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ALP.Lab

Markus Steinmaßl, Mohamed Berrazouane, Karl Rehrl

On the Impact of Classification Quality of Multiple Object Tracking Systems on Analysing the Path Choice Behaviour of Multimodal Traffic

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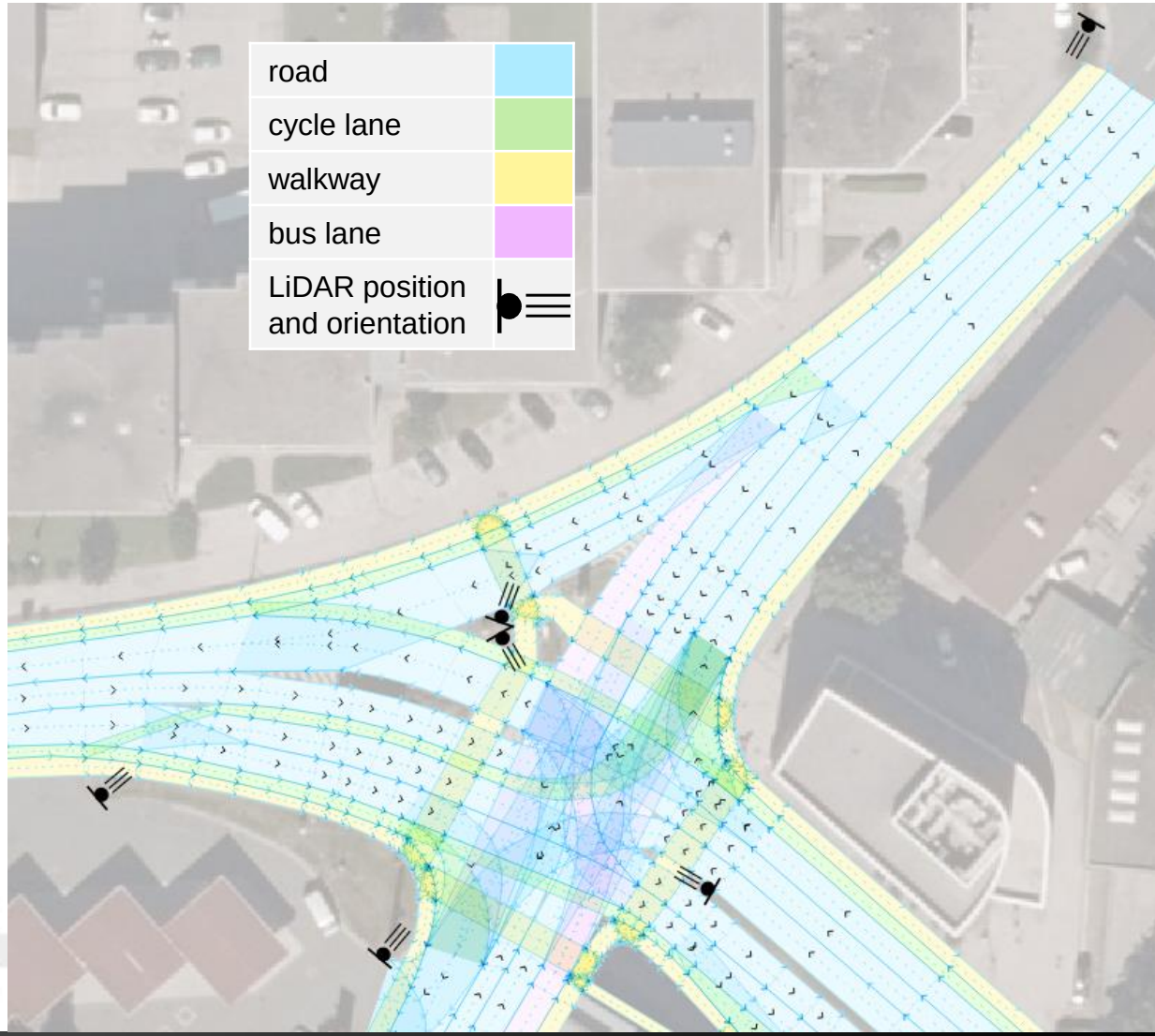
Intersection Layout and System Setup

