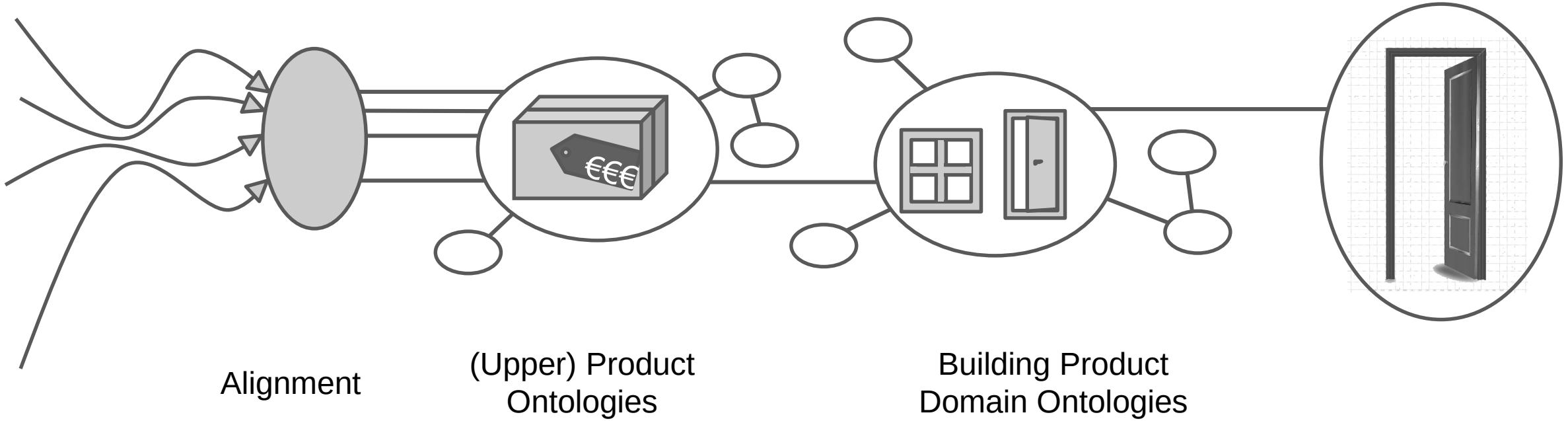
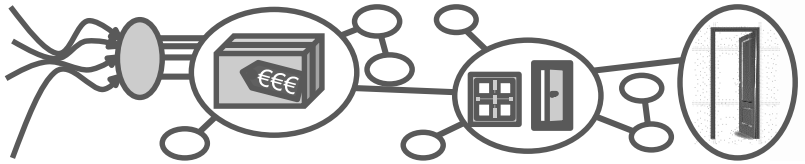
Linked Building Product Data

Lecturer: Anna Wagner, wagner@iib.tu-darmstadt.de

Assistants: Pieter Pauwels, Georg Ferdinand Schneider



Why do we need Linked Product Data?



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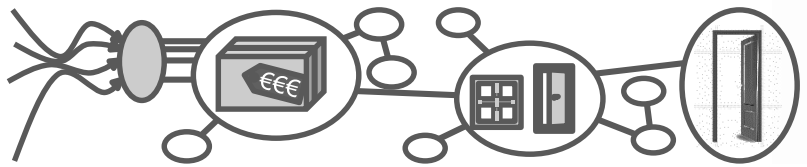
- Seamless integration of product data into Linked Building Data via linking from the building data towards the product description
- Unified querying over (partly) heterogeneous data schemes
- Support by search engines to help distribute products over the Web
- Unambiguous product descriptions for international markets

<u>After this lecture participants can</u>

- Perform simple alignments between different ontologies
- Describe products according to common product ontologies
- Apply taxonomies to product descriptions

What is „Linked Product Data“?



