

# A Complete Comparison of Multi-Point Target Tracking Algorithms over Simulation and NuScenes Data

Liping Bai\*, Jianan Liu\*, Yuxuan Xia, Bing Zhu

\*Authors contribute equally to the work.

September 29, 2021

# Project Overview

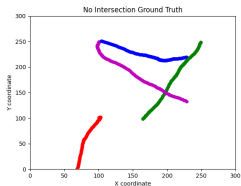
**Project Objective: Compare 3 Categories of Trackers over simulated scenarios and real measured NuScenes data**

- Random Vector Bayesian Filter based Trackers (PDA, JPDA + Track Management)
- Random Finite Set Filter based Trackers (PHD, CPHD, PMBM)
- Neural Network based Trackers (LSTM, Transformer)

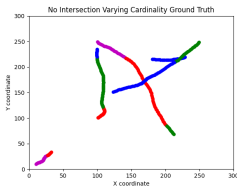
# Comparison by using Simulation Data

## Simulation Data: 6 Different Scenarios

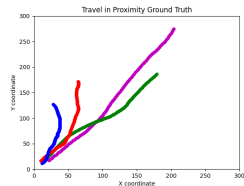
No Intersection No Cardinality Change



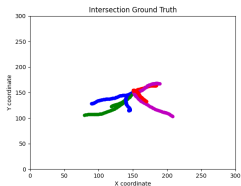
No Intersection with Cardinality Change



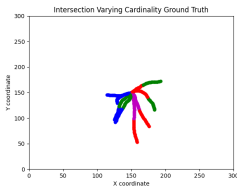
Travel in Proximity



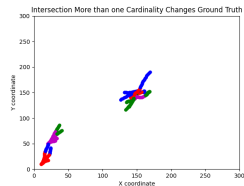
Intersection No Cardinality Change



Intersection with Cardinality Change



Intersection, Multi-Cardinality Changes



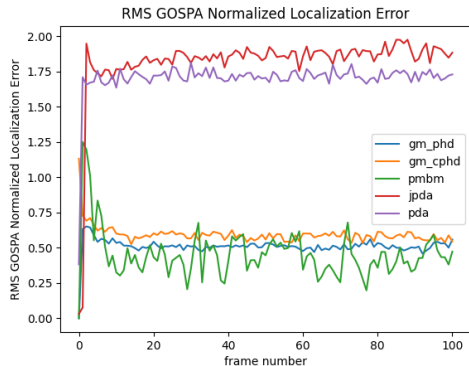
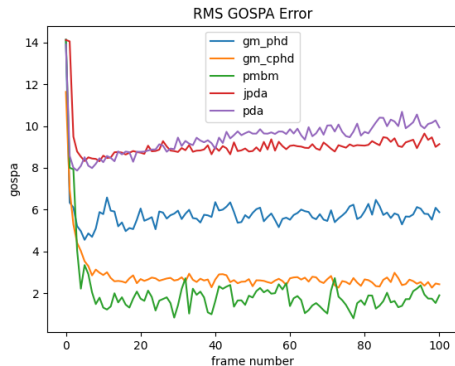
# Comparison by using Simulation Data

## Scenario 1: No Intersection, No Cardinality Change

- In this scenario, four targets are initiated and there would be no intersection whatsoever when the track progresses, also there will be no Cardinality change.
- The objective of this scenario is to act as a baseline.
- All trackers should perform relatively well for this scenario.

