



Potential of crowdsourced data for integrating landmarks and routes for rescue in mountain areas

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Session: T34/35-1 The frontier of crowdsourced geospatial information



Context: CHOUCAS project

Victim



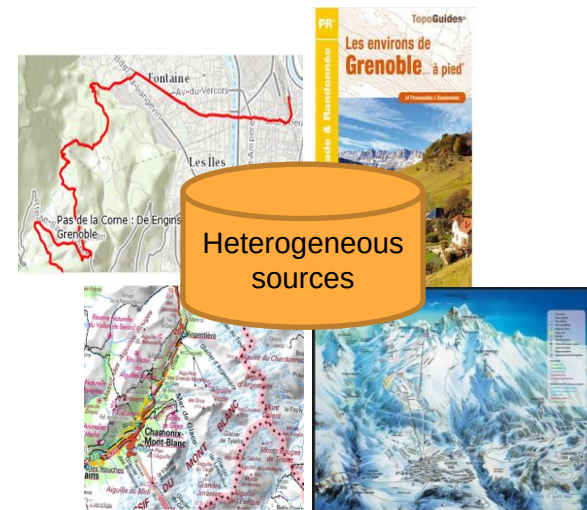
Rescue team



- Imprecise location and low confidence
- Poor knowledge of the mountain
- Inaccuracies when describing the route and his/her spatial environment
- Fear and stress

⇒ Propose methods and tools to improve the decision-making process concerning the locations of victims in mountain areas

- **Constitute**, enrich and query **geographic data from heterogeneous sources**
- Define reasoning models
- Define geovisualization environments



General Goals

Expressions given by victims :

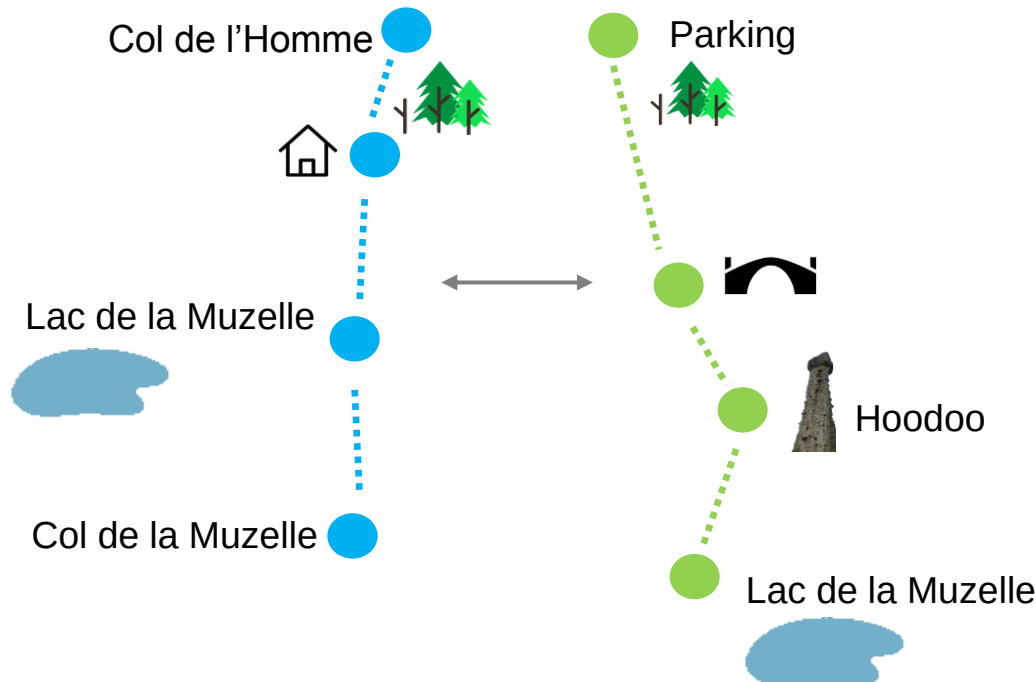
- « I'm seeing the **Muzelle summit** »
- « I'm near a **hoodoo** »
- « I'm walking along **GR54** »
- « I'm walking on the **route** that runs along the **lake de la Muzelle** »

