

The logo consists of the lowercase letters 'i' and '3' in a white, sans-serif font, positioned on a blue square background.

mainz

Institut für raumbezogene
Informations- und Messtechnik
Hochschule Mainz

A grayscale point cloud visualization of a crumpled paper bag, showing its complex, irregular shape and texture. The points are densely packed to form the surface of the bag.

Semantic 3D Annotations

Martin Unold

- Introduction
- 3D Data
 - Capturing
 - Storing
 - Analysing
- Semantic
 - 3D Annotations
 - GeoSPARQL



Introduction

What we did in our project ...

- BMBF-Projekt (2012-2015)
 - Akademie der Wissenschaften und der Literatur Mainz
 - Hochschule Mainz
- Website
www.spatialhumanities.de/ibr

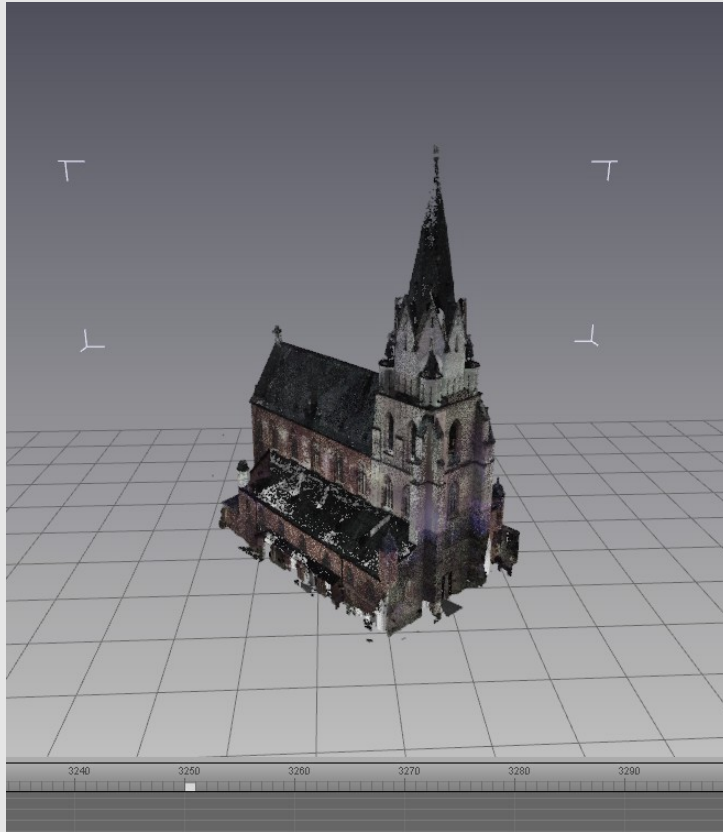
Liebfrauenkirche Oberwesel



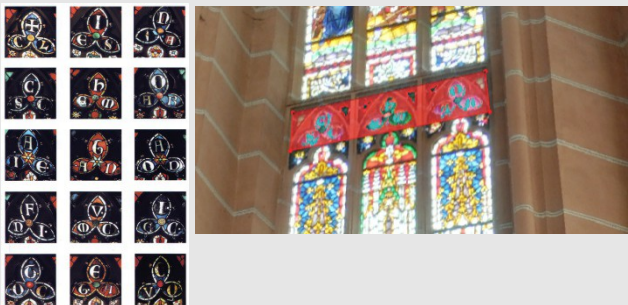
Liebfrauenkirche Oberwesel – Laserscan



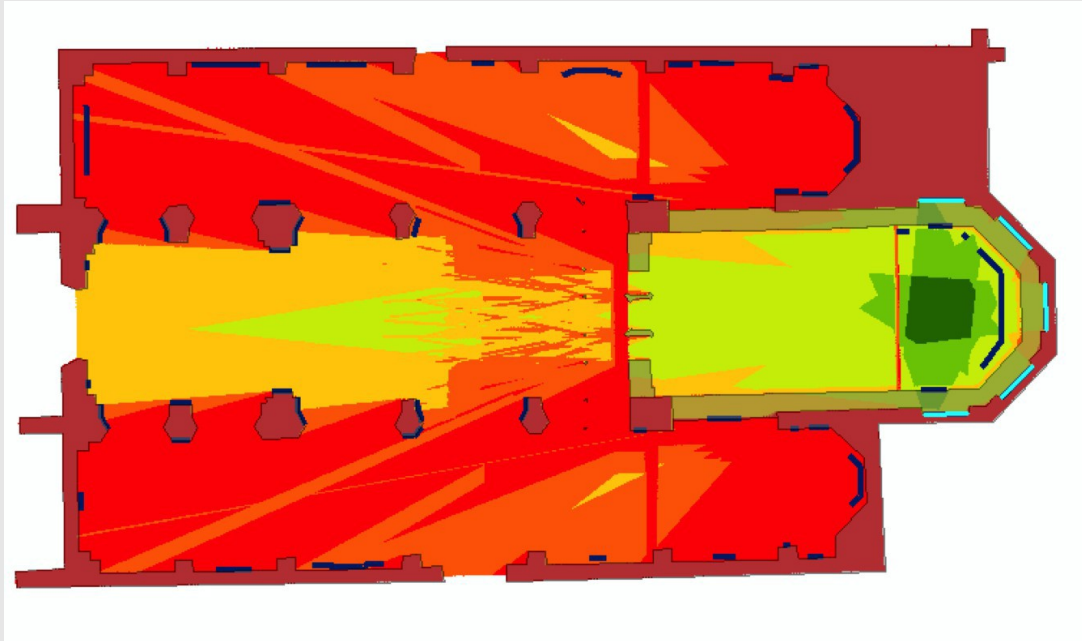
Liebfrauenkirche Oberwesel – Pointcloud



The foundational inscription



Visibility analysis





3D Data

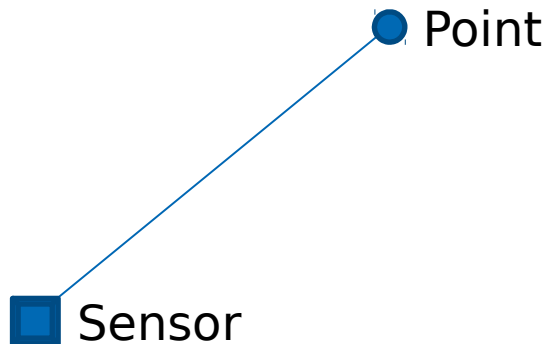
Capturing
Storing
Analysing

What do you want to measure?

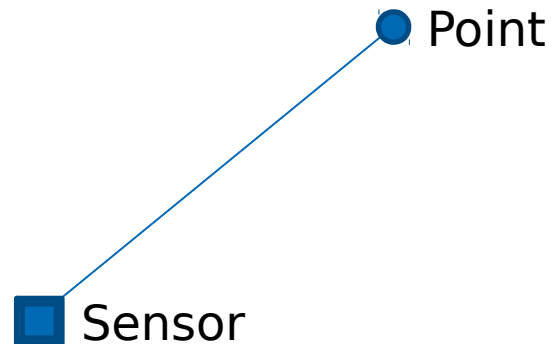
SPATIAL CONTEXT

Which measurement technique?

Structure From Motion



Optical Scan



What is measured?

Structure From Motion

Color

Direction

Optical Scan

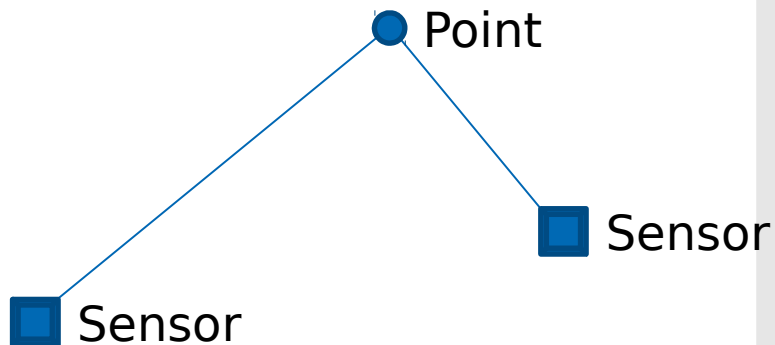
„Color“

Direction

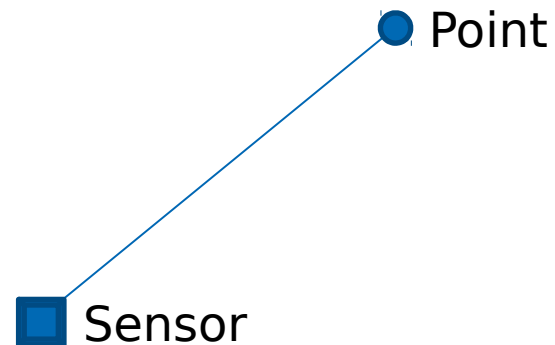
Distance

Which measurement technique?

