Challenge 4
Semantic Enrichment

Beam me up

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Context

Problem statement

- Association task (Association task between elements of a BIM model)
- Infer role in the structural relationship
- Enrich data set
- Enable semantic queries
- Use labelled data set in Machine learning (ML) or Graph Neural Network (GNN)?

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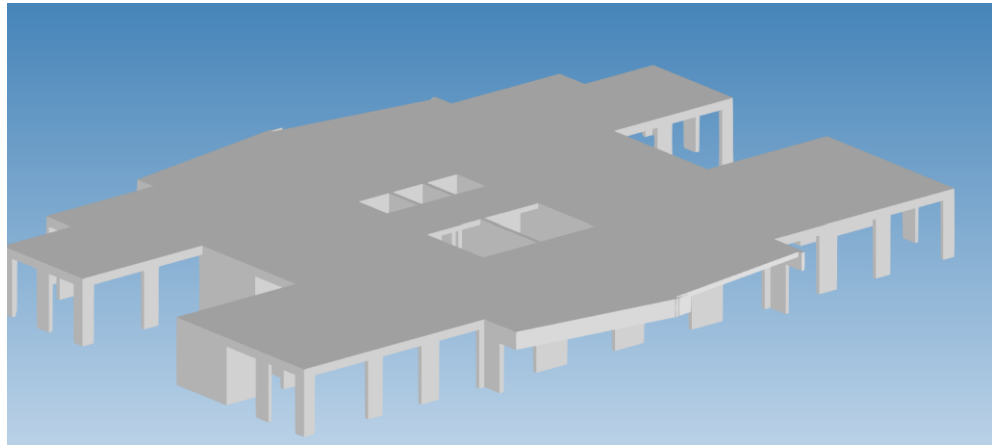
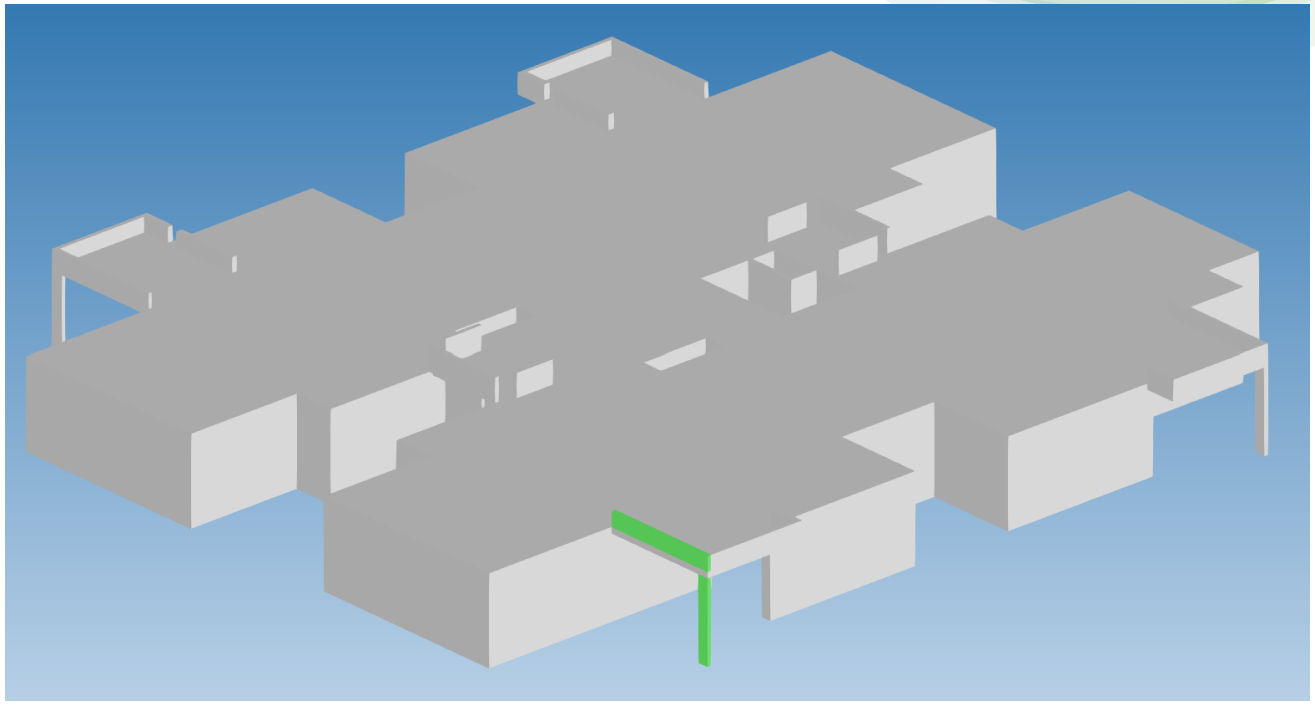
£5.1 -£6.1 /£1.00 invested