- Multimodal intersection
- Multiple lanes

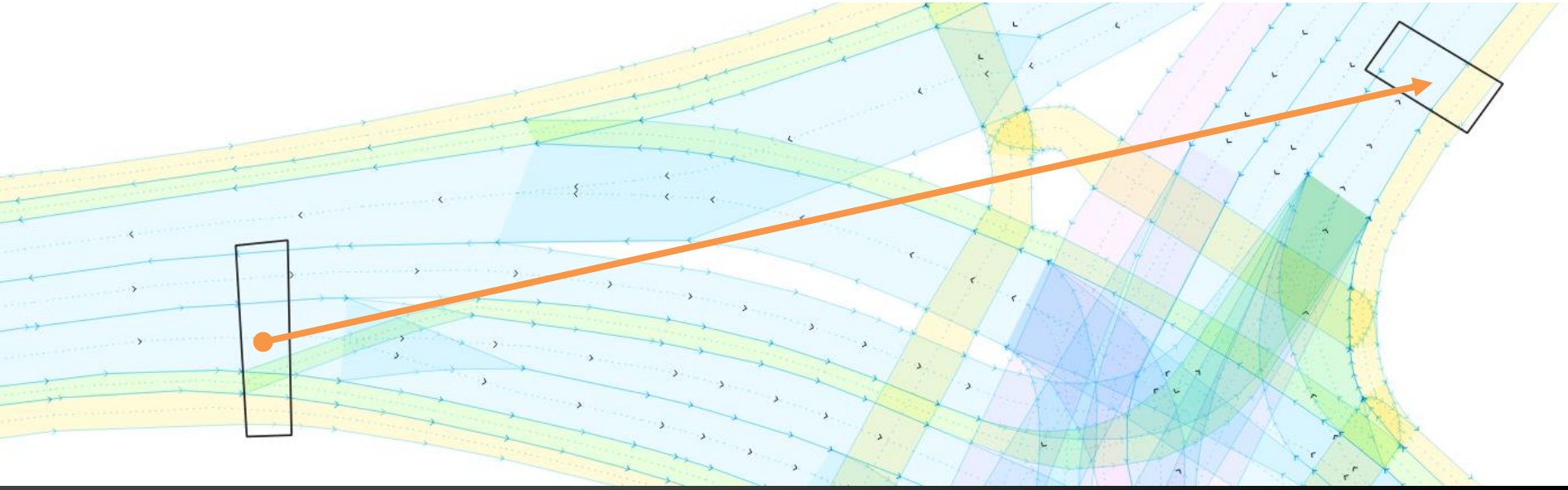
- 6x HESAI Pandar XT32
  - Field of view / resolution:
    - vertical: 31° / 1°
    - horizontal: 360° / 0.18° at 10Hz
- Perception Software SensR (Seoul Robotics)
- Processing and storage platform FlowMotion (Salzburg Research)



Topic

How to utilize this data for analysing the paths that different traffic participants take to cross the intersection?

1. Challenges regarding data quality
2. Trajectory clustering based approach
3. Analysis example



Data Characteristics – Pros and Cons

Pros

- Tracking of all traffic participants
- Tracking across the whole intersection
- High frequency (10Hz)
- Very precise localisation

Cons:

Classification granularity

- only three classes:
  - vehicle
  - two-wheeler
  - pedestrian
- challenging classification of VRUs
  - motorcycle, bicycle, e-bikes, e-scooters, …
  - riding bicycle vs. pushing bicycle