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complex, structured data

taxonomy

standardised

template-less

template

uniform

parametric data

hierarchy-less

fixed values

flat structures

for innovative products

flexible

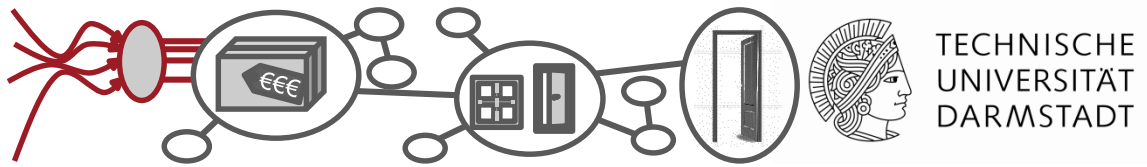
individual

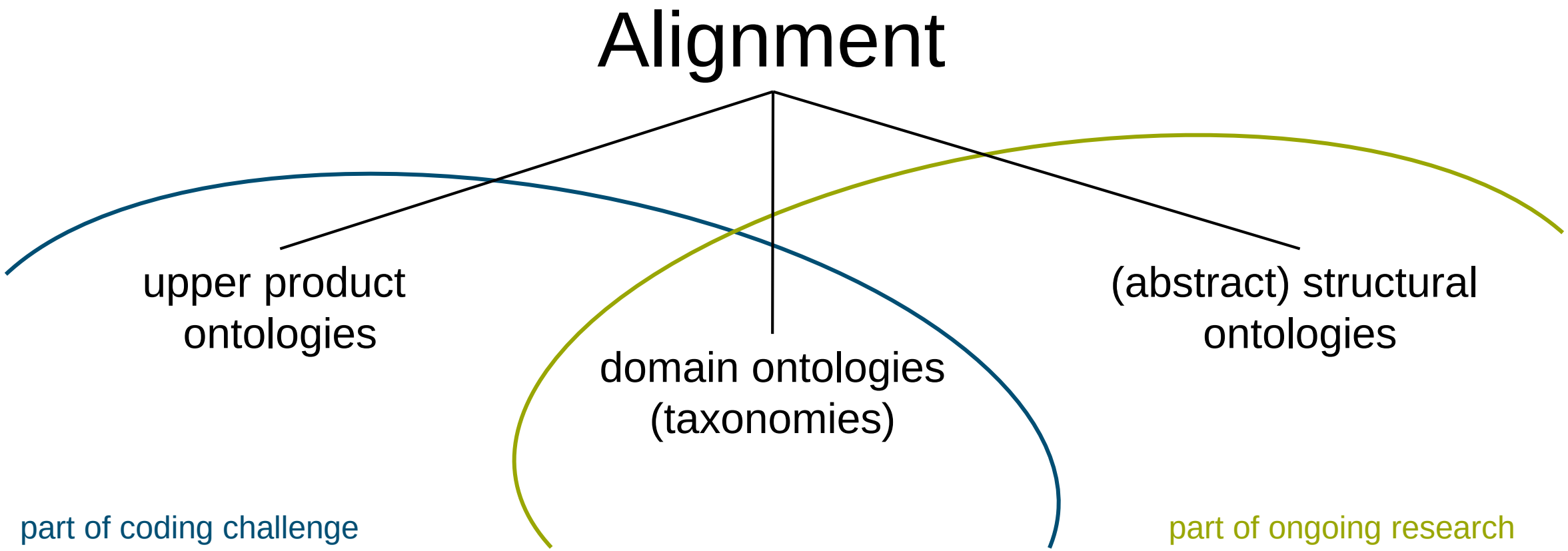
geometric dependencies

non-geometric

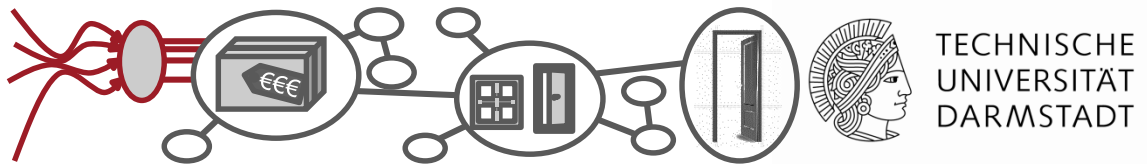
for ready-made products

Ensure same understanding from different perspectives





Alignment vs. (multi-)classification
General and individual rules



on Tbox level - Alignment

(rules on schema-level)

- generally valid rules of alignment

  „Every door is a product“
- defined once (by authors of the ontology)
  - restricts users in further alignments
  - changes in aligned ontologies may impact the original ontology
  - ensures intended application of the ontology

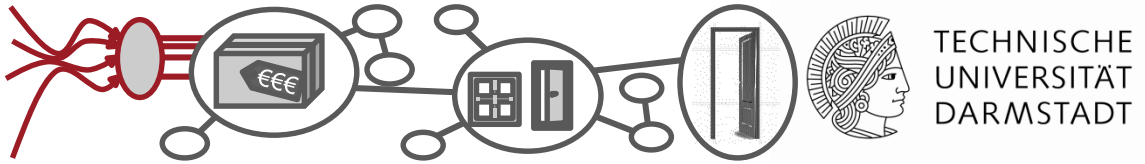
On Abox level - Classification

((multi-)classification of individuals)

- individual rules of alignment

  *„**This** door is a product“*
- defined for each graph / use case
  - danger of the ontology‘s misuse
  - error-prone
  - higher flexibility for further aligments
  - can be supported by recommendations

First step: Analysis of *both* ontologies
Criteria for aligning classes and properties



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Classes

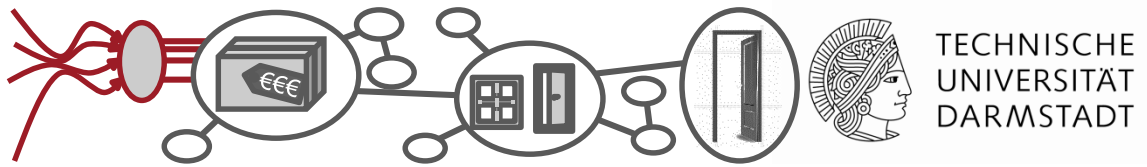
- definition (`rdfs:comment`)
- (hierarchical) context (`rdfs:subClassOf`, `owl:equivalentClass` and `owl:disjointWith`)
- class axioms (`owl:Restriction`)

Properties

- definition (`rdfs:comment`)
- property types (`owl:ObjectProperty`, `owl:DatatypeProperty`, `rdf:Property`, `owl:FunctionalProperty`, `owl:InverseFunctionalProperty`, `owl:SymmetricProperty` and `owl:TransitiveProperty`)
- (hierarchical) context (`rdfs:subPropertyOf`, `owl:inverseOf`, `owl:PropertyChainAxiom`, `owl:propertyDisjointWith` and `owl:equivalentProperty`)
- domain and range (`rdfs:domain` and `rdfs:range`)

Are the classes / properties used in rules? Are these rules valid for both classes / properties?

