Project Setup

The new files use most of the old files, from RTD-code and REFINE. Clone to the frs_scratch repository to access all the new files. The setup includes a package called refine. Refine contains the following:

- Agent
- entity/states/Robot_state
- planner/Refine_Planner
- Reachsets/FRS_loader
- Reachsets/FRS_Instance
- trajectory/Trajectory_Factory
- trajopt/Refine_Objective

The Refine Planner plans out the trajectories for the robot to follow for each planning iteration. The Forward Reachable Sets for different maneuver types(speed change and lane change) are generated one at a time by calling the FRS_loader class. These reachable sets are stored in the hdf5 files and are manually loaded - converted_Au_frs.h5, converted_dir_frs.h5 and converted_lan_frs.h5 where each file is for speed change, direction change and lane change maneuvers respectively.

The files (converted_Au_frs.h5 & converted_lan_frs.h5) are loaded in the Refine Planner class. For each maneuver type, the trajectories are optimized in the RtdTrajOpt class by generating constraints for all the instances of a particular reachset, creating these trajectories and calculating the cost for the reachsets. The costs for different maneuver types are compared and the lowest one is chosen to plan out the trajectory.

Steps to setup the Project

- Clone to the branch frs_scratch in RTD-code Github repository

```
git clone https://github.com/roahmlab/rtd-code-architecture-base.git
```

- Install CORA 2021

```
https://tumcps.github.io/CORA/
```

- Install docker and Use it to run matlab

```
./matlab_docker.sh
```

- Download these files converted_Au_frs.h5, converted_dir_frs.h5 and converted_lan_frs.h5

```
Insert link to the above here
```

- You will also need to download the packages loaders and temp

- Ensure all of these are in the working directory
- Run NewhighwaySimulation file in the package refine

Scope for Improvements

- Cost value for New REFINE is much higher than old REFINE even though the same cost function is being used
- Maybe the plotting for New simulation values are wrong, this could be causing the crash
- ref_Z value give an error after 2 simulations
- Refine Agent State, Refine Agent Info, Refine Dynamics, Refine Controller needs to be tested with the old simulation for validation of results

Key Functions and their locations

- Zonotope_slicing - slicing of the zonotope along a particular dimension. This function is used in the Refine_Objective and genNlconstraint in FRS_Instance
- Robot_State - This function extracts the required properties from the zonotope [x,y,h,u0,v0,r0]
- Refine_Planner_speed_change - This function in the Refine_Planner loads the FRS for speed change manu type, Trajectory_Factory, optimization engine and calls the constructor of class RtdTrajOpt
- Refine_Planner_lane_change - This function in the Refine_Planner loads the FRS for lane change manu type, Trajectory_Factory, optimization engine and calls the constructor of class RtdTrajOpt
- planTrajectory function in Refine_Planner optimizes the trajectories for speed change and lane change. It then compares the costs of both manu types and choses the one with the least cost to plan the trajectory.
- generateReachableSet function in FRS loader, compares the Robot_state with the initial conditions to find the desired_idx. The reachsets are generated only for those desired_idx.
- generateNlConstraints function in the FRS_Instance generates non-linear constraints for the reachsets during optimization in the RtdTrajOpt class.
- The genObjective function of the Refine_Objective in an objective callback function. This function calls the evaluateObjective to calculate cost for each reachset.