

ESTABLISHING AN OBJECT IDENTIFICATION
METHOD BASED ON THE DESCRIPTION OF
NEIGHBOURING ELEMENTS

MSc Geomatics for the Built Environment
Cathelijne Kleijwegt • 25 - 01 - 2019

C O N T E N T

- Introduction
- Literature review
- Methodology & Implementation
- Demo
- Tests & Results
- Conclusions



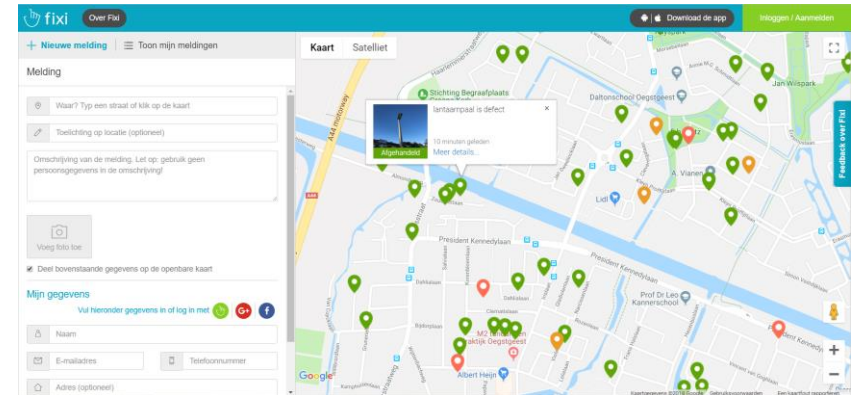
INTRODUCTION

Problem statement

- Fixi: application to report issues in public space
- Problems:
 - GNSS is turned off
 - Pointing out on a map is difficult
 - Reporting position of user, not of object



→ Describe the object



“CAN AN OBJECT IDENTIFICATION METHOD
BE ESTABLISHED BASED ON THE
DESCRIPTION OF NEIGHBOURING
ELEMENTS?”

INTRODUCTION

Research questions

1. What type of surrounding **elements** can be considered for the description of an object?
2. Which **datasets** are available that provide the position of those elements?
3. What kind of **spatial relationships** can be used as an input?
4. What method can be used to **process** the input?
5. To what extent does the developed method meet certain **requirements**?

INTRODUCTION

Scope

- **Spatial**
Municipality of Westervoort, Amsterdam & Joure
- **Data**
Data is correct and complete
- **Input of the user**
Correct and complete
User fill out a form
- **Implementation**
Test version

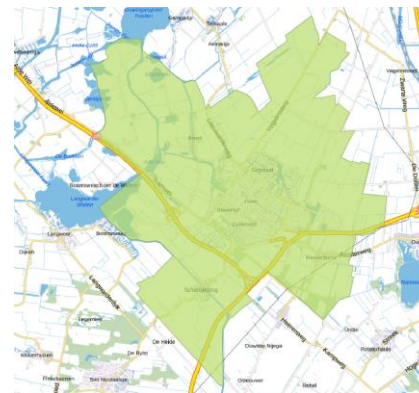
Amsterdam



Westervoort



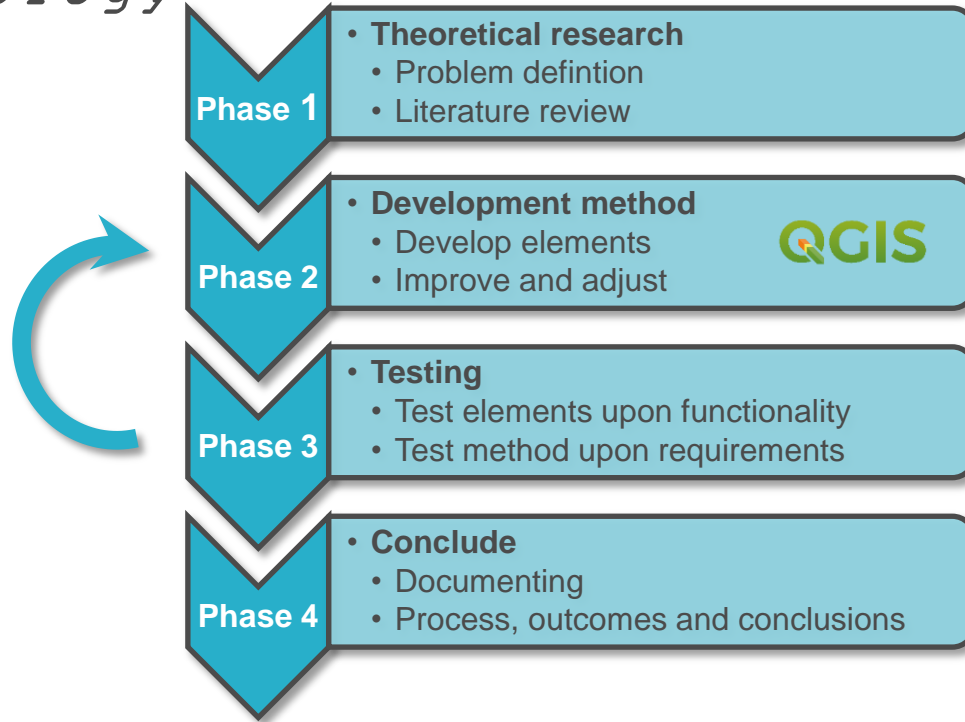
Joure



INTRODUCTION

methodology

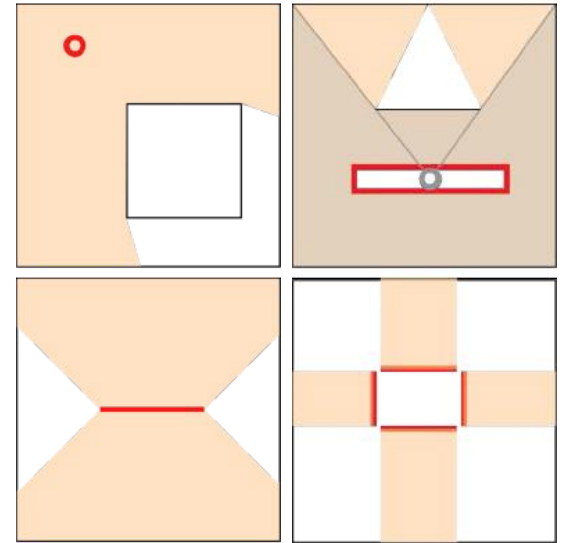
Research



LITERATURE REVIEW

Positioning based on landmarks [[Willems, 2017](#)]

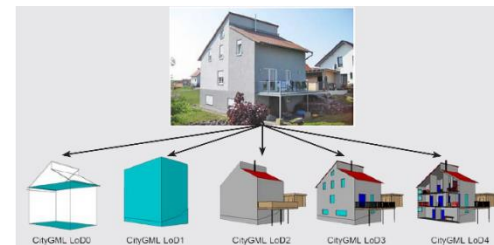
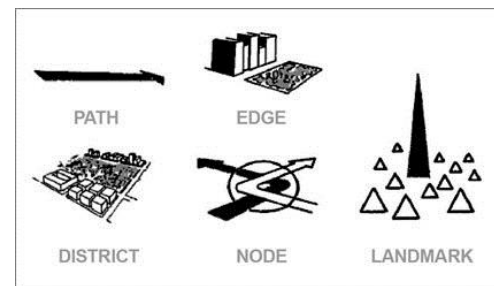
- Pure landmark approach
- Indoor
- Obstacles / visibility
- Structured input



LITERATURE REVIEW

Elements of a city – Models and definitions

- 5 Definitions of Lynch [[Lynch, 1960](#)]
 - Path, edge, district, node, landmark
- CityGML [[Gröger and Plümer, 2012](#)]
 - International model
 - Semantics of objects
 - 12 feature types, 5 Levels of Detail
- IMGeo [[Geonovum, 2018](#)]
 - “Plus objects” for BGT
 - Objects in public space



