Leveraging Routing Information to Enable Efficient Memory System Management of ScanMatch in Autonomous Vehicles

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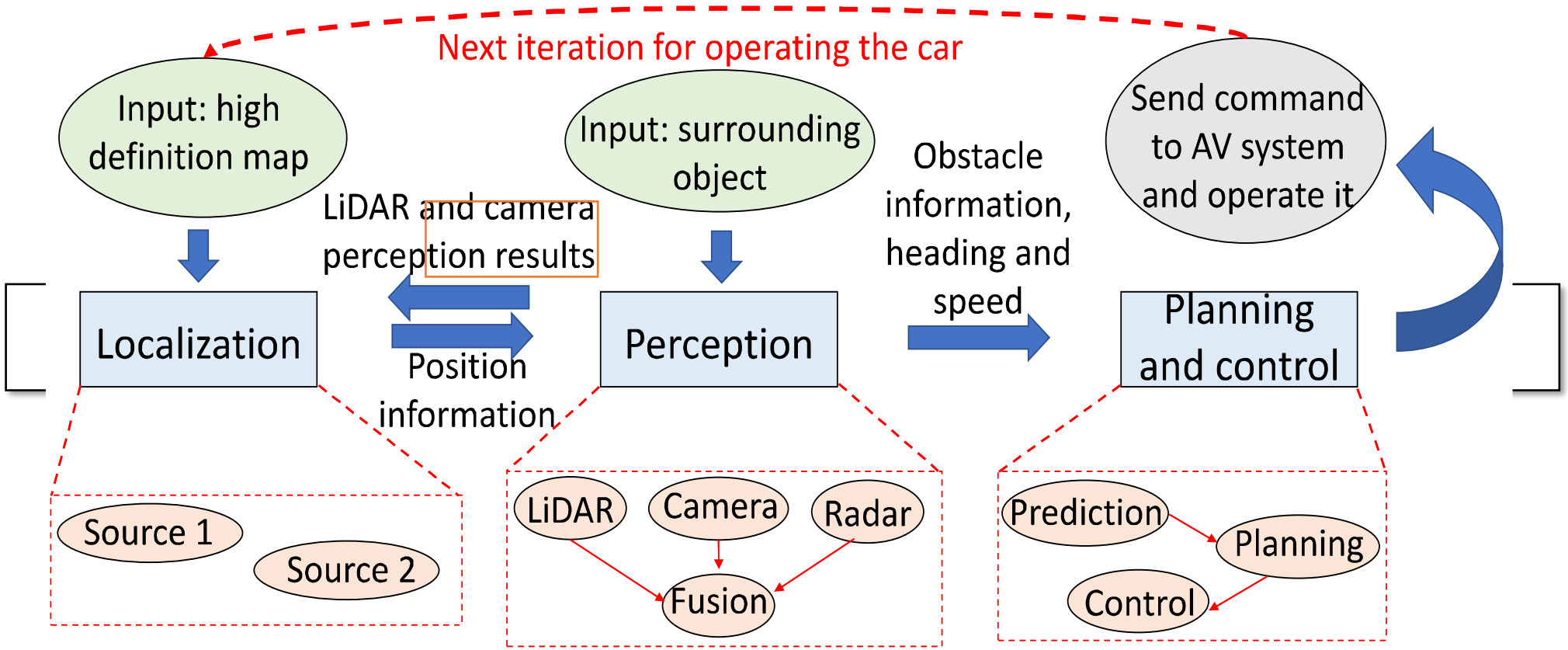
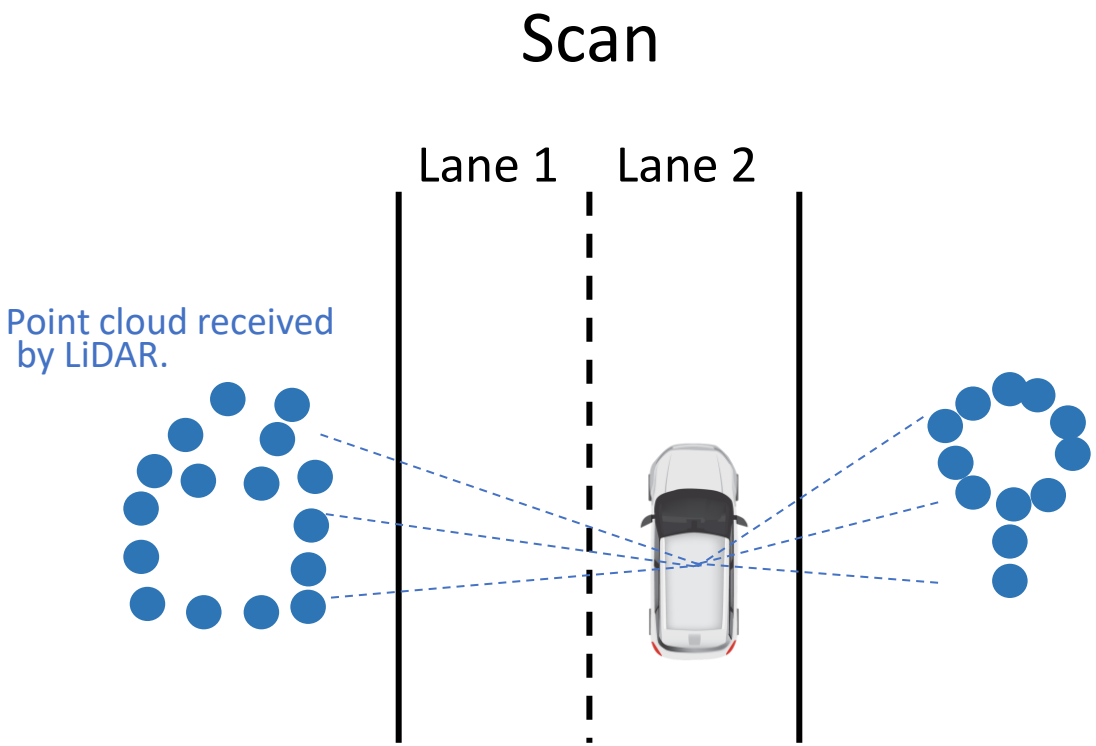
AV computing systems



What Is ScanMatch?



