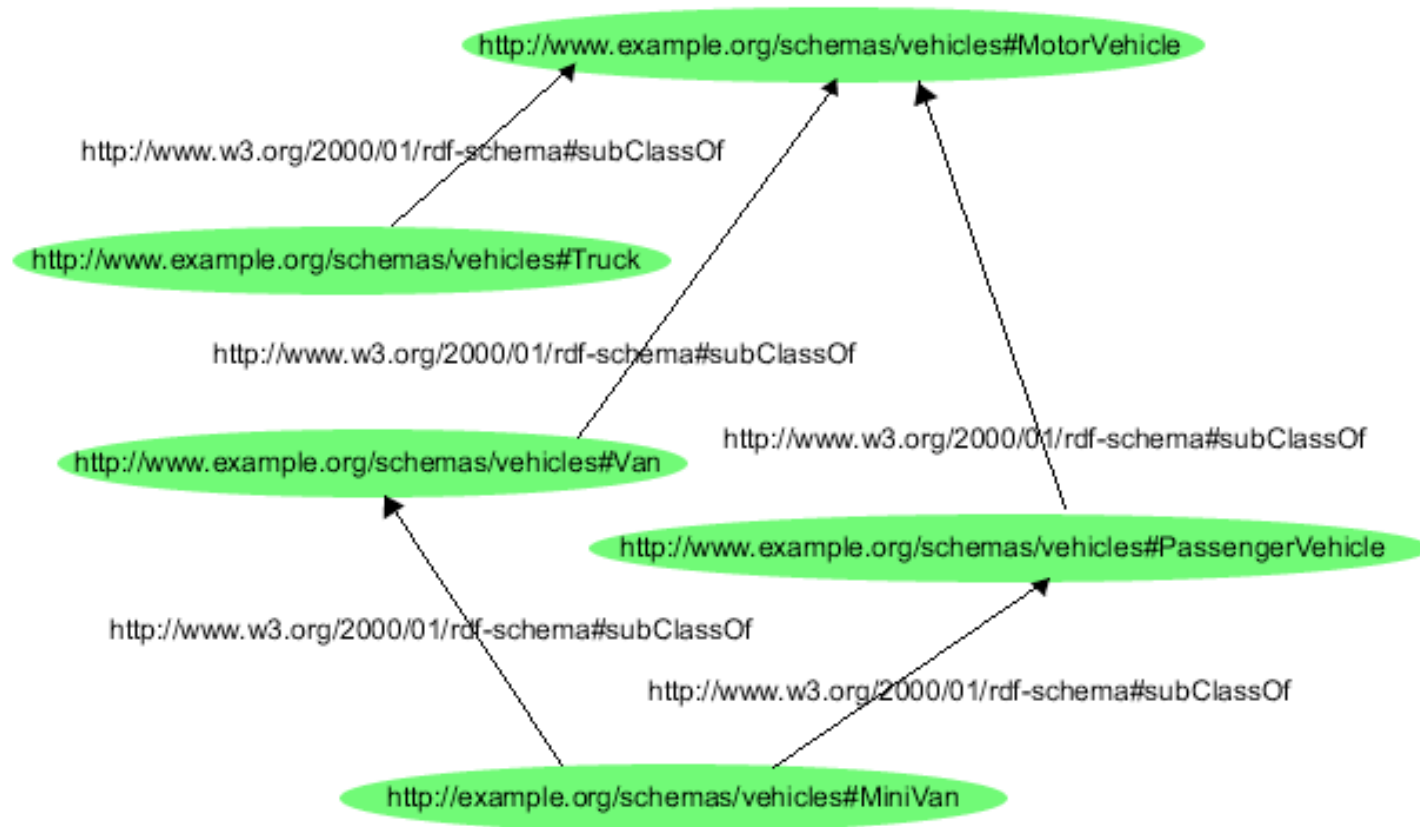


The Next Step: The Semantic Web



- Structuring of RDF resource description statements regarding two *things of interest*: Students and courses

The Next Step: The Semantic Web



- Classification of motor vehicles, including one that possesses characteristics of two vehicle types

Semantic Web Data Model Reduction

From flat-file record ...

Author:	Lee, T. B.
Title:	Cataloguing has a future
Content type:	Spoken word
Carrier type:	Audio disc
Subject:	Metadata
Provenance:	Donated by the author

University of Strathclyde

CENTRE FOR DIGITAL LIBRARY RESEARCH

Semantic Web Data Model Reduction

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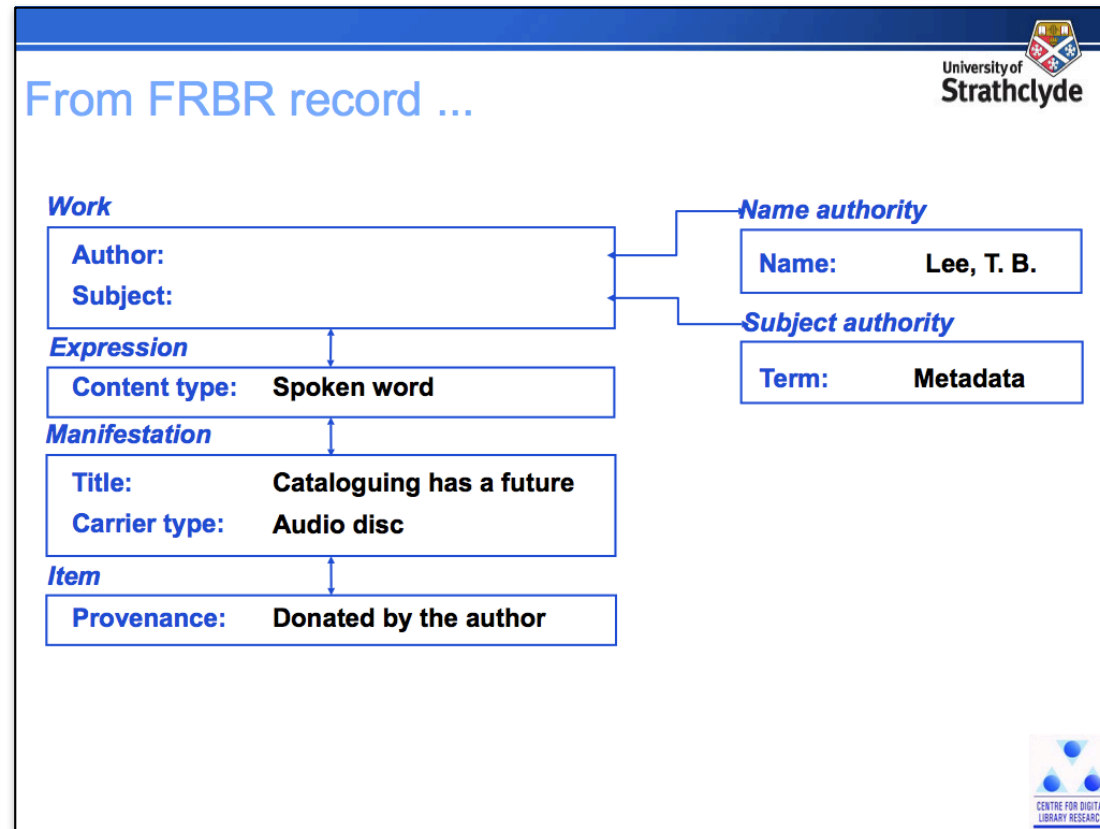
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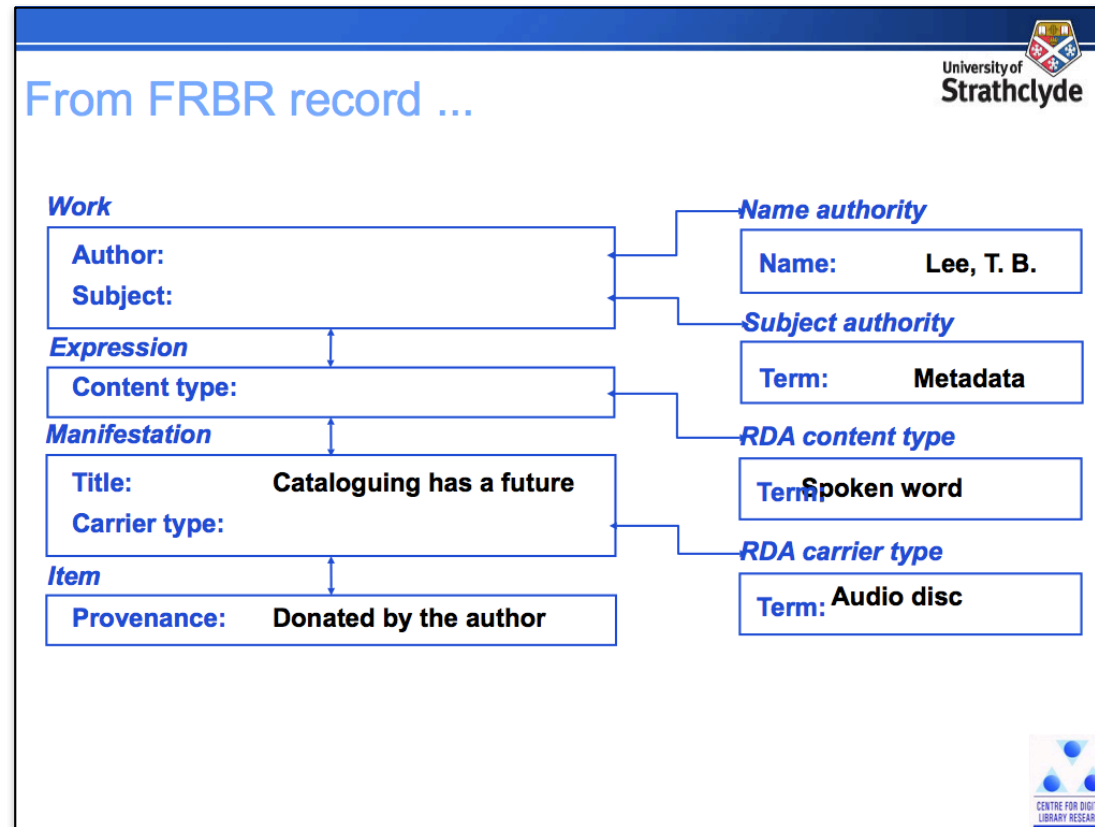
- A key Semantic Web design consideration is that disaggregated RDF resource descriptions can be reassembled as needed

Semantic Web Data Model Reduction



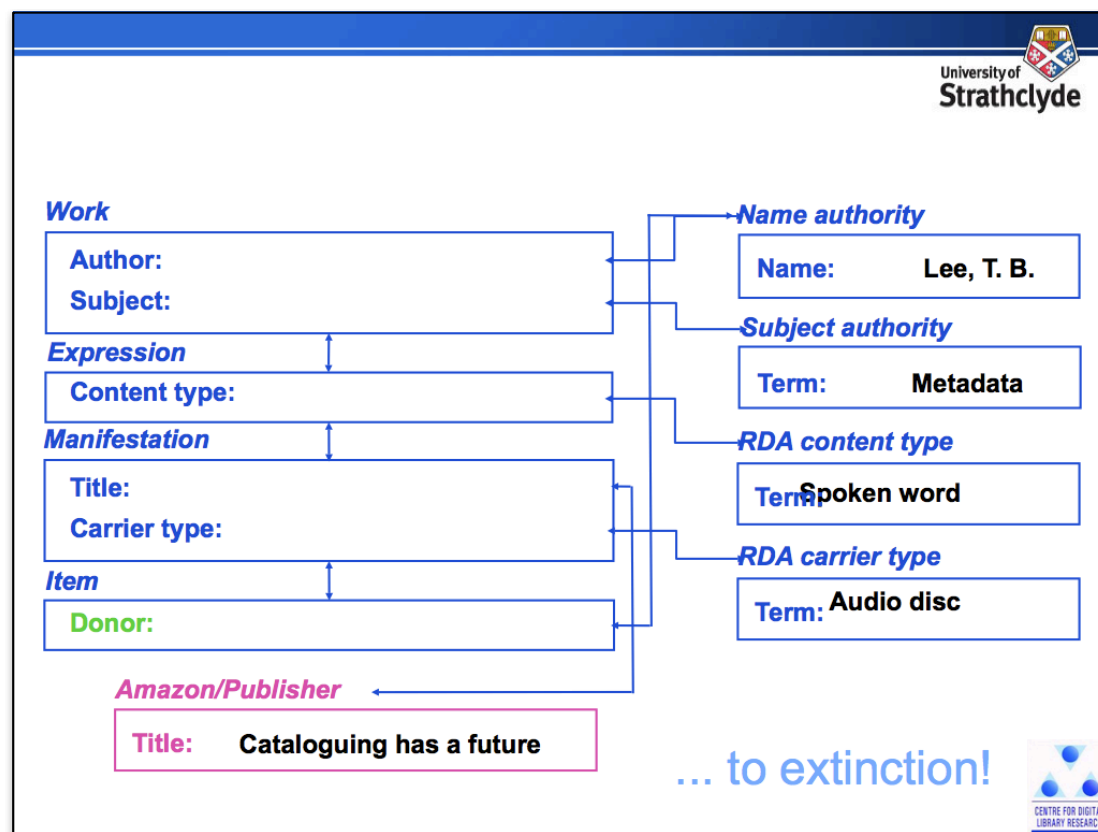
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Semantic Web Data Model Reduction



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Semantic Web Data Model Reduction

The Semantic Web will be a web of metadata, broken-down into simple statements which can be re-aggregated in many different combinations. If all archive, library and museum metadata are processed in this way, the different domains can take advantage of each other's expertise and output.

- A key Semantic Web design consideration is that disaggregated RDF resource descriptions can be reassembled as needed

Semantic Web Data Model Reduction

*There will be no metadata records, only one metadata record covering everything, or a near-infinite number of different metadata records, depending on the **point-of-view** of the metadata user. The Semantic Web will allow machines to create a metadata record for a particular resource just-in-time and on-the-fly, rather than have static records stored just-in-case. **The benefits of metadata creation and maintenance by information professionals will be available to all.***

- A key Semantic Web design consideration is that disaggregated RDF resource descriptions can be reassembled as needed

Semantic Web Data Model Reduction

*The user will have control over the presentation and detail of metadata. Recombination from the **basic building blocks of the RDF triples** will allow information retrieval interfaces to display a record in formats familiar to users of archives, libraries or museums (and users of Amazon, Google and Flickr), as well as innovative layouts. (Dunsire)*

Semantic Web Data Model Reduction

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- As far as FRBR theory is concerned, this is a “... *but not simpler*” scenario

Semantic Web Data Model Reduction

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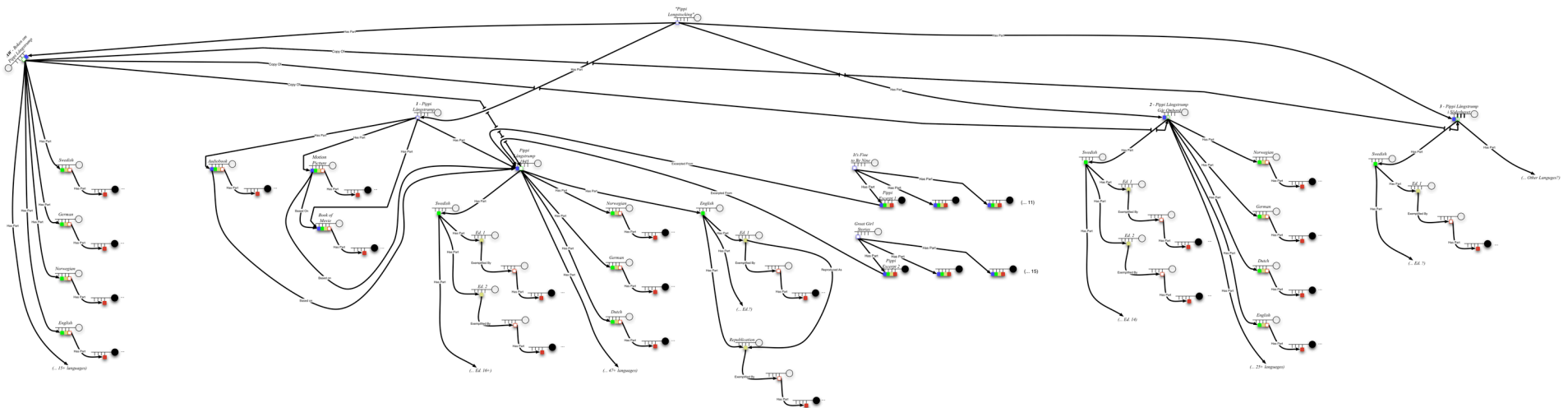
- The “basic building block” scenario as stated does not allow for the construction of *new classes of building blocks* composed of the basic RDF units

Semantic Web Data Model Reduction

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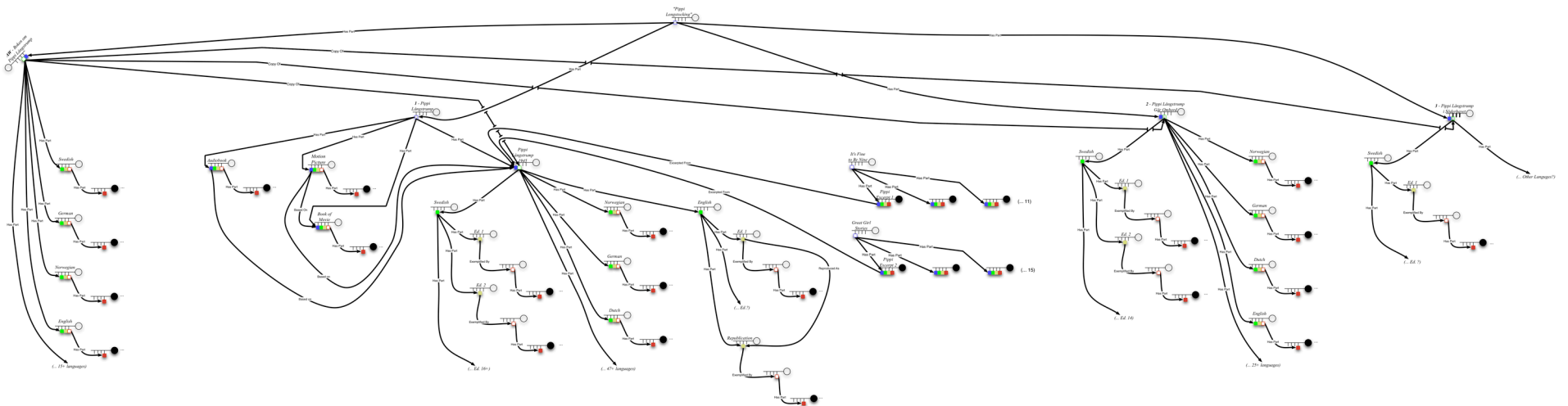
- The theoretical situation compares to describing the universe in terms of subatomic particles – with no *persistent* intermediate entities like stars, people, etc.

Semantic Web Data Model Reduction



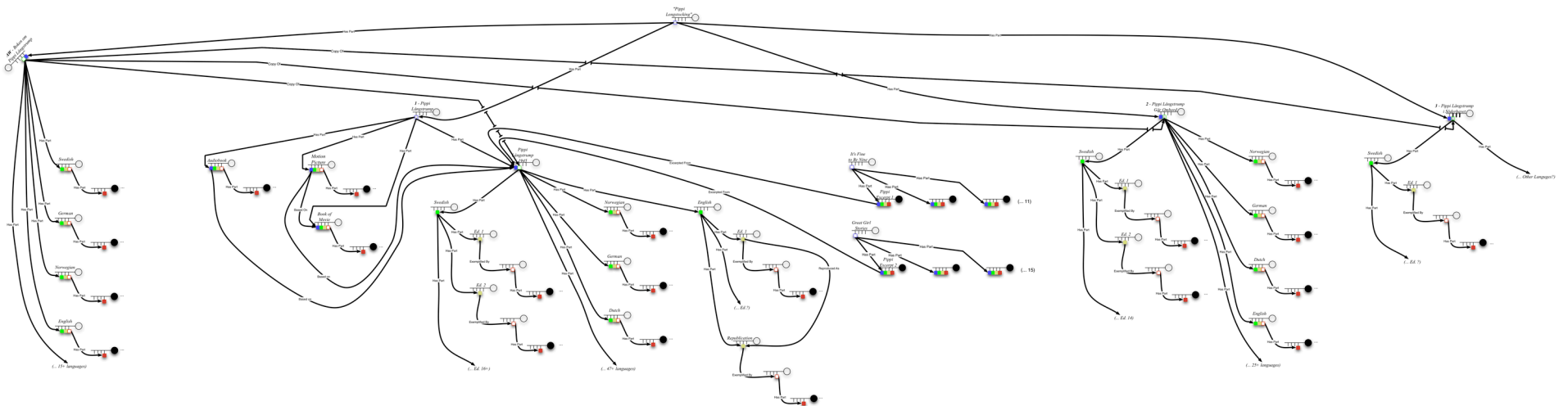
- In Dunsire's system, *sub-webs* of relationships between FRBR resource descriptions – webs whose properties can be glimpsed in *Pippi* – are not possible

Semantic Web Data Model Reduction



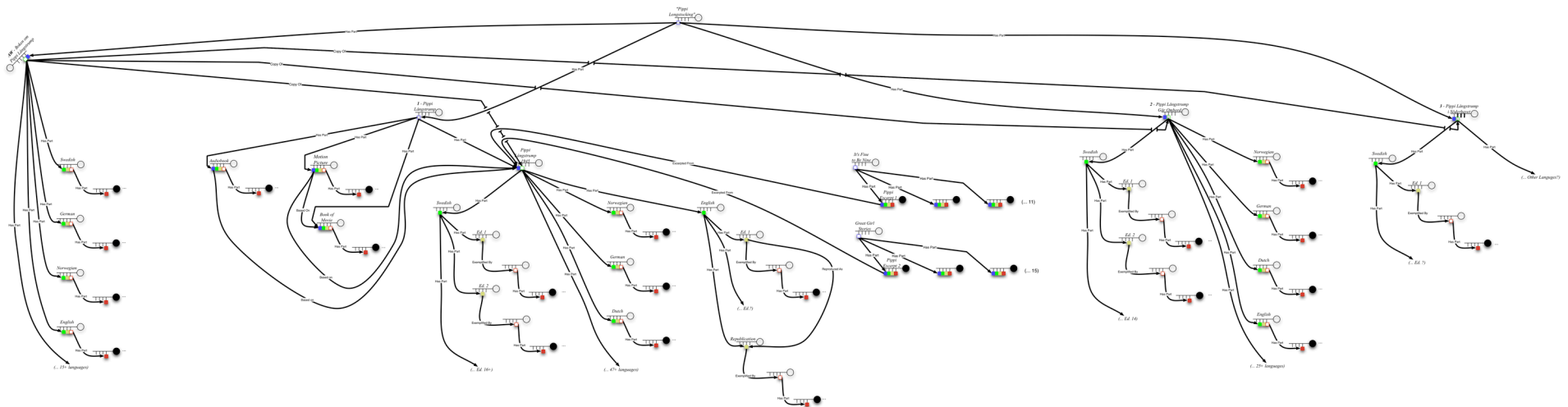
- The *Pippi* relationships were defined between *FRBR-specific* building blocks. Those blocks would be built from “simple” RDF statements

Semantic Web Data Model Reduction



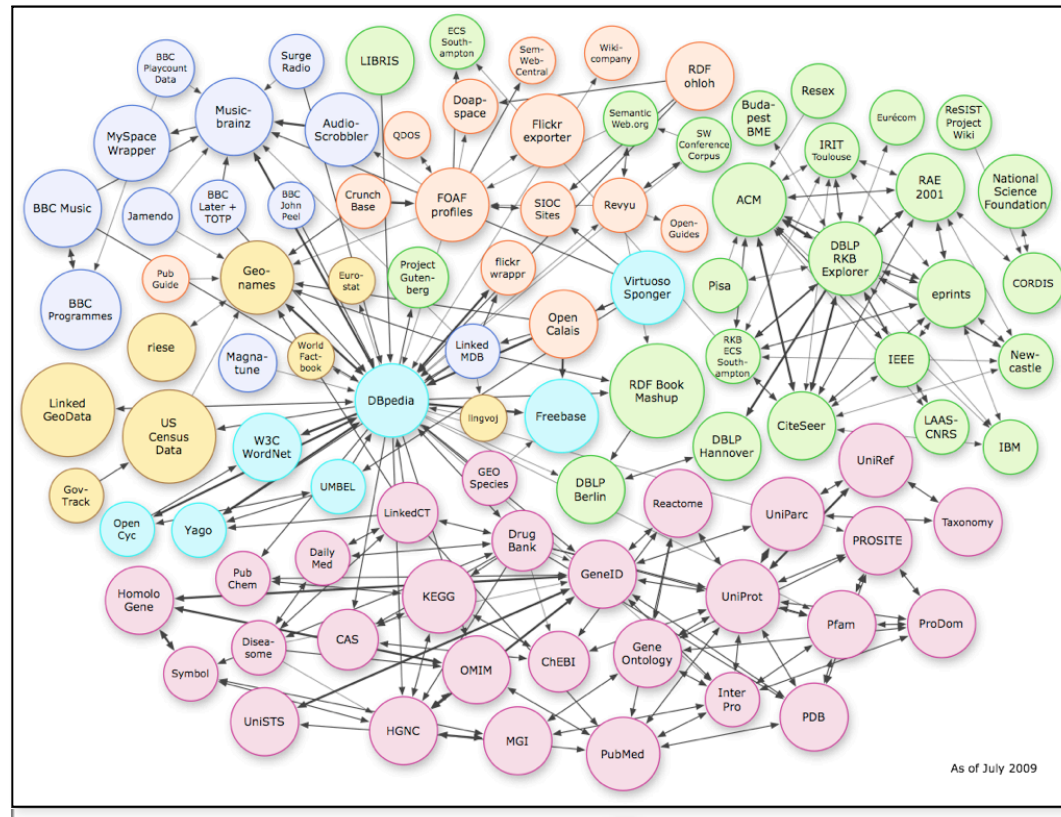
- Manipulations using the FRBR Paper Tool can be used to make a strong case for revising Dunsire's Semantic Web vision

Semantic Web Data Model Reduction



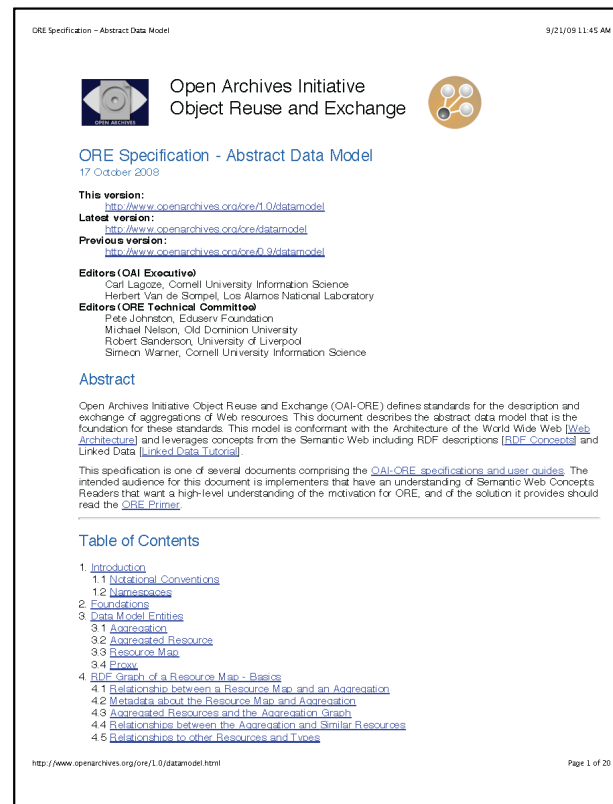
- Fortunately, another Semantic Web initiative focuses on creating intermediate Semantic Web building blocks of the type required to support FRBR theory

Two and a Half Semantic Web Resource & Resource Description Innovations



- The *Data Web* - A complex resource constructed by assigning URIs to data sources; allowing URIs to be referred to and looked up; adding useful resource descriptions; and linking to related Web resources