Next step: Aligning concepts
Equivalence and inheritance



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Bi-directional equivalence

- all criteria are met as „equivalent“
- any property of one object is also applicable for the other
  - requires full understanding of both objects
- example: acronyms of words

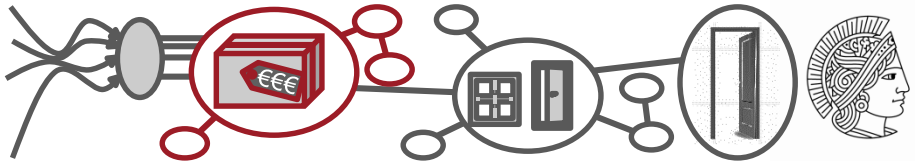
  „IFC ≡ Industry Foundation Classes“
- `owl:equivalentClass` or `owl:equivalentProperty`

One-directional equivalence (inheritance)

- all criteria are met as „similar“ (at least)
- any property of object *B* is applicable for object *A*
- properties of object *A* are not applicable for object *B*
- example: specification of concepts

  „two-winged door ⊑ door“
- `rdfs:subClassOf` or `rdfs:subPropertyOf` ranging from the more specialised object *A* to the more generic object *B*

Upper level ontologies



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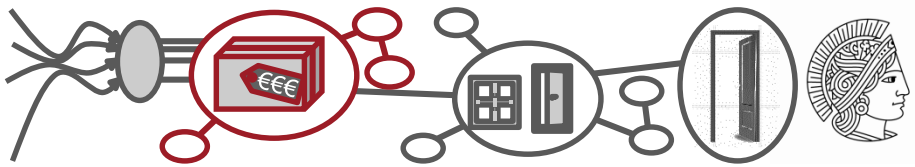
Domain-independent	Wide support, e.g. by search engines
Generic definition of terms	Most detailed definition that is true in *any* domain or context
Basis for domain ontologies	Domain-specific terms can be abstracted to upper level terms
Corner-stone of interoperability	Multiple domains can extend the same upper level term
Reliable definitions	Wide field of application requires constant upper level terms

Upper product ontologies



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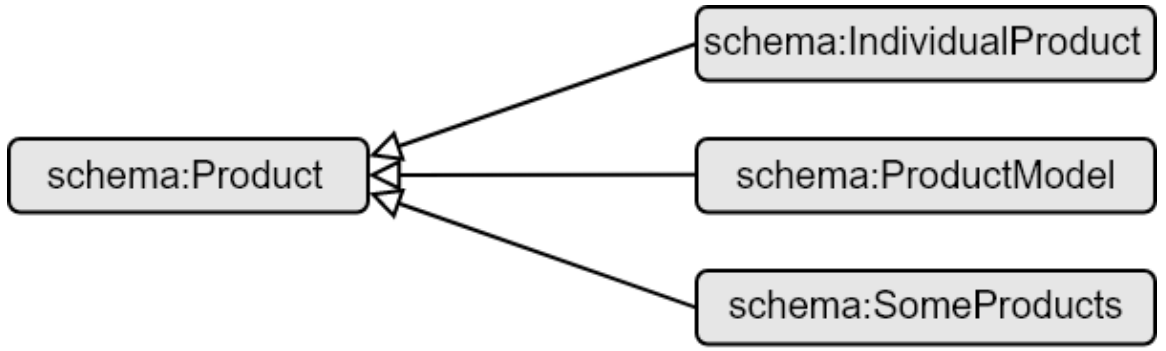
- **GoodRelations:** dedicated ontology for e-commerce for publishing product and service details on the web. Supported by common search engines (incl. Google, Yahoo! and BestBuy) - http://www.heppnetz.de/projects/goodrelations/
- **Schema.org:** vocabulary that aims to serve as shared reference-vocabulary for various domains. Founded by Google, Microsoft, Yahoo! and Yandex. Adapted GoodRelations vocabulary - https://schema.org/Product
- **Lighter Upper Product Ontology:** LUPO serves as a basis for the Feature-based Product Ontology (FPRO), introducing a framework of concepts to describe a product including its structure - http://www.loa.istc.cnr.it/ontologies/LupoLib.zip
- **Suggested Upper Merged Ontology:** SUMO aims to act as a foundation ontology for multiple domains, offering terms ranging from meta-level objects to specific domain ontologies - http://www.adampease.org/OP/