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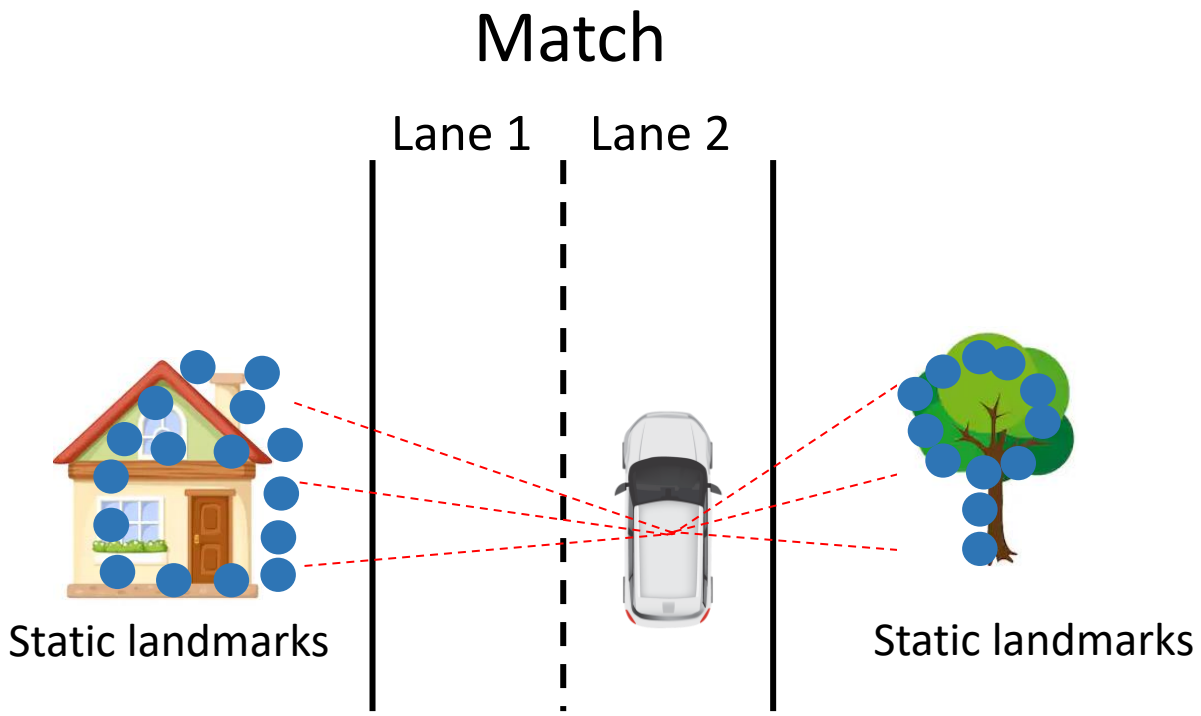

Compare with static map and get the world coordinate of the vehicle.

How are static maps organized?

How to store a landmark in static map?

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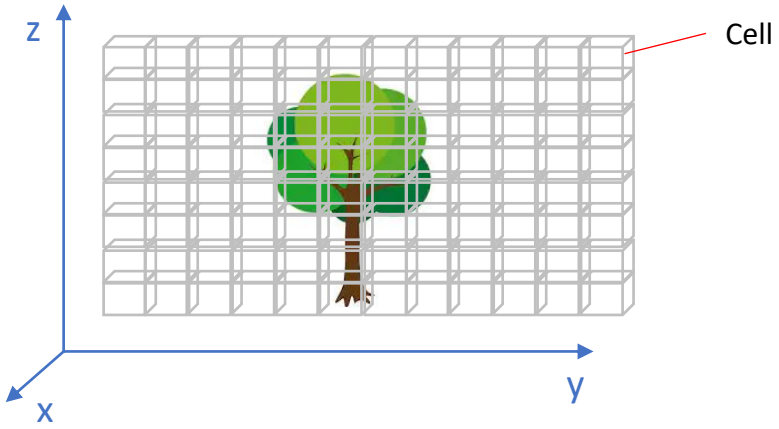

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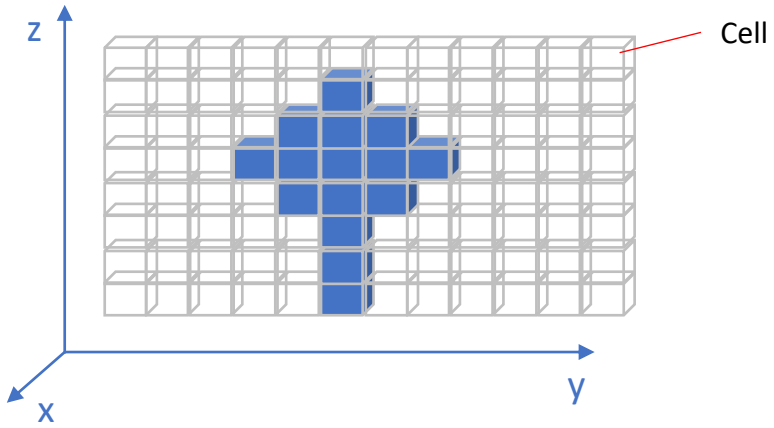
How to store a landmark in static map?



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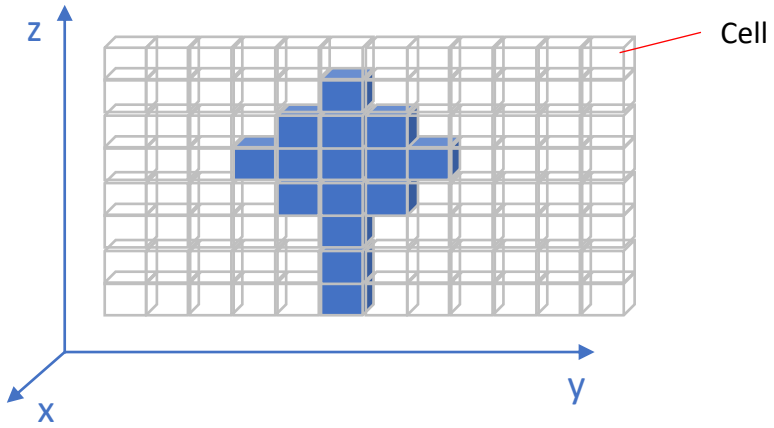
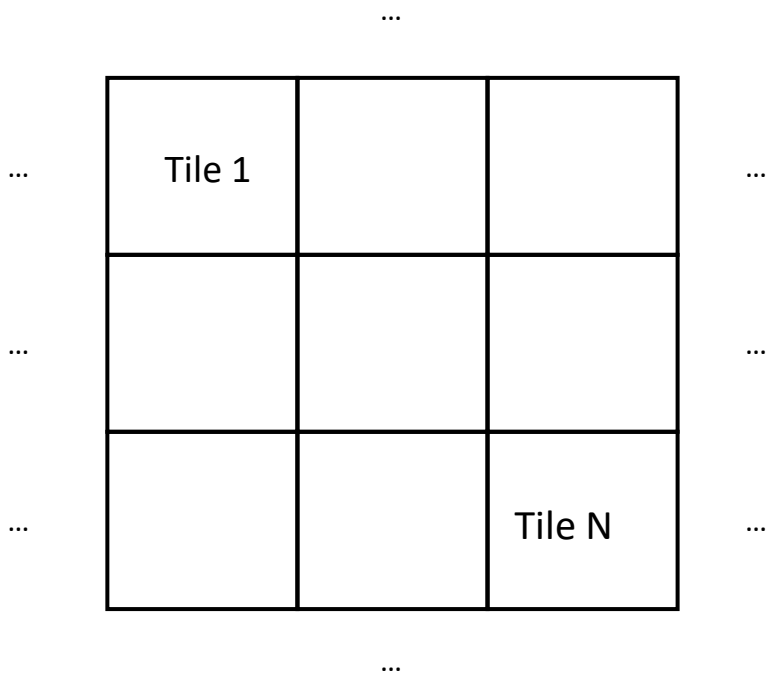


Therefore, static map contains two data structures: cell coordinate and value.

