

香港中文大學
The Chinese University of Hong Kong



PGDrive: Procedural Generation of Driving Environments for Generalization

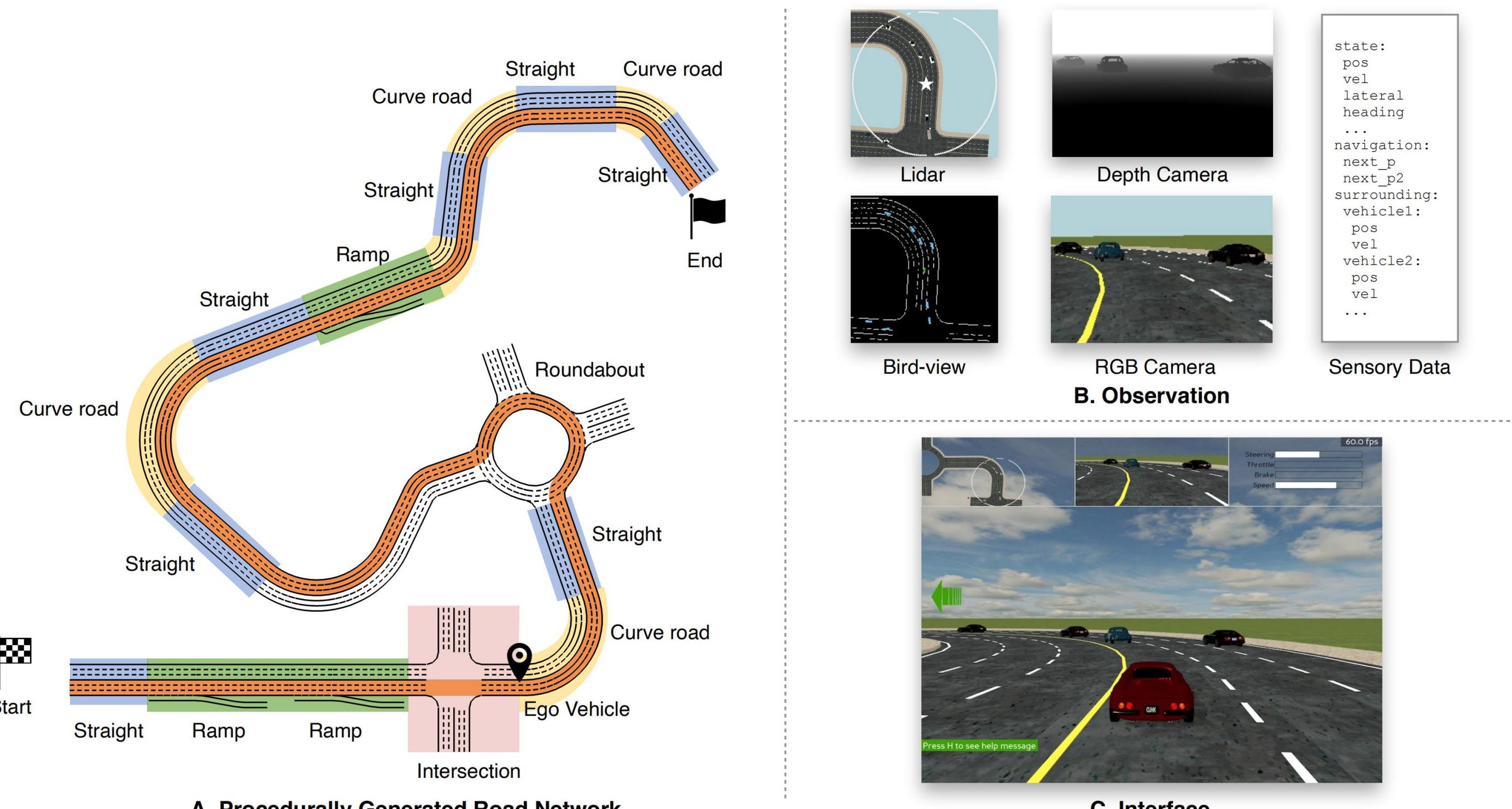
Quanyi Li^{1*}, Zhenghao Peng^{2*}, Qihang Zhang^{3,4}, Chunxiao Liu³, Bolei Zhou²

¹Centre for Perceptual and Interactive Intelligence, ²The Chinese University of Hong Kong, ³SenseTime Research, ⁴Zhejiang University



PGDrive Simulator

To evaluate and improve the generalization of end-to-end driving, we introduce PGDrive, an open-ended and highly configurable driving simulator.