Schema.org

https://schema.org/Product

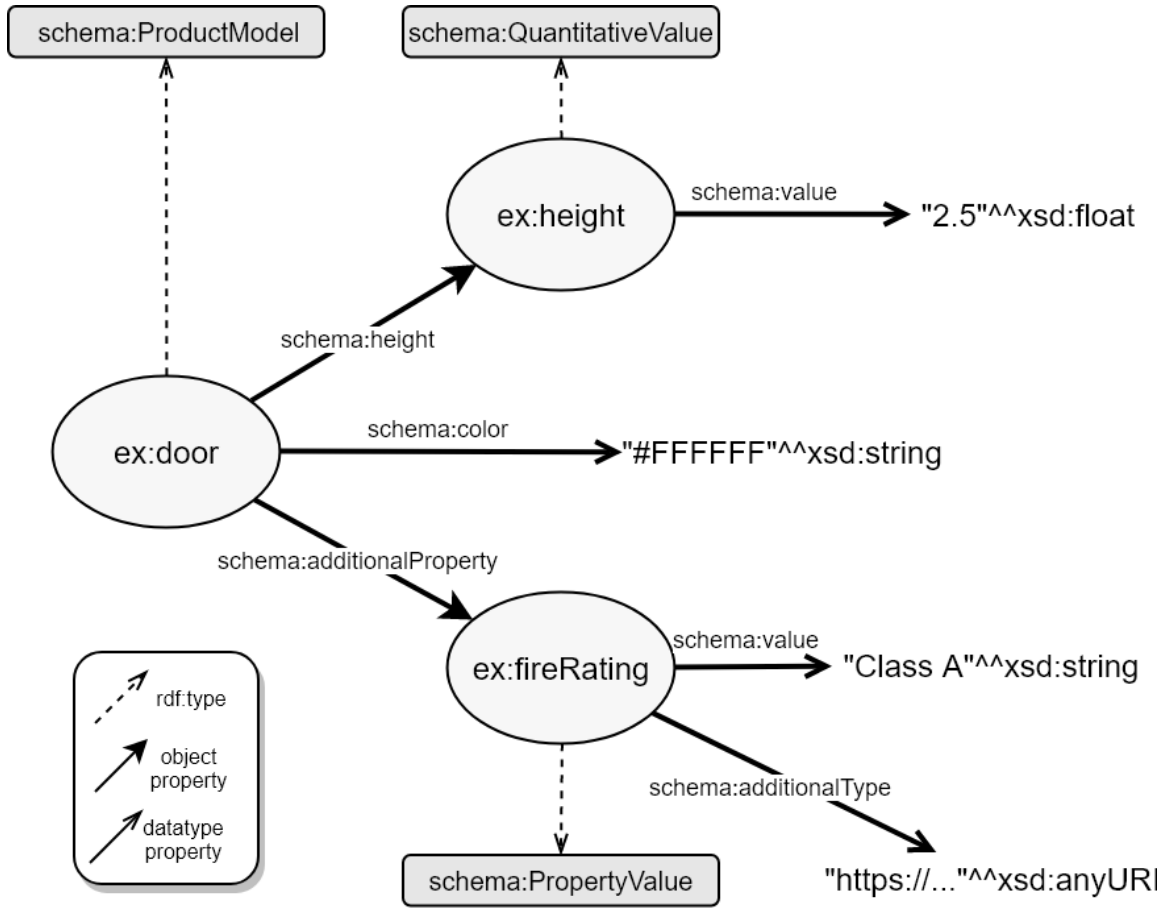
Superclass for more specific types

- **Individual product:** real object that can be pruchased / is sold, unique properties that vary from the model‘s properties (e.g. serial number)
- **Product model:** description of a product series with properties that are valid for any products of that model
- **Some products:** placeholder for a group of similar models of the same type (e.g. offering for a certain number of products from the same product model)



Schema.org - Properties

- Most properties are modelled with intermediate nodes (QuantitativeValue, QualitativeValue)
- Pre-defined properties for typical poduct properties
  - colour, depth, height, material, weight, width,…
- Generic properties and property class to add individual properties
  - additionalProperty
  - PropertyValue
  - Classification of properties (or even products) via additionalType



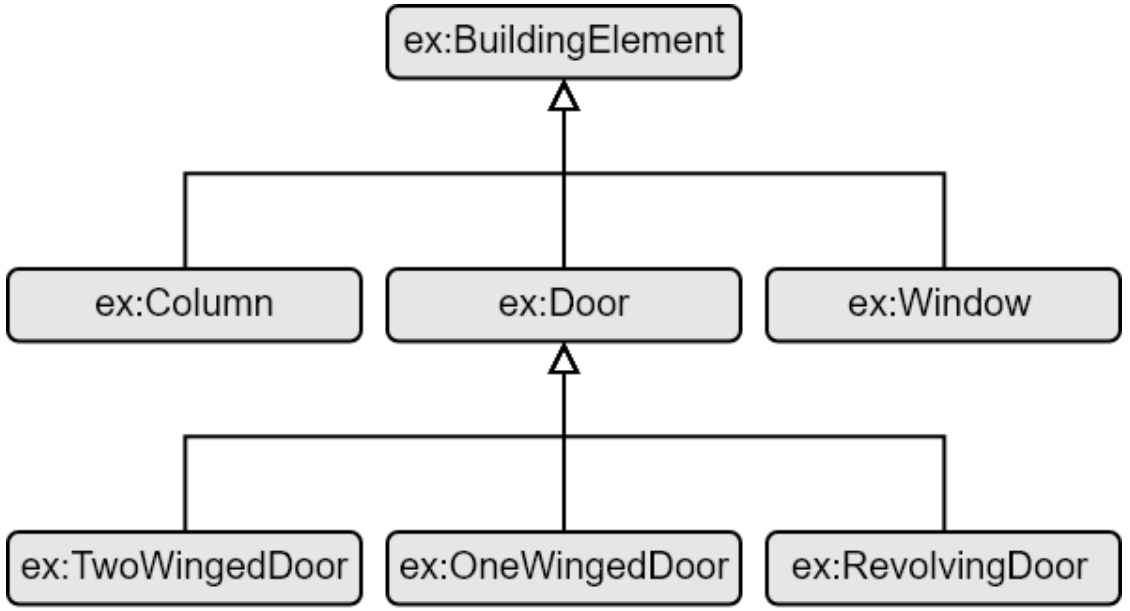
Domain ontologies

- Depict the **understanding** of terms and concepts from the perspective of the domain
- Defines relations for concepts

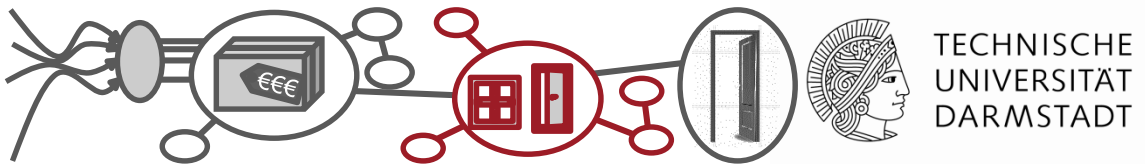
  “a door is a subtype of a building element and has a width”

- Can define properties including domain and range or classes including class axioms
- Usually do not contain details about the internal structure of those concepts and terms

  “a door consists of a leaf and frame”



