Inverse Reinforcement Learning with Hybrid-weight Trust-region Optimization and Curriculum Learning for Autonomous Maneuvering

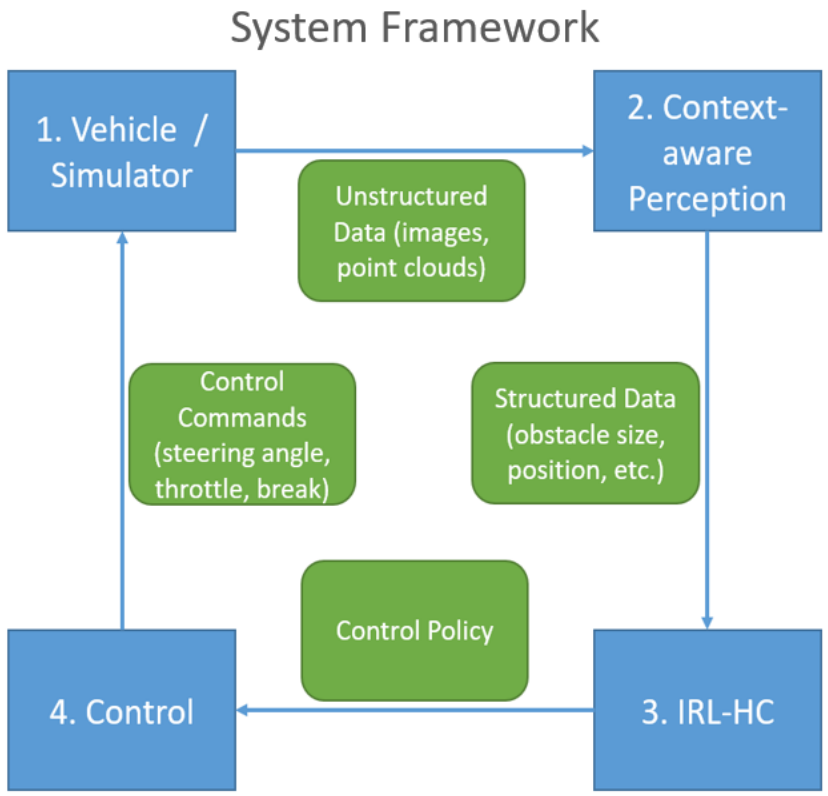
Yu Shen, Weizi Li, Ming C. Lin

