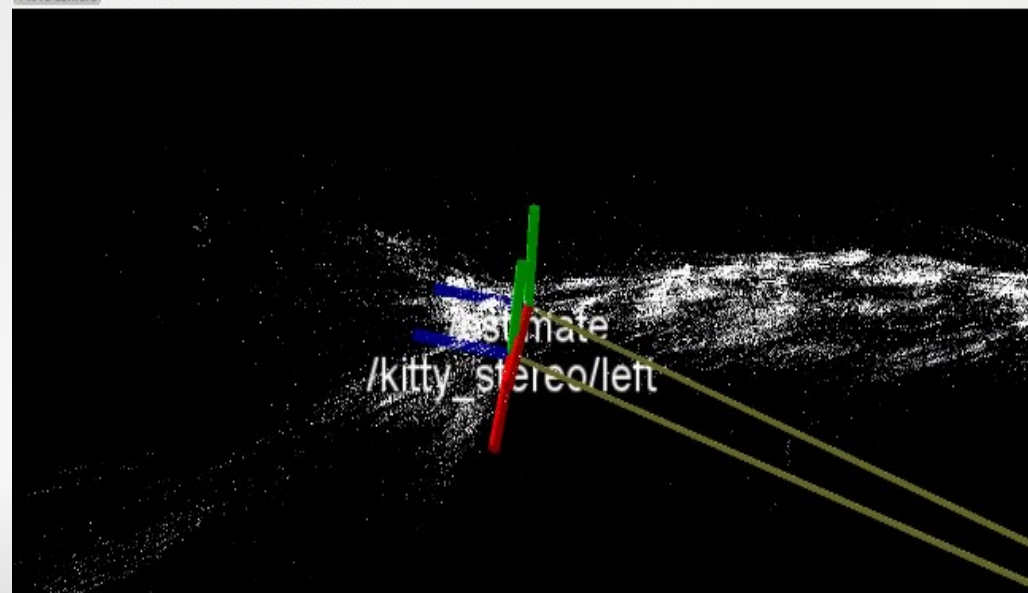


Applied Computer Vision in Robotics

Team Waitinglist:

- Ross Kidson
- Alvaro Gauterin
- Karol Hausman



Exercise sheet 3



Exercise sheet 4



Project Motion Planning

- Motion planning in static scenarios



Project Motion Planning

- Motion planning in dynamic scenarios



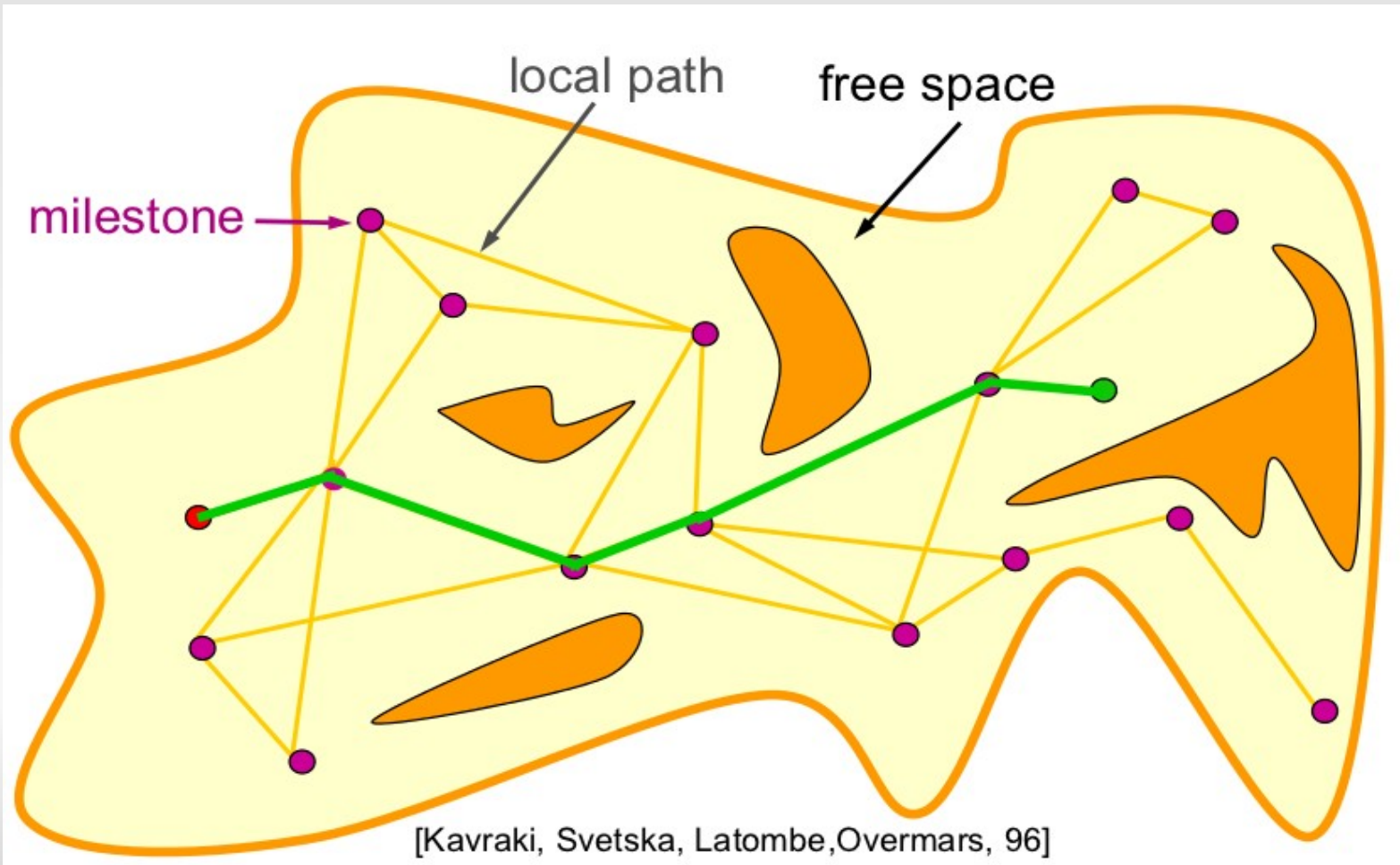
Autobahn - WIP 060605 - JVP 2006 - Wings3D+Poseray+POV-Ray - 10h7m