How are static map organized?

The whole static map (bird view).



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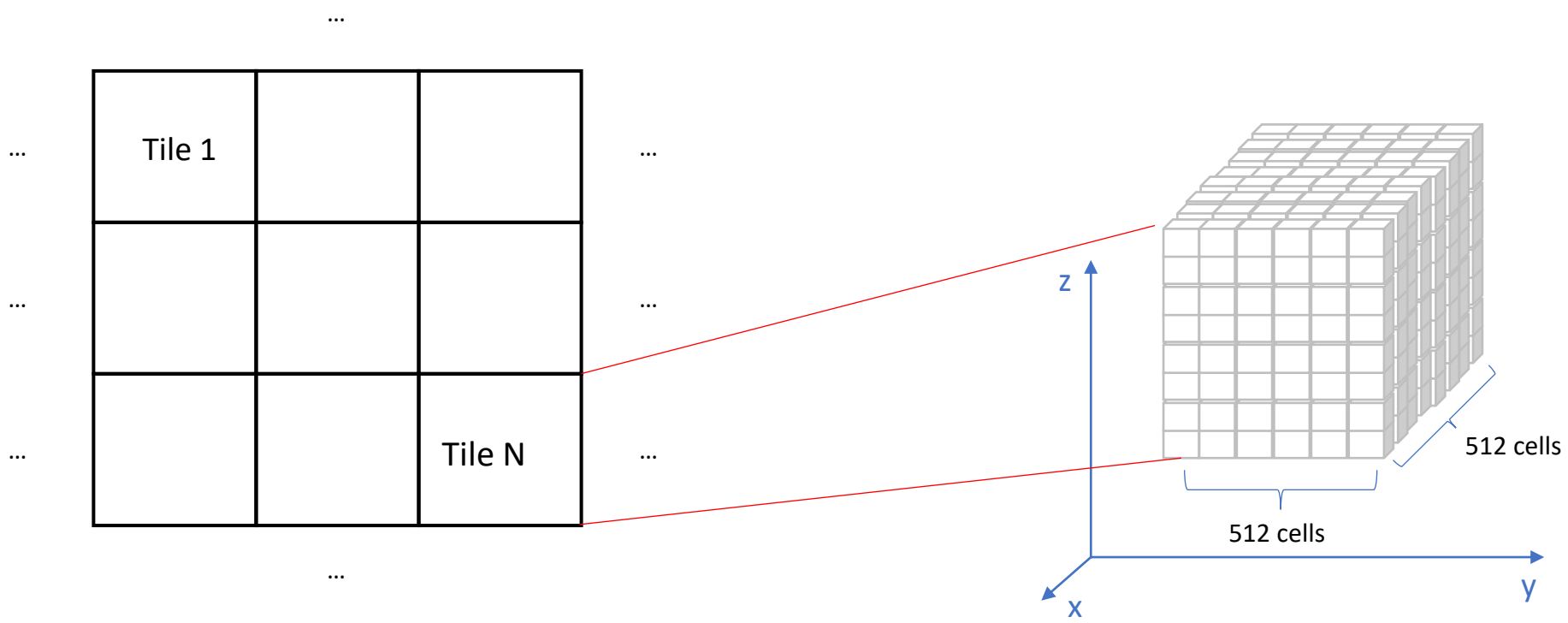
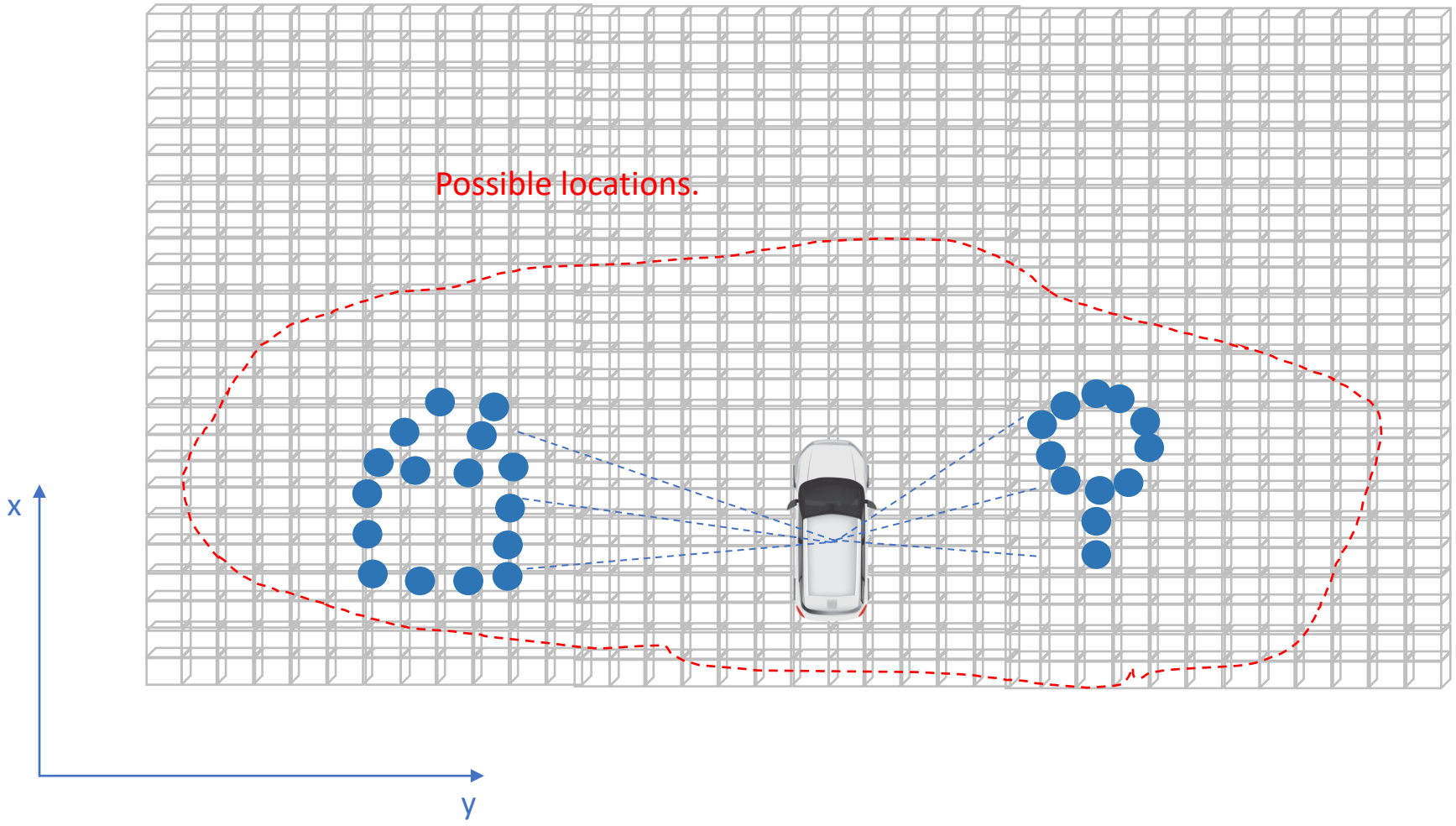


