

Spatio-temporal Motion Planning for Autonomous Vehicles with Trapezoidal Prism Corridors and Bézier Curves

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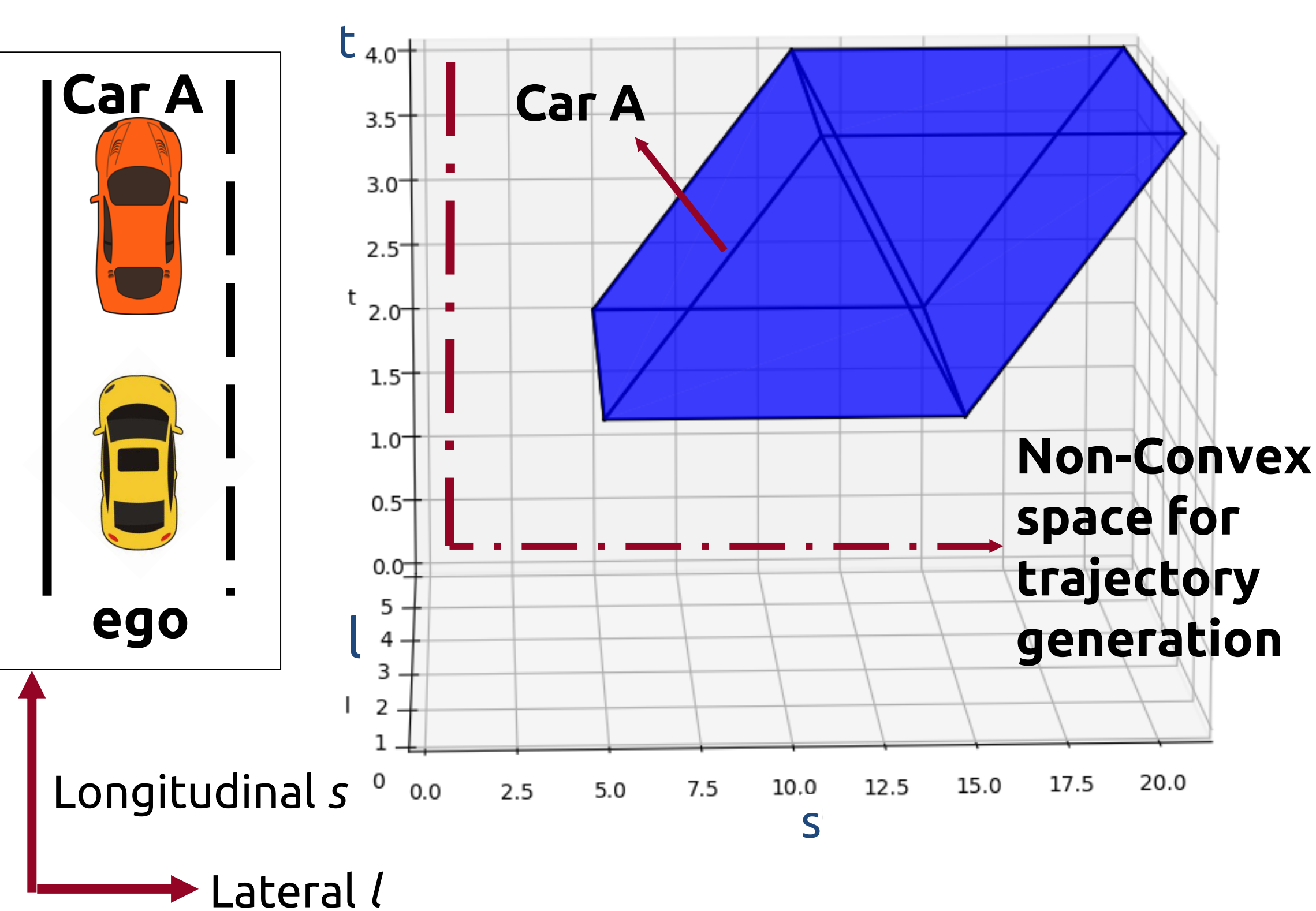
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1. Introduction

- Safety-guaranteed motion planning is critical for self-driving cars.
- Common approach: layered or decoupled path + speed planning
 - suboptimal in the presence of dynamic obstacles.
- Our approach: direct 3D optimization
 - spatio-temporal planning
 - 2D Position + 1D Time.