Two and a Half Semantic Web Resource & Resource Description Innovations



- The Open Archive Initiative Object Reuse and Exchange (OAI-ORE) specification

Two and a Half Semantic Web Resource & Resource Description Innovations

4. RDF Graph of a Resource Map - Basics

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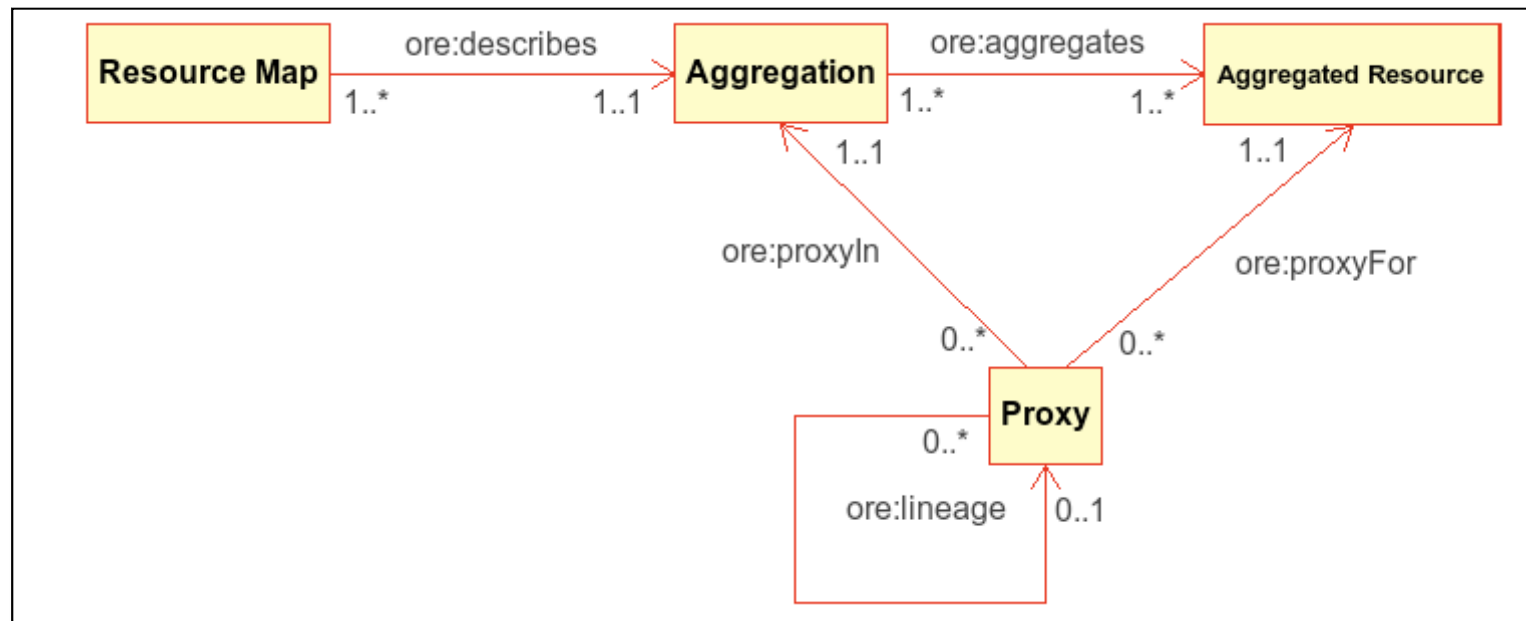
- OAI-ORE abstract data model prose specification

Two and a Half Semantic Web Resource & Resource Description Innovations

Subject	Predicate	Object	Occurs (Min, Max)	Note
ReM-1	ore:describes	A-1	(1, 1)	Relationship between Resource Map and Aggregation (4.1)
A-1	ore:isDescribedBy	ReM-i	(1, *)	Relationship between Resource Map and Aggregation (4.1)
ReM-1	rdf:type	ore:ResourceMap	(0, 1)	Typing of Resource Map (4.1)
ReM-1	dcterms:creator	Agent	(1, *)	Metadata about Resource Map (Required) (4.2)
ReM-1	dcterms:modified	literal	(1, 1)	Metadata about Resource Map (Required) (4.2)
ReM-1	URI-Property	literal or URI-Object	(0, *)	Metadata about Resource Map (Optional) (4.2)
URI-Subject	URI-Property	ReM-1	(0, *)	Metadata about Resource Map (Optional) (4.2)

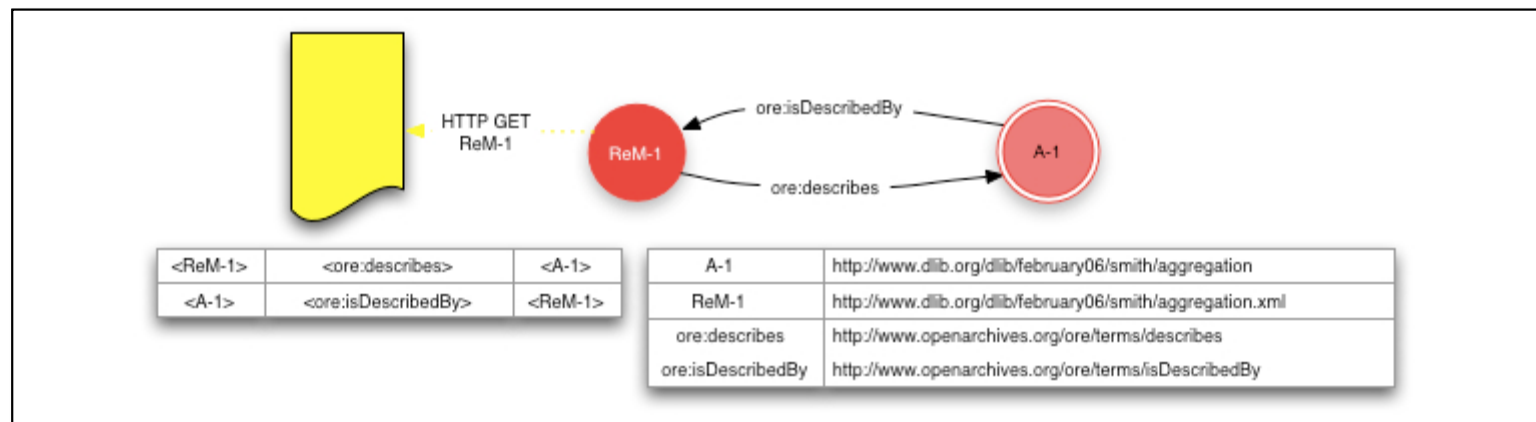
- *OAI-ORE Example* – Unified Modeling Language (UML) data model statements

Two and a Half Semantic Web Resource & Resource Description Innovations



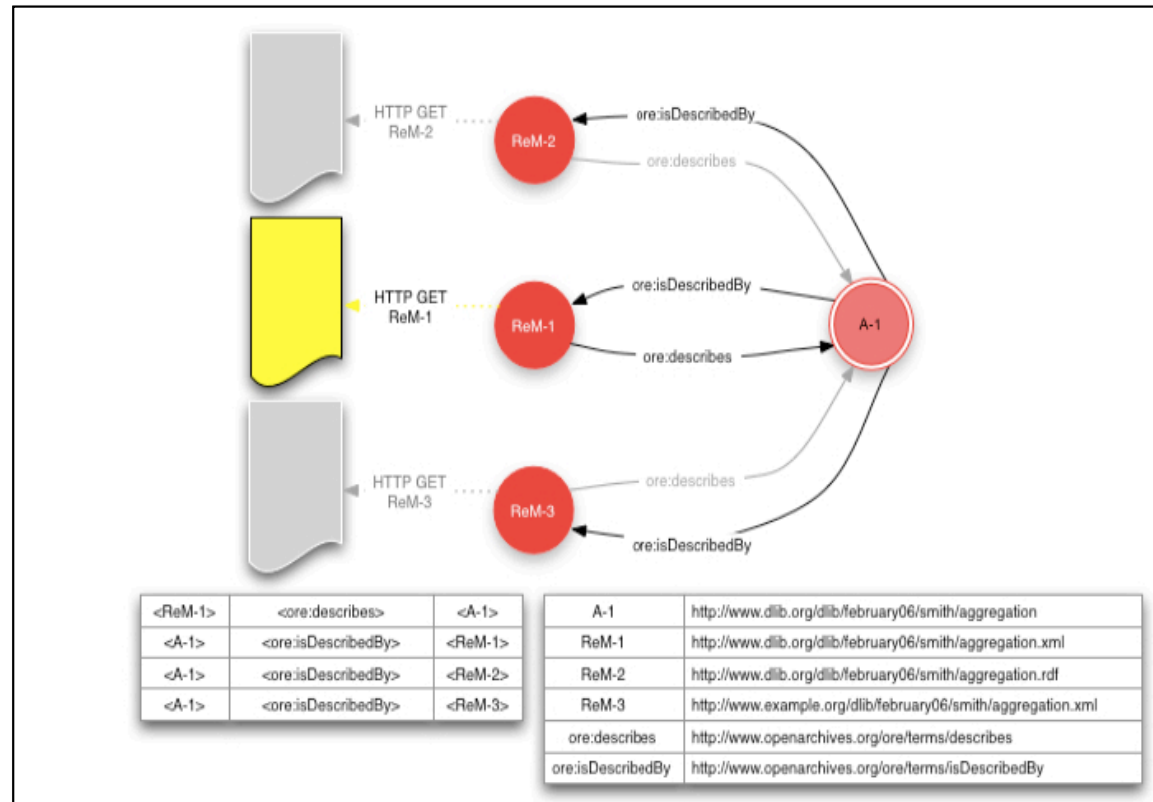
- OAI-ORE Unified Modeling Language data model. Note the one-way data modeling statements

Two and a Half Semantic Web Resource & Resource Description Innovations

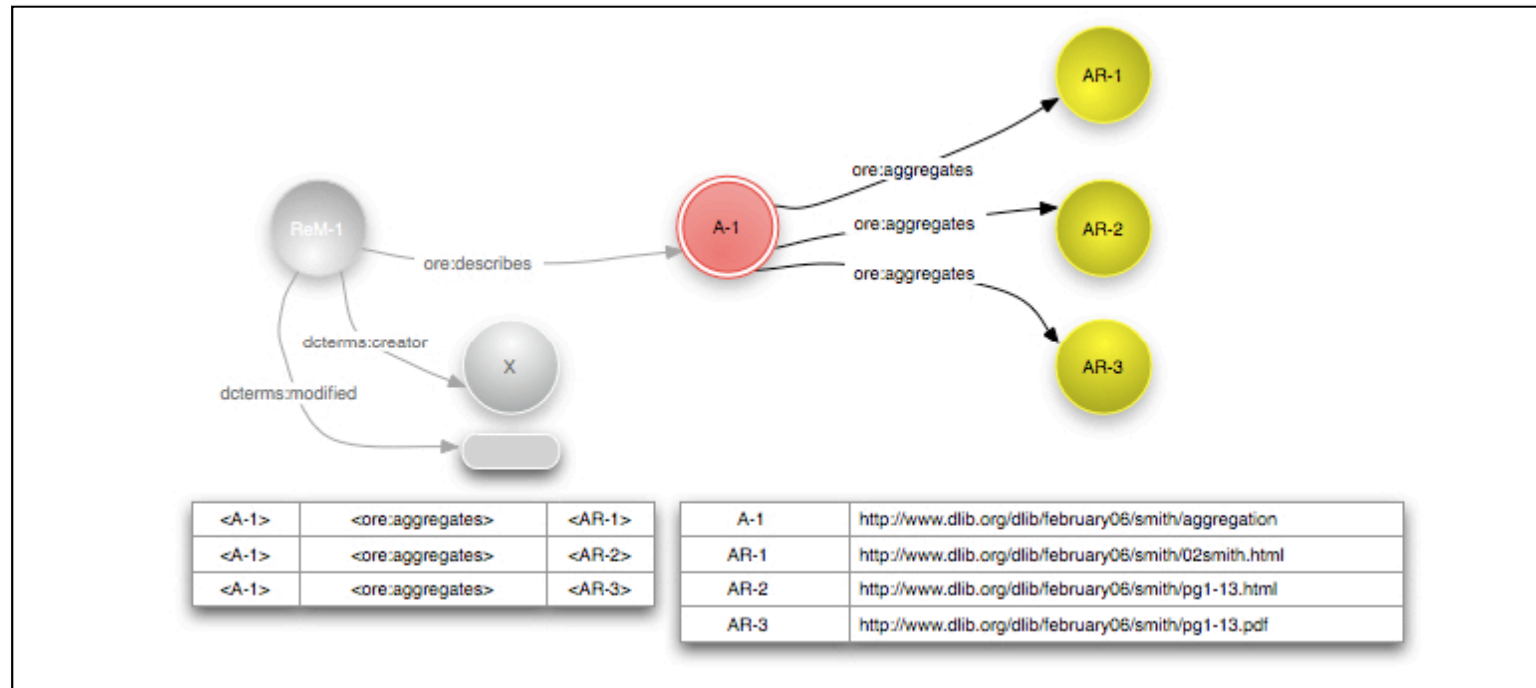


- *RDF Triple Two-Way Sentences* —
 - An aggregation is described by a resource map
 - A resource map describes an aggregation

Two and a Half Semantic Web Resource & Resource Description Innovations

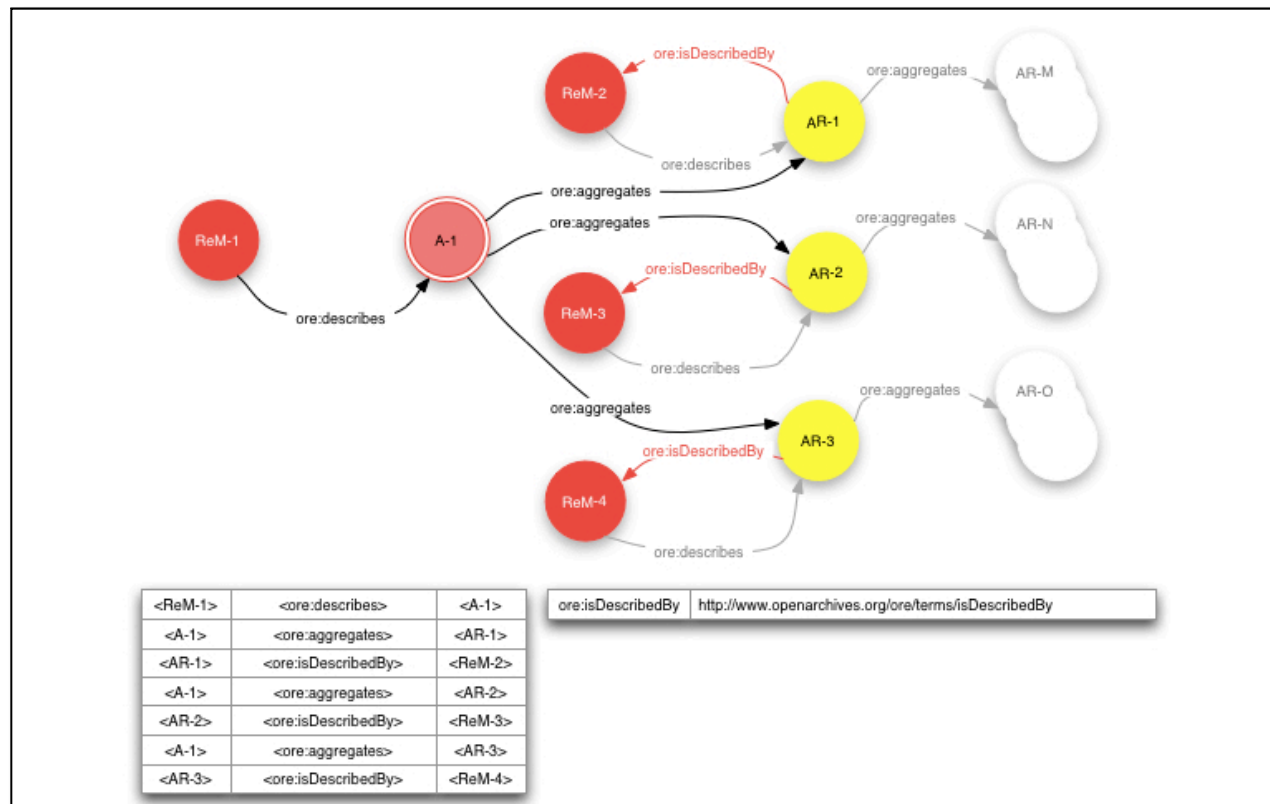


Two and a Half Semantic Web Resource & Resource Description Innovations

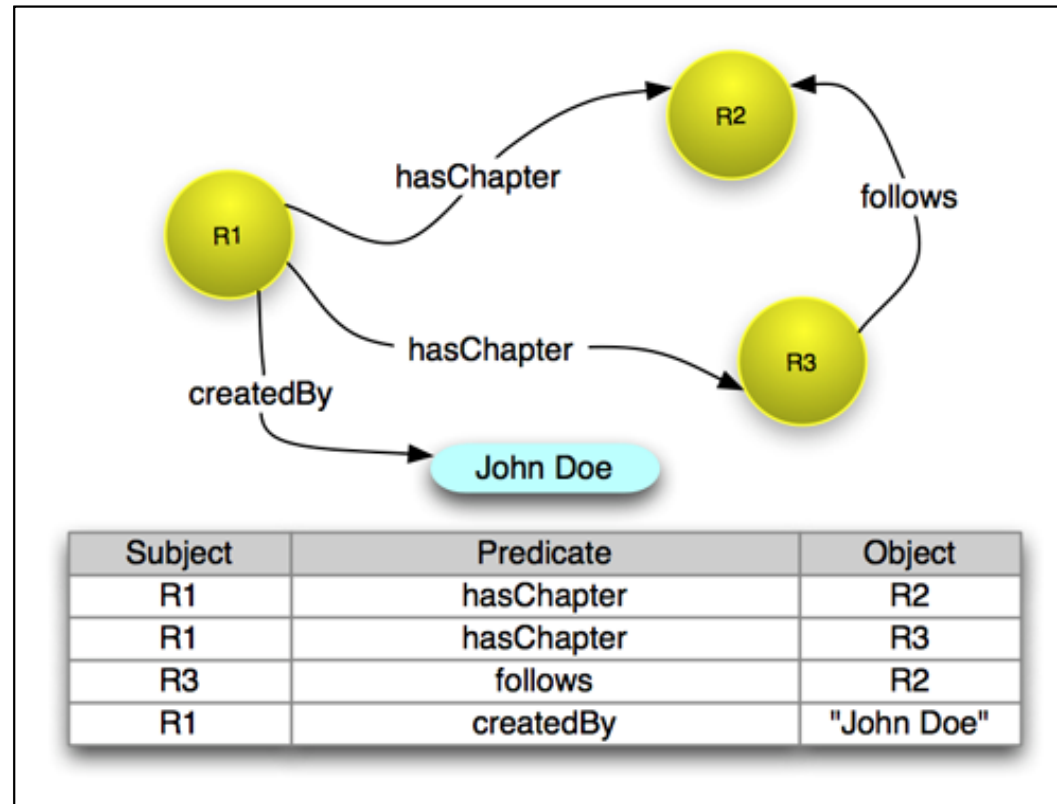


- *Managing RDF Triples* – Note the utility of bounding off selected resources and resource descriptions from *much larger* pools of resources and RDF statements (the tables go on and on...)

Two and a Half Semantic Web Resource & Resource Description Innovations

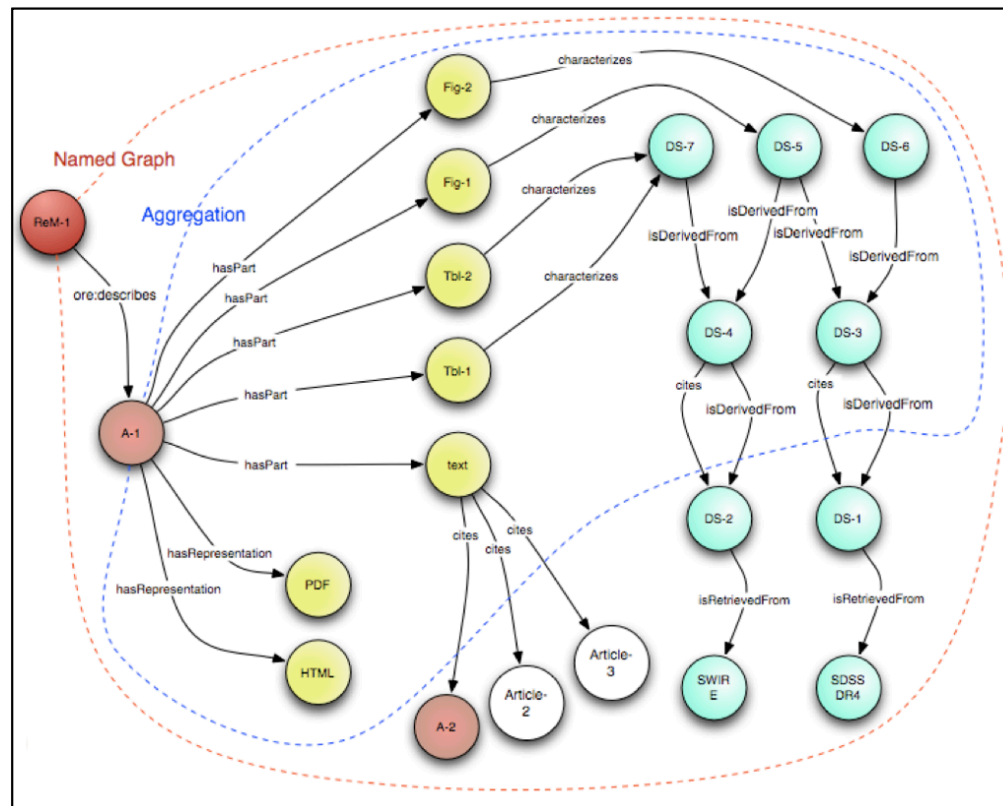


Two and a Half Semantic Web Resource & Resource Description Innovations



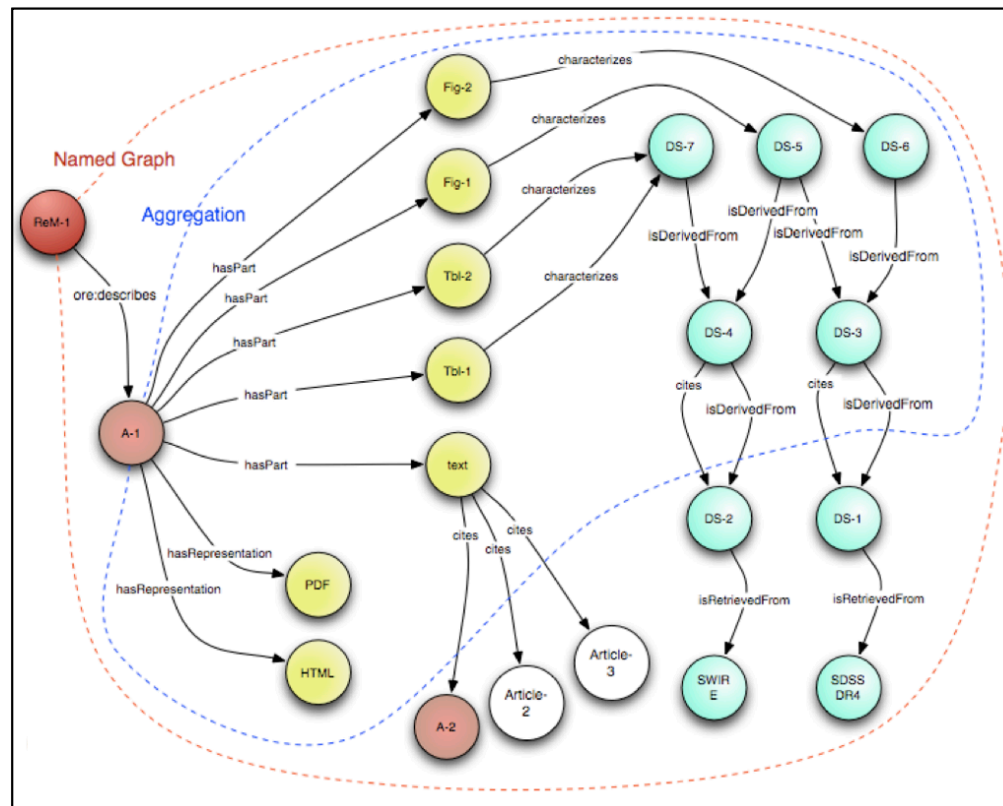
- *Useful Structures* – Structures built from elementary resource description statements can reflect *user views*. Emergent properties of and relationships between user views then become of interest

Two and a Half Semantic Web Resource & Resource Description Innovations



- *In Search of* – Persistent structured resources and structured resource descriptions that can serve as building blocks for user views

Two and a Half Semantic Web Resource & Resource Description Innovations



- OAI-ORE *Named Graphs* - Resource/resource description complexes. Named Graph construction will be ad-hoc, pragmatic and/or theory-based. *Whose theories or business rules* will direct it?

