>>> Imitation via Abstraction and Planning
>>> [Talk at ETH]

Kashyap Chitta[†] (University of Tübingen)

20-02-2023

>>> What We'll Discuss

* TransFuser: SOTA driving agent on CARLA
* Imitating algorithms
* New directions via data-driven simulation

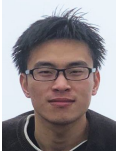
>>> Team

Kashyap Chitta

Bernhard Jaeger

Katrin Renz

Aditya Prakash



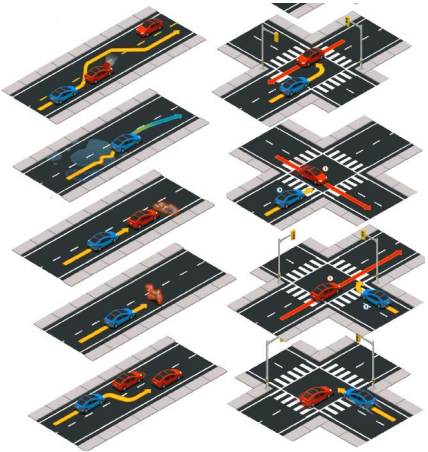
Zehao Yu

Andreas Geiger

>>> "Autonomous Intersection in Action"

[Video Credit: Black Sheep Films]

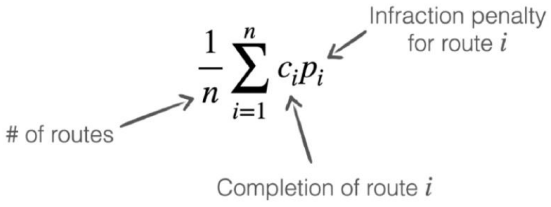
>>> CARLA Leaderboard

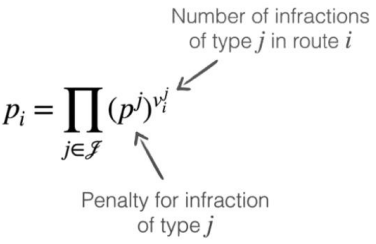


- 10 routes x 2 weathers x 5 repetitions
- 173 Km of driving experiences

[Slide Credit: German Ros]

>>> Evaluation





[Slide Credit: German Ros]

>>> How?

* Modular pipeline?

>>> How?

* Modular pipeline?
* Reinforcement learning?

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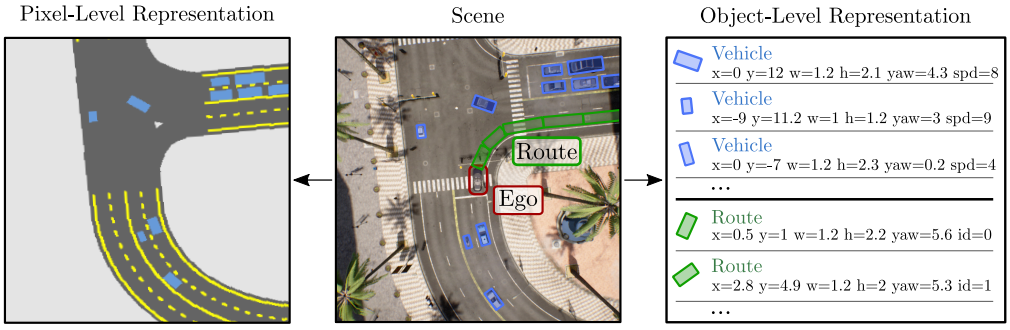
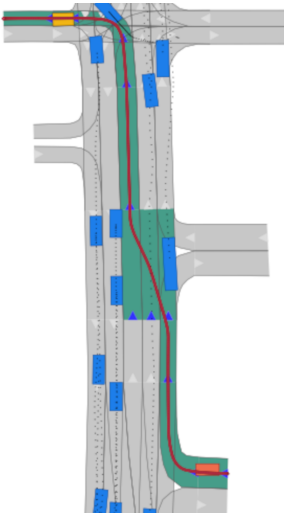
* Modular pipeline?
* Reinforcement learning?
* Imitation learning?

