Robot Parallel Motion Planning

Final Presentation

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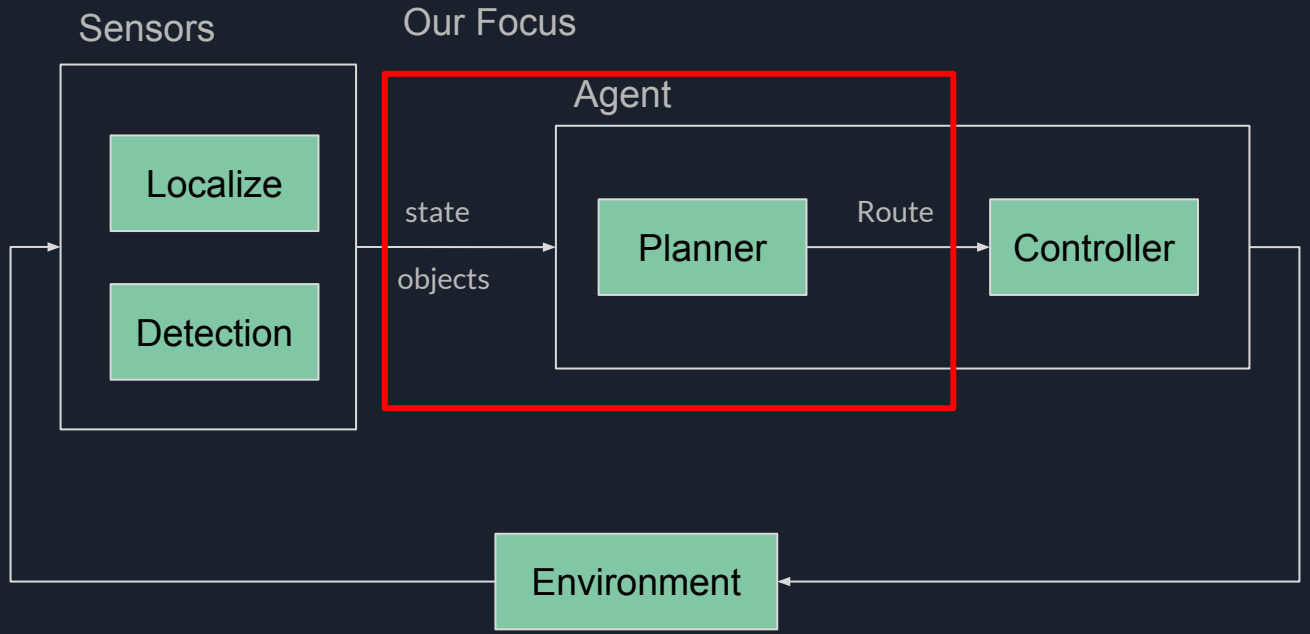
Problem Setup and Goal

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



Typical Autonomous Robot Pipeline

Problem Setup and Goal

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

- Python Wrapper for CUDA code
- Kernels written in C/C++
- Our GMT* algorithm written here