LITERATURE REVIEW

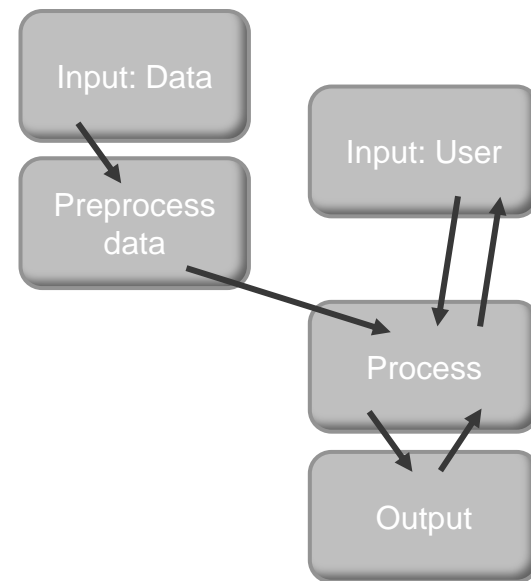
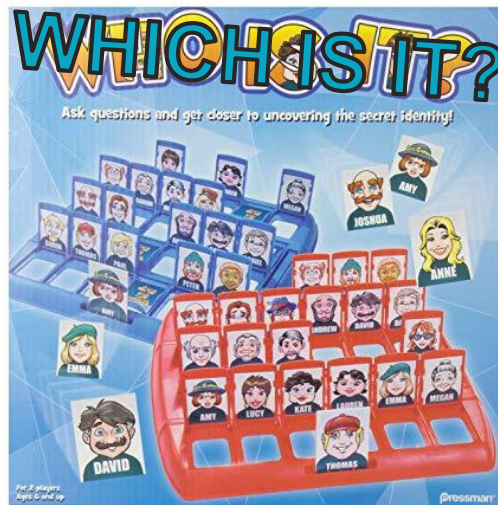
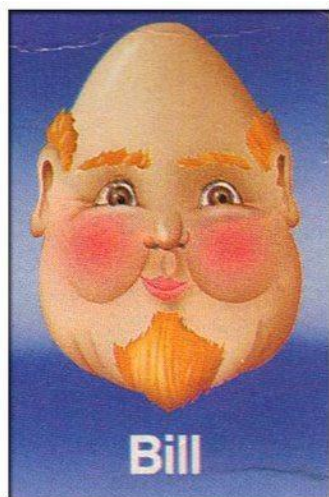
Spatial relationships [[Egenhofer and Herring, 1990](#)]

- Describe relationships between elements
- Point, line, & area elements
 - 4 Intersection Model
 - 9 Intersection Model
 - Dimension Extended Model
 - Calculus Based Model

Calculus Based Model

	Point/point	Point/line	Point/area	Line/line	Line/area	Area/area
Touch		X	X	X	X	X
In	X	X	X	X	X	X
Cross				X	X	
Overlap				X		X
Disjoint	X	X	X	X	X	X

METHODOLOGY & IMPLEMENTATION

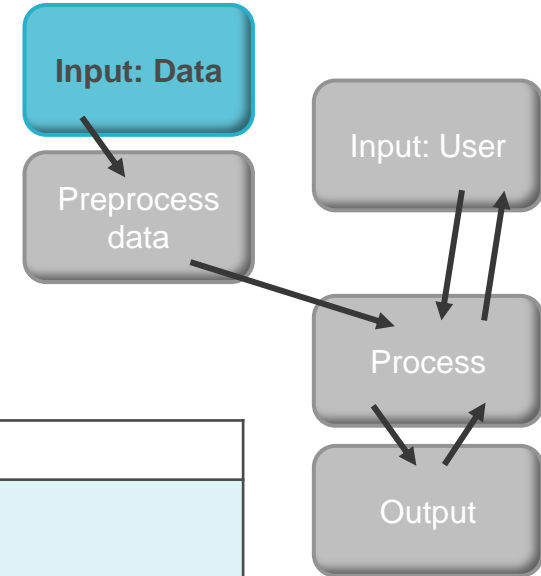


METHODOLOGY & IMPLEMENTATION

Input: Data

- Reference data of described elements
- PDOK datasets
 - BGT: *road, railroad, bin, pole, sign*
 - NWB: *road names*
 - CBS: *districts and neighbourhoods*
 - BRK: *municipality boundary*
 - BRT: *backgroundmap*

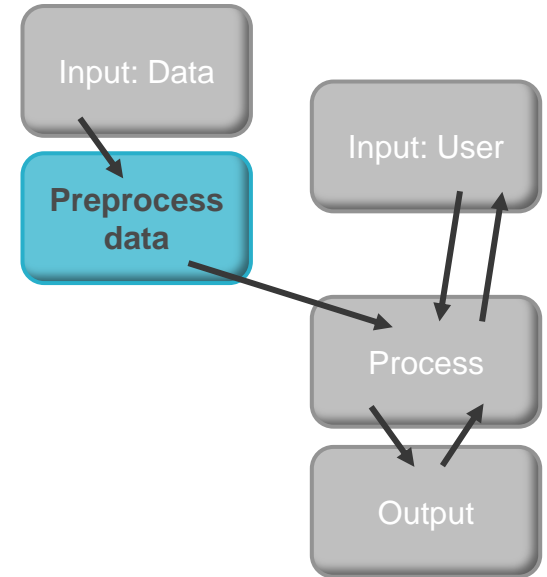
Element	Feature
1. Path	Street
2. Edge	Railroad
3. District	Neighbourhood and roadtype
4. Node	Crossing of two streets
5. Landmark	Sign and bin



METHODOLOGY & IMPLEMENTATION

Preprocess datasets

- Explore data
- Remove attributes which are of no need
- Spatially restrict dataset to case boundary
 - Westervoort, Amsterdam, Joure
- Remove features that do not exist (end date)



METHODOLOGY & IMPLEMENTATION

Input: User

- Form to fill out
- Iterative with process element
 - Options dependent on input and process output

Stap 1: Selecteer gemeente
Stap 2: Wat wilt u melden?
Stap 3: Wat is er in de omgeving?

Geen buurt bekend

Langs

Tweede straat onbekend

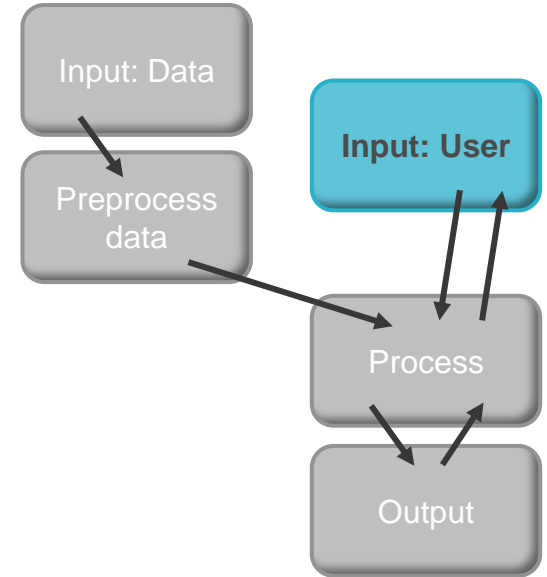
lichtmast

verkeersbord

Spoor is niet beschikbaar

Op weftype

Voorgestelde objecten: 3



METHODOLOGY & IMPLEMENTATION

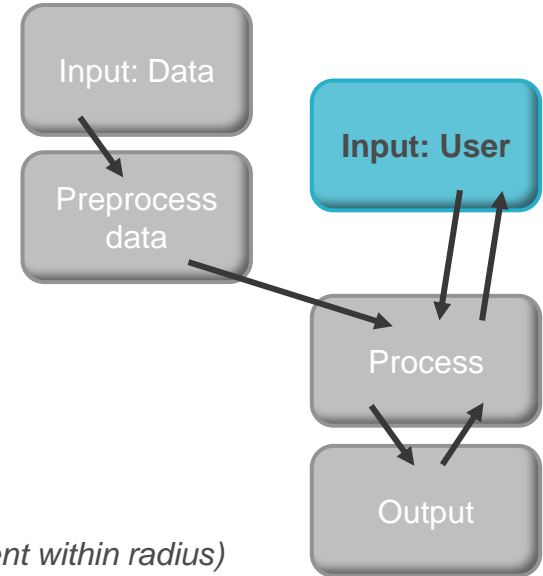
Input: User

- Three versions:
 - Version 1: spatial relationships and indicated distances
 - Version 2: spatial relationships
 - Version 3: indicated distances