Landmark

Route

Proper name

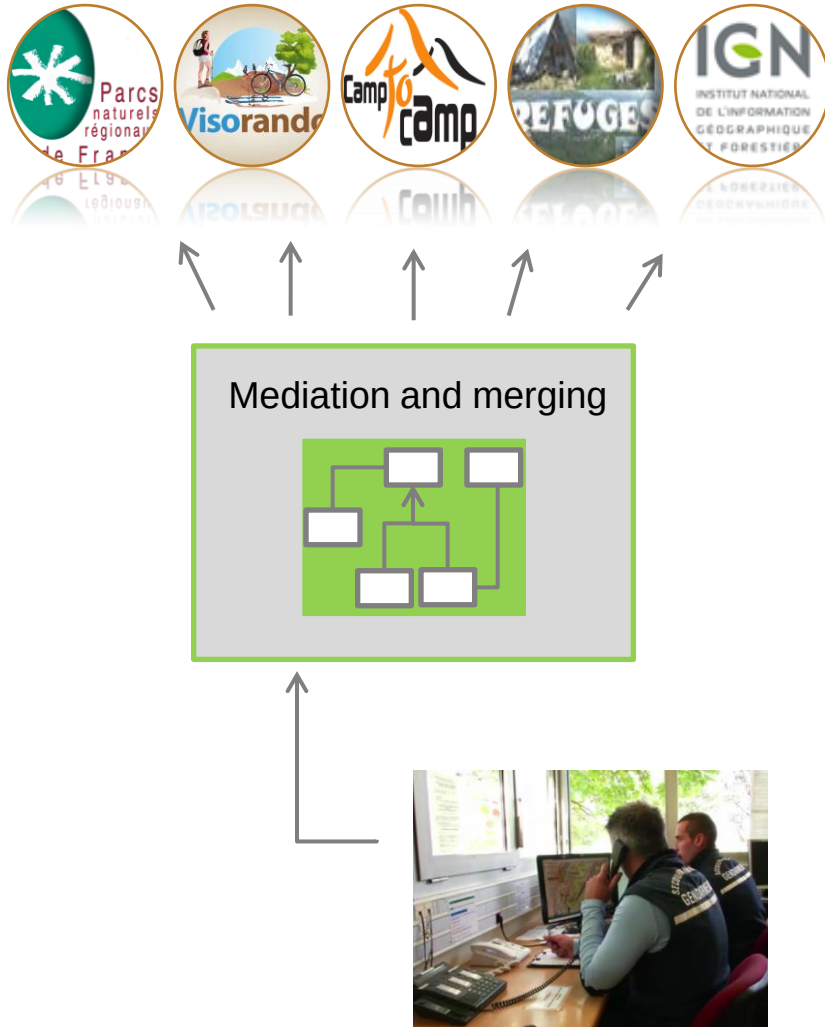
Common name



Research goal : to build a reference landmarks and route database

⇒ study the potential of different sources by defining both homologous routes and landmarks

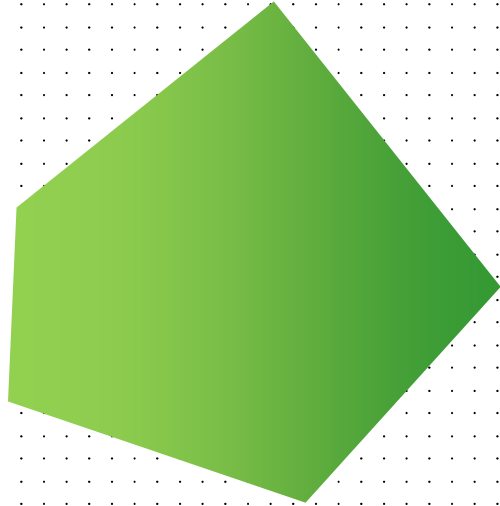
Service-oriented architecture



Why ?

- Facilitate the freshness of data
- Integrate and reuse different sources
- Require a layer mediation to realize data fusion ⇒
 - Identify relevant sources
 - Specify sources and describe their characteristics
 - Define mapping rules between schemas sources
 - Identify semantic conflict