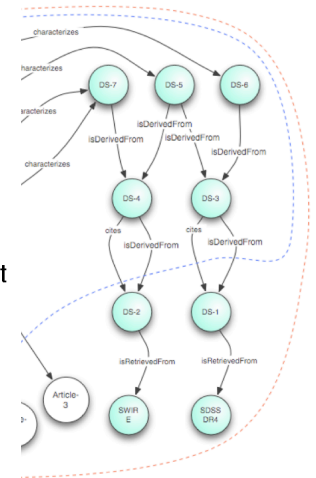
Semantic Web:

OAI-ORE Paper Tool Possibilities

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- An OAI-ORE Paper Tool - Using OAI-ORE diagrams to work out *exemplars* or to refine the underlying theory

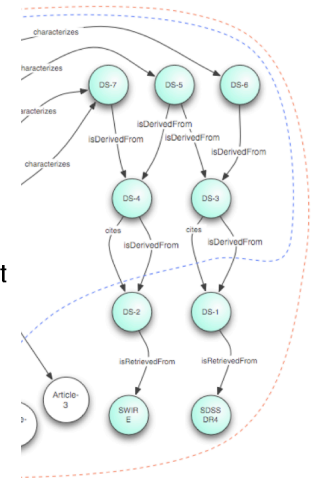
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- The OAI-ORE specification contains all of the elements used to make an OAI-ORE Paper Tool

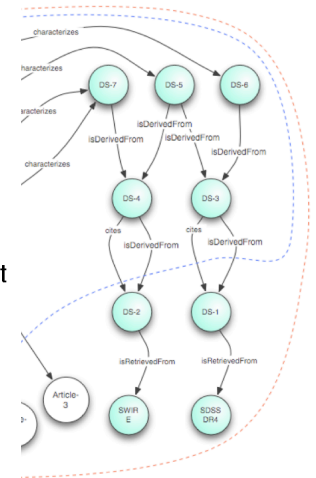
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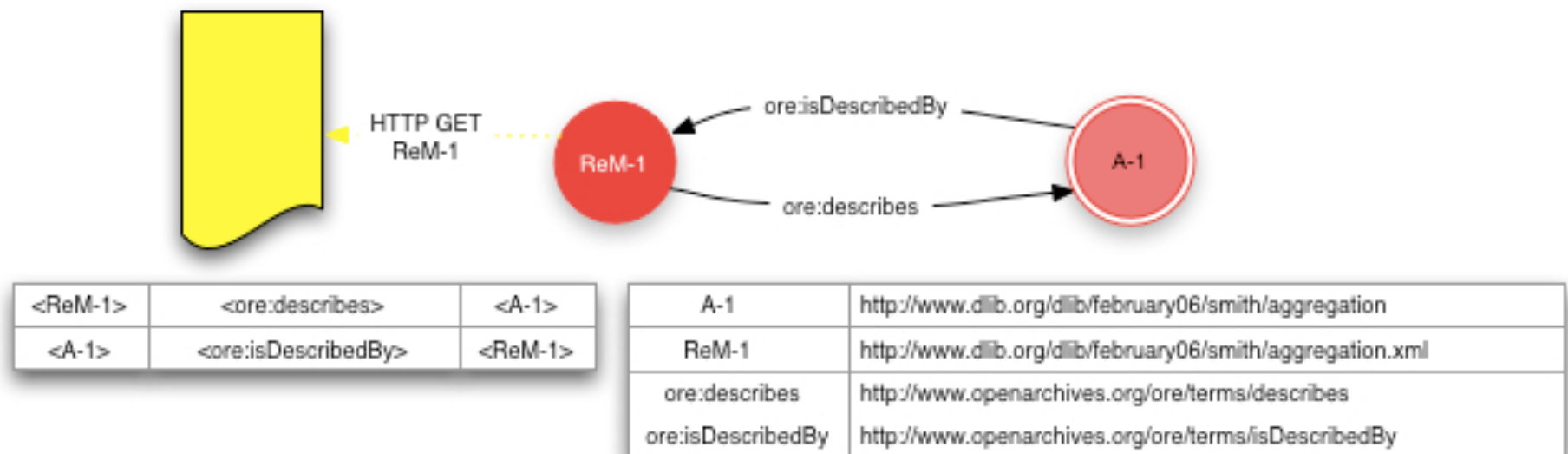
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- A (graph) theory-based approach to resource description

Semantic Web:

OAI-ORE Paper Tool Possibilities



- A set of diagrammatic elements generated by theory. Relationships are constrained to OAI-ORE defined resource description and aggregation

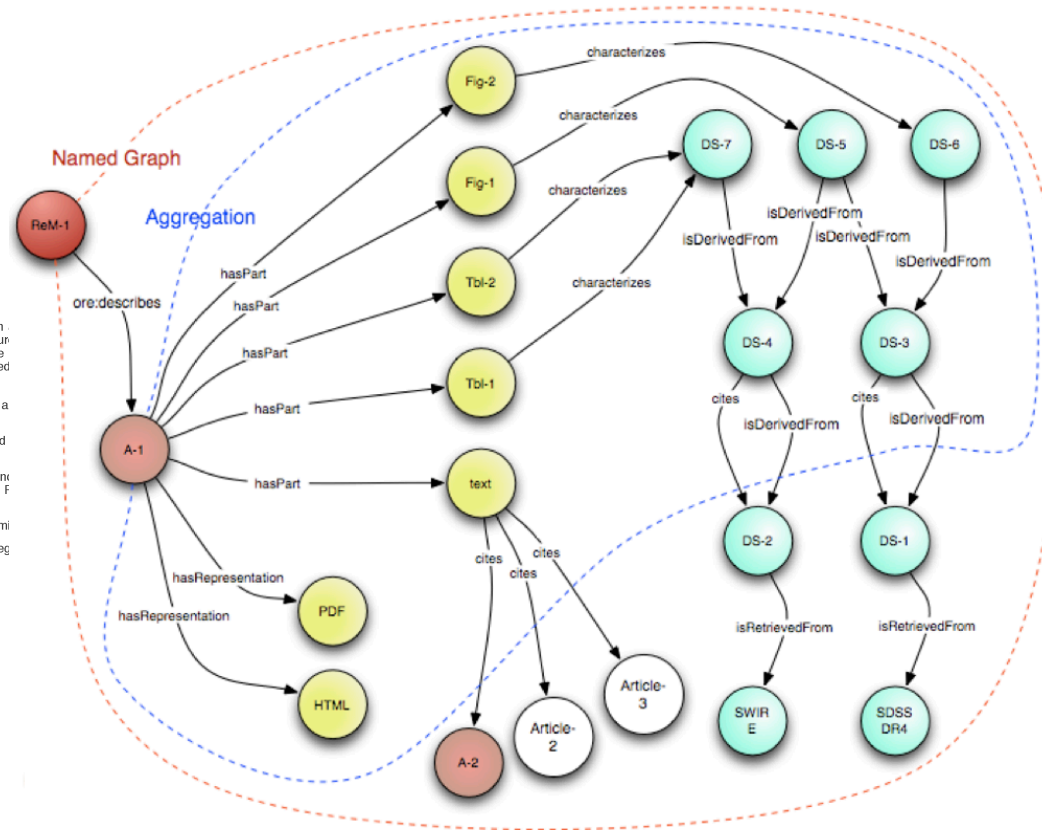
Semantic Web:

OAI-ORE Paper Tool Possibilities

4. RDF Graph of a Resource Map - Basics

A Resource Map asserts a set of RDF triples expressing information. Aggregated Resources, metadata about the Aggregation and Resource RDF Graph that is manifested by the triples asserted by a Resource restrictions. The graph MUST be connected, with its structure defined numbered section accompanying each bullet):

- It MUST express the relationship between the Resource Map and the Resource Map (4.1).
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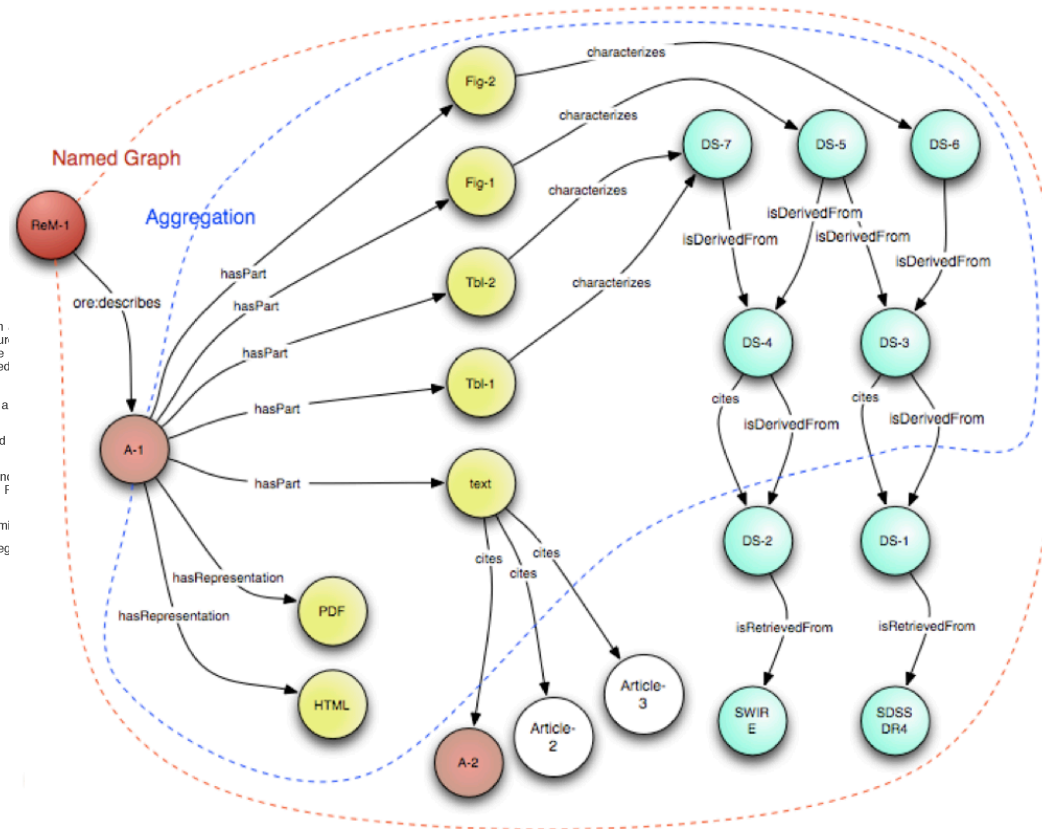
Semantic Web:

OAI-ORE Paper Tool Possibilities

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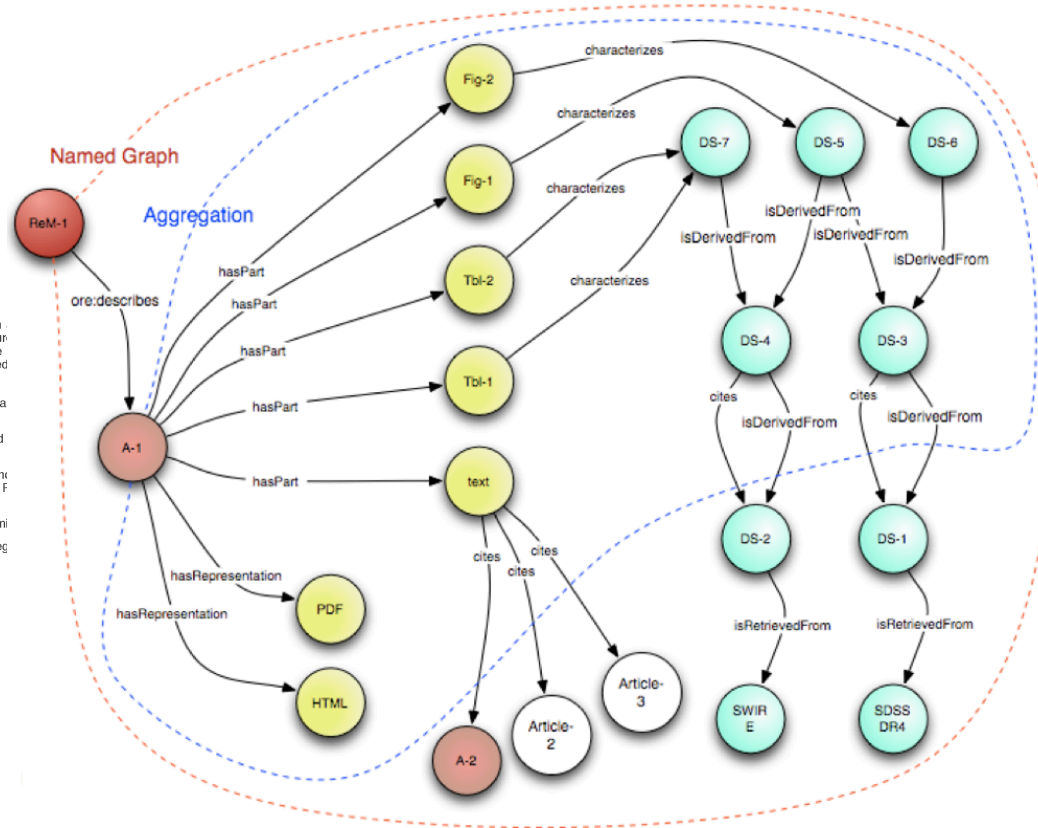
- Manipulation of graphical elements can have theoretical implications. This *Aggregation* resource/description boundary is arbitrarily defined

Semantic Web: OAI-ORE Paper Tool Possibilities

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- OAI-ORE Named Graphs can serve as a Semantic Web building blocks: Persistent resource/resource description aggregations (i.e. *subgraphs*)

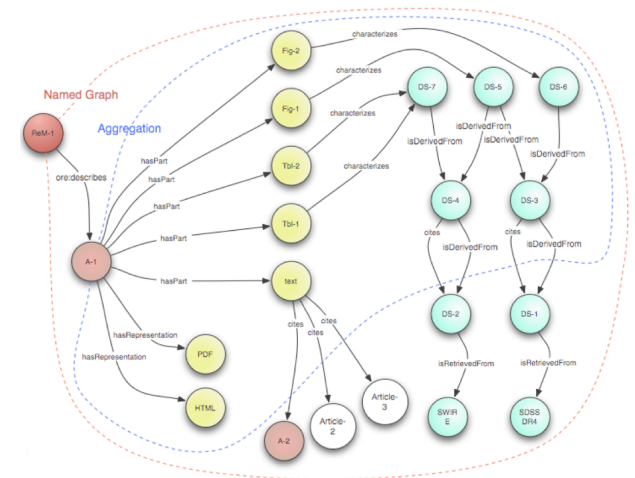
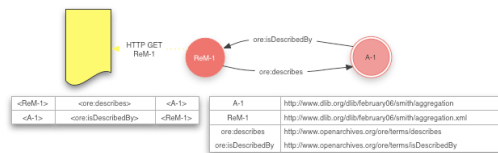
Semantic Web:

OAI-ORE Paper Tool Possibilities

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- Each subgraph can be treated according to the specific rules governing an entity within an ad-hoc or well-defined resource description scheme

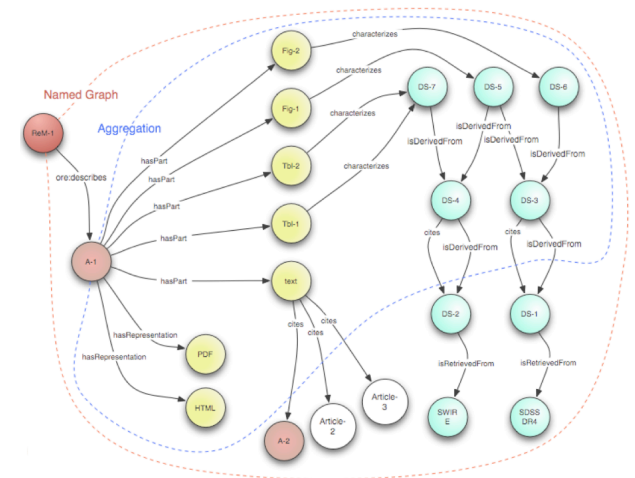
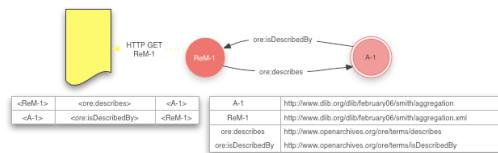
Semantic Web:

OAI-ORE Paper Tool Possibilities

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- A Named Graph becomes a configuration for managing RDF complexity by consistently structuring resources and resource descriptions

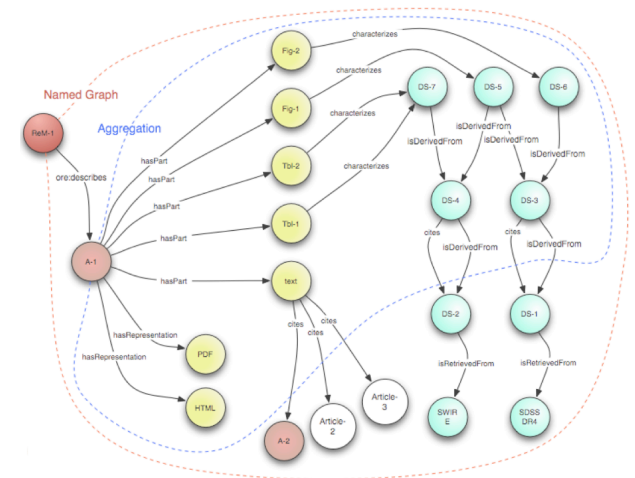
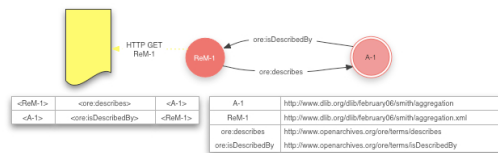
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- OAI-ORE Named Graphs can function as elemental resource description units: They become the *things of interest* that are usually modeled as entities

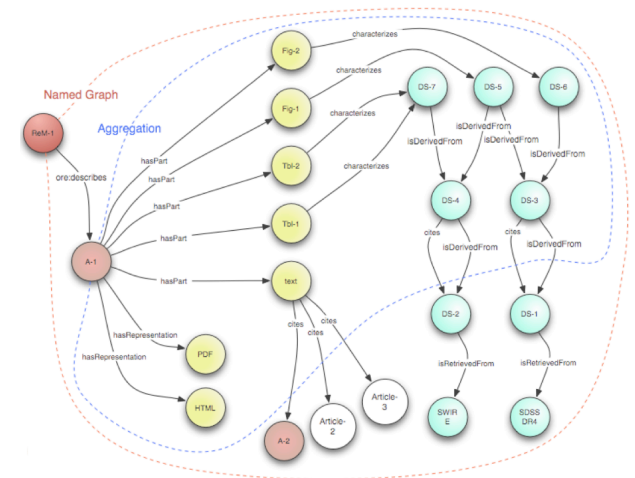
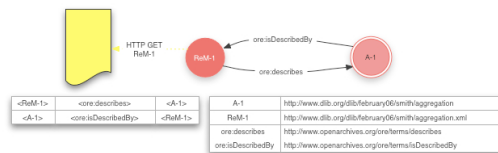
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- RDF Triples:OAI-ORE Named Graph::
Attributes & Relationships:E-R Modeling Entity

Semantic Web:

OAI-ORE Paper Tool Possibilities

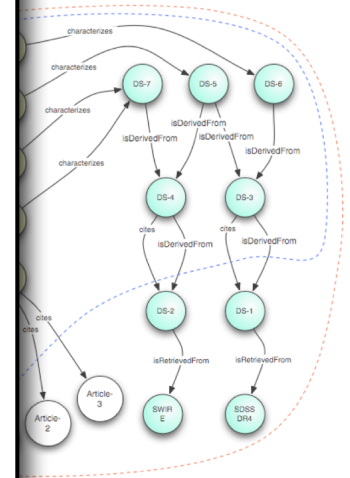
What is the Visualizability of the OAI-ORE Named Graph “Building Block” Approach?

Given a strategy of resource description via the definition of RDF triples, what kind of *picture* of OAI-ORE-based resource description and management processes is available to us?

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- To get a FRBR Paper Tool, use OAI-ORE building blocks (RDF triples and relationships) to define *FRBR building blocks* (Works, etc.)

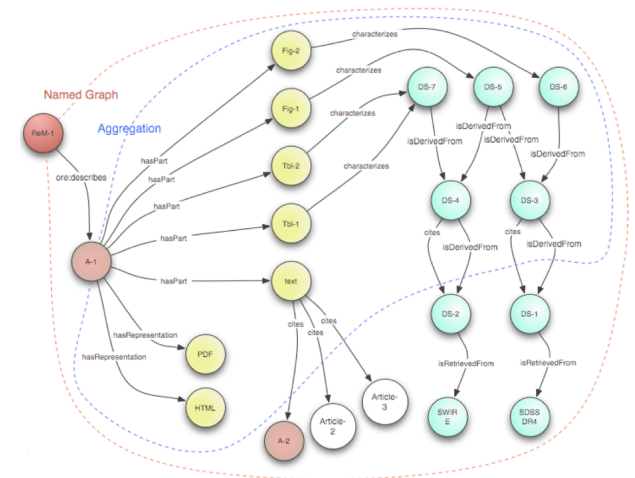
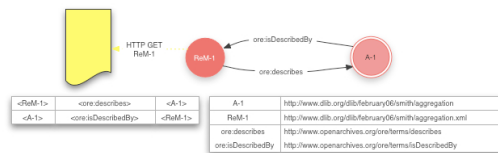
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The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*

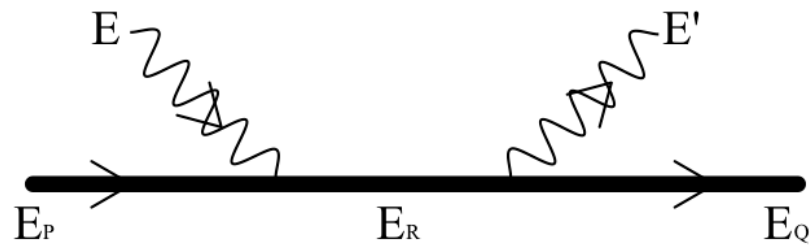
*It is wrong to think that the task of physics is to
find out how Nature is*

Physics concerns what we can say about Nature

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*

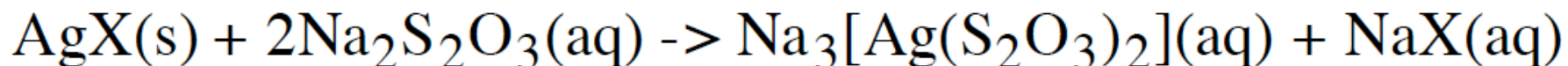
- A bottom-up weaving together of complex physical and informational phenomena – seen through the *Paper Tools* used to depict and reason about them

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



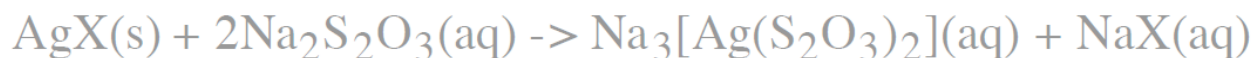
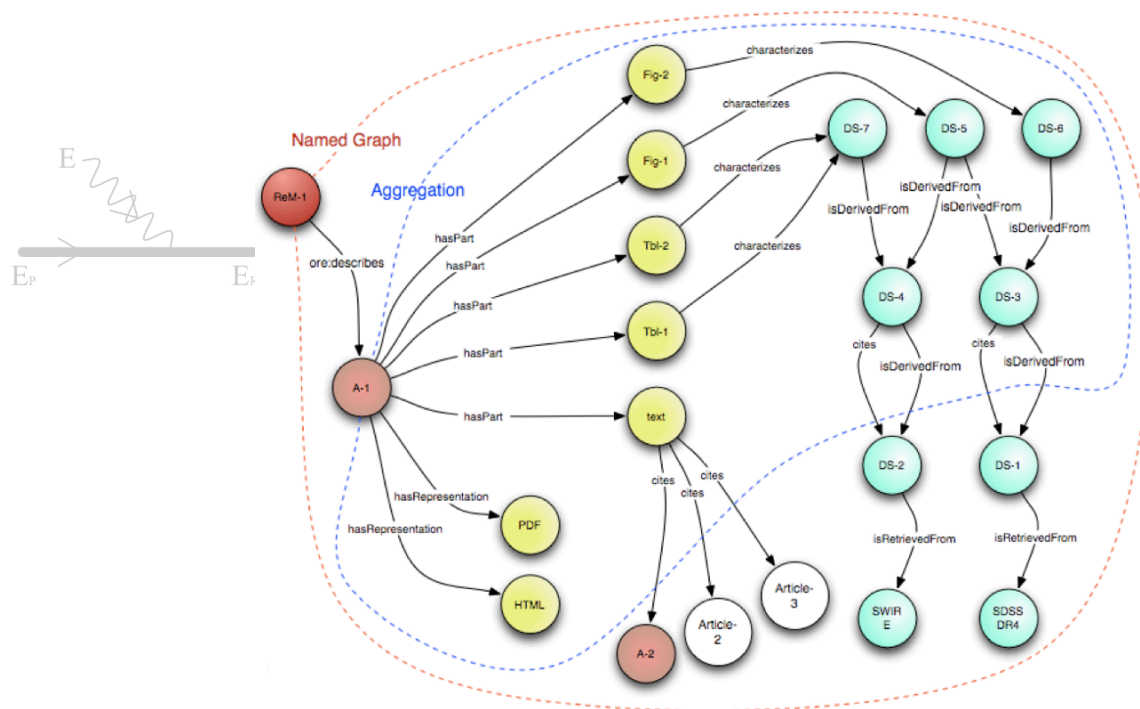
- Feynman diagram of particle interactions

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



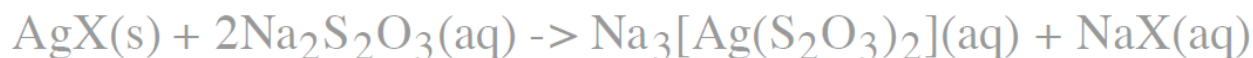
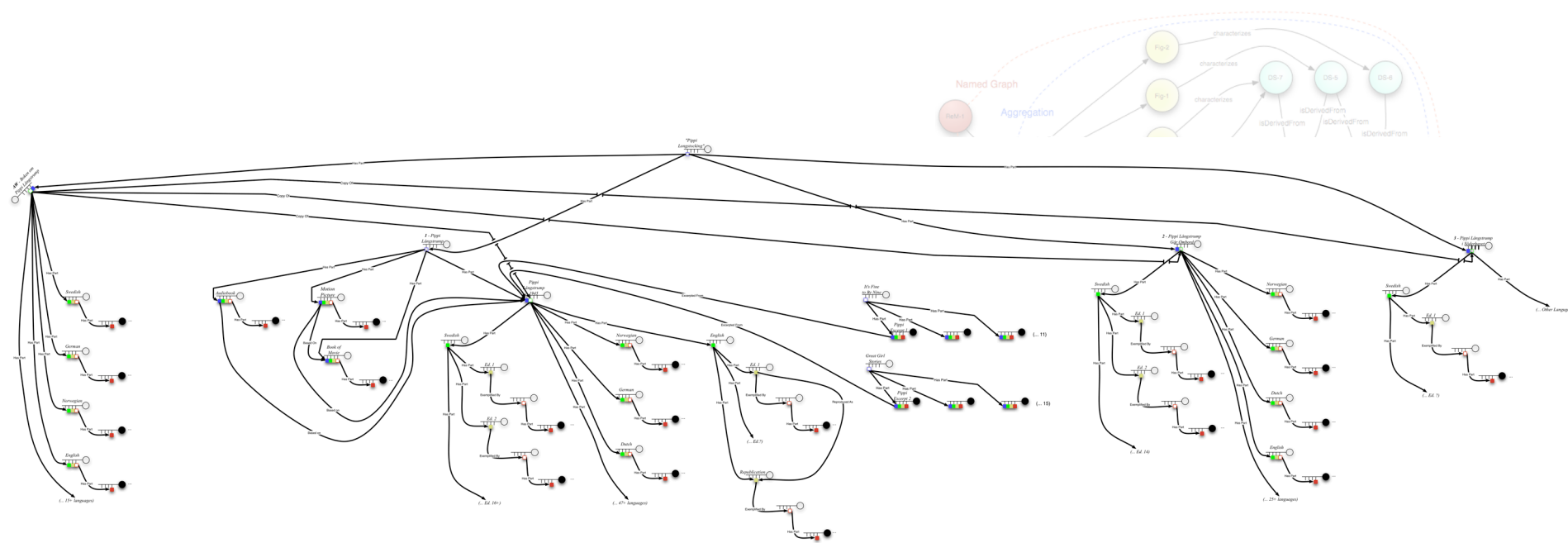
- A modern version of the “building block” chemical notation used by Jöns Jacob Berzelius in developing his *Theory of Chemical Proportions*

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



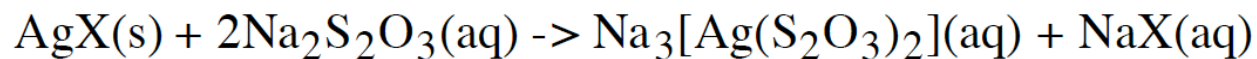
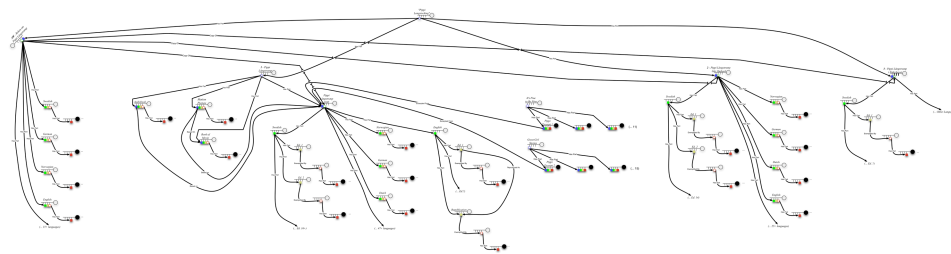
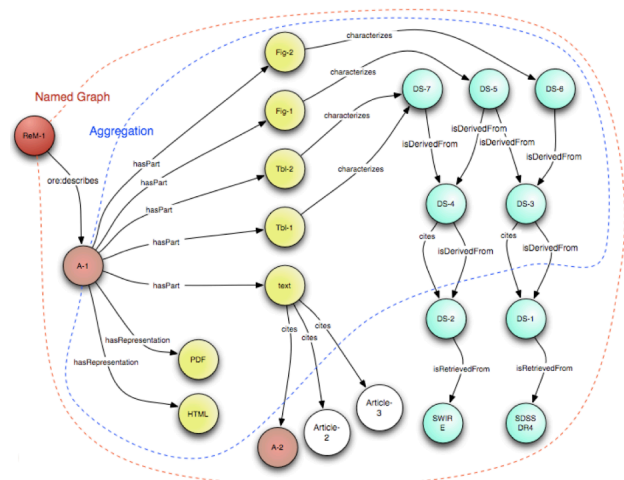
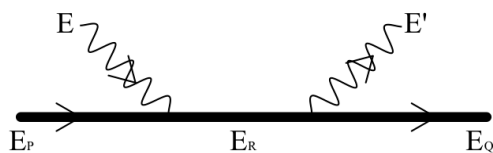
- An OAI-ORE Paper Tool that depicts, groups, and names RDF statements regarding physical and cultural things of interest