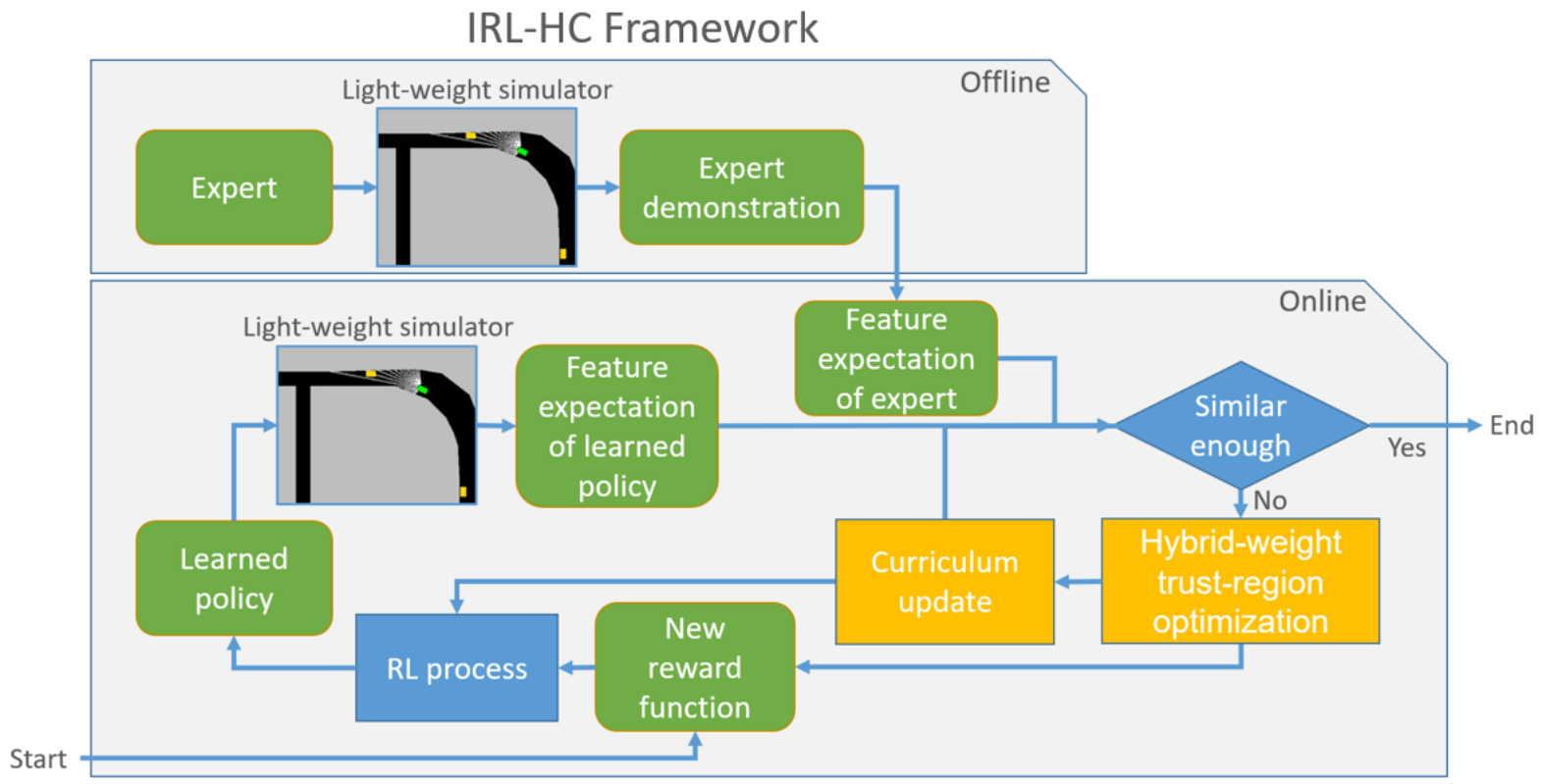
Key Contributions

- A novel IRL framework that contains hybrid-weight trust-region optimization and curriculum learning (IRL-HC).