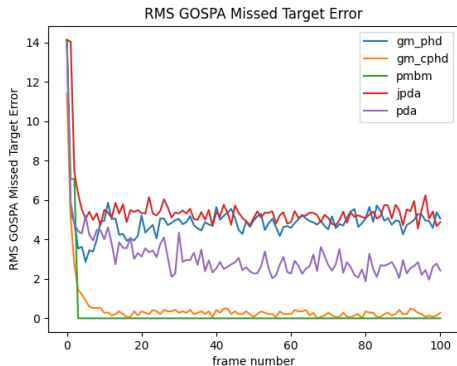
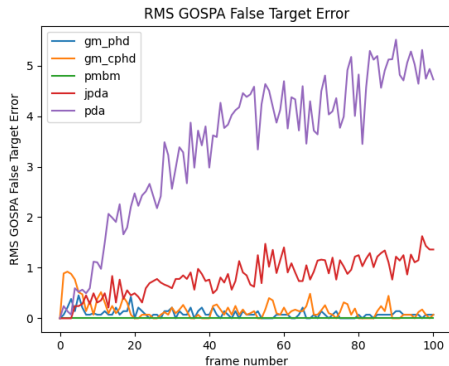
# Comparison by using Simulation Data

## Scenario 1: No Intersection, No Cardinality Change



# Comparison by using Simulation Data

## Scenario 1: No Intersection, No Cardinality Change



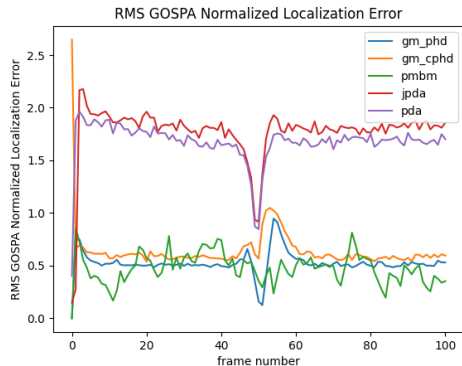
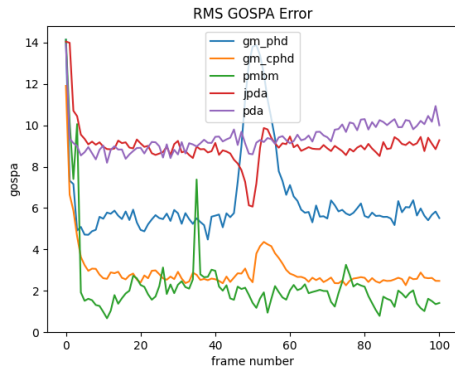
# Comparison by using Simulation Data

## Scenario 2: Intersection, No Cardinality Change

- The four tracks will meet at  $n\_scan/2$  steps, and the Cardinality will remain the same through out the simulation.
- The objective of this scenario is the compare how the 5 trackers fare against the intersection point.

# Comparison by using Simulation Data

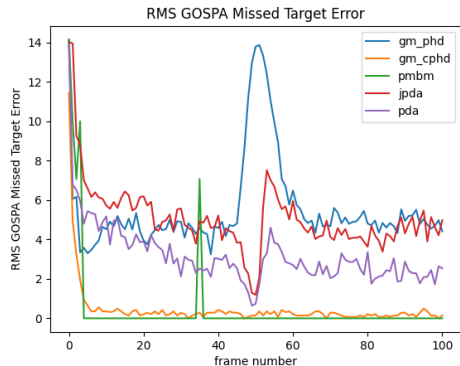
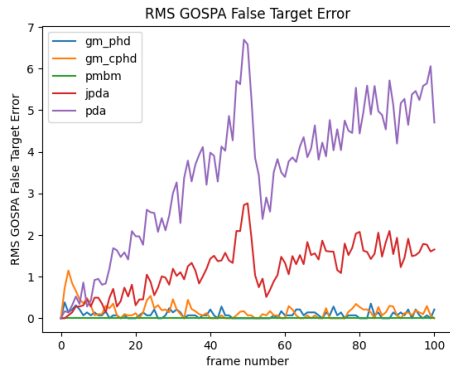
## Scenario 2: Intersection, No Cardinality Change