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*

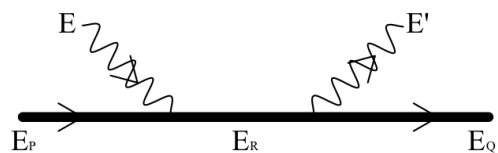


- A FRBR Paper Tool used to depict and explore relationships between creative expressions

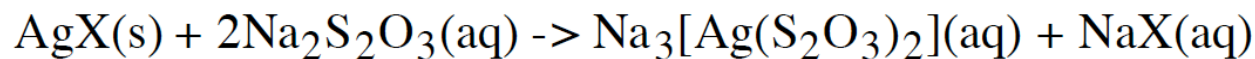
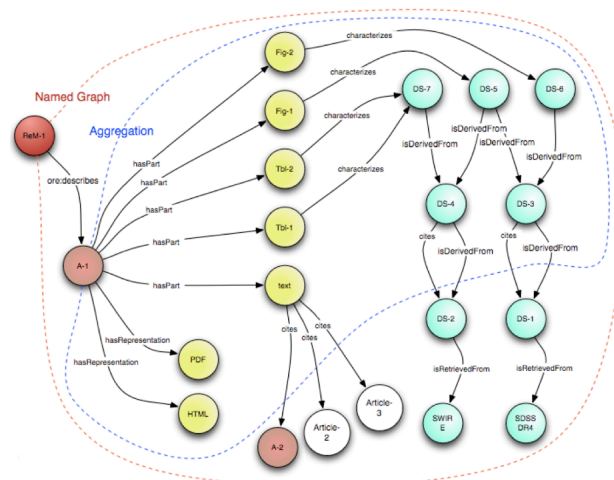
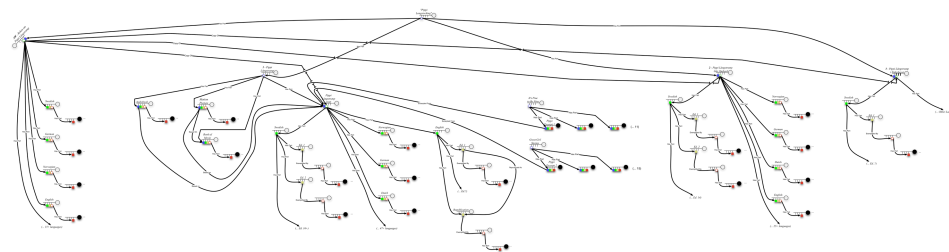
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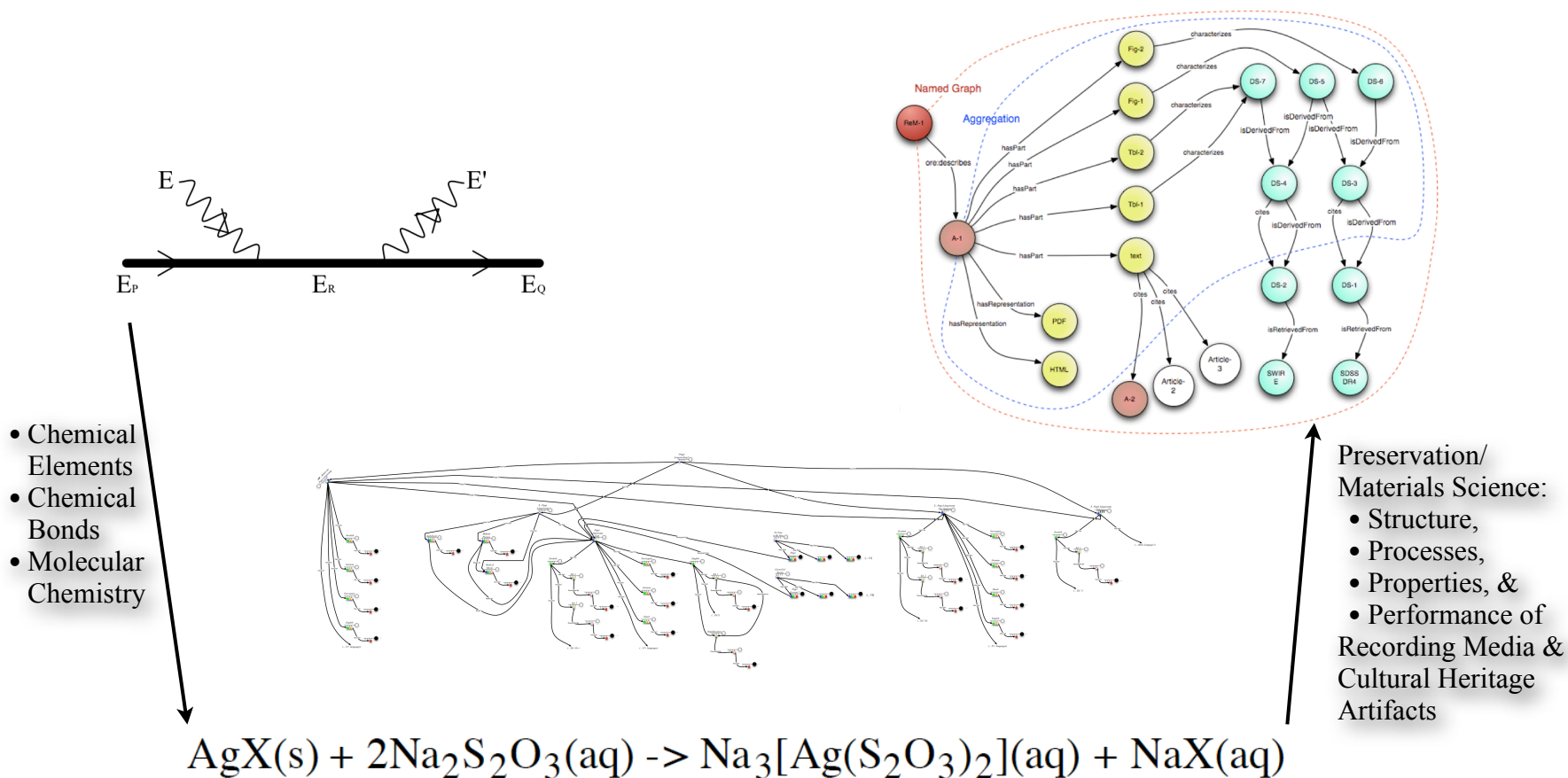
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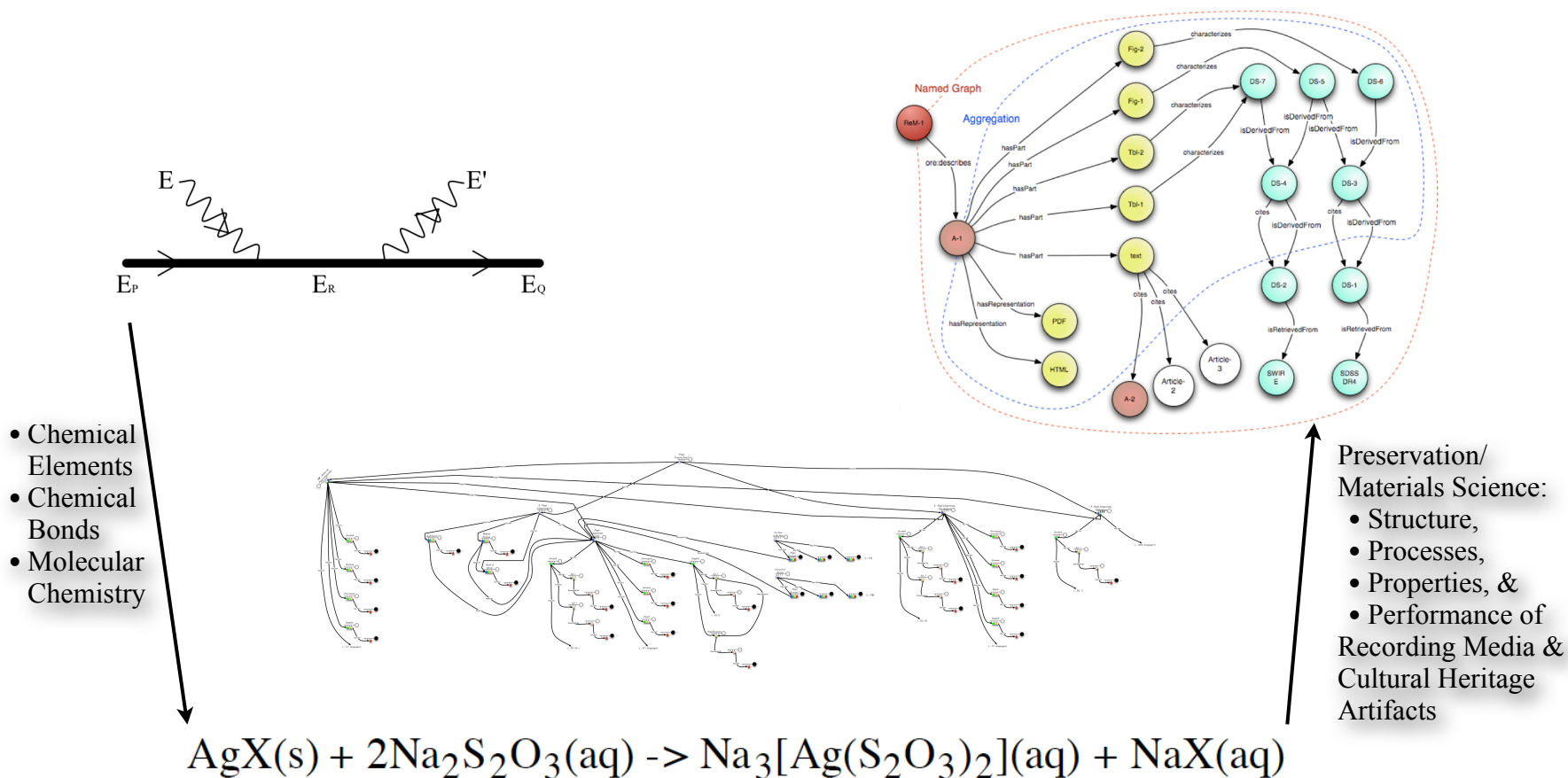
- Chemical Elements
- Chemical Bonds
- Molecular Chemistry



The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*

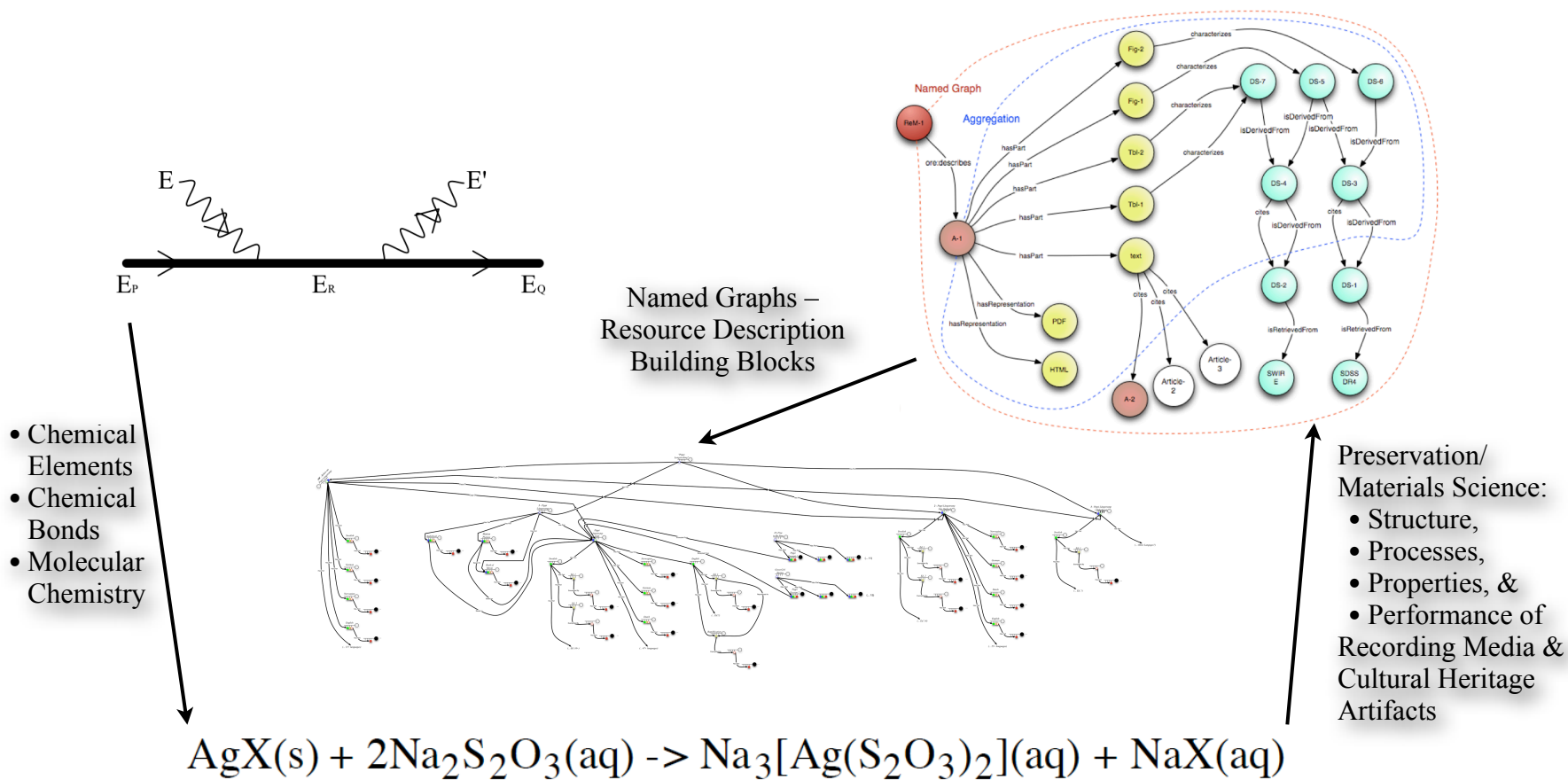


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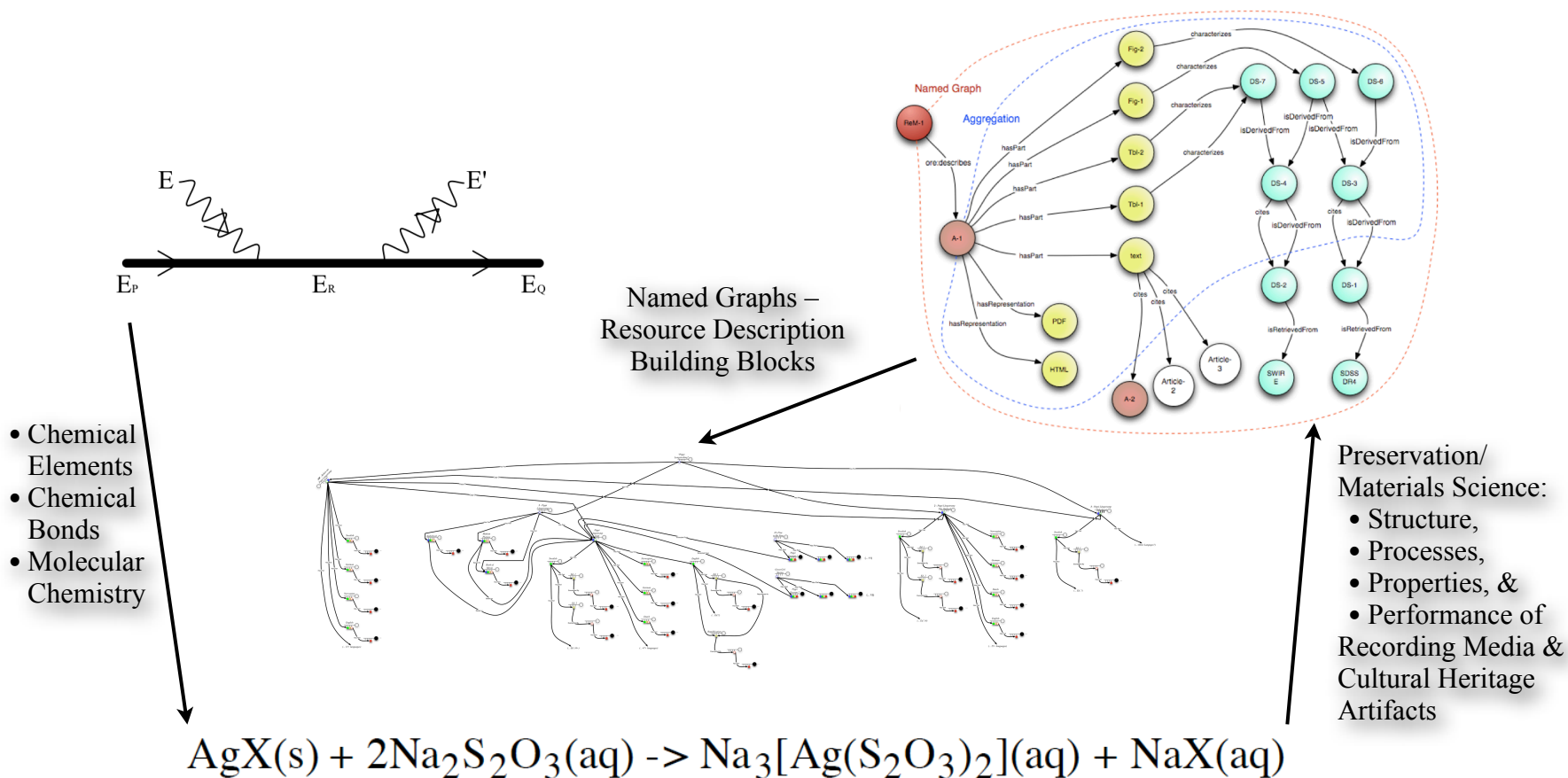


- Resources are created and given social significance through physical and social processes usually external to Cultural Heritage institutions

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*

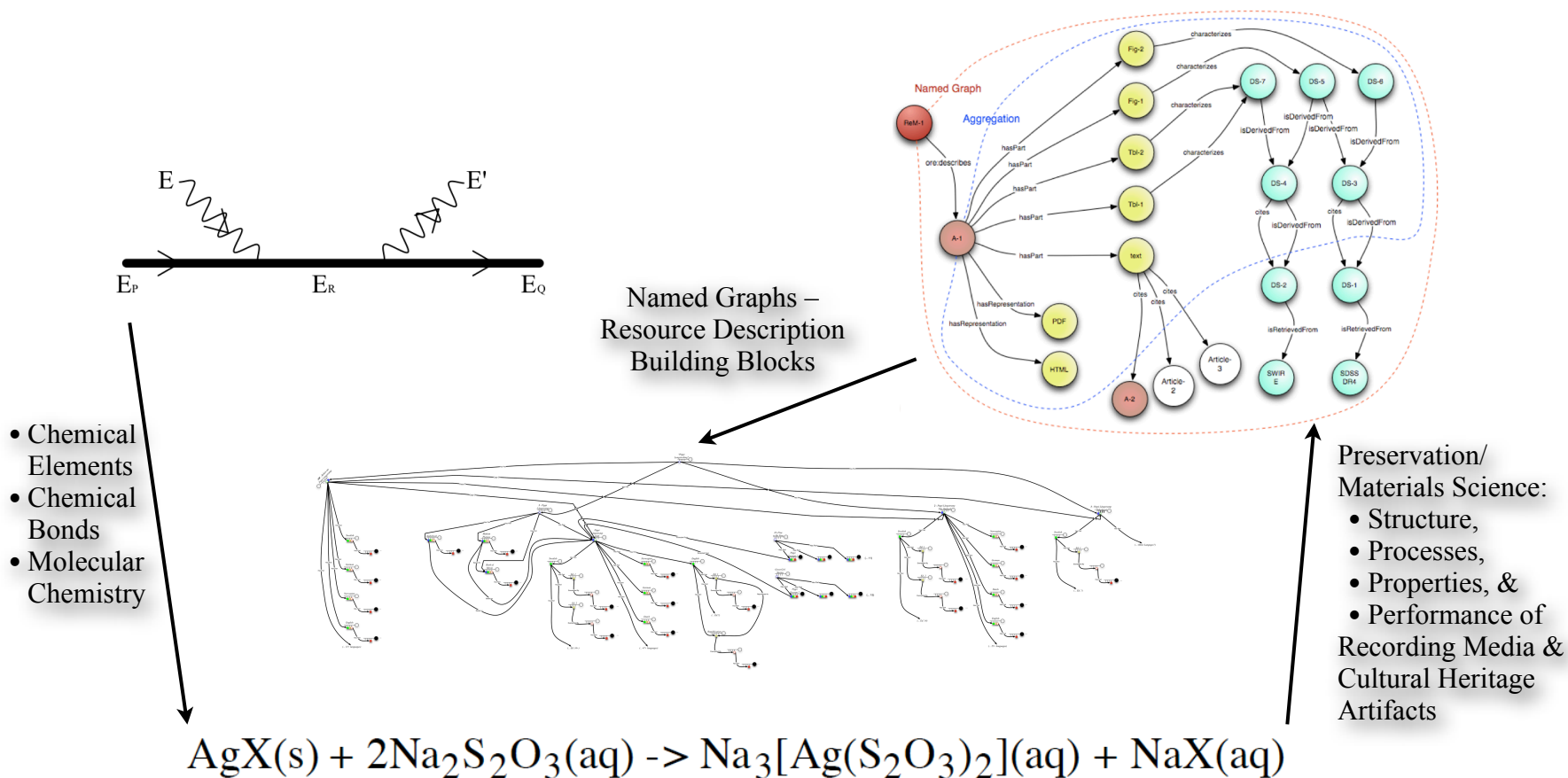


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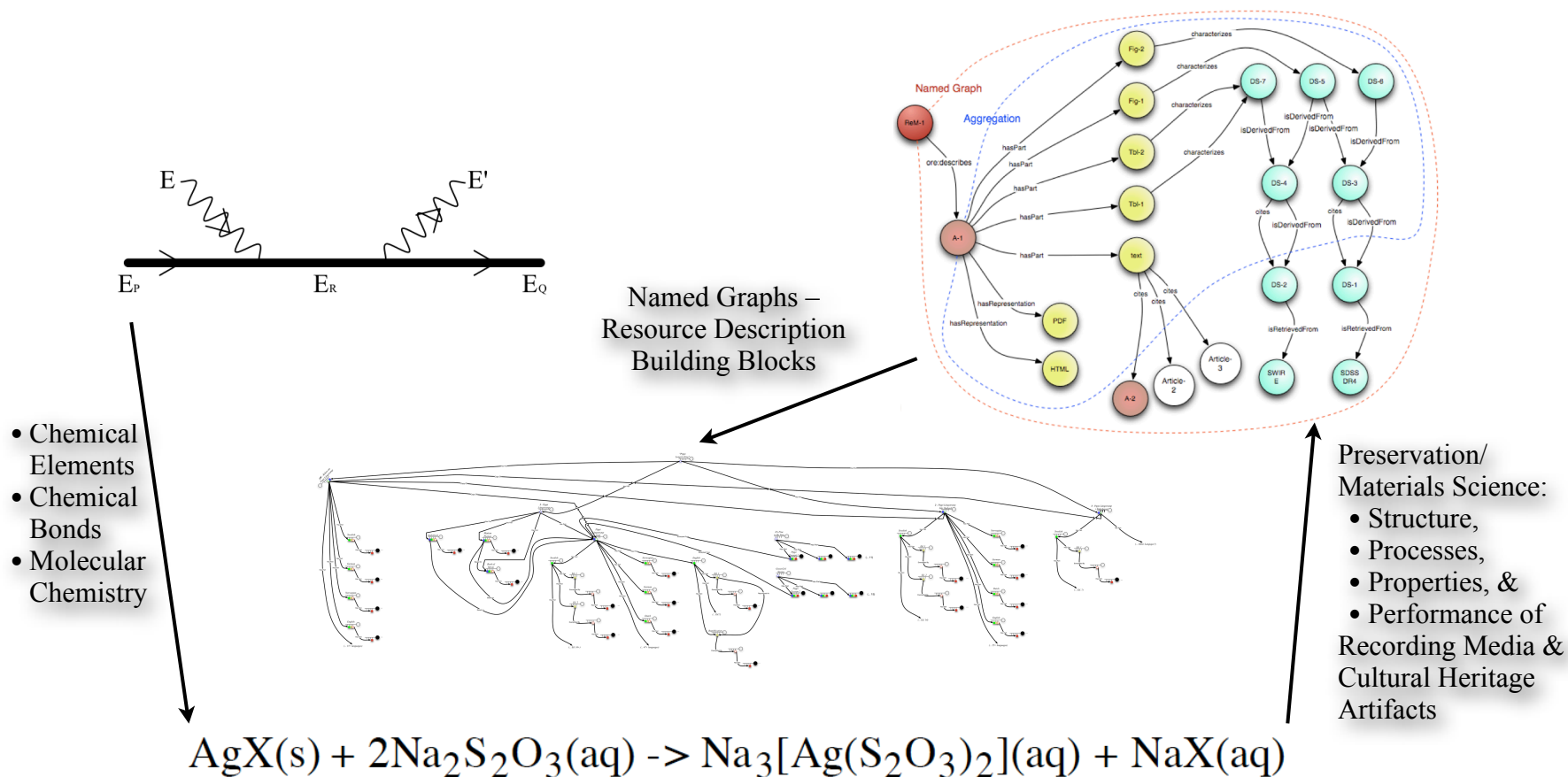
- What happens if a preservation-focused Material Science laboratory represents its things of interest as OAI-ORE Named Graph building blocks?