Static Scenario - Possible solutions

- Different motion planning libraries:
 - OMPL
 - Sampling based planning library
 - No collision detection provided
 - Difficult integration with ROS
 - SBPL
 - Search based planning library
 - No dynamic model of a car

Static Scenario - OMPL Theory

- Probabilistic Motion Planning
 - Rapidly exploring random tree (RRT)



Static Scenario - OMPL Approach

- OMPL → incorporate dynamics of a car
- Implement collision detection
- Dynamics of the second order car:

$$\dot{x} = v \cos \theta$$

$$\dot{y} = v \sin \theta$$

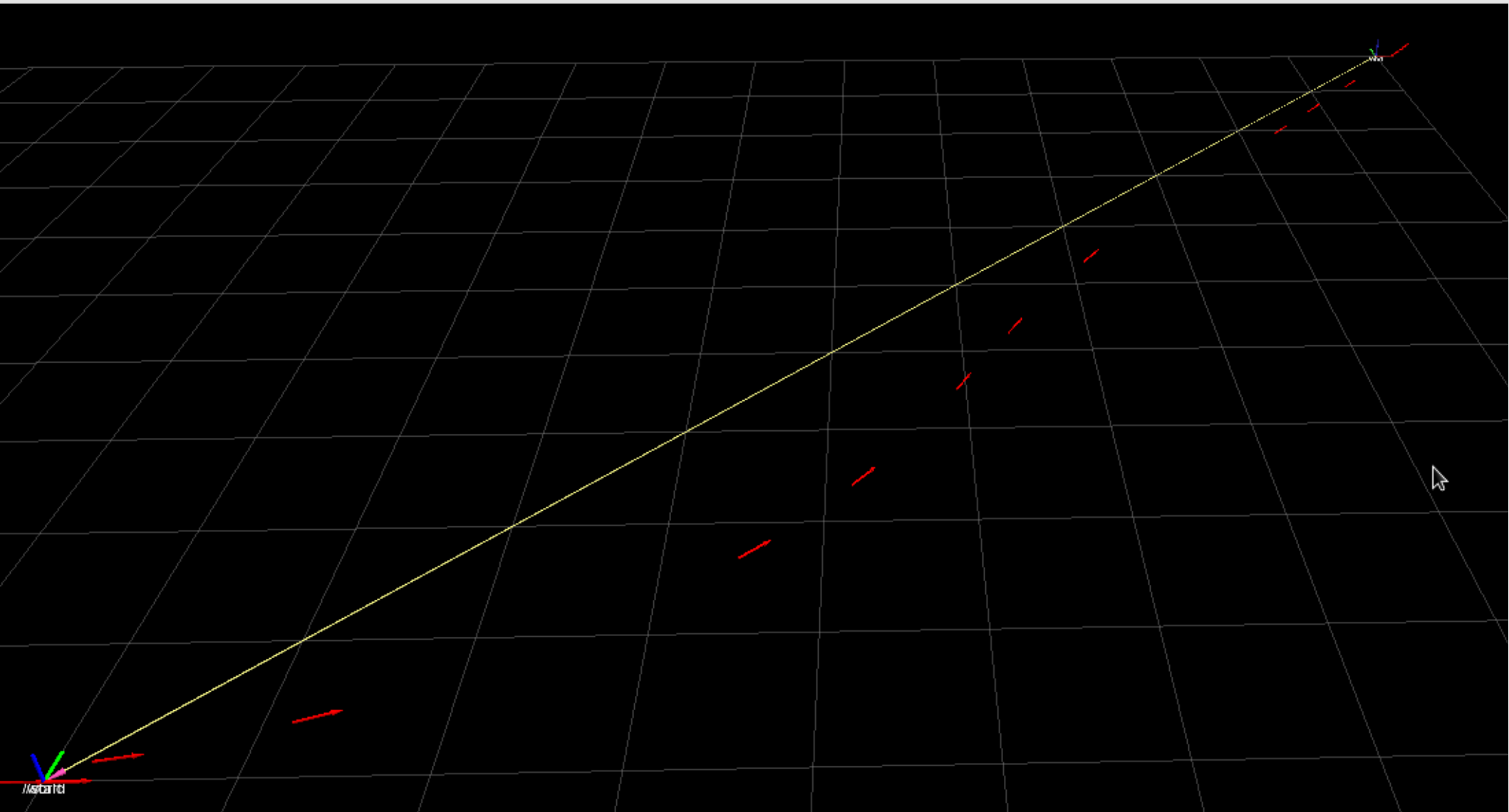
$$\dot{\theta} = \frac{vm}{L} \tan \varphi$$