# Comparison by using Simulation Data

## Scenario 2: Intersection, No Cardinality Change



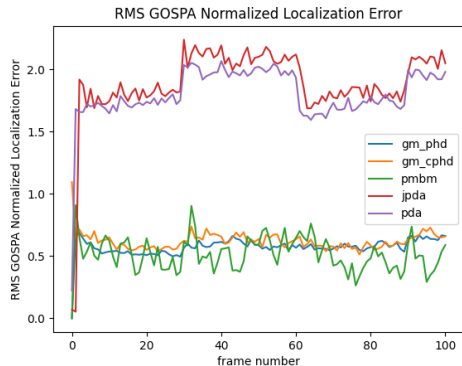
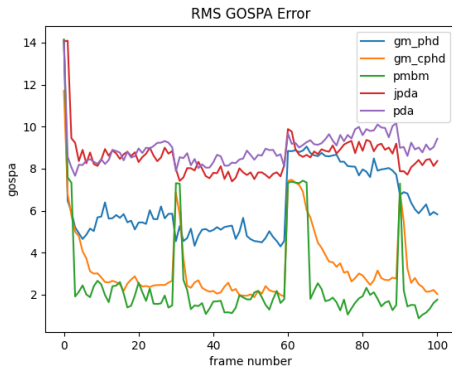
# Comparison by using Simulation Data

## Scenario 3: No Intersection, with Cardinality Change

- In this scenario, four targets are initiated and there would be no intersection whatsoever when the track progresses. However, there will be Cardinality changes every 30 scans, indicated by the color changes in the following graph.
- The objective of this scenario is to see how the trackers fare against Cardinality variation.

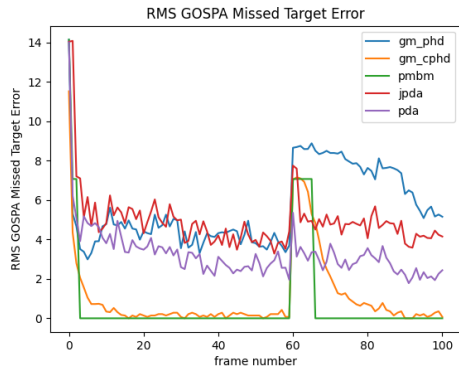
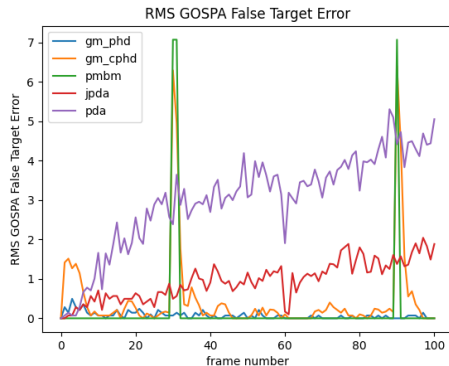
# Comparison by using Simulation Data

## Scenario 3: No Intersection, with Cardinality Change



# Comparison by using Simulation Data

## Scenario 3: No Intersection, with Cardinality Change



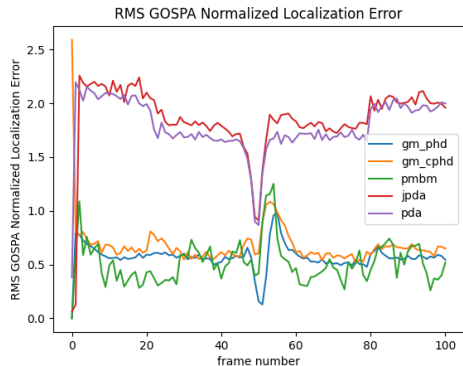
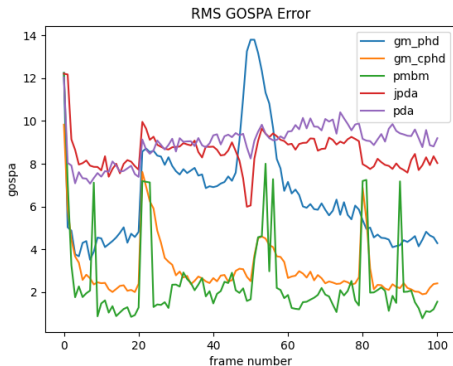
# Comparison by using Simulation Data

## Scenario 4: Intersection, with Cardinality Change

- The tracks will meet at  $n\_scan/2$  steps, and the Cardinality will change every 30 scans.
- The objective of this scenario is to compare how the 5 trackers fare against the intersection point and Cardinality variation.