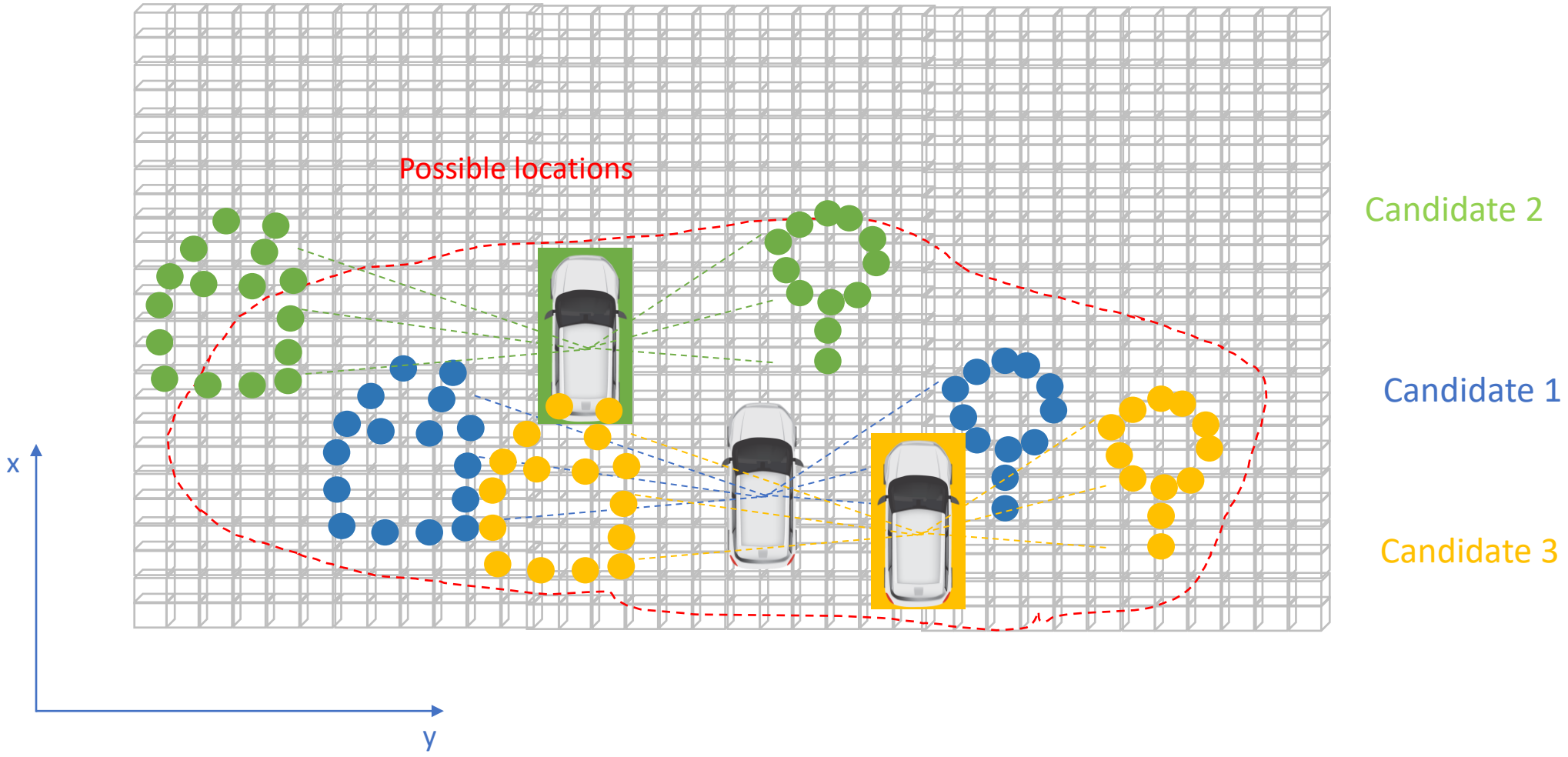
Tile size: 512 cells (x) * 512 cells (y) * round($\frac{z-height}{cell-size}$)

How to perform ScanMatch?



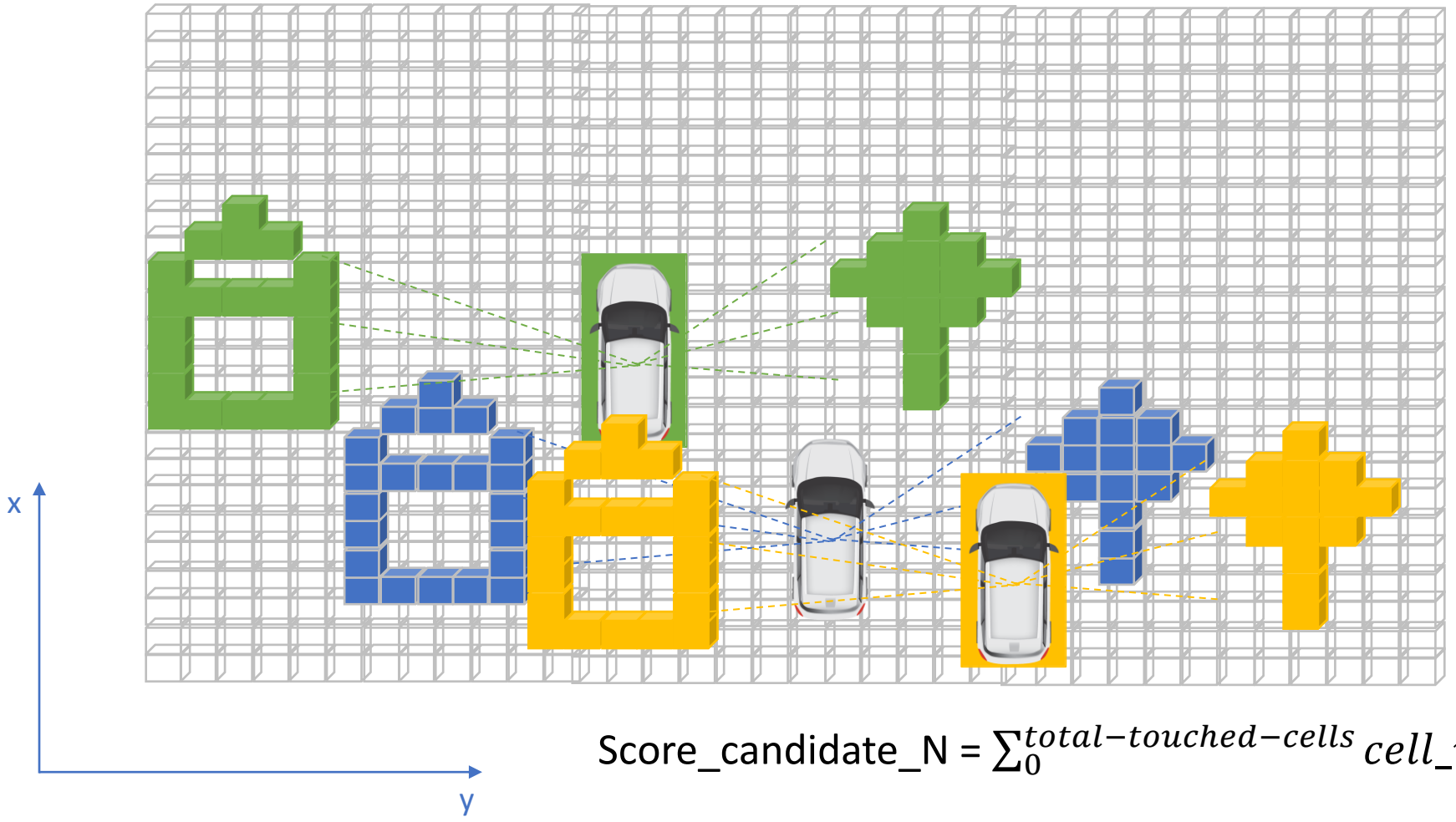
How to perform ScanMatch?

