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GRIAD: General Reinforced Imitation for Autonomous Driving

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Context and Setup

The CARLA Simulator [1]

- Open-source simulator in urban environment for research in autonomous driving.

Our goal

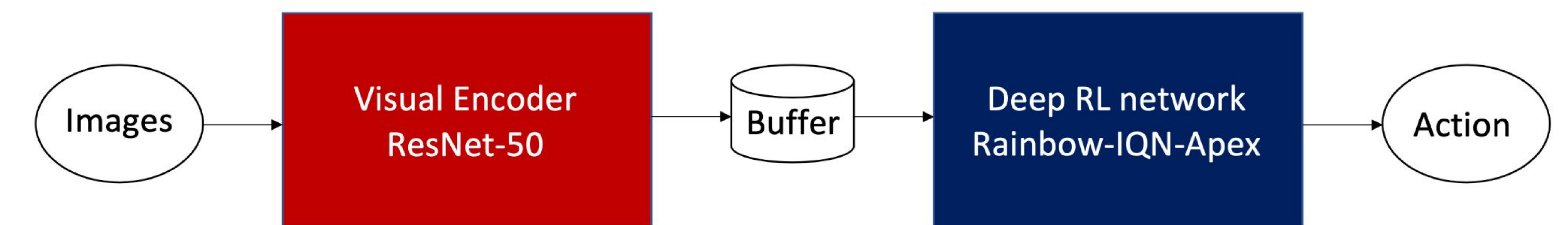
- Best score on CARLA leaderboard.
- Important metrics: driving score, route completion.



The baseline

End-to-end AD pipeline [2]

- Images are encoded to what is called *Implicit Affordances (IAs)*, then used as RL state.



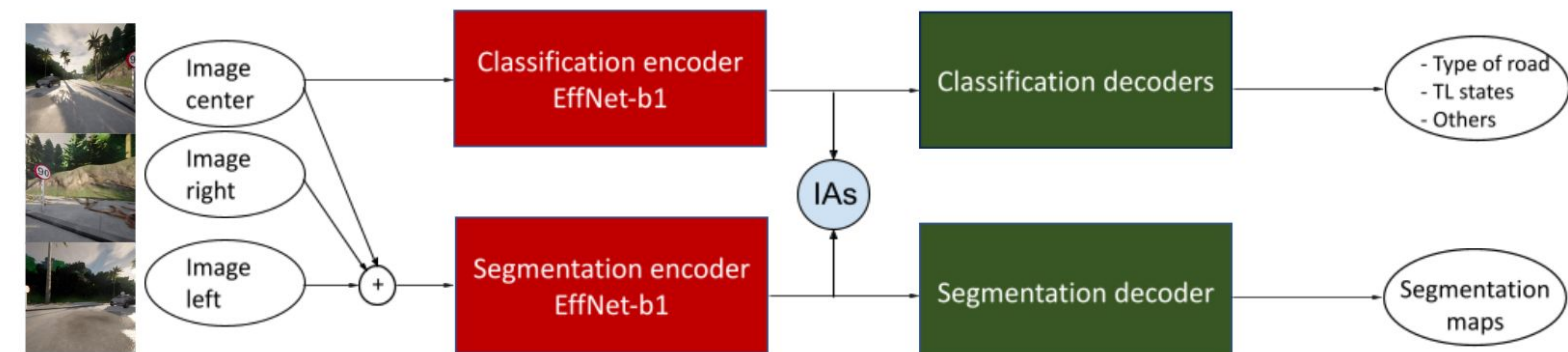
Design of the visual encoder

Design of the visual encoding part

- **Two small specialized EfficientNet [6]**: one for classification tasks, one for segmentation. Results are concatenated.
- **Three cameras** front center, front right and front left.

Training the network

- Visual encoding block is **pre-trained** with carefully chosen decoders, then frozen.