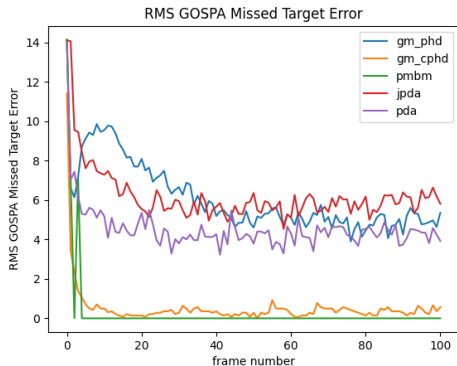
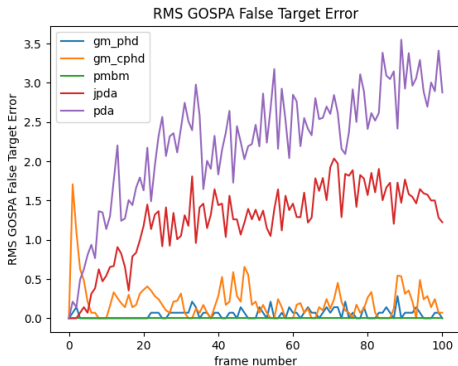
# Comparison by using Simulation Data

## Scenario 4: Intersection, with Cardinality Change



# Comparison by using Simulation Data

## Scenario 4: Intersection, with Cardinality Change



# Comparison by using Simulation Data

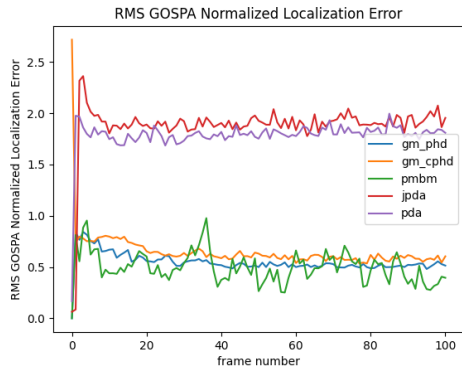
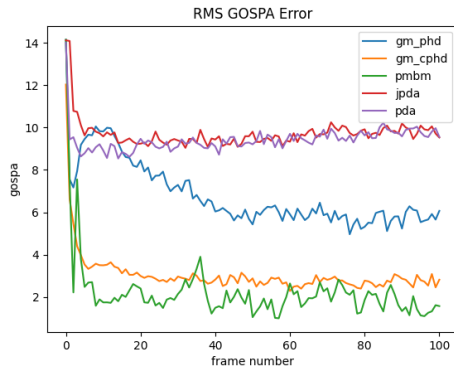
## Scenario 5: Travel in Proximity

- This scenario has 4 targets travel in proximity, without any Cardinality changes.
- This scenario is designed to mimic the road traffic where cars are moving in parallel with each other closely.



