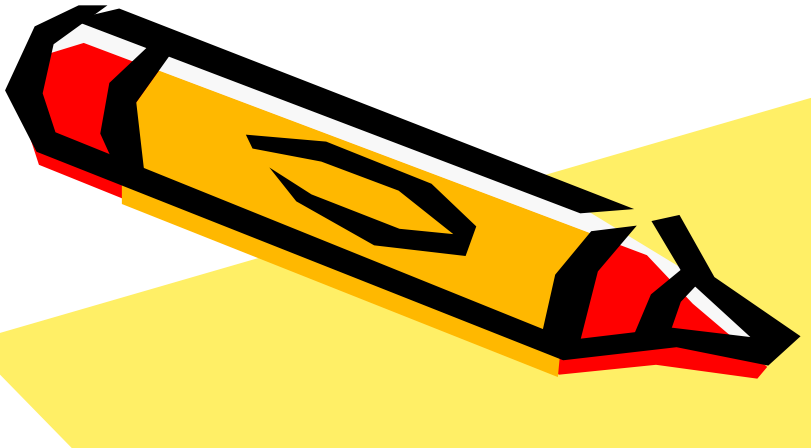
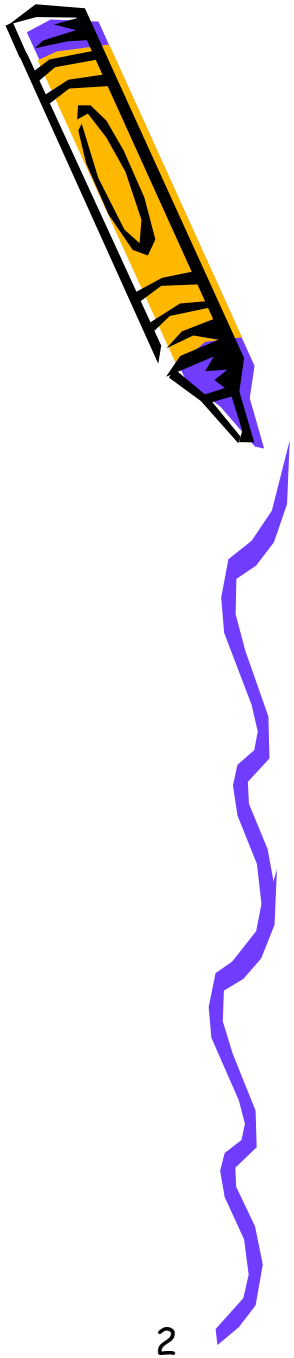


Visualization-based Study on Information Specification Languages for Network Management using Formal Concept Analysis

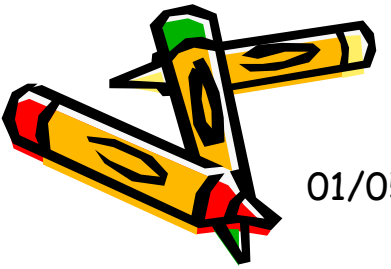
Hui Xu

Huazhong Normal University

Outline

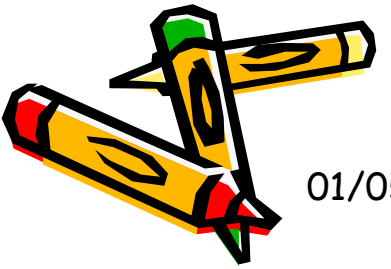


- Problem Statement
- Related Work
- Proposed Approach
- Example Demonstrations
- Conclusion and Future Work



Background (1)

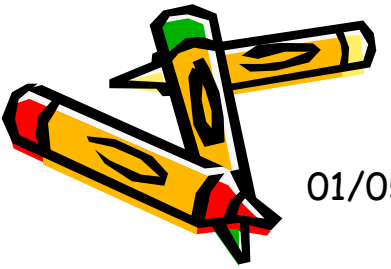
- Standardization of network management started in the late 1980s, and until now there have been several solutions, the widely adopted one of which is Simple Network Management Protocol (SNMP)



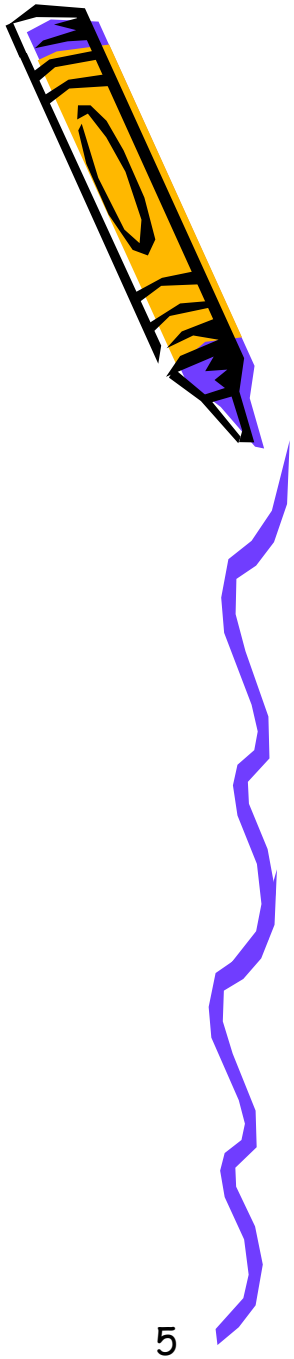
Background (2)

- Recently, more studies and the industry as well focus on future Internet, three key points of which may be content, service and management

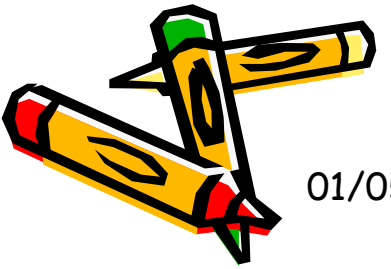
These days show an increasing interest by research and industry in future Internet and its management