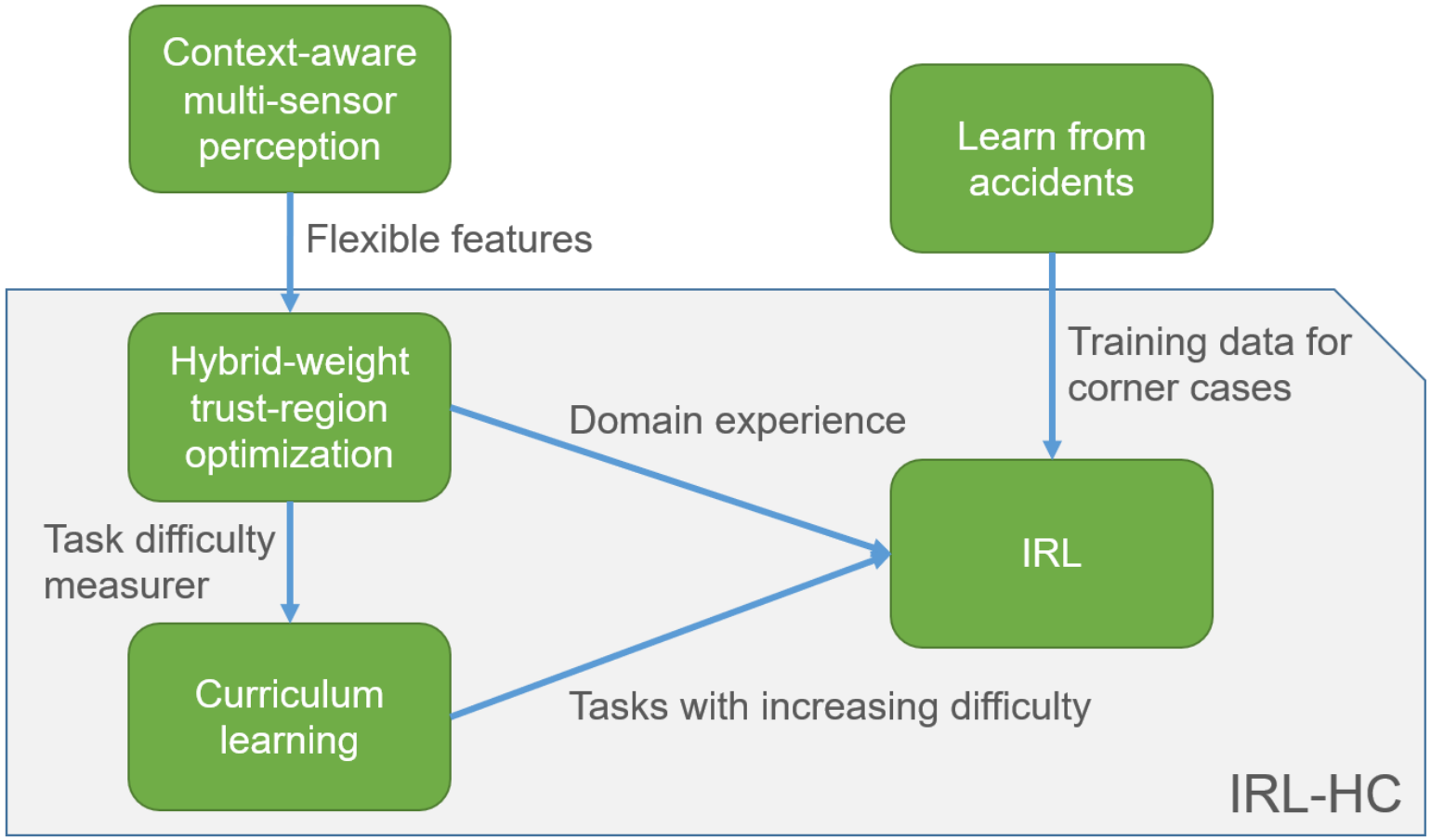
- A mediated-perception framework that contains context-aware multi-sensor perception and IRL-HC.

Framework


System Framework
1. Vehicle / Simulator
2. Context-aware Perception
Unstructured Data (images, point clouds)
Control Commands (steering angle, throttle, break)
Structured Data (obstacle size, position, etc.)
Control Policy
4. Control
3. IRL-HC


IRL-HC Framework
Offline
Light-weight simulator
Expert
Expert demonstration
Online
Light-weight simulator
Feature expectation of learned policy
Feature expectation of expert
Similar enough
Yes
End
No
Learned policy
Curriculum update
Hybrid-weight trust-region optimization
RL process
New reward function
Start

