Querying Relational Concept Lattices

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Introduction
Relational Concept Analysis (RCA) constructs conceptual abstractions from a relational context family (RCF). An RCF is a set of objects described by both own properties and inter-object links. It generates several lattices that are connected via relational attributes. Navigating such interrelated lattice family in order to find concepts of interest is not a trivial task due to the potentially large size of the lattices and the need to move the expert’s focus from one lattice to another. We propose a query-based navigation approach that helps an expert to explore a concept lattice family, according to a navigation schema.

Definition: Relational Context Family
An RCF is a pair \( (K, R) \) where \( K \) is a set of formal (object-attribute) contexts \( K_i = (O_i, A_i, L_i) \) and \( R \) is a set of relational (object-object) contexts \( R_{ij} \subseteq O_i \times O_j \) where \( O_i \) (domain of \( R_{ij} \) and \( O_j \) (range of \( R_{ij} \) ) are the object sets of the contexts \( K_i \) and \( K_j \), respectively.

Example RCF
An RCF of countries, restaurants, Mexican dishes, ingredients, and salsas, together with relations between them.

Definition: Relational Query
A relational Q on a relational context family \( (K, R) \) is a pair \( Q = (A_q, O_q, R_q) \), where: \( A_q = \{q_{K_i} | q_{K_i} \} \) is a simple query on \( K_i \in K \) composed of a set of attributes from \( A_i \); \( O_{qK} \) is the set of query objects \( R_q \) is a set of relational constraints \( R_q = \{(o_{i1}, r_{ij}) | O_j\} \).

Example: Query
Find a country described by “fr”, a restaurant of this country that serves a dish containing “chicken”, “cheese”, and “corn-tortilla”, and a salsa that is “hot” and suitable with this dish.

Navigating a Concept Lattice Family with a Query
A human expert query defines a natural path (that guides an algorithm) for navigating a lattice family. Starting from country lattice, we can locate “France” as the answer for “q-country”. We extract its relational attributes \( has:Concept_{16}, has:Concept_{17}, has:Concept_{20} \). In restaurant lattice, “Hard Rock” in Concept_{17} cannot be an answer to “q-restaurant”. Like this for “q-restaurant”, we have two restaurants [Old el Paso, El Sombrero]. They serve at least a dish answering “q-dish” and “q-salsa”.

Conclusion
The query approach is a guiding method that enables a human expert to navigate a lattice family to locate interesting solutions. Each selected object is a departure point for inspecting the objects of the selected concept, exploring the neighborhood, going up by relaxing constraints or going down by adding constraints.