Future Internet: in USA

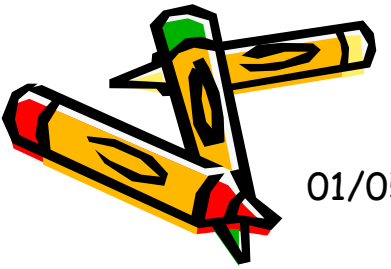


- Future Internet Design (FIND)
- Globe Environment for Network Innovation (GENI)



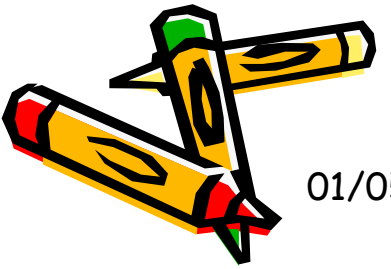
Future Internet: in Europe

- Future Internet Research and Experimentation (FIRE)



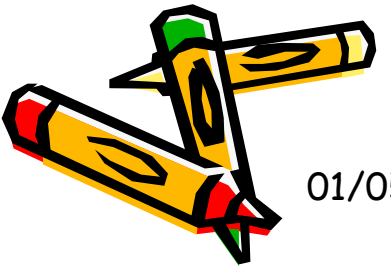
Future Internet: in Japan

- New Generation Network (NGN)



But …

- Traditional solutions have limitations of some degree in terms of performance, scalability, flexibility, maintainability and reliability, thus don't seem to be quite appropriate for future network management

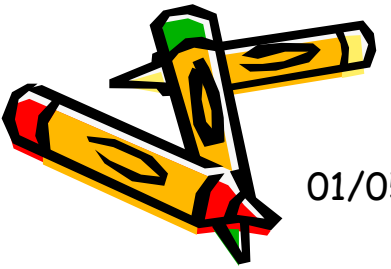


What's the Problem?

- Although many of these initiatives consider network management as an important research area that should be an integral part for the design of future Internet instead of just being an "add-on" capability, it is still unclear how this management should look like

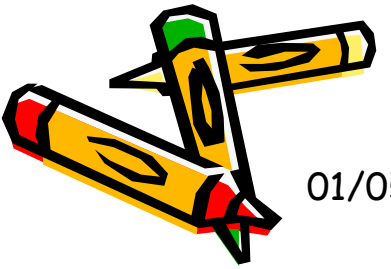
Management Mediation

- The translation between managing and managed systems, which introduces management hierarchies
  - Mediation at transport level
  - Mediation of the management protocol
  - Mediation of management information

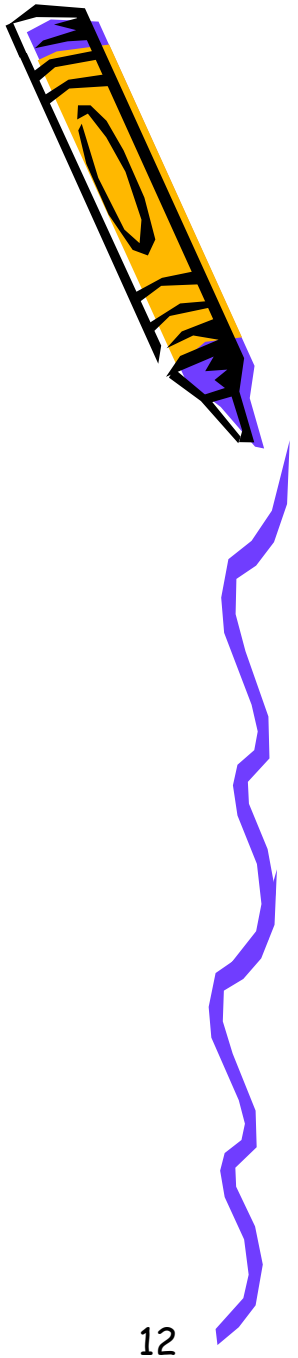


Focus

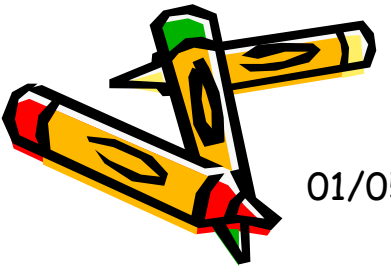
- This paper tries to discuss network management information hierarchy from the viewpoint of granularity, which may possibly solve two existing significant problems
  - Lack of unification
  - Low level of formalism



Network Management Information Hierarchy

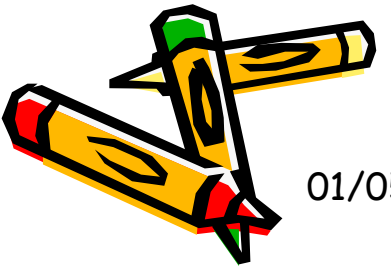


- Three levels
  - Meta-schema (management information specification language)
  - Schema (MIB definition as management information specification)
  - MIB instance (management information)



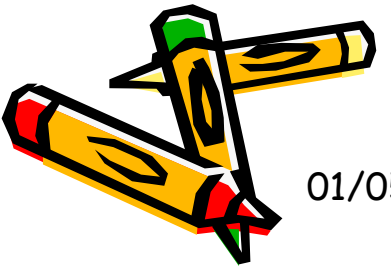
Notes (1)

- Current studies mainly focus on management information and its specification, but rarely on management information specification languages. However, meta-schema is the guideline for schema, which is then the one for MIB instance



Notes (2)