Generate candidates through coordinate transformation.



How to perform ScanMatch?

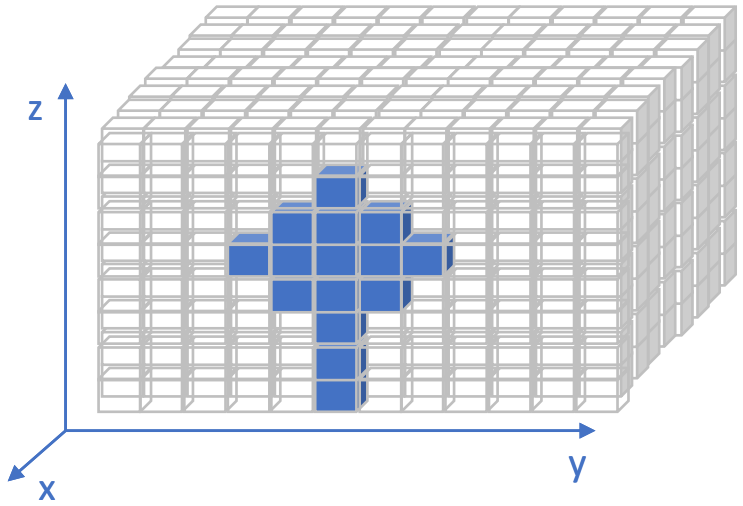
The candidate has the highest score will be selected as the scan and match result.



Score_candidate_N = $\sum_{0}^{total-touched-cells} cell\_value$

Challenge 1: sparsity in static map

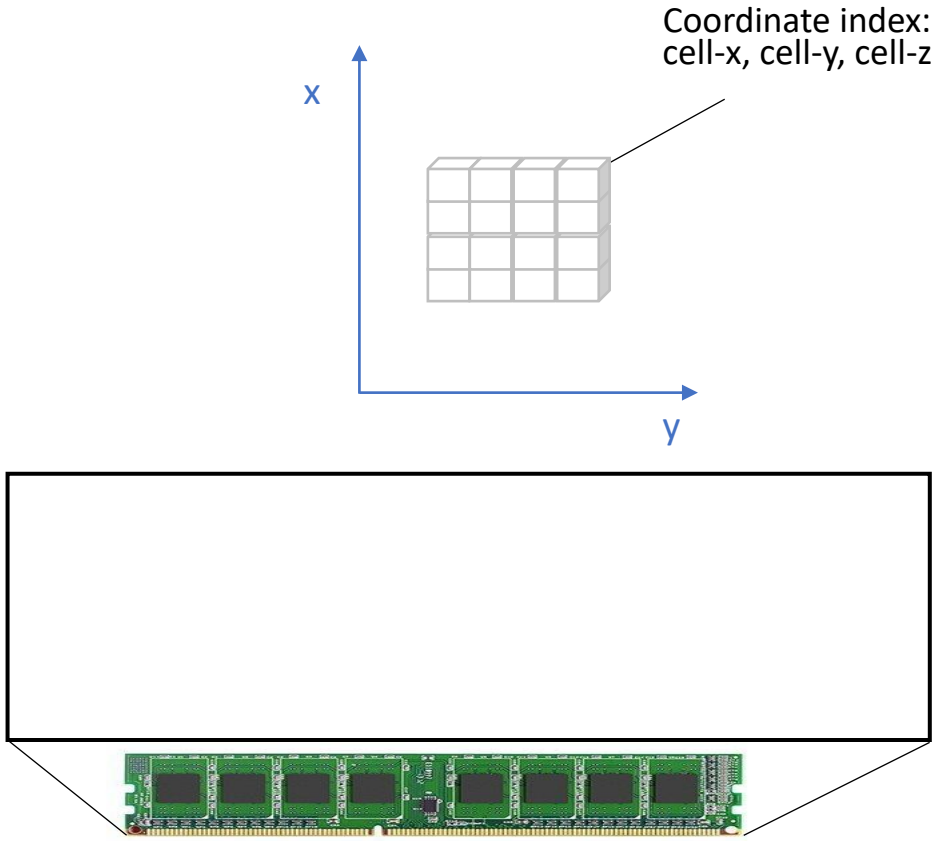
- In real world, most cells are zeros.
- It is a waste of memory capacity to store these zeros.



According to the log analysis, more than 95% cells are zero-valued.

Challenge 2: AV direction vs. locality

- How the static maps stores in memory.