Concept

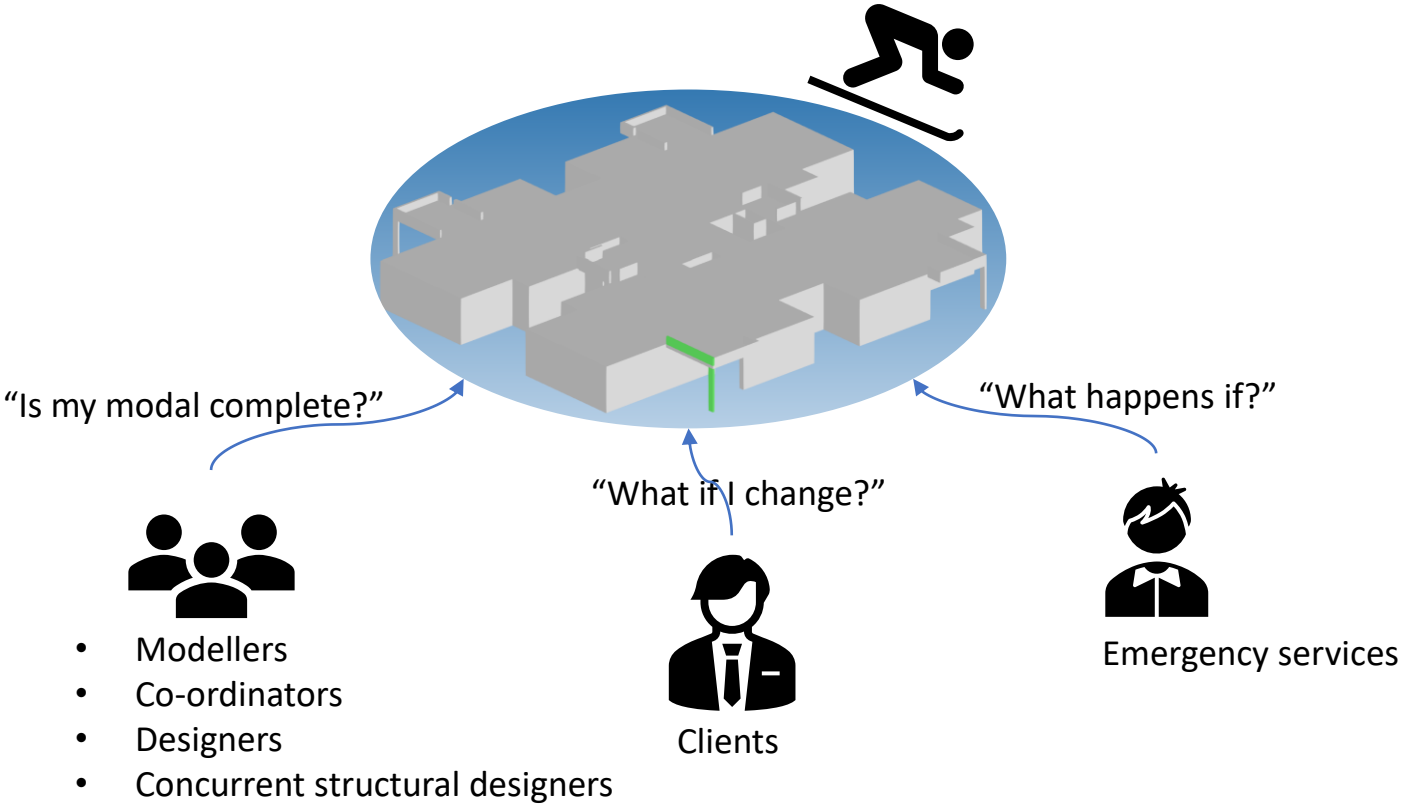
Problem definition





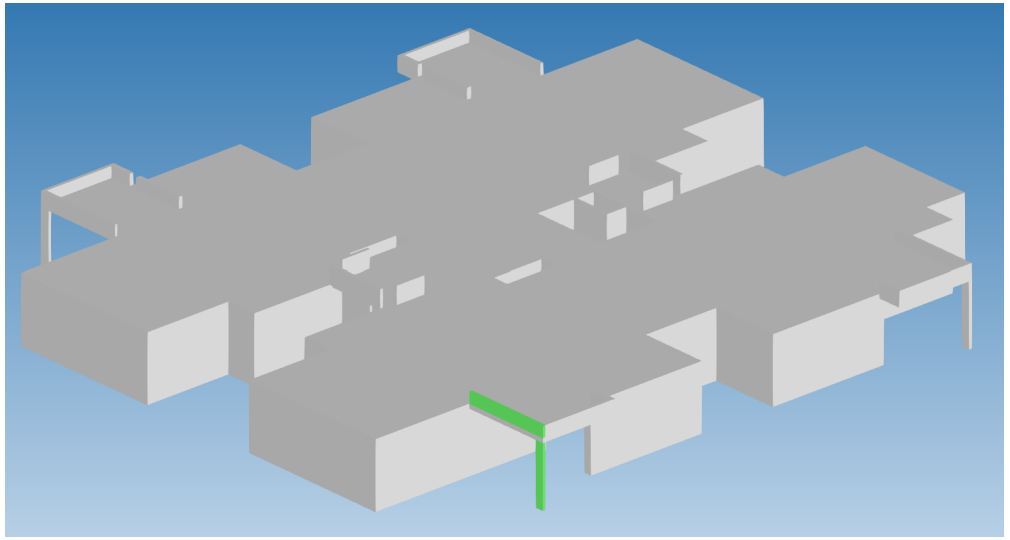
Concept

Stakeholders



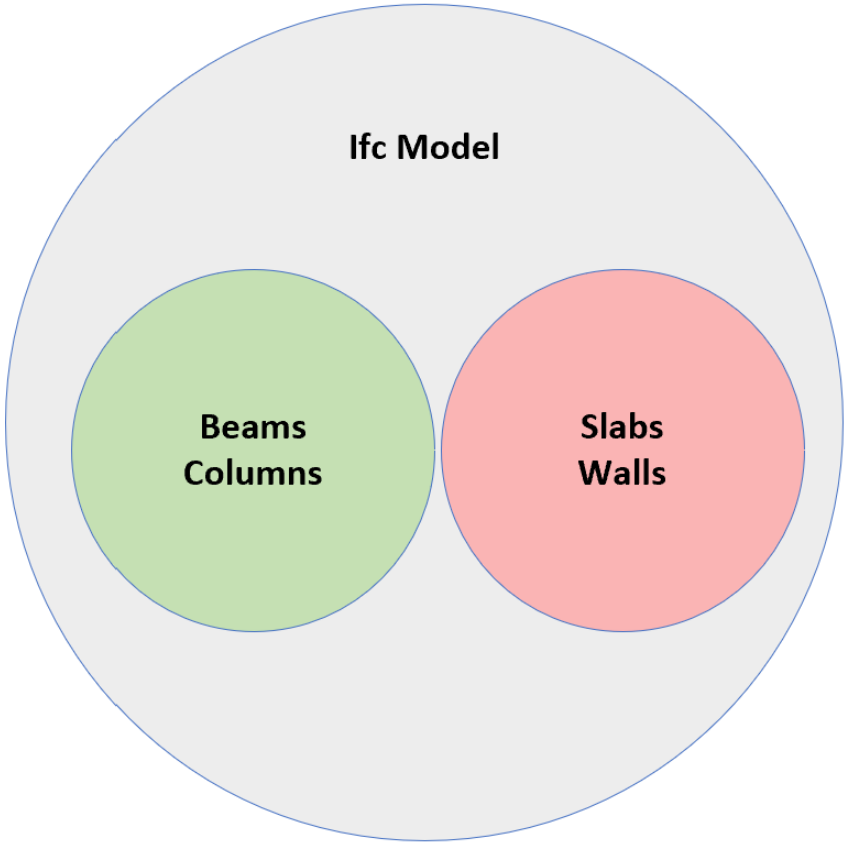
Concept

Problem definition



Within scope

Out of scope



Implementation

Rule based inference
Confirm: object location/association

- Touch points
- Confirm association
- Export to table to show relations
- Enrich ifc file with established associations