- The middleman between CARLA and PyCuda

- Our Simulator
- Built on top of UE4
- Gives us the environment and physics

Our Results

Default CARLA

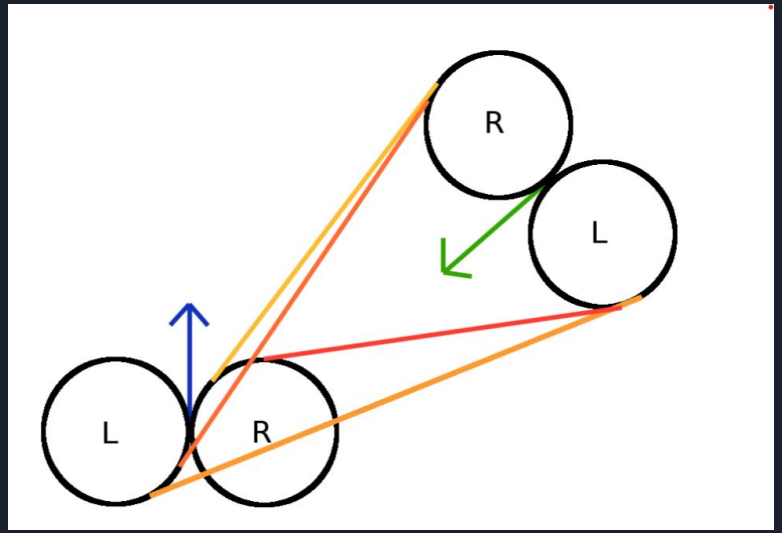
Our Implementation

Our Results

Dubins Paths

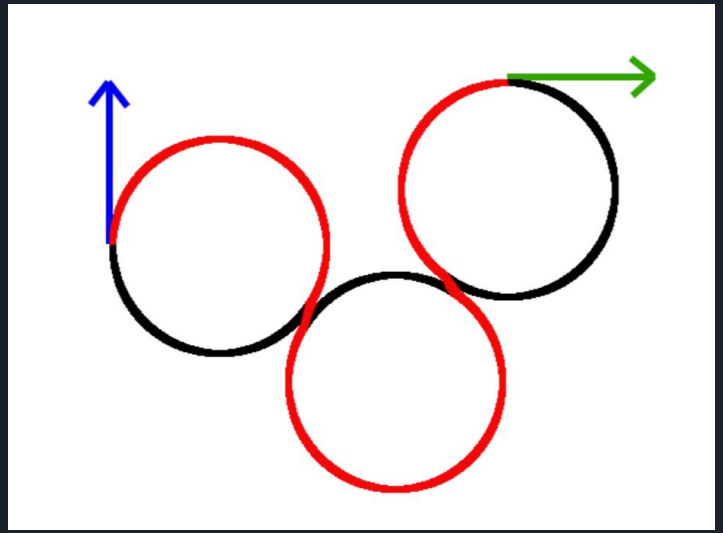
$(X_0, Y_0, \theta_0) \longrightarrow (X_1, Y_1, \theta_1)$

Curve-Straight-Curve



LSL, RSR, LSR, RSL

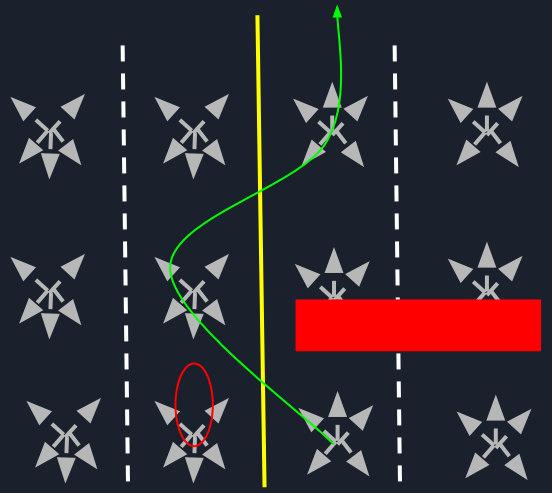
Curve-Curve-Curve



LRL, RLR

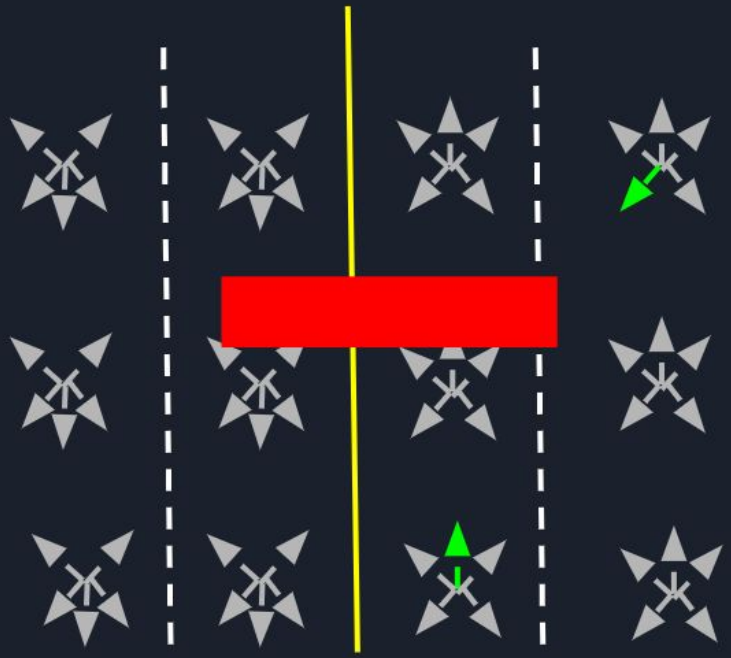
https://gieseanw.files.wordpress.com/2012/10/dubins.pdf