[TransFuser: Imitation with Transformer-Based Sensor Fusion. Chitta et al., PAMI 2022]

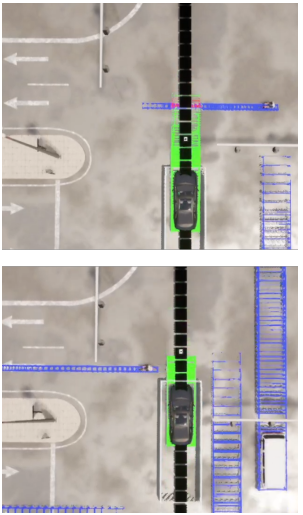
>>> Step 1: Abstraction



>>> Step 2: Planning

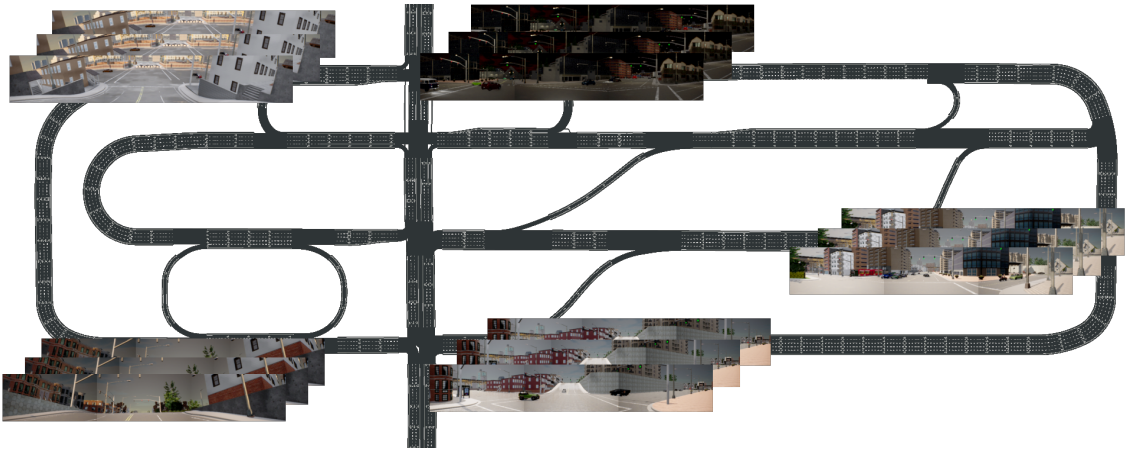


Optimal Path



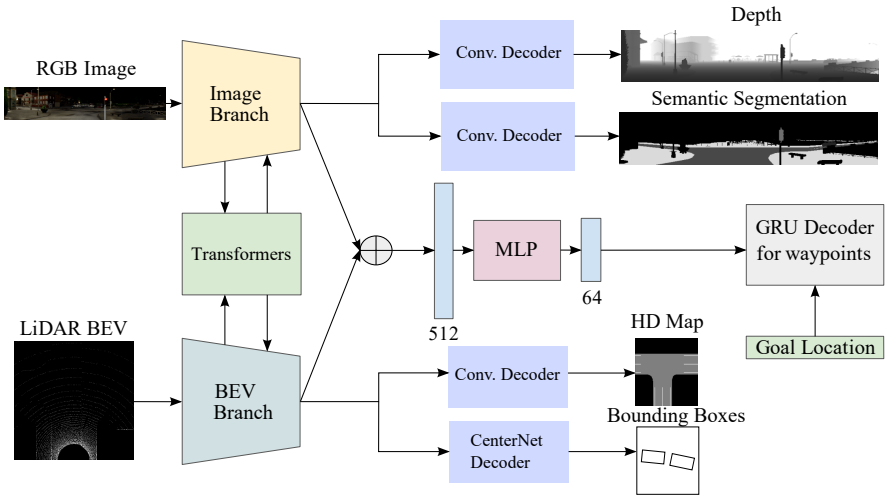
Model Predictive Control

>>> Step 3: Imitation



[TransFuser: Imitation with Transformer-Based Sensor Fusion. Chitta et al., PAMI 2022]

>>> Architecture



>>> Key Result

Method	Driving ↑	Completion ↑	Safety ↑
Late Fusion (LF)	22 ± 4	83 ± 3	0.27 ± 0.03
Geometric Fusion (GF)	27 ± 1	91 ± 1	0.30 ± 0.02
TransFuser (Ours)	47 ± 6	93 ± 1	0.50 ± 0.00
Privileged MPC	*77 ± 2*	*89 ± 1*	*0.86 ± 0.03*

* GF, TransFuser and MPC have similar completion
* Clear trend in infractions (MPC > TransFuser > Baselines)

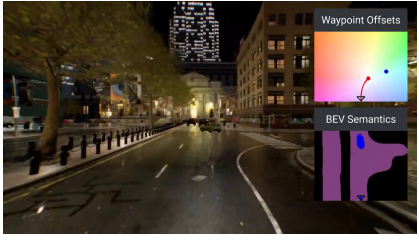
>>> CARLA Leaderboard (Challenge 2021)