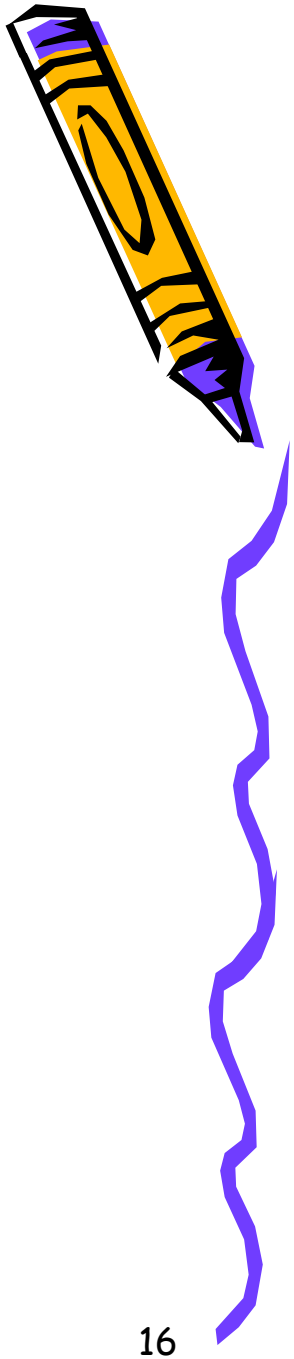
- Since the syntax of a management information specification language often reflects its distinctive characteristics in modeling managed objects and their relationships, visualization-based study by means of concept lattices may be a promising way to examine these languages in an integrated way



How?

- The aim of this paper is then to analyze these languages for network management information granularity based on visualization using Formal Concept Analysis (FCA, theory of concept lattices)

Outline



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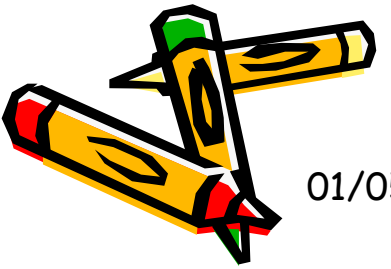
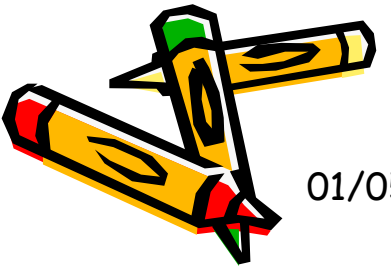
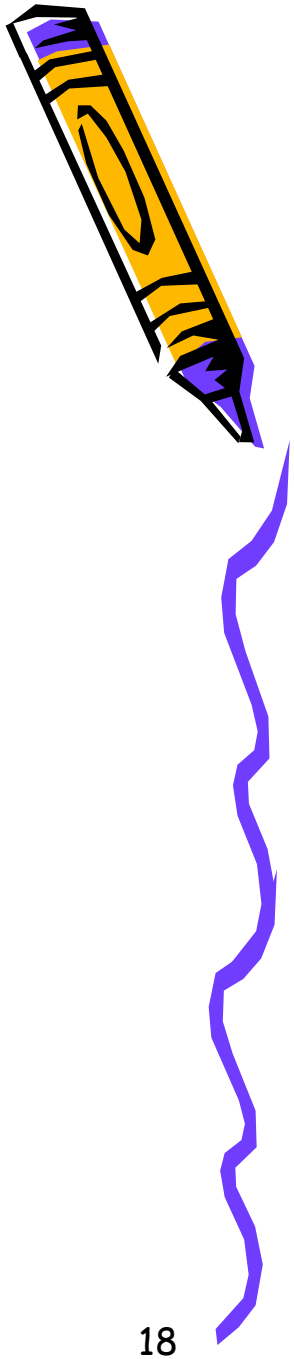


Related Work

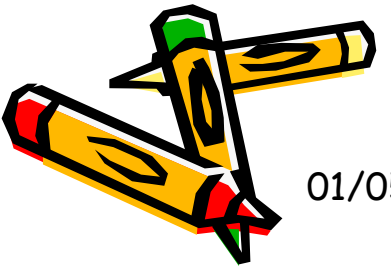
- Researches on this topic are enthusiastic about applying ontology languages to Merge and Map (M&M) management information
  - López de Vergara, J. E., Villagrá, V. A., Asensio, J. I., Berrocal, J.: Ontologies: Giving Semantics to Network Management Models. IEEE Network. vol. 17, no. 3, pp. 15--21 (2003)
  - López de Vergara, J. E., Villagrá, V. A., Berrocal, J.: Applying the Web Ontology Language to Management Information Definitions. IEEE Communications Magazine. vol. 42, no. 7, pp. 68--74 (2004)



Main Problem

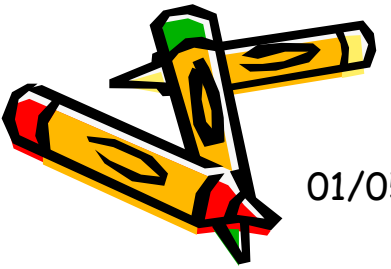


- Researches on this topic may not take adequate considerations for information granularity



Theory of Granularity

- Proposed by J. R. Hobbs
- Its framework for which consists of abstraction, simplification, idealization, articulation and intelligence
  - The crucial features from the environment of network management need to be abstracted, in order to determine an appropriate information granularity
  - When shifts in perspective are required, articulation axioms may be used



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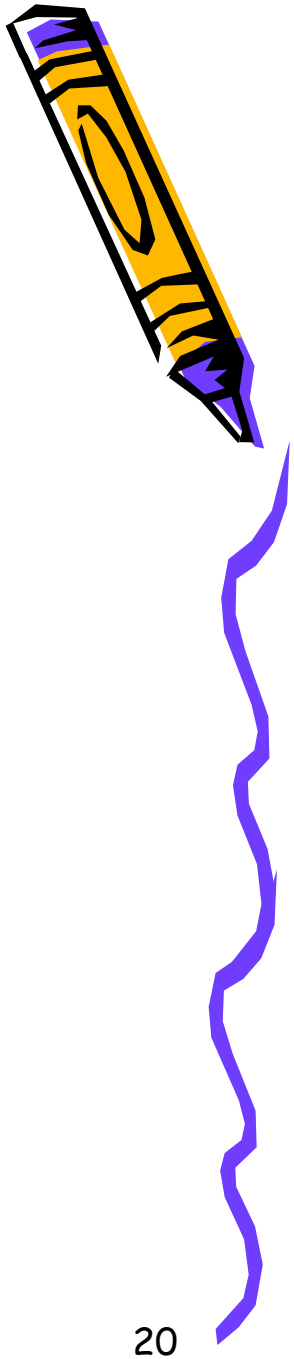