Structure From Motion



Optical Scan



What are the results?

Structure From Motion

NO scale

NO global reference

Optical Scan

Measures distances

Higher precision

What are the results ?

- Point cloud (XYZ)

-2.747 -9.833 0.262

-1.777 -8.554 0.272

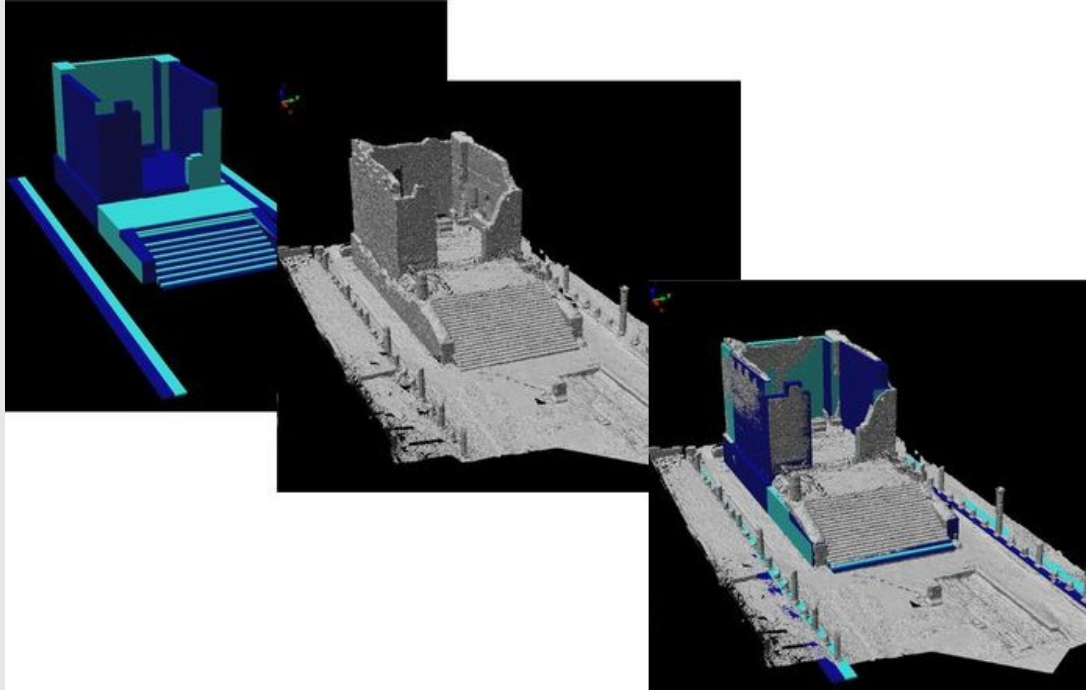
-2.603 -9.914 0.272

-3.198 -2.585 0.267

-2.743 -2.481 0.263

-3.197 -2.398 0.271

3D Model vs Point cloud



What can be derived from point cloud ?

- 3D Model (WKT)

```
POINT(-2.747 -9.833 0.262)
```

```
LINestring
```

```
(-2.603 -9.914 0.272,  
-3.198 -2.585 0.267)
```

