

Demonstration of Software Tools

Case Studies

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Problem

We want to write applications for a buildings

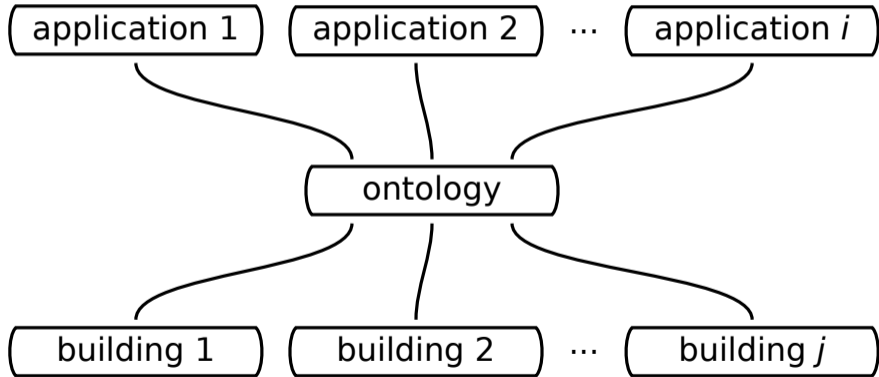
Attractive qualities:

- ▶ **Portability** The application can be executed on a many buildings without modification.
- ▶ **Maintainability** A change in the building does not translate to a need for changing the application.

How do we accomplish this?

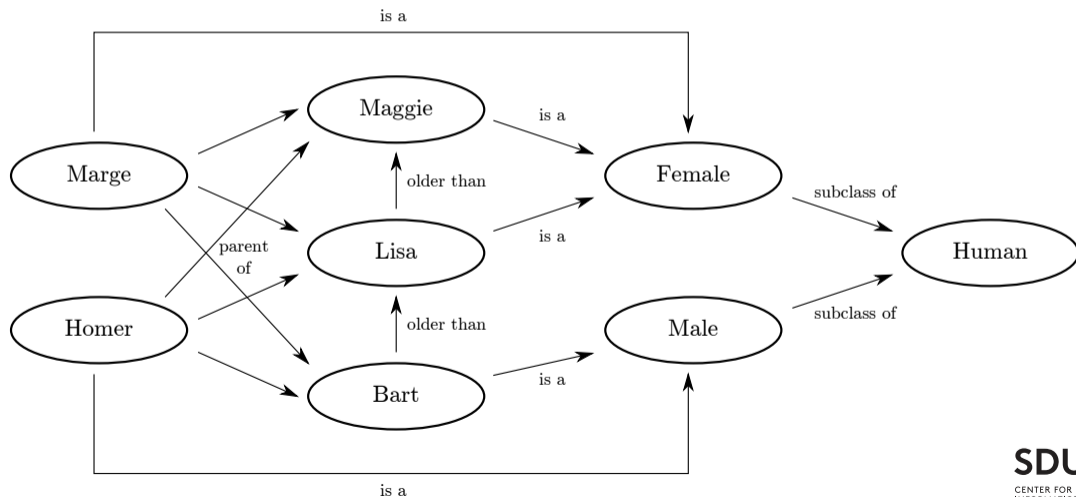
Approach: A Narrow Waist

The labor intensive job of mapping out the equipment, data streams and relations between those may be shared between a portfolio of applications