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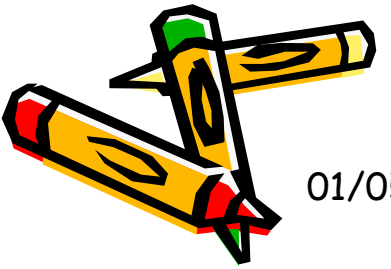
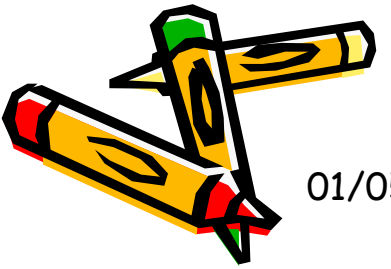


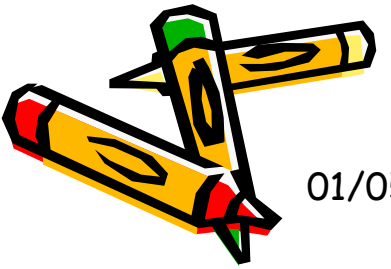
A More Independent Study is Needed

- Permanent relationships of managed objects are always described by not-lasting terms, such as management information specification languages or OWL
- These terms reflect not only the fashion of the times but also the preferences of the designers or a particular organization



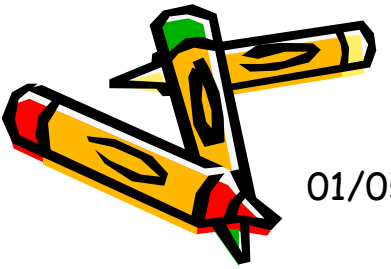
Proposed Approach

- Delighted by the thinking of reconstructing a MIB definition as the corresponding MIB tree, we argue that conceptual scheme may be a suitable choice

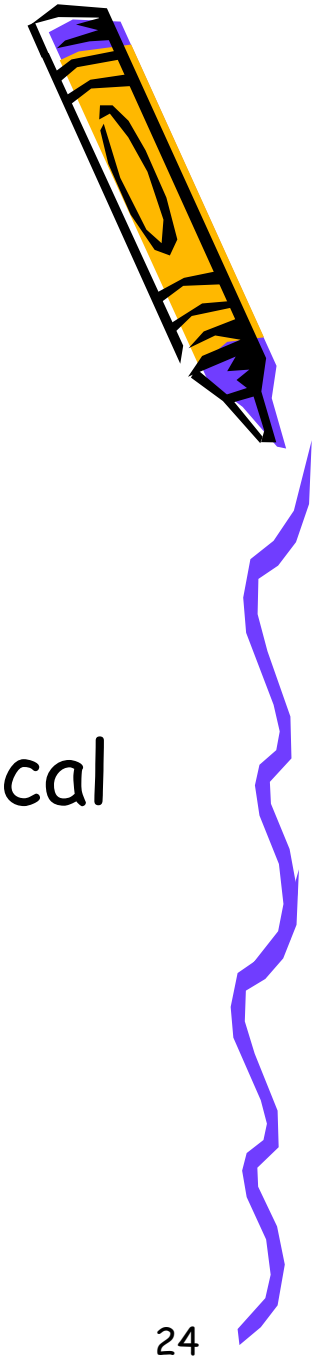


Concept Lattices

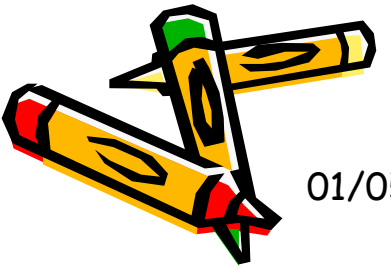
- As one origin of Granular Computing (GrC), concept lattices are an exact mathematic model, essentially reflecting the entity-attribute relationship
- Its corresponding Hasse chart can reveal notional hierarchy



Formal Concept Analysis



- As the theory of concept lattices, the FCA approach is a mathematization of the philosophical understanding of concepts

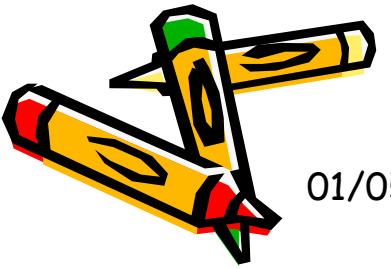


Formal Context

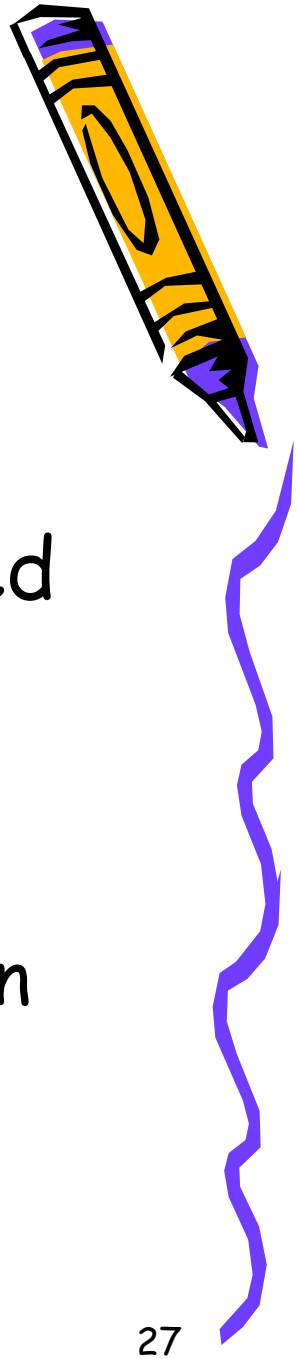
- We define formal context gained from each information specification language as Ki = (Oi, Ai, Ii), where Oi represents a set of objects, Ai represents a set of attributes, and Ii indicates which objects in the set Oi have which attributes in the set Ai