Outline

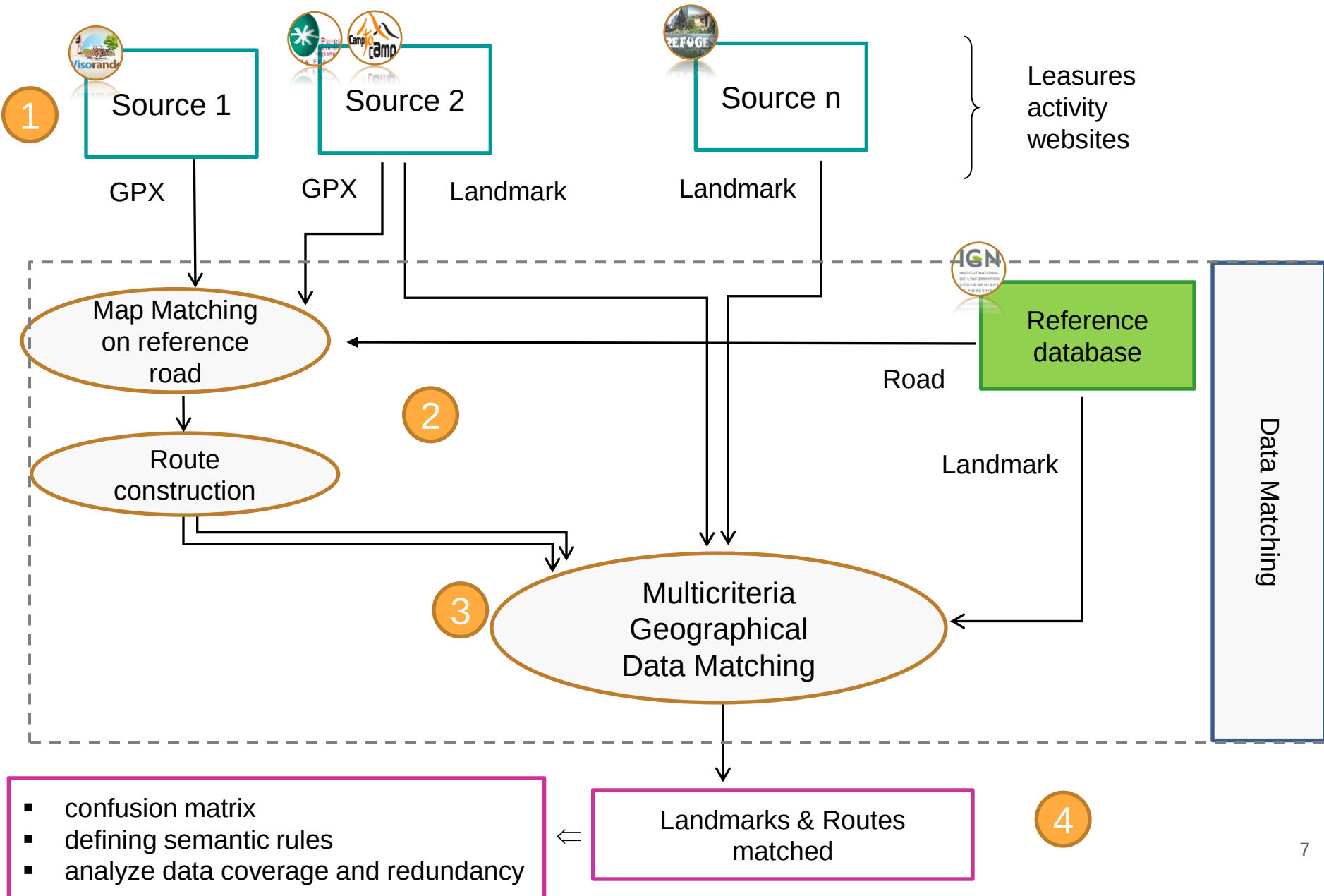


1. Methodology
2. Data sources
3. Data-matching results
4. Conclusion and future work



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Proposed methodology



Map matching and route construction: step

2



1. Map matching on reference road:

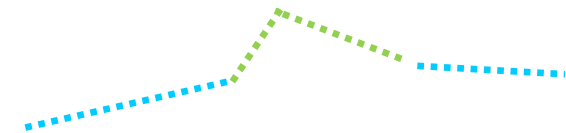
[Newson & Krumm 2009]

2. Route reconstruction

$$\frac{\text{crow flies distance}}{\text{shortest path distance}} < 2$$

3. New routes dataset

⇒ the geometry of a route is linear being composed by all edges



○ Tracks (GPX) : list of points

— Reference road (BDTOPO)

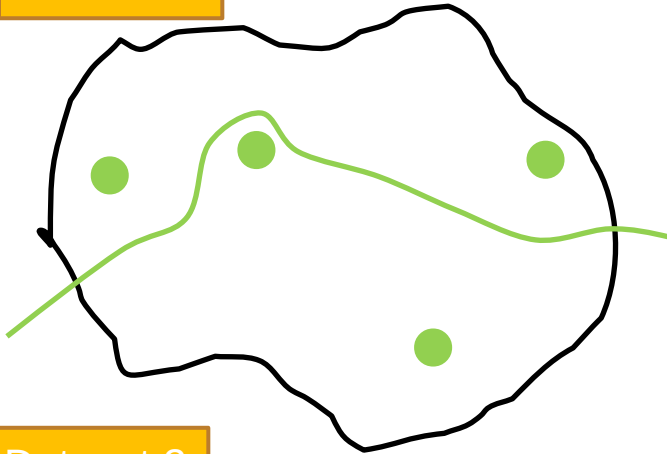
— Corresponding edges of map matched points

— Added edges

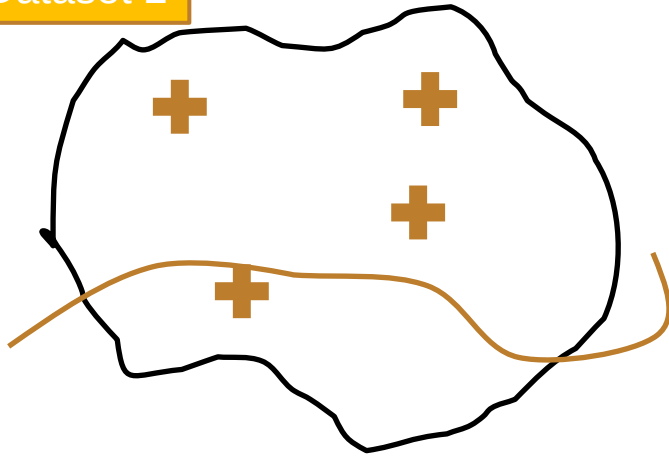
Defining homologous features representing the same object in the real world (Walter and Fritsch, 1999)

- Homologous landmarks: features representing the same real world object
- Homologous routes: features having closed geometry

