

Towards Context-Aware Navigation for Long-Term Autonomy in Agricultural Environments

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Motivation

The future of agriculture is already a central driver for robotic innovation

- Integrated long term autonomy benefits robotic applications
- Farms are non-standardized work environments with large, heterogeneous areas
- Robots need to work in and switch between different contexts



Prior and Related Work

Navigation:

- Eband, DWA, Global Planner, Move Base Flex,

Localization:

- Robot localization, AMCL

Control Architecture:

- SMACH

Environment Modelling & Representation:

- Waypoint Server, Costmap 2D, QGis

Experimental Setup



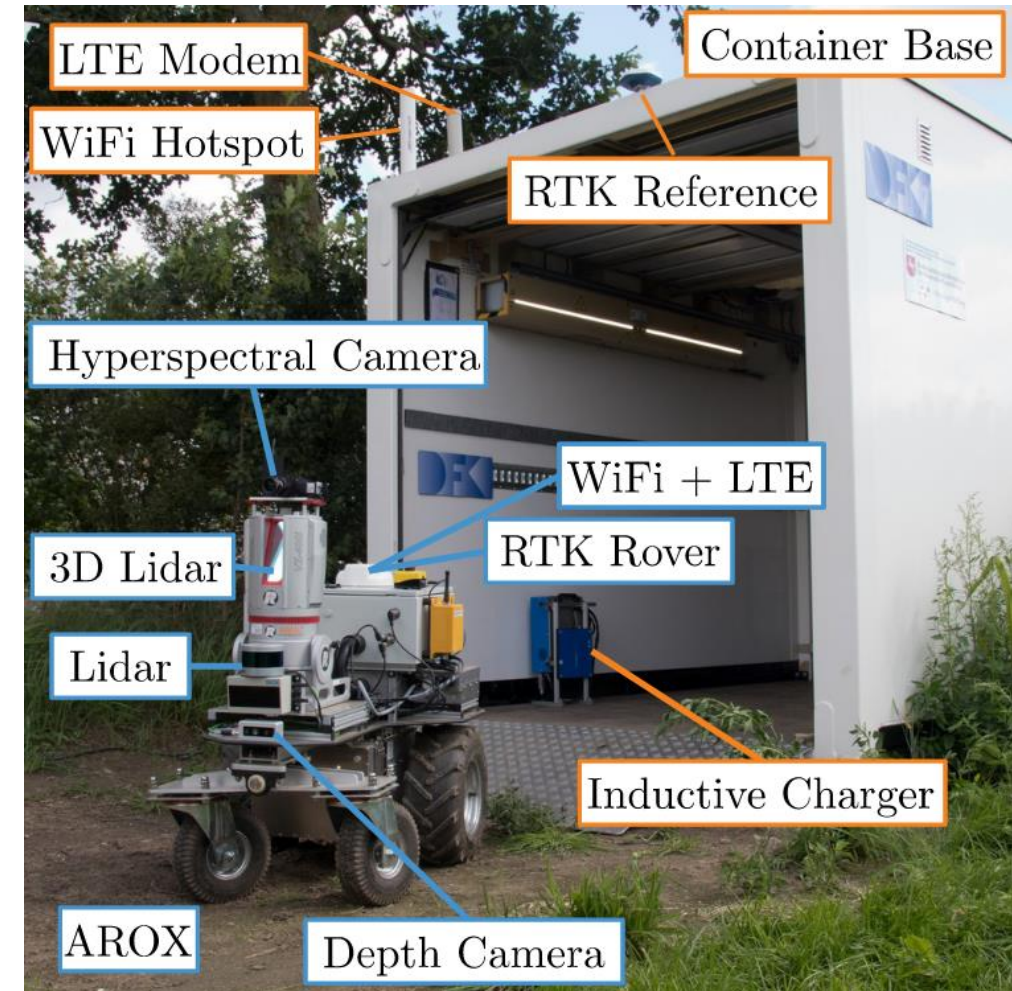
Experimental Setup

Autonomous Robotic Experimental Platform:

- RTK Multi-GNSS
- WIFI & 4G Data uplink
- Multiple 2D and 3D LIDAR sensors

Base Station Container:

- WIFI & 4G Data Uplink
- Inductive Charging Station
- Monitoring and Data Server



Context Aware Navigation

Different contexts in different areas:

- Area usage / crop type
- Time of day
- Season
- State of an agricultural process

Topological planning:

- Abstract Path Planning
- Each zone represents a context
- Different set of parameters for each context



