

Formalization of conceptual
relationships with a view to
implementing them in the Ontology
Editor *Protégé*: Processing the
terminology of finished ceramic
products

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Objectives

- Method for formalizing the conceptual relationships between specialized concepts
- Research Group TecnoLeTTra Projects:
 - TxtCeram: Electronic corpus on industrial ceramics
 - Ontodic: Development of an onomasiological dictionary of industrial ceramics using an ontology editor

Introduction

- Definition of conceptual relation
- Catalogue of conceptual relationships
- Elements for the description and formalization of conceptual relationships
- Example of how our formalization model allows for the onomasiological retrieval of conceptual information implemented in a standard ontology editor (*Protégé*)

Definition of conceptual relationship

- Formalism (Otman, 1996; Feliu, 2004):
$$a R b, n$$
- a and b represent concepts belonging to a conceptual class: entity, property or activity (Sager & Kageura, 1994)
- n represents the fact that b can be multiple (recursivity)
- R: link between concepts

Catalogue of conceptual relationships

- Logical relations
- Meronymic relations
- Sequence relations
- Argumental and circumstantial relations
- Other relations

Logical relations

- Establishment of hierarchies taking into account common and differentiating characteristics:
 - Vertical relationships:
 - superordinate-subordinate:
pieza cerámica (*ceramic piece*)-baldosa cerámica (*ceramic floor tile*)
 - Horizontal relationships:
 - subordinate-subordinate:
Cubrecantos (*beads*)-escuadra (*right angle*)

Meronymic relations

- Functional component-object: arista (*edge*)-baldosa (*floor tile*)
- Member-collection: tesela (*tesserae*)-mosaico (*mosaic*)
- Portion-mass:
- Material-object: arcilla (*clay*)-baldosa cerámica (*ceramic floor tile*)
- Stage-process: etapa de gran fuego (*high firing*)-cocción (*firing*)
- Characteristic-activity:
- Space-area:
- Part-part: cara vista (*facing tile*)-arista (*edge*)

Sequential relations

- Spatial sequentiality
 - Localization: adhesivo (*adhesive*)-adherendo (*adherend*)
 - Direction
- Temporal sequentiality
 - Simultaneous
 - Consecutive

Argumental and circumstantial relations

- Process-agent: cocción (*firing*)-horno (*kiln*)
- Process-product: moldeo (*moulding*)-baldosa cerámica (*ceramic floor tile*)
- Process-patient: alicatado (*wall tiling*) –azulejo (*glazed tile*)
- Process-instrument: colocación en capa gruesa (*thick layer tiling*)-cemento aditivado (*additivated cement*)
- Process-state:
- Process-method:
- Cause-effect: fricción (*friction*)-abrasión (*abrasion*)
- Object-use: baldosa (*floor tile*)-revestimiento de suelos (*floor covering*)

Other relations

- Phenomenom-measure:
dureza Mohs (*Mohs hardness*)-escala de Mohs (*Mohs scale*)
- Object-characteristic:
azulejo (*glazed tile*)-resistencia a la helada (*frost resistance*)
- Associative relation:
ensayo (*test*)-propiedad de los materiales (*property of materials*)

Elements for the implementation

- Definition of the relationship in natural language
- Conceptual classes: which conceptual class may appear on each side of the relationship formalism (nature of a and b)
- Mathematical properties of the relationship and special features of meronymic relations

Entities

- Obtained by abstraction of independent elements of experience and knowledge. Can be defined separately.
 - Azulejo (*wall tile*), baldosa (*floor tile*) (ceramic products)
 - Arcilla (*clay*), gres (*stoneware*) (raw materials)
 - prensa oleodinámica (*oil hydraulic press*), horno de rodillos (*single deck roller kiln*) (machinery)
 - Secadero (*dryer*), pared (*wall*) (places)

Activities

- Obtained through the abstraction of processes, operations or events done by or with entities.
 - prensado en seco (*dust pressing*), cocción (*firing*) (fabrication processes)
 - Embaldosado (*tiling*), colocación en capa fina (*thin set tiling*) (laying processes)

Properties

- Derived from the analysis of the components and characteristics of entities, activities and relationships. They constitute concepts on a second level of analysis.
 - resistencia a la helada (*frost resistance*), porosidad (*porosity*), color (*colour*) (characteristics of ceramic products)

Relations

- Different types of logical and ontological relationships among entities, properties and activities.
- Identify links existing or established among other concept classes.
 - phase, composition

Mathematical properties

- Transitivity: If $a R b$ and $b R c$, then $a R c$
 - superordinate-subordinate:
Producto cerámico acabado (a) R baldosa cerámica (b) R baldosa esmaltada (c), then
producto cerámico acabado (a) R baldosa esmaltada (c)
- Symmetry: If $a R b$, then $b R a$
 - part-part:
Cara vista (a) R cara posterior (b), then
cara posterior (b) R cara vista (a)
- Inverse relationships: If $a R b$, then $b R' a$
 - process-product (R) and product-process (R'),
Moldeo por extrusión (a) R baldosa extrudida (b), then
baldosa extrudida (a) R' moldeo por extrusión (b)
- Recursivity: If $a R b_1, b_2, b_3...$
 - material-object:
 - Arcilla (a) R baldosa cerámica (b1), baldosin catalán (b2)

Meronymic features

- **Functional:** parts have a specific role in the whole
 - functional component-object:
 - Arista (a) R baldosa cerámica (b)
- **Homeomeric:** parts have the same nature as the whole
 - portion-mass:
- **Separable:** parts can be separated from the whole
 - member-collection:
 - Esmalte (a) R baldosa cerámica (b)
- **Simultaneous:** parts and the whole
 - material-object:
 - Arcilla (a) R baldosa cerámica (b)

Formalization of the relationship process-product

Name of the relation	Process-product
Definition in natural language	relationship established between a process and its final product.
Conceptual classes	
–Domain	Activity
–Range	Entity
Mathematical properties	
–Transitivity	No
–Symmetry	No
–Recursivity	Yes
–Inverse relation	Product-process

Implementation of concepts and relations in *Protégé*

- Concepts are represented in a hierarchy of *Classes*
- Relations are represented by *slots* where their properties can be defined
- *Classes* are linked by these *slots*, whose values are other *Classes* in the hierarchy

Which ceramic tiles are produced by dust pressing?

a (domain) R b (range)

Which ceramic tiles (b) are produced by dust pressing (a)?

Which ceramic tiles are produced by dry pressing?

Name of the relation	Process-product
Definition in natural language	relationship established between a process and its final product.
Conceptual classes	
–Domain	Dust pressing
–Range	Ceramic tile
Mathematical properties	
–Transitivity	No
–Symmetry	No
–Recursivity	Yes
–Inverse relation	Product-process

Answer to the query: Which tiles are made by dust pressing?

The screenshot shows the Protégé 3.1 interface. The main window displays a query result for the query " baldosas-cerámicas prensadas en seco ". The query is defined as " baldosas-cerámicas " contains " prensado en seco ". The search results on the right show three items: " pavimento cerámico esmaltado (Pavimento de gres)", " pavimento cerámico (Pavimento de gres)", and " baldosas de gres porcelánico (Baldosa de gres porcelánico)".

Query Name: baldosas-cerámicas prensadas en seco

Query Library: baldosas-cerámicas resistentes a la helada, baldosas-cerámicas prensadas en seco

Conclusion

- If we are able to define conceptual relations in a formalized way and to implement them using an ontology editor, we will be able to retrieve information onomasiologically.