

# AUTOMATIC DRIVING SIMULATION GENERATION TO EXPLORE PARAMETERS OF CRASH SCENARIOS IN SELF DRIVING CARS

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# Motivation



The post-crash event analysis of car collision has not done yet by the car crash reconstruction scenarios



No realistic road geometry and environment (synthetic) for scenarios creation that does not reflect the true simulations from the car crash report.



The velocity and way points parameter of the collision is difficult to address the parameter space becomes huge when considering the velocity and way points of both ego car and victim car. This information is not included in the **NMVCSS** **NHTSA** database; thus it makes car crash report inaccurate.

# Problem Statement

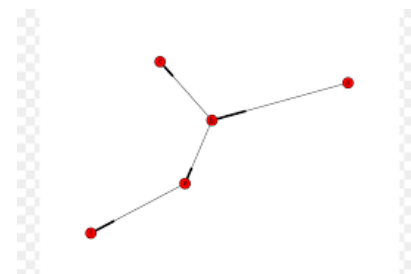
- ▶ Explore the parameters such as way points and velocity for the reconstruction of car crash scenario of self-driving cars from police car crash report by extraction the aftermath information to evaluate the accuracy of the car crash simulation in realistic simulated environments.

1. Post-Crash Data Extraction
2. Open Street Map Road Geometry Data Extraction
3. Finding the **best parameters** such as Velocity and Way Points.





# Proposed Solution



# Natural Language Processing



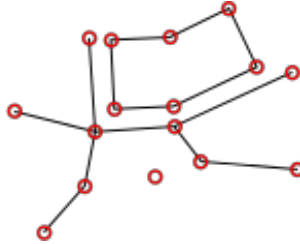
- ▶ Preprocessing
- ▶ Dictionary Expansion
- ▶ Post-Crash Event Sentences Extraction
- ▶ Post-Crash Event Extraction (**Striker and Victim Vehicle**)
  - Rotation
  - Degrees
  - Direction
  - Distance from Crash Point
- Triples Creation - Subject, Verb, Object

# Pre-Crash and Crash Event Data (AC3R)

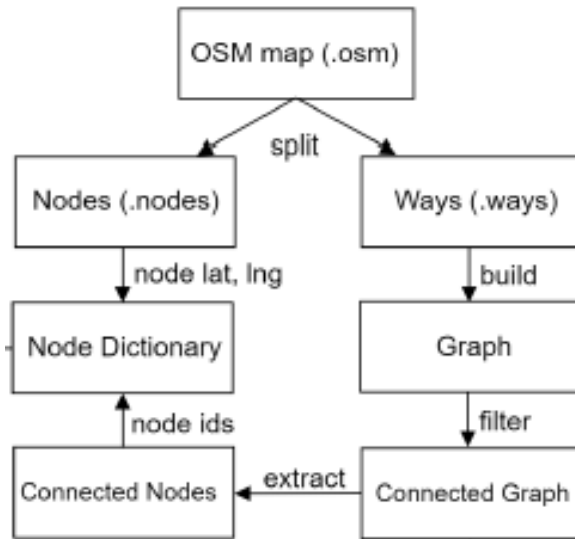
## Striker and Victim Vehicle.

- ▶ Pre-Crash Event
  - Initial Direction of Car.
  - Number of lanes
  - Type of Road- For Instance, T-Intersection
- ▶ Crash Event
  - Car Damage Area.

# Open Street Map Geometry



- Extraction of Way Points of Roads from Overpass api.