$$\dot{v} = u_0$$

$$\dot{\varphi} = u_1$$

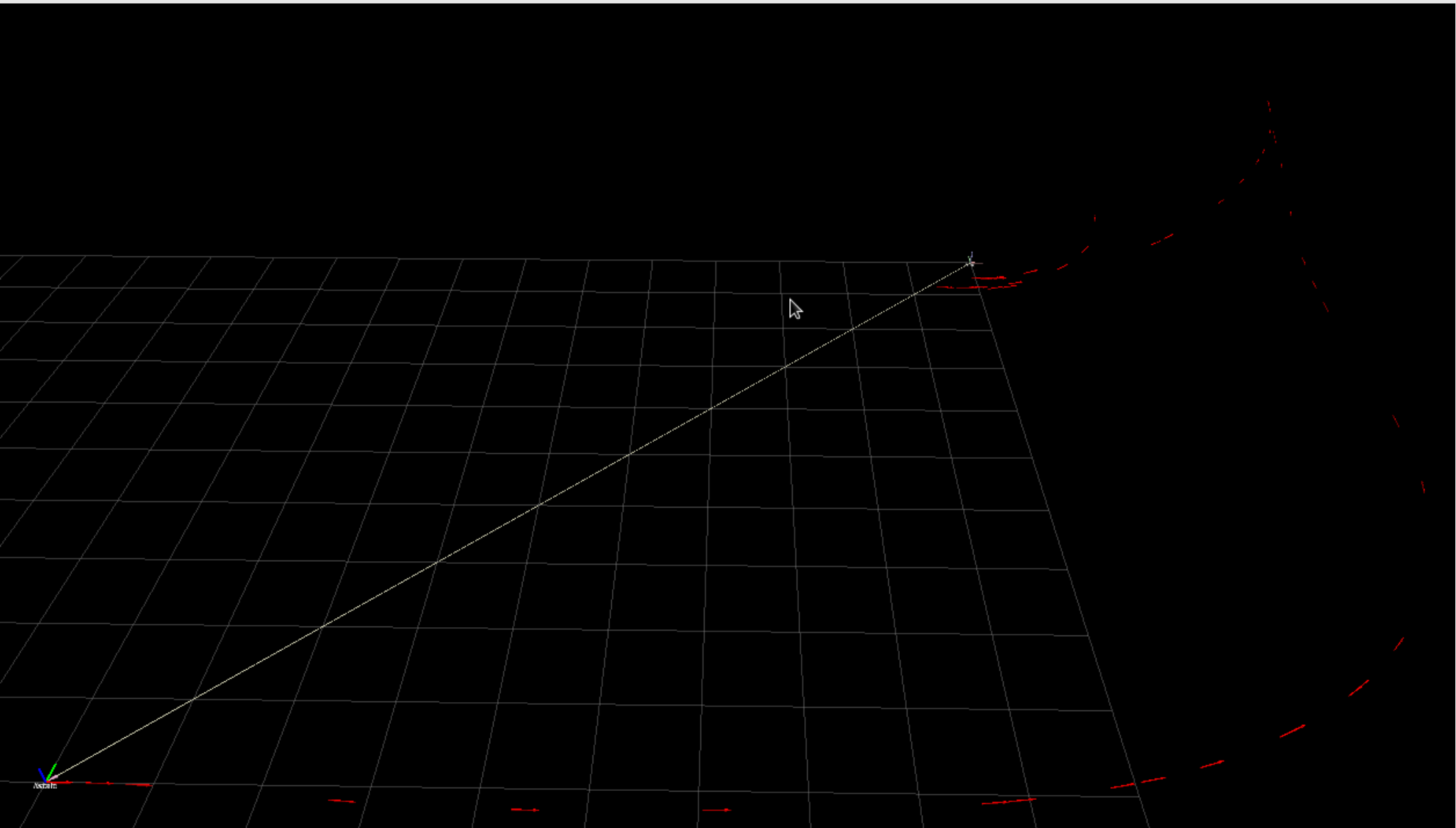
Static Scenario – OMPL Results

- Suboptimal



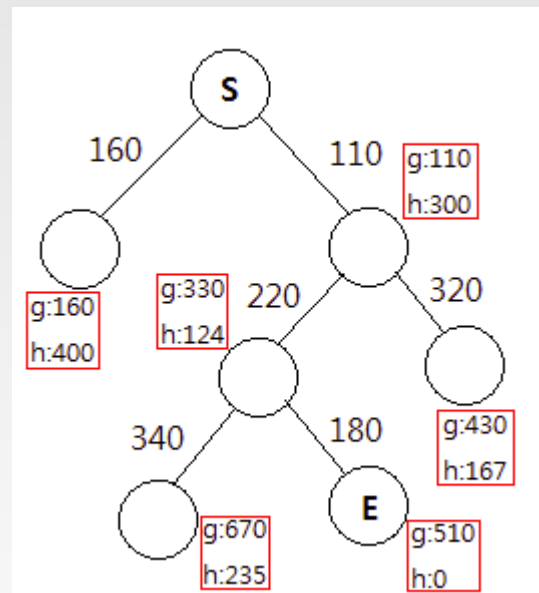
Static Scenario – OMPL Results

- Suboptimal



Static Scenario - SBPL Theory

- SBPL Planner uses ARA* (Anytime Repairing A*) algorithm that was developed by Maxim Likhachev at CMU
- A* algorithm
 - Can be slow
 - Always optimal



Static Scenario - SBPL Theory

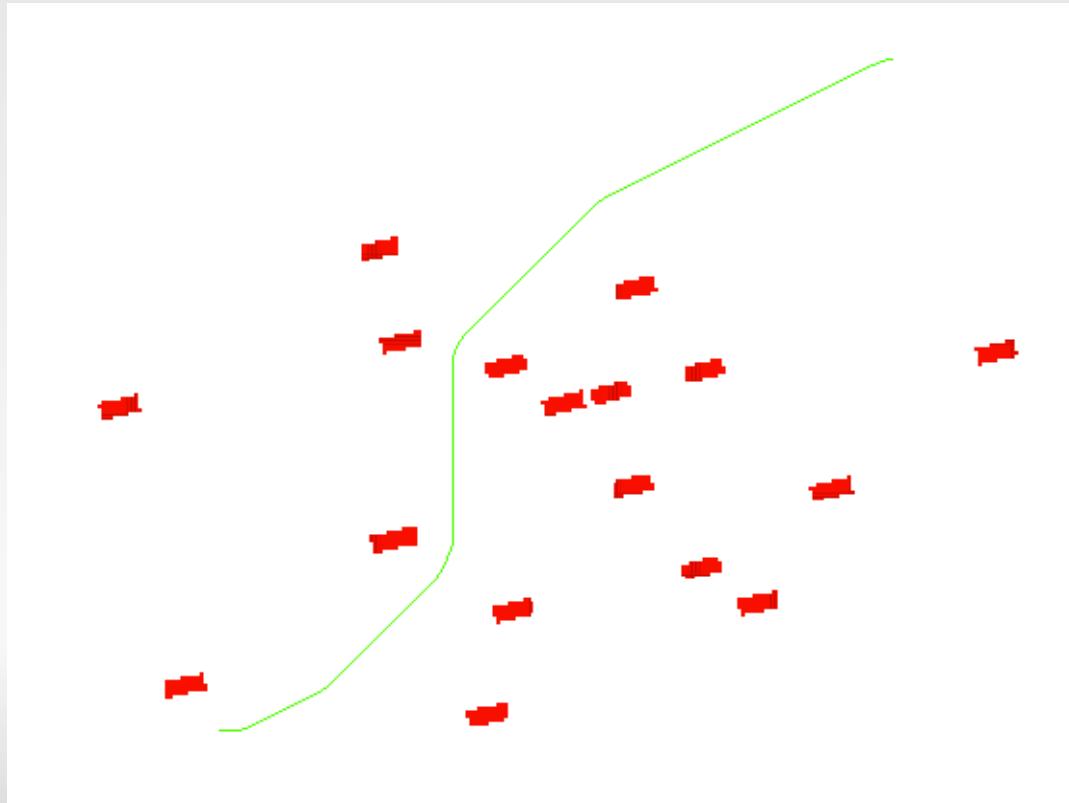
- ARA* algorithm
 - A* with inflated heuristics
 - Actual heuristics multiplied by an inflation factor $\epsilon > 1$

$$f(s) = g(s) + \epsilon * h(s)$$

- Suboptimal but faster \rightarrow suboptimality is predictable
- Many iterations \rightarrow ϵ is getting smaller
- If there is time remaining \rightarrow try with smaller ϵ

Static Scenario - SBPL Approach

- SBPL integration with Rviz
- User Interface by clicking start and goal poses
- Integration with BMW Software