Step 1

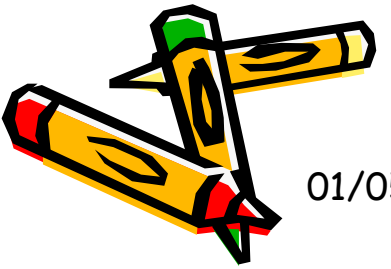
- Obtain the formal context Ki = (Oi, Ai, Ii), from each management information specification language
  - The corresponding concept lattice is defined as L(Ki)



Step 2

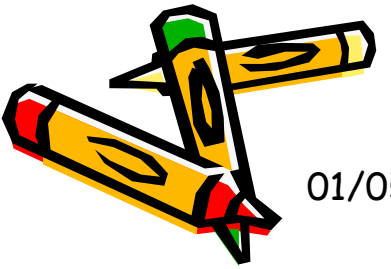


- Generate all the concepts contained in L(Ki) and then to determine the concept hierarchy
  - Construct the concept lattice for management information specification ontology through existing algorithms

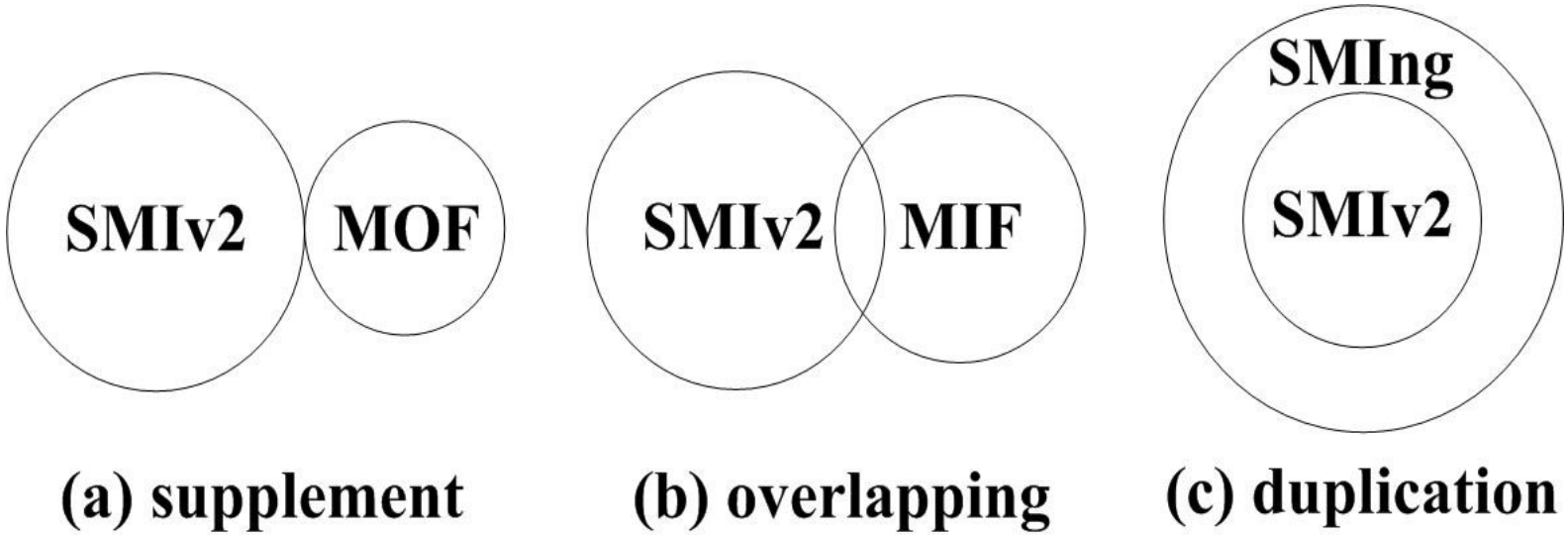


Benefits

- Working with management information specification languages seems to become easier with a visual representation, and FCA techniques may possibly be utilized to provide visualization based on concept lattices



Three Relationships of Attribute Areas

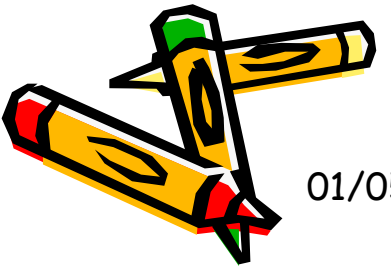


(a) supplement (b) overlapping (c) duplication

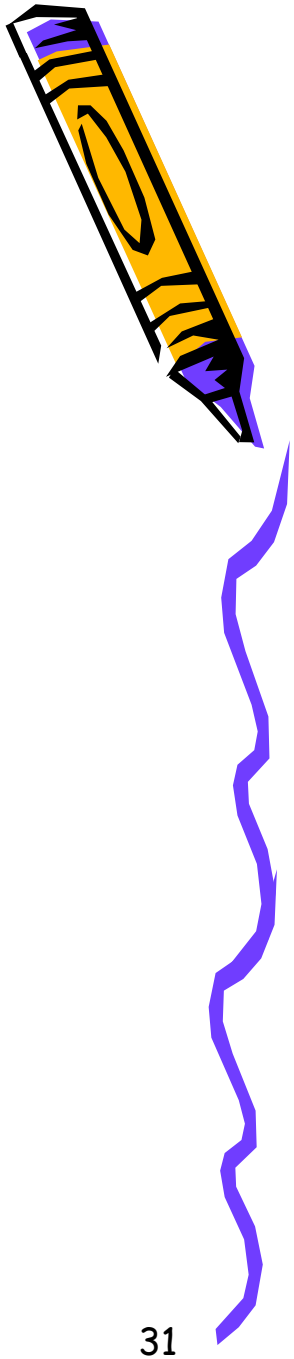
MOF: Managed Object Format MIF: Management Information Format