3D Model vs Point cloud

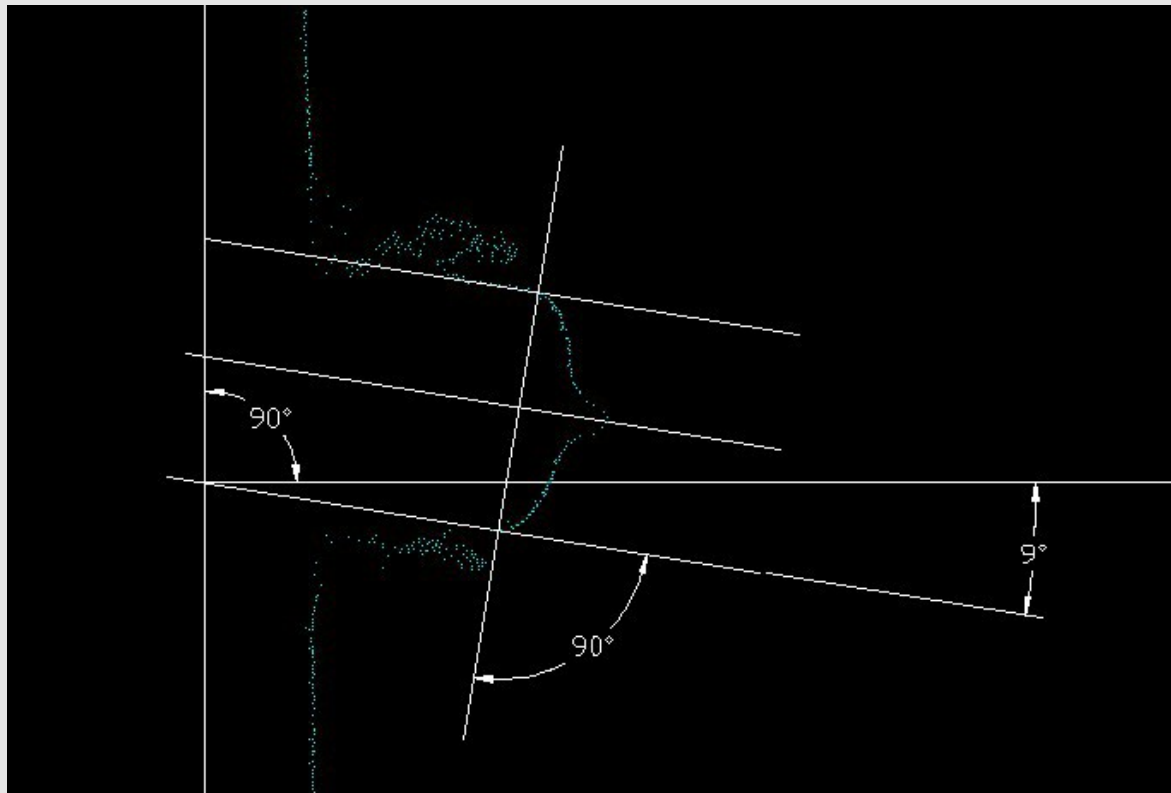
3D Model

- Man-made
 - subjective
 - time consuming
 - past/future possible
- Surfaces
 - only corners stored
 - sketchy structure