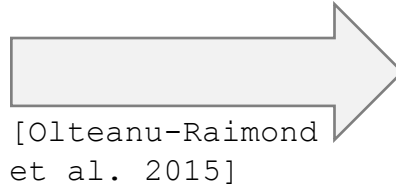
Dataset 1



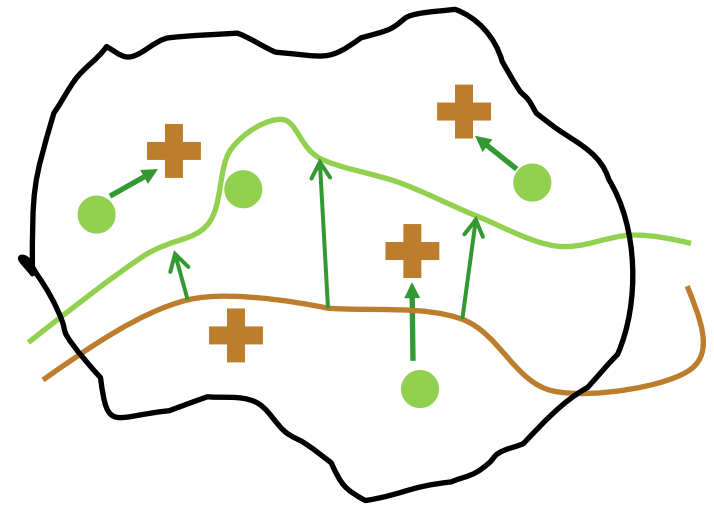
Dataset 2



Multi-criteria approach
based on Belief Theory



[Olteanu-Raimond
et al. 2015]



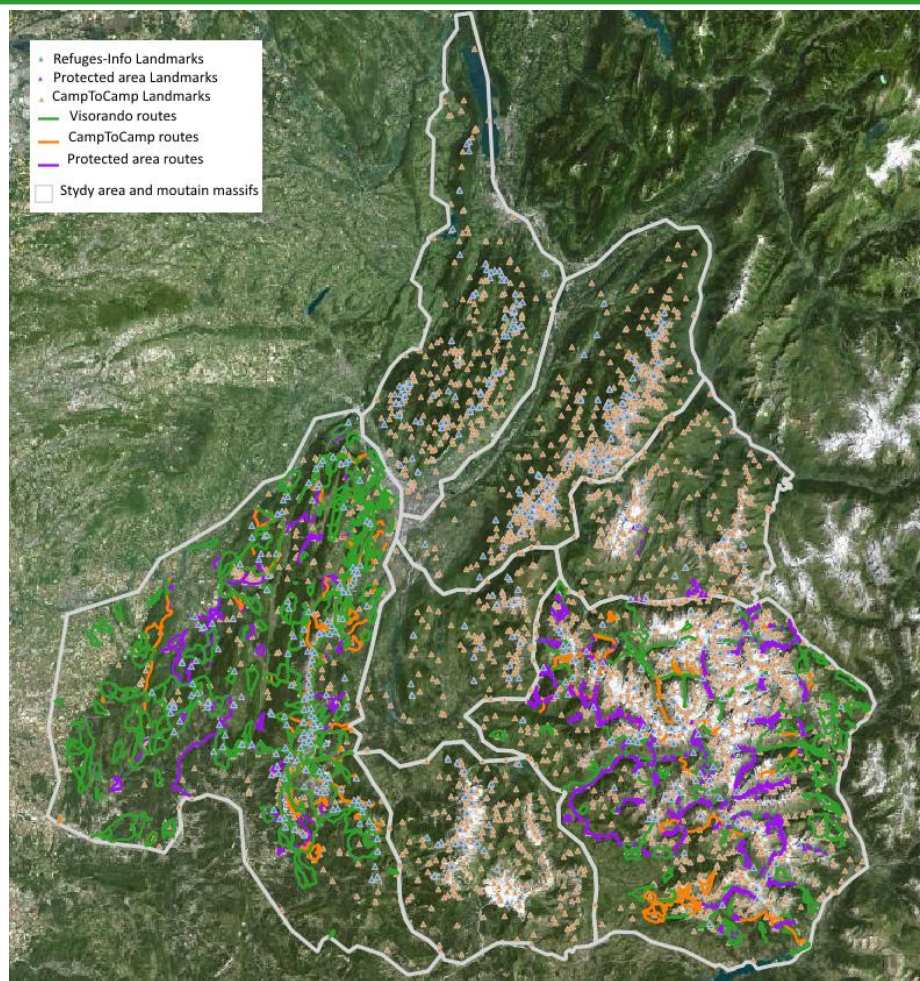
Data matching – definition of criteria

Criteria	Position criterion	Name Criterion	Semantic criterion
Data			
Landmarks	• Euclidean distance	• Samal distance (Samal et al., 2005)	• GeOnto ontology (Mustière et al., 2011) → Wu-Palmer distance (Wu and Palmer, 1994)
Routes	• Average of minimum of Hausdorff distance	• Cosinus distance	X



