

A decorative graphic on the left side of the slide consisting of two overlapping parallelograms. The front one is blue and the back one is light green. They are positioned diagonally, with the blue one partially covering the green one.

Robot Parallel Motion Planning

Milestone 2

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Roadmap

Goal: Enable autonomous robot to navigate to a goal in an unknown environment using the power of the GPU

- Milestone 1 (11/18):
 - Simulation infrastructure
 - Understanding GMT*

- Milestone 2 (11/25):
 - Motion planning (GMT*)

- Milestone 3 (12/2):
 - Perception and localization
 - Optimizations

- Final Submission (12/8):
 - Presenstation
 - Performance analysis

Issues

Sampling and node cost structure

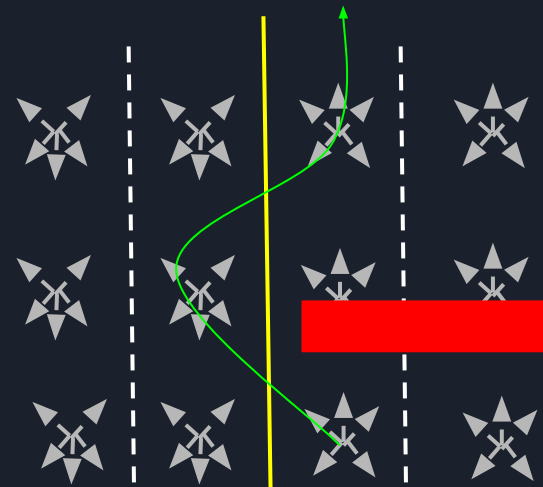
Sensor syncing

Solutions

Contact author and review references

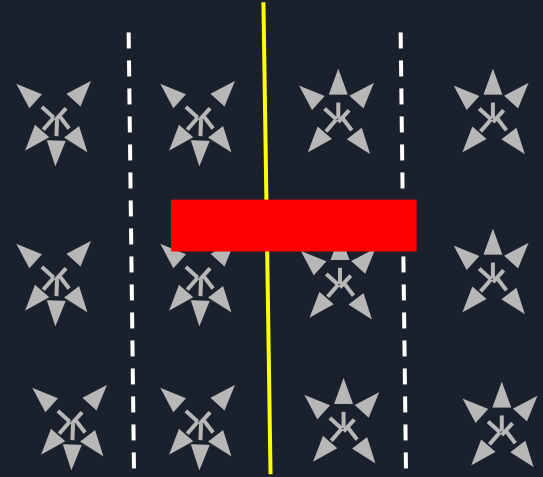
Review CARLA documentation

Samples



How do we decide how costly each movement is?

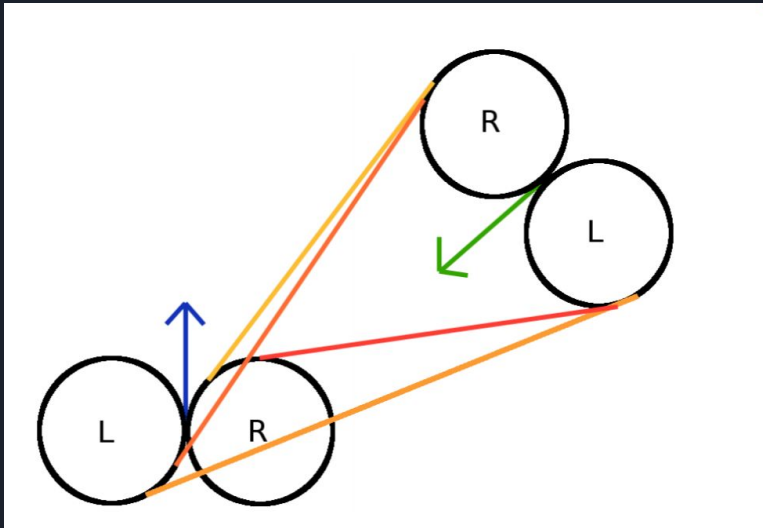
- Car is a non-holonomic robot
- We assume that our car can only go forward
- It is proven then the most optimal path is going to be one of the Dubins paths as long as some constraints are met