Domain ontologies for building product data



Construction industry:

- **FreeClassOWL:** GoodRelation-compliant definition of terms related to the construction industry
- **Product and property taxonomies:** defintion of building element types and properties
- **bSDD-LD:** Linked Data version of the buildingSMART Data Dictionary, currently populated by property (set) definitions from the PSD

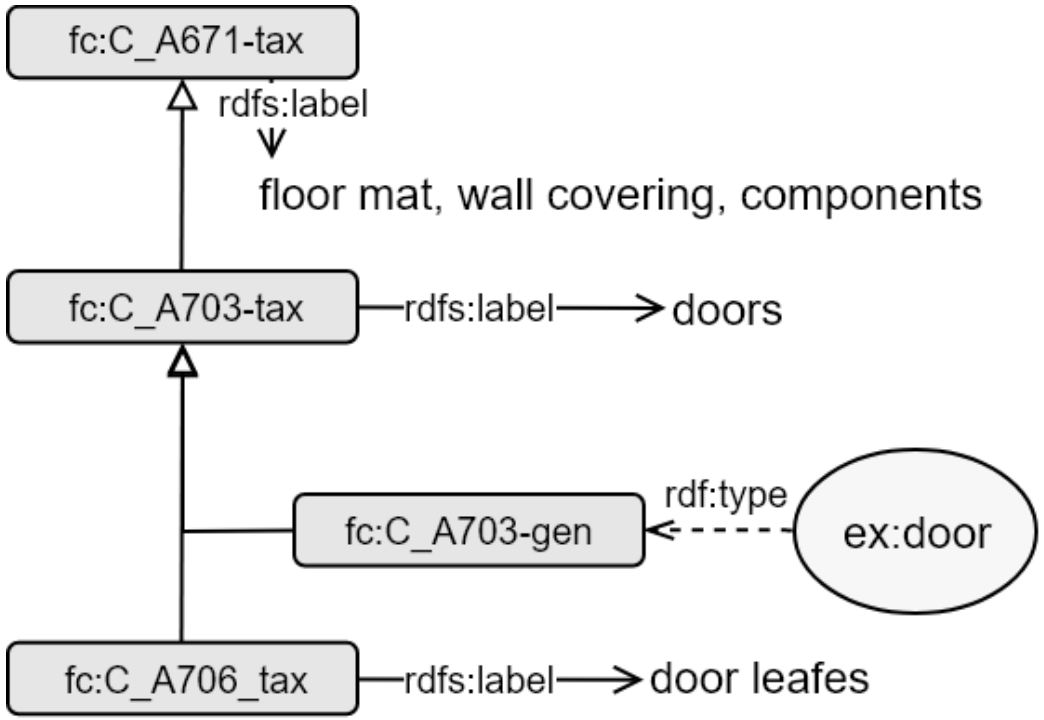
Other domains:

- Units (e.g. Ontology-based Specification of Quantities, Units, Dimensions and Types [QUDT], Custom Datatypes [CDT], Ontology of unity of Measure [OM], …)
- Materials, construction-related domains, …

FreeClassOWL

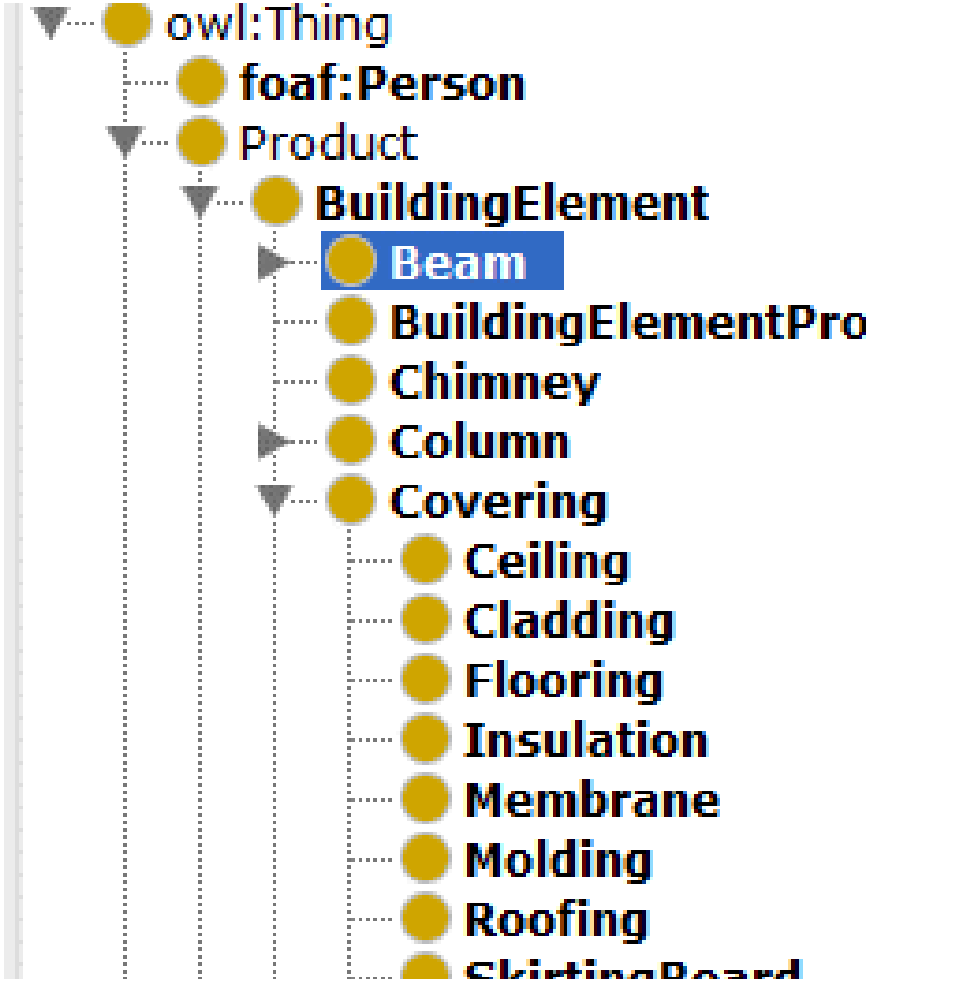
http://www.freeclass.eu/freeclass_v1.html