Static Scenario – SBPL Results

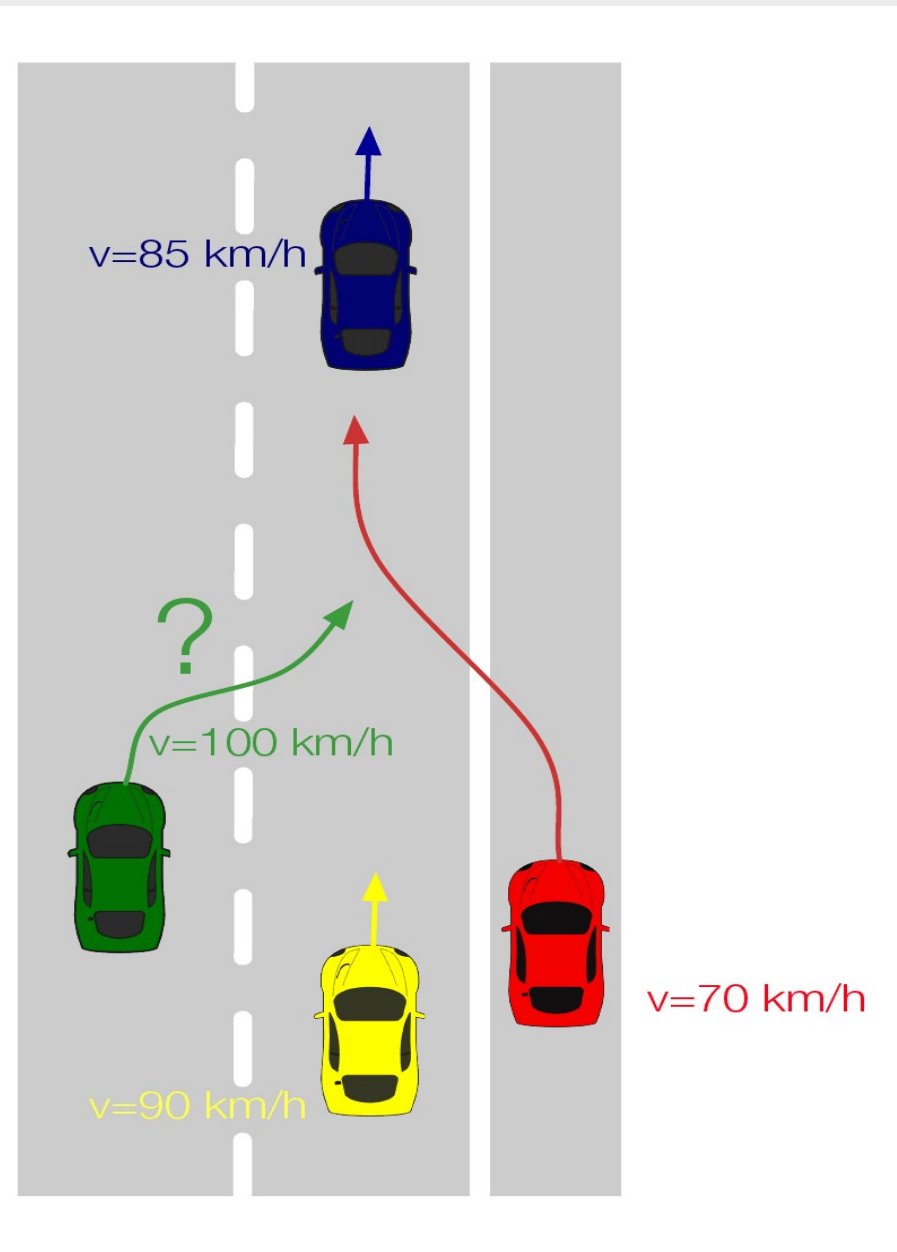


Static Scenario - SBPL Results

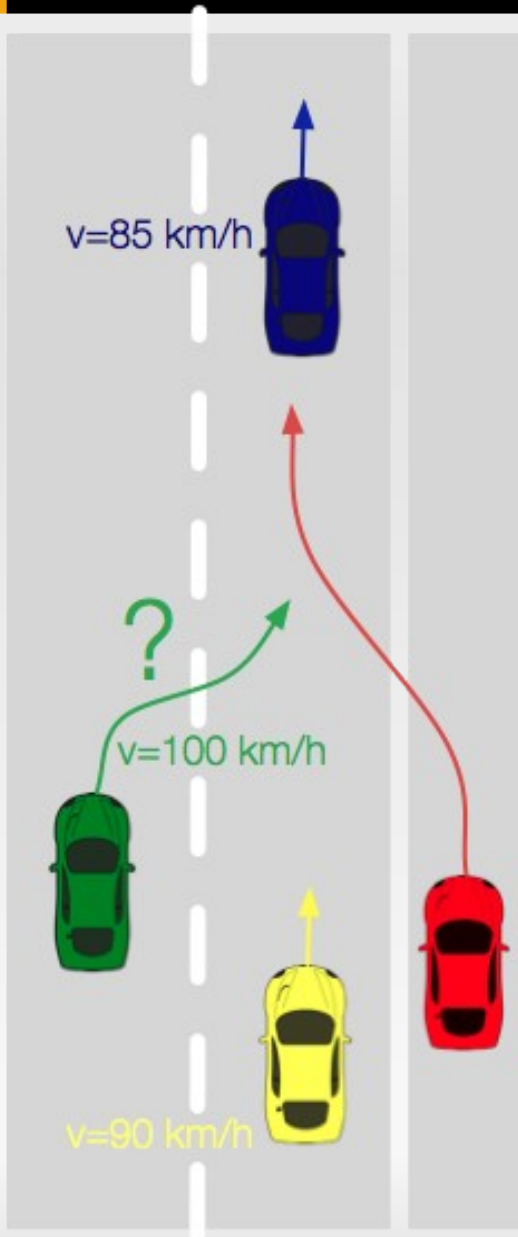


Dynamic Scenario

- Overtaking a car
- AI involved?