- Spatial relationships
 - Calculus Based Method
 - Fixi issues
 - QGIS spatial analysis

Spatial relationships

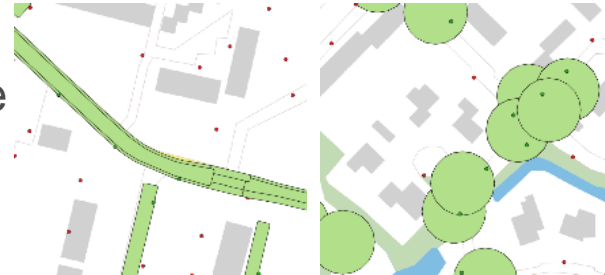
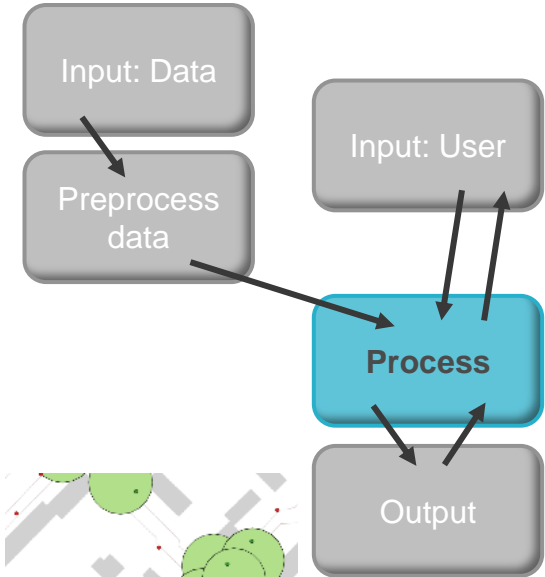
- Langs (*along*)
- In de buurt (*close by*)
- Aanwezig binnen straal (*present within radius*)
- Niet aanwezig binnen straal (*absent within radius*)
- Op (*on*)



METHODOLOGY & IMPLEMENTATION

Process

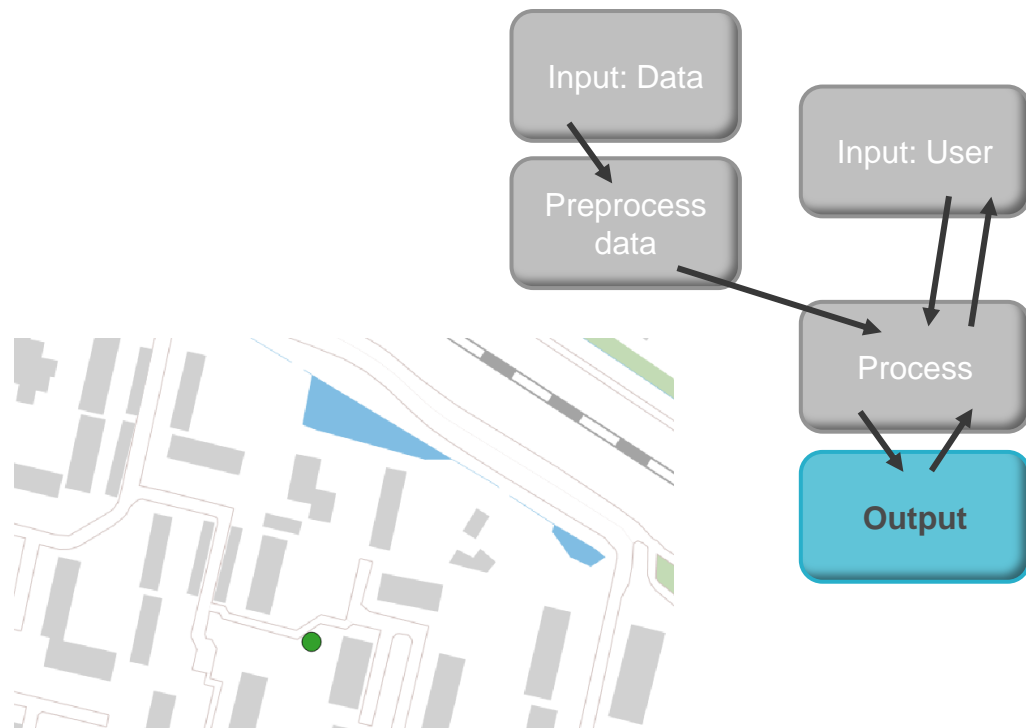
- Technical method that identifies the object
- Spatial analysis
 - Vector approach
 - Vector data
 - Level of detail: object identification
 - Buffers, clipping, presence/absence



METHODOLOGY & IMPLEMENTATION

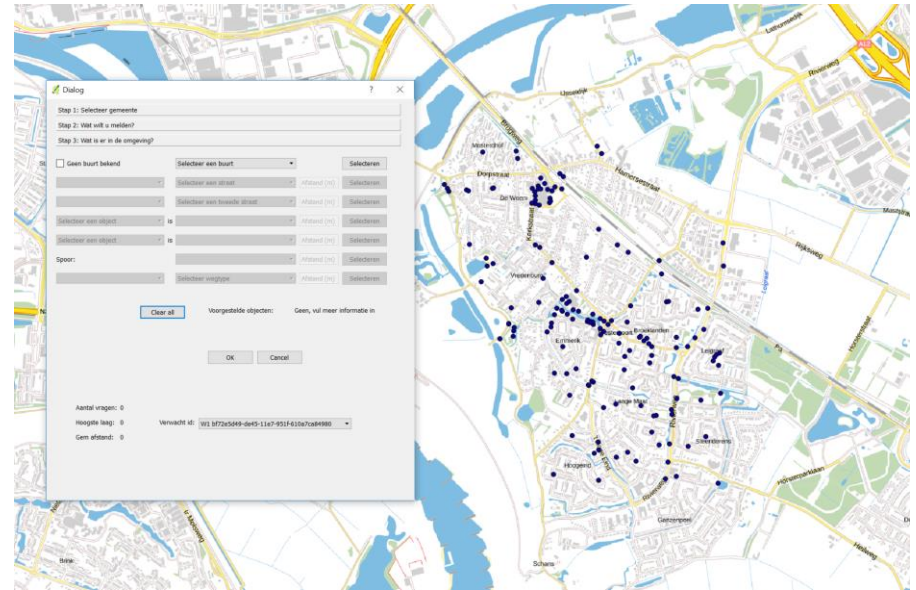
Output

- Preliminary outcomes
 - Visualized on the map
 - Number of objects
- Final output on the map



DEMO

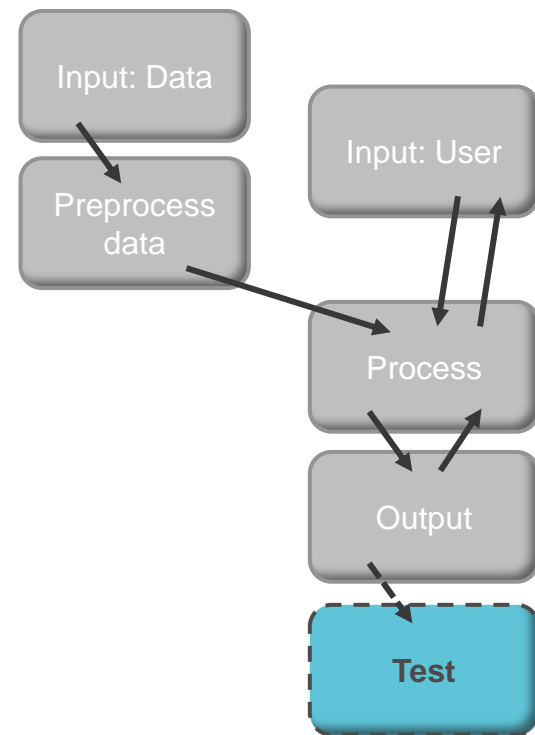
8 - Object ID: bd4a33be1-de40-11e7-8ec4-89be260623ee
Object type: afvalbak
Neighbourhood: Westervoort
Street: 5m Klapstraat
Street 2: xx
Object 1: 6m lichtmast
Object 2: 12m verkeersbord
Railroad: 389m
Roadtype: on tegels