Method	Driving ↑	Completion ↑	Safety ↑
LAV	62	94	0.64
TransFuser (Ours)	61	87	0.71
GRIAD	37	62	0.60
WOR	31	58	0.56

* Simple (competitors have complex multi-stage training)
* Rank 2, with least infractions among top methods
* Still gets blocked more often than LAV
* With engineering improvements (3x data), won the map track in 2022

[TransFuser: Imitation with Transformer-Based Sensor Fusion. Chitta et al., PAMI 2022]

>>> Imitating Algorithms

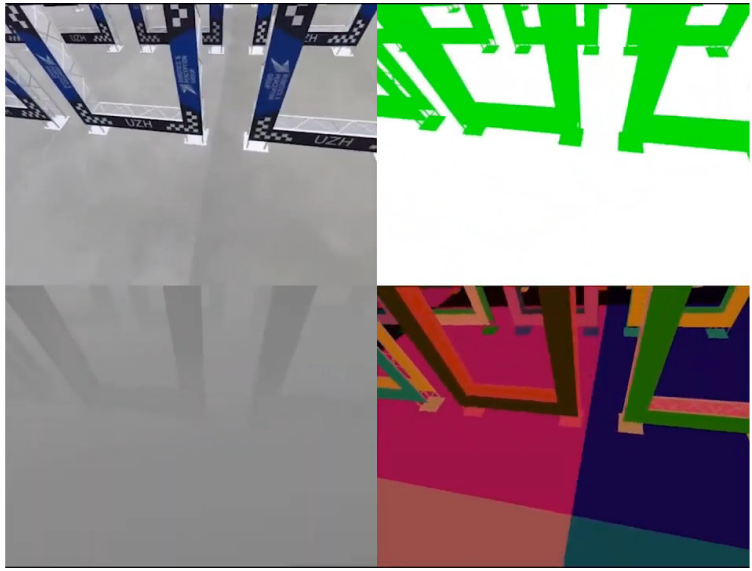


Legged Locomotion

Driving

>>> Superhuman?

>>> Step 1: Abstraction



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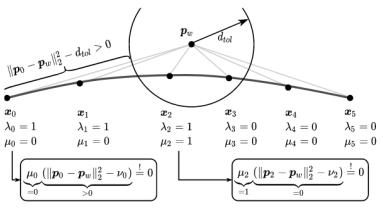
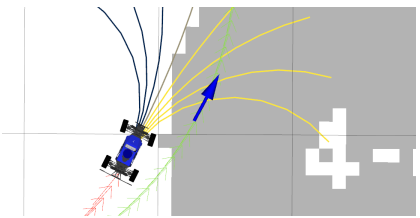


Optimal Path



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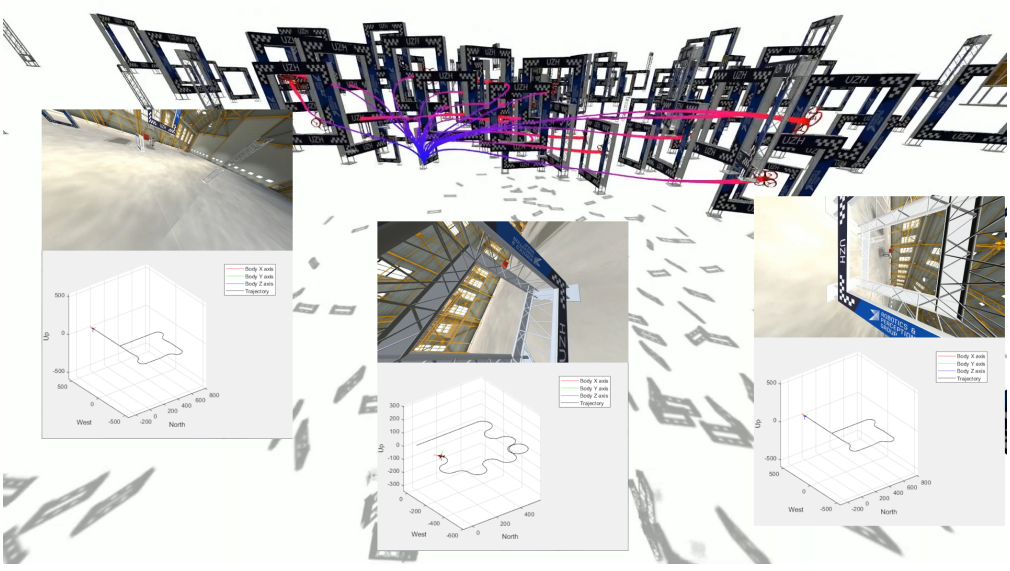
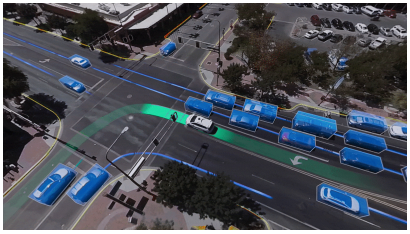


