Path-Based Query Computation by Automated Deduction

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AG 2

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Background

Deduction Systems

- First-Order
- Classical and Knowledge Representation Logics
- Refutational and Model Computation
- Implementations

Applications

- Diagnosis
- Deductive Databases
- Computational Linguistics

This Talk

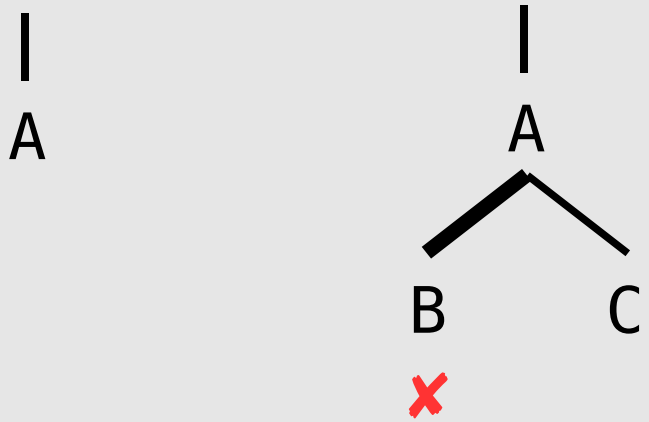
- Computing paths through database schema
- Express task in logic programming framework
- Use “KRHyper” Deduction System
- Connection to AG 5: complements XXL search engine?

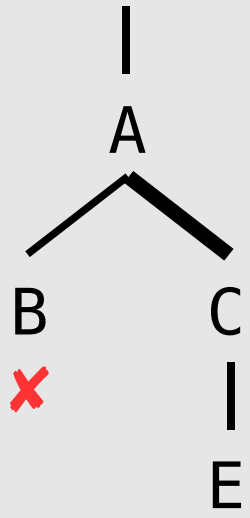
KRHyper

- Disjunctive logic programs
- Stratified default negation
- Model computation
- Perfect model semantics
- Serious implementation

$$A \leftarrow \quad (1)$$
$$B \vee C \leftarrow A \quad (2)$$
$$A \vee D \leftarrow C \quad (3)$$
$$\text{false} \leftarrow A, B \quad (4)$$

$$E \leftarrow C, \text{not } D$$



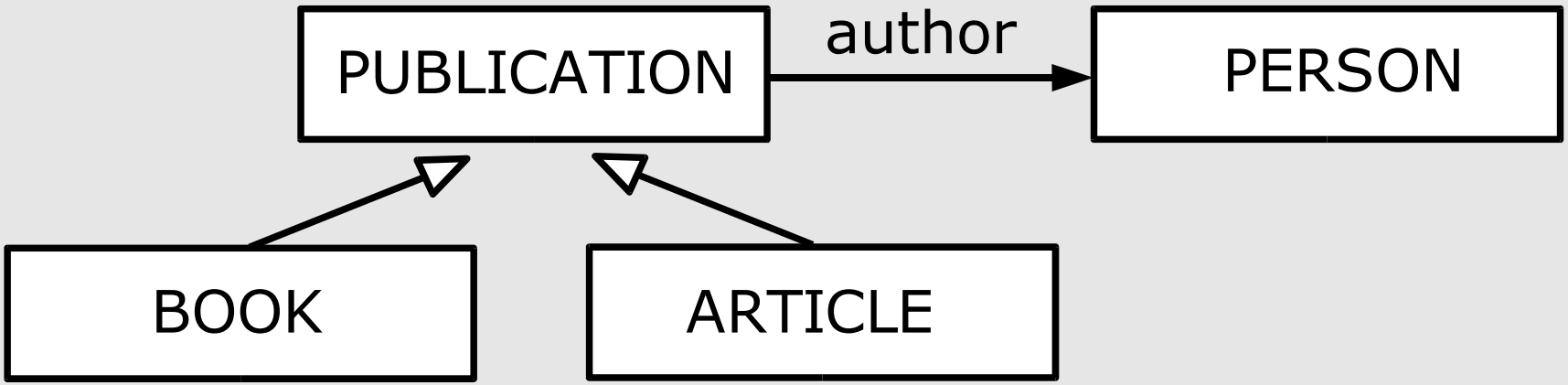


$\{\} \not\models (1)$ $\{A\} \not\models (2)$ $\{A,B\} \not\models (4)$ ✘ $\{A,C\} \models (1)\text{-}(4)$ ✔