TESTS & RESULTS

Tests

- Scenarios selected at random
 - 10 for each municipality
- Object & description is known
 - To check output
- Two tests
 - Implemented elements
 - Overall method

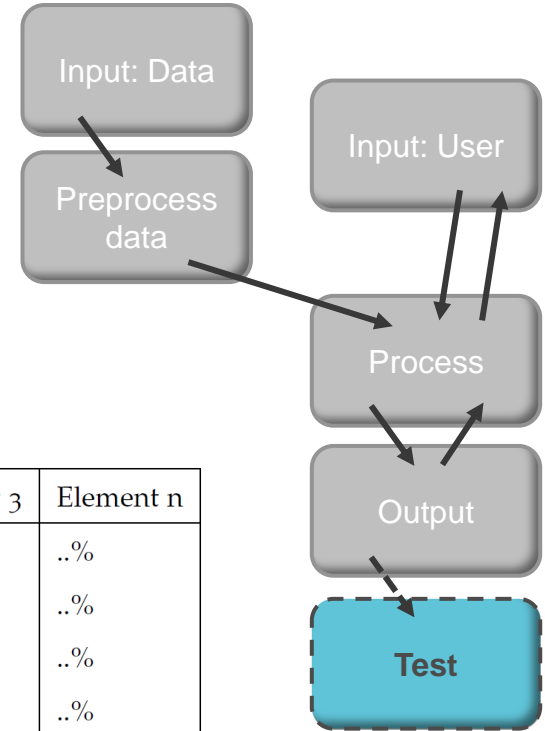


TESTS & RESULTS

elements

Implemented

- Reference (neighbouring) elements
- Degree of selectivity of each element
- First selection upon entire dataset
 - For each scenario and each element ($m \times n$ tests)
- Percentage remaining objects



	Element 1	Element 2	Element 3	Element n
Scenario 1	..%	..%	..%	..%
Scenario 2	..%	..%	..%	..%
Scenario 3	..%	..%	..%	..%
Scenario m	..%	..%	..%	..%

TESTS & RESULTS

elements

Implemented

- Each municipality different results
 - Dependent on data and scenario
- Remaining percentage
 - Street most selective for each municipality

	Before	Neighbourhood	Street	Railroad	Roadtype	2 streets	Feature 1	Feature 2
Scenario 8	158	56,3%	1,9%	34,2%	17,7%	100,0%	32,3%	36,7%

Order	Westervoort	Amsterdam	Joure
1	Street (4%)	Street (1%)	Street (12%)
2	Roadtype (31%)	Neighbourhood (3%)	Two streets (24%)
3	Two streets (35%)	Two streets (30%)	Feature 1 (32%)
4	Railroad (41%)	Feature 1 (44%)	Roadtype (38%)
5	Neighbourhood (47%)	Roadtype (47%)	Neighbourhood (42%)
6	Feature 2 (50%)	Railroad (90%)	Feature 2 (69%)
7	Feature 1 (52%)	Feature 2 (92%)	Railroad (100%)

	Before	Neighbourhood	Street	Railroad	Roadtype	2 streets	Feature 1	Feature 2
Scenario 1	2066	57,8%	1,2%	2,3%	6,2%	100,0%	58,7%	15,6%
Scenario 2	24	100,0%	8,3%	70,8%	62,5%	25,0%	66,7%	12,5%
Scenario 3	2066	57,8%	0,2%	0,5%	49,5%	0,2%	12,4%	60,8%
Scenario 4	2108	17,6%	0,1%	52,2%	29,7%	0,0%	55,9%	11,6%
Scenario 5	2066	57,8%	2,2%	7,5%	0,1%	1,1%	29,1%	100,0%
Scenario 6	75	32,0%	25,3%	100,0%	65,3%	18,7%	80,0%	45,3%
Scenario 7	2066	57,8%	0,5%	41,1%	27,0%	0,1%	60,8%	30,3%
Scenario 8	158	56,3%	1,9%	34,2%	17,7%	100,0%	32,3%	36,7%
Scenario 9	2108	17,6%	0,1%	16,1%	25,8%	100,0%	35,6%	100,0%
Scenario 10	2108	10,4%	2,0%	85,5%	25,7%	0,1%	85,8%	100,0%

(a) Westervoort

	Before	Neighbourhood	Street	Railroad	Roadtype	2 streets	Feature 1	Feature 2
Scenario 1	23269	1,2%	0,0%	100,0%	55,6%	0,0%	57,6%	100,0%
Scenario 2	1090	2,7%	0,1%	100,0%	25,7%	0,1%	23,6%	100,0%
Scenario 3	23269	1,8%	0,1%	100,0%	12,7%	100,0%	100,0%	100,0%
Scenario 4	23269	1,5%	0,1%	100,0%	38,9%	100,0%	35,6%	100,0%
Scenario 5	270	3,7%	1,1%	100,0%	77,0%	0,7%	30,7%	23,7%
Scenario 6	23269	3,0%	0,3%	100,0%	64,5%	0,1%	4,7%	100,0%
Scenario 7	36	2,8%	2,8%	100,0%	80,6%	2,8%	50,0%	100,0%
Scenario 8	23269	3,0%	0,0%	100,0%	94,5%	0,0%	100,0%	100,0%
Scenario 9	148	12,2%	4,1%	100,0%	12,8%	100,0%	6,8%	100,0%
Scenario 10	23269	0,8%	0,0%	3,3%	9,9%	0,0%	26,1%	100,0%

(b) Amsterdam

	Before	Neighbourhood	Street	Railroad	Roadtype	2 streets	Feature 1	Feature 2
Scenario 1	127	18,9%	21,3%	100,00%	33,1%	100,0%	11,0%	100,0%
Scenario 2	119	18,5%	8,4%	100,00%	51,3%	8,4%	46,2%	100,0%
Scenario 3	127	18,9%	5,5%	100,00%	14,2%	100,0%	18,1%	100,0%
Scenario 4	18	83,3%	16,7%	100,00%	33,3%	16,7%	44,4%	5,6%
Scenario 5	127	54,3%	6,3%	100,00%	78,7%	3,9%	34,6%	100,0%
Scenario 6	127	11,0%	0,8%	100,00%	26,0%	0,8%	0,8%	100,0%
Scenario 7	9	33,3%	11,1%	100,00%	66,7%	11,1%	88,9%	22,2%
Scenario 8	127	54,3%	1,6%	100,00%	14,2%	1,6%	4,7%	100,0%
Scenario 9	119	30,3%	10,9%	100,00%	22,7%	4,2%	5,0%	5,9%
Scenario 10	53	100,0%	37,7%	100,00%	47,2%	1,9%	67,9%	60,4%

(c) Joure

TESTS & RESULTS

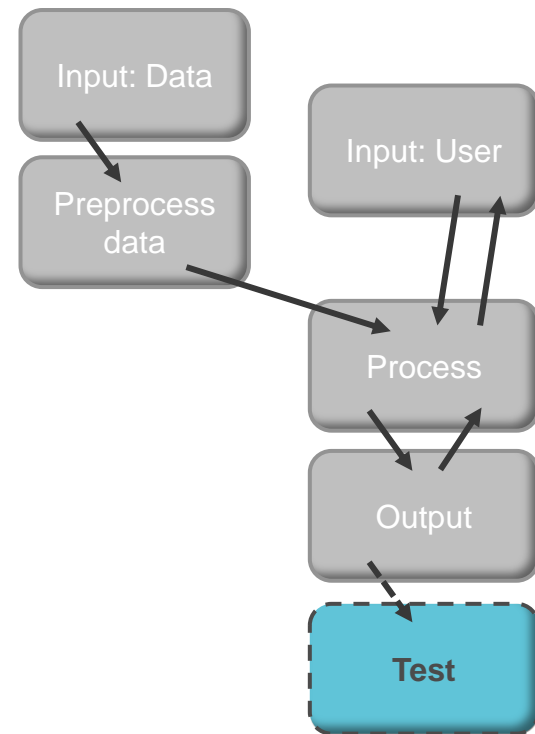
Overall method

- Six requirements:

(Least desired)

(Most ultimate)

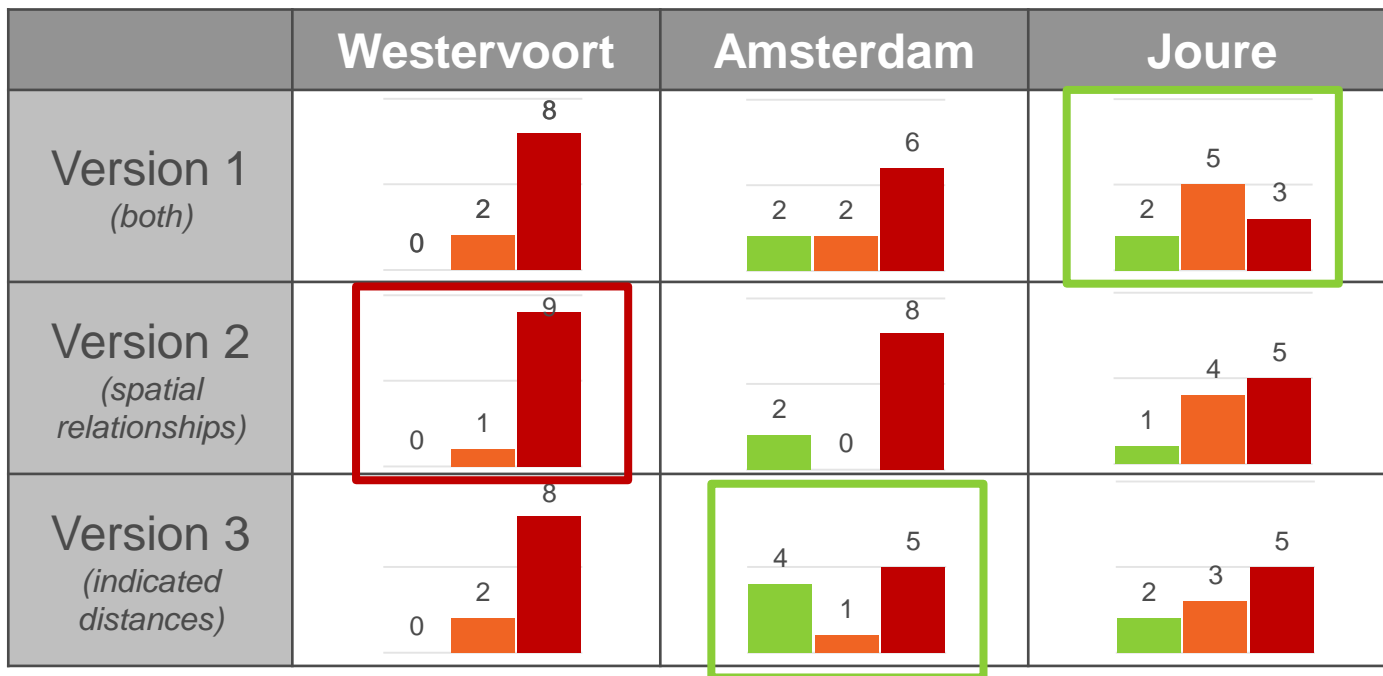
Requirements	Low	Middle	High
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TESTS & RESULTS

Overall method

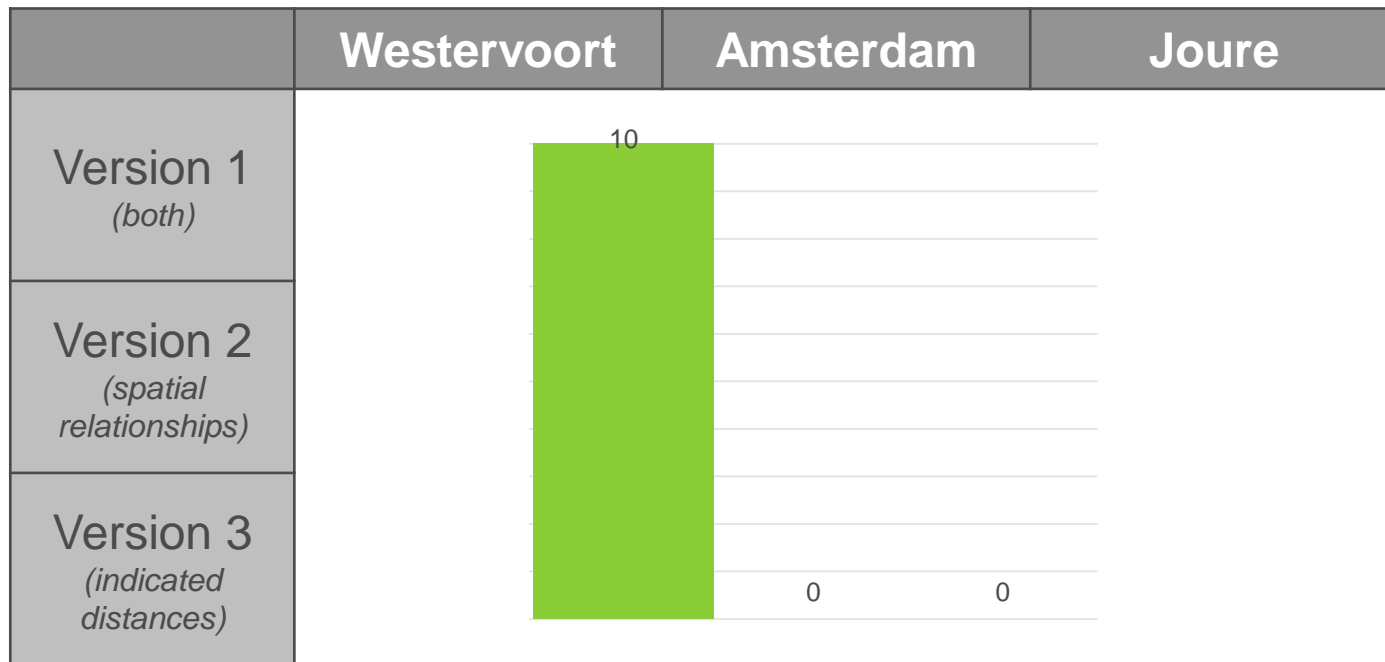
1. Number of questions **High:** <3 | **Middle:** 3 - 5 | **Low:** >5 questions