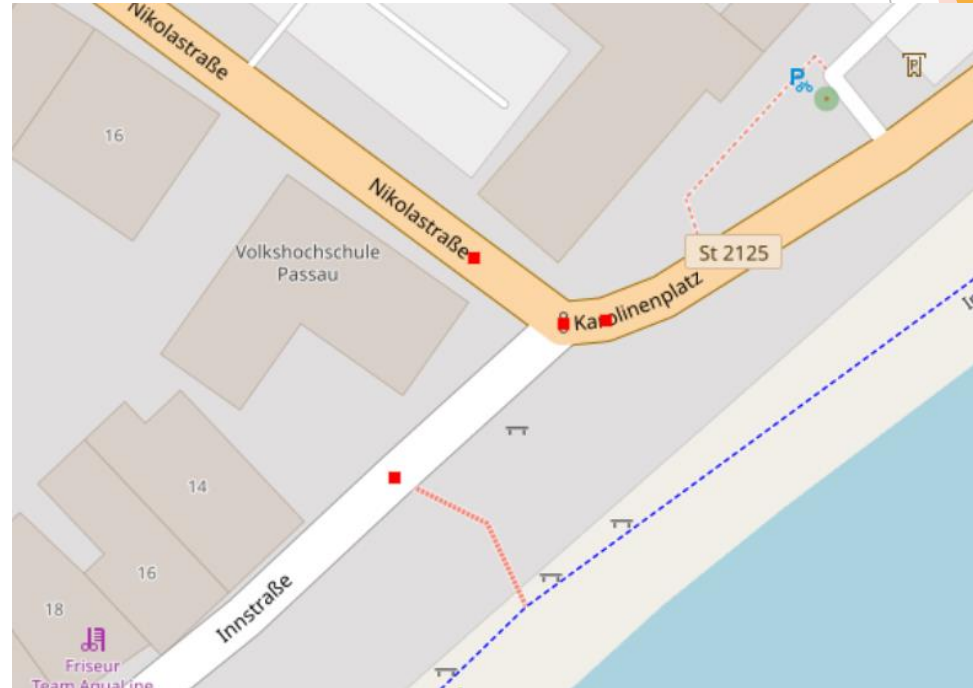


- ❖ Preprocessing of open street map
- ❖ Creation road Graph and removing non connected roads.

# Finding Roads in Open Street Map

## Querying the Graph for Type of Intersection

- Number of Lanes
- Width of Roads
- Type of Intersection
  - i. 3-way Intersection
  - ii. 4-way Intersection



- One or multiple instance of roads Geometry



# BeamNG Simulation Creation

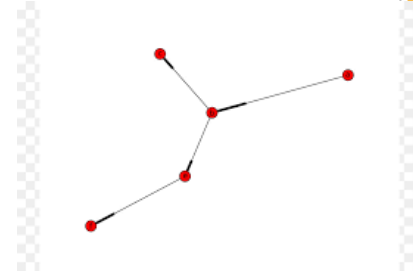


- ▶ Direction of road.
- ▶ Number of lanes
- ▶ Length of each road.
- ▶ Angle between connected roads.

OSM -> BeamNG  
(T-Intersection)