Application of FCA for Articulation

- Compared to the merge process, the alignment is a pair of mappings between the source lattices and their articulation
- FCA techniques can be utilized to provide visualization for articulation of management information specification languages by alignment



Outline



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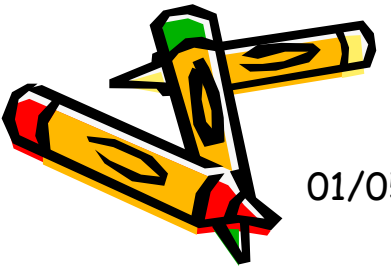
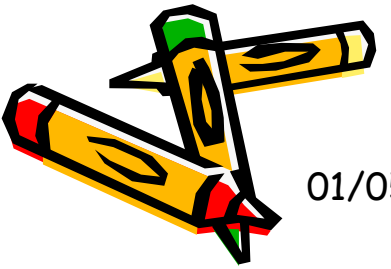


A Brief Version of SMIv2 OBJECT-TYPE Macro

```
-- definition for objects
OBJECT-TYPE MACRO ::=
BEGIN
    TYPE NOTATION ::=
                    "SYNTAX" Syntax
                    UnitsPart
                    "MAX-ACCESS" Access
                    "STATUS" Status
                    "DESCRIPTION" Text
                    ReferPart
                    IndexPart
                    DefValPart

    VALUE NOTATION ::=
                    value(VALUE ObjectName)

    ... ...

    UnitsPart ::=
                    "UNITS" Text
                    | empty

    ......

    ReferPart ::=
                    "REFERENCE" Text
                    | empty

    IndexPart ::=
                    "INDEX" "{" IndexTypes "}"
                    | "AUGMENTS" "{" Entry "}"
                    | empty

    ......

    DefValPart ::=
                    "DEFVAL" "{" Defvalue "}"
                    | empty

    ......

END
```