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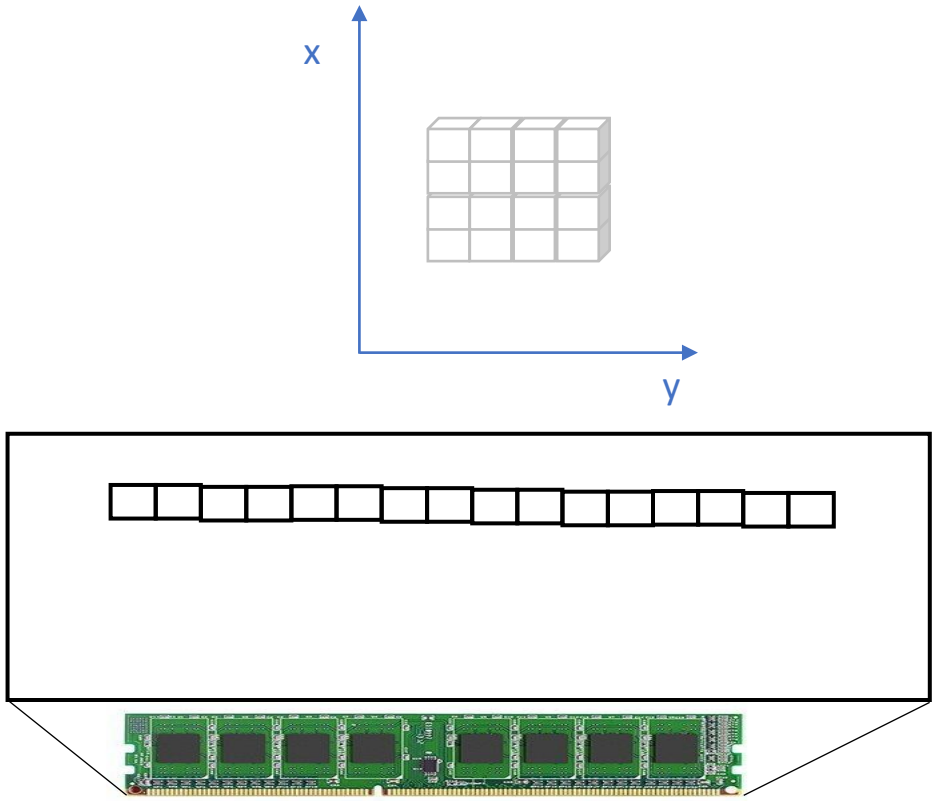
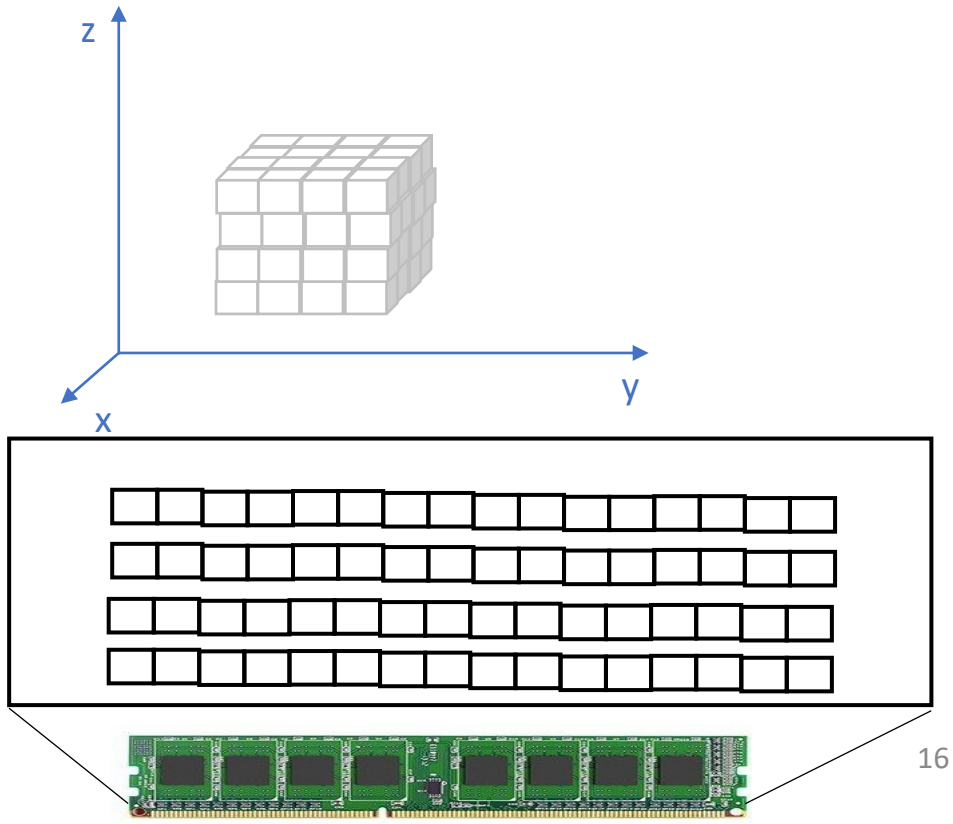
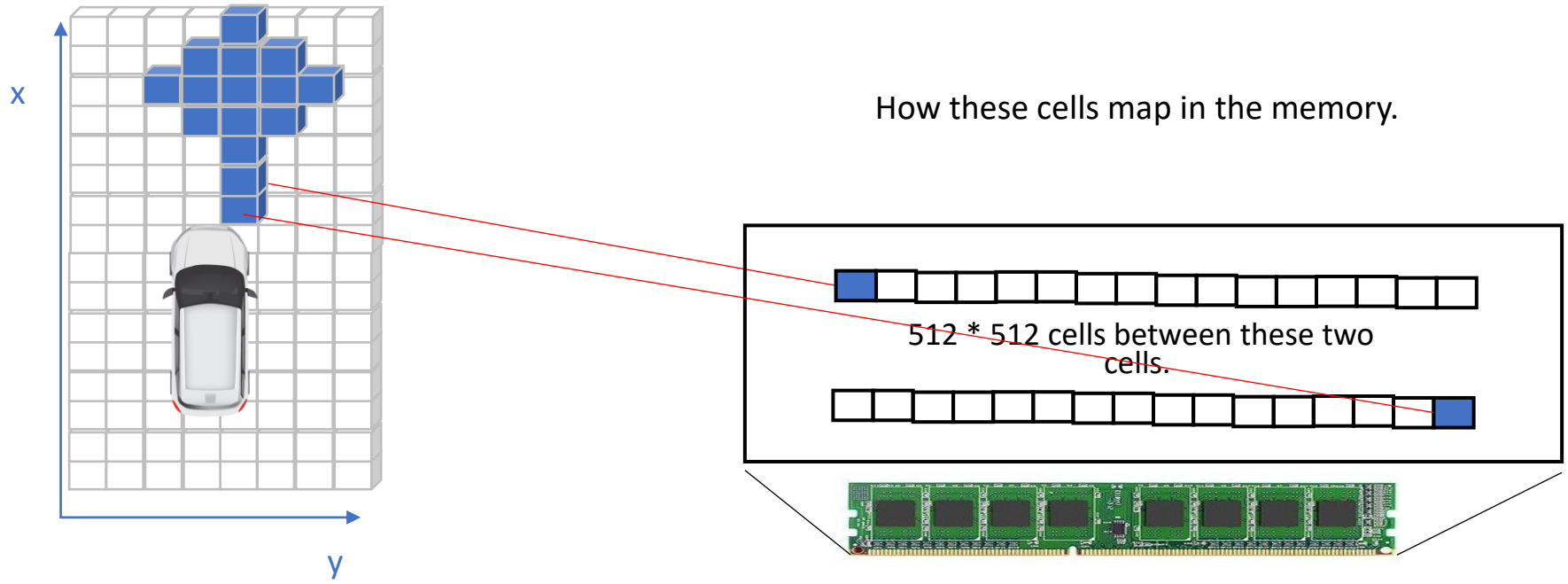