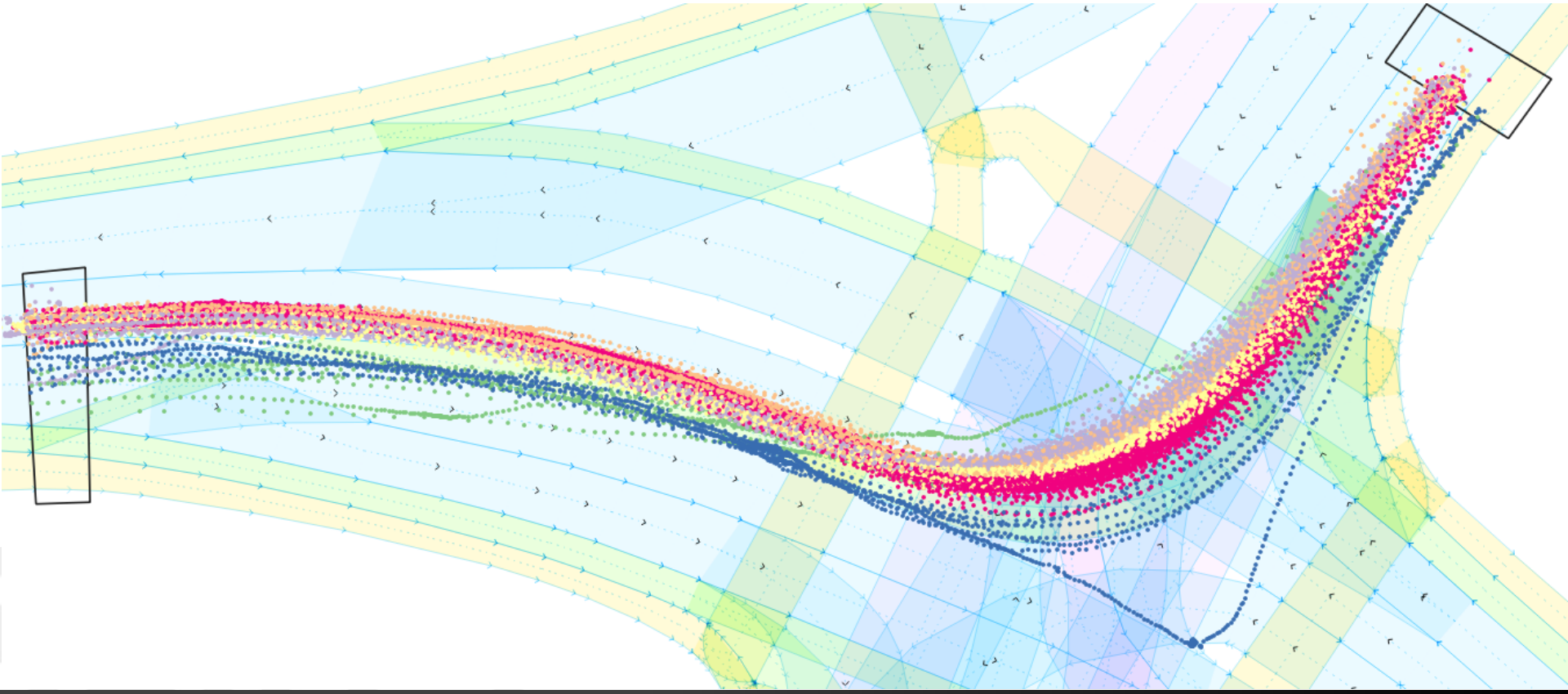
Implications on Path Choice Analysis

- Analysing paths per object class is not meaningful.
  - e.g., cannot distinguish motorbikes from bicycles.
  - → Cannot directly analyse how cyclists use the intersection.
- Using additional information to sub-classify objects can bias analyses!
  - e.g., classifying two-wheelers on bicycle lanes as bicycles.
  - → cyclists would use the dedicated infrastructure by definition.
  - ➔ Classification should be solely based on the appearance of the object.
- Analysis approach: Clustering of trajectories
  - Affinity Propagation Clustering (Frey and Dueck, 2007) using
  - Dynamic Time Warping Distance (Berndt and Clifford, 1994).
  - → Focus on paths taken to cross the intersection (good data quality).

Berndt, Donald J., and James Clifford. 1994. 'Using Dynamic Time Warping to Find Patterns in Time Series'. In *Proceedings of the 3rd International Conference on Knowledge Discovery and Data Mining*, 359–70. AAAIWS'94. Seattle, WA: AAAI Press.
Frey, Brendan J., and Delbert Dueck. 2007. 'Clustering by Passing Messages Between Data Points'. *Science* 315 (5814): 972–76. https://doi.org/10.1126/science.1136800.