TESTS & RESULTS

Overall method

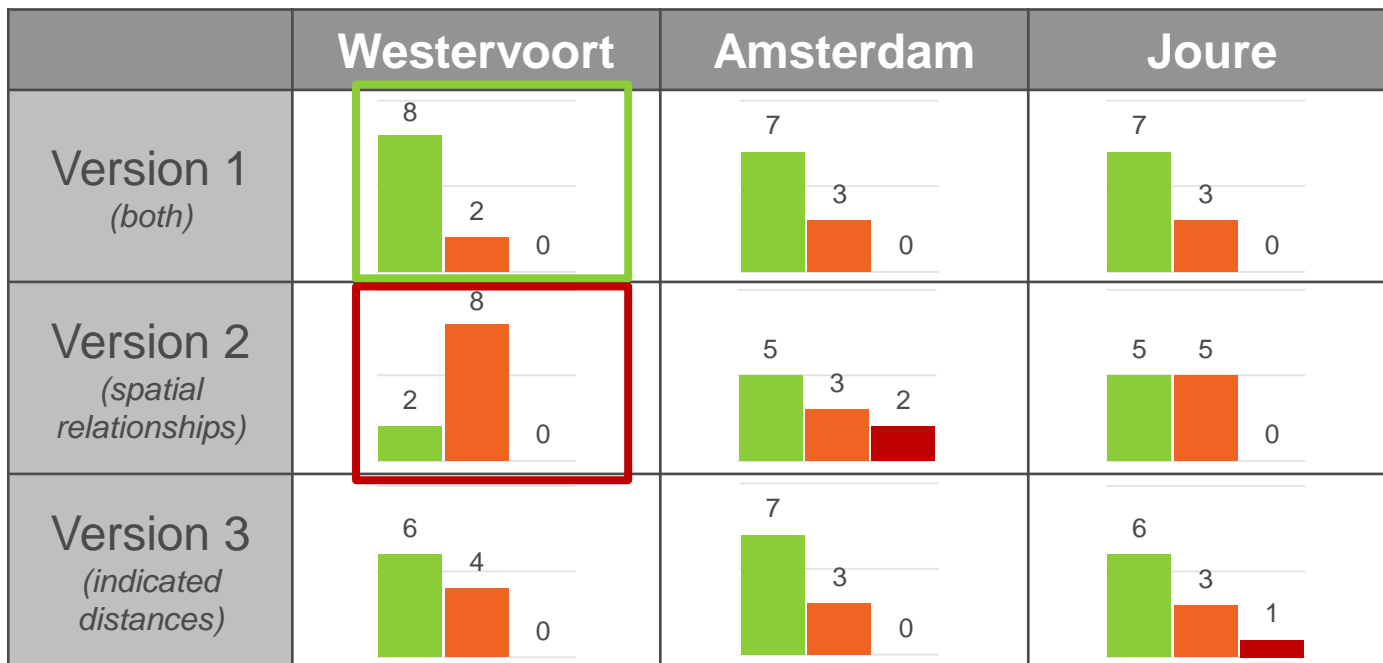
2. Is the object present? High: present



TESTS & RESULTS

Overall method

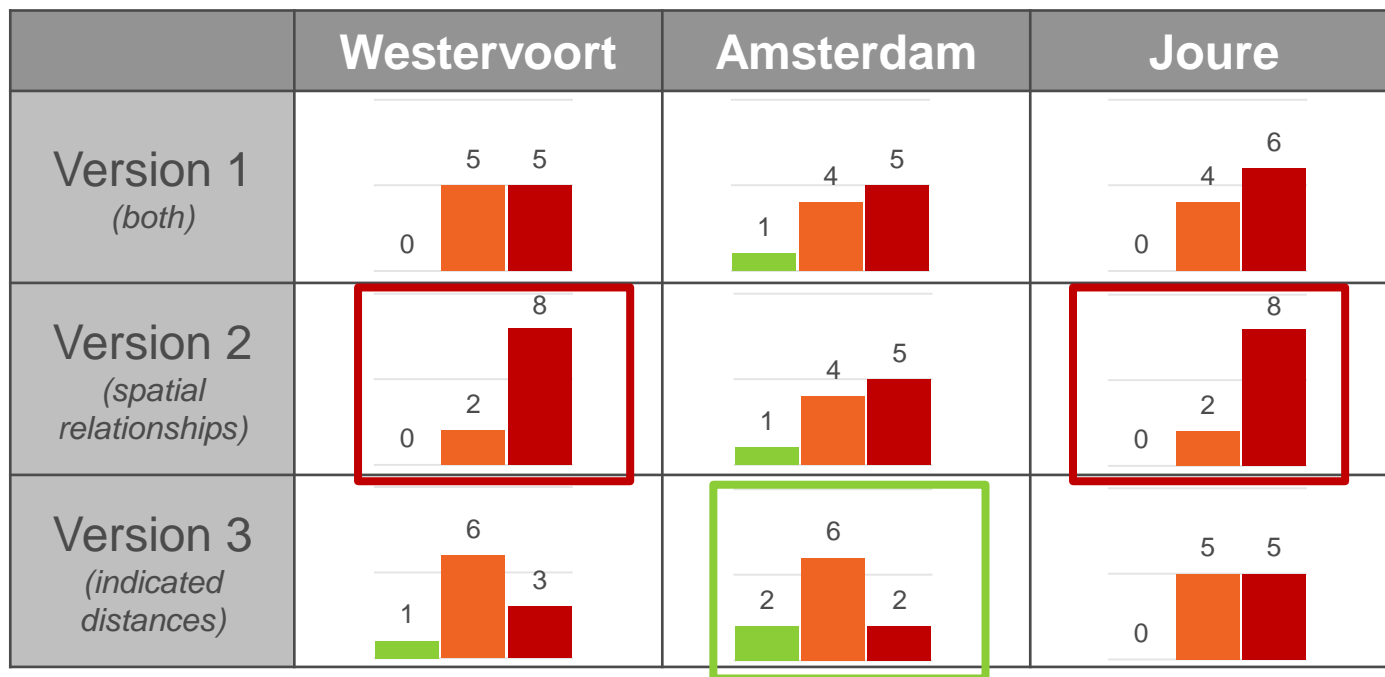
3. Amount of suggested objects High: <3 | Middle: 3 - 15 | Low: >15 objects



TESTS & RESULTS

Overall method

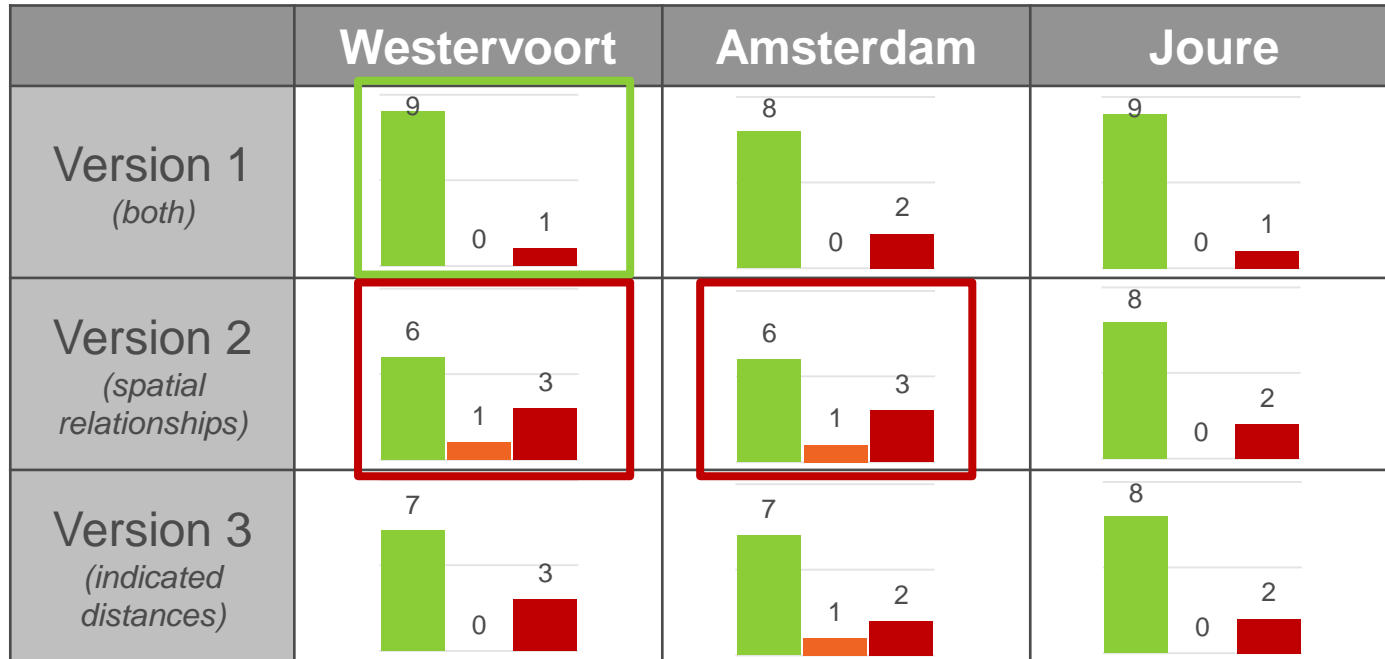
4. Average distance to elements High: <5 | Middle: 5 - 15 | Low: >15 meter