RDF conversion + ontology

- Ifc to RDF conversion
- Ontology applied to ifc file
- Confirm attribute assignment

Query capability

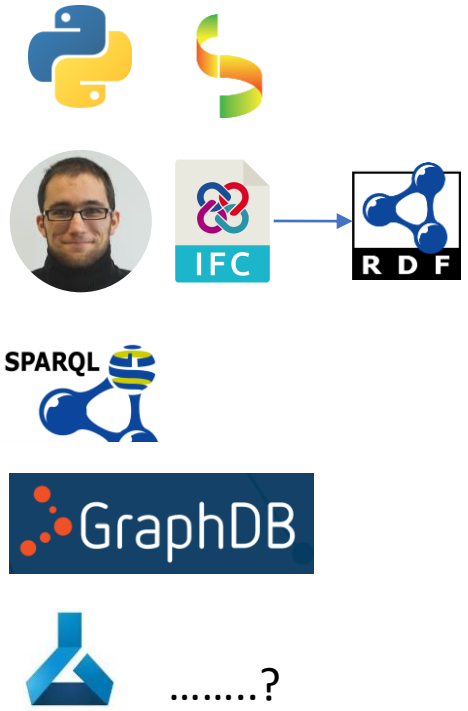
- Supports/Supported
- Chain query. traceability.