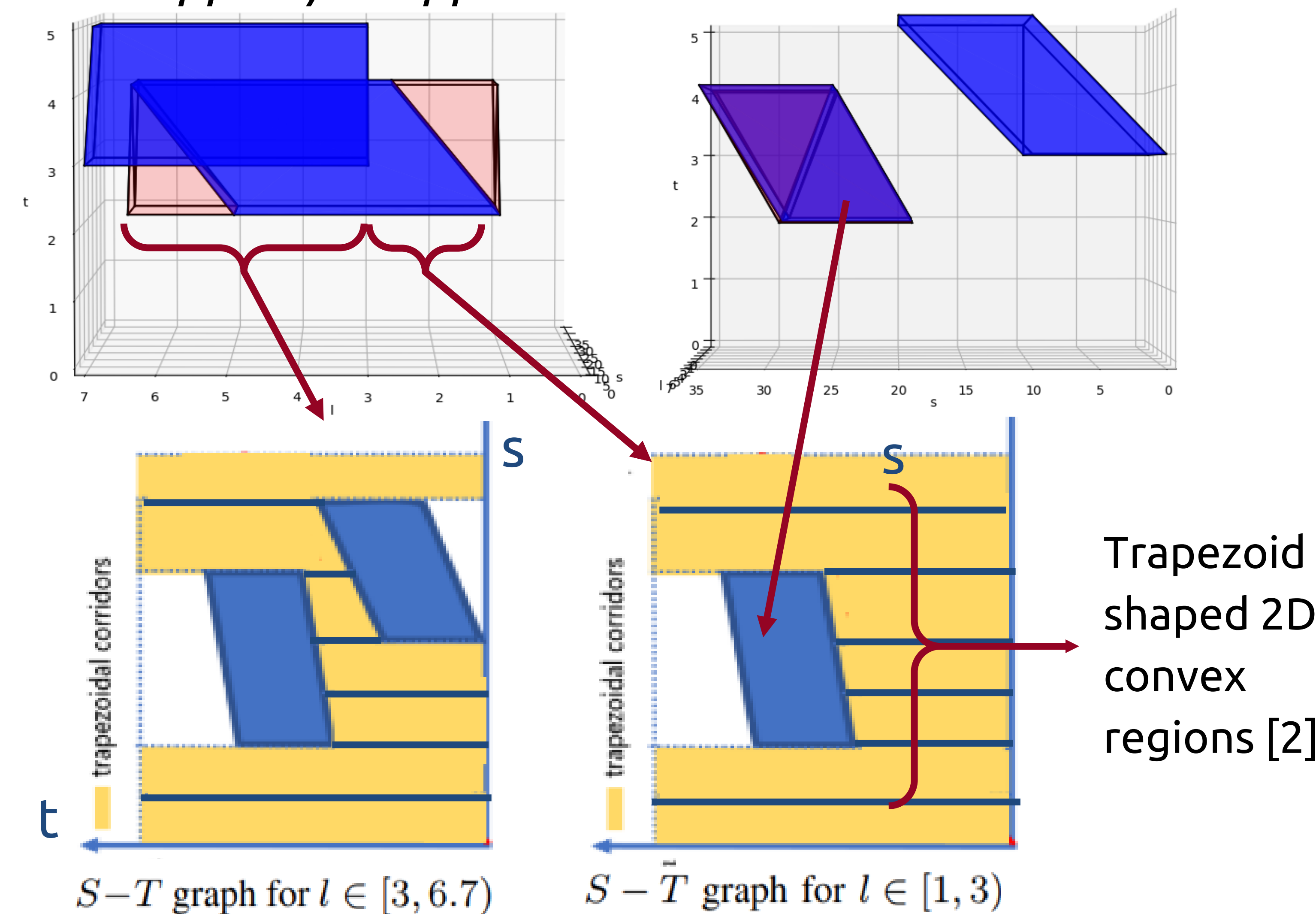


2. Challenges

- Solution space for optimization is *non-convex* → need to convert into series of convex regions to solve a collective optimization problem.
 - Cuboidal shaped regions have been previously used, but they limit the search space [1].
- Enforcing safety on the trajectory across a *continuous* time interval.

3. Proposed Method

- Key idea: For the given time horizon, *shape* of the *st* representation we use for cars on the road changes across the lanes of the road *only when* surrounding cars *appear/disappear*.



- “Dragging” the regions across the width of the cars until a car appears/disappears gives 3D convex regions.
- Construct “piece” of our trajectory in the *relevant* convex regions; continuous pieces form one trajectory.