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Data sources



	Landmark <i>(study area)</i>	Route <i>(only national parc)</i>
Protected area	1,102	181 (1,650 km)
Camp2Camp	3,229	126 (1,945 km)
Refuges.info	478	X
Visorando	X	397 (3,300 km)
<u>BDTopo</u>	21,097	25,422 Km

- **2 authoritative data**
- **3 crowdsourced data**

French Alps, south-east of France (9 870 km²)

! No data portals having bulks imports (OSM, GeoNames, IGNrando)

! Data matching strategy → by type and two by two : for each data source we are looking for candidates in **BDTopo**

⇒ 6 data matching results

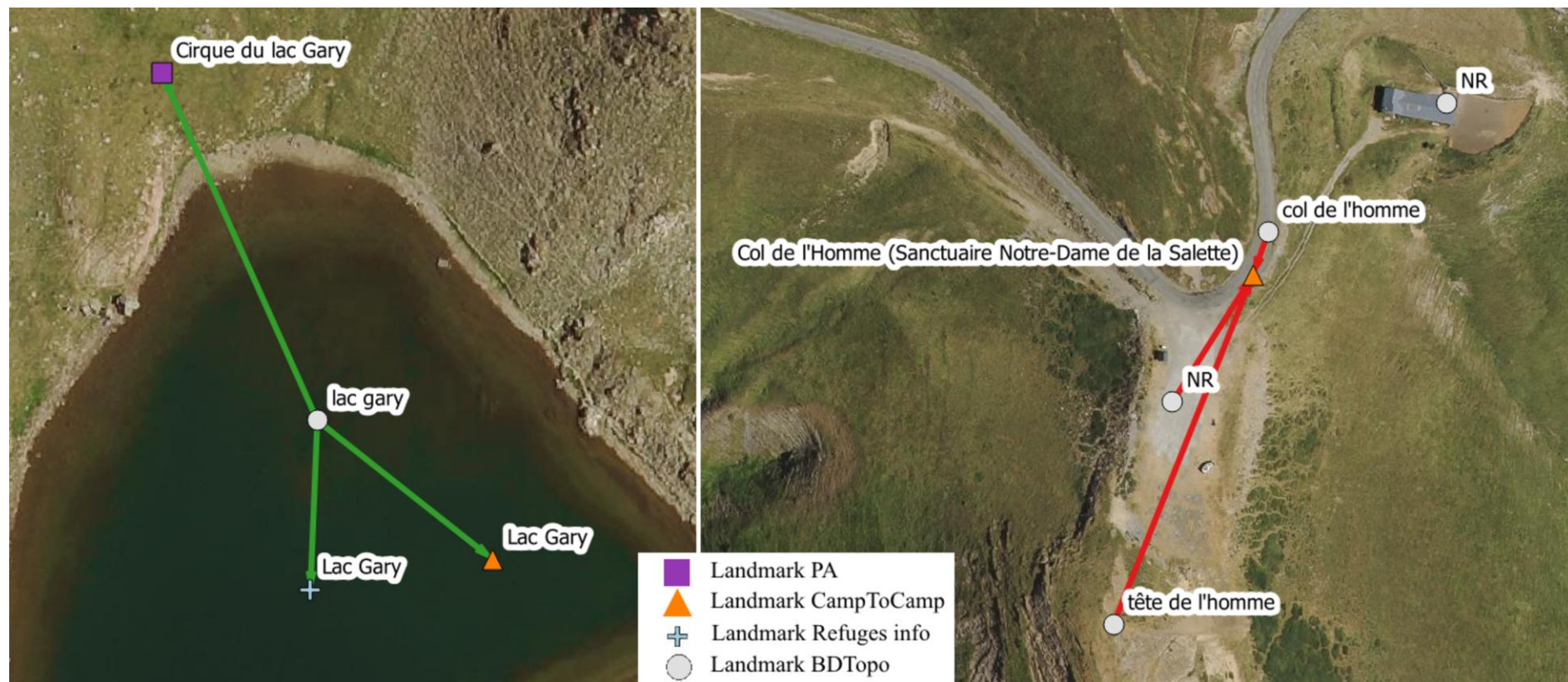


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Data matching results - landmarks