Dubins Paths

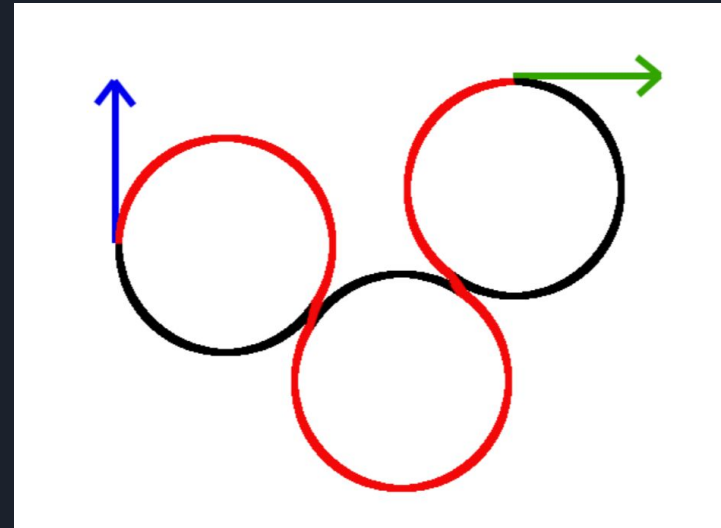
$$(X_0, Y_0, \theta_0) \longrightarrow (X_1, Y_1, \theta_1)$$

Curve-Straight-Curve



LSL, RSR, LSR, RSL

Curve-Curve-Curve

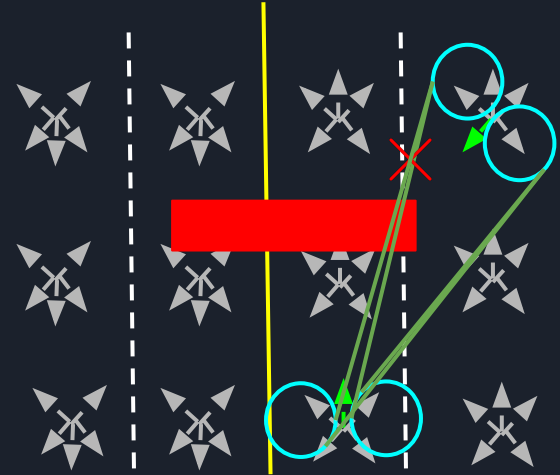


LRL, RLR

Dubins Paths + Collision Check

Let's look at the Curve-Straight-Curve paths!

- Right->Straight->Left
- Right->Straight->Right
- Left->Straight->Right
- Left->Straight->Left



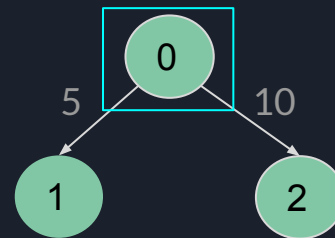
GMT*

0	1	2	3	4	5	waypoints
[1,2]	[0,3]	[0,3,4]	[1,2,4]	[2,3,5]	[4]	neighbors
-1	-1	-1	-1	-1	-1	parent
0	∞	∞	∞	∞	∞	cost

0	1	1	1	1	1	unexplored
0	0	0	0	0	0	closed
1	0	0	0	0	0	open
1	0	0	0	0	0	wave front

Cost threshold: 0

0	1	1	0	0	0	unexplored neighbors
1	2	X	stream compact			



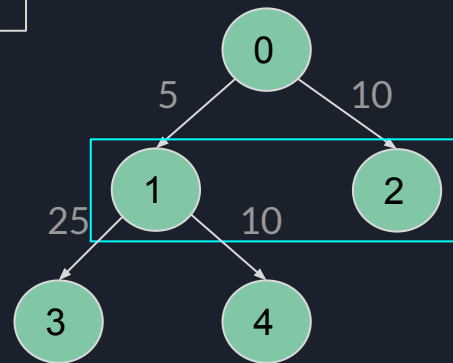
GMT*

0	1	2	3	4	5	waypoints
[1,2]	[0,3]	[0,3,4]	[1,2,4]	[2,3,5]	[4]	neighbors
-1	0	0	-1	-1	-1	parent
0	5	10	∞	∞	∞	cost

0	0	0	1	1	1	unexplored
1	0	0	0	0	0	closed
0	1	1	0	0	0	open
0	1	1	0	0	0	wave front

Cost threshold: 10

0	0	0	1	1	0	unexplored neighbors
3	4	X	stream compact			



GMT*

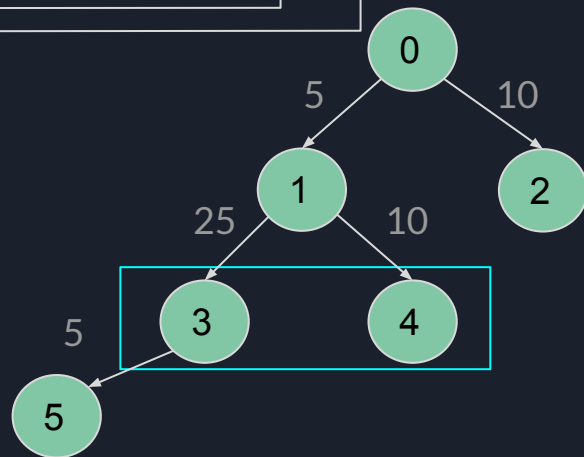
0	1	2	3	4	5	waypoints
[1,2]	[0,3]	[0,3,4]	[1,2,4]	[2,3,5]	[4]	neighbors
-1	0	0	1	1	-1	parent
0	5	10	30	15	∞	cost