- Aligned to GoodRelations
- Taxonomy for materials and services of the construction domain (classes and properties)
- Introduces generic and taxonomy concepts with hierarchical structures
  - Taxonomy concept: to define instances in general and represents the FreeClass hierarchical structure
  - Generic concept: to define type of goods and is a subclass of a taxonomy concept and the GoodRelation product concept



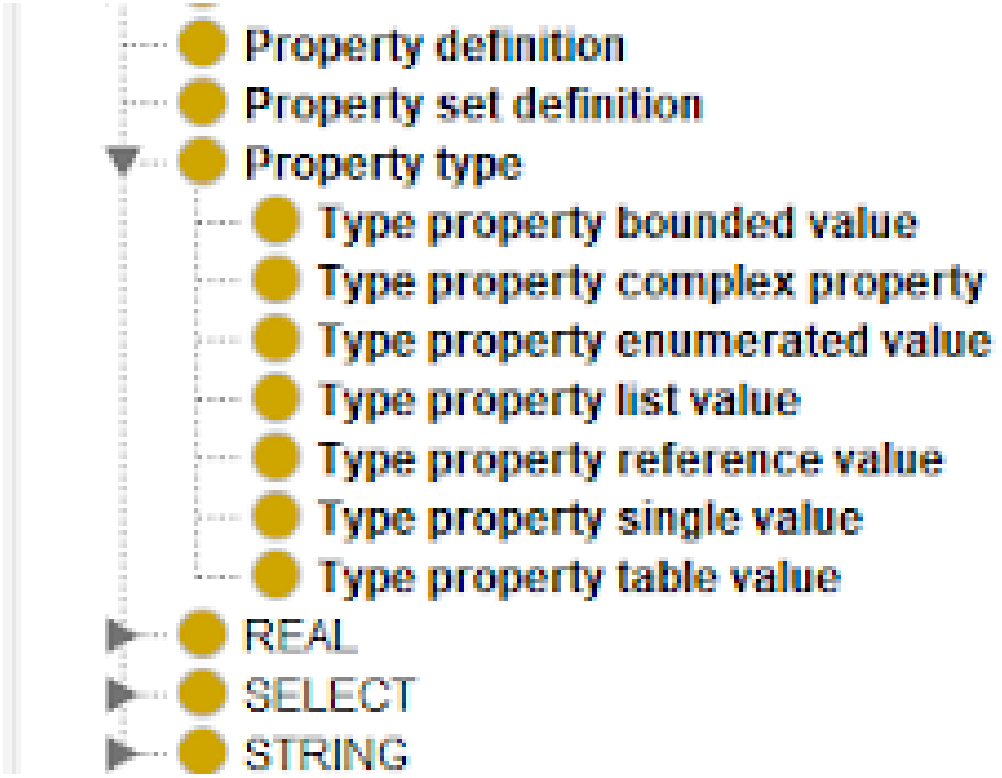
Building Element Taxonomies

- Building elements are already defined in BIM schemes (e.g. IFC)
- Example for extracting building element concepts from the IFC into RDF
  - https://github.com/w3c-lbd-cg/product
  - Based on ifcOWL
  - Grouped for different building domains
    - Building elements
    - MEP
    - Furnishing