- Variant for predicate logic
- Extensions: minimal models, abduction, **default negation**

Description Logics (DL)

- Old-fashioned, problematic graphical notation



- $\mathcal{ALC}$ and successors:

  $\text{PUBLICATION} \sqsupseteq \text{BOOK} \sqcup \text{ARTICLE}$

  $\text{PUBLICATION} \sqsubseteq \exists\, \text{author}.\text{PERSON}$

- Corresponds to decidable fragment of first-order logic
- Standard sevices: consistency, classify, retrieve, ...
- *The* KR formalism for the "Semantic Web"

More DL Language Features

Class definitions: PUBLICATION $\sqsubseteq \exists$ author.PERSON
PUBLICATION $\sqsubseteq \forall$ author.PERSON

Subroles: author $\sqsubseteq$ creator

Inverse/trans. roles: author^{-} / colleague^{+}

QVR: MANYAUTHORS $\sqsubseteq$ ($\geq$ 10 author^{-}).PUBLICATION

Concrete domains: Int, String, ...

Nominals:

Cycles:

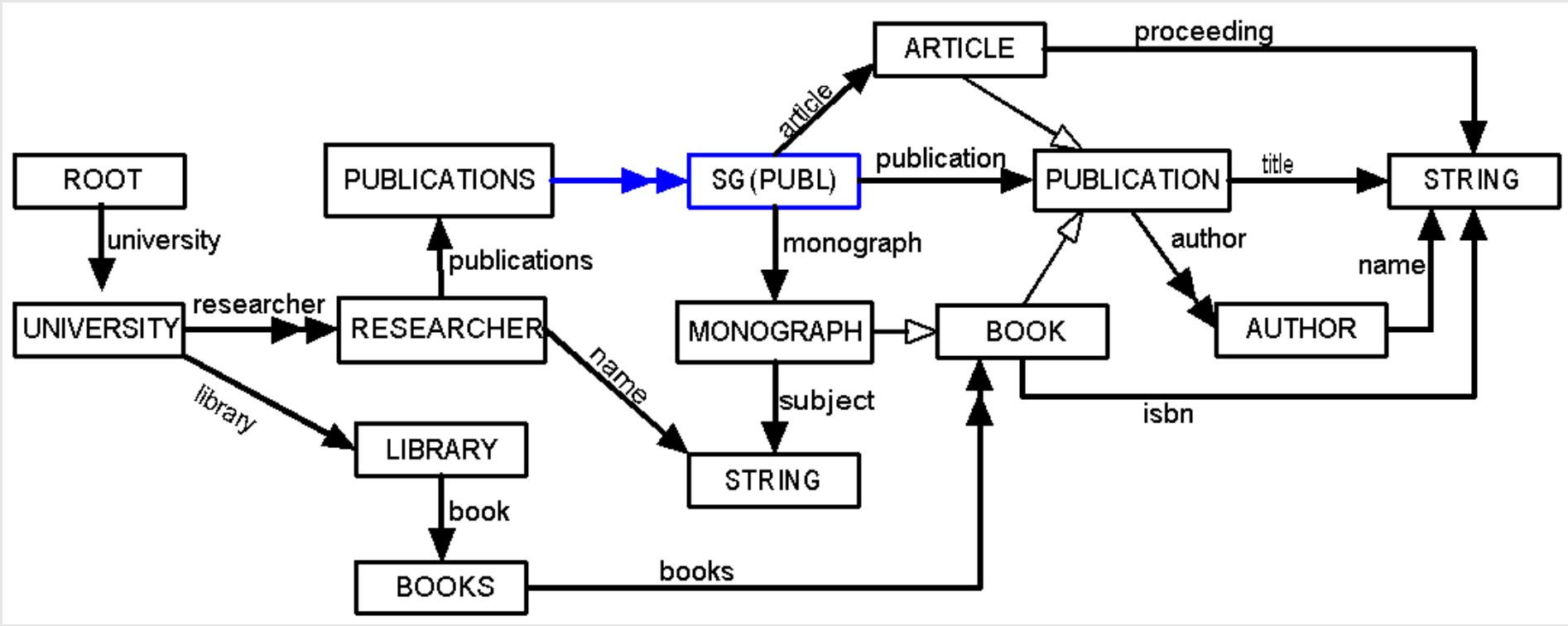
...

