Trasportare algoritmi di partizionamento di oggetti in ambito teoria dei concetti

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Concept Theory

Intensional/Concept Level

Concept Level: concepts - intensional containment relation

Set-Theoretical Level: objects - inclusion relation
Concept Theory and Computer Science

Intensional/Concept Level

Information Modeling  databases, software engineering, formal methods

Formal Concept Analysys  linguistics, artificial intelligence, information retrieval

Extensional/Set Theoretical Level
Partitioning

Intensional/Concept Level

Extensional/Set Theoretical Level

Semantic Level

Object Level

- Mapping Algorithms from semantic classes to object classes
- Decomposition of classes and inheritance of attributes
- Designed at the set theoretical level
Semantic and Object Classes

- **Person**
  - **is-a** Employee
  - **is-a** Student
  - **name**
  - **salary**
  - **identifier**

- **Employee**
- **Student**

Diagram:

- **a)**
- **b)**
- **c)**
- **d)**
Semantic Classes

\[
<\text{person}, \{\text{SSN}, \text{Name}, \text{BirthDate}\}> \\
<\text{student}, \{\text{SchoolName}, \text{SchoolType}, \text{Grade}\}> \\
<\text{employee}, \{\text{Company}, \text{Salary}, \text{JobDesc}\}> \\
<\text{univ_student}, \{\text{UniDept}, \text{Courses}, \text{Exams}\}>
\]
Decomposition
New Decomposition

\[ \langle \text{person} \cap \text{employee} \cap \text{student} \rangle \]

\[ \langle \text{student} \rangle \]

\[ \langle \text{employee} \rangle \]

\[ \langle \text{person} \rangle \]

\[ \langle \text{univ\_student} \rangle \]
Object Classes
The Methodology

- Formal background
- Semantic classes transportation
- Mapping transportation
Intensional Containment Relation

concept $u$ contains intensionally concept $v$ $\iff u \supseteq v.$

$u$ compatible $v$ $\iff u \perp v$

$u$ incompatible $v$ $\iff u \top v$

$u$ comparable $v$ $\iff u \triangleleft v$

$u$ incomparable $v$ $\iff u \triangledown v$

intensional negation of $u$ $\iff \neg u.$
Properties

\[ u \perp v \implies \exists u \oplus v \]  (least upper bound)

\[ u \sqcap v \implies \exists u \otimes v \]  (greatest lower bound)

\[
\text{set} (u \oplus v) = \text{set}(u) \cap \text{set}(v)
\]

\[
\text{set} (u \otimes v) = \text{set}(u) \cup \text{set}(v).
\]

\text{restricted intensional negation of concept } u \iff \neg r u.
Information contents

\[ u = [u_j, j \in J] \geq \forall = [v_i, i \in I] \]

\[ [u_j, j \in J] \oplus [v_i, i \in I] = [u_j, j \in J] \]

\[ [u_j, j \in J] \otimes [v_i, i \in I] = [v_i, i \in I] \]

*restricted intensional negation of concept* \( u \iff \neg r [u_j, j \in J] \).
Concept Level

- **Concepts**: Finite number of Information Contents

- **Structures of concepts**:
  - nodes $\rightarrow$ concepts;
  - links $\rightarrow$ relations of intensional containment
Semantic Classes Transportation

- A graph of semantic classes can be correctly transformed into a single level graph of semantic classes

- A one-one correspondence can be established between the single level graph of semantic classes and the single level concept structure
The number of disjoint classes is related with the graph topology
Initial Concept Structure.
Transportability

- Individuate the initial concept structure
- Define the process of concept construction and intensional inclusion relations
- Provide a resulting concept structure enclosing
  - All and only the concepts related with the initial concept structure
  - All and only the intensional inclusion relations among the constructed concepts
- Recognize the concepts that can be mapped to disjoint classes
- Organize the set of disjoint classes into a graph representative of the object classes
- Transform it into a graph representative of the semantic classes
Case 2: Initial Concept Structure

- $name_s \mid income_s$
- $immatriculation_s$
- $name_e \mid income_e$
- $salary_e$
- $name_p \mid income_p$
Case 2: Resulting Concept Structure
Intensional and Extensional Aspects of Concepts

\[ \text{name} \models \Phi (s \Phi_p) \]
\[ \text{income} \models \Phi (s \Phi_p) \]
\[ \text{income} \models \Phi (s \Phi_p) \]
\[ \text{matriculation} \models \Phi (s \Phi_p) \]
\[ \text{salary} \models \Phi (s \Phi_p) \]

\[ \text{name} \models \Phi (s \Phi_p) \]
\[ \text{income} \models \Phi (s \Phi_p) \]
\[ \text{matriculation} \models \Phi (s \Phi_p) \]
\[ \text{salary} \models \Phi (s \Phi_p) \]

\[ \text{P - S - E} \]
\[ \text{S - E} \]
\[ \text{S \cap E} \]

\[ \text{E - S} \]
\[ \text{E} \]
Attributes implicitly specified

\[
\text{name} |_{e} \Phi\left(\Phi_{p}\right)
\]
\[
\text{income} |_{e} \Phi\left(\Phi_{p}\right)
\]
\[
\text{name} |_{s} \Phi_{e}
\]
\[
\text{income} |_{s} \Phi_{e}
\]
\[
\text{matriculation} |_{s} \Phi_{e}
\]
\[
\text{salary} |_{s} \Phi_{e}
\]

\[\text{P - S - E}\]

\[\text{E - S}\]
\[\text{S - E}\]
\[\text{S \cap E}\]

\[\text{E - S}\]
\[\text{S - E}\]
\[\text{S \cap E}\]
\[\text{E}\]

\[\text{Is} - a_{0}\]
From object classes to semantic classes

**Diagram**

- **P**
  - Name
  - Income
  - Is a
  - Matriculation
  - Salary

- **E**
  - Name
  - Income
  - Is a
  - Matriculation

- **S**
  - Name
  - Income
  - Is a
  - Matriculation

- **P-S-E**
  - Income
  - Is a
  - Matriculation

- **E-S**
  - Name
  - Income
  - Is a
  - Matriculation
  - Salary

- **S-E**
  - Name
  - Income
  - Is a
  - Matriculation
  - Salary

- **S \cap E**

- **S**
  - Name
  - Income
  - Is a
  - Matriculation
  - Salary

- **E**
  - Name
  - Income
  - Is a
  - Matriculation
  - Salary
Attributes implicitly specified

\[
P \rightarrow E \rightarrow S \rightarrow P-S-E \rightarrow E-S \rightarrow S \cap E
\]

\[
P \rightarrow S \rightarrow E \rightarrow P-S-E \rightarrow S-E \rightarrow E-S \rightarrow S \cap E
\]
Discussion

S

S - E

E - S

P - S - E

name / e Φ s income / e Φ s
matriculation / e Φ s

name / e Φ ( sΦ p)
income / e Φ ( sΦ p)

name / sΦ e income / sΦ e
salary / sΦ e

name / e income / e salary / e

name / p income / p

name / s income / s
matriculation / s
Transportability: Importance

- The concept level and the set theoretical level are two related but distinct levels - This is an innovation in computer science and information engineering

- Algorithms to generate concept structures corresponding to classes supported by object systems can be defined - These algorithms are not yet available at the concept level

- Within the resulting concept structure, each object class can be linked with all the classes under which it falls - A discussion has been made for future research advances
Further Developments

- Applications
- Further research
- Algorithms
  - Resulting concept structures
  - Object classes
  - Semantic classes