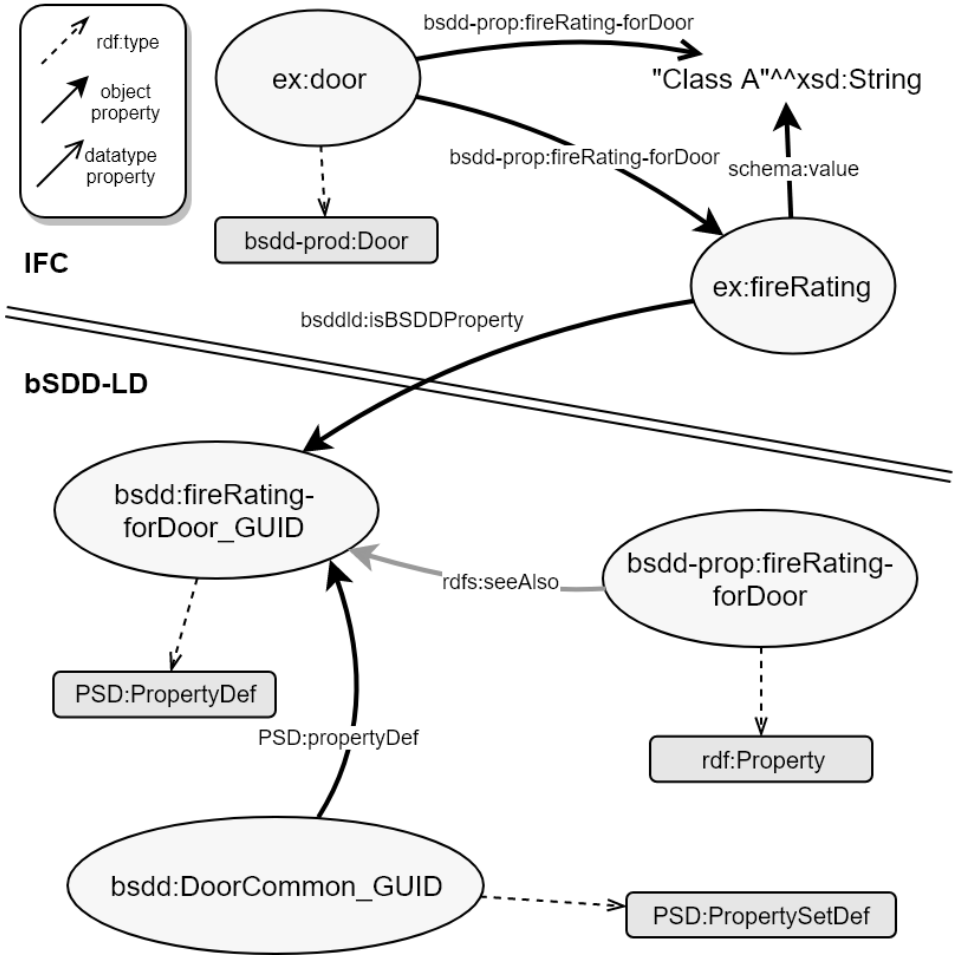
Property (Set) Taxonomies

- Properties, incl. their domain and range, are are already defined in BIM schemes (e.g. buildingSMART‘s PSD)
- Example for converting PSDs into RDF by Peter Willems and Léon van Berlo
  - https://github.com/openBIMstandards/BIMbots-PSD-Repository
  - Concepts of PSD translated into RDF
  - Populated by published PSDs
    - e.g. ColumnCommon, DoorCommon, DoorWindowGlazingType, …

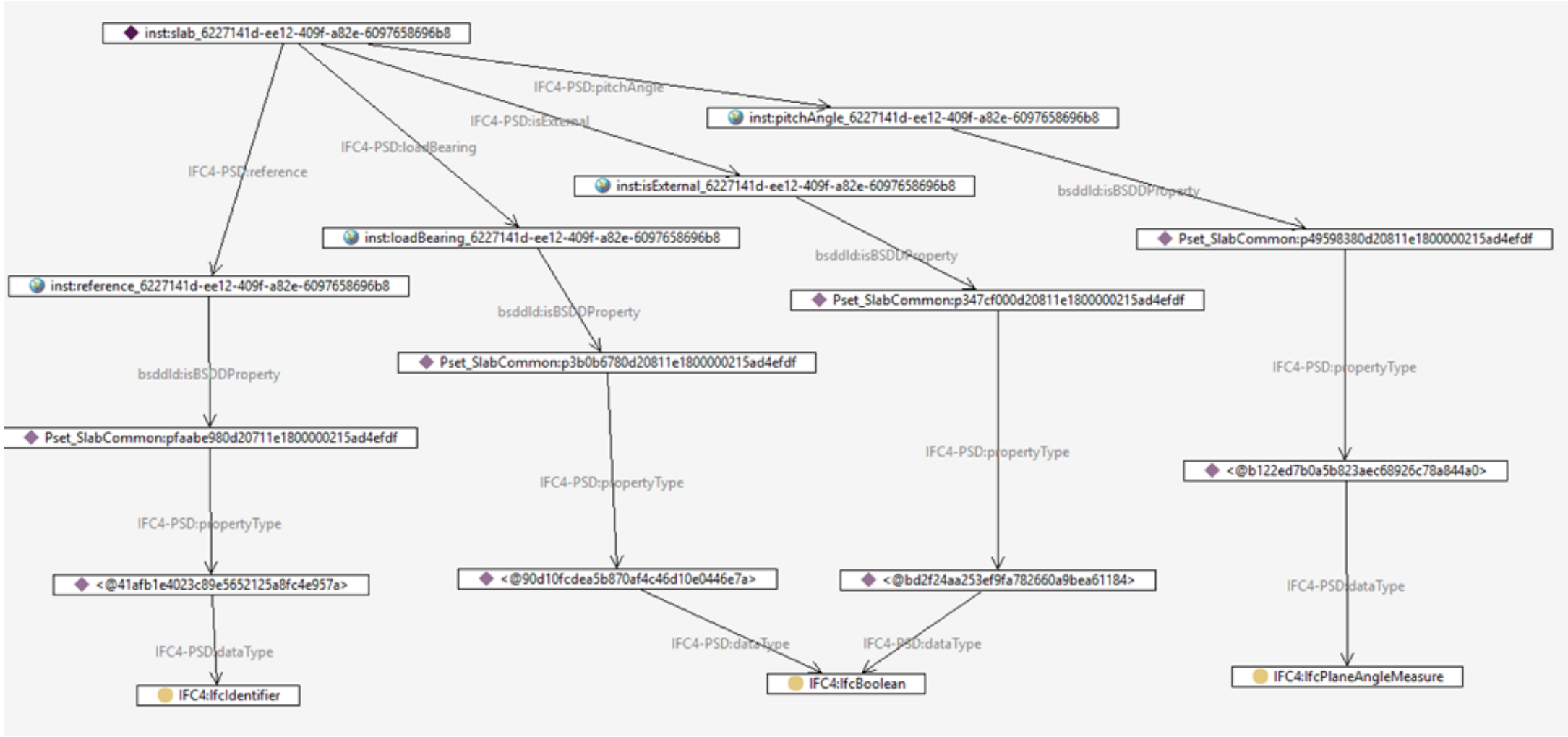


bSDD-LD

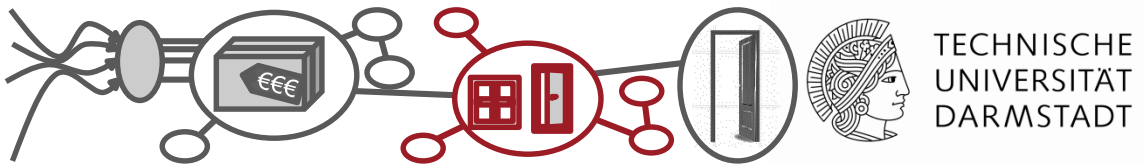
- buildingSMART Data Dictionary serves as international vocabulary for the construction domain
- Conversion to RDF currently in development
- Demo
  - Linking method of bSDD-LD (property L1 and L2)
  - PSD definitions
  - Assumption of product types within bSDD-LD