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



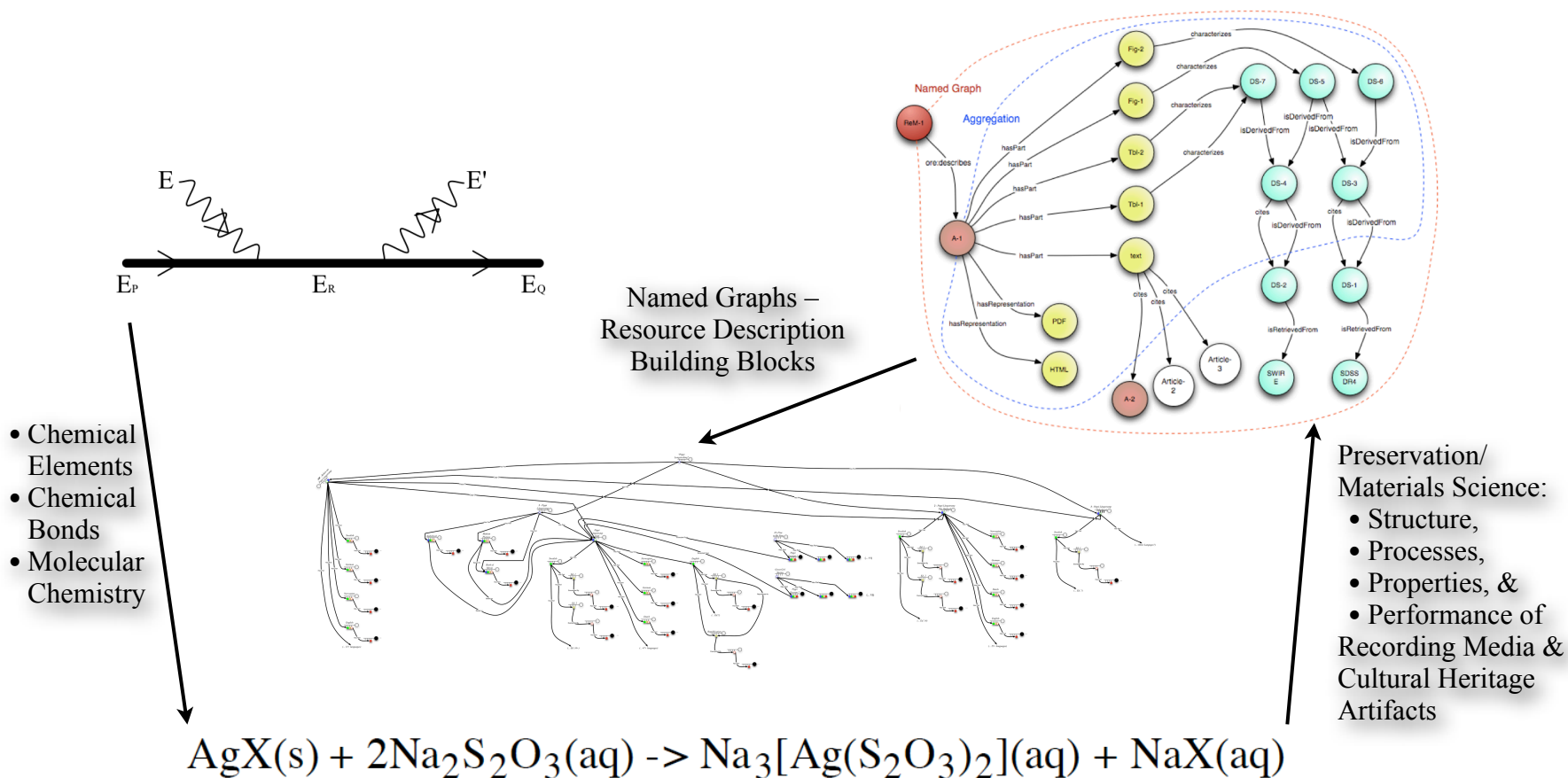
- *Sorry:* Full integration of Preservation Science points of view etc. into Cultural Heritage resource descriptions awaits further theory and modeling

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



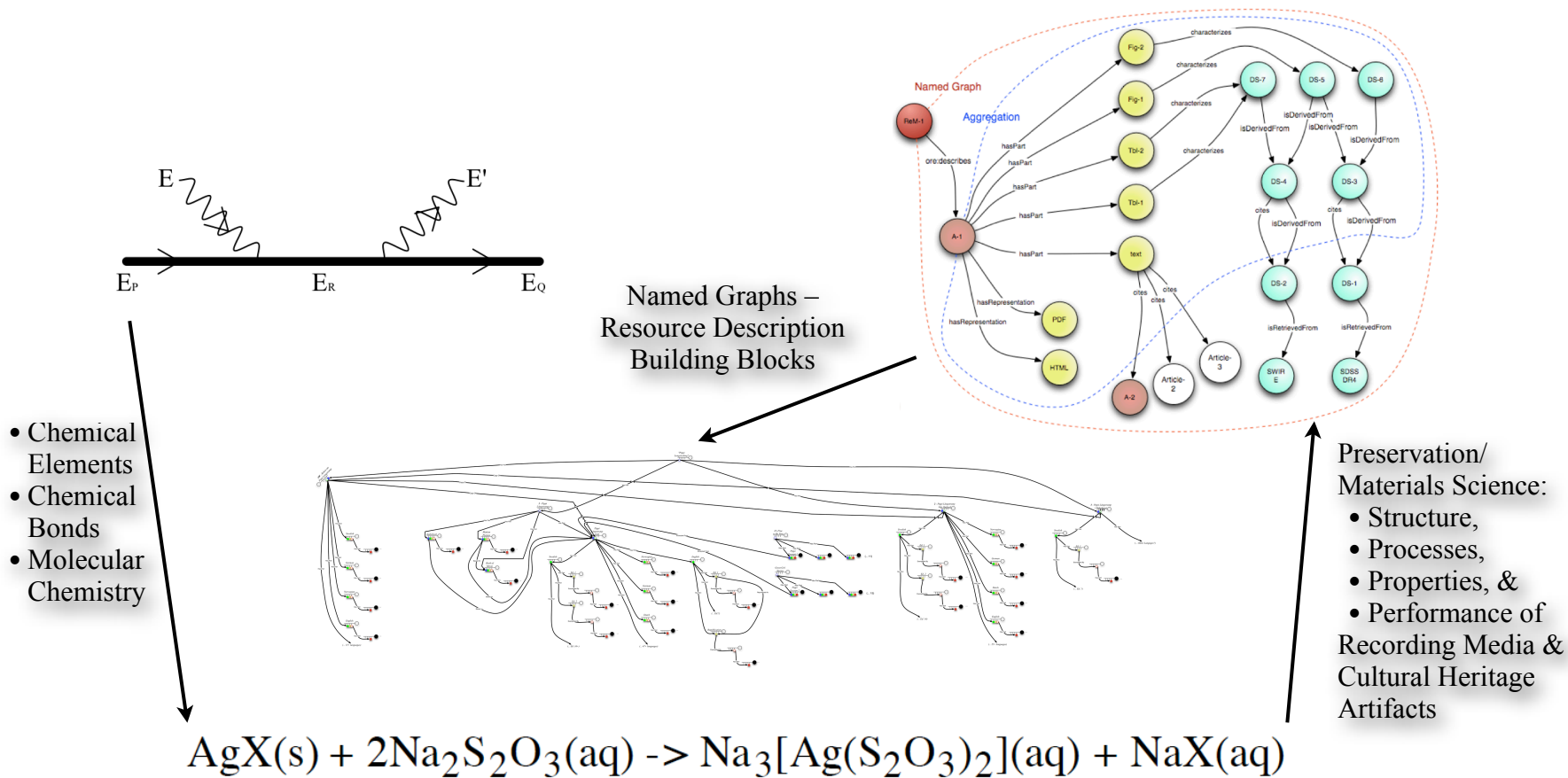
- What happens if large-scale FRBR structures are composed only of large quantities of the ungrouped RDF statements that FRBR entities *reduce* to?

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



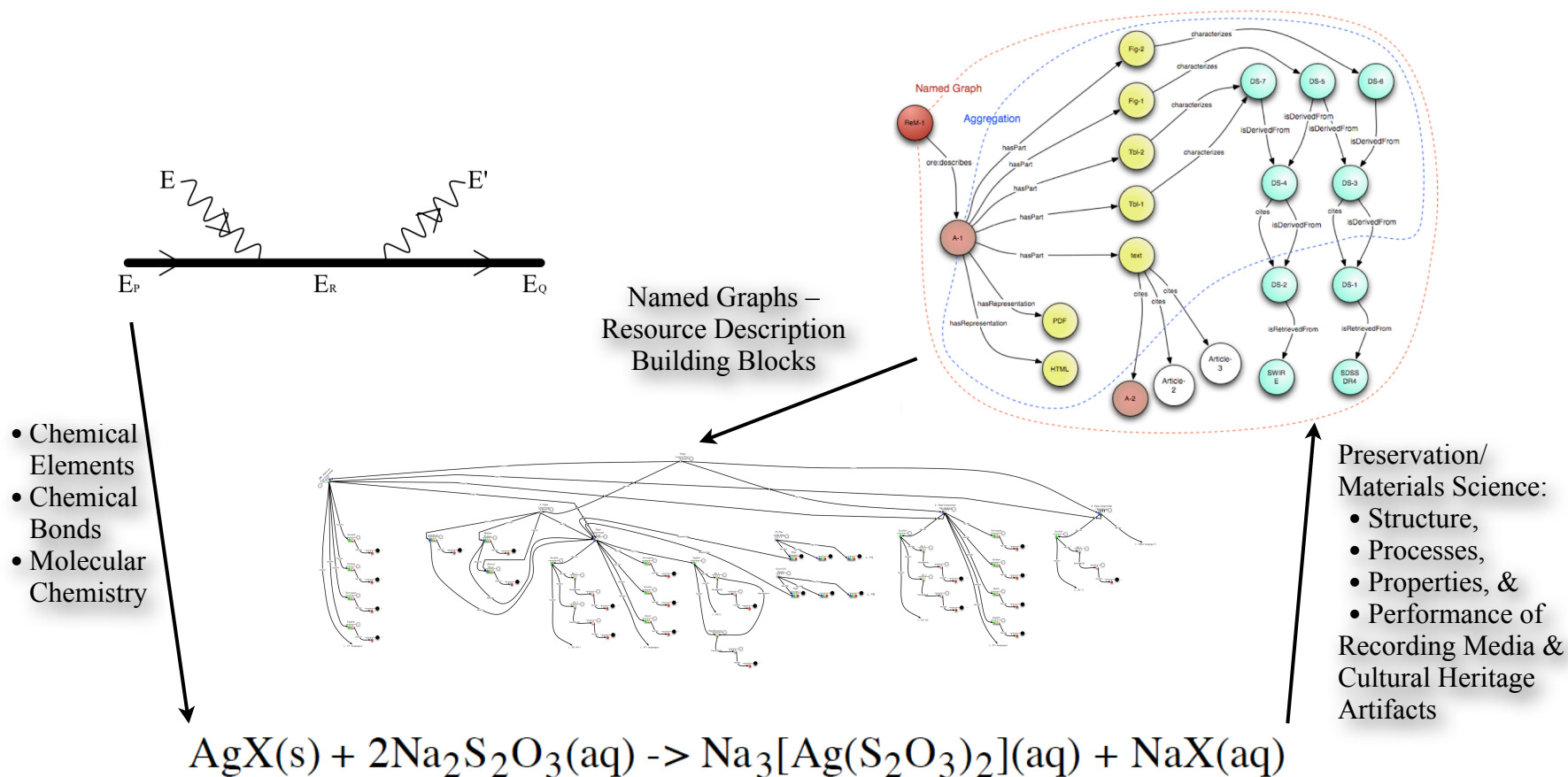
- Imagine this presentation - audience members included - explained in terms of subatomic particle interactions. Ditto for *Pippi* with RDF only

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



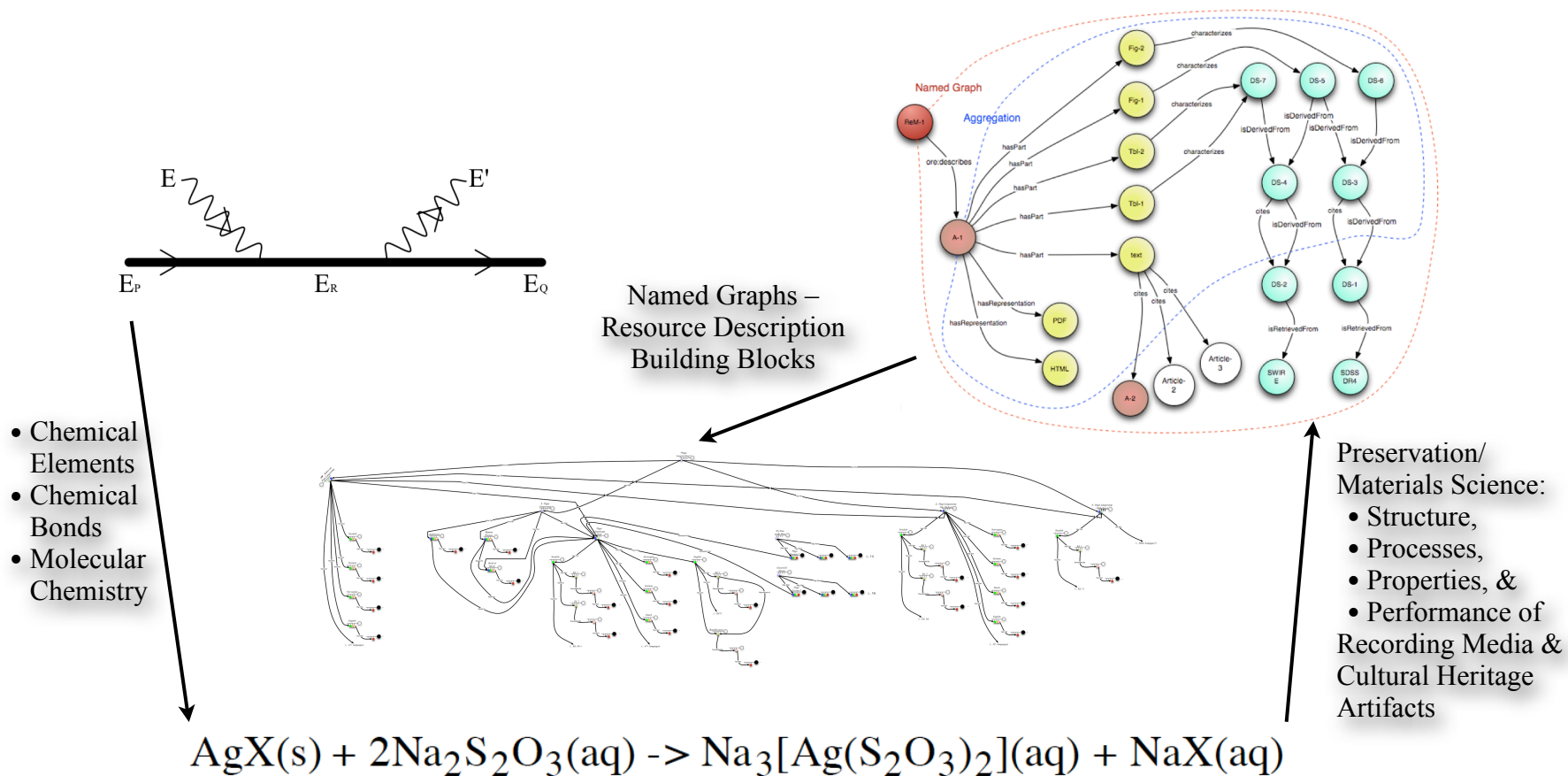
- This would discourage the creation and exploration (for fun or for theory) of structures like the *Pippi Longstocking* example

The Semantic Web: Paper Tools in Multidisciplinary *Trading Zones*



- *Trading Zones* - The places where the descriptions of the “things of interest” in one level can be copied/combined/paraphrased, etc. for use by other levels

The Semantic Web: Paper Tools and Trading Zones in Practice

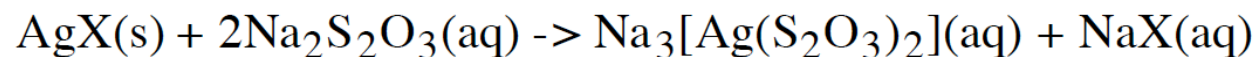


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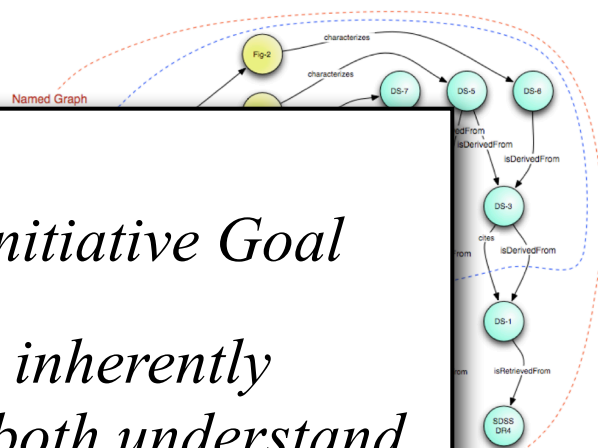
The Web Science Research Initiative Goal

*Web science, therefore, must be inherently interdisciplinary; its goal is to both understand the growth of the Web and to create approaches that allow **new powerful and more beneficial patterns** to occur*

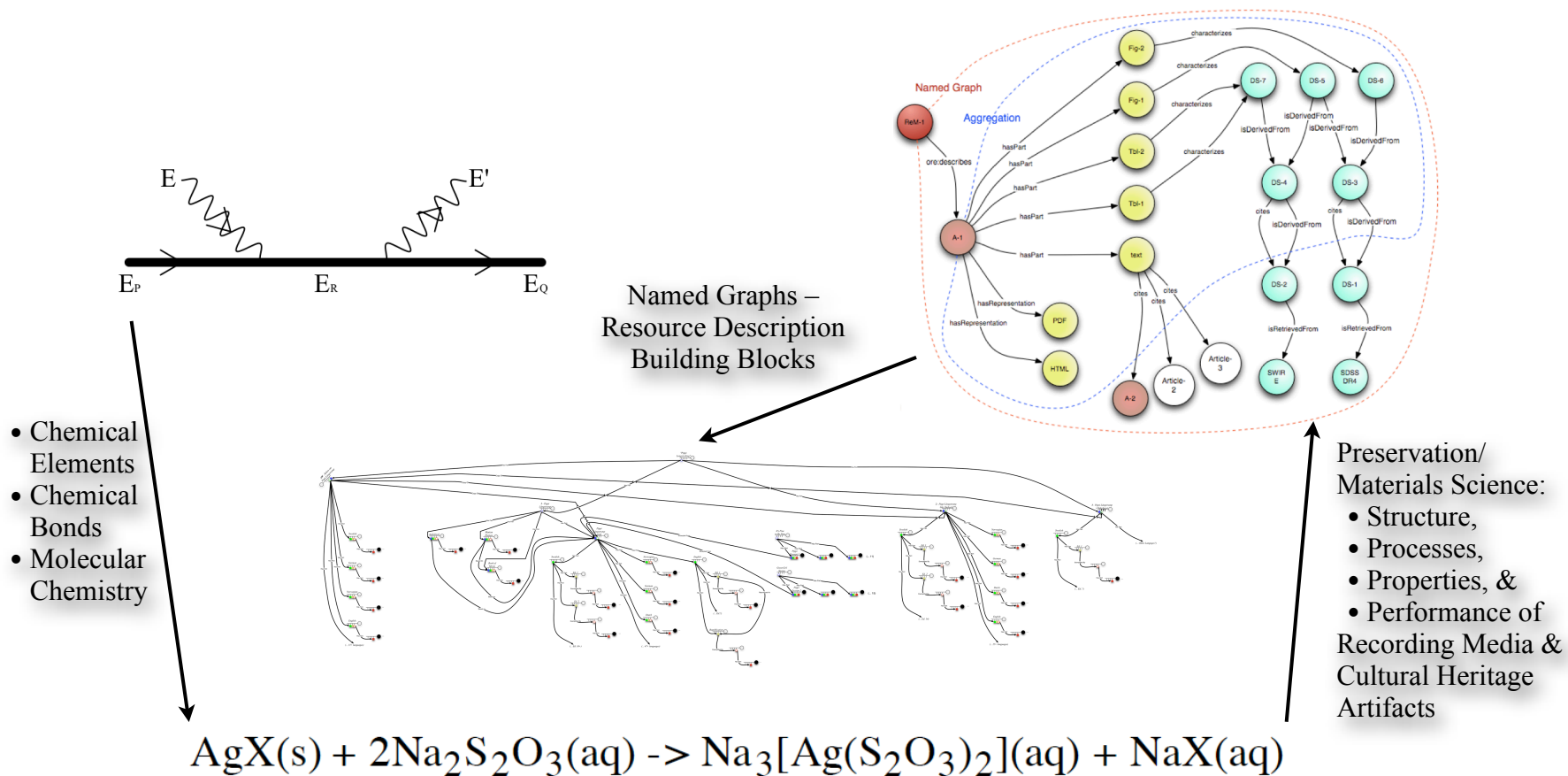
- Chemical Elements
- Chemical Bonds
- Molecular Chemistry



- Preservation/
Materials Science:
- Structure,
 - Processes,
 - Properties, &
 - Performance of Recording Media & Cultural Heritage Artifacts

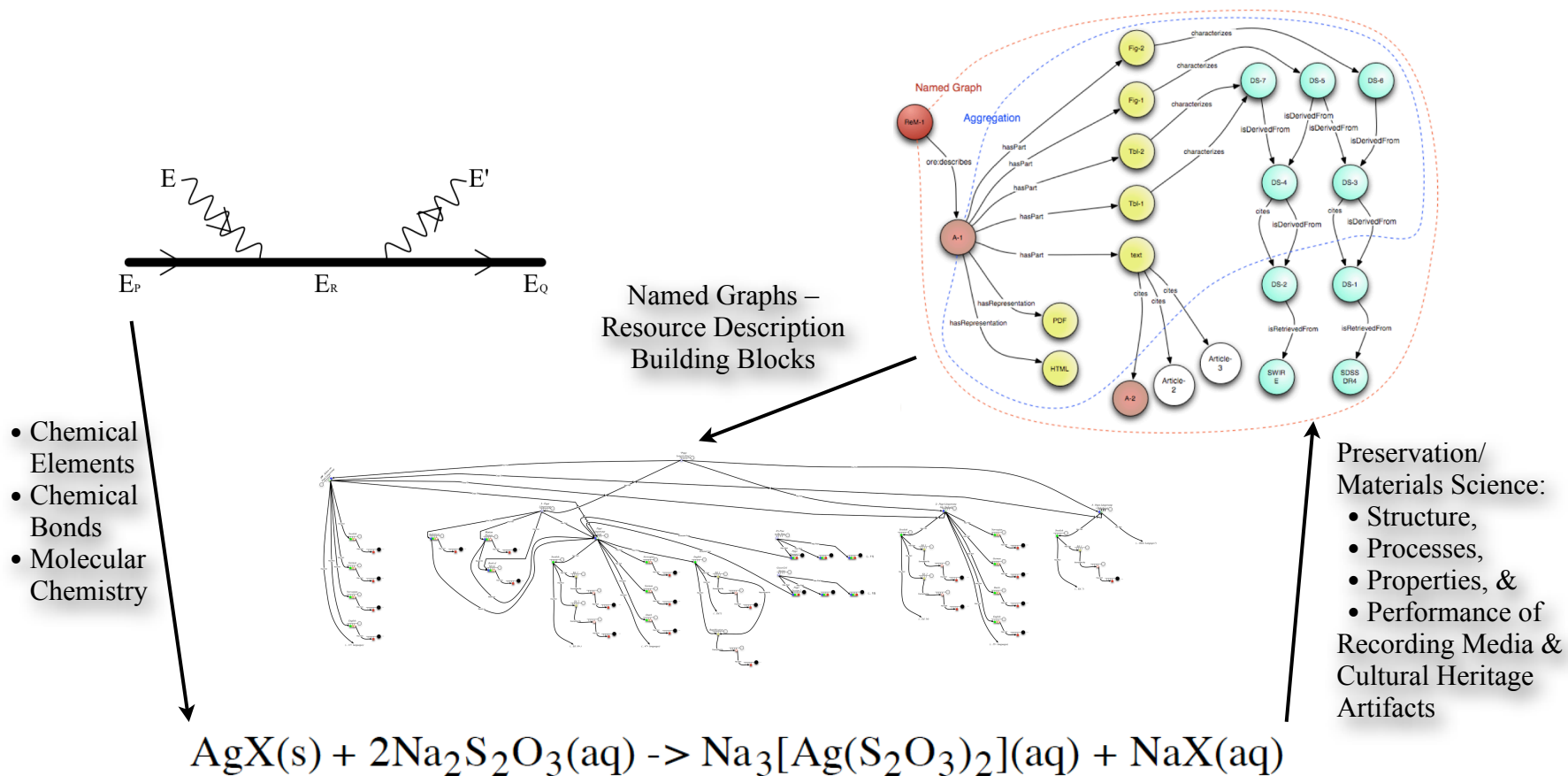


The Semantic Web: Paper Tools and Trading Zones in Practice



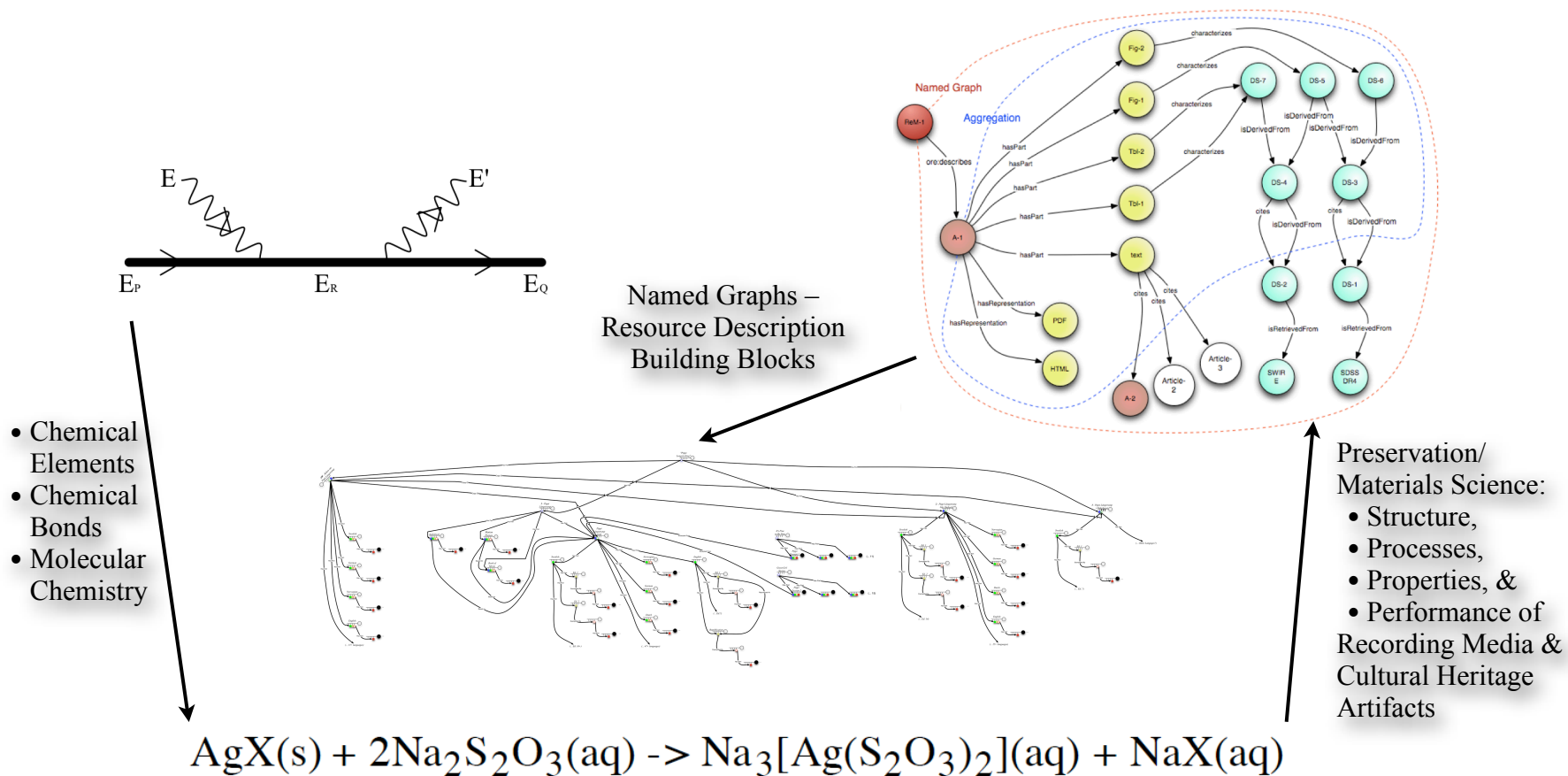
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The Semantic Web: Paper Tools and Trading Zones in Practice



- *Creation of a Trade Language* - It becomes essential to evolve a common “language” or *pidgin* used to identify and exchange resources of interest

The Semantic Web: Paper Tools and Trading Zones in Practice



The Semantic Web: Paper Tools and Trading Zones in Practice

Pidgin, n.