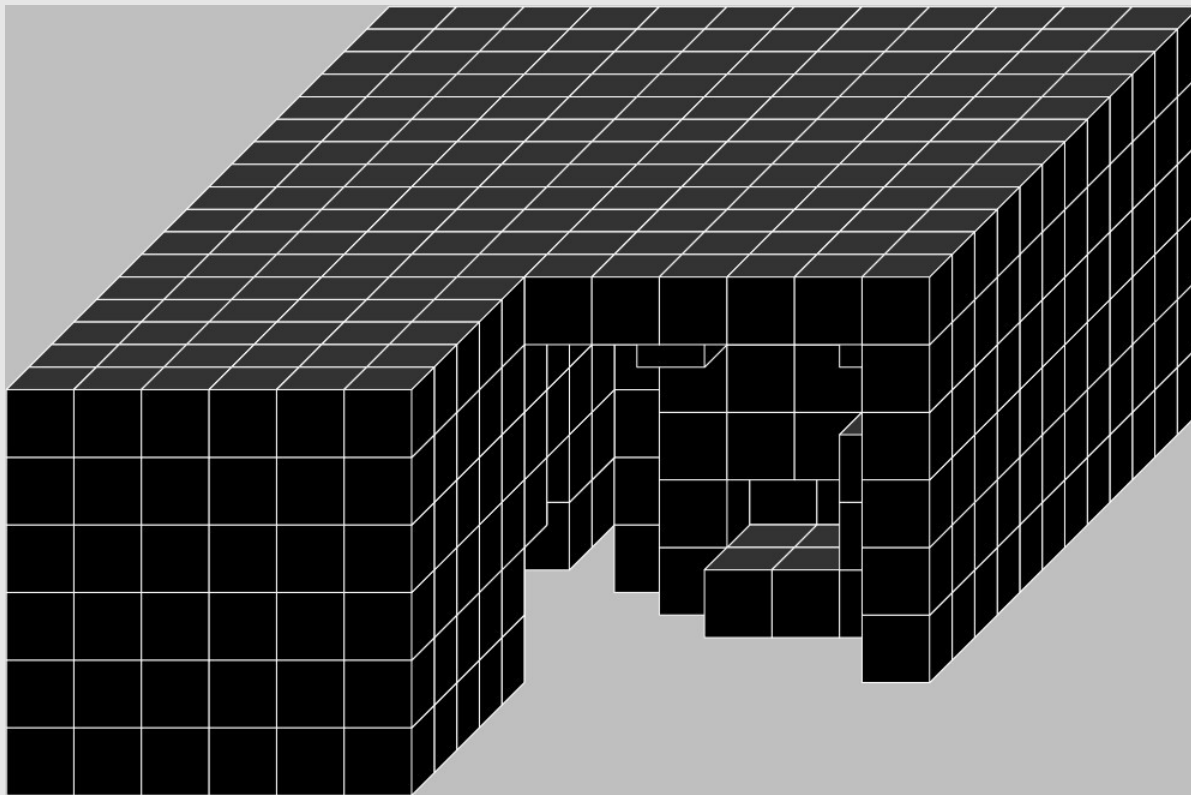
Point cloud

- Surveyed
 - free of interpretation
 - rather cheap
 - current state
- Points
 - a lot of disk space
 - very detailed