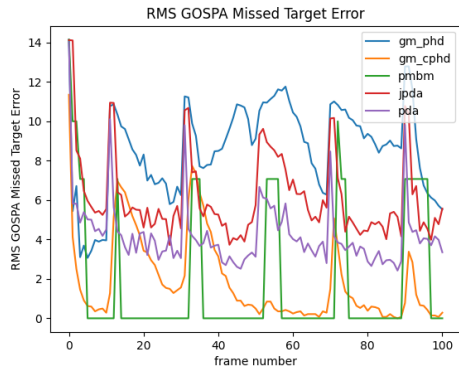
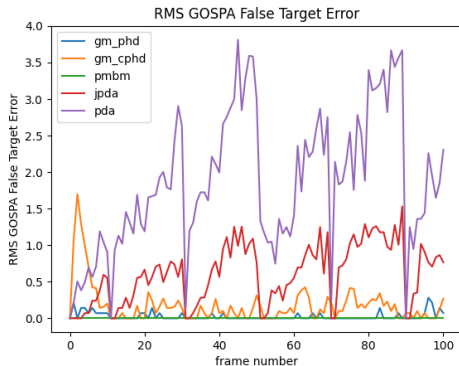
# Comparison by using Simulation Data

## Scenario 5: Travel in Proximity



# Comparison by using Simulation Data

## Scenario 5: Travel in Proximity



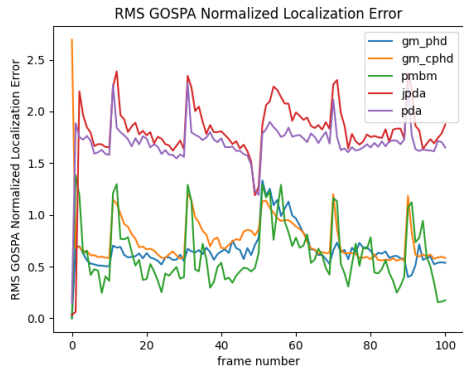
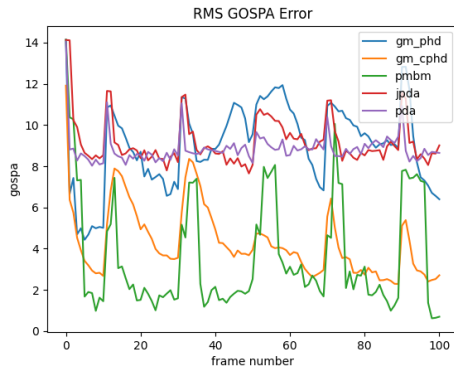
# Comparison by using Simulation Data

## Scenario 6: Intersection, with Multiple Cardinality Change

- This scenario is designed to be the highest difficulty. At  $n\_scan/2$  step, there would be intersection. There would also be multiple varying Cardinalities, such as disappearing of more than one object and appearing of more than one object simultaneously.

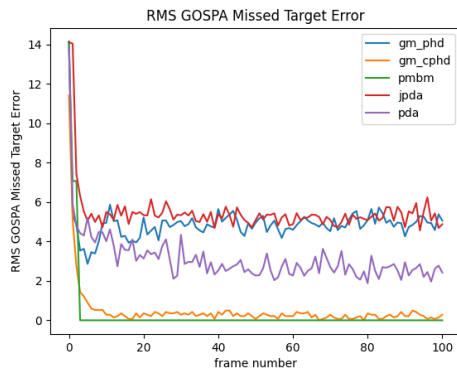
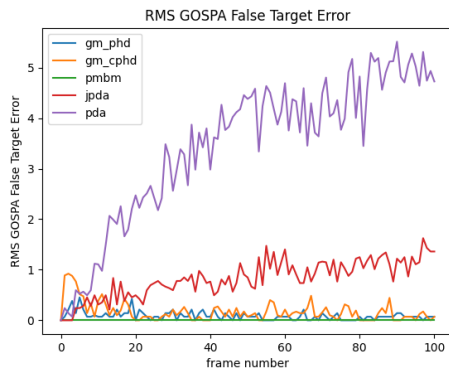
# Comparison by using Simulation Data

## Scenario 6: Intersection, with Multiple Cardinality Change



# Comparison by using Simulation Data

## Scenario 6: Intersection, with Multiple Cardinality Change



**NuScenes Data: N Different Scenarios**

# Comparison by using NuScenes Data

# Comparison by using NuScenes Data



# Comparison by using NuScenes Data

# Comparison by using NuScenes Data