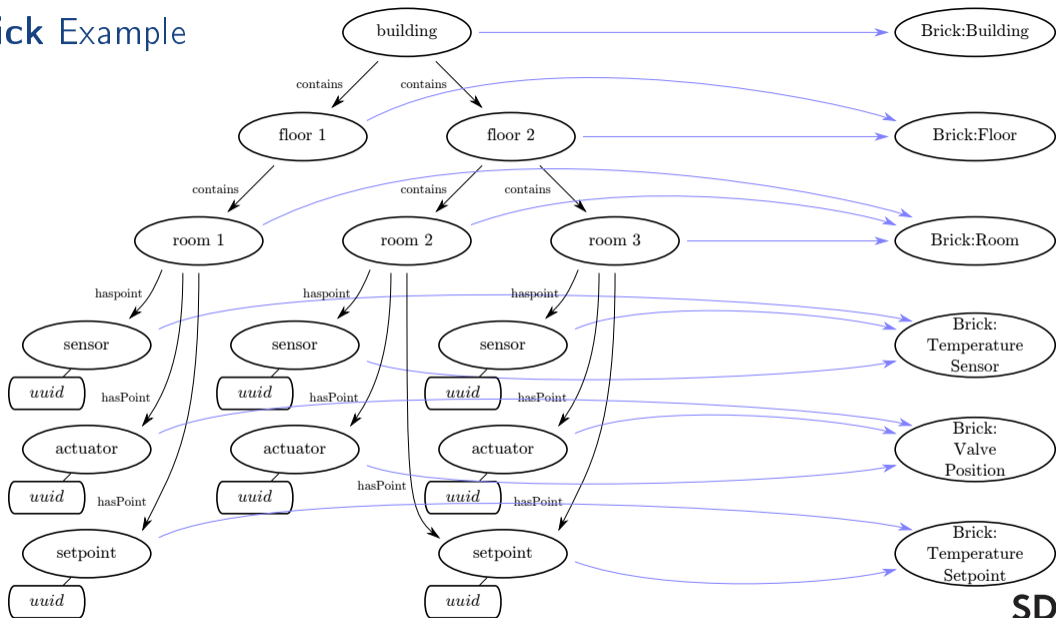


Ontologies A Primer

A graph describing relations between data



Brick Example



The Maersk Mc Kinney Moller Institute



Instrumentation

- ▶ Meters
 - ▶ Domestic water
 - ▶ (District) Heating
 - ▶ Electricity
- ▶ Lighting control
 - ▶ PIR
 - ▶ Light level metering
 - ▶ Control
- ▶ BMS
 - ▶ Ventilation
 - ▶ Heating
- ▶ Comfort
 - ▶ Temperature
 - ▶ Humidity
 - ▶ CO2

Instrumentation

- ▶ Meters (**EnergyKey**)
 - ▶ Domestic water
 - ▶ (District) Heating
 - ▶ Electricity
- ▶ Lighting control (**KNX**)
 - ▶ PIR
 - ▶ Light level metering
 - ▶ Control
- ▶ BMS (**Satchwell Sigma from Schneider**)
 - ▶ Ventilation
 - ▶ Heating
- ▶ Comfort (**ICMeter**)
 - ▶ Temperature
 - ▶ Humidity
 - ▶ CO2

Standby Consumption: Problem

Are there any obvious efficiency issues with MMMI?

Relevant instrumentation:

- ▶ Occupancy counters delivering a signal representing the number of occupants in the whole building
- ▶ Domestic water main meter
- ▶ District heating main meter
- ▶ Electricity main meter

Standby Consumption: Query

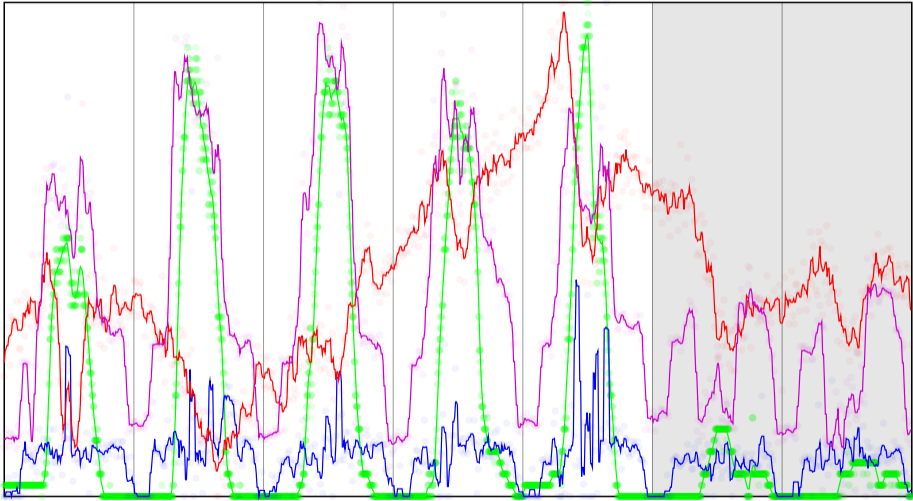
```
SELECT ?building_name ?meter_type ?meter_uuid
WHERE {
    ?building rdf:type/rdfs:subClassOf* brick:Building .
    ?meter    rdf:type/rdfs:subClassOf* brick:Meter .

    ?building rdfs:label ?building_name .
    ?meter    rdf:type/rdfs:label ?meter_type .

    ?building bf:hasPoint ?meter .
    ?meter    bdsmap:hasData/bdsmap:uuid ?meter_uuid .
}
```

("MMMI", "Electricity Meter", "c405c583-2e57-4ba1-bd83-53a17abc6b0a")

Standby Consumption: Results



— Occupancy — Water — Heat — Electricity

Crossing Systems: Problem

Occupants are complaining about the office climate in MMMI.

