



# Reference and Alternative Maneuvers

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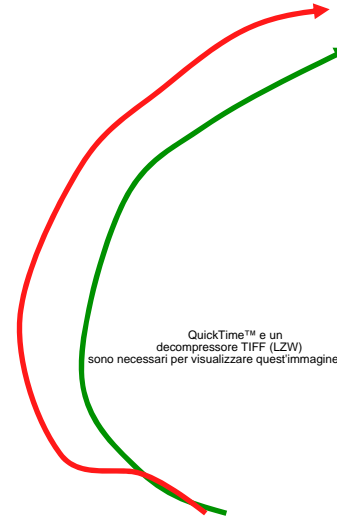


- System architecture and problem definition
- Reference Manoeuvre:
  - Scenario representation and problem definition
  - Risk level assessment
  - Suggestions for driver
  - examples
- Alternative (Evasive) Manoeuvre:
  - Multiple solutions/scenarios
  - Comparisons and suggestions
  - Examples
- Conclusions

# System architecture and problem definition



- Problem statement:
  - Based on the all-around scenario reconstruction:
    - Rate the level of risk of the possible manoeuvres
    - Suggest corrective actions



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- Scenario representation
  - Road geometry  
(curvature, num. of lanes,  
etc.)
  - Landmarks as speed  
constraints
  - Fixed and moving  
obstacles as penalty  
“bubbles”

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- Solution:
  - Rate the risk level of the manoeuvre by computing a “safe-optimal” manoeuvre used as a reference (“reference driving plan”).
  - The concept “optimal” is defined by a hierarchical set of driving rules:
    - 1. Absolute safety
    - 2. User friendliness (or comfort)
    - 3. Efficiency (or mobility)

# The reference manoeuvre (2)



- How the reference driving plan is computed :
  - The problem is posed as an optimal control problem that:
    - Finds the controls (gas, brake, steer) that move the ego-vehicle from its dynamic state to a final safe one in order to comply with:
      - 1. Absolute safety:
        - Comply with ego-vehicle physical constraints
        - Comply with scenario constraints (obstacles, road geometry, landmarks, etc.)
      - 2. User friendliness
        - Lateral, longitudinal accepted accelerations
      - 3. Efficiency:
        - Whenever the above criteria are met it promotes accelerations.



# The reference manoeuvre (3)



- Information obtained from the reference driving plan:
  - Speed plan up to a distance of 200m
  - Trajectory plan
  - “Optimal” controls that produce the driving plan
  - A risk index that evaluates the performance of the computed manoeuvre
  - A set of sub-risk indices that rates the risk level of each threats.



# The reference manoeuvre (4)



- Example:

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# The Alternative manoeuvre (1)



- The R.M. represents a unified way to evaluate the manoeuvre risk level since it includes the whole vehicle dynamics.
  - The risk index can be used to compare two (or more) alternative manoeuvre

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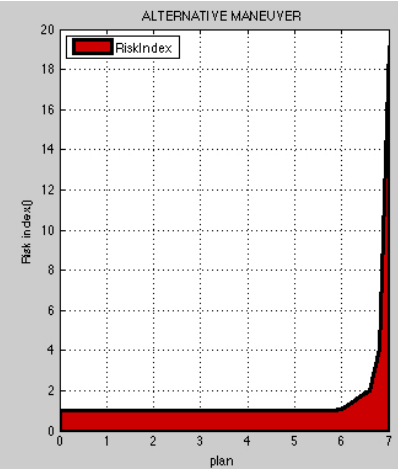
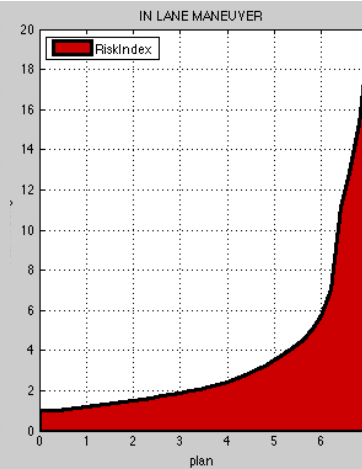
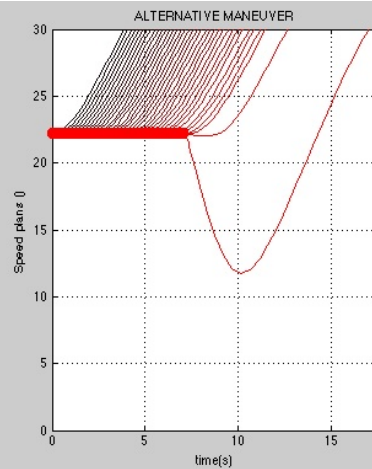
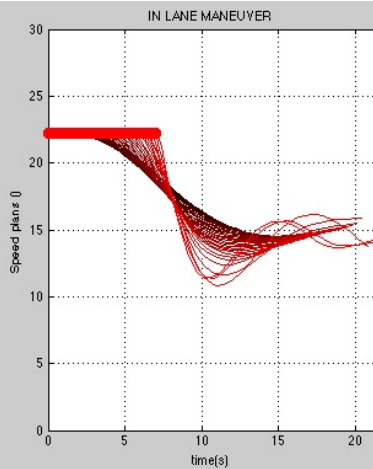
- Test case scenario:
  - In lane manoeuvre vs change lane manoeuvre

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# The Alternative Manoeuvre

- The “in lane” manoeuvre suggests for speed reductions: the risk level increases progressively.
- The “lane change” manoeuvre is less critical until the egovehicle is close to the front obstacle.



# Conclusions



- The reference manoeuvre represents is a method to evaluate a holistic driving plan that account for everything (road, geometry, vehicle dynamics, etc.).
- Computed risk level and controls tell what the driver should do. It is a valuable input to warning an intervention strategies.

