End-to-End Driving in a Realistic Racing Game with Deep Reinforcement Learning

Etienne Perot¹
Maximilian Jaritz¹,²
Marin Toromanoff¹
Raoul de Charette²

Learning direct control from image

Challenges
- Full control
- Realistic graphics, complex dynamics
- Racing setup: fast driving, drifting

State Encoder and Policy

Game

Steering [-1, 1]
Acceleration [0, 1]
Brake [0, 1]
Handbrake [0, 1]

Dedicated API
- Receive image, speed and angle, send controls

Related works
- Deep reinforcement learning [1] TORCS
- Direct perception [2] TORCS
- Behavioral cloning for lateral control [3] Transformed real images

A3C Algorithm [1]
- Asynchronous: No experience replay needed
- Multi-agent: Parallel computing

State Encoder
- LSTM takes additional inputs (previous action, current speed)
- Outputs action probabilities (softmax)

Reward
- Frame-wise, function of speed and angle
- New: add distance from the middle of the track as penalty

Joint training on 3 tracks with different graphics and physics

Task specific evaluation metrics
- Performance after 170 million steps
- Generalization

Test on unseen track
- Trained with 15 agents (5 per track)
- Average run: 121 km/h, 1.29 km, 2.5 crashes/km
- Qualitative performance in video