Assertions:

author(TACP,Knuth)

DL language alone and services offered by systems do not suffice to solve task below!

Application: XML Schema Reasoning

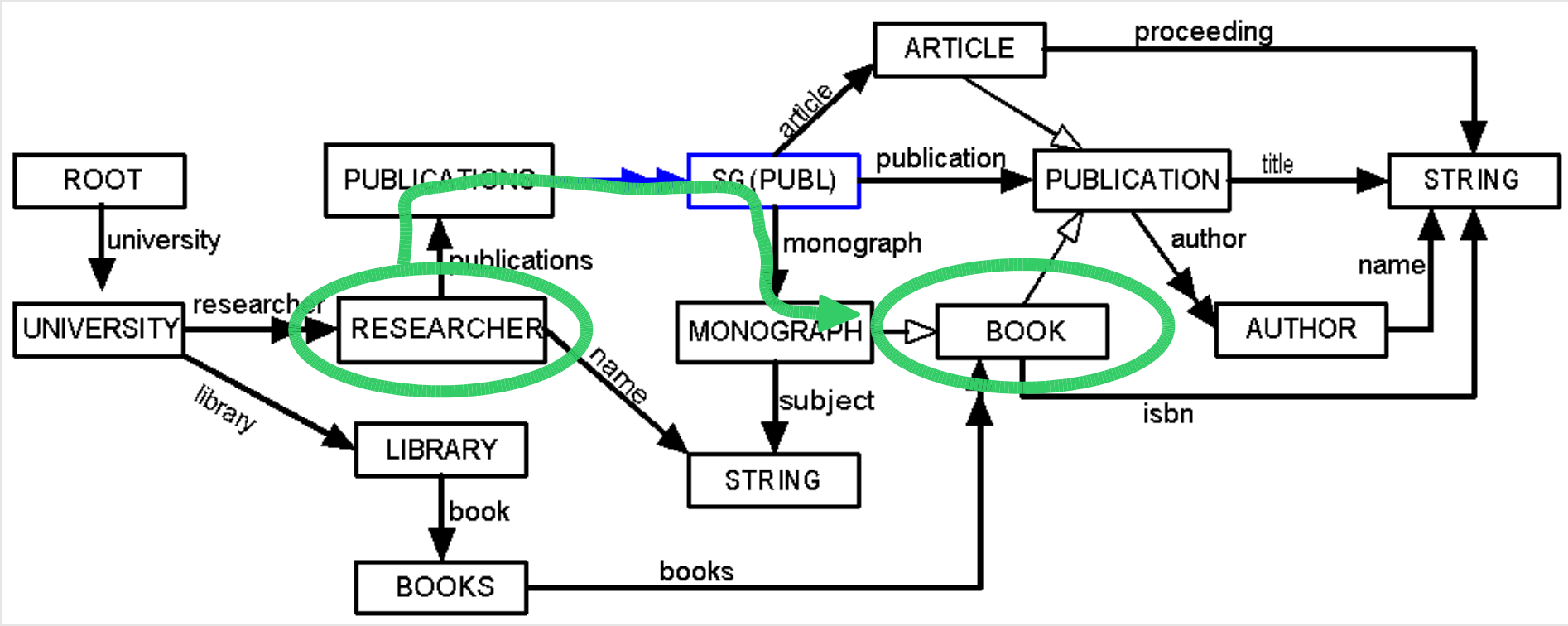