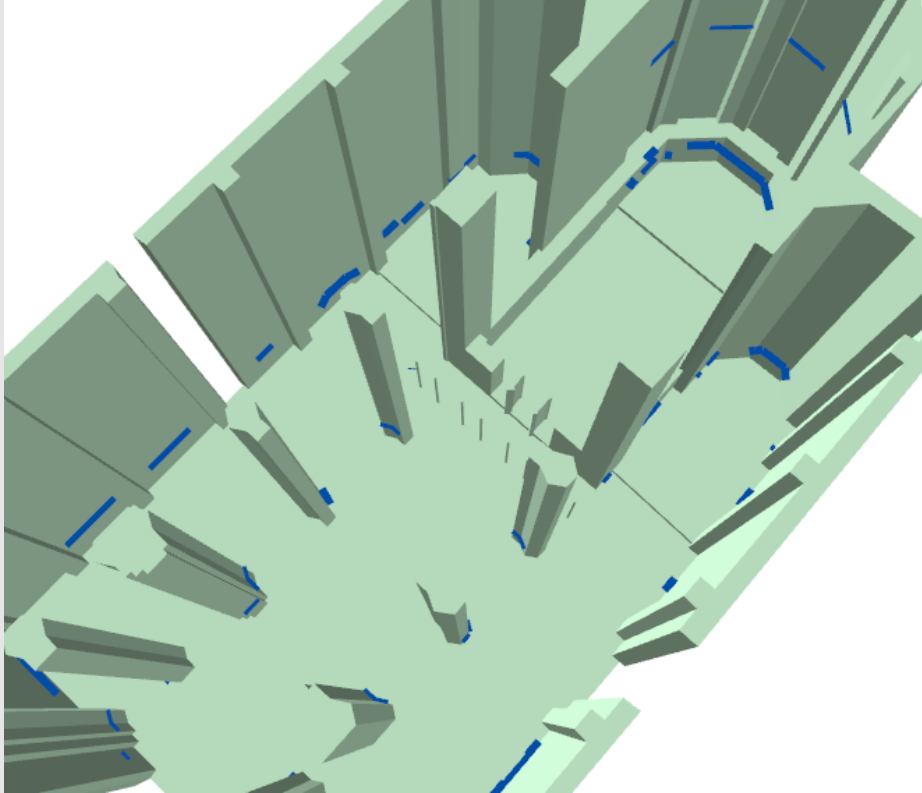
Analysis in point cloud: sight angle



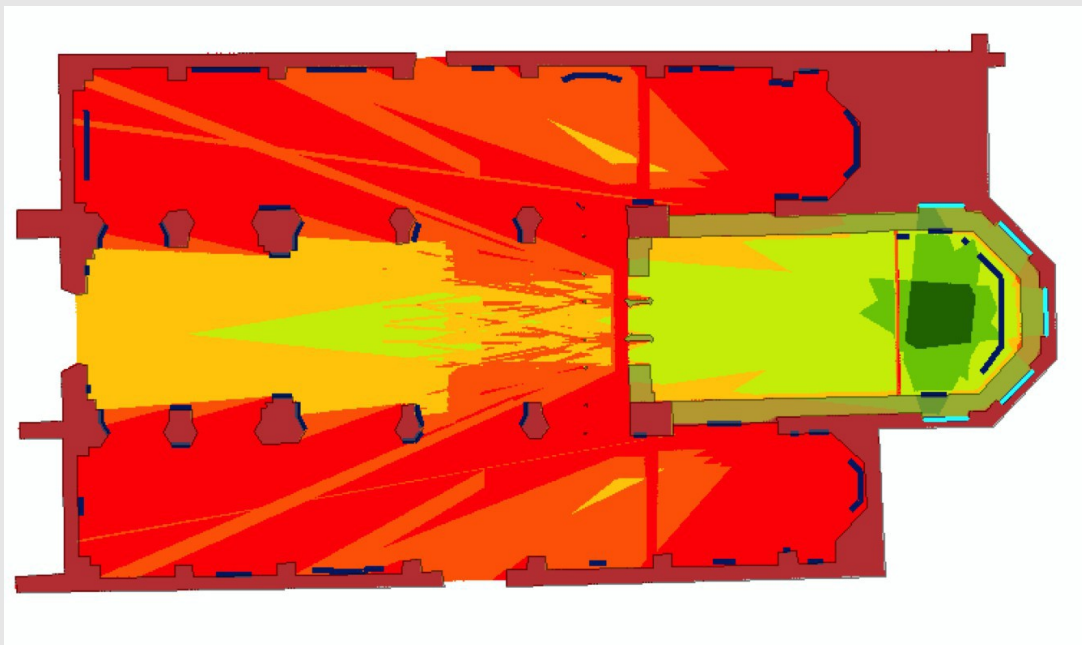
Analysis in point cloud: visibility



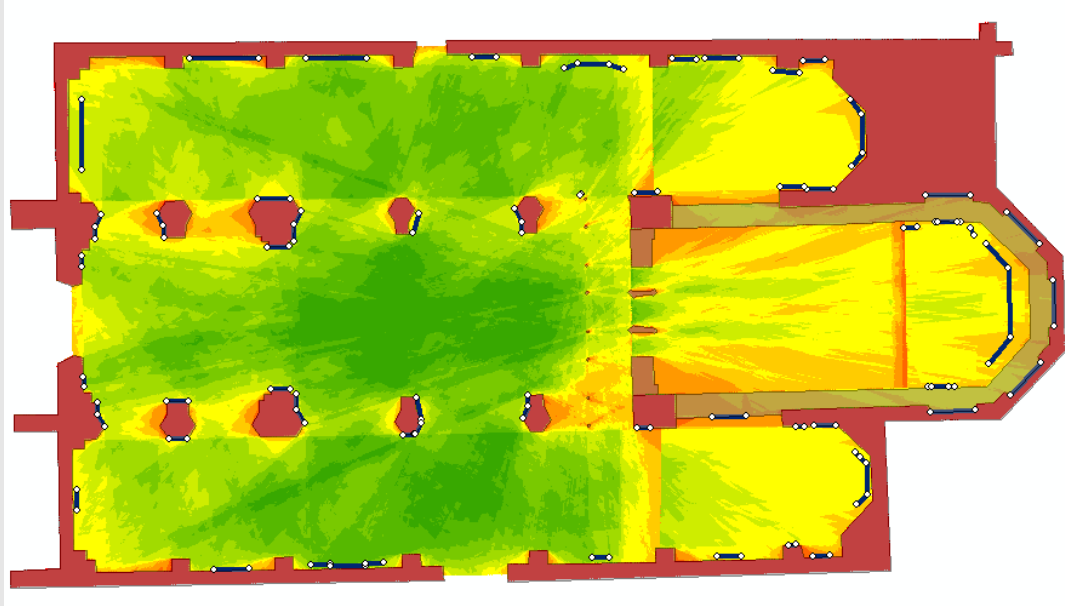
Analysis in 3D model



Analysis in 3D model: visibility



Analysis in 3D model: space syntax





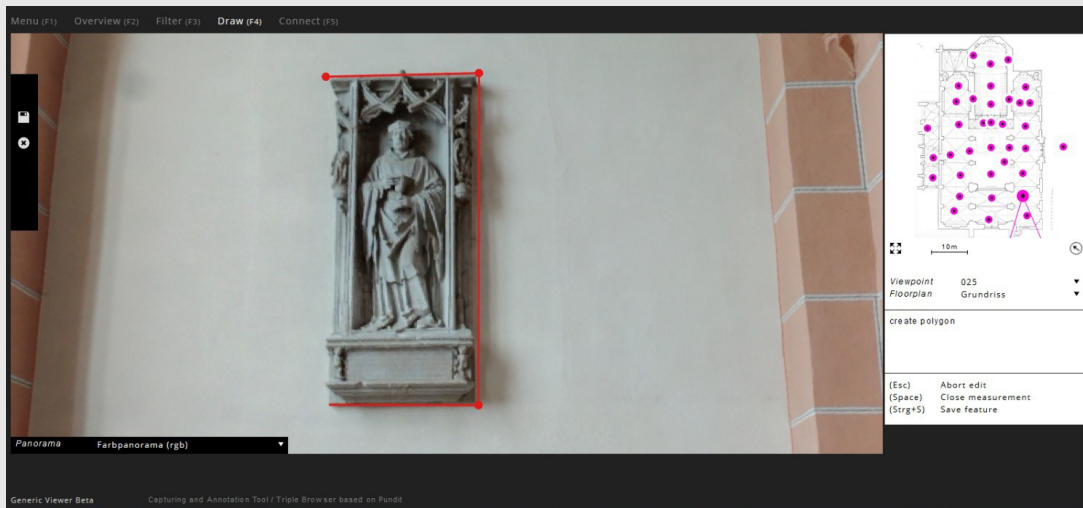
Semantic

3D Annotations
GeoSPARQL

Identification of parts of the 3D data

- Automatic
 - 3D object detection
 - pattern recognition
 - machine learning
- Manual
 - CAD software

Identification of parts of the 3D data



Link geometric information to other expert data

Geometric Information

Point cloud

```
-19.838807925300156 -9.531380798359208 5.696547729492187
-19.83862230642309 -9.531382935585771 5.683608276367187
-19.838717797513468 -9.53139688827027 5.676741821289062
-19.838783246008283 -9.53141620425846 5.670577270507812
-19.838843331199406 -9.531405477651094 5.663710815429687
-19.838657712322338 -9.531407614877647 5.657454711914062
-19.838597627131215 -9.531418341485022 5.650893432617187
-19.83831651716377 -9.531406526027085 5.644240600585937
-19.838251068668956 -9.531387210038897 5.637679321289062