A language containing lexical and other features from two or more languages, characteristically with simplified grammar and a smaller vocabulary than the languages from which it is derived, used for communication between people not having a common language; a lingua franca. *(OED Online)*

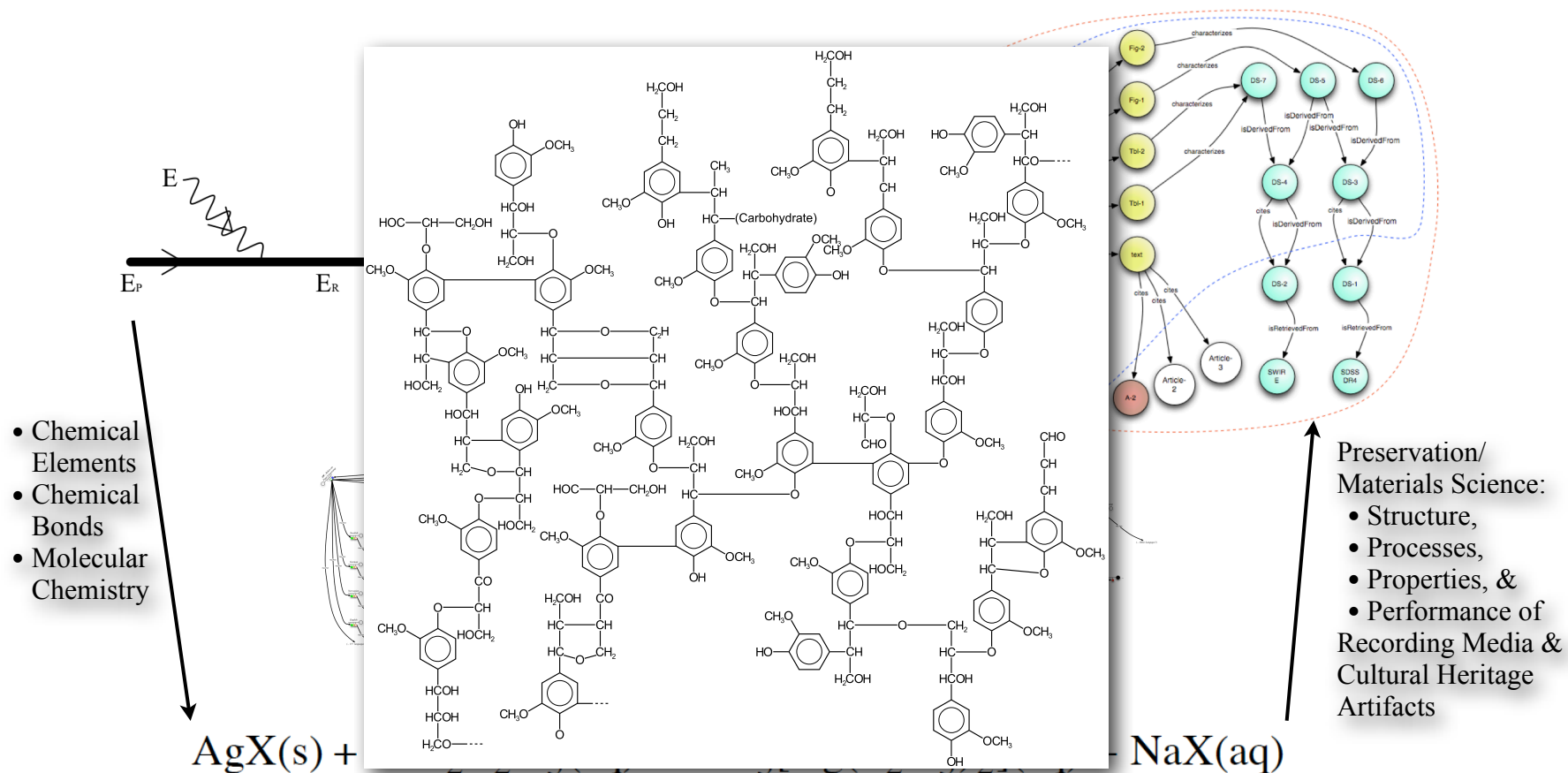
Chemical Elements
Chemical Bonds
Molecular Chemistry

Preservation/
Materials Science:
• Structure,
• Processes,
• Properties, &
• Performance of
Recording Media &
Cultural Heritage
Artifacts

$$\text{AgX(s)} + 2\text{Na}_2\text{S}_2\text{O}_3(\text{aq}) \rightarrow \text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2](\text{aq}) + \text{NaX}(\text{aq})$$

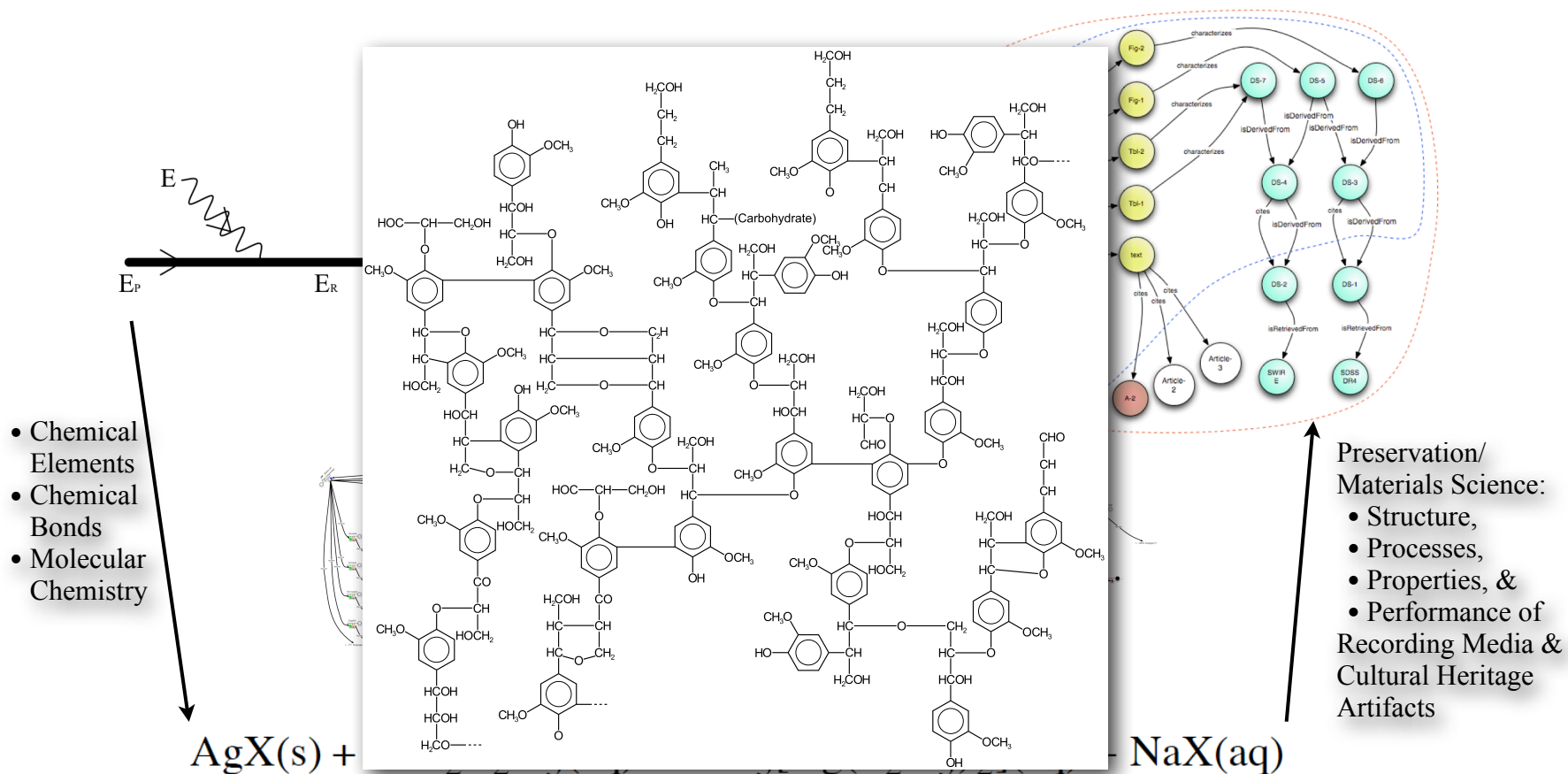
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The Semantic Web: Paper Tools and Trading Zones in Practice



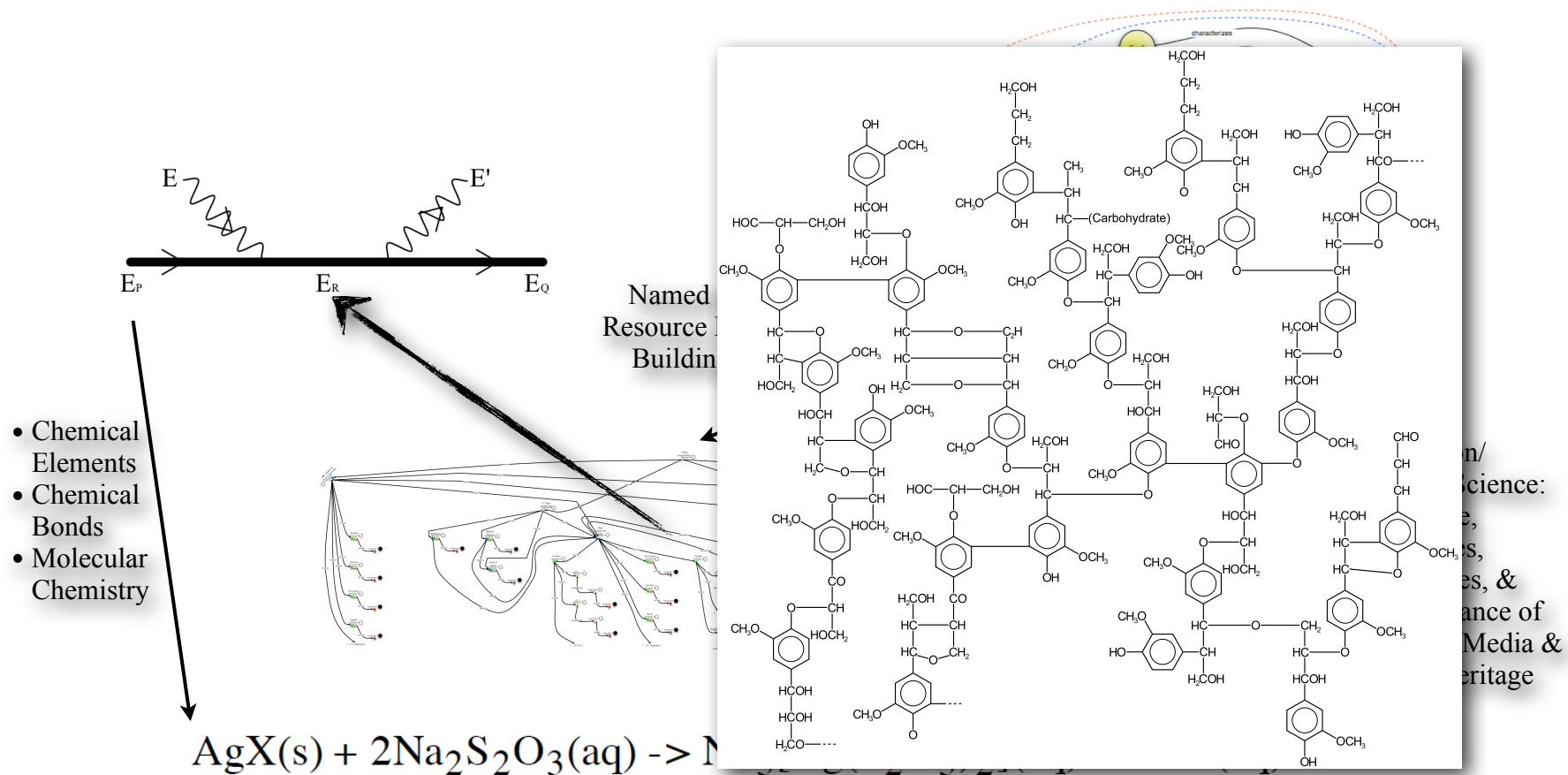
- *Lignin* - A complex chemical compound derived from wood. When present in newsprint, it is responsible for yellowing with age and loss of print legibility

The Semantic Web: Paper Tools and Trading Zones in Practice



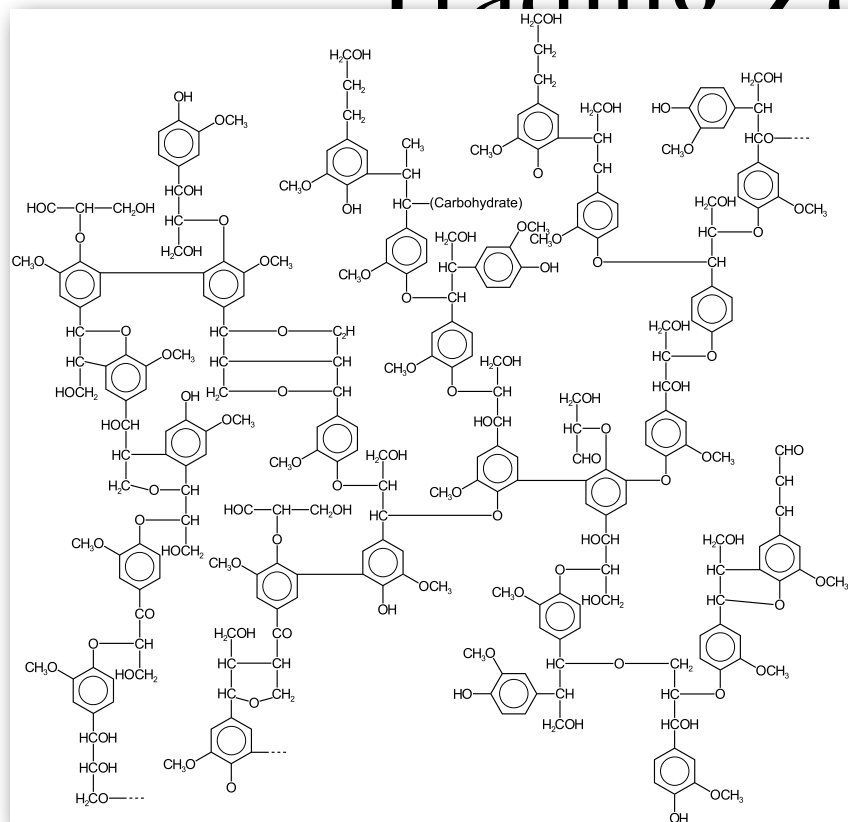
- *Boundary Crossing* - An appreciation of the Cultural Heritage implications of Lignin levels in newsprint will engage the full range of paper tools

The Semantic Web: Paper Tools and Trading Zones in Practice

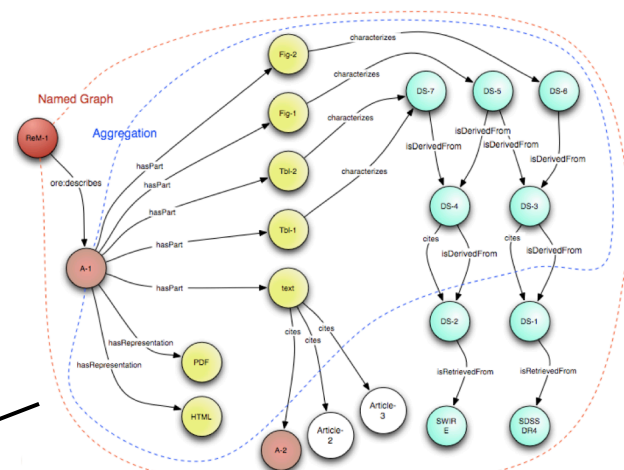


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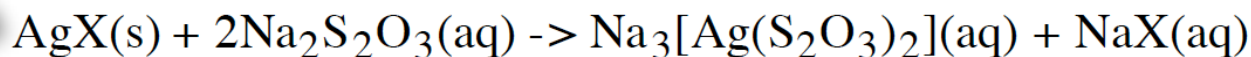


Named Graphs –
source Description
Building Blocks



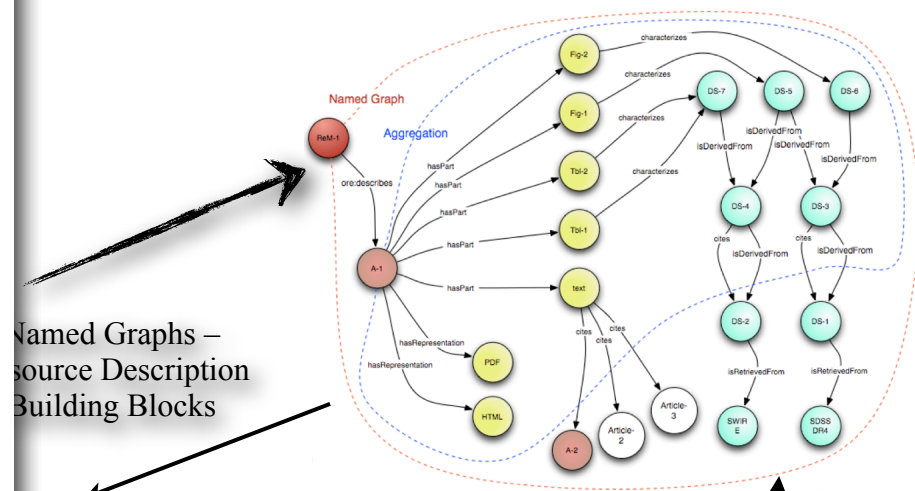
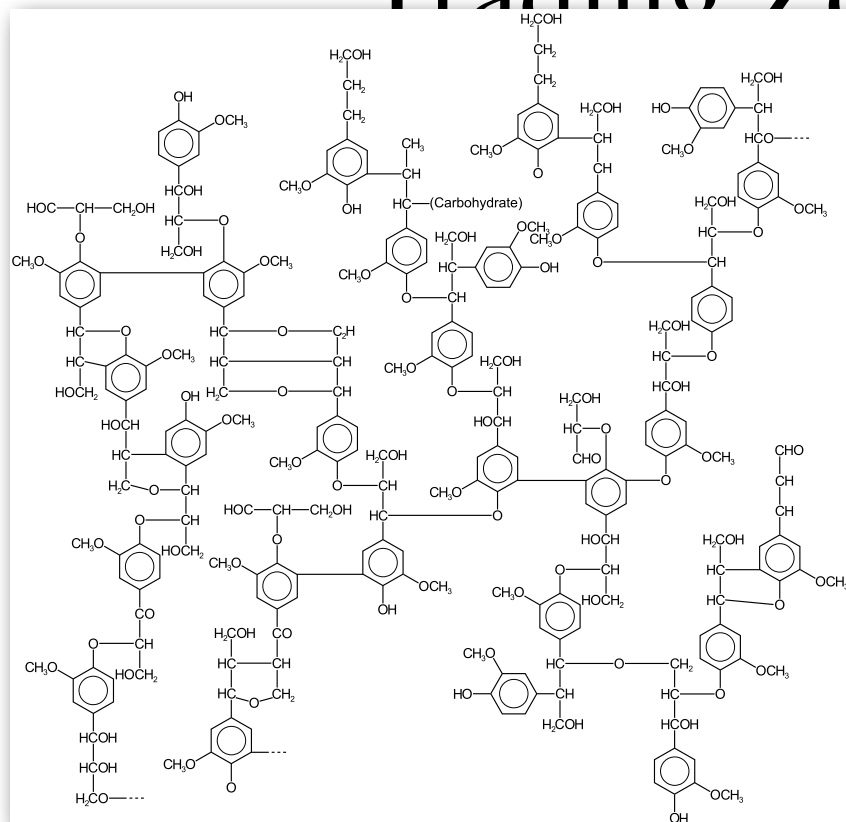
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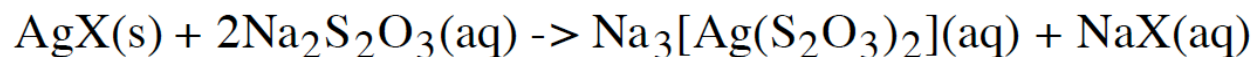
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The Semantic Web: Paper Tools and Trading Zones in Practice



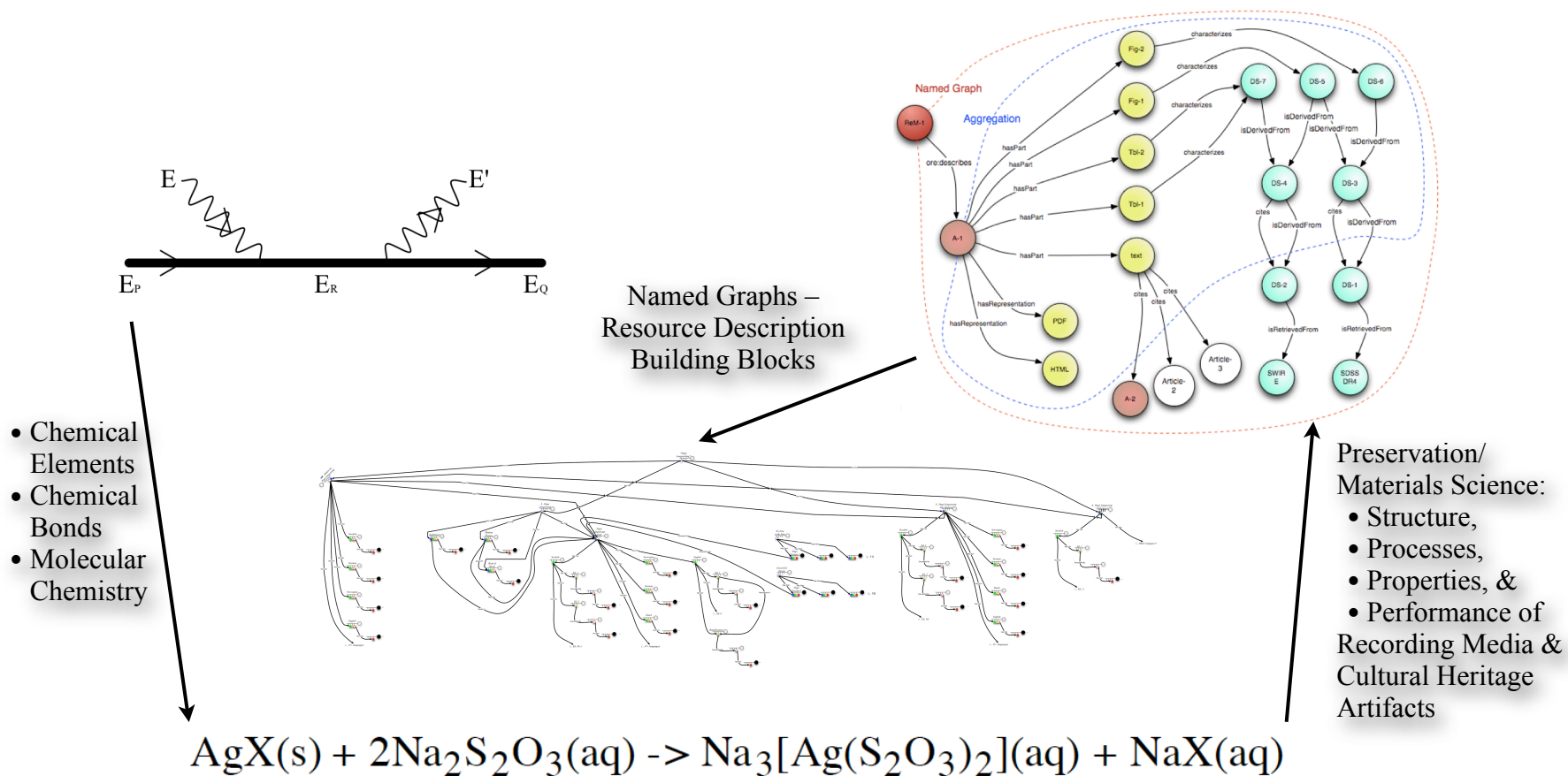
Preservation/
Materials Science:

- Structure,
- Processes,
- Properties, &
- Performance of Recording Media & Cultural Heritage Artifacts