Is there a problem?

And if so, how does it relate to occupancy?

Crossing Systems: Query

```
SELECT ?sensor_type ?data_type
WHERE {
    ?room    rdf:type/rdfs:subClassOf* brick:Room .
    ?sensor  rdf:type/rdfs:subClassOf* brick:Sensor .

    ?room rdfs:label "E11-612a-1" .
    ?room bf:hasPoint ?sensor .

    ?sensor rdf:type/rdfs:label ?sensor_type .
    ?sensor ?hasdata ?data .

    ?hasdata rdfs:subPropertyOf* bd:hasData
    ?hasdata rdfs:label ?data_type .
}
```

("Humidity Sensor", "sMAP Database")

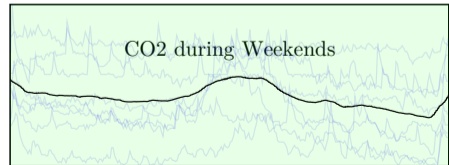
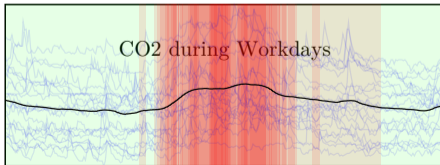
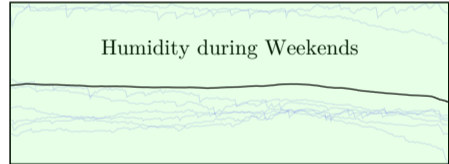
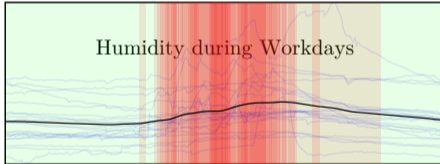
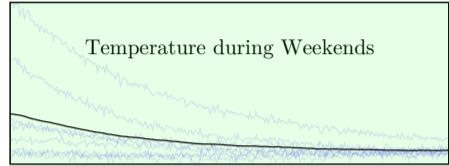
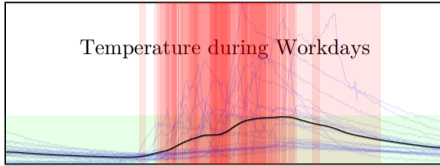
Crossing Systems: Analysis

The query resulted the following sensors:

- ▶ Temperature
- ▶ Humidity
- ▶ CO2
- ▶ Occupancy (PIR)

In addition to this, *Arbejdstilsynet* has defined acceptable bands of temperature, humidity and CO2

Crossing Systems: Results



Heterogeneity among Rooms: Problem

We want to implement some generic room control application

How different are the rooms?

Heterogeneity among Rooms: Query

```
SELECT ?room_name ?point_type ?point_name ?point_uuid
WHERE {
    ?room  rdf:type/rdfs:subClassOf* brick:Room .
    ?point rdf:type/rdfs:subClassOf* brick:Point .

    ?room  rdfs:label ?room_name .
    ?point rdfs:label ?point_name .

    ?room  bf:hasPoint ?point .
    ?point rdf:type ?point_type .
    ?point bdsmap:hasData/bdsmap:uuid ?point_uuid .
}
```

("1.6", "PIR_Filter", "PIR flter", "bb12dd94-36f4-4cc3-a460-dad4c8025b03")

Heterogeneity among Rooms: Results

All members of a room class have the same subset of point types

40 classes were found:

- ▶ The largest class consisted of 8 rooms
- ▶ The second largest class consisted of 3 rooms
- ▶ The third largest class consisted of 2 rooms
- ▶ The remaining 37 classes each contained 1 room

This is known as a (very) long tail

Note: Part of this can be explained by typos in the point names

Questions?