Module Relation



Comparison

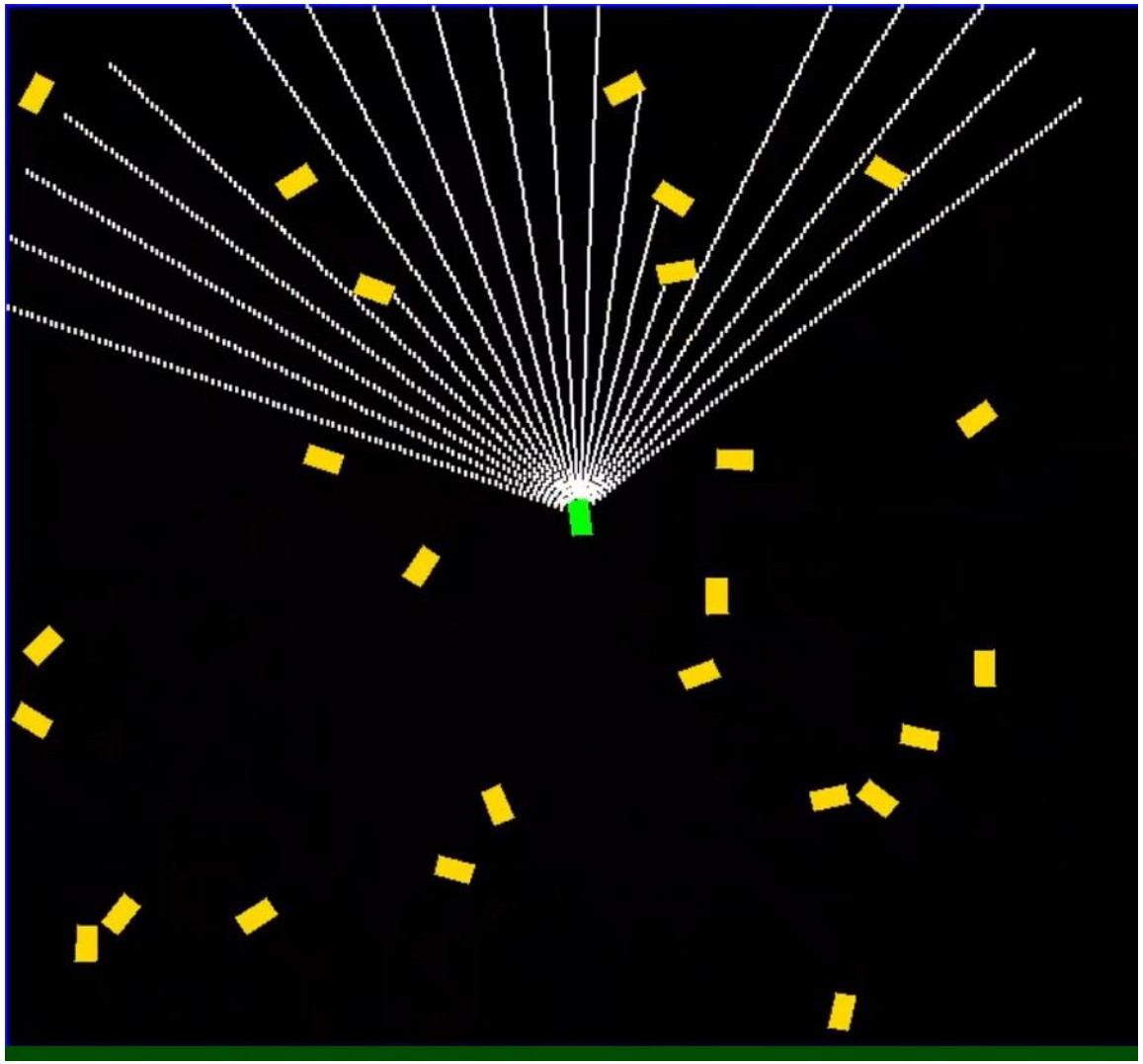
- Our method achieves highest score (s) and safe distance (l) among all the methods in all the test scenarios.

Method	$s_{final,2}$	$s_{final,3}$	$l_{final,1}$	$l_{final,2}$	$l_{final,3}$
IM [34]	77.4	60.1	105.6 m	53.7 m	44.7 m
IRL [2]	110.7	59.7	228.8 m	69.4 m	33.2 m
GAIL [19]	103.0	52.8	49.1 m	69.9 m	35.1 m
AIRL [21]	119.9	83.6	74.1 m	73.6 m	50.7 m
Ours	**203.2**	**179.6**	**279.1** m	**733.5** m	**335.9** m

Demo: Collision Avoidance in Open Space

A top-down view on AV navigating among multiple moving cars in open space.