TESTS & RESULTS

Overall method

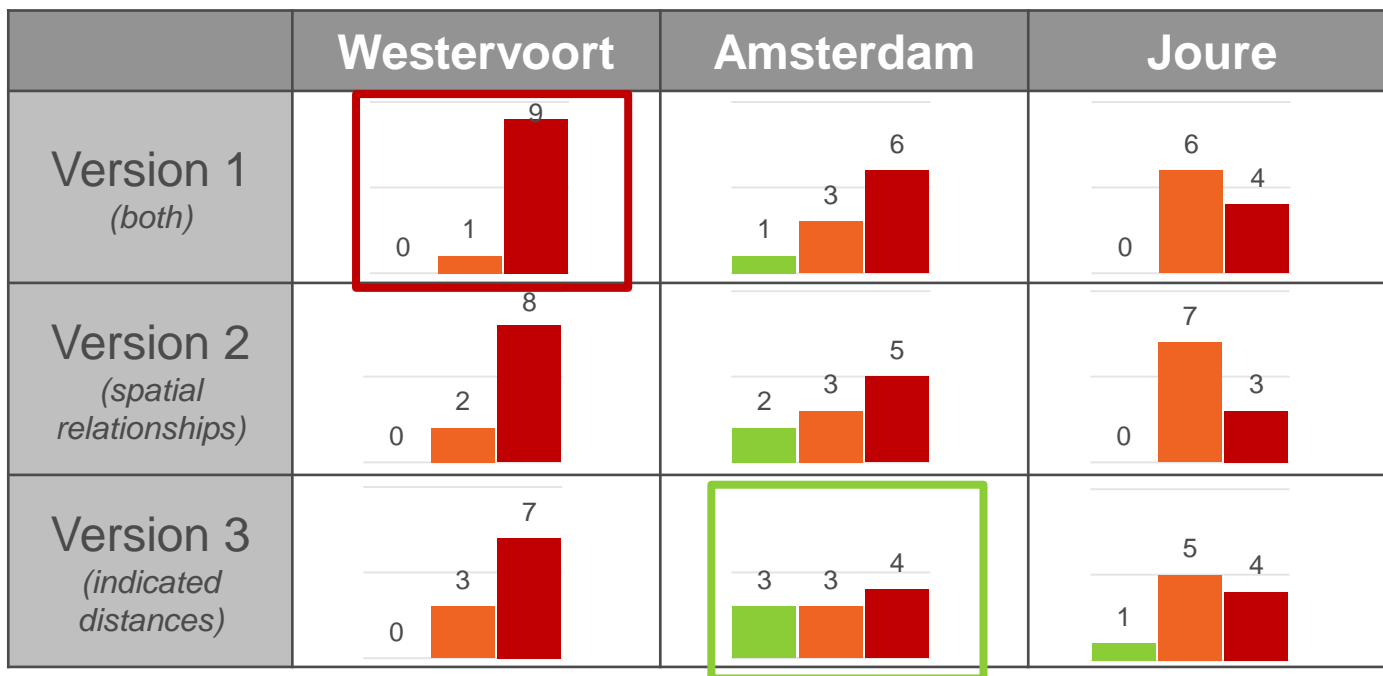
5. Covered area of suggested objects High: <200 | Middle: 200 - 500 | Low: >500 m²



TESTS & RESULTS

Overall method

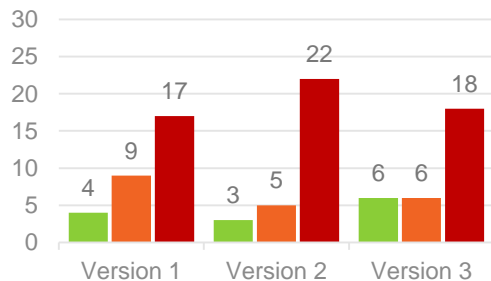
6. Completion time of description **High:** <20 | **Middle:** 20 - 45 | **Low:** >45 seconds



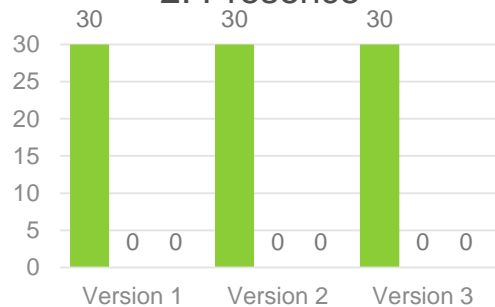
TESTS & RESULTS

Overall method

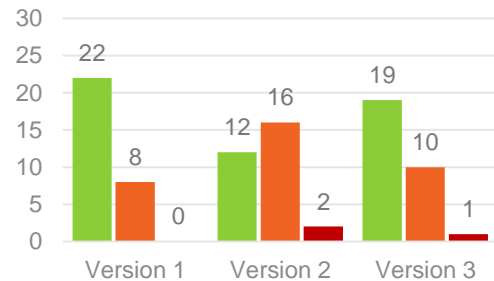
1. Questions



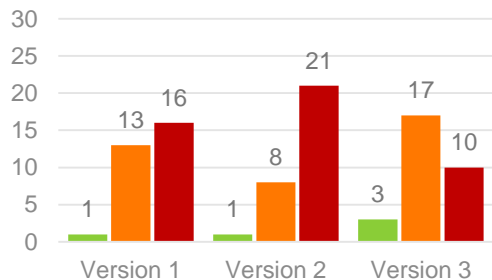
2. Presence



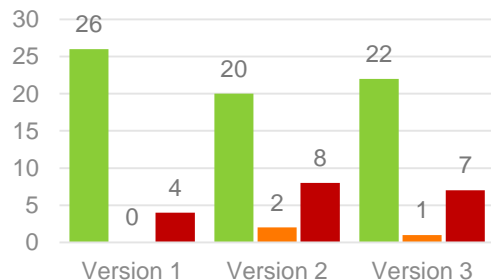
3. Number of objects



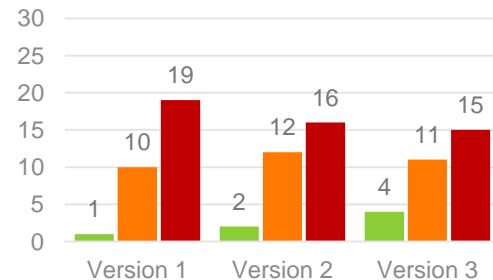
4. Average distance



5. Covered area



6. Time



TESTS & RESULTS

Overall method

General

- Version 3 scored best (*only distances*)
- Version 1 slightly worse (*distance and spatial relationships*) → *time requirement*
- Version 2 scored worst (*only spatial relationships*) → *less details*

- Improvements:
 - Number of questions
 - Average distance to elements
 - Completion time

- 1. What type of surrounding elements can be considered for the description of an object?**
 - Position & relevance
 - Definitions of Lynch: *path, edge, district, node, and landmark*
 - Data models: CityGML and IMGeo
- 2. Which datasets are available that provide the position of those elements?**
 - Official & open data
 - PDOK: BGT, NWB, CBS, BRK, BRT

CONCLUSIONS

Research questions

3. What kind of spatial relationships can be used as an input?

- CBM, Fixi notifications, QGIS spatial analysis
- Along, close by, present within radius, absent within radius, on

4. What method can be used to process the input?

- Vector approach: spatial analysis
- Buffer/clipping, based on presence and absence

5. To what extent does the developed method meet certain requirements?

- Six criteria and three scores per criteria to test

CONCLUSIONS

Research questions

Can an object identification method be established based on the description of neighbouring elements?

The method has been developed and tested, and it worked. But...