ML to look for commonality once multiple models and spreadsheets aggregated

- Inference checks
- Automated based on rule based compliance data

Implementation

Tool

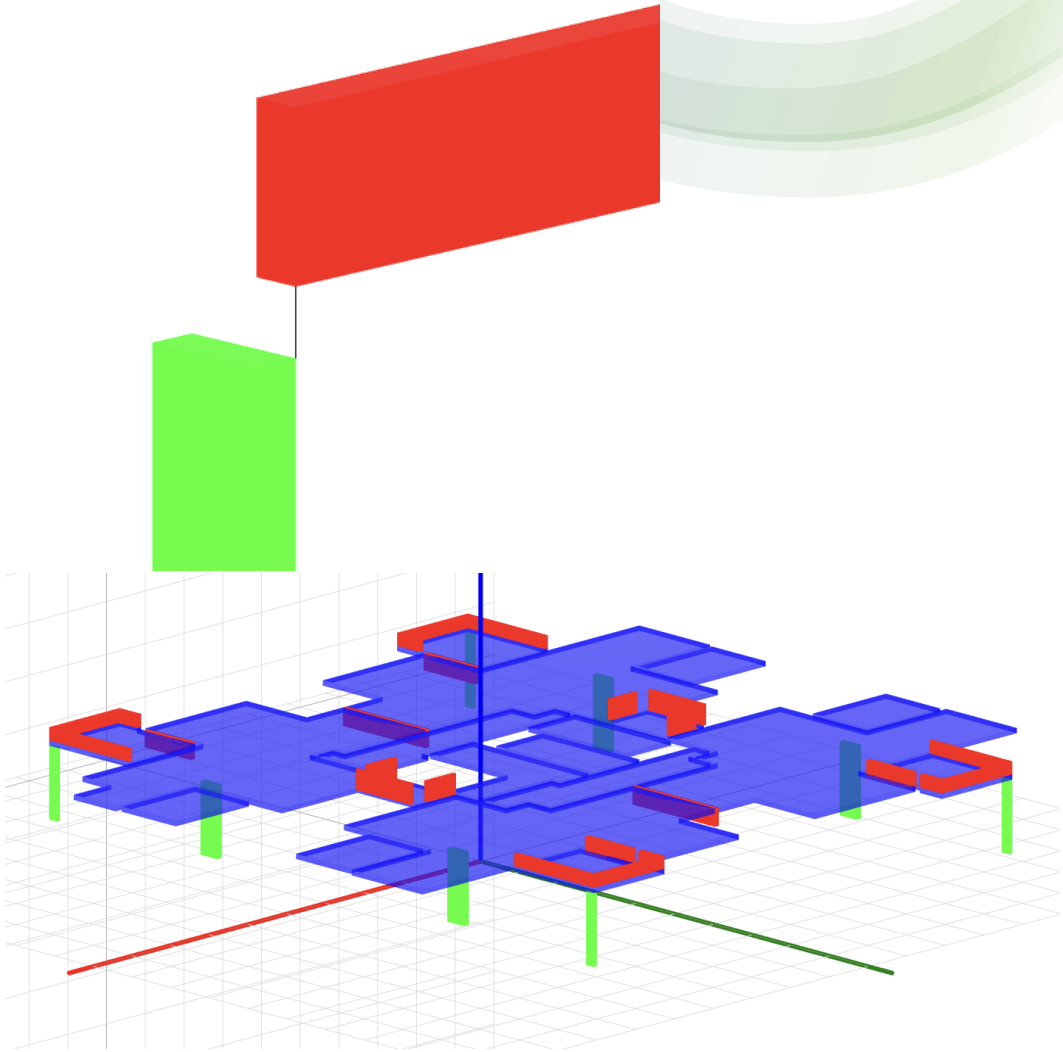


data sources

Implementation

Rule based inference

- Python – geometric interrogation
  - Proximity between elements
  - Proximity threshold: 300mm
  - Using centerpoints to determine which element, support which



Implementation and exploitation

Packages & Tools

RDF graph and SPARQL queries

- The application IFC to RDF was used to transform the IFC file into a knowledge graph