0	0	0	0	0	1	unexplored
1	1	1	0	0	0	closed
0	0	0	1	1	0	open
0	0	0	1	1	0	wave front

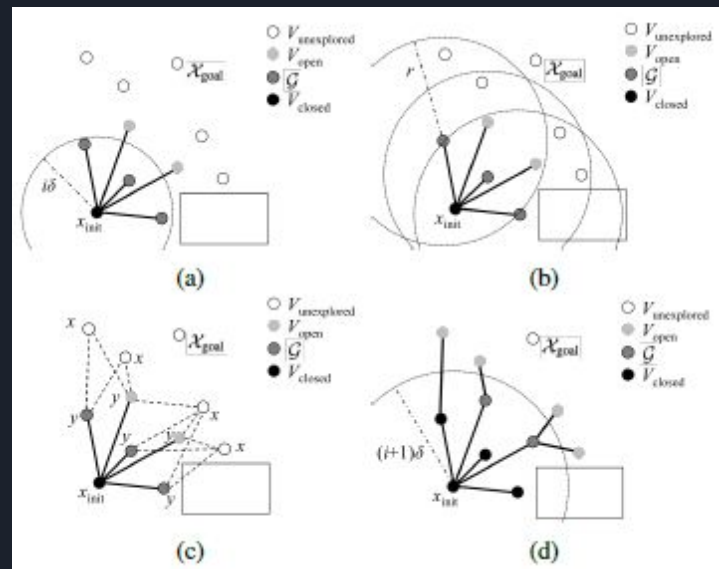
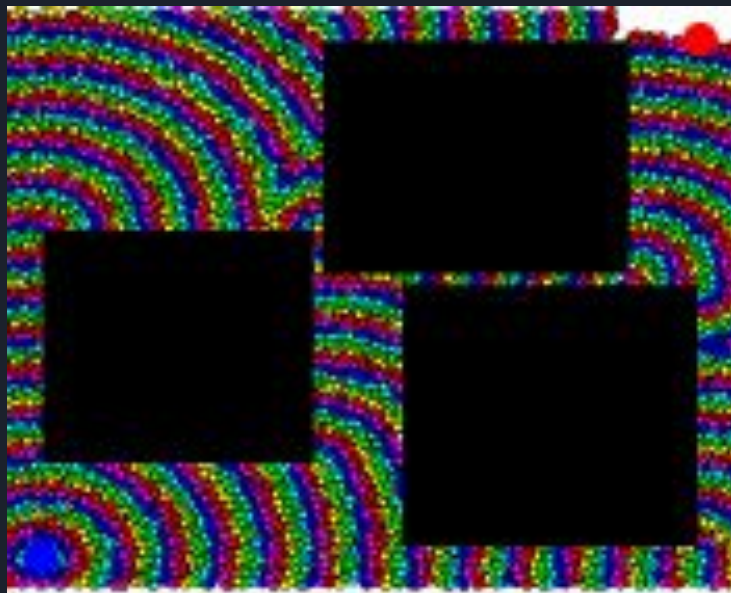
Cost threshold: 30

0	0	0	0	0	1	unexplored neighbors
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5 X stream compact



Wavefront Parallelization



<https://arxiv.org/pdf/1705.02403.pdf>



Future Work

- Milestone 1 (11/18):
 - Simulation infrastructure
 - Understanding GMT*
- Milestone 2 (11/25):
 - Motion planning (GMT*)
- Milestone 3 (12/2):
 - ~~Perception and localization~~ → Finish GMT*
 - Optimizations
- Final Submission (12/8):
 - Presentation
 - Performance analysis
 - Perception