-19.83831651716377 -9.531406526027085 5.624678833007812
-19.838130898286707 -9.531408663253648 5.617720825195312
-19.837915236814077 -9.531416163783899 5.611464721679687
-19.838040770500015 -9.531424753164712 5.605025512695312
-19.837945279409638 -9.531410800480211 5.598464233398437
-10.8376480701056 -6.6317660477681719 5.601027471676007
```

3D Model

```
GEOMETRYCOLLECTION(
  MULTIPOLYGON(
    (
      (-19.821976846934 -10.7477902901255 3.14616320800781,
        -19.8409991372056 -9.54406884243867 3.18443217134361,
        -19.8402317745279 -9.58079152388823 5.83991939115639,
        -19.821976846934 -10.7477902901255 3.14616320800781
      )
    ),
    (
      (-19.821976846934 -10.7477902901255 3.14616320800781,
        -19.8402317745279 -9.58079152388823 5.83991939115639,
        -19.8212790063737 -10.7799999437003 5.82731555179781,
        -19.821976846934 -10.7477902901255 3.14616320800781
      )
    )
  )
),
  MULTIPOLYGON(
    (
      (-20.0499538272354 -10.7513934979392 3.14617925838568,
        -20.0689761175069 -9.54767205025238 3.18444822172148,
        -20.0600074446088 -8.606061767048 8.9398384113242
      )
    )
  )
)
```