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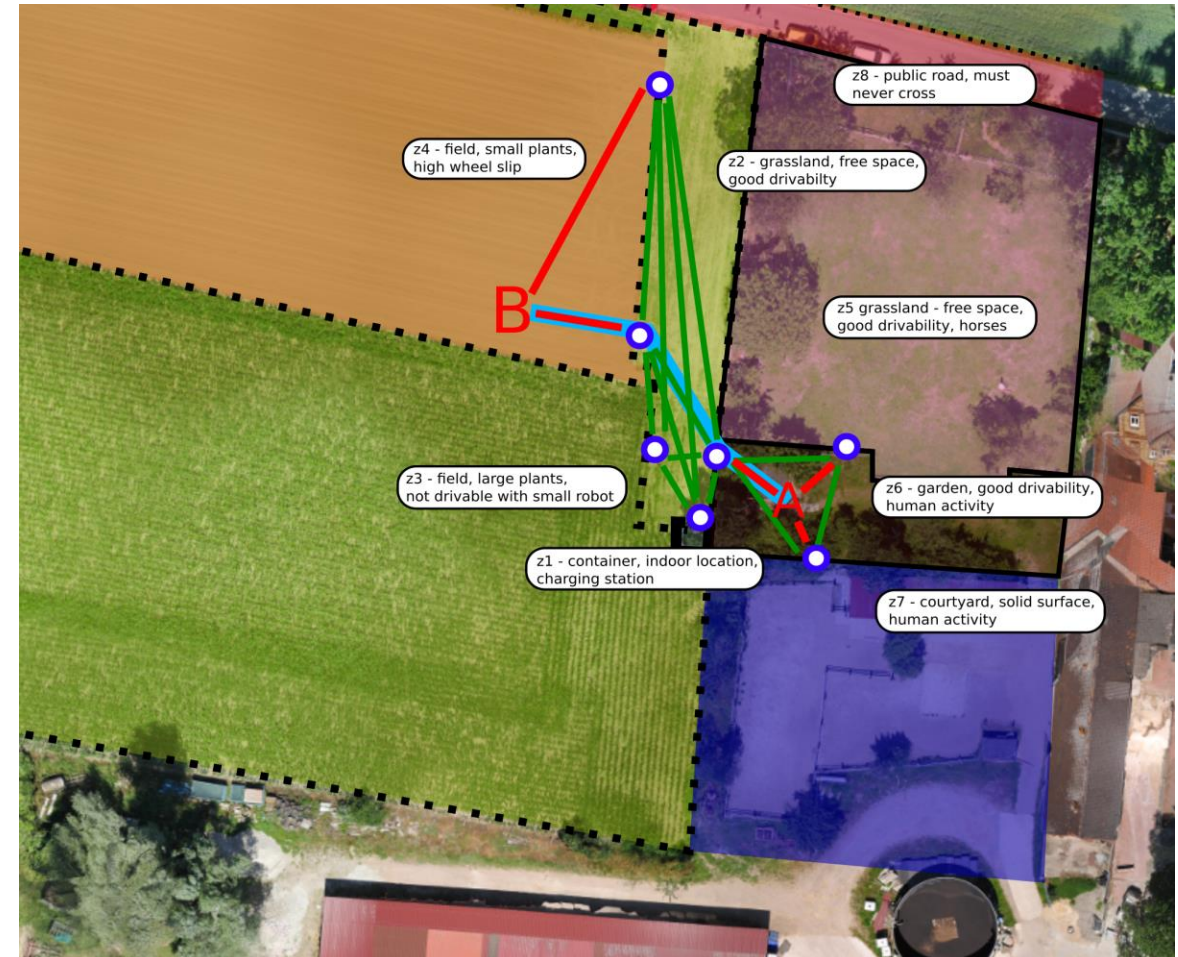
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