>>> Summary: Imitating Privileged Planners

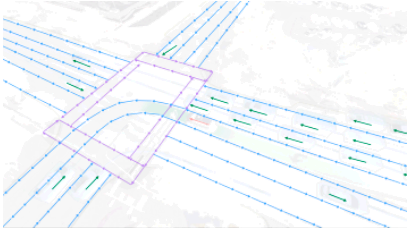


State

Action

Abstraction and Planning

Imitation

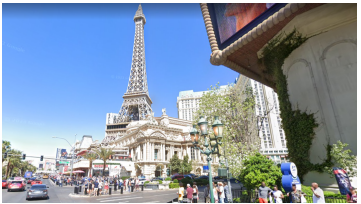


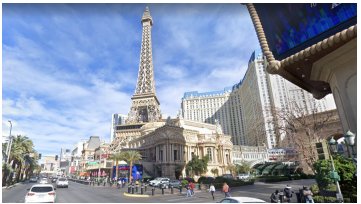
State

Action

>>> Abstraction in the Real World





>>> Step 1: Mapping

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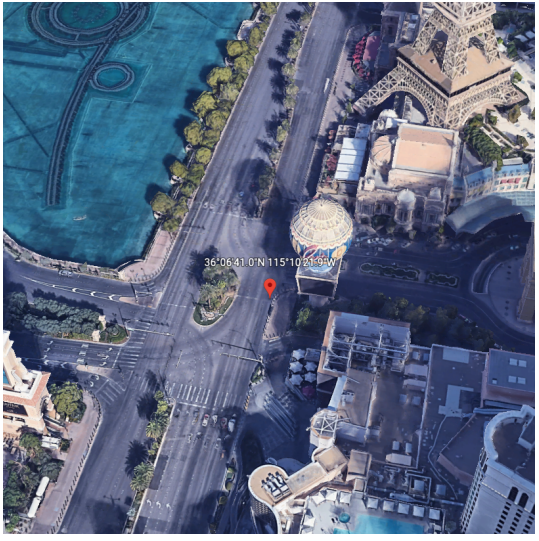