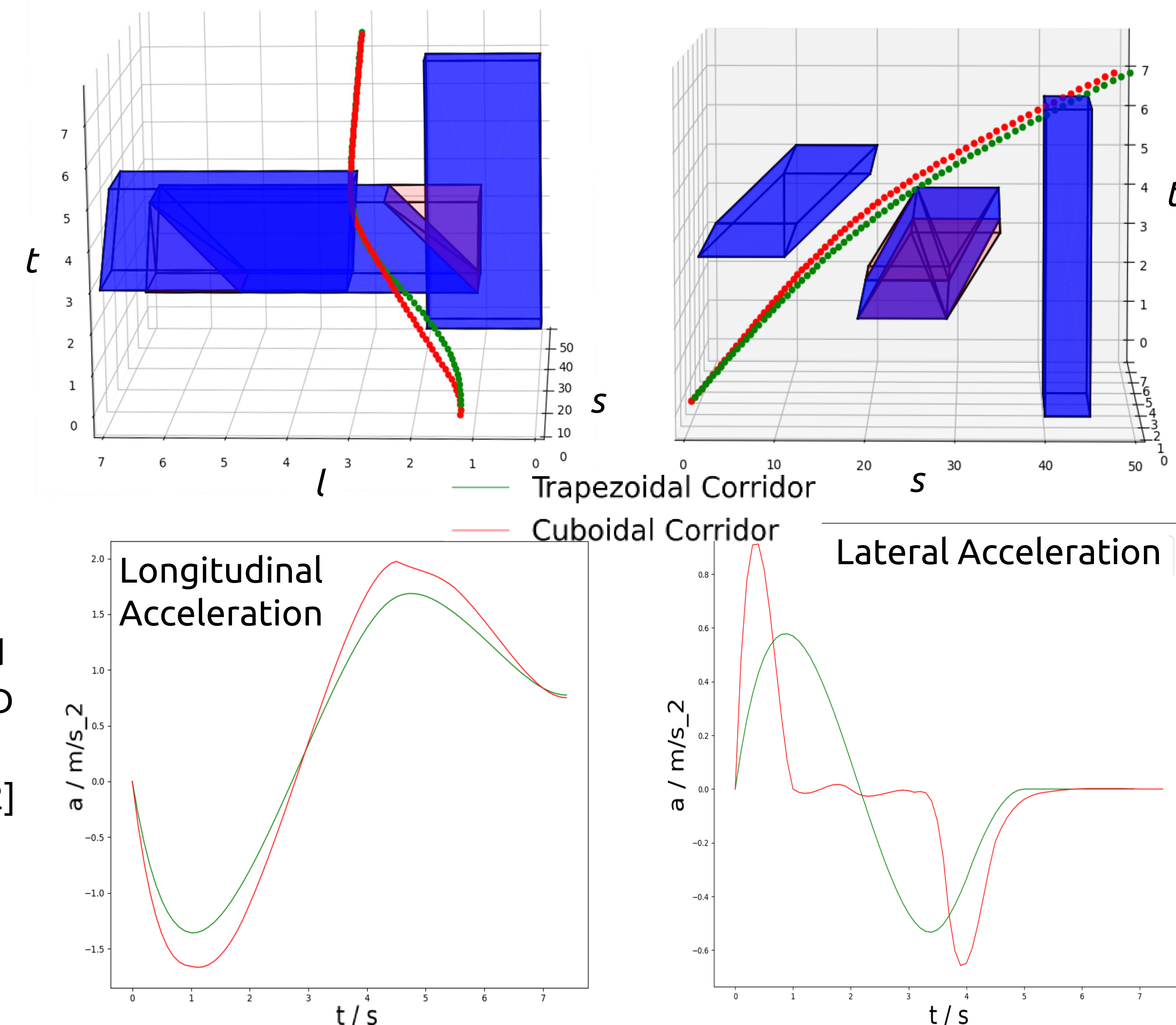
4. Bézier Curves

- Control points lie in the 3D convex corridors described above → Bézier curve lies inside their convex hull → trajectory generated is collision-free.

8. References

1. W. Ding et al., "Safe Trajectory Generation for Complex Urban Environments Using Spatio-Temporal Semantic Corridor," in 2019
2. J. Li et al., "Motion planning by search in derivative space and convex optimization with enlarged solution space," in 2022

5. Results



- Trajectory generated by trapezoidal prism-shaped corridors is more comfort-optimal than that generated by cuboidal corridors.

6. Conclusion

Our method enlarges the solution space for optimization by extending 2D trapezoidal convex regions to 3D and provides safety conditions for a collision free and comfort optimal trajectory.

7. Acknowledgment

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