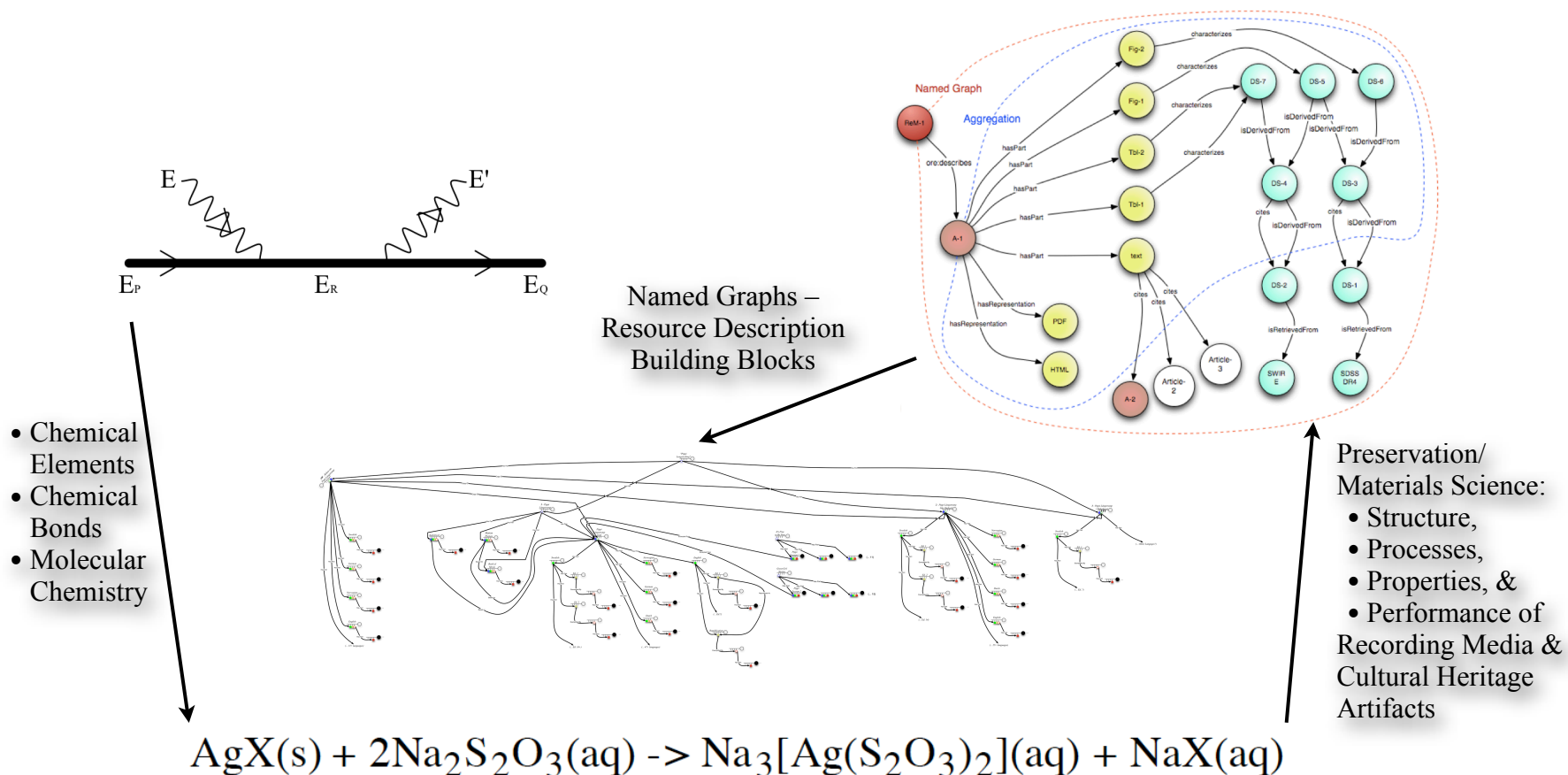
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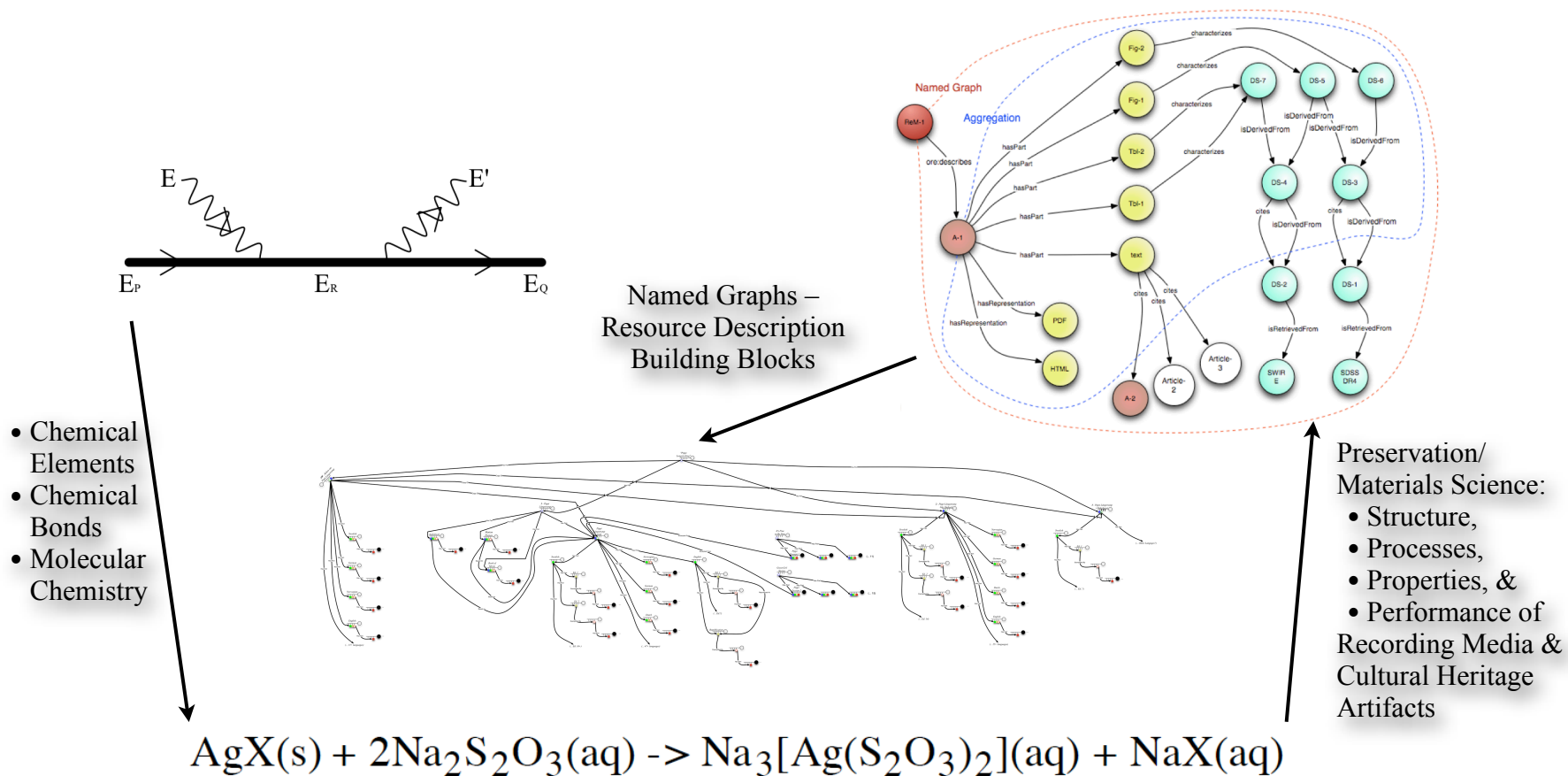
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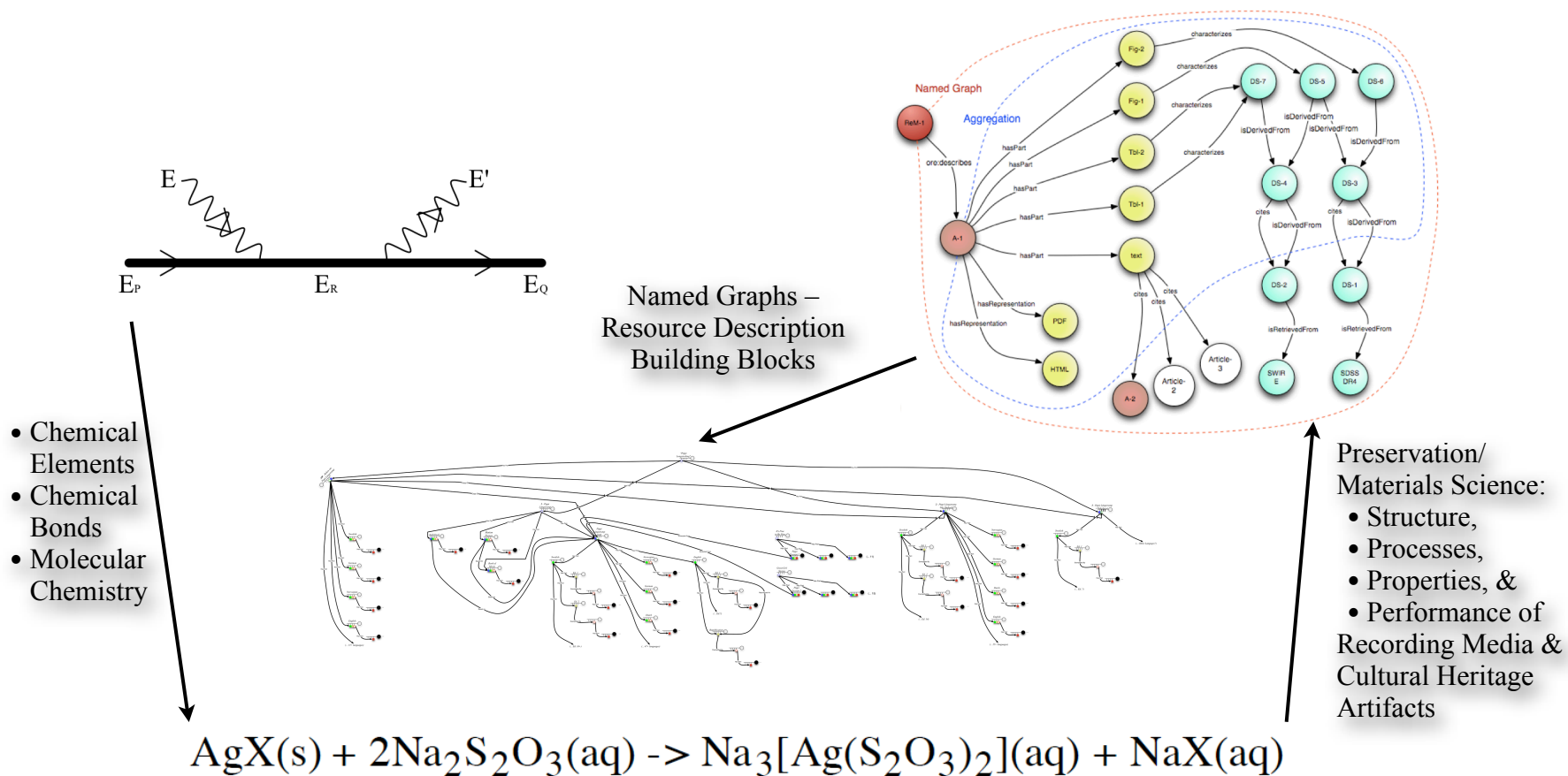
- *Boundary Crossing* - Whatever information is transferred across trading zones will be organized around *level-specific* building blocks

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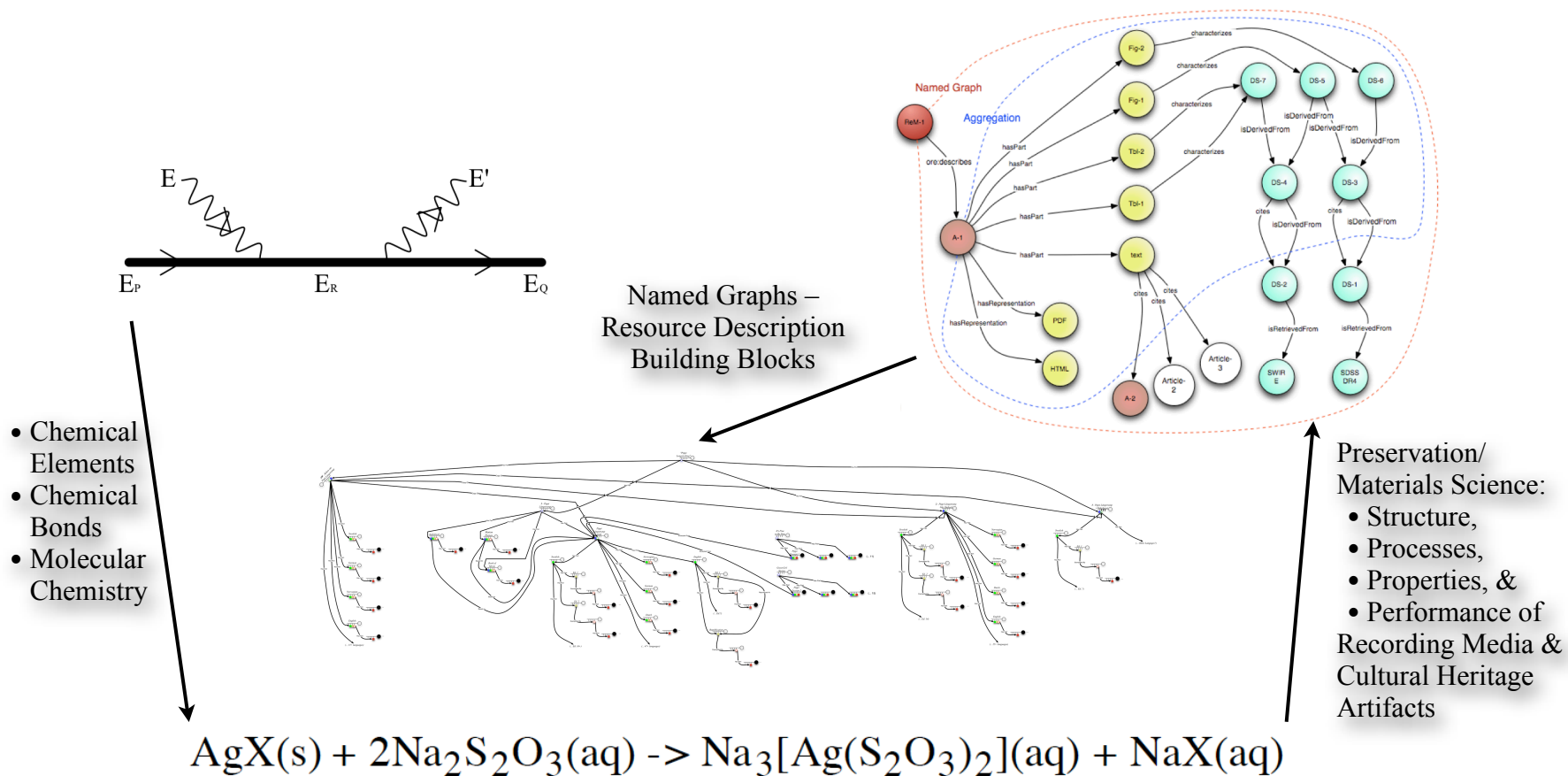
- *Boundary Crossing* - A pidgin will consist of trading zone-specific relationships and rules to enable “just enough information” to pass between levels

The Semantic Web: Paper Tools and Trading Zones in Practice



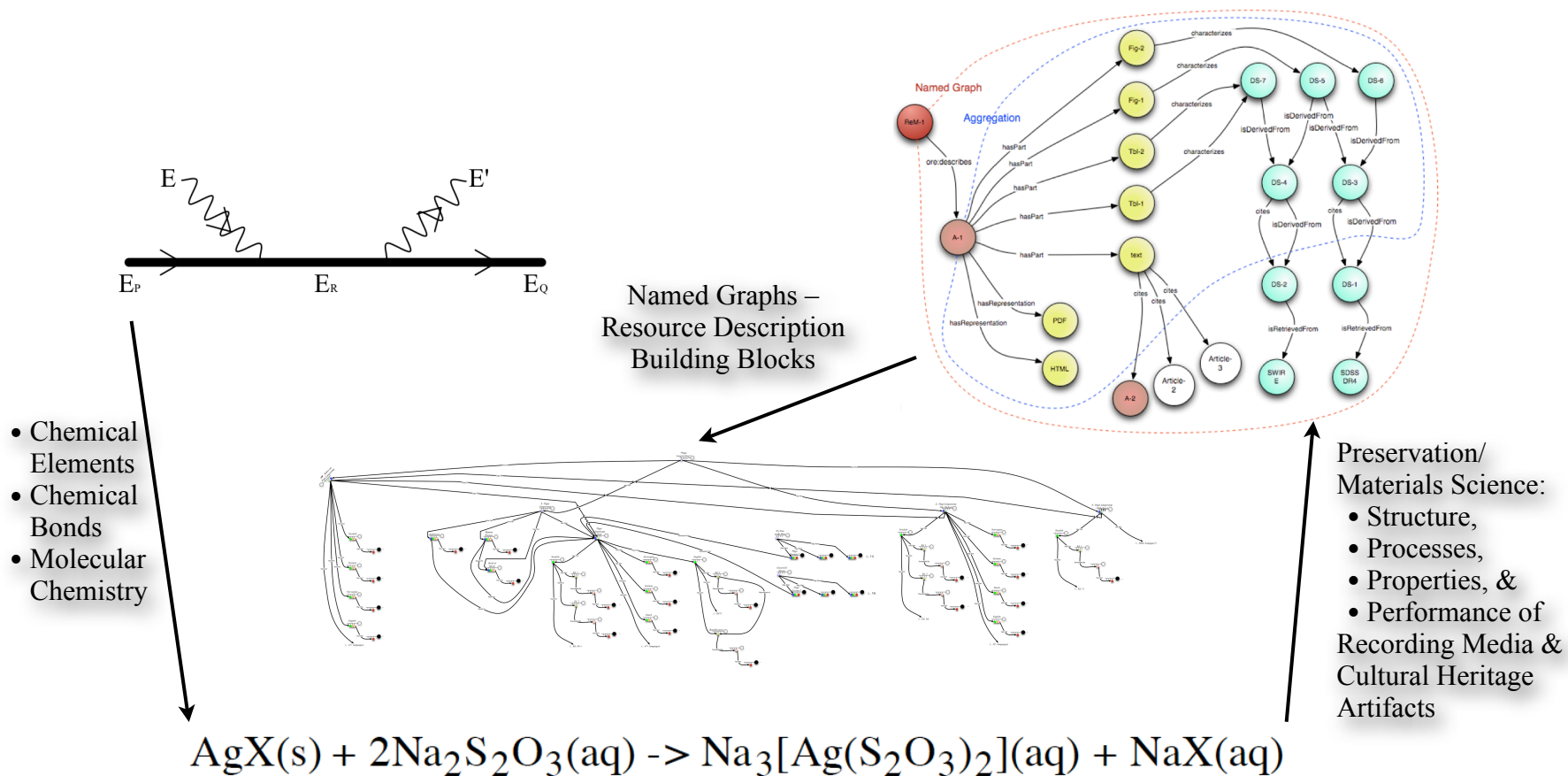
- *Boundary Crossing* - As the FRBR paper tool demonstrated, building blocks at each level have their own construction etc., rules and complex results

The Semantic Web: Paper Tools and Trading Zones in Practice



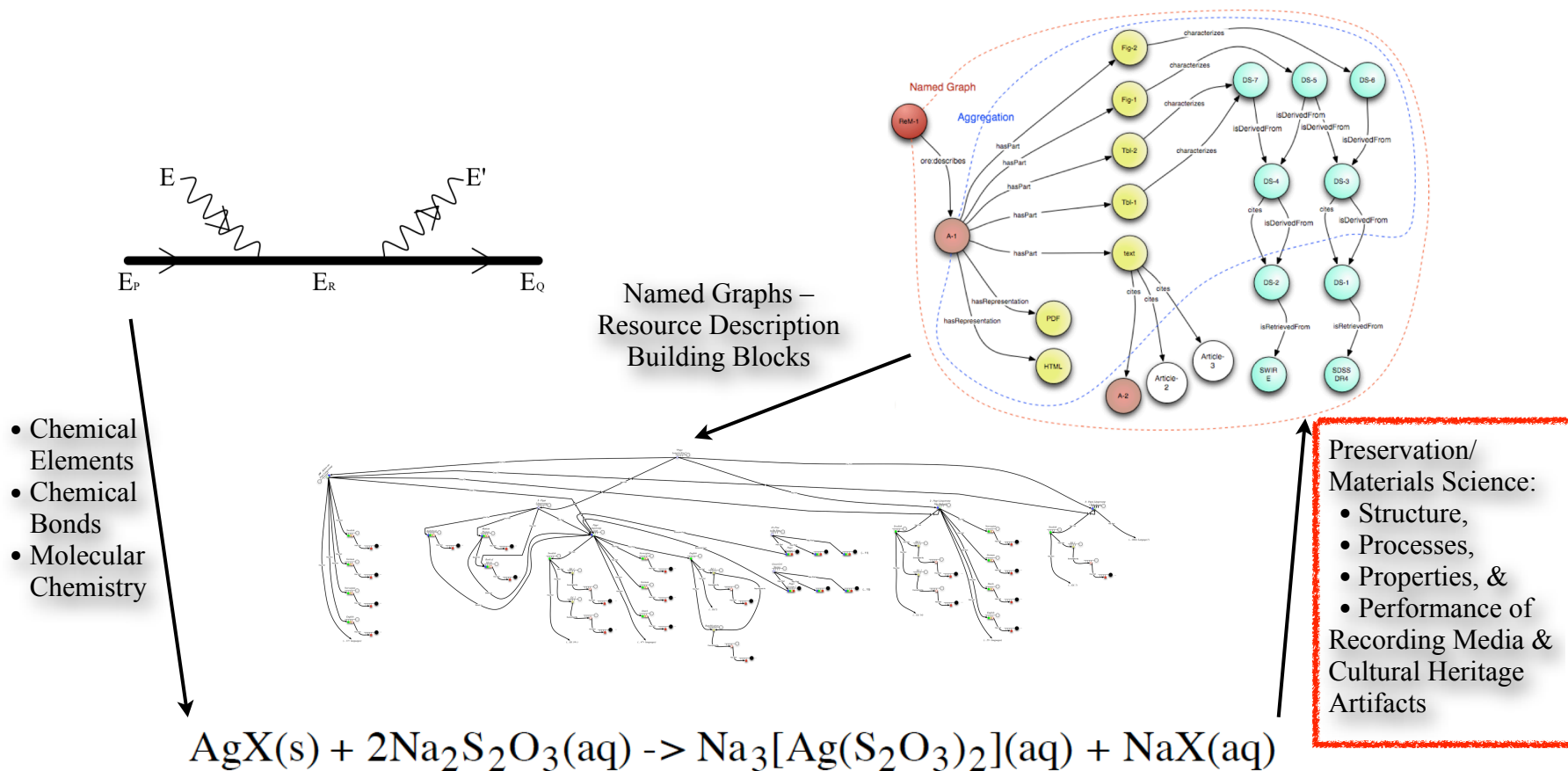
- *Example* - From RDF statements about subatomic particles and interactions, “chemical element” and “chemical bond” building blocks are constructed

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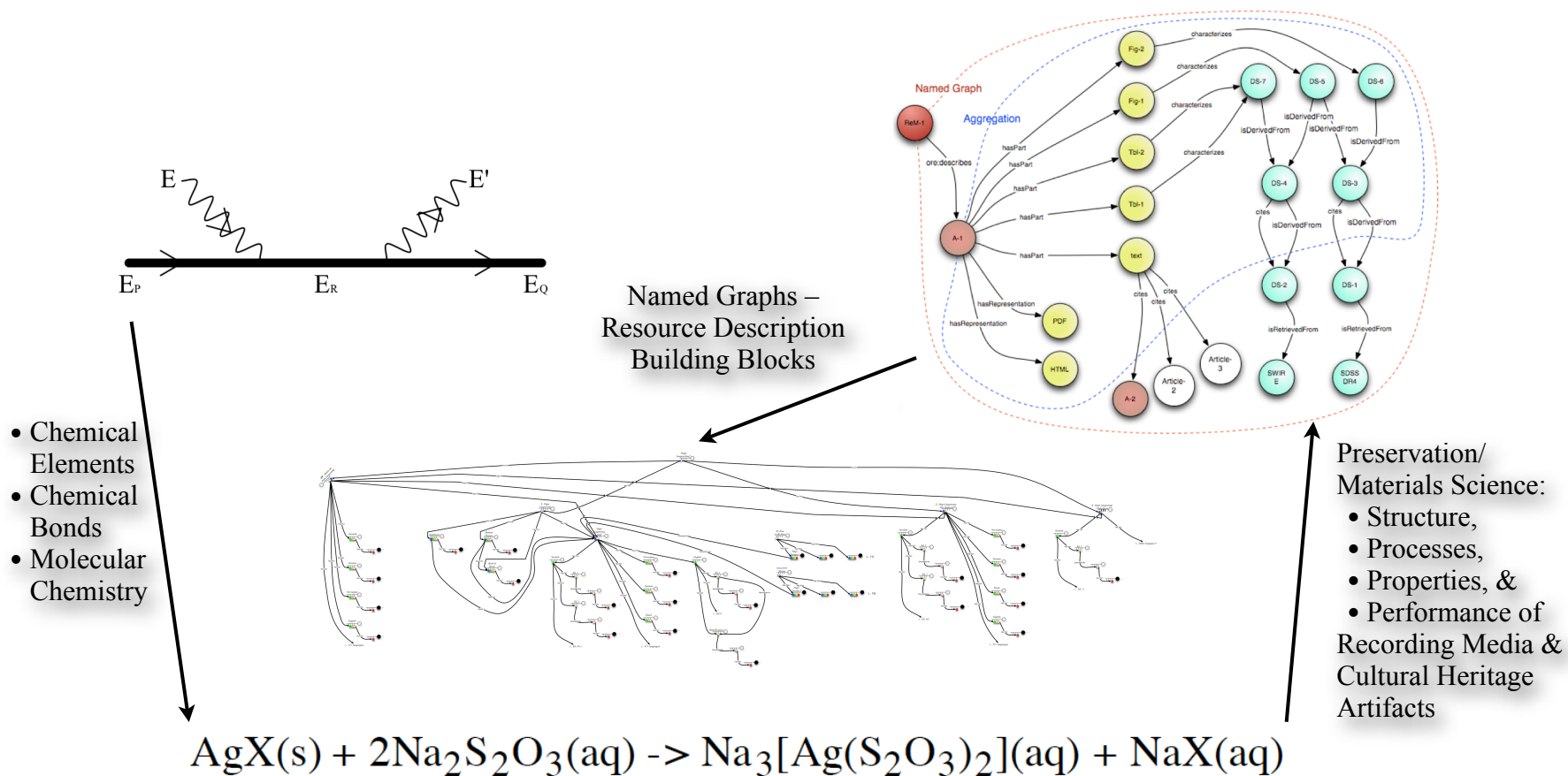
- *Example* - Chemical element and chemical bond building blocks are used to construct molecule and compound building blocks

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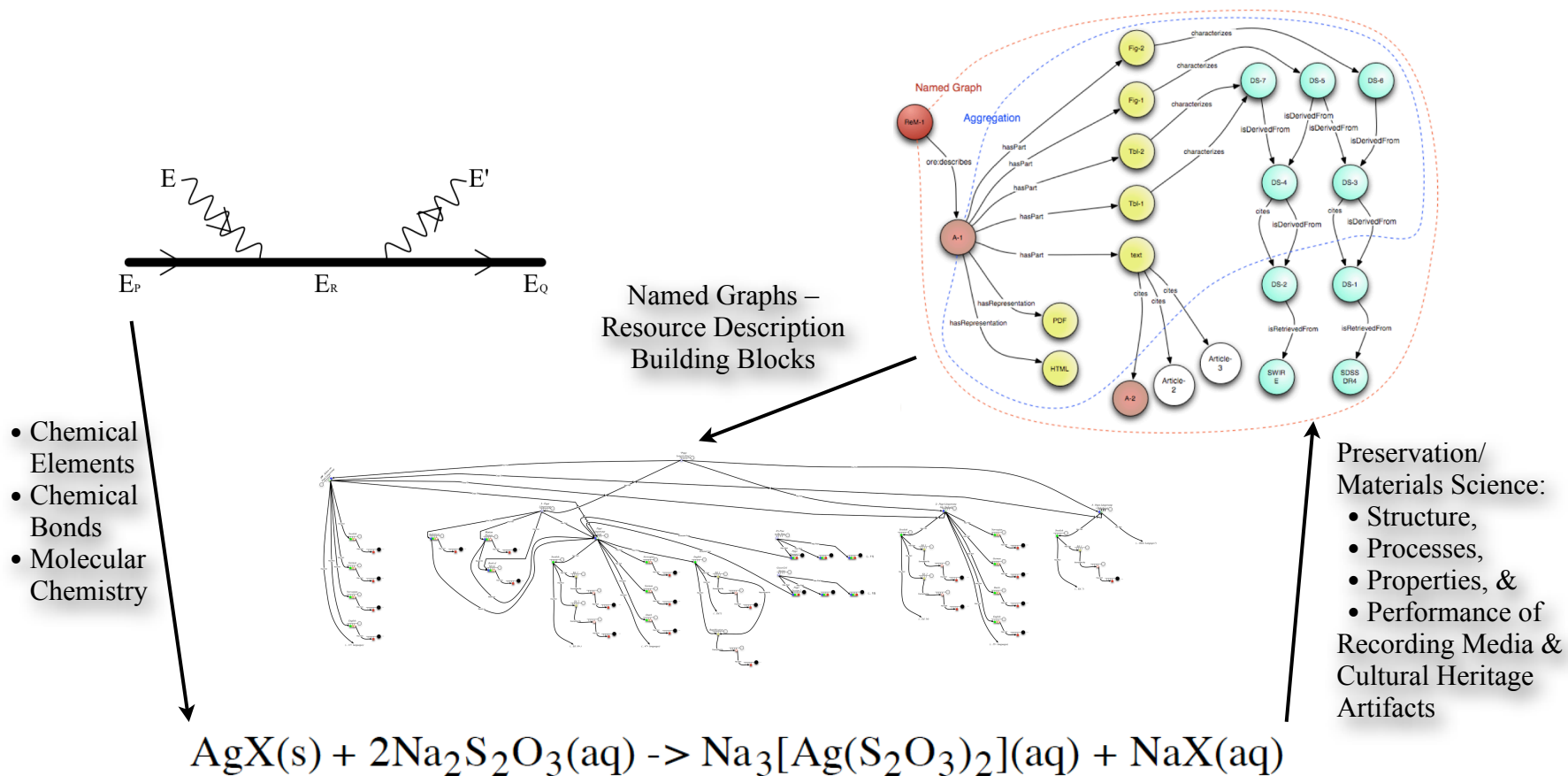
- *Example* - Molecule, compound, (etc.) building blocks support construction of Materials Science building blocks for a recording medium: *newsprint*

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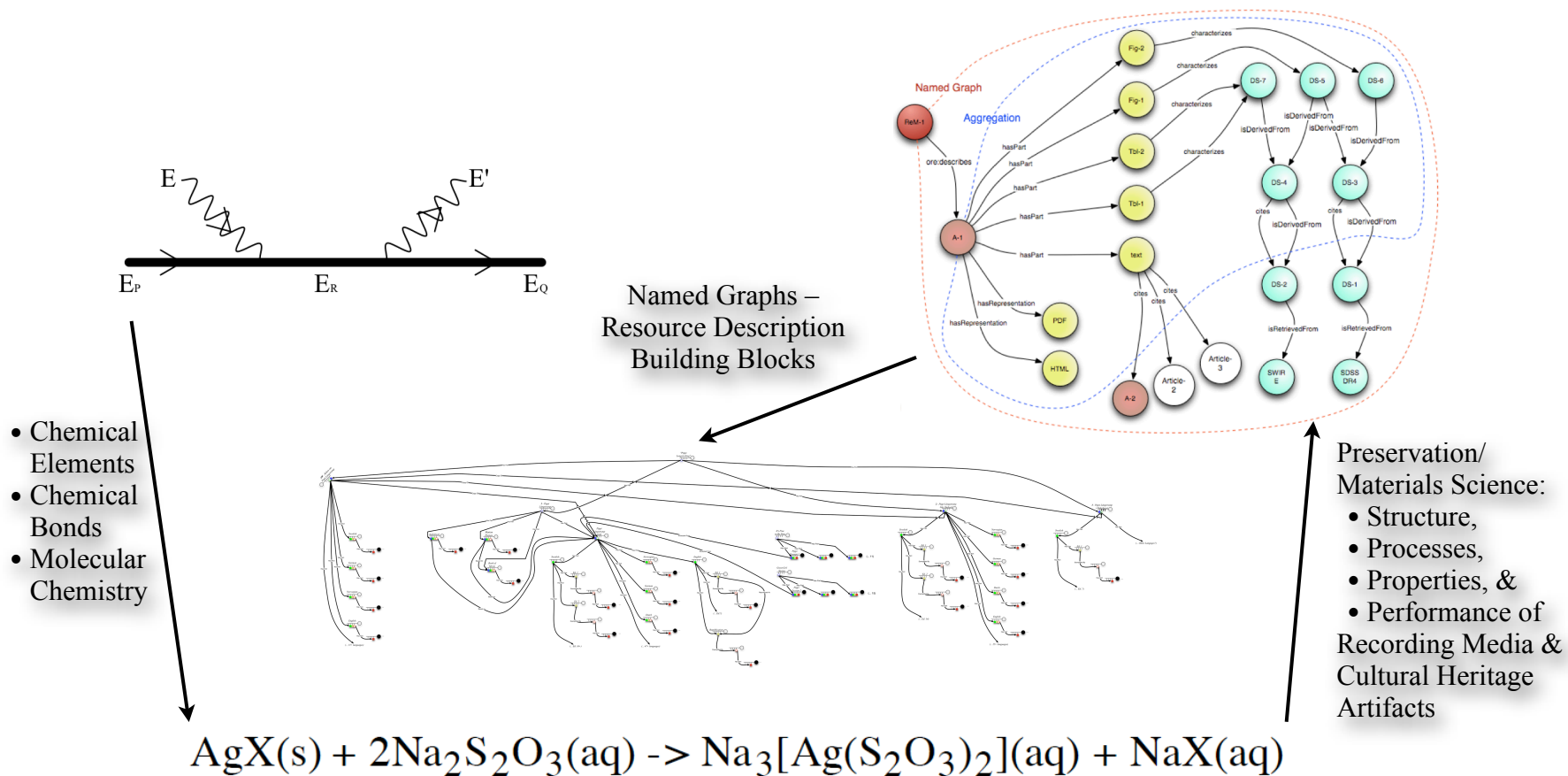
- *Condition Assessment* - Qualitative measures of the newspaper page are further informed by quantitative measurements/descriptions of a newsprint sample