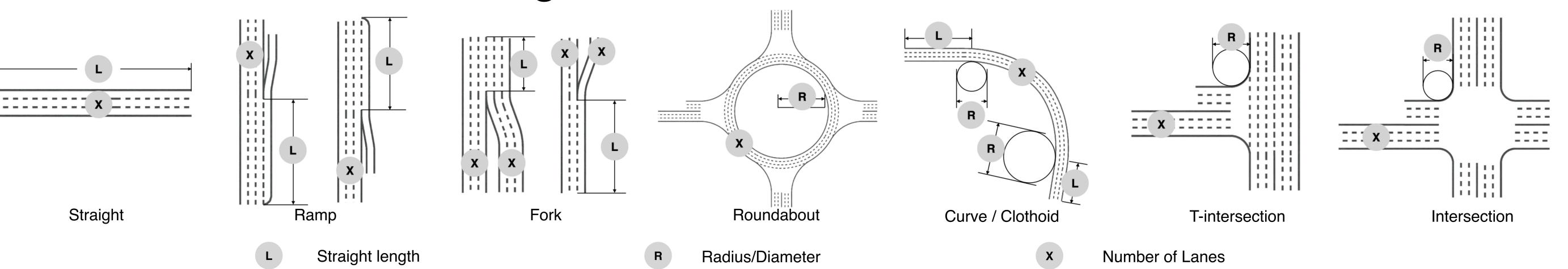
A. Driving map built from elementary road blocks.

B. Multi-modal observations provided by PGDrive, including Lidar-like cloud points, RGB / depth camera, bird-view semantic map and scalar sensory data.

