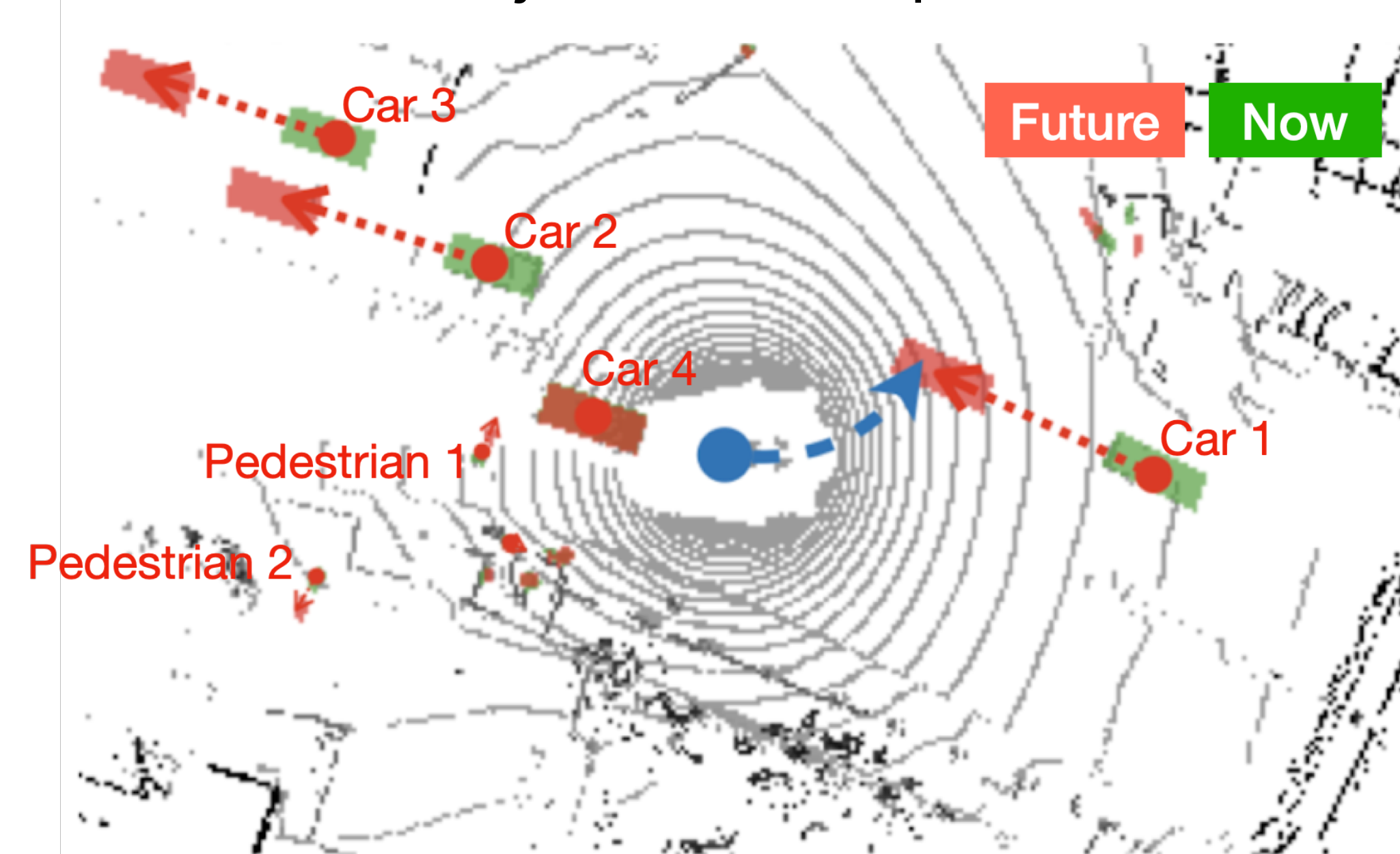# Safe Local Motion Planning with Self-Supervised Freespace Forecasting