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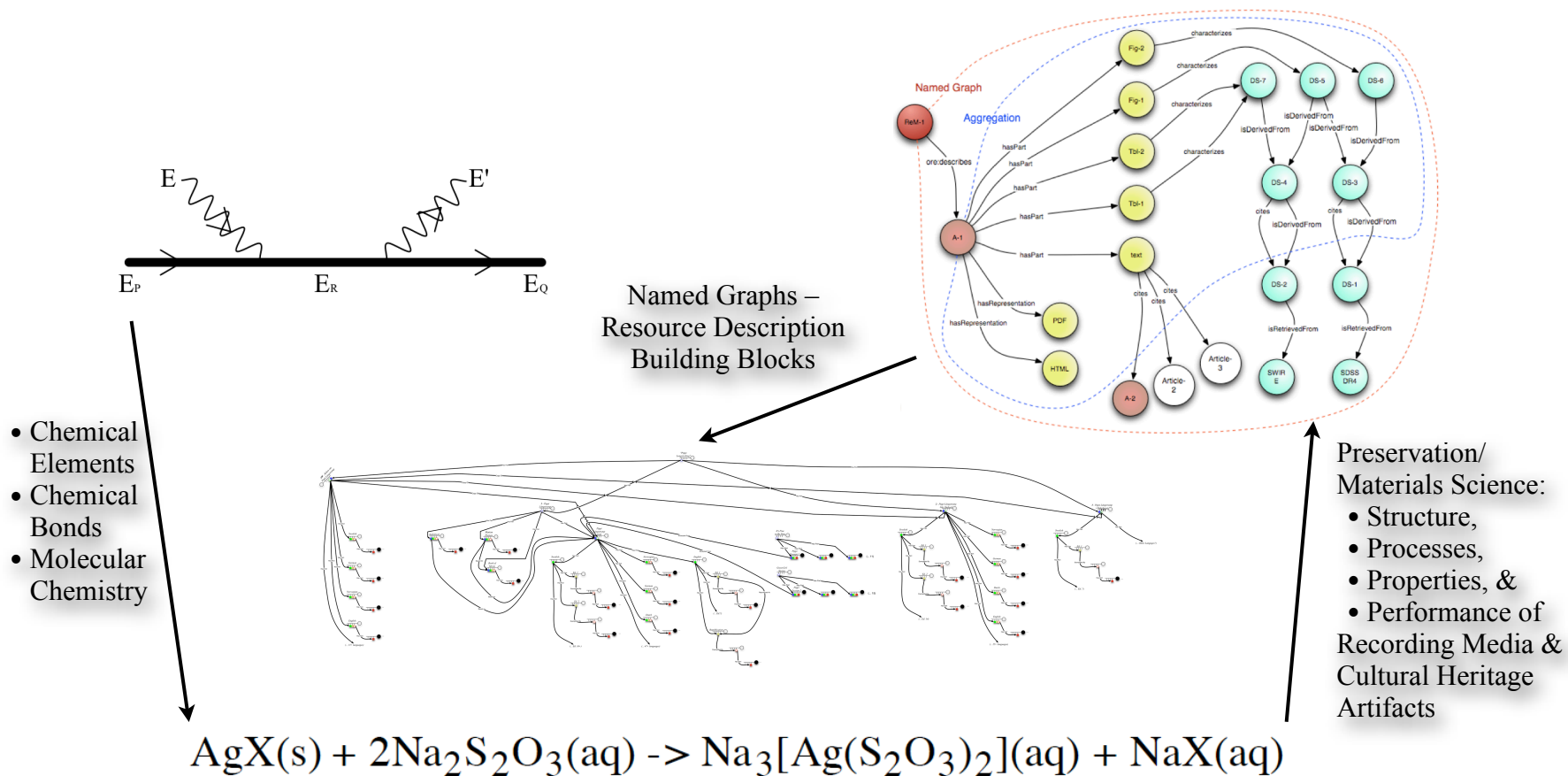
- *Outcome* - A Paper Conservator decides that the newspaper page can no longer tolerate routine handling, and prescribes conservation treatments

The Semantic Web: Paper Tools and Trading Zones in Practice



- *Outcome* - Access to the page is restricted, and the treated page is stored in a controlled environment. Digital and analog surrogates are created for access

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- *Outcome* - The change in access status of the page is noted, and a link directing users to alternate resources/ descriptions (and to policy/business rules) is added

Chemical Elements

Chemical Bonds

Molecular Chemistry

Named Graphs – Resource Description Building Blocks

Named Graph

Aggregation

Preservation Materials Science

Structure

Processes

Properties

Performance

Recording Media

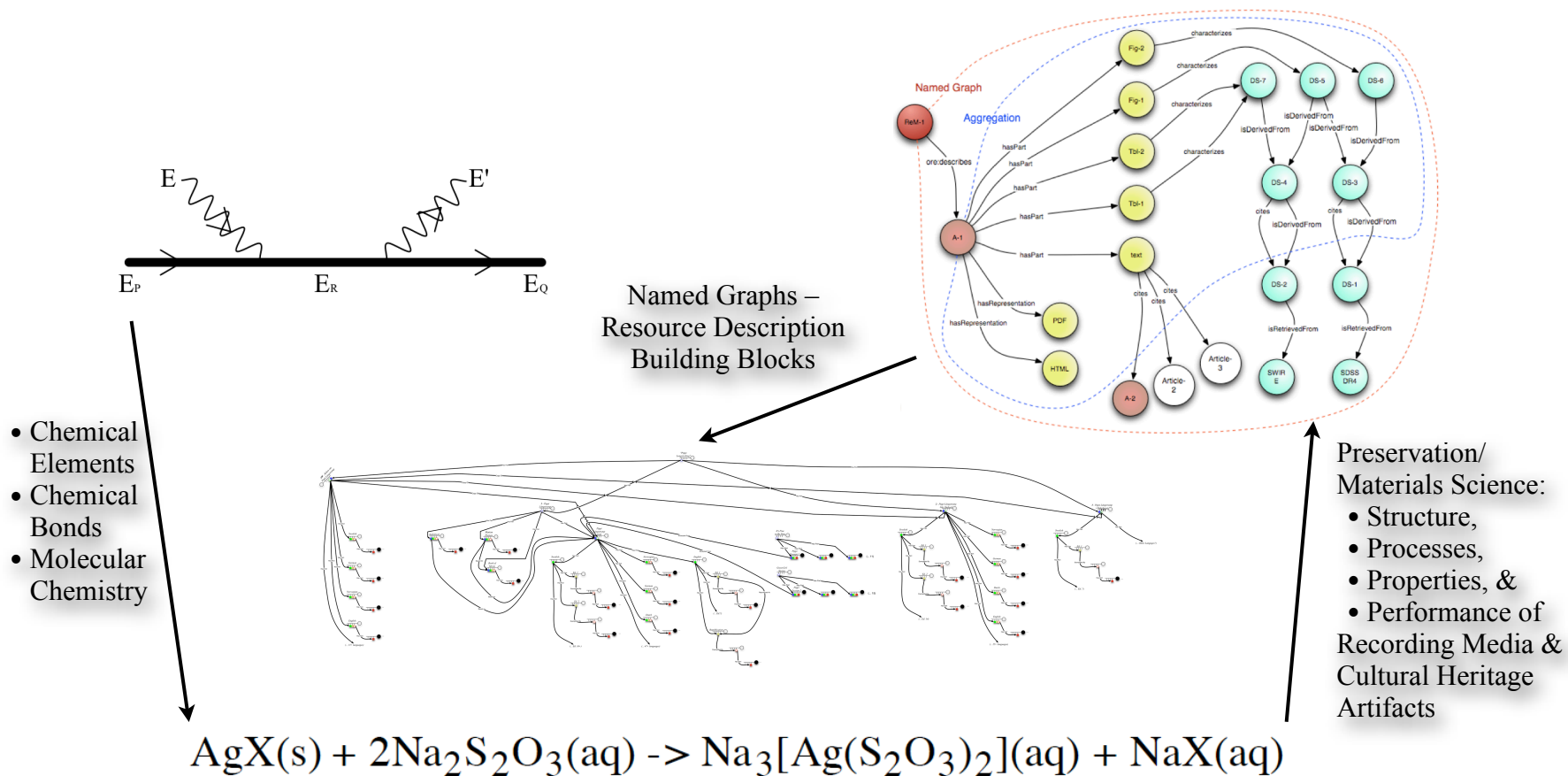
Cultural Heritage

Artifacts

$$\text{AgX(s)} + 2\text{Na}_2\text{S}_2\text{O}_3\text{(aq)} \rightarrow \text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2]\text{(aq)} + \text{NaX(aq)}$$

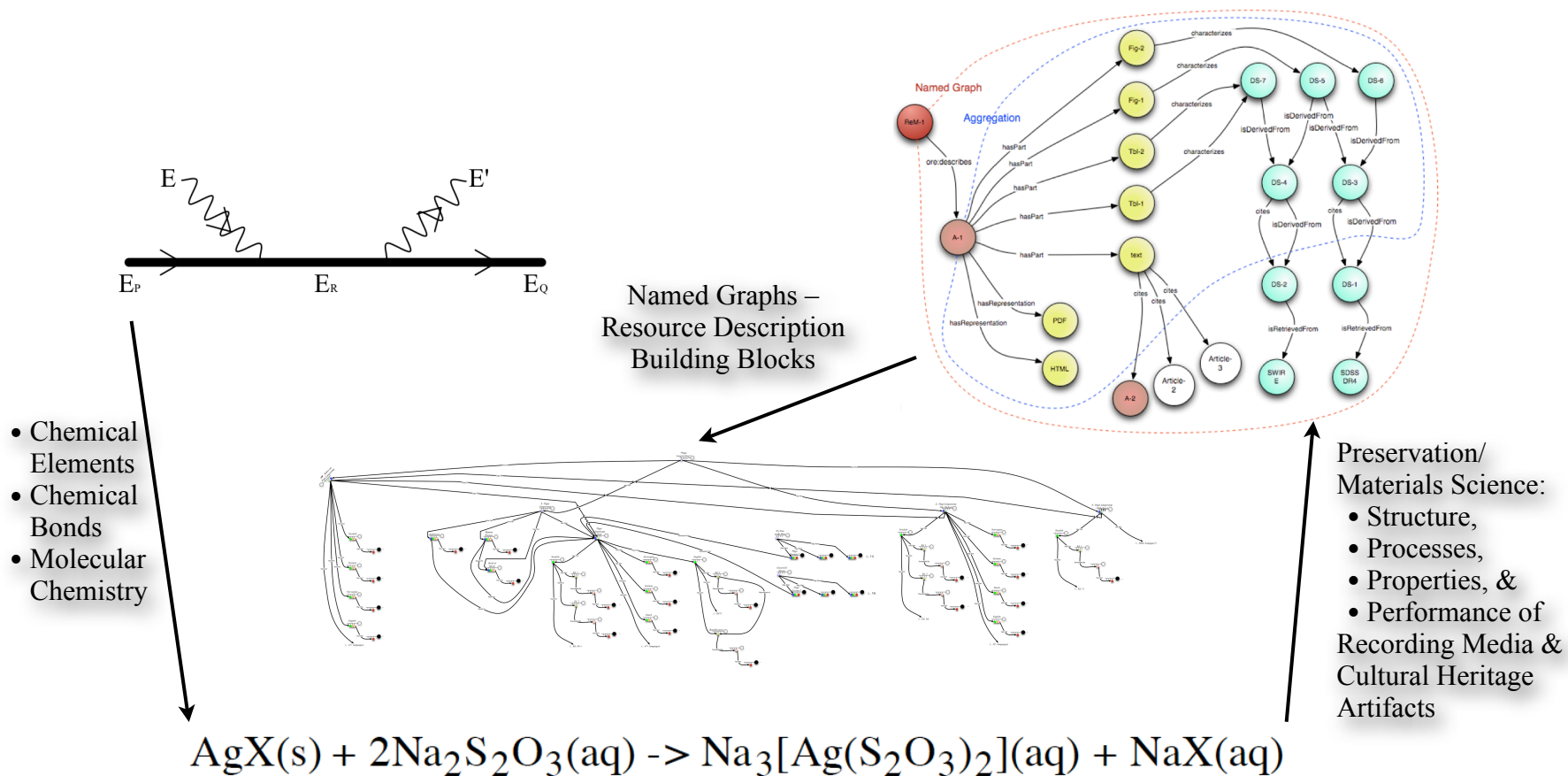
- Measurements/description of (initially quantum-physical) properties of an object contributed to a chain of operations on a resource/its descriptions

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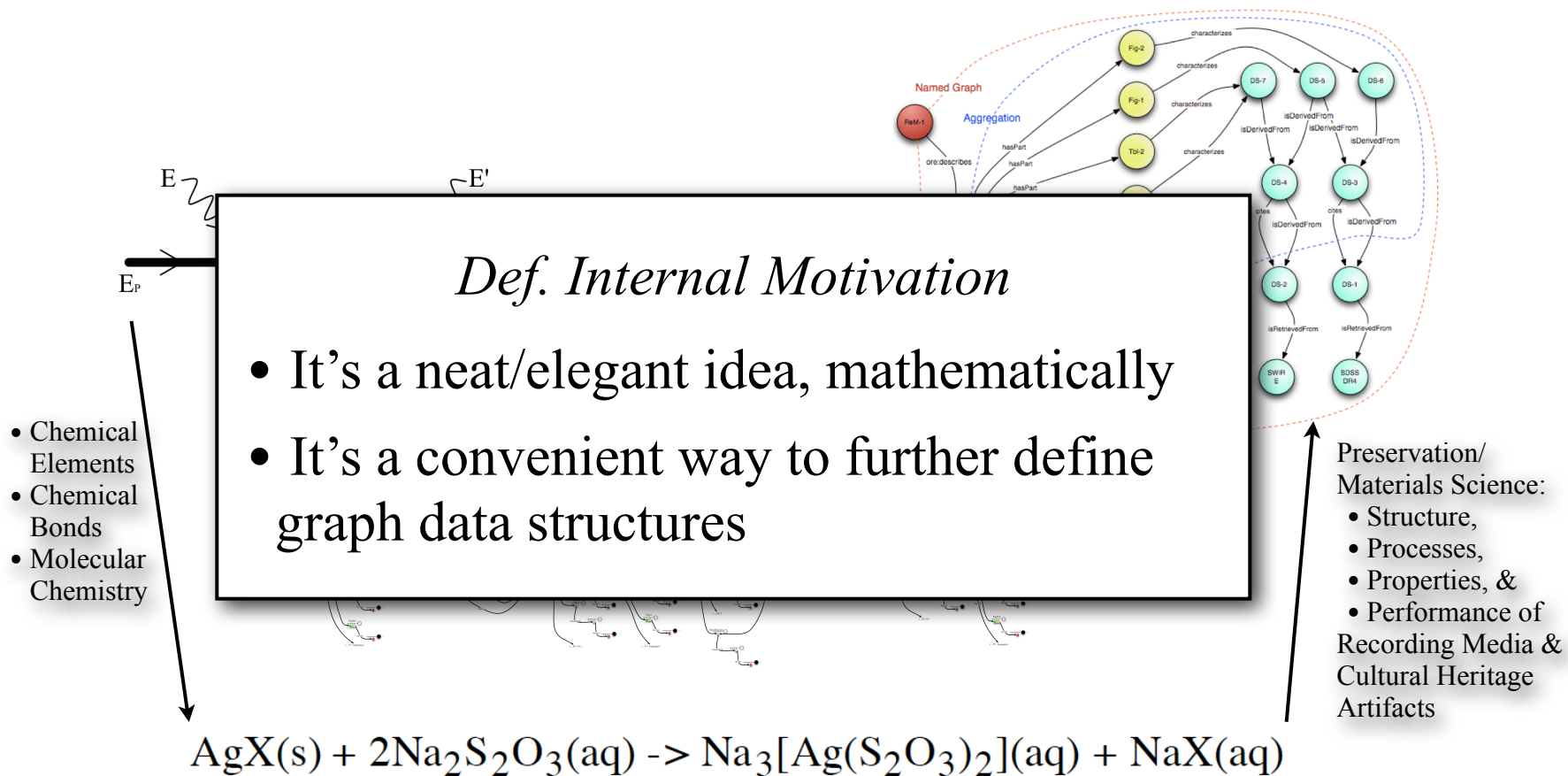
- “New, powerful, and more beneficial patterns” are achievable with layers of resource descriptions that *bottom-out* eventually to RDF

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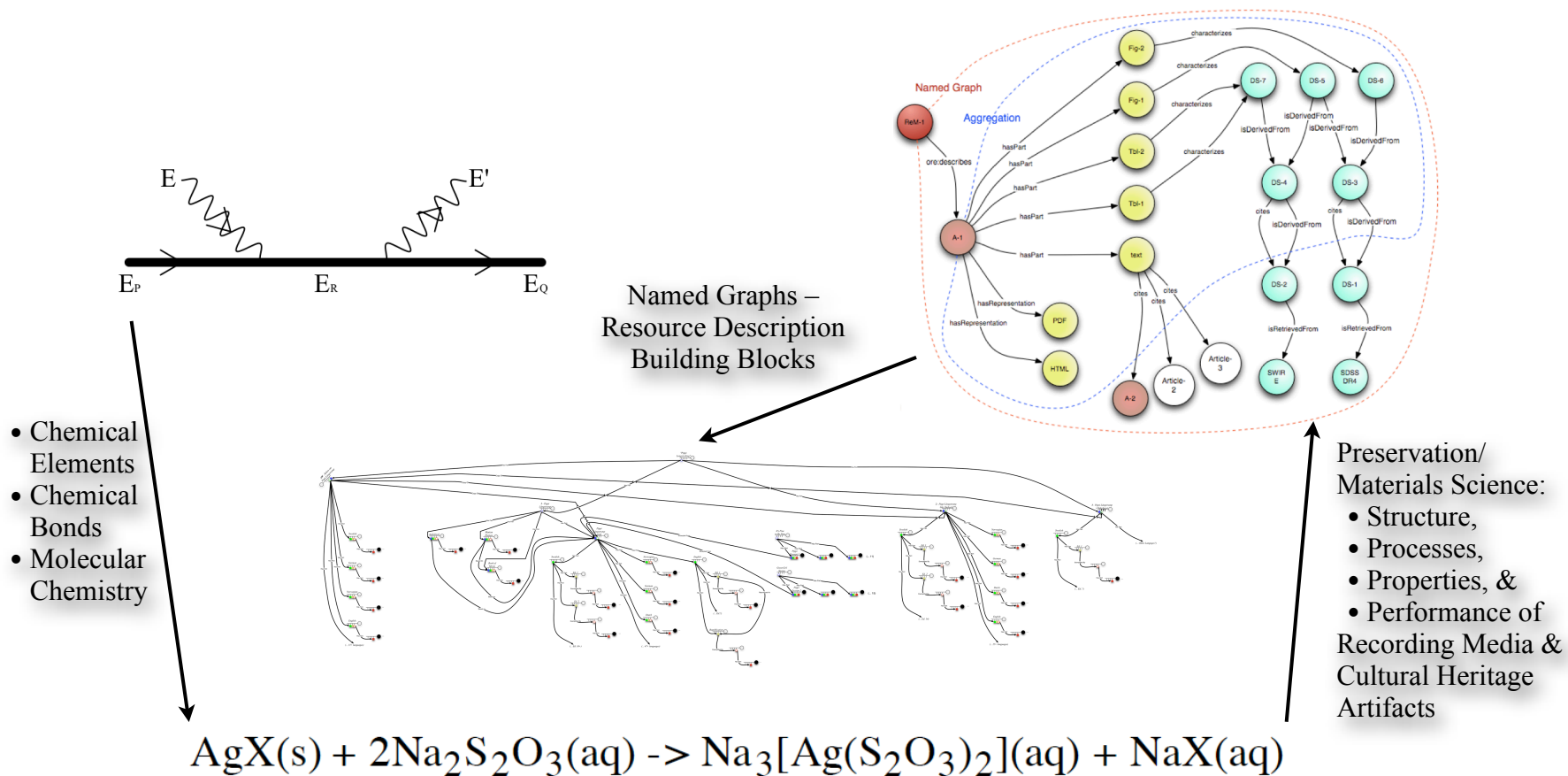
- World Wide Web researcher and developers are proceeding in this direction with OAI-ORE Named Graph standards based on “*internal*” motivations

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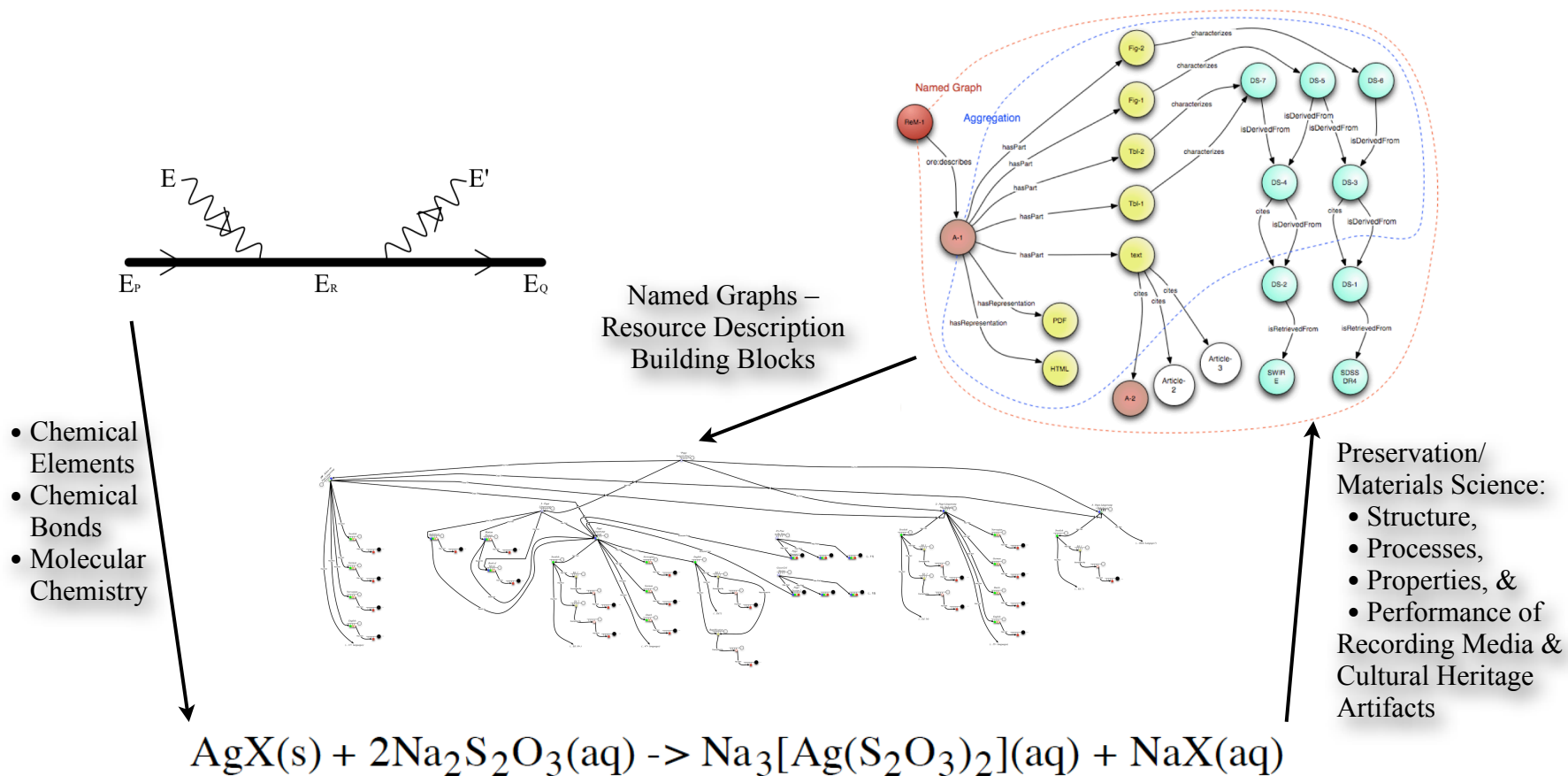
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- This paper tool-mediated demonstration of theory-relevant resource/description possibilities can serve as an additional motivation and a guide

Conclusions: The Practicality of Good Theories for Understanding Complex Phenomena

- *Cataloging Theory* - If so desired, FRBR resource descriptions can be composed so as to reflect the full complexity of Cultural Heritage resources. A full appreciation of the FRBR model's *complexity on demand* capabilities benefits from perspectives supplied by other fields of investigation
- *History of Science* - Mental (visual in this case) imagery can be employed to effectively represent and explore complex bibliographic and physical entities of current and future interest to Cultural Heritage institutions

Conclusions: The Practicality of Good Theories for Understanding Complex Phenomena

- *Conceptual Data Modeling* - Information system design techniques can successfully identify things and relationships of interest to a Cultural Heritage institution. Key to this task is the identification and removal of previous system limitations
- *Ethnomathematics* - Mathematical ideas resident in the Cultural Heritage “subculture” can be identified by examining cataloging products and end-user resource discovery activities. These ideas share similarities with those found in scientific domains

Multidisciplinary Approaches to Cultural Heritage Resource Description

- A multidisciplinary approach can render comprehensible many aspects of the complex and layered processes by which a culture's many and varied creative expressions find their way to their intended publics and to Cultural Heritage institutions. The *things of interest* to us include:
 - Analog and electronic media signals & recorded materials
 - Formal and informal resource description schemes
 - People
 - Computing devices
- If this process can be accurately modeled and understood, we can improve prospects for education/training, theory formation, and for information system design

Developing Theories

- *What frequently happens in physics is that, from seeing some part of the experimental situation, you get a feeling of how the general experimental situation is. That is, you get some kind of picture. Well, there should be quotation marks around the word 'picture.'* This picture allows you to guess how other experiments might come out. And, of course, then you try to give this picture some definite form in words or mathematical formula.

Developing Theories

- *Then what frequently happens later on is that the mathematical formulation of the 'picture' or the formulation of the 'picture' in words, turns out to be rather wrong. Still the experimental guesses are rather right, that is, the actual 'picture' which you had in your mind was much better than the rationalization which you tried to put down in the publication.*

Developing Theories

- *That is, of course, a quite normal situation, because the rationalization, as everyone knows, is always a later stage and not the first stage. So first one has what one may call an impression of how things are connected, and from this impression you may guess, and you have a good chance to guess the correct things.*
- *But then you say, 'Well, why do you guess this and not that?' then you try to give rationalizations, to use words and say 'Well, because I described such and such.' The picture changes over and over and it's so nice to see how such pictures change.*

Re-Imagining The Bibliographic Universe: FRBR, Physics, & The World Wide Web

Acknowledgements - Judith Kuhagen, David Hay, Gordon Dunsire, Herbert van de Sompel,
Peter Murray, Dianne van der Reyden, Myron Chace, James Hodson