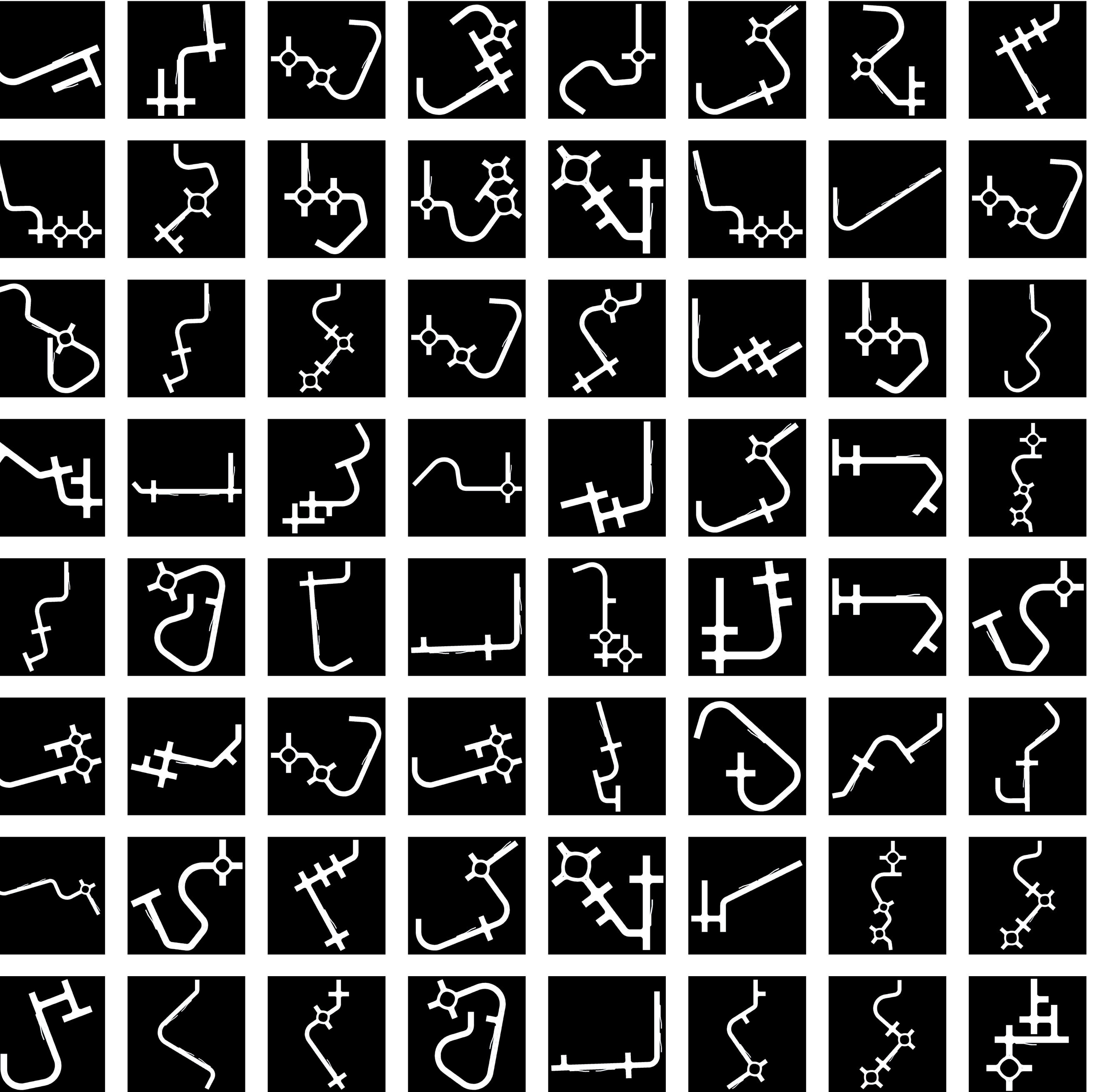
C. Interface of the PGDrive simulator for visualization and manual control.

Procedural Generation

We define seven typical types of road blocks and use the Procedural Generation (PG) technique to automatically select and assemble these blocks into diverse driving scenes.