- The ontology was extended to add the supports/supported_by transitive relationship
- We developed the SPARQL queries to obtain the use case information from the knowledge graph.

SPARQL Query and Update

A SPARQL query on structural elements that returns which elements support or are supported by other structural elements

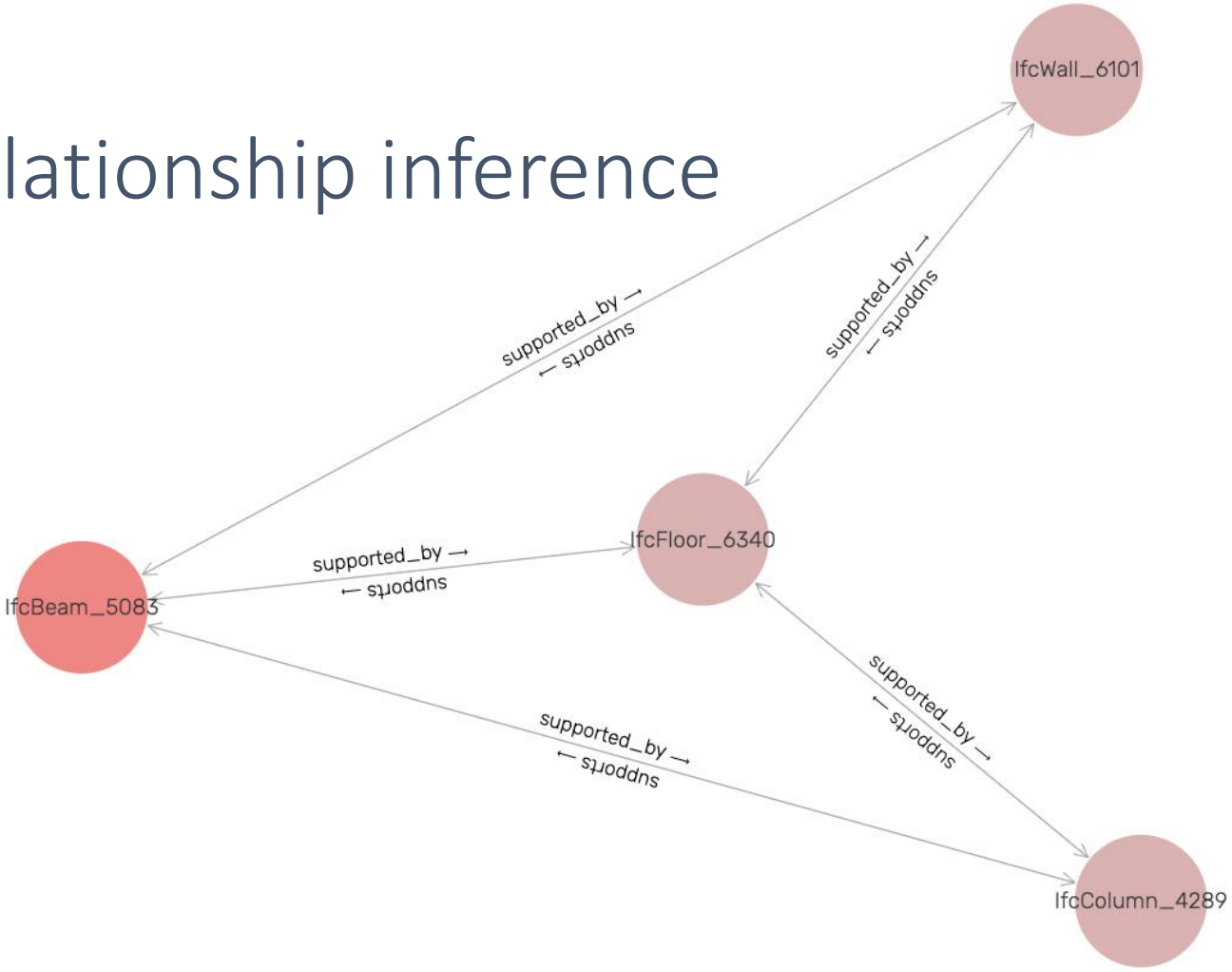
```
prefix onto:<http://www.ontotext.com/> PREFIX express: <https://w3id.org/express#>
PREFIX inst: <http://linkedbuildingdata.net/ifc/resources20220608_181915/>
select ?supports ?supported {
    ?supports <http://buildmeup.com#supports> ?supported.
    FILTER(?supported=inst:IfcBeam_5083)
}
```