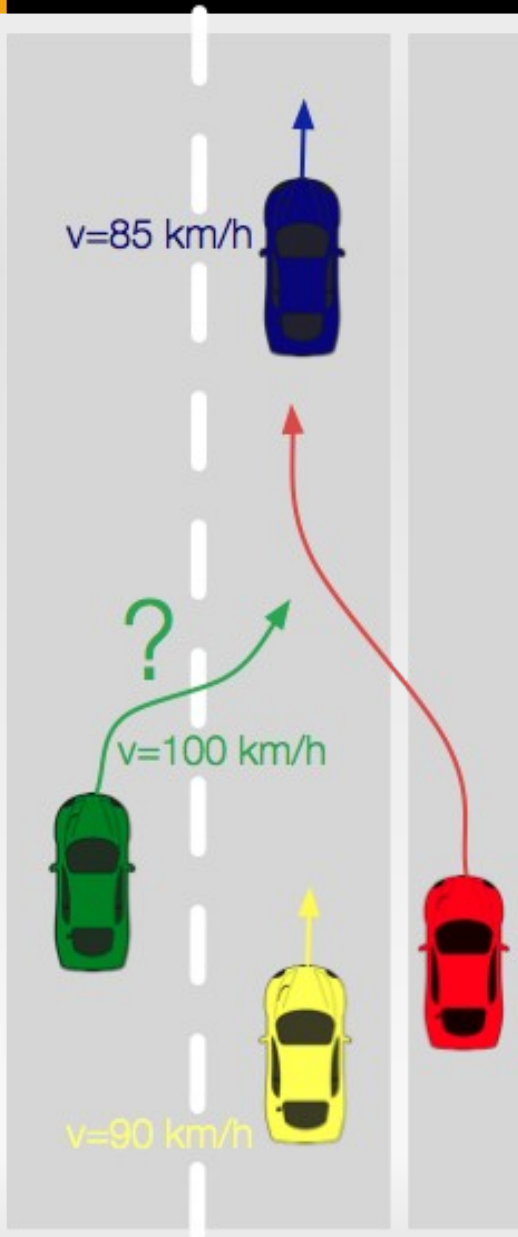
Dynamic Scenario - PLAN



■ THE PLAN:

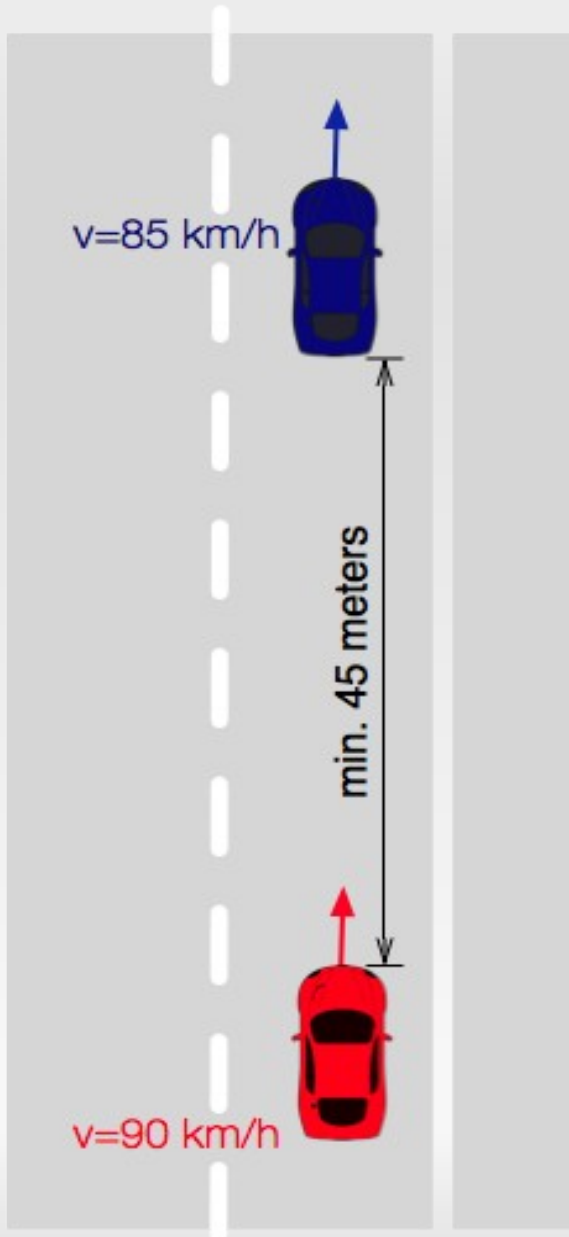
- Accelerate on the emergency lane
- Change to the lane on the left
- Again – change to the lane on the left
- Keep driving straight ahead