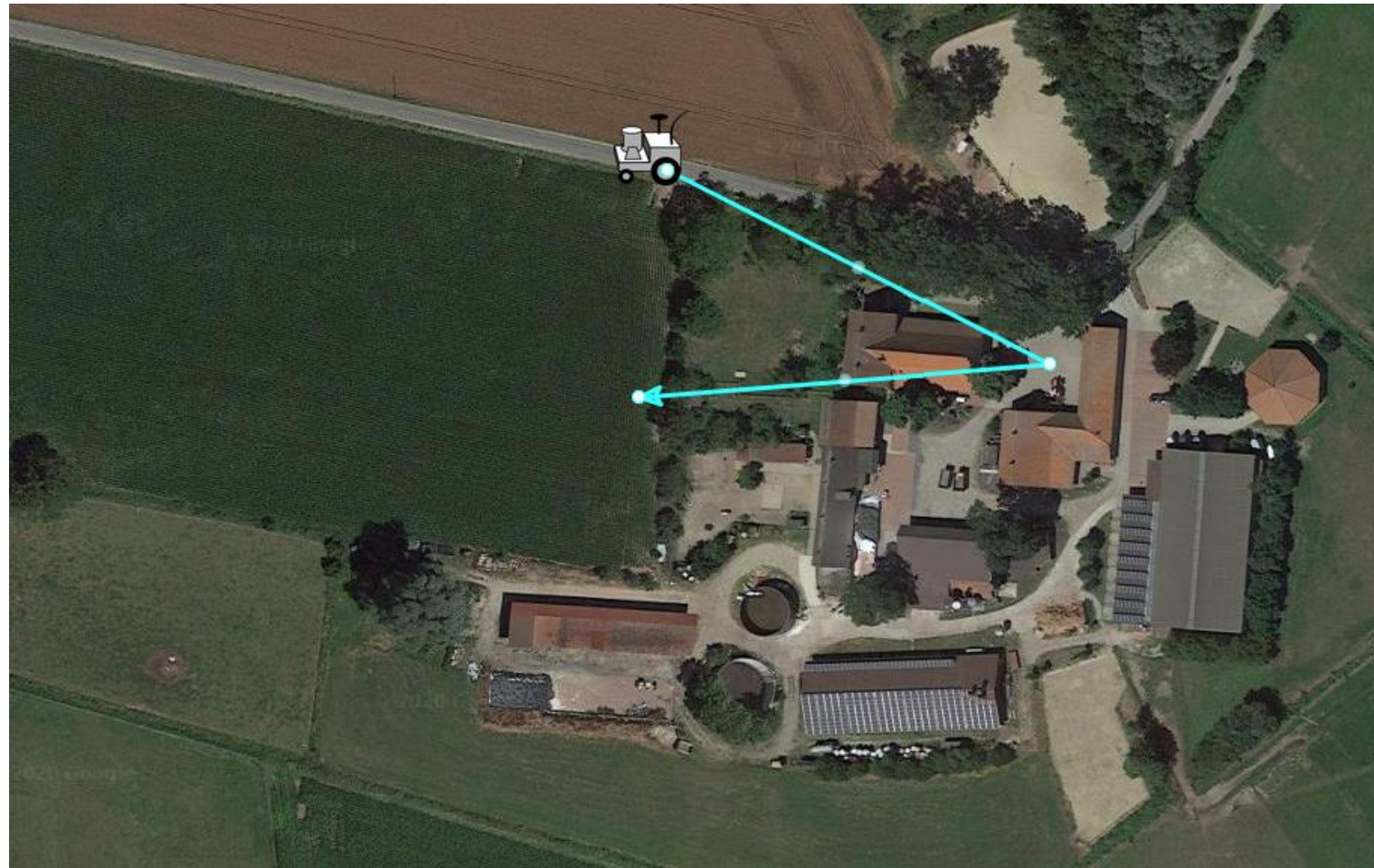
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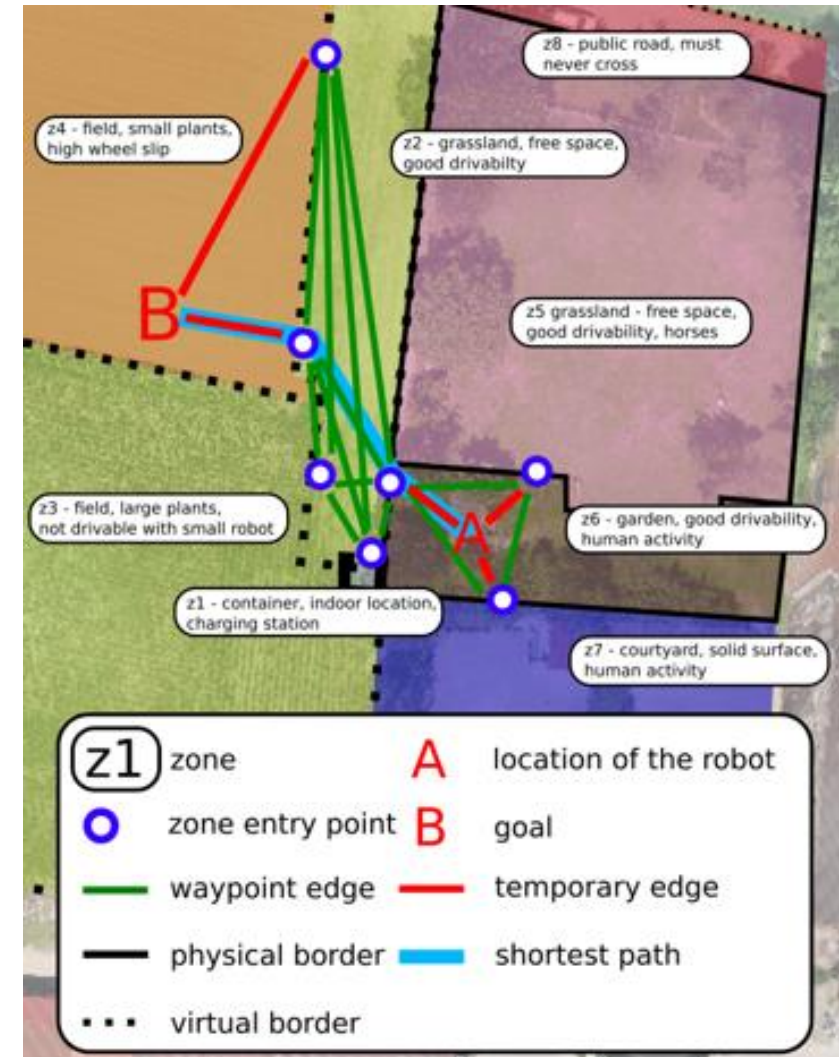