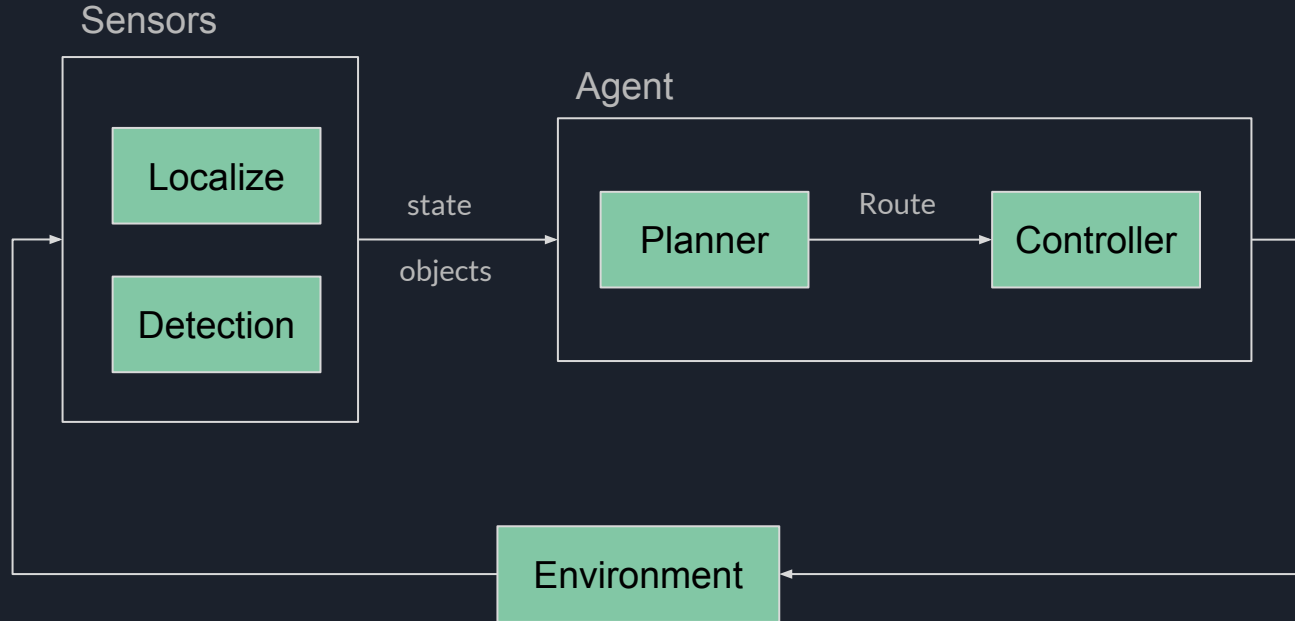
References

1. CARLA
 - a. <http://carla.org/>
 - b. <https://carla.readthedocs.io/en/latest/>
2. PyCuda
 - a. <https://document.tician.de/pycuda/>
 - b. <https://wiki.tiker.net/PyCuda>
3. GMT*
 - a. <https://arxiv.org/pdf/1705.02403.pdf>
4. Dubins
 - a. <https://gieseanw.files.wordpress.com/2012/10/dubins.pdf>
5. FMT*
 - a. <https://arxiv.org/pdf/1306.3532.pdf>

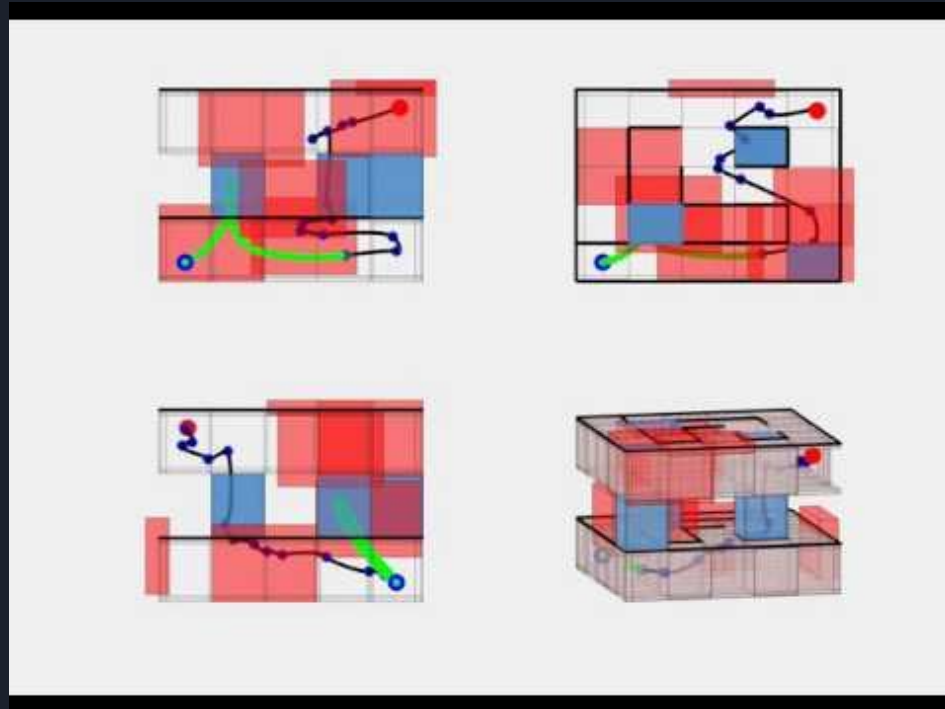


Q & A

Pipeline



Previous Work



<https://arxiv.org/pdf/1705.02403.pdf>