Dynamic Scenario – Check list



- Check list – to be checked every second:
 - Is there a threat by the car in front of me?
 - Is there a threat by the car behind me?
 - Execute the plan

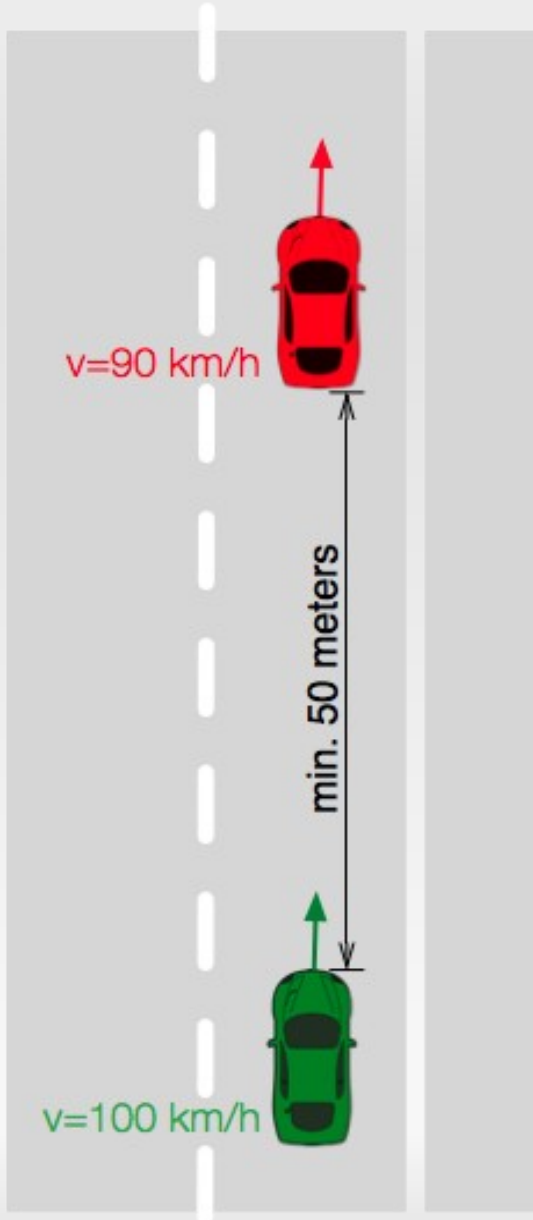
Dynamic Scenario – Check list



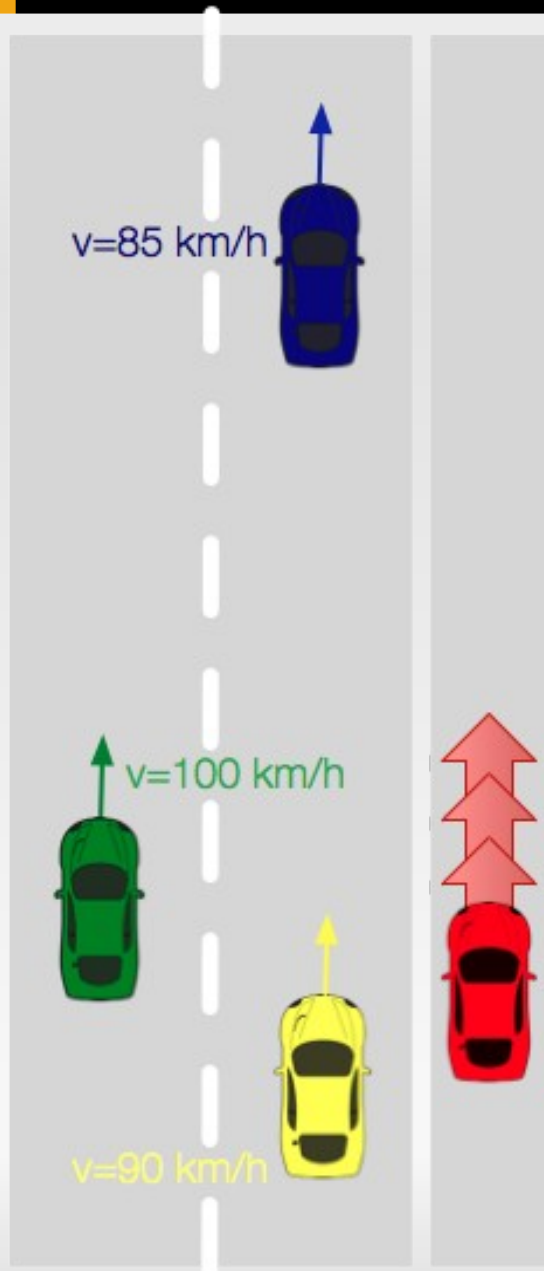
- Threat by a car in front
 - If distance smaller than half of my velocity \rightarrow slow down

Dynamic Scenario – Check list

- Threat by a car behind
 - If distance smaller than half of his/her car → accelerate