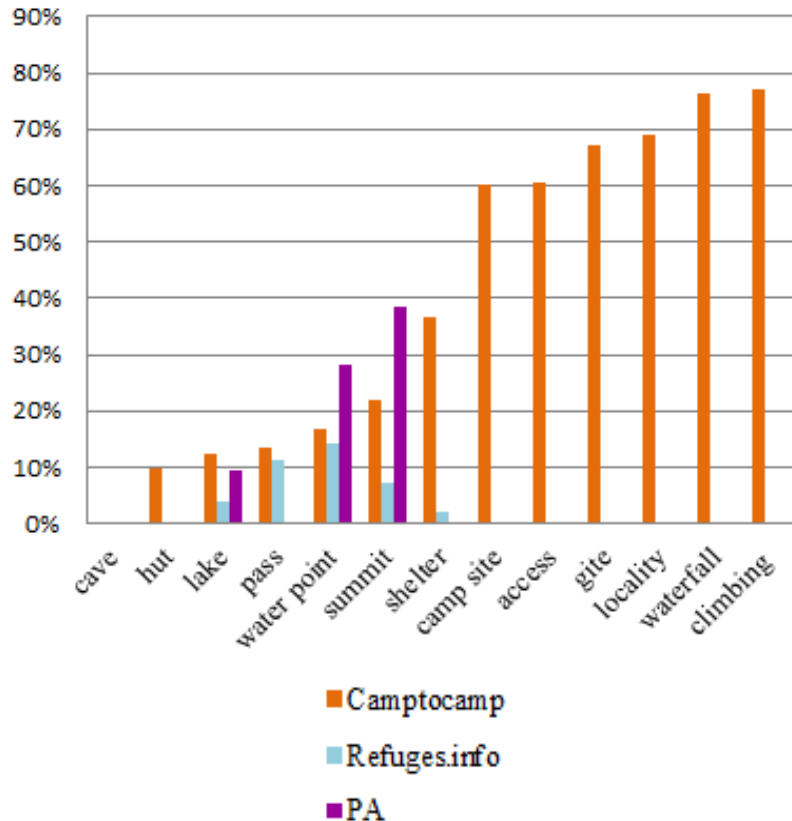
➤ 3 data-matching results

	1:0	1:1	Uncertainty
C2C – BDTopo	1167	1938	214
Refuges.info – BDTopo	80	367	34
PA – BDTopo	863	180	61



Data matching results - landmarks

➤ 1:0 links → analysis



Percentage of non-matched landmarks by type

➤ **1:1 links** → manually validation

	1:1	Precision
C2C - BDTopo	1938	0,95
Refuges.info - BDTopo	367	0,95
PA - BDTopo	180	0,71

- 37 homologous landmarks are present in all data sources
- Refuges.info is very comparable with BDTopo in term of semantic, and less complementary
- PA – very different from the other sources...but still interesting
- campTocamp : very interesting source

Data matching results - landmarks

➤ 1:1 links → confusion matrix

BDTopo

Étiquettes de lignes	Barra	Campir	Waterf	Cirque	Pass	Const	Ridge	Cliff	Public	Bus sta	Train	Train	Glac	Canyon	Cave	Lake	Mais	Mount	Parking	P
shelter																				
hut																	1			
camp_site		2																		
waterfall			10		2									1						
pass					466		1							5	1					
gite																	1		1	
cave															10					
lake																118				
locality	1				1				1				12	1						
accees					33	1			7	1	1	3				1			40	
water point															1					
climbing_outdoor			4	2	5		1				1			3	4					
summit					3		29	4						1	1			8		2
Total	1	2	14	2	510	1	31	4	8	1	1	4	12	11	17	119	2	8	41	2

campTocamp

Étiquettes de lignes	Peal	Plain	Water point	Brig	Shelter	Rock	Summit
shelter			1		23		
hut			2		92		
camp_site							
waterfall			6			3	
pass	1		1			5	4
gite			6		2		
cave						1	
lake							
locality			3	1		1	
accees			52	11	1		
water point			3				
climbing_outdoor			2	2	3	12	6
summit	259	4				52	547
Total	260	4	76	14	121	74	557

New semantic rules :

- Access : pass, parking...
- Summit: summit, rock, peak...
- ...etc.

Data matching results - routes

- Map matching on reference road:
 - ⇒ 97% of points are map matched
 - ⇒ root mean square error of displacements: 12.94m
- Route reconstruction:
 - ⇒ total length of added missing edges: 337km, representing 4%
- 1:1 links → manually validation

	1:1	Precision
GeoTrek - Visorando	59	0.87
C2C - Visorando	20	0.86
C2C – GeoTrek	14	0.83