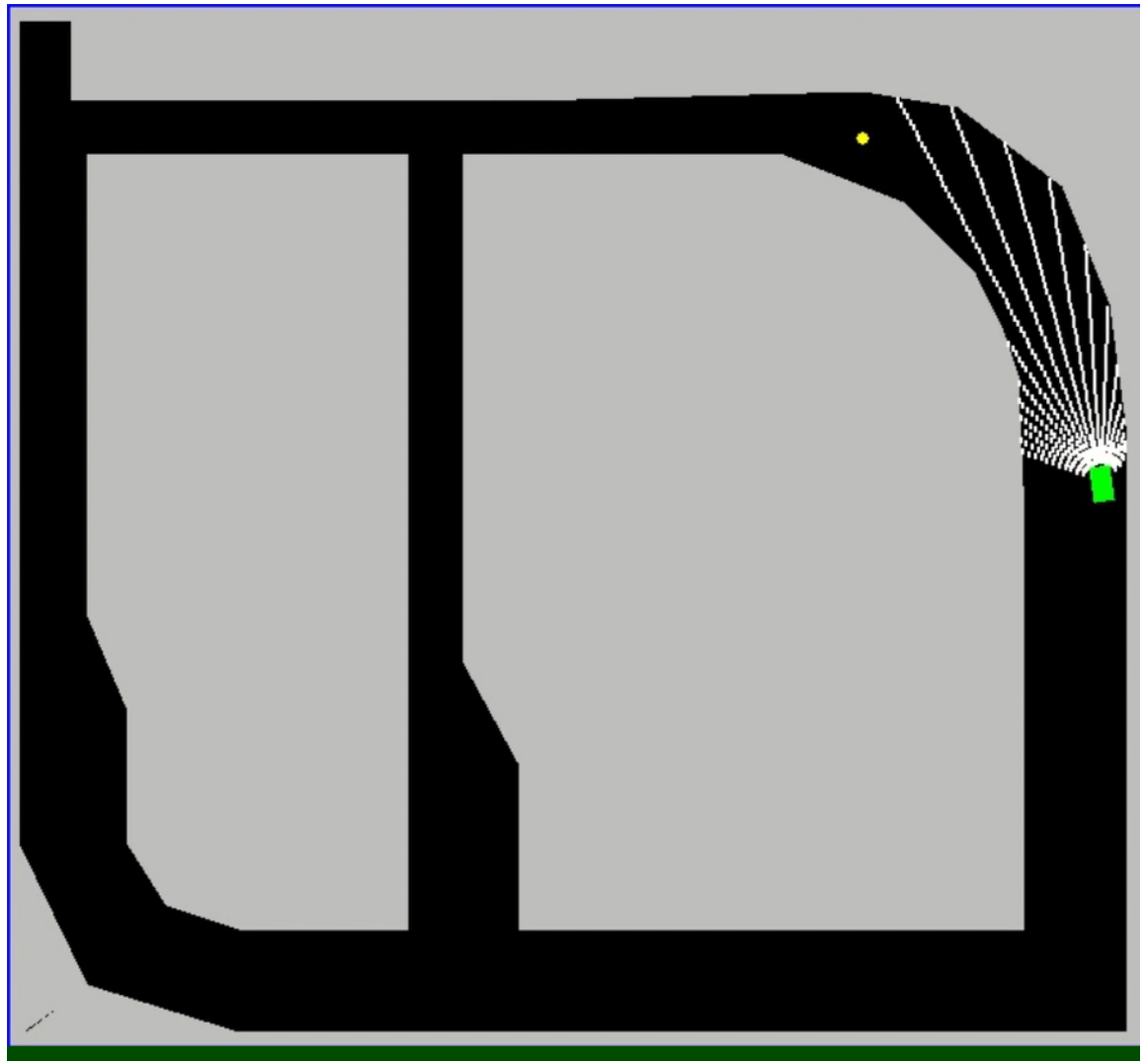
Green box: our car
Golden box: other cars



Demo: Collision Avoidance on City Streets

A top-down view on AV navigating in a city scene.