- *Reference elements: relevant for the case and position known*
- *Input: distance provides valuable information*
 - *presence and absence of reference elements*
- *Process: preserve level of detail*
- *Criteria: not all criteria score high*

CONCLUSIONS *Discussion*

Reflection

&

- **Available information reference elements** – only position
- **Efficiency code** – no priority (*but criteria*)
- **Test scenarios** – 30 scenarios & author executed the tests

CONCLUSIONS

work

Recommendations & Future

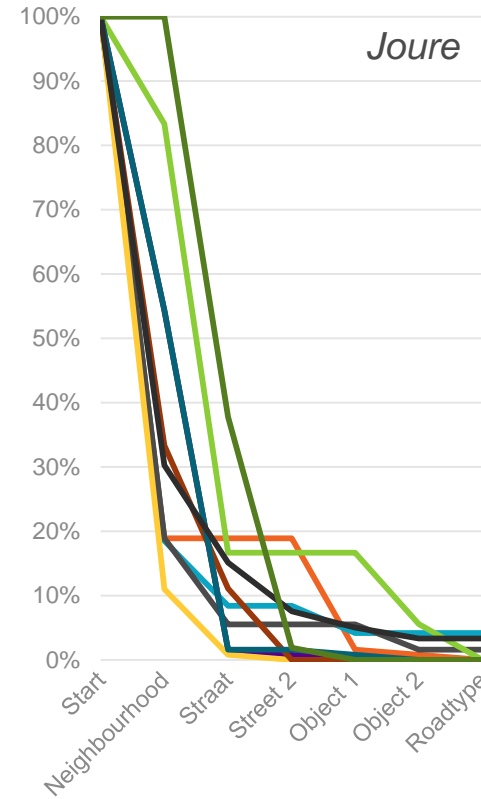
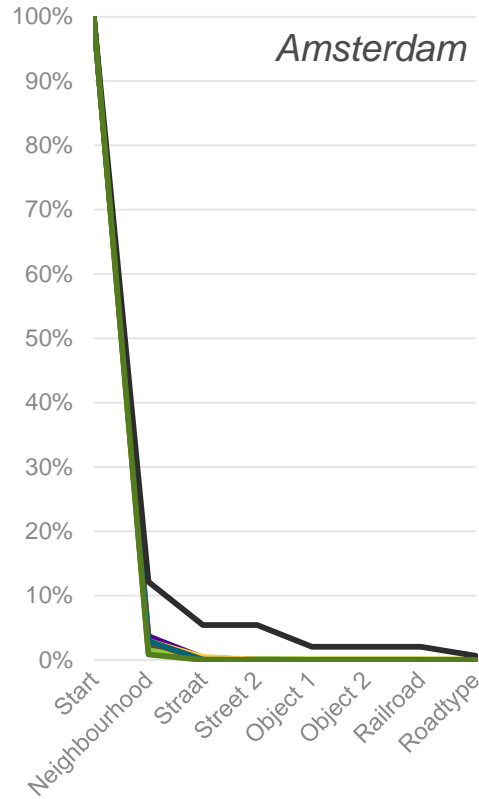
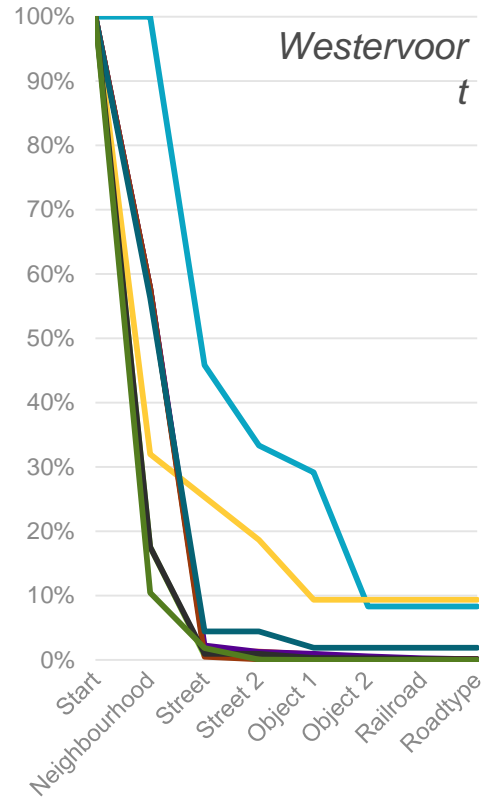
- **Way of buffering** – doughnut or with orientation (*traffic sign*)
- **User experience** – improve the process for the user
- **Visibility analysis** – digital surface model and obstructions
- **Vector & raster approach** – compare the two versions

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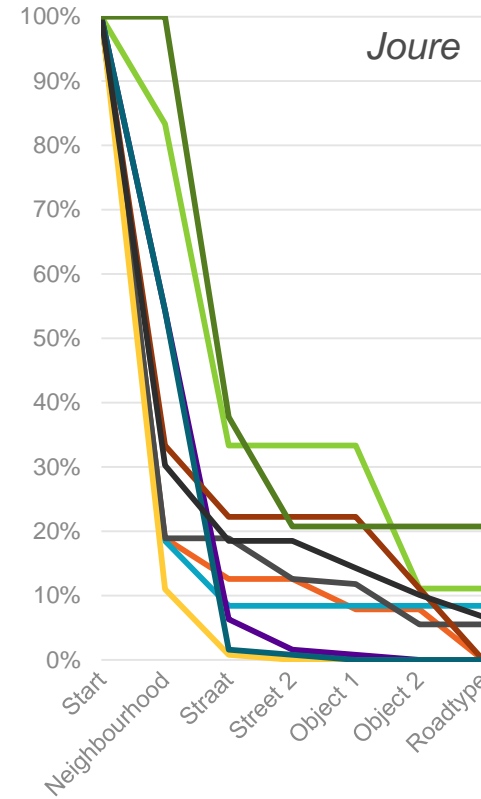
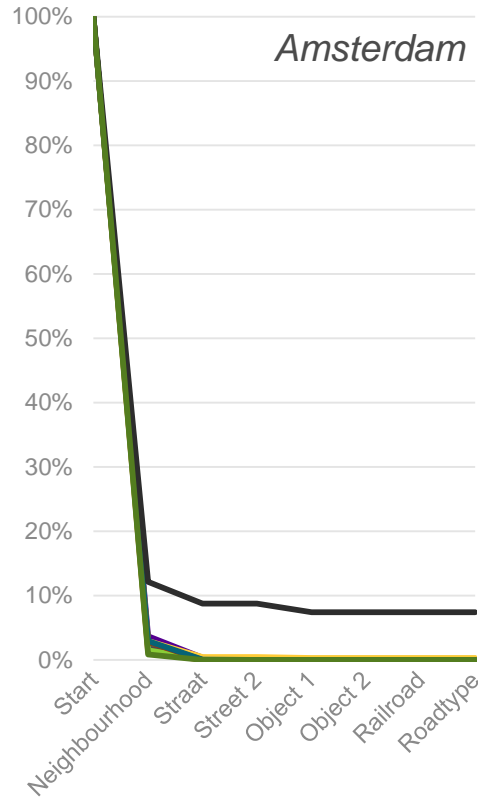
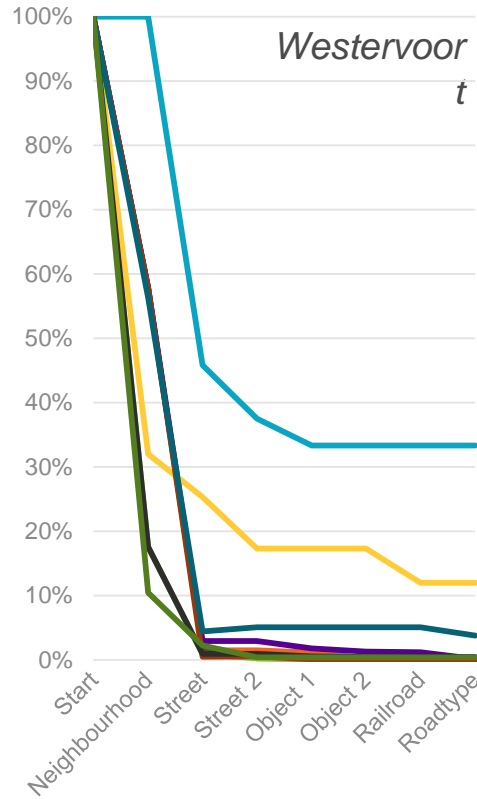
APPENDIX

Decrease objects version 1



APPENDIX

Decrease objects version 2



APPENDIX

Decrease objects version 3