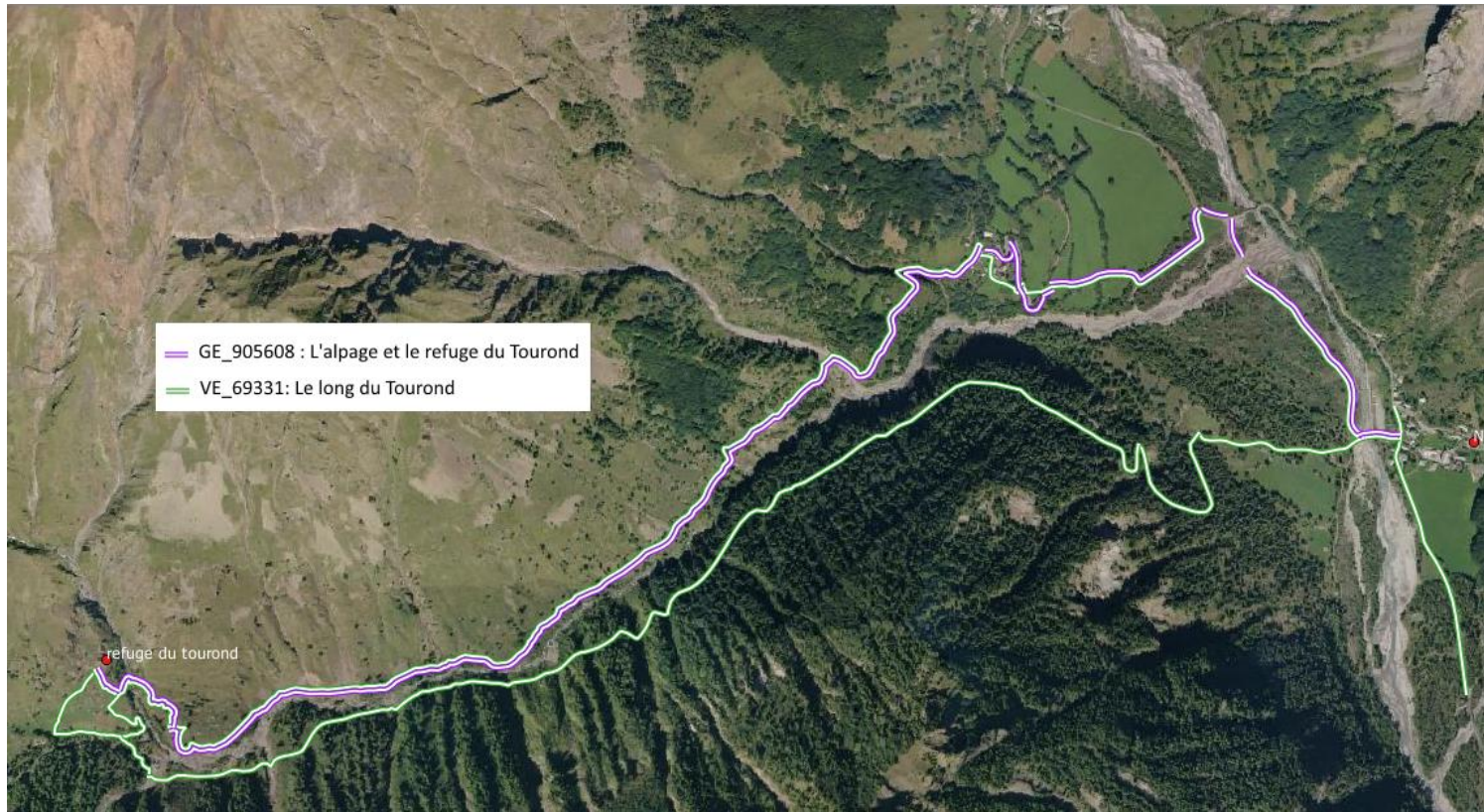
- 3 data-matching results

	1:0	1:1	Uncertainty
GeoTrek - Visorando	92	59	14
C2C - Visorando	76	20	21
C2C – GeoTrek	77	14	6

Data matching results - routes

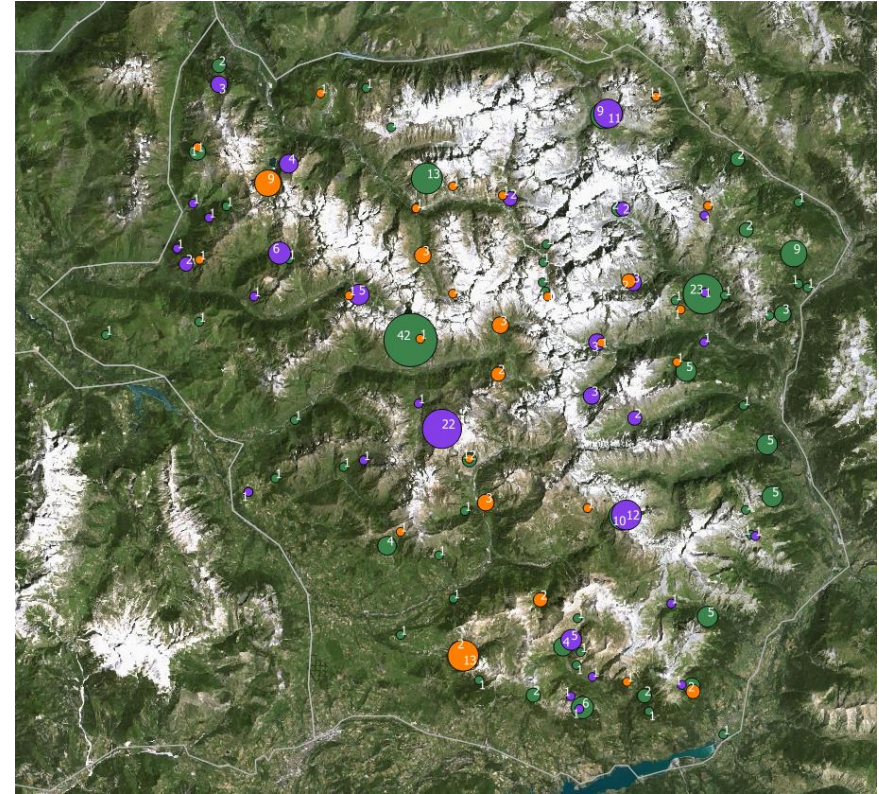
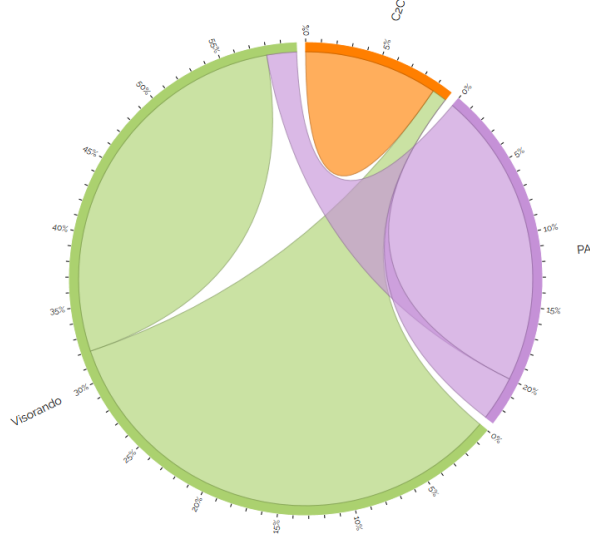
The **1:1 links** and the **uncertainty** links represent mostly this 3 cases:

- when it exists a variant of the route and the detour is short
- when two routes are very closed and have the same direction
e.g. when they border a river
- when the start points are a few meters one from each other



Data matching results - routes

1. Connected components of data sources



2. Confusion matrix – hiking level information

Protected area and Visorando

	Easy	Middle	Difficult	Very difficult	Extremely difficult
Very easy	2		1		
Easy	4	6			
Medium	5	15	7		
Difficult	1	7	9	2	
Very difficult					



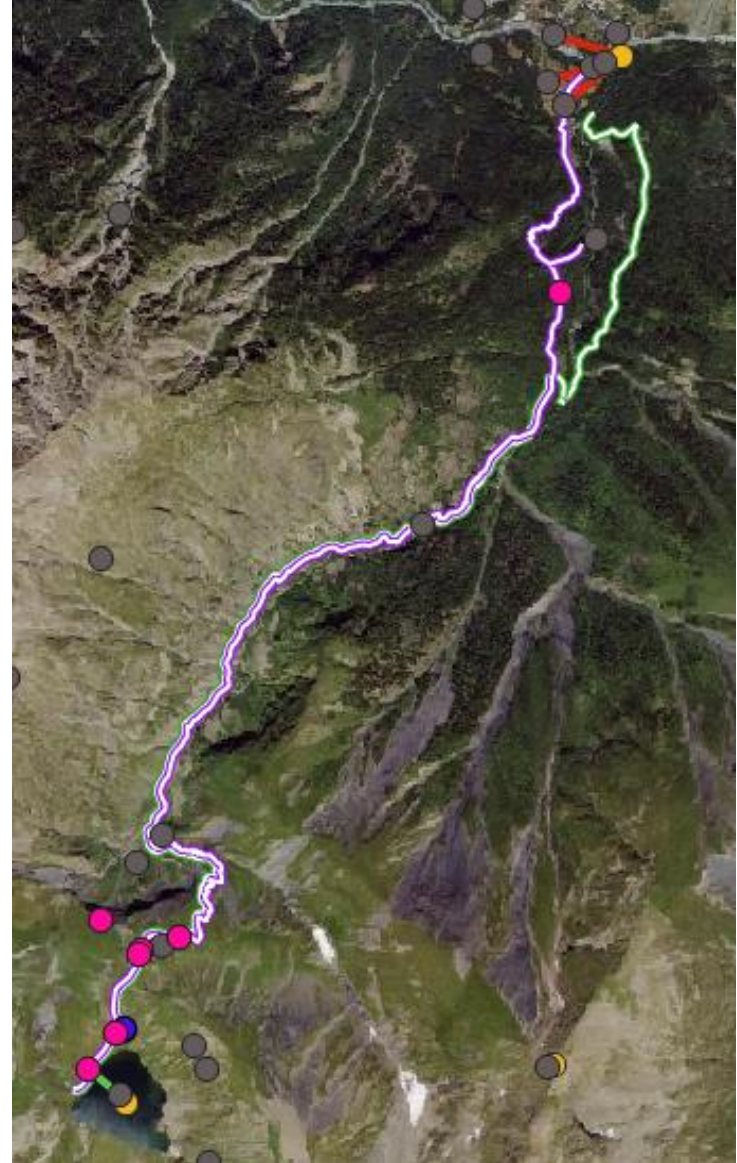
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Conclusion and future work

- Methodology to define homologous landmarks and route allowing to constitute an unique network of routes and landmarks
 - Noticed the richness and complementarity of data
 - Identified semantic rules between different data sources

Future work

- Adapt the definition of homologous routes by taking into account the landmarks: add a new criterion based on the idea that homologous routes should share the same landmarks
- Optimise data matching method by taking into account:
 - multi-sources (match sources in the same time)
 - multi-features types (e.g. landmarks and routes)
- Propose a data fusion approach: multi-features and multi-geometries



Thank you !

Questions?