Context: Semistructured Data, Schema Integration

Task: Determine path based database queries

Solution: XPath (?) vs. **Query generated from schema**

Application: XML Schema Reasoning



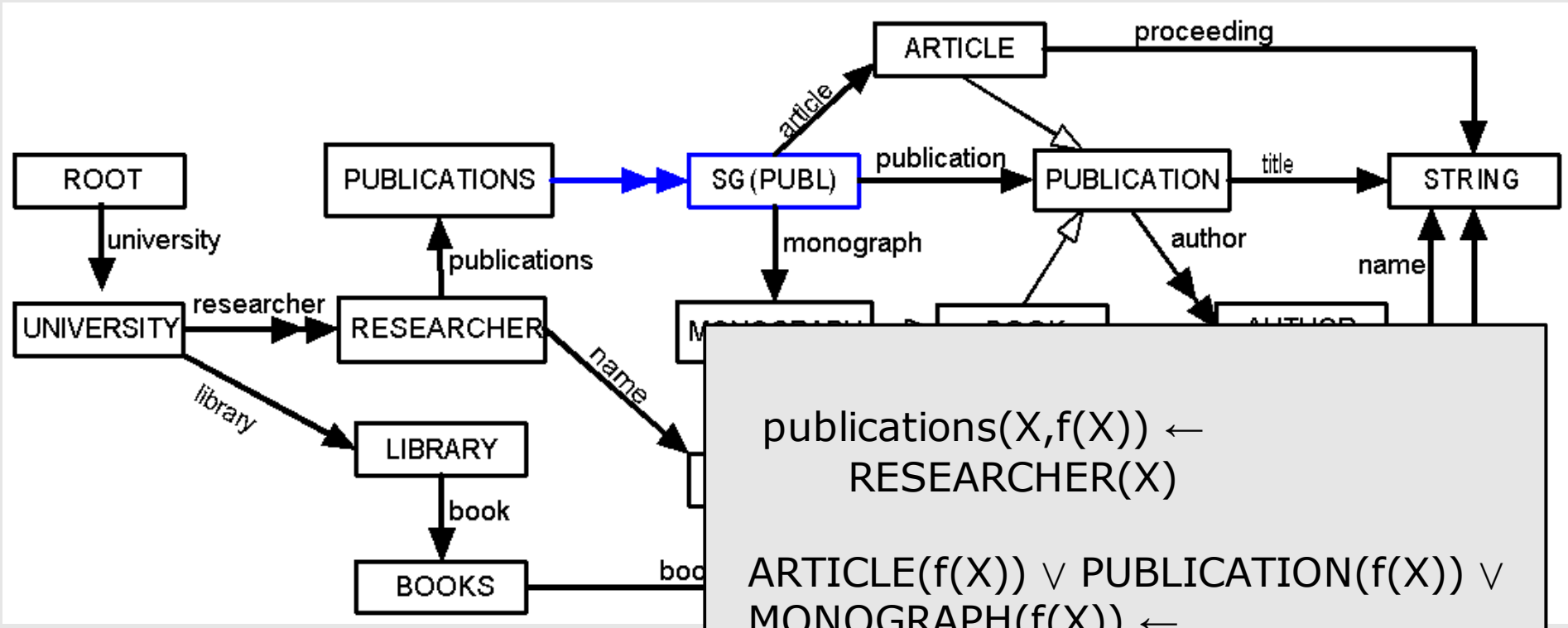
Generate query:

Steps: (1) Schema → DL → If-Then Rules

(2) Start and End → Assertions/If-Then Rules

(3) Path based query → Computed modell

Application: XML Schema Reasoning



(1) Schema → DL → If-Th

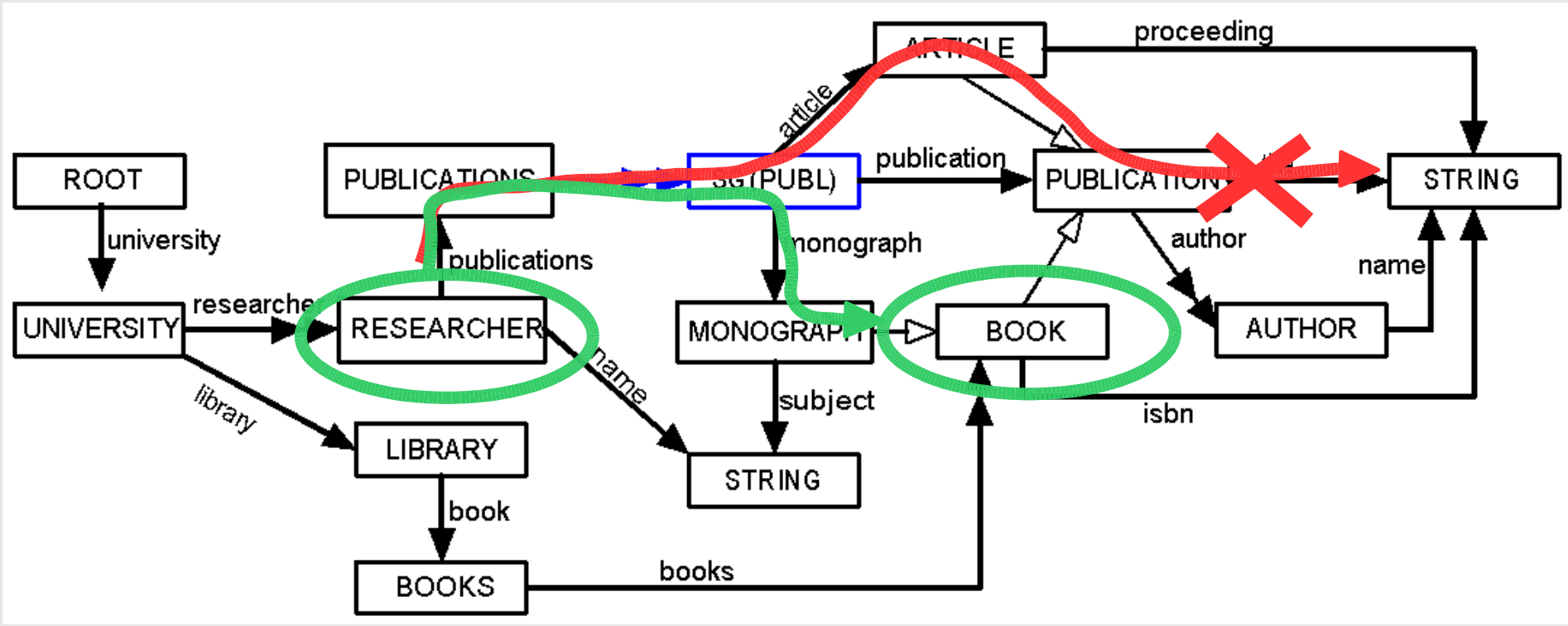
$$\mathtt{RESEARCHER} \sqsubseteq \exists\, \mathtt{publications}.(\mathtt{ARTICLE} \sqcup \mathtt{PUBLICATION} \sqcup \mathtt{MONOGRAPH})$$

$$\mathtt{ARTICLE} \sqcap \mathtt{MONOGRAPH} \sqsubseteq \bot$$

$$\mathtt{PUBLICATION} \sqsupseteq \mathtt{BOOK} \sqcup \mathtt{ARTICLE}$$

...

Application: XML Schema Reasoning



(2) Start and End → Assertions/If-Then rules

RESEARCHER(a) (Start)

$\bot \leftarrow$ not $\exists X$ BOOK(X) (End)

Solution (almost) trivial!

Conclusions

- Approach taken:
  - rather inexpressive DL
  - transformation to logic programming
  - model computation
  - purely declarative
- Did not succeed with “standard” Description Logic reasoners,
  although may be used complementary
- Further issues:
  - cycles in schema graph
  - numbers
  - first-order level reasoning useful?
- Presented first ideas only ...