Samples

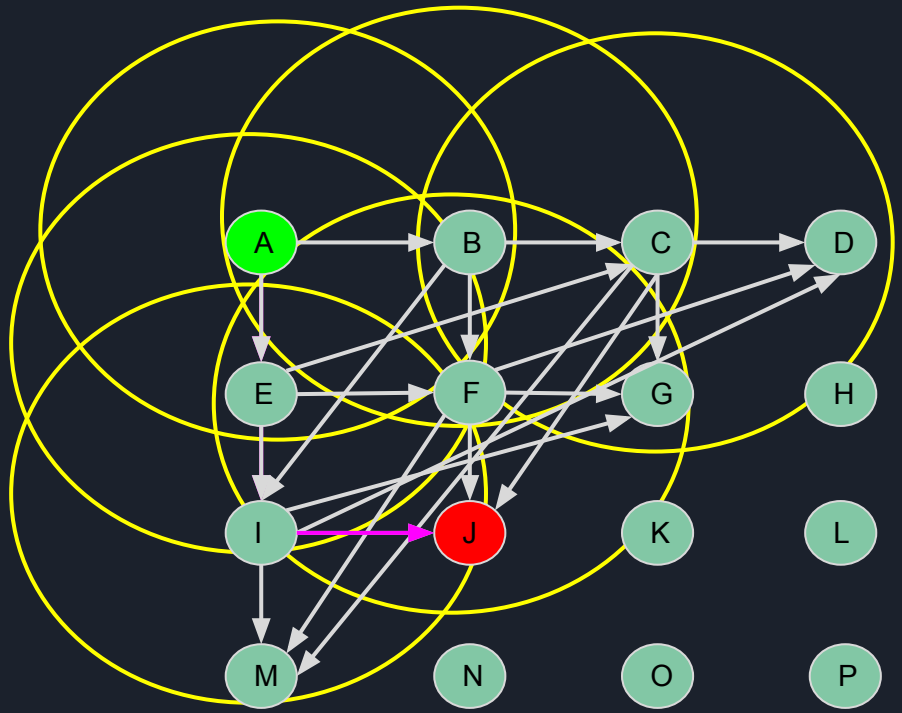


Note missing orientation on opposite side of the road

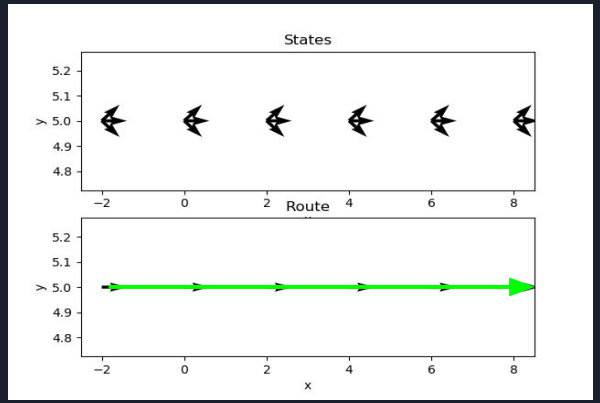
Dubins Paths + Collision Check



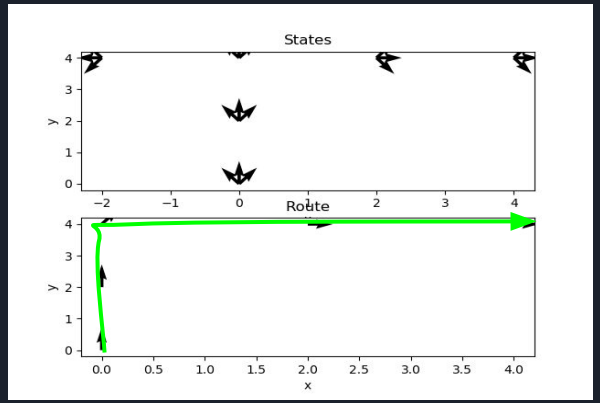
GMT* Wavefront Parallelization



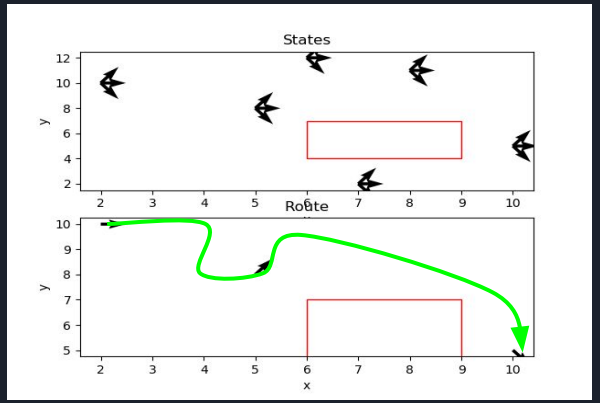
Unit Testing and Debugging



Unit Test for testing straight paths

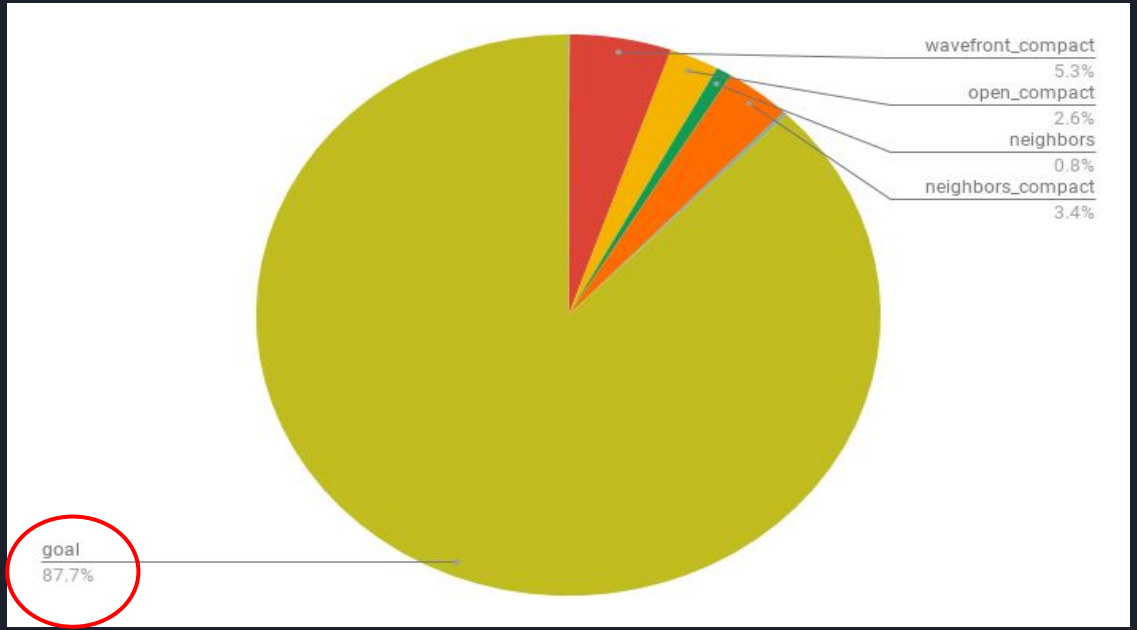


Unit Test for testing turns



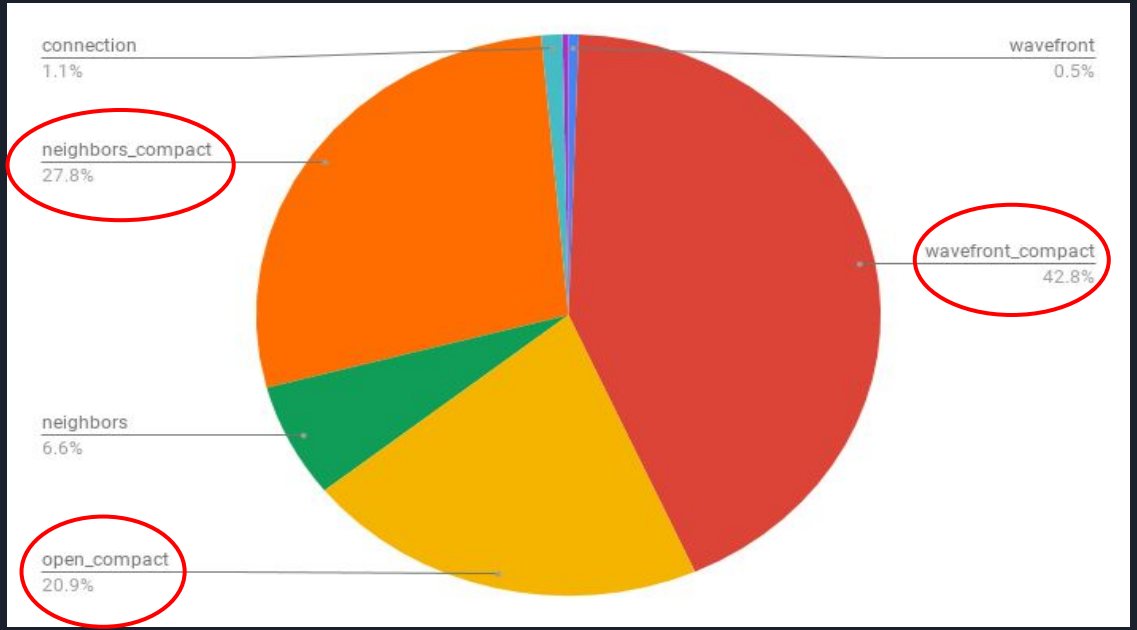