Peiyun Hu, Aaron Huang, John Dolan, David Held, Deva Ramanan

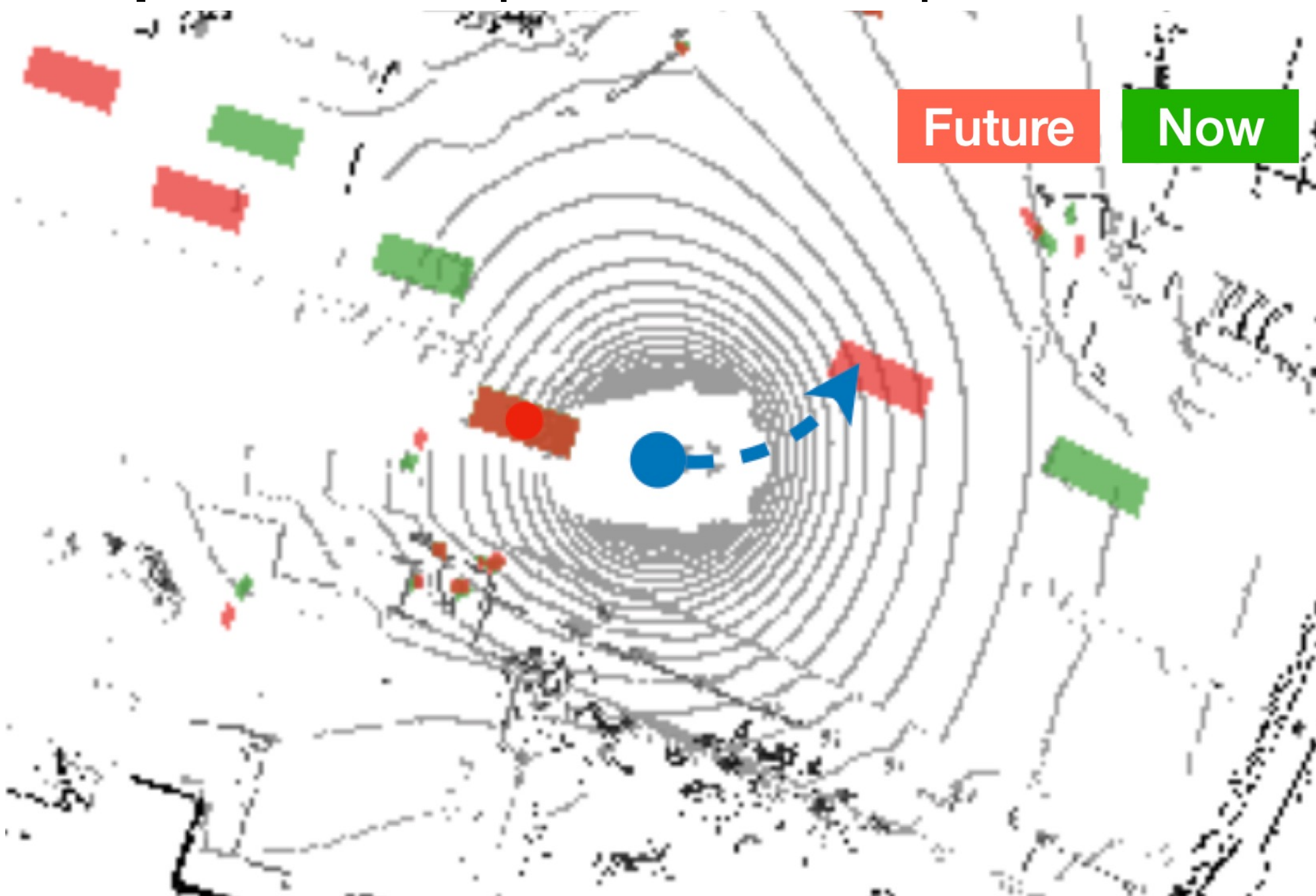Carnegie Mellon University, Argo AI

CVPR VIRTUAL JUNE 19-25

Representations that Support Local Planning