Expert Data

Type

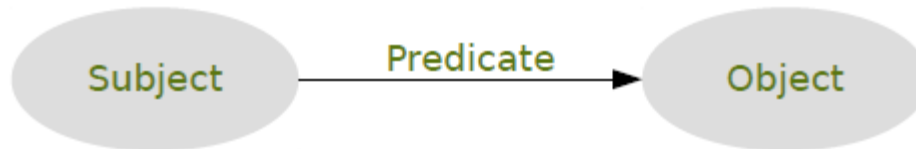
Person

...

Epitaph

Petrus Lutern

- Uniform Resource Identifier (URI)
 - `http://example.org/uri`
- Triple Statement (Turtle Syntax)
 - Subject Predicate Object .



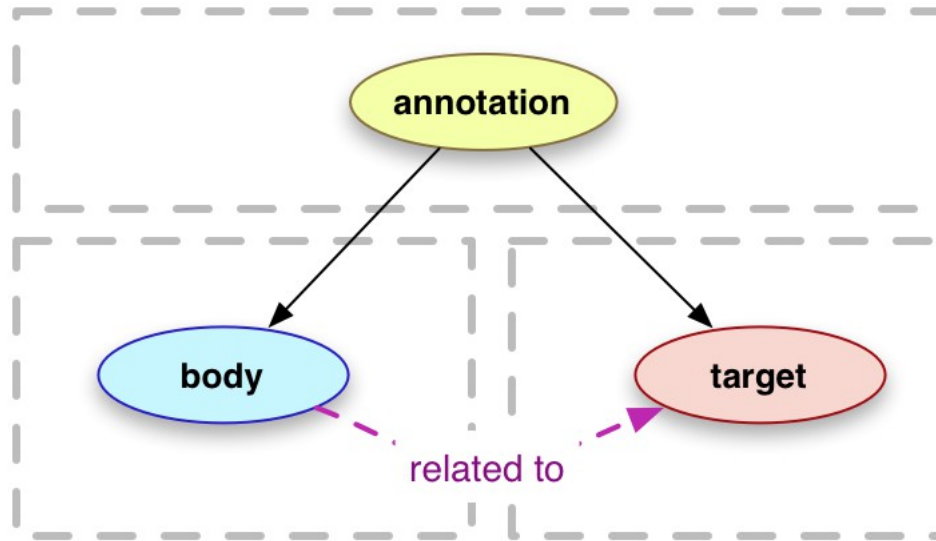
- ## Linked Data

```
myObject ogc:hasGeometry GEOMETRY .  
GEOMETRY rdf:type wkt:GeometryCollection .  
GEOMETRY ogc:asWKT "GeometryCollection(...)" .
```

```
myObject rdf:type myontology:Epitaph .  
myObject myontology:depicts LUTERN .  
LUTERN rdf:type foaf:Person .
```

```
...
```

- Open Annotation



- Open Annotation

```
ANNOTATION rdf:type oac:Annotation .  
ANNOTATION dc:title "My Annotation" .  
ANNOTATION dcterms:creator CREATOR .  
CREATOR foaf:name "Martin Unold" .  
...  
ANNOTATION oac:hasTarget GEOMETRY .  
...  
ANNOTATION oac:hasBody myObject .  
myObject rdf:type myontology:Epitaph .  
...
```

- Get all Epitaphs within myRoom

```
SELECT ?object WHERE {  
    ?object rdf:type myontology:Epitaph .  
    ?object ogc:hasGeometry ?geom .  
    myRoom ogc:hasGeometry ?roomgeom .  
    ?geom ogc:within ?roomgeom .  
}
```

- Get all Epitaphs within myRoom

```
SELECT ?object WHERE {  
  ?object rdf:type myontology:Epitaph .  
  ?object oac:annotates ?geom .  
  myRoom oac:annotates ?roomgeom .  
  ?geom ogc:within ?roomgeom .  
}
```



Thank You for Attention

Martin Unold