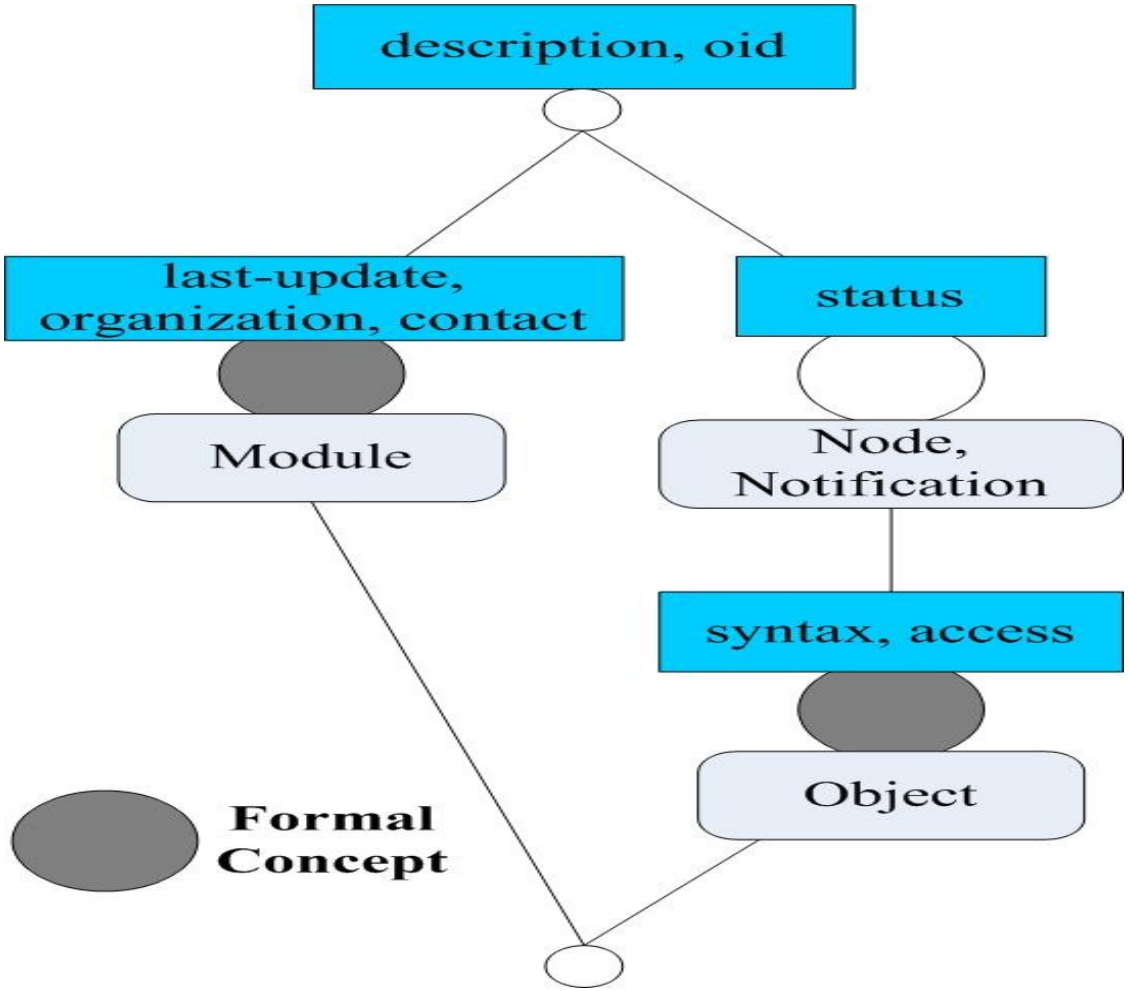


Part of formal context for SMIv2

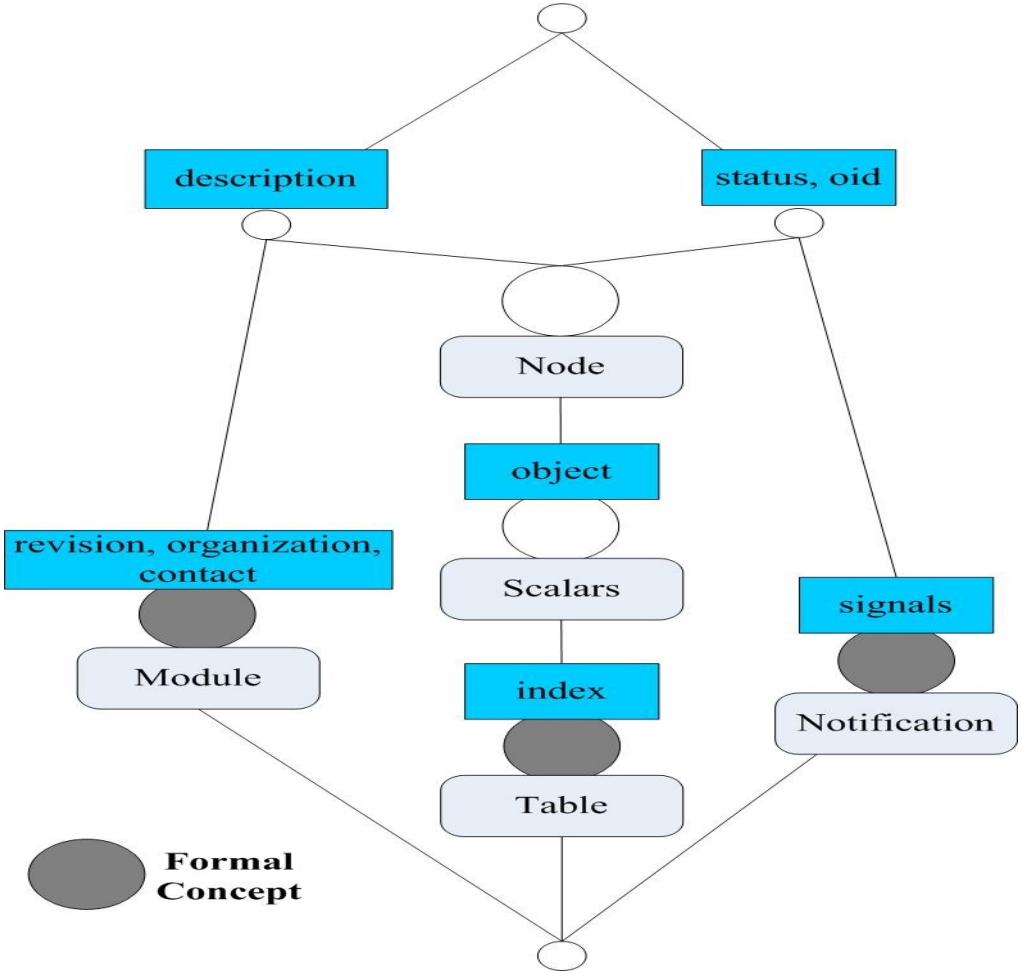
	Last-update	organization	contact	syntax	access	status	description	oid
Module	•	•	•				•	•
Node						•	•	•
Object				•	•	•	•	•
Notification						•	•	•

Mandatory properties are selected as formal attributes, while optional properties are not considered as formal attributes, since they are not necessary for the definition of the corresponding information specification

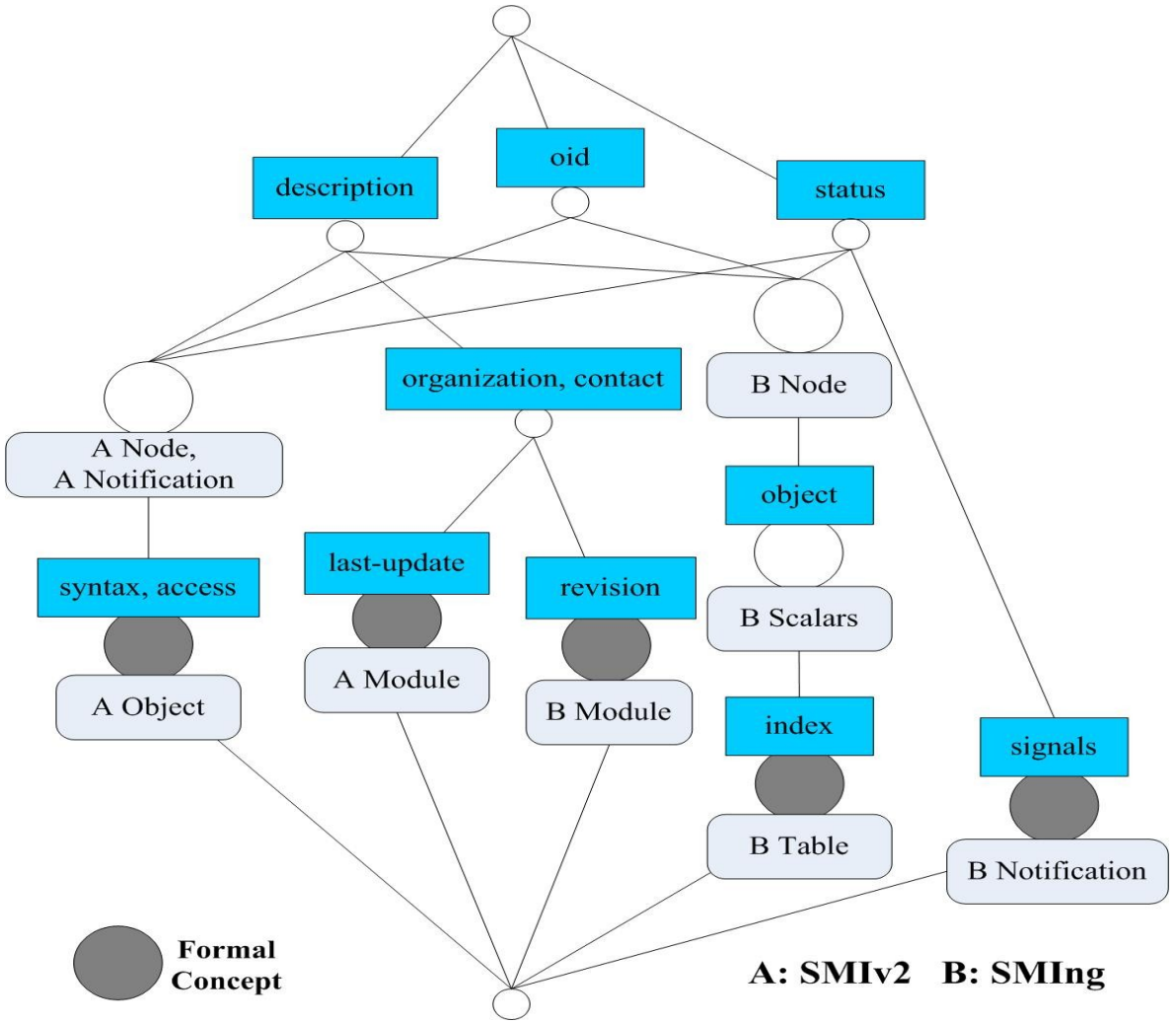
Generated concept lattice for SMIv2 formal context