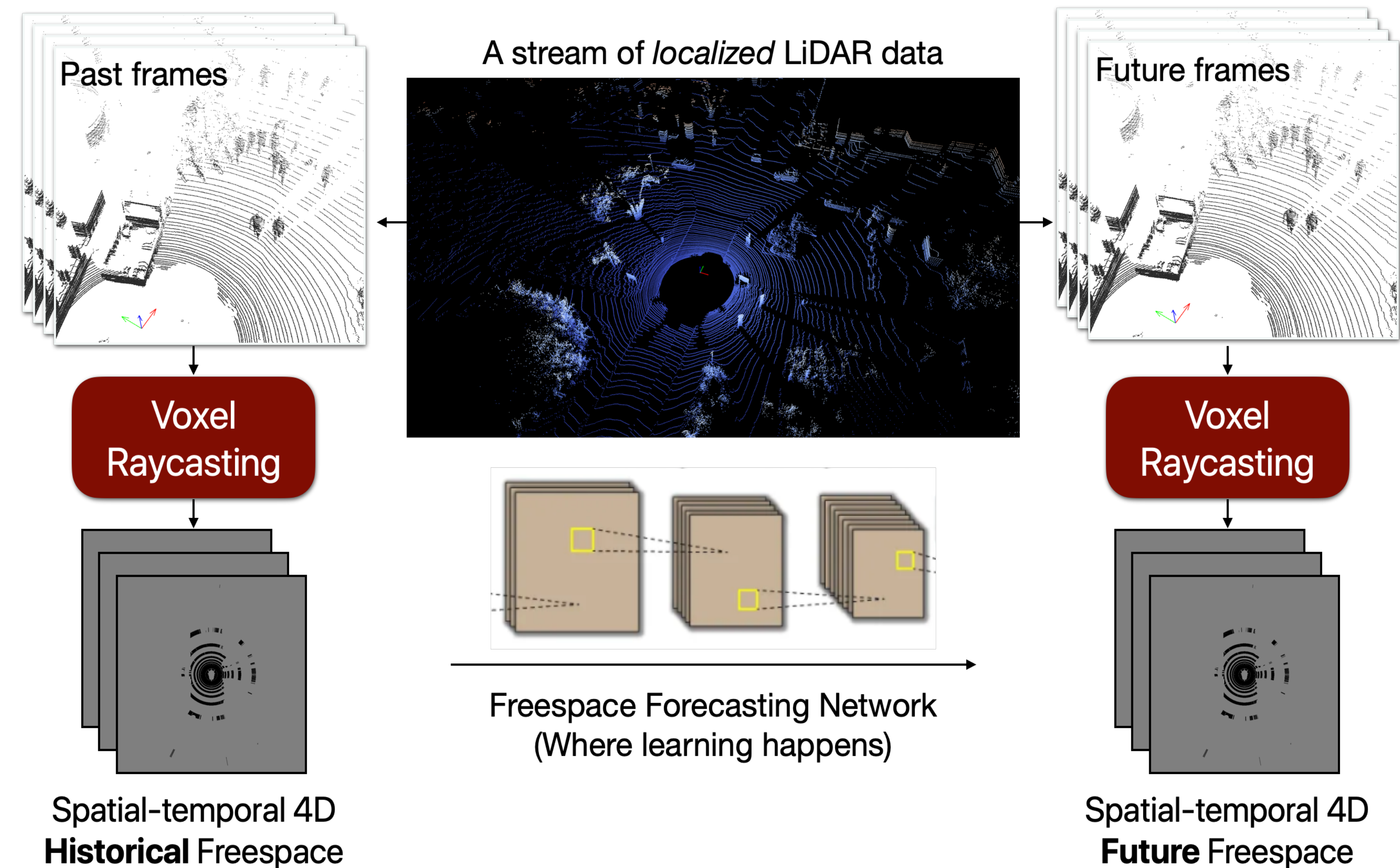
Standard: object-centric representations

- *Pros*: provide detailed object properties
- *Cons*: forecasting requires extensive labels