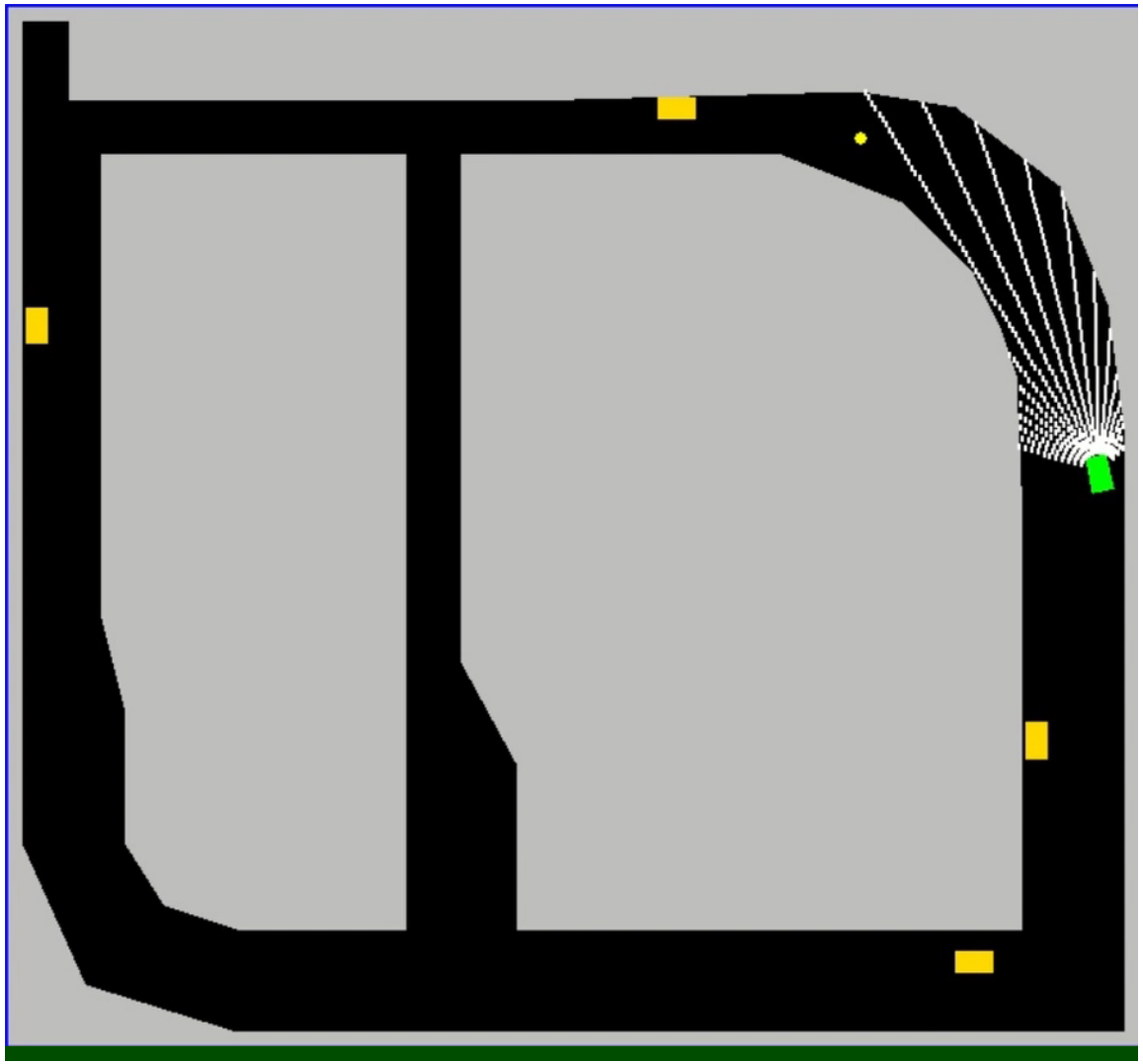
Green box: our car
Grey area: obstacles
Yellow dots: waypoints



Demo: Collision Avoidance on City Streets with Other Cars

A top-down view on AV navigating in a city scene with multiple moving cars.

Green box: our car
Grey area: obstacles
Golden box: other cars
Yellow dots: waypoints



Demo: System-level

A 3D perspective view of the AV driving toward a destination through city streets passing multiple moving vehicles.

Thanks!