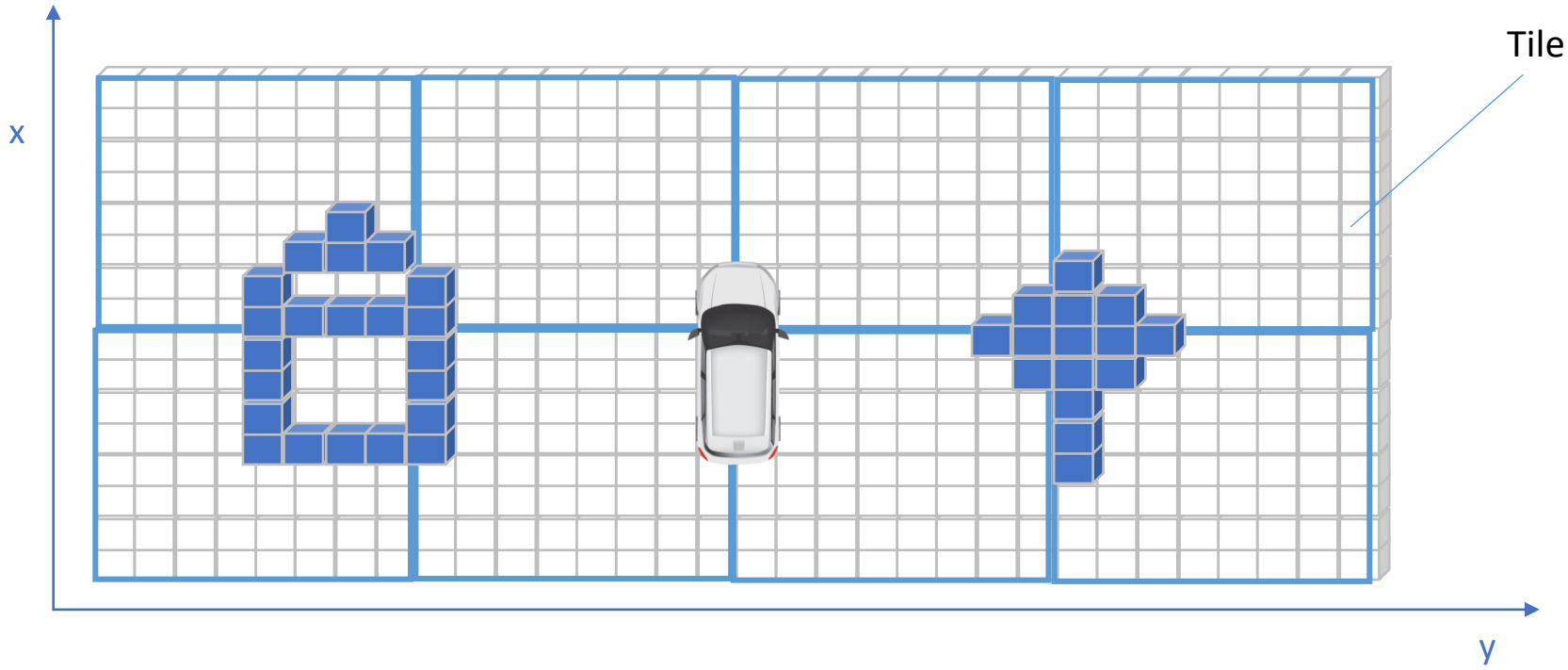
Challenge 2: AV direction vs. locality

- Neighbor cells in physical map may be far away from each other in the memory.
- Cell index calculation: cell_y + cell_x * 512 + cell_z * 512 * 512



Challenge 3: loading useless data

- Most loaded cells are useless.