Context Aware Navigation



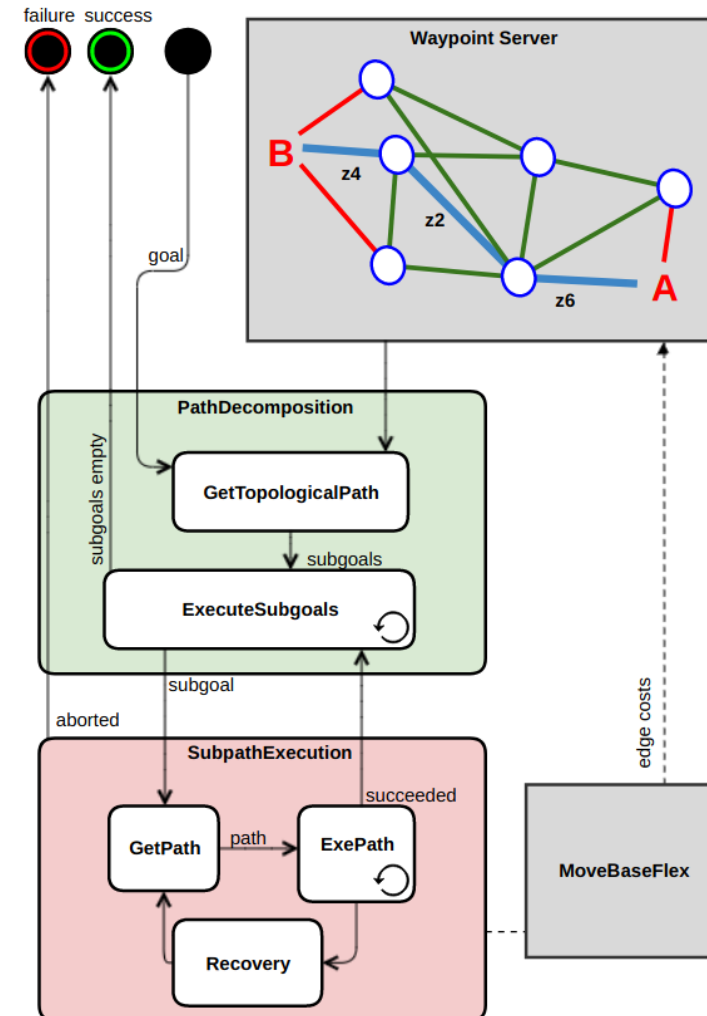
Context Aware Navigation

- Goal and robot pose are added into the graph as temporary vertices
- These vertices are connected with all waypoints in the same zone
- Dijkstra's algorithm to compute path in the graph
- Each edge traversed is a path segment
- Move base flex is called to execute the segment with parameters given from the zone model