Generated concept lattice for SMIng formal context

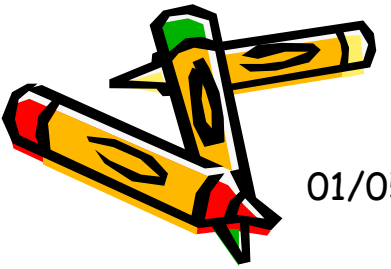


Aligning Concept Lattices for Articulation



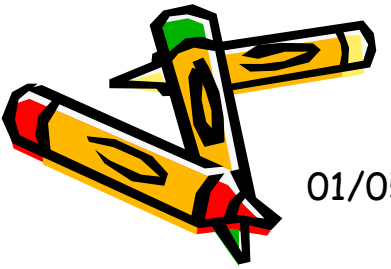
Summary (1)

- Visualization of a concept lattice is
  - interesting as it makes the information contained in the lattice more accessible
  - easier to be used in a collaborative environment for humans

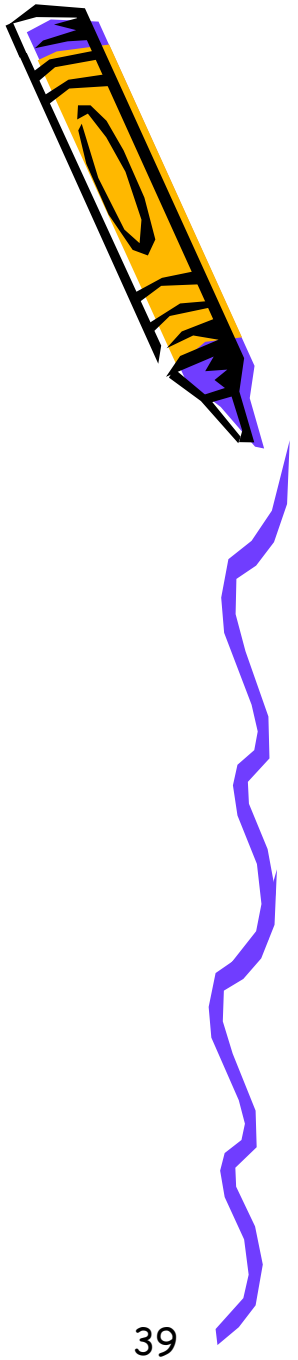


Summary (2)

- FCA techniques have been exploited to provide visualization by aligning management information specification languages for articulation
  - When comparing different languages, two objects of source lattices are considered as close to each other if they share most of the same attributes
  - The lattice resulting from the alignment can also be reused to analyze each source lattice separately



Outline



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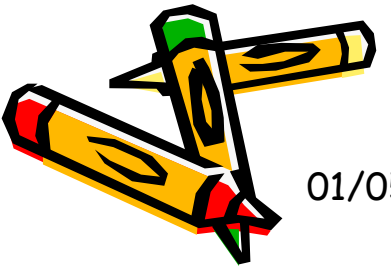
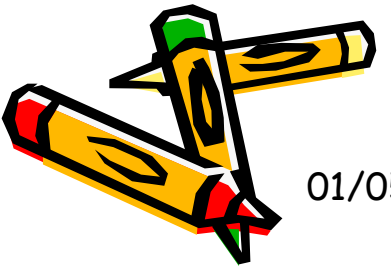


Conclusion

- Discuss management information specification languages from the viewpoint of information granularity
- Utilize visualization by means of concept lattices benefited from FCA, in order to discover inner modeling rules of existing information specification languages for the sake of network management and implement their articulation by alignment

Future Work

- Since this paper only provides a simple example for solving the articulation problem by alignment, future work includes the design of a general alignment method for the articulation of management information specification languages



More Information …

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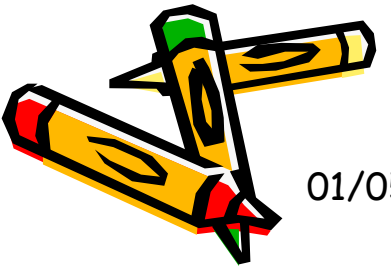
- Address: Dept. Computer Science, Huazhong Normal University, Wuhan, China, 430079
- Phone: +86 027 67866108
- Email: xuhui_1004@hotmail.com



The End

Thanks