HAL open science

GRIAD: General Reinforced Imitation for Autonomous Driving

R Chekroun, M Toromanoff, F Moutarde

To cite this version:

R Chekroun, M Toromanoff, F Moutarde. GRIAD: General Reinforced Imitation for Autonomous Driving. PAISS summer school, Jun 2021, Paris, France. hal-04232465

HAL Id: hal-04232465

https://hal.science/hal-04232465v1

Submitted on 8 Oct 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

GRIAD: General Reinforced Imitation for Autonomous Driving

R. Chekroun, M.Toromanoff, F. Moutarde
raphael.chekroun@minesparis.psl.eu, fabien.moutarde@minesparis.psl.eu, marin.toromanoff@valeo.com

Context and Setup

The CARLA Simulator [1]

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

Our goal

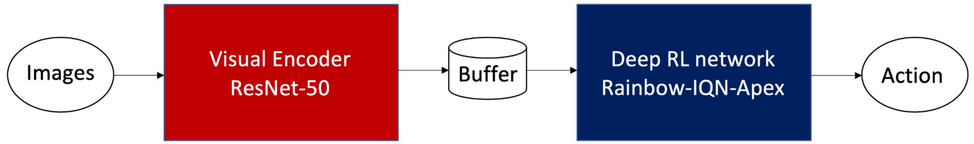
- Best score on CARLA leaderboard.
- Important metrics: driving score, route completion.

The baseline

End-to-end AD pipeline [2]

.

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



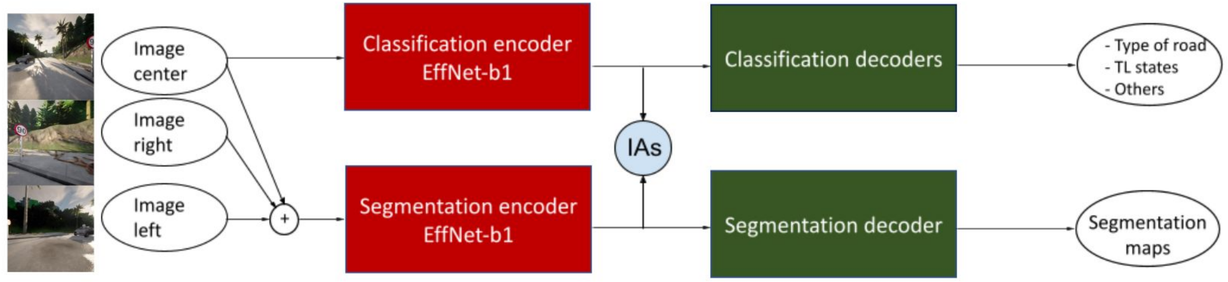
Design of the visual encoder

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