Clustering based Approach: An Analysis Example

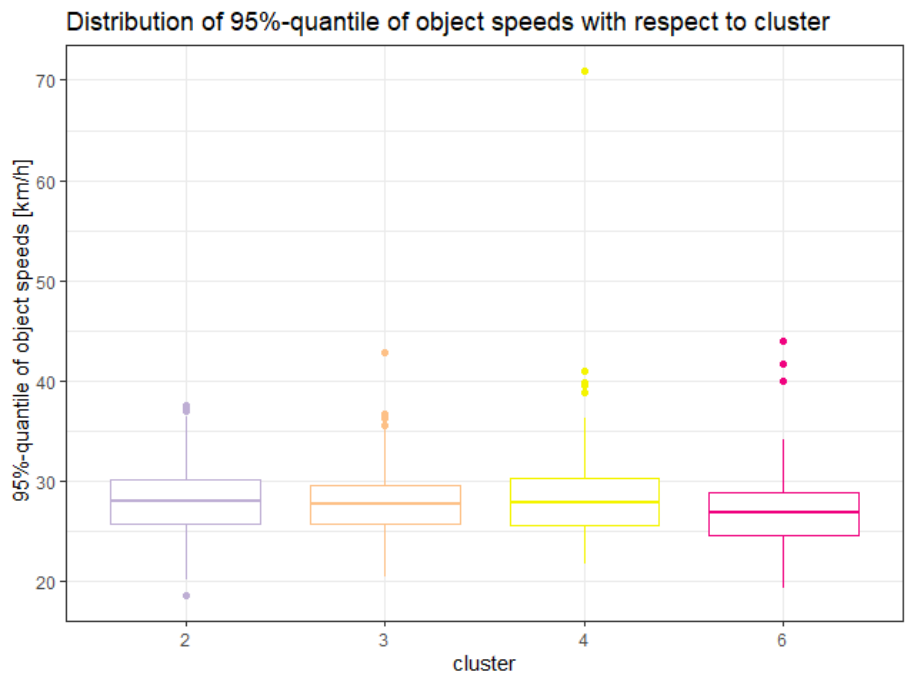
- Clustering of objects crossing the intersection from west to north (left turn)
- Data over 2 hours (2023-07-31 11:00h - 13:00h)