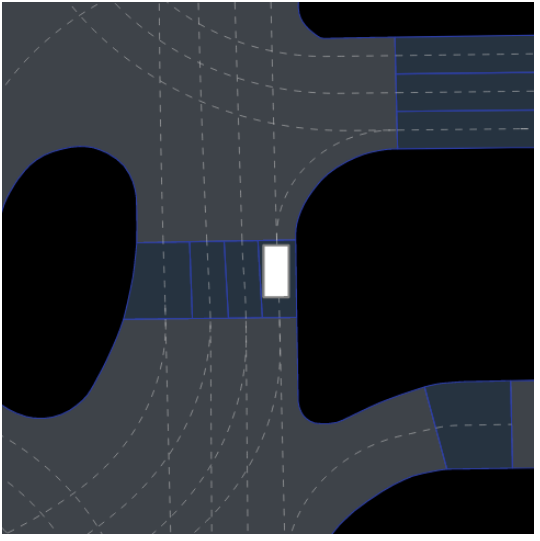

>>> Step 2: Auto-Labeling

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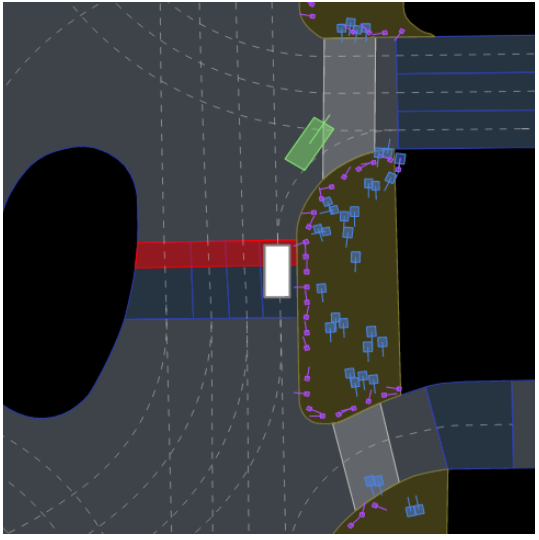
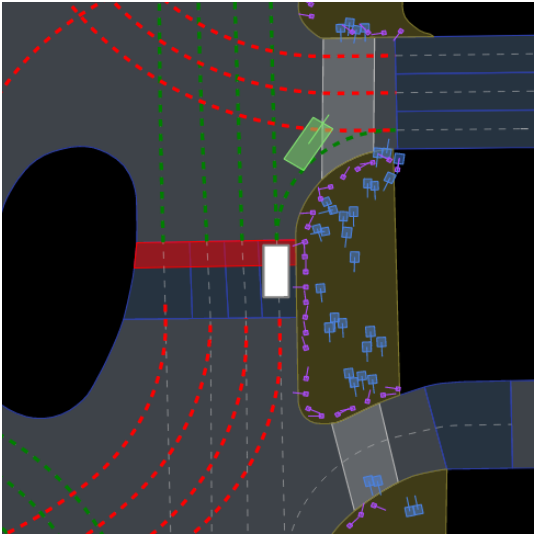
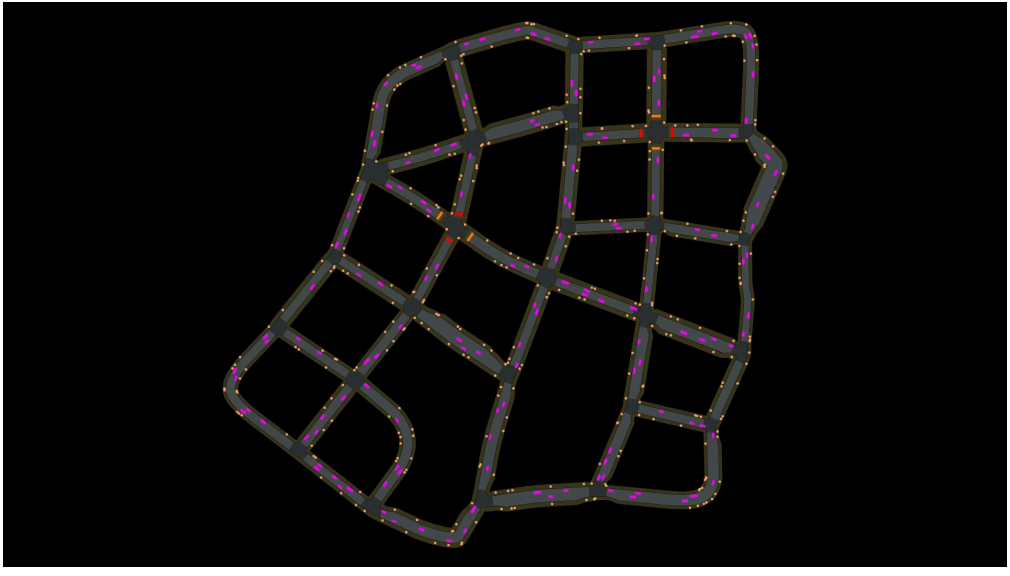




>>> Step 3: Moving Things



nuPlan Planning

website GitHub Stars 280 Forks 46 submission EvalAI

Task Description

Previous benchmarks focus on short-term motion forecasting and are limited to open-loop evaluation. nuPlan introduces long-term planning of the ego vehicle and corresponding metrics. Provided as docker containers, submissions are deployed for simulation and evaluation.

Participation

The primary metric is the mean score over three increasingly complex modes: open-loop, closed-loop non-reactive agents, and closed-loop reactive agents. Participants can follow the steps to begin the competition. To submit your results on EvalAI, please follow the submission instructions.

Important Dates

Test Phase End	May 18, 2023
Finalist Notification and Verification	May 19, 2023
Winner Announcement	Jun 02, 2023
Winner Presentation	Jun 18, 2023

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* Simple imitation of algorithmic expert is SOTA on CARLA
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* nuPlan: an exciting new challenge!
  www.github.com/motional/nuplan-devkit/

>>> Other Work

* Chitta et al. NEAT: Neural Attention Fields ICCV, 2021.
  BEV predictions from 2D images via neural fields can improve safety

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  Optimizing train data to contain near-collisions halves collision rates

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* Renz et al. PlanT: Explainable Planning Transformers CoRL, 2022.
  Transformer planners can identify the most relevant object while driving

>>> Check out our challenges!

[Thank You!]

>>> Inviting Contributions! (Deadline 01.03.2023)