	supports	supported
1	inst:IfcColumn_4289	inst:IfcBeam_5083
2	inst:IfcFloor_6340	inst:IfcBeam_5083
3	inst:IfcWall_6101	inst:IfcBeam_5083

Implementation

Packages & Tools

Relationship inference



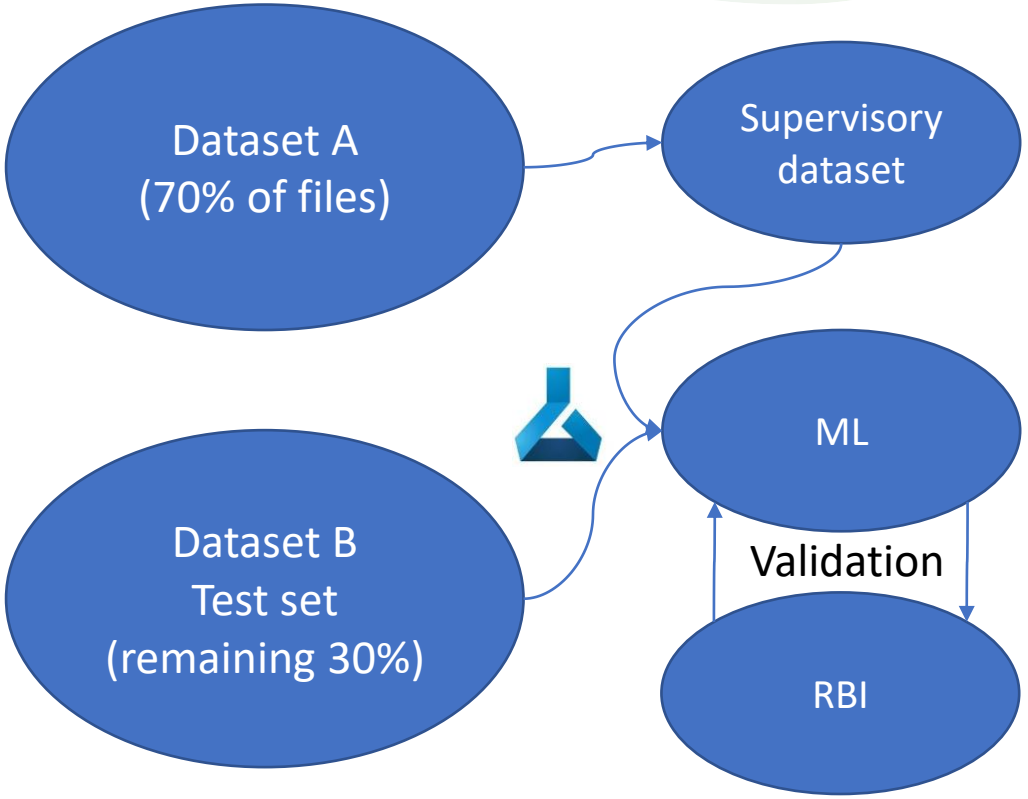
Implementation and exploitation

Packages & tools

Machine learning enrichment

Data Matrix for Naive Bayes Machine Learning Algorithm

Element 1 Type	Element 1 GUID	Element 2 Type	Element 2 GUID	Tolerance	delta X	delta Y	delta Z	Connection
beam	2omDBI$wv0pxfVdW12qIMG	column	2omDBI$wv0pxfVdW12qIM6	0.300	0.000	0.000	0.000	isSupportedBy
column	2omDBI$wv0pxfVdW12qIM6	beam	2omDBI$wv0pxfVdW12qIMG	0.300	0.000	0.000	0.000	isSupporting
beam	2omDBI$wv0pxfVdW12qIMG	column	2omDBI$wv0pxfVdW12qIM0	0.300	9.255	15.455	0.000	null
beam	2omDBI$wv0pxfVdW12qIM4	column	2omDBI$wv0pxfVdW12qIM2	0.300	12.125	9.250	0.000	null
beam	2omDBI$wv0pxfVdW12qIM9	column	2omDBI$wv0pxfVdW12qIM7	0.300	8.150	16.500	0.000	null
beam	2omDBI$wv0pxfVdW12qIM3	column	2omDBI$wv0pxfVdW12qIM1	0.300	0.000	0.000	0.000	isSupportedBy
beam	2omDBI$wv0pxfVdW12qIM8	column	2omDBI$wv0pxfVdW12qIM4	0.300	0.000	0.000	0.000	isSupportedBy
beam	2omDBI$wv0pxfVdW12qIM9	column	2omDBI$wv0pxfVdW12qIM5	0.300	9.255	15.425	0.000	null
beam	2omDBI$wv0pxfVdW12qIM2	column	2omDBI$wv0pxfVdW12qIMG	0.300	12.175	9.250	0.000	null
column	2omDBI$wv0pxfVdW12qIM5	beam	2omDBI$wv0pxfVdW12qIM8	0.300	0.000	0.000	0.000	isSupporting
column	2omDBI$wv0pxfVdW12qIM4	beam	2omDBI$wv0pxfVdW12qIM9	0.300	0.000	0.000	0.000	isSupporting
column	2omDBI$wv0pxfVdW12qIM0	beam	2omDBI$wv0pxfVdW12qIM2	0.300	0.000	0.000	0.000	isSupporting
column	2omDBI$wv0pxfVdW12qIM1	beam	2omDBI$wv0pxfVdW12qIM9	0.300	9.255	15.575	0.000	null
column	2omDBI$wv0pxfVdW12qIMG	beam	2omDBI$wv0pxfVdW12qIM2	0.300	12.255	9.275	0.000	null
beam	2omDBI$wv0pxfVdW12qIM3	column	2omDBI$wv0pxfVdW12qIM1	0.300	0.000	0.000	0.000	isSupportedBy
column	2omDBI$wv0pxfVdW12qIM5	beam	2omDBI$wv0pxfVdW12qIM4	0.300	0.000	0.000	0.000	isSupporting
column	2omDBI$wv0pxfVdW12qIMG	beam	2omDBI$wv0pxfVdW12qIM9	0.300	0.000	0.000	0.000	isSupporting
column	2omDBI$wv0pxfVdW12qIM1	beam	2omDBI$wv0pxfVdW12qIM5	0.300	5.275	11.465	0.000	null
column	2omDBI$wv0pxfVdW12qIM0	beam	2omDBI$wv0pxfVdW12qIM3	0.300	17.175	10.275	0.000	null



impact

- Save time in design and modelling
  - Design phase
  - Renovation implementation
  - Further enrichment
- Intuitive interface for users
- Allow for quick analysis of
  - Load paths
  - Schedule creation – parts lists fo
  - Critical elements of a building
    - Emergency services
    - Design efficiency – robustness

Impact

Further work

- Provide multiple geometric checks
- Visual query interface

Impact

Further work

- Provide multiple geometric checks
- Visual query interface

Q&A