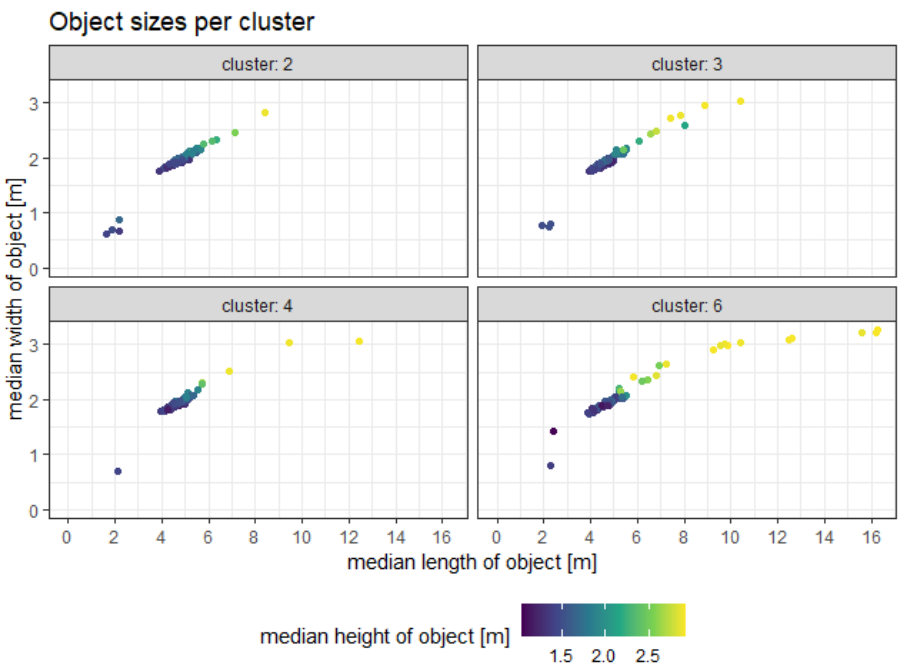


high share of class vehicle

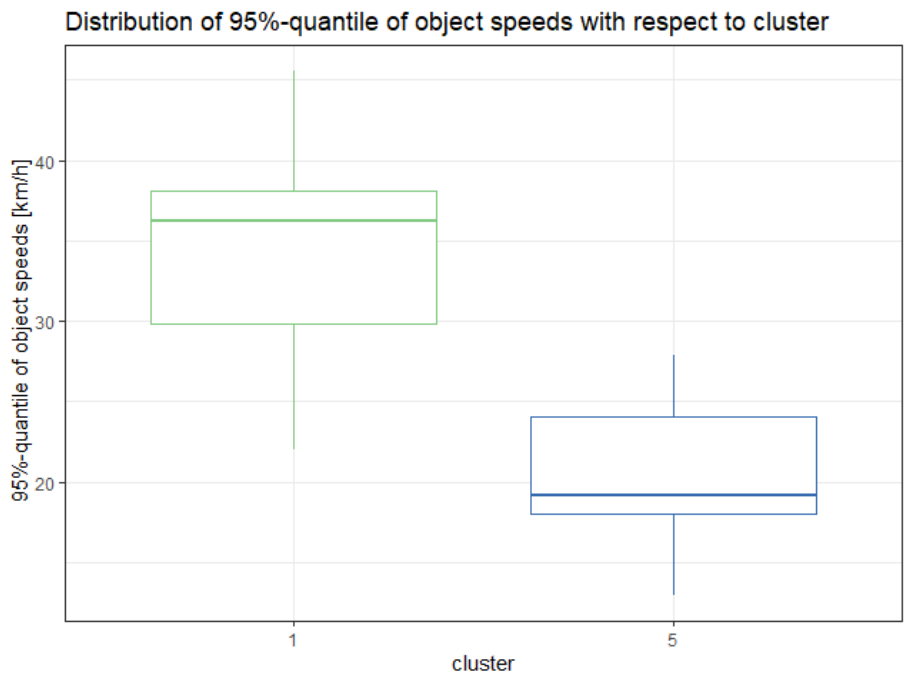
cluster	vehicle	two-wheeler	total
1 = green	3	7	10
2 = purple	137	4	141
3 = orange	170	3	173
4 = yellow	131	1	132
5 = blue	0	8	8
6 = red	141	1	142

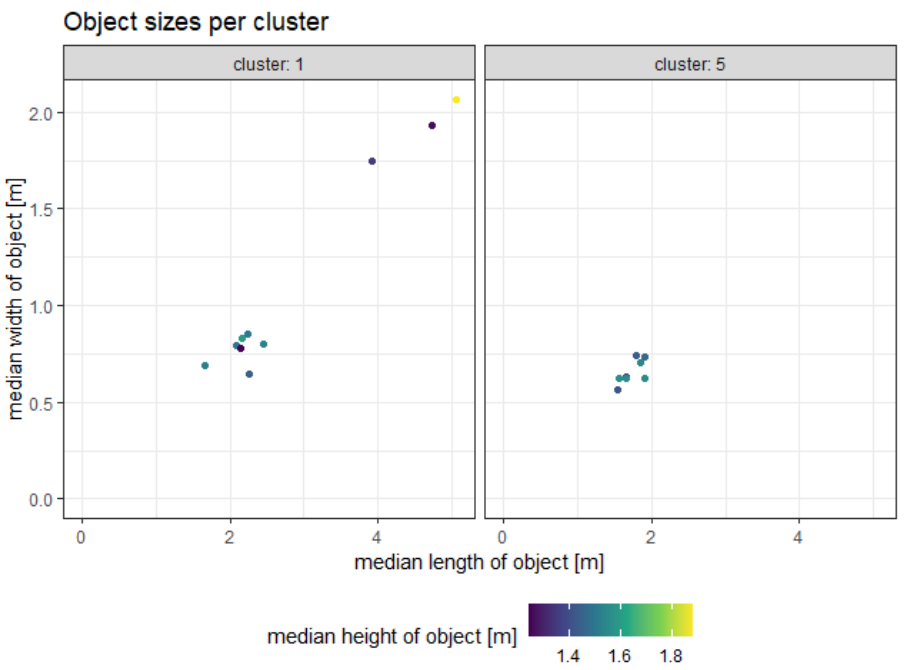
high share of class two-wheeler





cluster	stopped objects
2 = purple	47%
3 = orange	82%
4 = yellow	46%
6 = red	65%





cluster	stopped objects
1 = green	50%
5 = blue	50%

Conclusions

- Despite challenging classification quality…
  - … derived knowledge about the different paths taken and their frequency.
  - … derived indication on object and situation characteristics influencing the path choice.
- Helpful approach for identifying situations to look at in detail.

- Future improvements of the approach
  - Consider more features, e.g.:
    - position of stops
    - position in queue when traffic light turns green
    - presence of other objects, e.g., cyclist next to vehicle

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Contact

Markus Steinmaßl

Salzburg Research Forschungsgesellschaft m.b.H.
Jakob-Haringer-Straße 5/3 | Salzburg, Austria

+43 662 2288 318

markus.steinmassl@salzburgresearch.at