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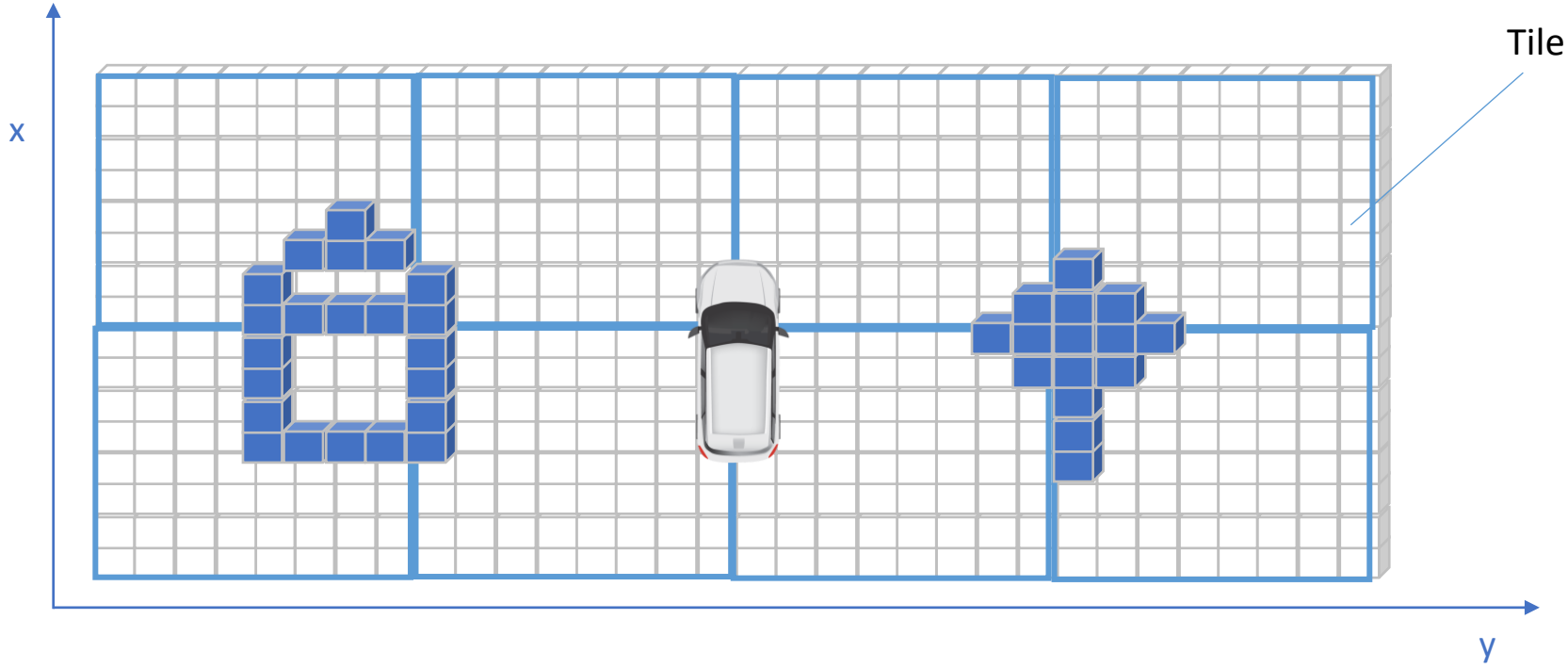
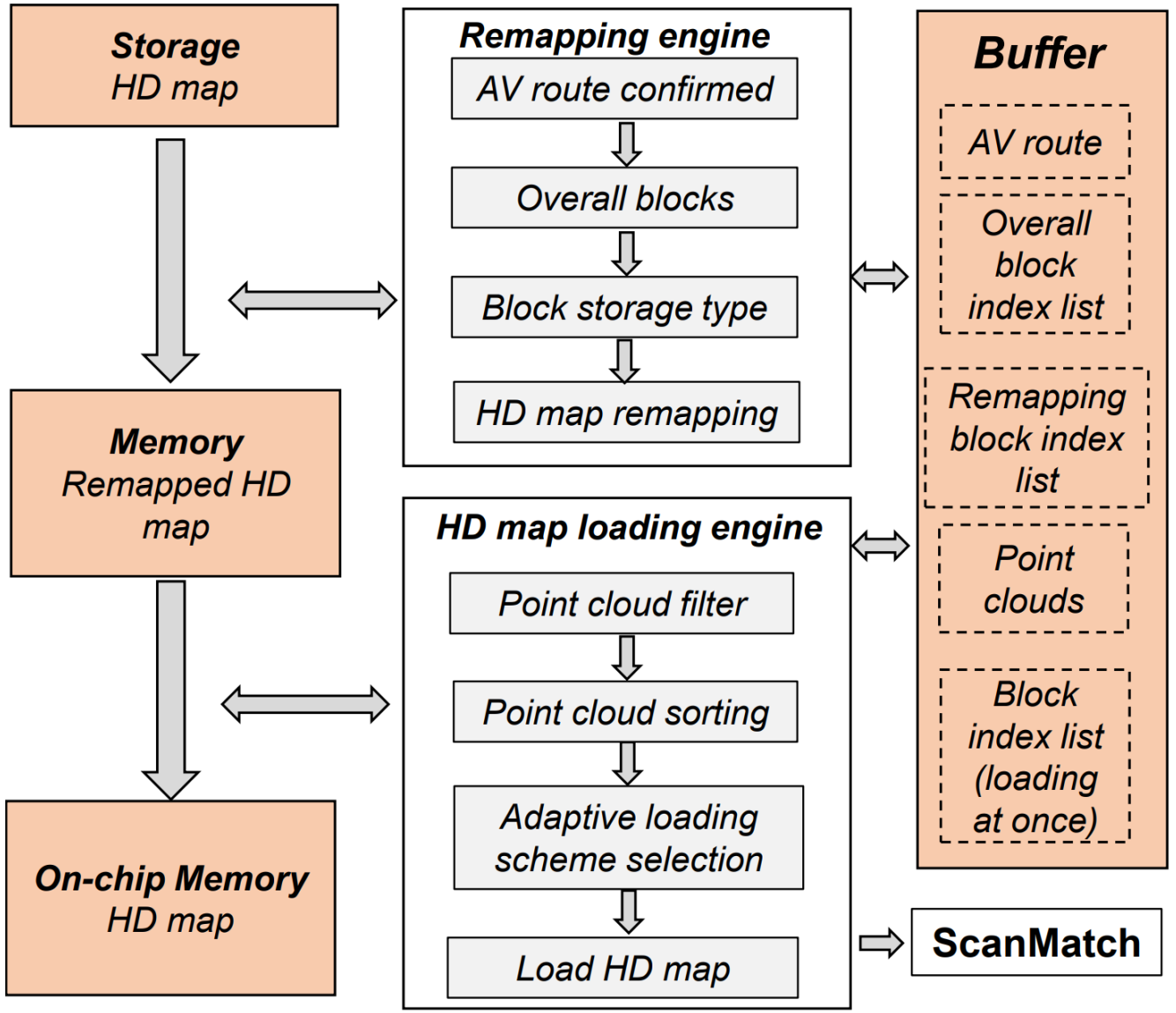
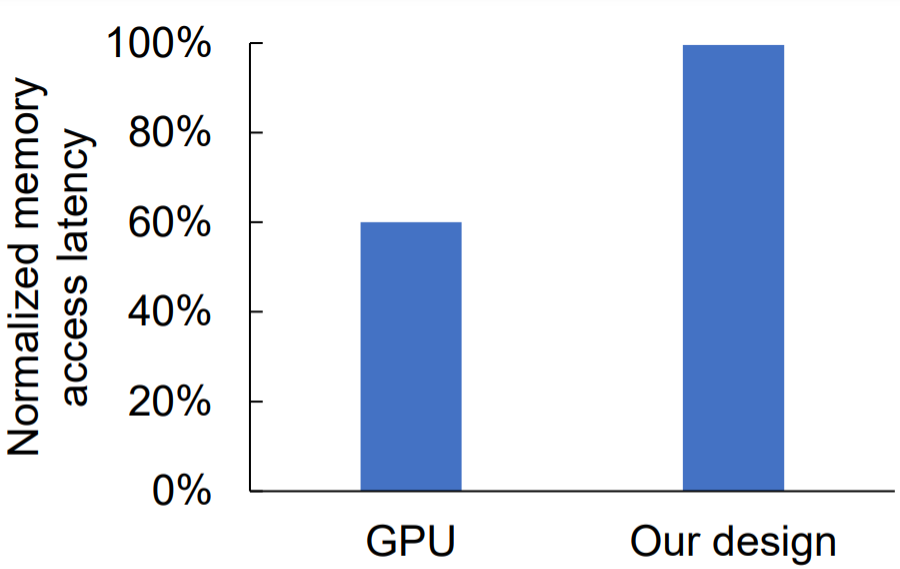


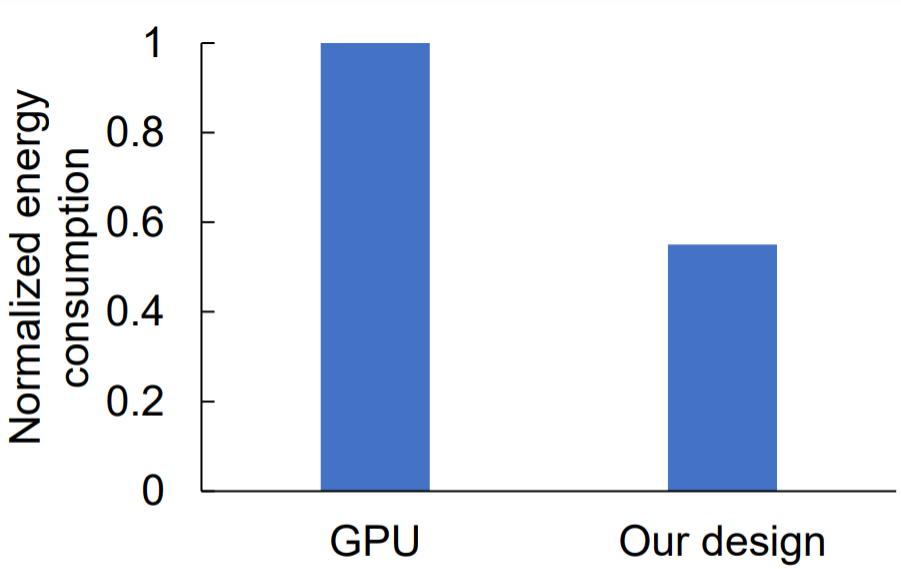
Design


Storage
HD map
Memory
Remapped HD map
On-chip Memory
HD map
Remapping engine
AV route confirmed
Overall blocks
Block storage type
HD map remapping
HD map loading engine
Point cloud filter
Point cloud sorting
Adaptive loading scheme selection
Load HD map
Buffer
AV route
Overall block index list
Remapping block index list
Point clouds
Block index list (loading at once)
ScanMatch

Evaluation



(a) On-chip memory hit rate comparison between our design and the GPU.



(b) Normalized energy consumption comparison between our design and the GPU.

Thank you!