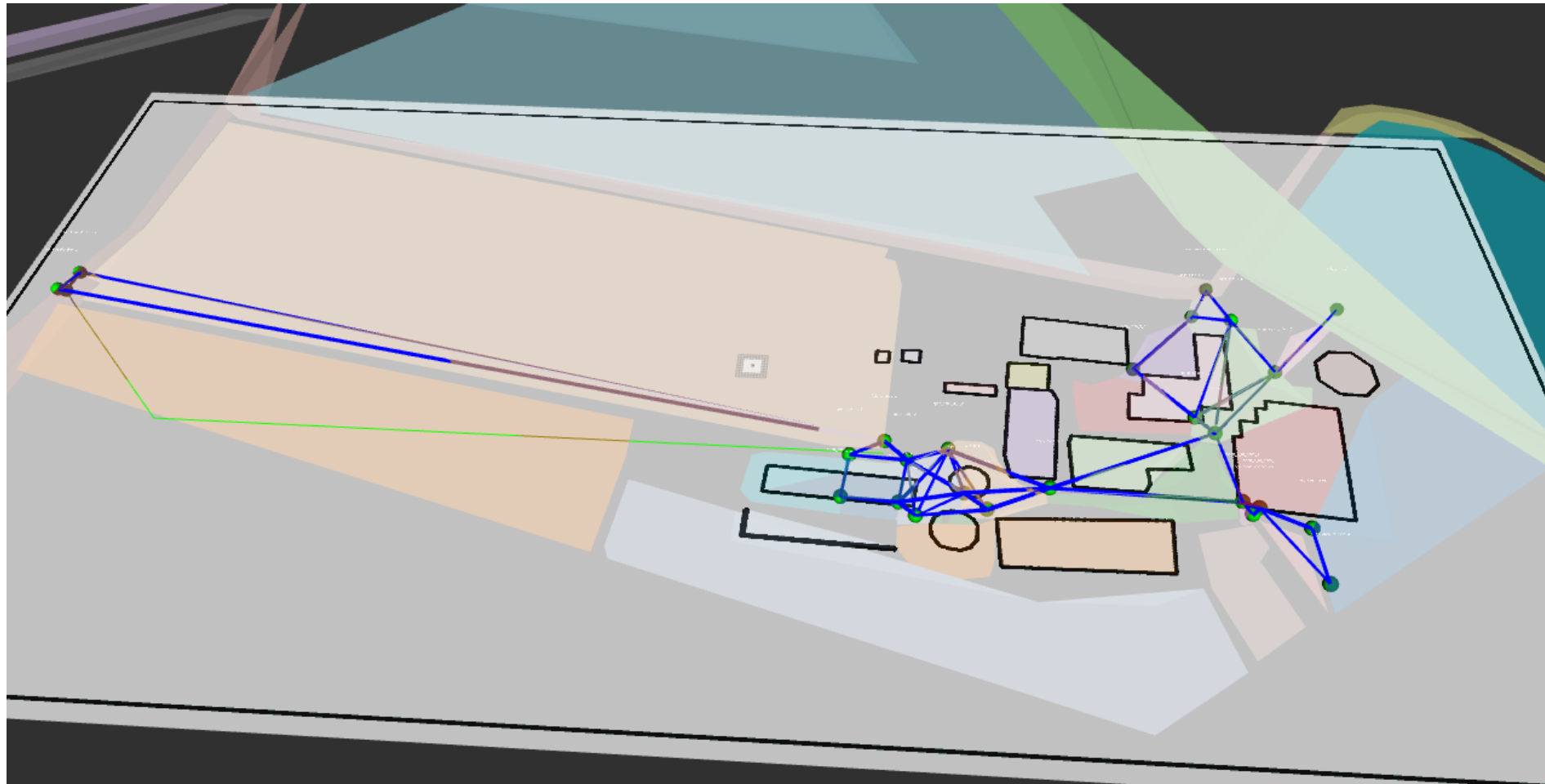


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Context Aware Navigation



Video



Future Work – System Enhancements

Further extend Move Base Flex:

- Adapt costmap representation
- More specialized controllers
- Automated zone generation

From Contexts to Semantics:

- Enrich Zones with semantically inferable information
- Generate Zones with logical reasoning
- Adapt behaviour based on semantic knowledge

Conclusion

- Integration of multiple heterogenous contexts is required to achieve long term autonomy
- Hierarchical abstraction with flexible behaviour implementation facilitates the adaption of robotic behaviour according to semantic inference
- The flexible architecture allows different state-of-the-art software stacks to be applied where most beneficial

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