Design on the RL part

DRL architecture

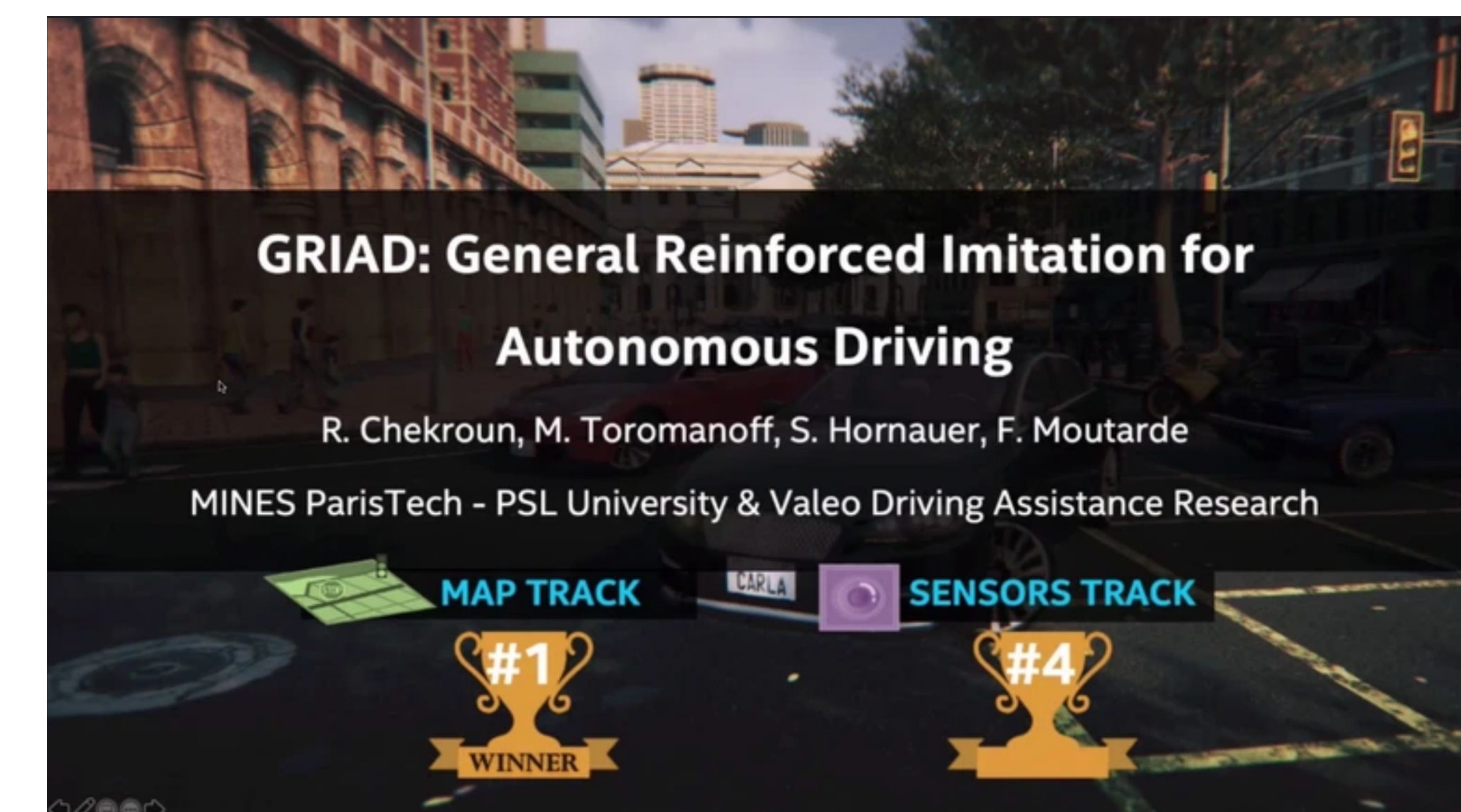
- Rainbow-IQN-Apex: distributed DQN with some optimizations [3].

Limitations

- Slow training: exploration in CARLA is expensive. Offline RL might be a solution [4].
- Complex task: RL is difficult to train and design

Reinforced Imitation Learning (RIL)

- GRI: New RL scheme also using expert data. Training is 5x faster and metrics 30% better. [5]
- **CARLA Challenge 2021 Winner**



Conclusions

- Showed the advantages of two specialized visual encoders over a single bigger one.
- Introducing the GRI scheme, shown to accelerate training and improve final results.
- Winner of the CARLA Challenge 2021. Presented at NeurIPS 2021, ML4AD Workshop. Updated version published in *Robotics in 2023*.

References

- [1] Dosovitskiy et al., *CARLA: An Open Urban Driving Simulator*, 2017
- [2] Toromanoff et al., *End-to-End Model-Free Reinforcement Learning for Urban Driving Using Implicit Affordances*, 2020
- [3] Toromanoff et al., *Is Deep Reinforcement Learning Really Superhuman on Atari? Leveling the playing field*, 2019
- [4] Levine et al., *Offline Reinforcement Learning: Tutorial, Reviews and Perspectives on Open Problems*, 2020
- [5] Chekroun et al., *GRI: General Reinforced Imitation and its Application to Vision-Based Autonomous Driving*, 2021
- [6] Tan et al., *EfficientNet: Rethinking Model Scaling For Convolutional Neural Network*, 2020