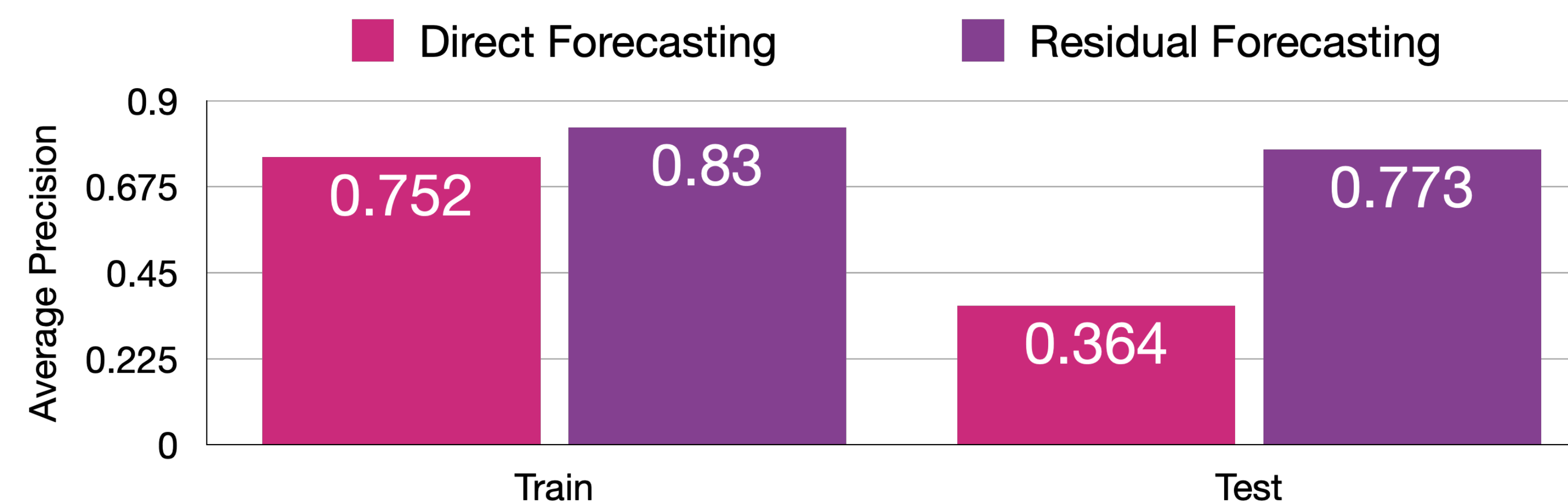### Proposed: freespace-centric representations

- *Cons*: no semantic, no instance, only geometry
- *Pros*: forecasting can be self-supervised
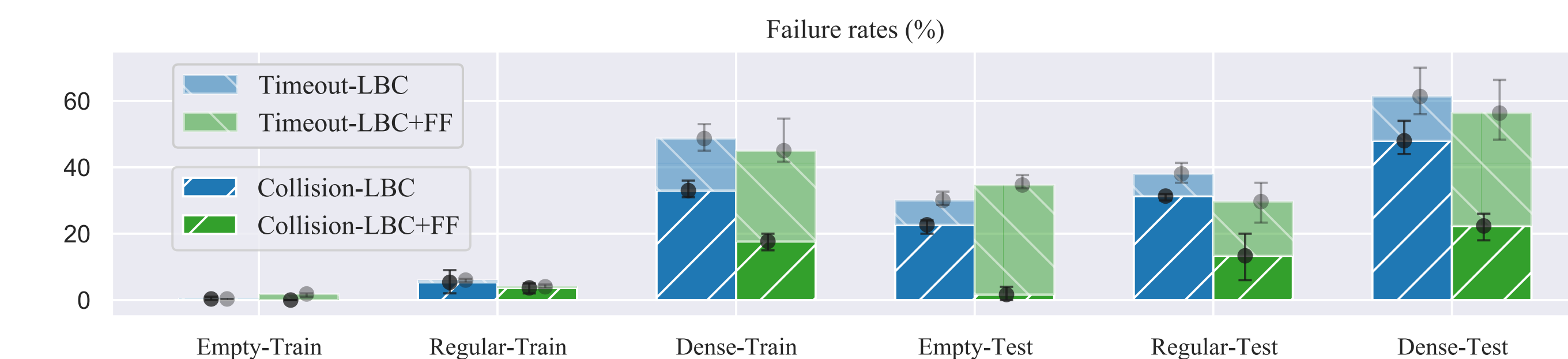
Self-Supervised Freespace Forecasting