Unit Test for obstacle avoidance

Performance Analysis



Kernel for checking if we made it to the goal taking 90% of current 2.16s run time

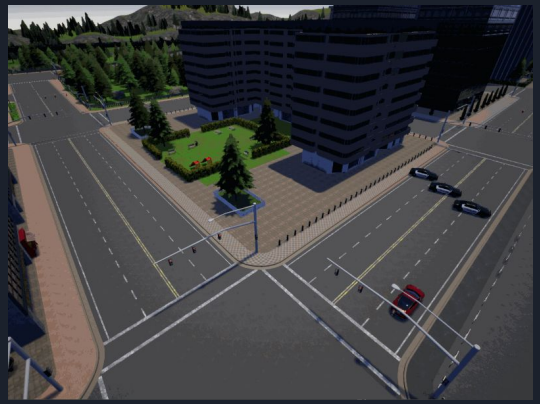
Performance Analysis



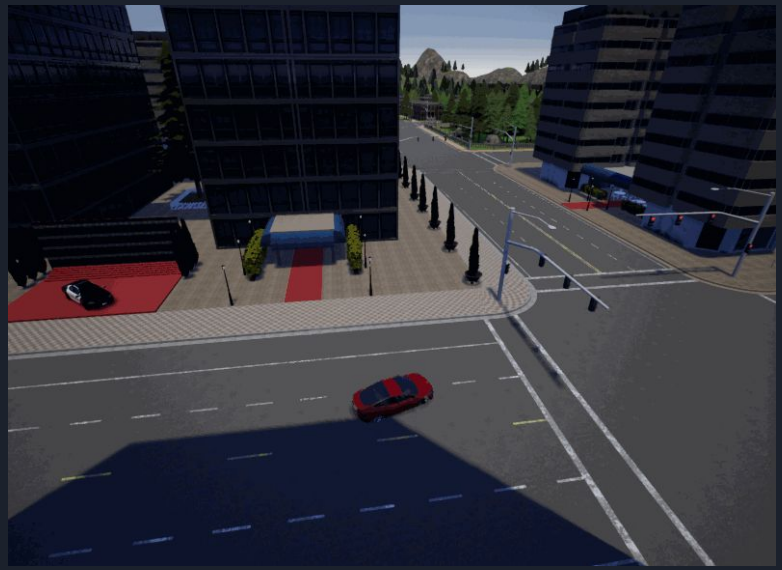
Compaction to prevent thread divergence under 3ms per iteration

Future Improvements

- Clever approach to checking if the goal has been found
- Compaction operations also need to be reduced
- State estimation and Perception
- Estimate the states of other agents in the environment
- Improve controller by: tuning the PID, return Dubin's control, or optimal control
- CPU multi-threading can be used to control the GPU planning while other threads manage other parts of the code.



Bloopers



References

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Check our Project Github:

http://bit.do/GH-RPMP

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