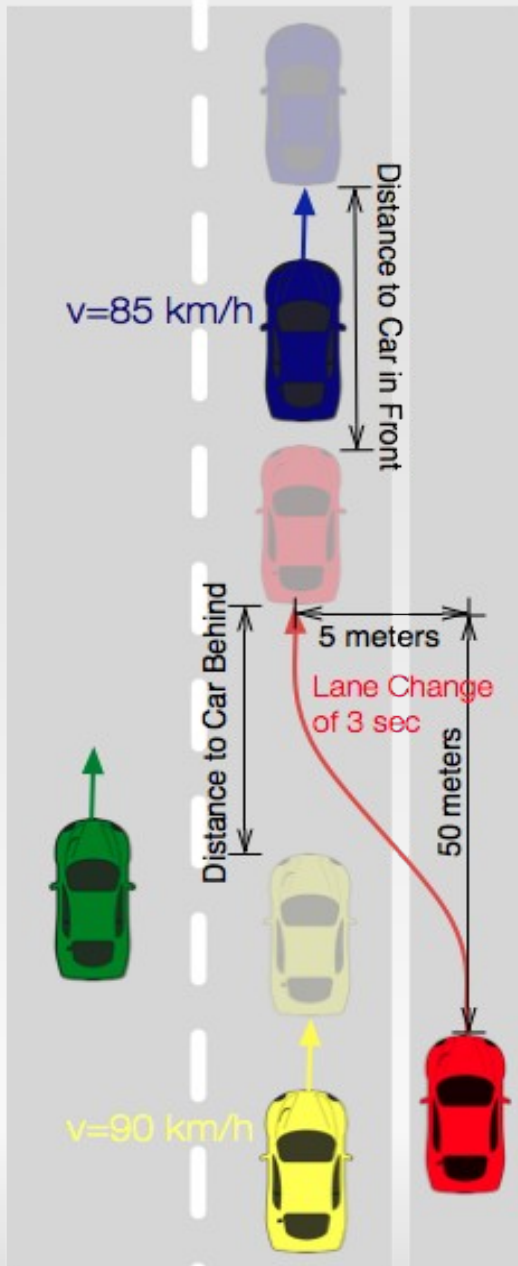


Dynamic Scenario – Plan Execution



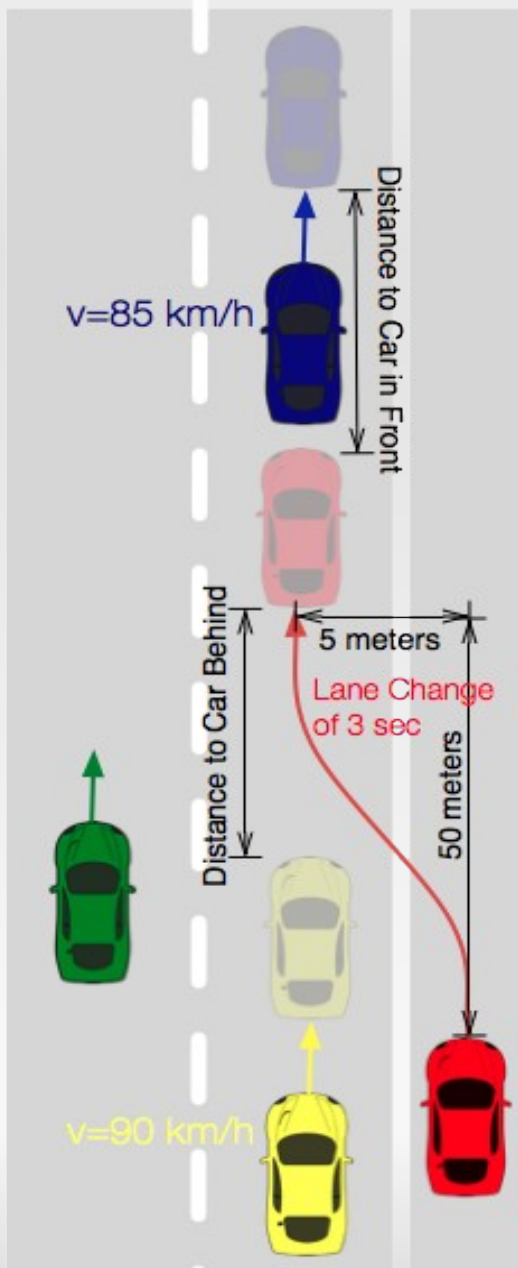
- Acceleration on emergency lane
 - Accelerate to the avg velocity of the cars on the left lane next to me

Dynamic Scenario – Plan Execution



- Can I change a lane?
 - Lane change takes 3 sec.
 - Where would I be if I change the lane?
 - Where would other cars be in 3 sec.?
 - Calculate hypothetical distances to the car in front and behind me
 - If distances too big → do not change the lane

Dynamic Scenario – Plan Execution



- If a lane change is not possible
 - Is the problem a car in front of me? → slow down
 - Is the problem a car behind me?
 - is it slower than me? → accelerate in order to change the lane
 - Is it faster than me? → keep the same velocity so that other car can overtake me

Dynamic Scenario – Final Result?



Dynamic Scenario – Final Result



Thank you

- QUESTIONS?