Some Generated Maps



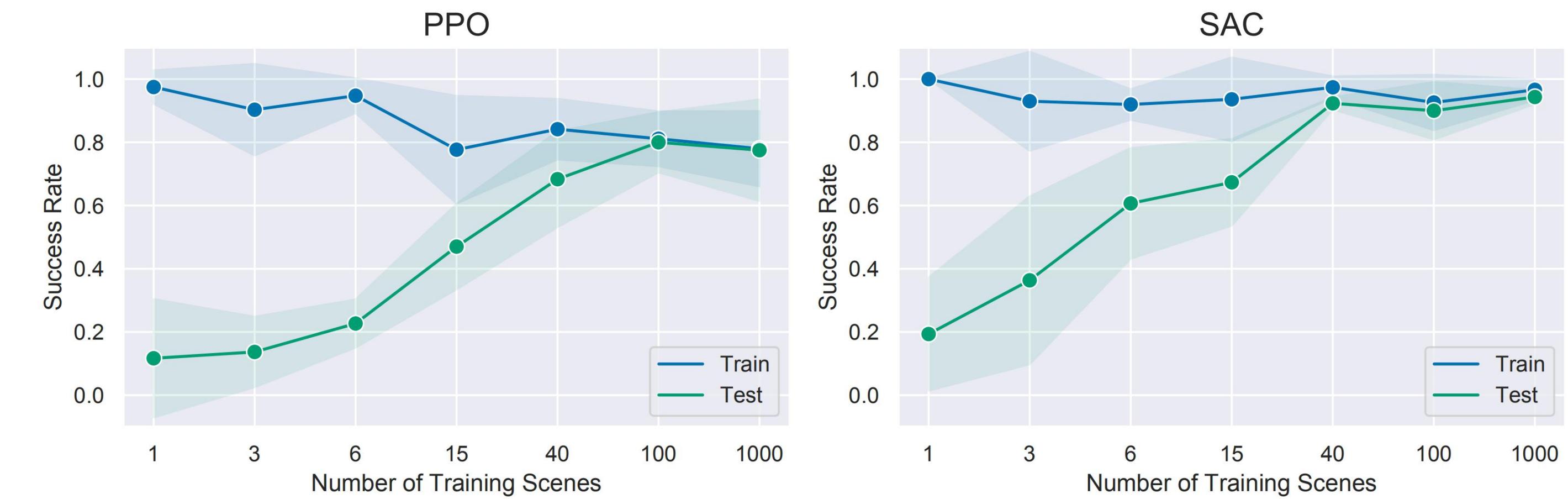
Experiment Result

Experiment Setting:

We split the generated maps into two sets: the **training** set and **test** set. We train the agents with two popular Reinforcement Learning (RL) algorithms, PPO and SAC.

Main Result:

The generalization of RL agents can be improved by increasing the diversity of training environments.



Other Applications

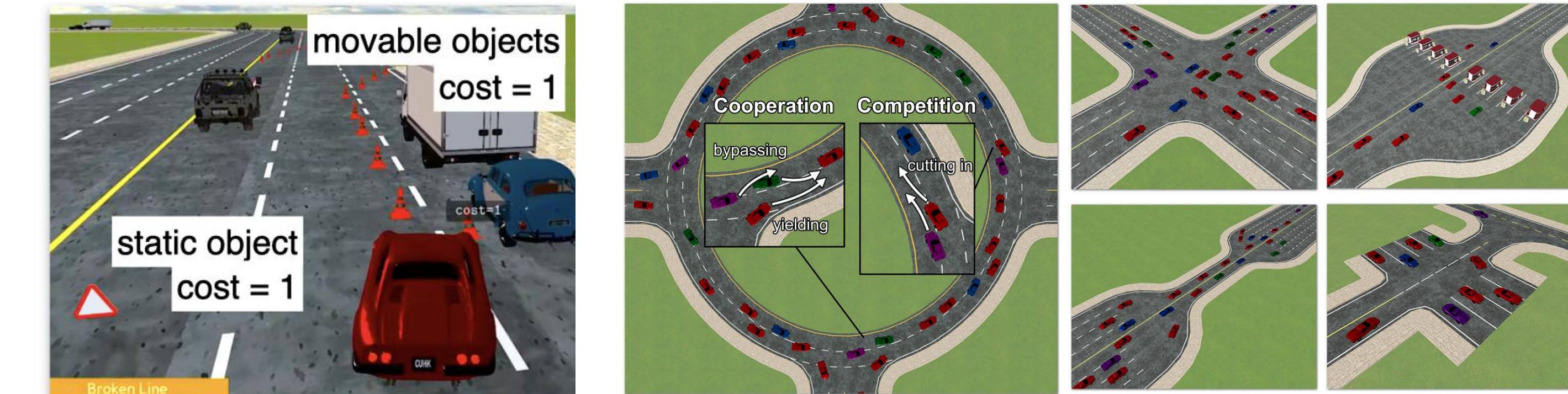


Fig. 1 Safe RL

- Safe RL:** PGDrive supports scattering obstacles in the road and recording the collision, which is useful for investigating the safe exploration problem in RL.
- Multi-agent RL:** Complex Multi-agent scenarios such as tollgate, roundabout, intersection, parking lot, bottleneck etc. can be easily assembled. Besides, PGDrive can reach ~50 FPS in PC with +40 controllable agents running concurrently.

Conclusion

We introduce the **PGDrive**, an open-ended and highly customizable driving simulator with the feature of procedural generation. Experiment results show that increasing the diversity of training environments can substantially improve the generalization of the end-to-end driving.

Website: <https://decisionforce.github.io/pgdrive/>

Github: <https://github.com/decisionforce/pgdrive>

Paper: [Improving the Generalization of End-to-End Driving through Procedural Generation](#)