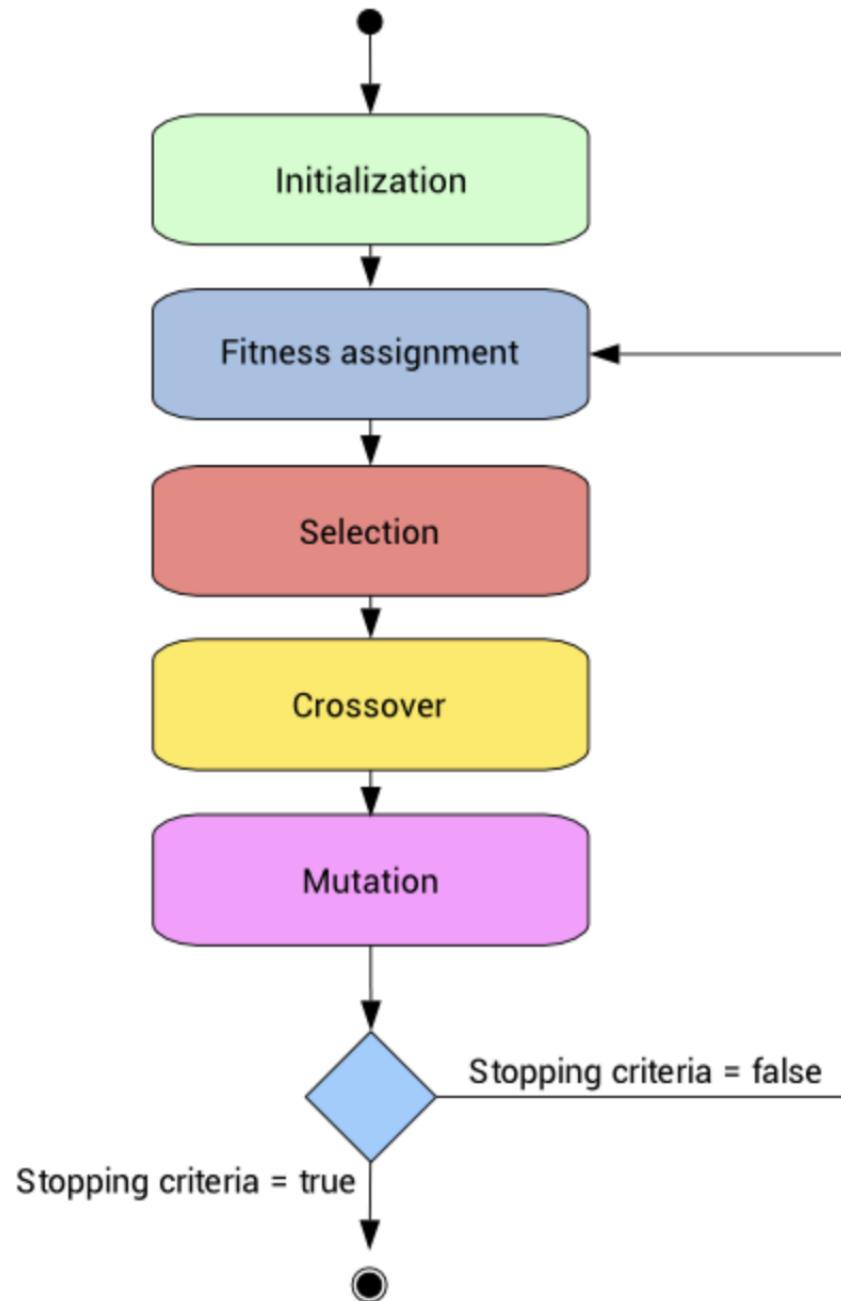
# Vehicle State Extaction



For each striker and victim vehicle,

- ▶ Car Collision Damage Area
- ▶ Velocity at each Way point after crash
- ▶ Distance of car from collision point
- ▶ Direction of car (facing)
- ▶ Rotation of Car (clockwise and counter-clockwise)
- ▶ Degrees of rotation (For instance, 90 degrees)

All these information **is** required for the post-crash event generated simulation analysis.



# Genetic Algorithm

Input Parameters : Velocity, way-points of striker and victim vehicle.

# Multi-Objective Fitness Function



- ▶ Strong correlation between crash event (objective 1) and pos-crash event (objective 2). Our crash event is highly dependent on crash event.

objective Function 1	correct output of crash point * .25
objective Function 2	correct output of post-crash * .625

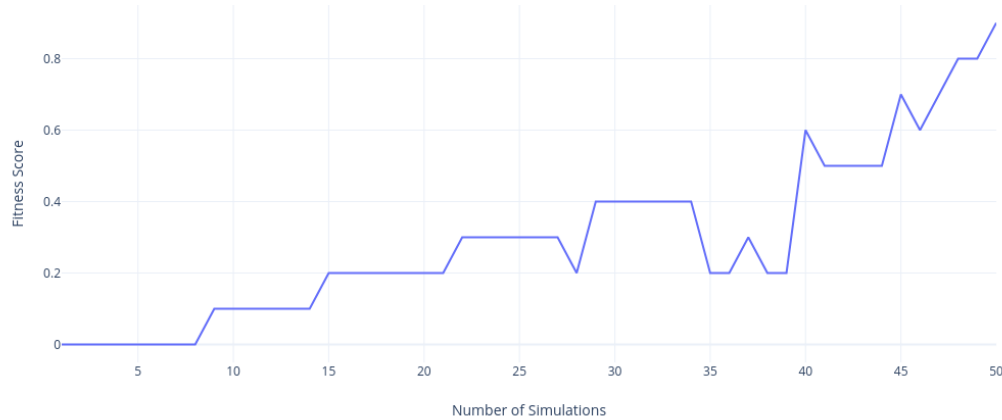
Total Fitness	objective function 1 + objective function 2
Threshhold	0.7

- If objective function accuracy is not good, it cannot pass the minimum threshold of the multi-objective function.

# Evaluation



## Road Geometry 1



## Road Geometry 2



Each simulation is run for the fixed budge/time to achieve maximum fitness. Maximum fitness correspond to high accuracy.

**The maximum fitness in minimum time is our final output**

Striker Speed	Striker X1	Striker X2	Vicitm Speed	Victim X1	Victim X2
35	-60	-1	25	2	40



# Thank You

Any Questions