Past frames

A stream of *localized* LiDAR data

Future frames

Voxel Raycasting

Voxel Raycasting

Freespace Forecasting Network
(Where learning happens)

Spatial-temporal 4D **Historical** Freespace

Spatial-temporal 4D **Future** Freespace

Forecasting Residuals

Direct Forecasting | Residual Forecasting

Average Precision

	Train	Test
Direct Forecasting	0.752	0.364
Residual Forecasting	0.83	0.773

Planning with Forecasted Freespace

CARLA NoCrash [1]

LBC [2]

Failure rates (%)

Timeout-LBC
Timeout-LBC+FF
Collision-LBC
Collision-LBC+FF
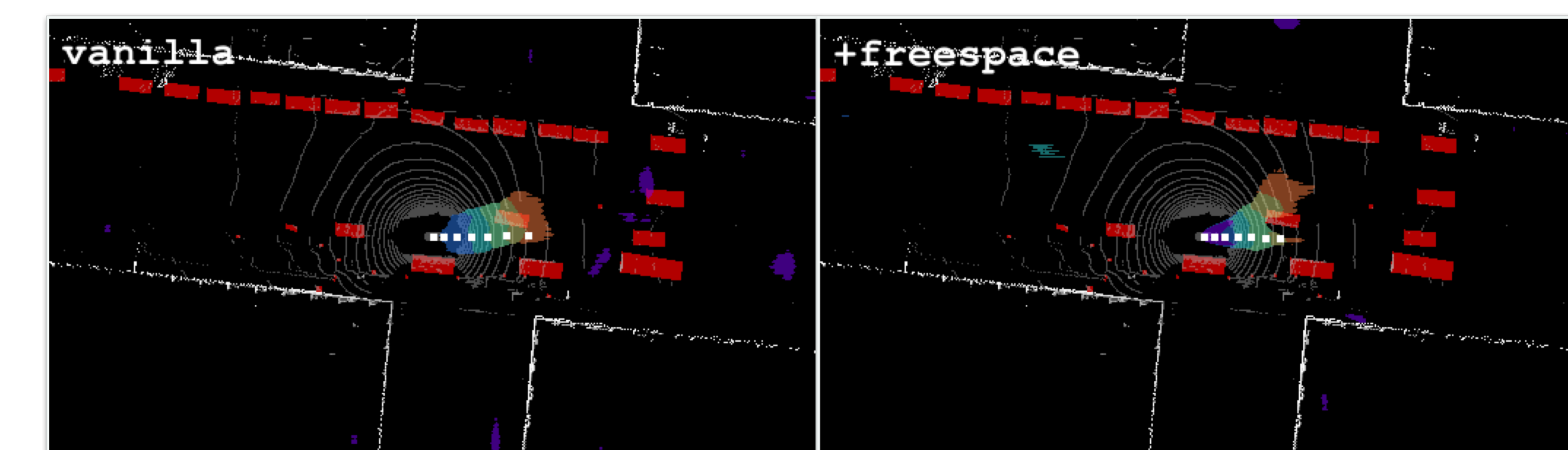
Post-processing LBC[2] on CARLA NoCrash[1]

Learning to Plan with Future Freespace

Vanilla NMP [3]   + freespace supervision

[1] Exploring the Limitations of Behavior Cloning for Autonomous Driving, Codevilla et al.
[2] Learning by Cheating, Chen et al.
[3] End-to-end Interpretable Neural Motion Planner, Zeng et al.

Website: https://cs.cmu.edu/~peiyunh/ff