



Energy-Efficient Train Trajectory Optimization and Its Application in Driver Advisory System

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Energy Efficiency

for railways means reducing the energy consumption whilst further growth of rail traffic.



Technologies

- Renewable energy sources
- Energy storage system
- Automatic train control
- **Driver advisory system (DAS)**
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DAS

provides **information** and **driving advice** to drivers and helps them in train control.

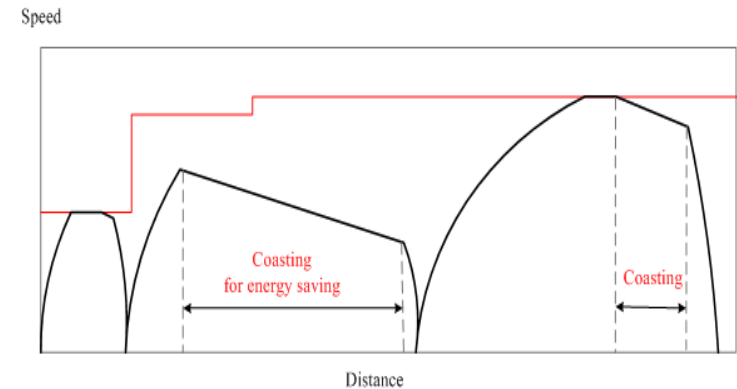
Train Driver Advisory System

Main Challenge

find an optimal speed trajectory

Difficulties

- **Multiple objectives**
punctuality, safety, and energy-saving
- **Complex practical situations**
changing speed limits and gradients, delay
- **Real-time Performances**
computation time, accurate results



My PhD research

- an advanced trajectory optimization algorithm
- a prototype DAS, named ETO

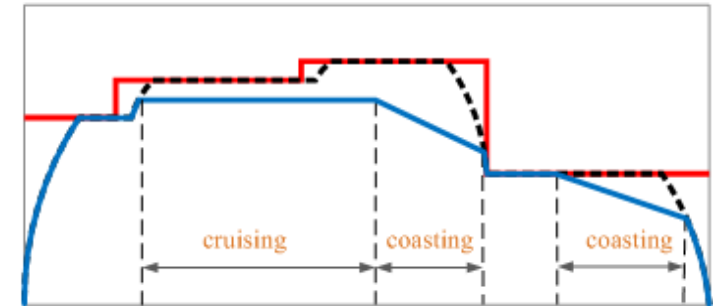
Trajectory Optimization Algorithm

The first priority is **maintaining the timetable** and then **minimizing energy consumption**.

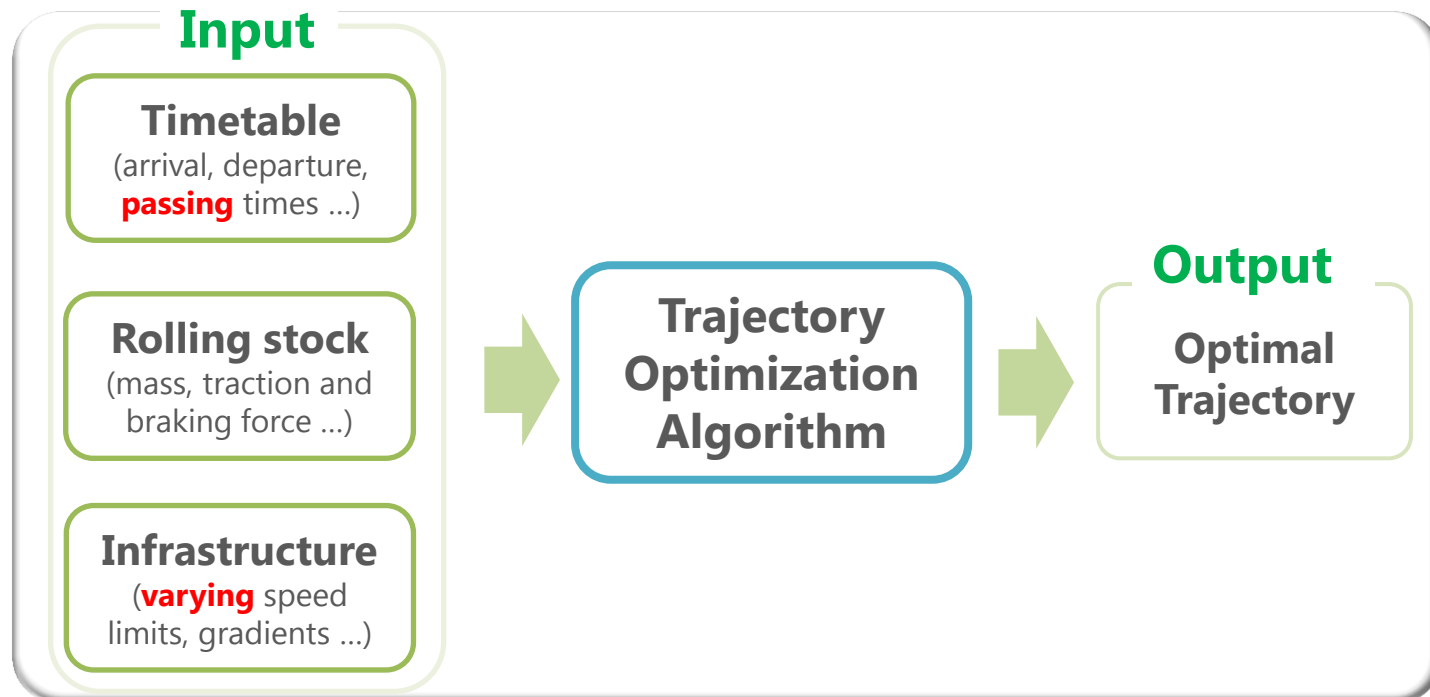
Driving strategies:

- Delay-recovery driving
- Energy-efficient driving

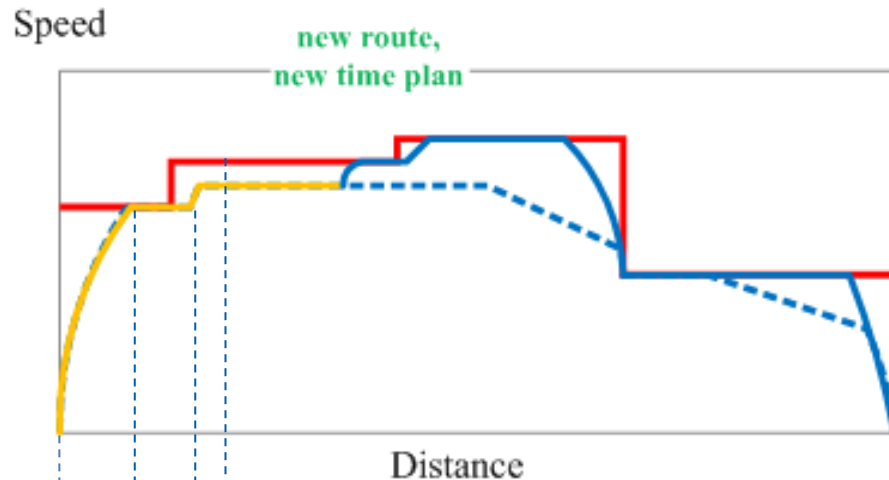
Speed



Distance



1 Compute the optimal trajectory before departing



Acceleration

Cruising

Acceleration

Cruising

advice examples

2 Monitor train state

- Position, speed, time
- Energy consumption
-

3 Compute Advice

- Speed recommendations
- Control regimes
- Info about time keeping
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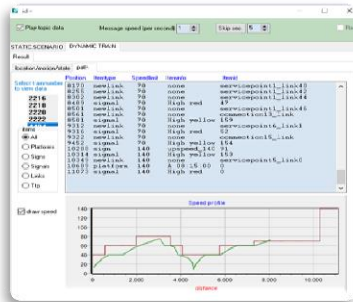
4 Update the advised trajectory if

Current path deviates from the advised path over some threshold.

5 Update the advised trajectory if

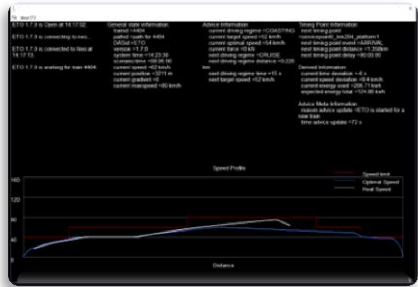
- ETO receives new information (new routes, time targets).

distributed simulation platform



simulator

real-time
train state



ETO

energy efficient driving

trajectory adjustment

delay-recovery driving

trajectory adjustment



“The proposed algorithms contribute to improve the punctuality and the energy efficiency of railway systems.”

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