bSDD-LD and PSD implementation in IFCtoLBD tool



Structural ontologies



- Define the internal structure of products
  - e.g. assembly structures or bill of materials
- Domain-independent
- Not necessary for products that can be described using flat templates without product composition

Examples:

- Feature-based Product Ontology (FPRO), based on LUPO http://www.loa.istc.cnr.it/ontologies/LupoLib.zip
- PRoduct ONTOlogy (PRONTO), product (dis)composition based on the product‘s Bill of Material (not available online)
- Building Product Ontology (BPO), multi-layered approach including alignment to upper product and domain ontologies https://w3id.org/bpo

Example – BauDataWeb

http://semantic.eurobau.com/

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FreeClass Semantic Search for Construction Materials

Online tool for demonstrating how the usage of Semantic Web technologies can improve a search for building and construction materials.

FreeClass

FreeClass code: 14101010 freeClass

FreeClass Properties

Fetch relevant properties

Optional Search Parameters

Type of customer: Enduser Reseller Business

Delivery method:

Delivery mode: Rental truck Own fleet with liftgate Own fleet with crane

Delivery Address

Street address: Anichstraße

Post code:

City: Innsbruck

Country: Austria

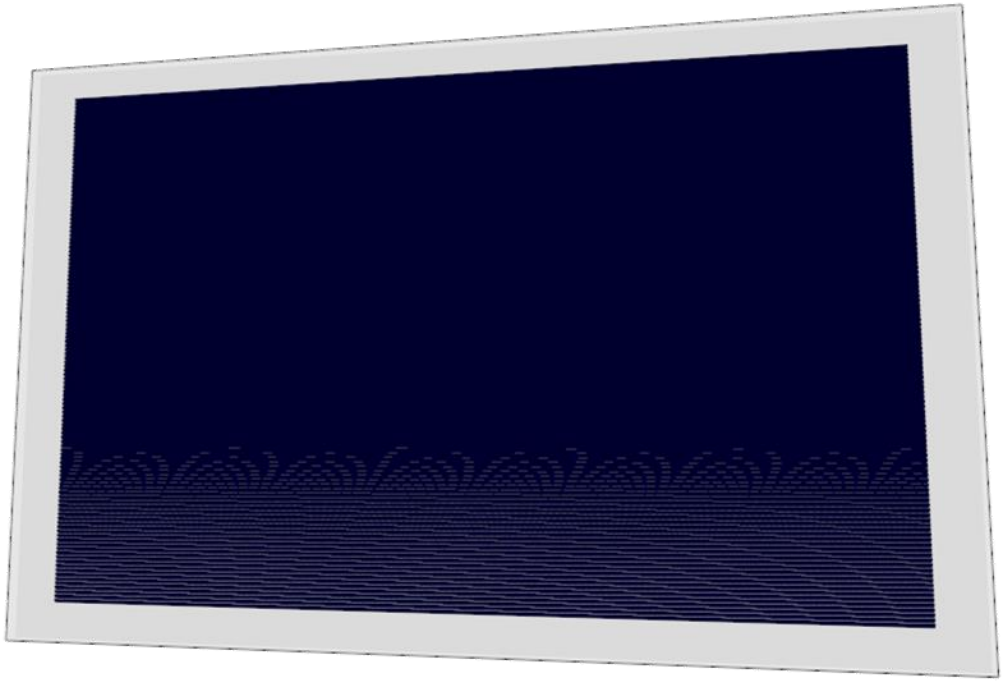
Determine geo position from address

Longitude ( ) Latitude ( )

Search

Example - SolConPro

- Description of innovative, multi-functional building components
- No restrictions imposed by templates
- Three layers
  - Taxonomy
  - Product structure
  - Geometry

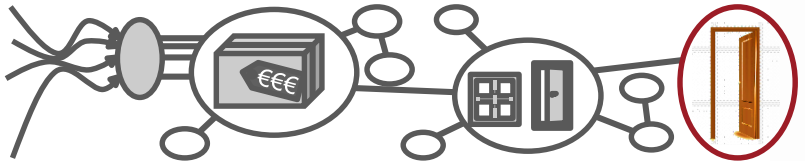


Example - Door (Hands on)

Door Type A

- Height 2.20 m
- Width 1.00 m
- Colour #7f4b03
- Material walnut wood
- Fire Safety Class T30 (DIN EN 1634-1)
- Price 2.499 €

Example - Door
Possible result Tbox



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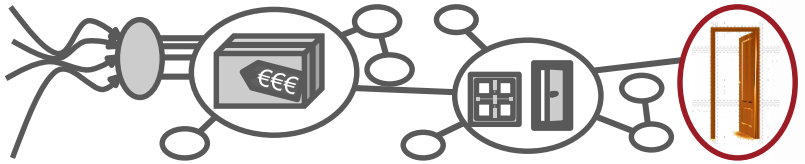
Example - Door
Possible result Abox



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