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Intelligent computing budget allocation for on-road trajectory planning based on candidate curves

Key words: Intelligent computing budget allocation, Trajectory planning, On-road planning, Intelligent vehicles, Ordinal optimization

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Motivation

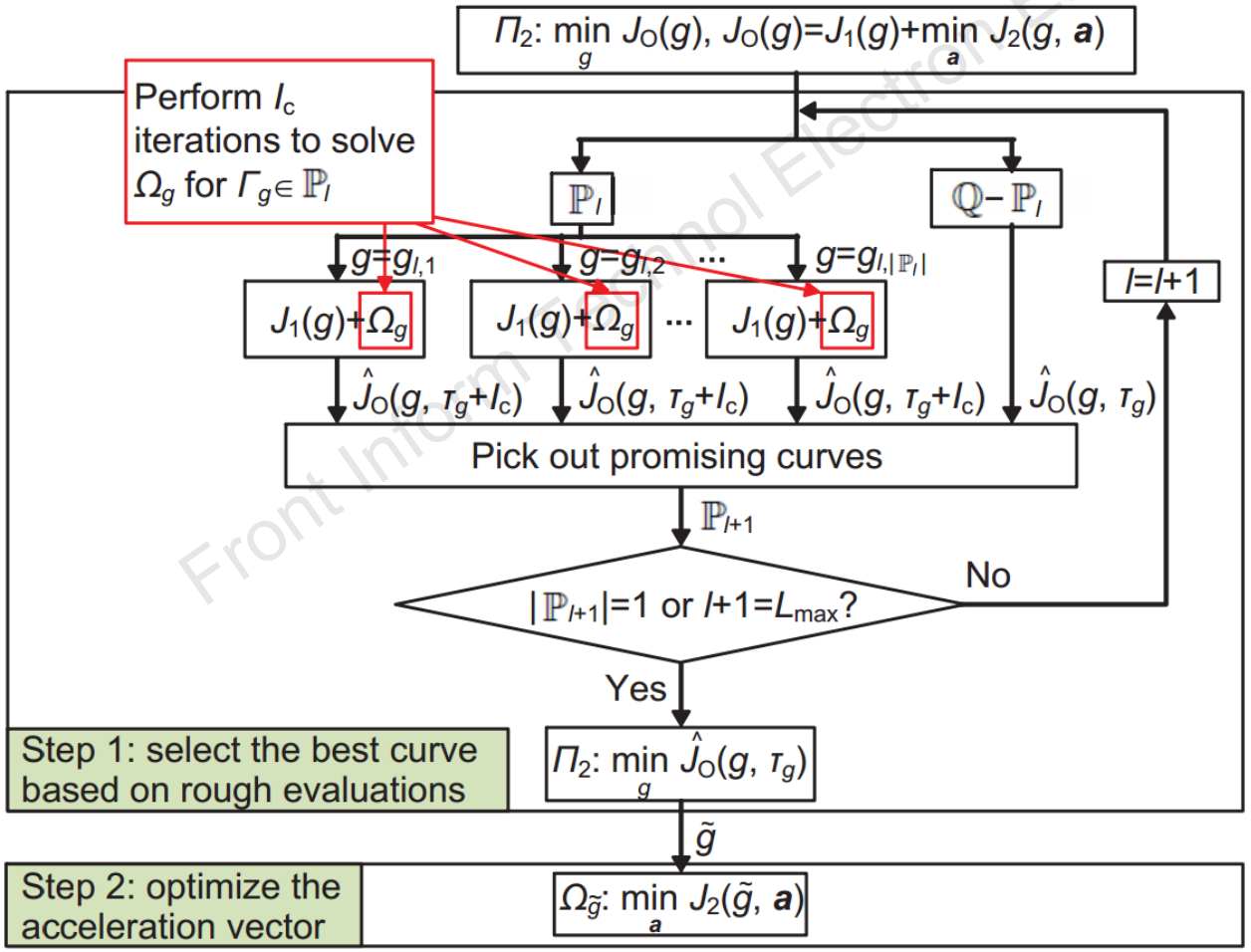
- Trajectory planning is fundamental and important for developing driver assistance systems and driverless vehicles, and planning efficiency is the most significant concern.
- To achieve a trade-off between planning speed and the optimality of the solution, the authors proposed the ordinal optimization-based differential evolution (OODE) algorithm.
- OODE planned the trajectory in two parts: trajectory curve and acceleration profile. The best curve is picked from candidate curves, where each curve is evaluated by solving a subproblem with the DE algorithm. By intelligently allocating the DE iterations to individual curves, the planning efficiency can be improved.

Main idea

- The more iterations DE performs, the more accurate the evaluation will become. Thus, we can intelligently allocate the iterations to individual curves so as to reduce the total number of iterations performed. Meanwhile, the selected best curve is ensured to be one of the truly top curves with a high enough probability.
- The computing budget (measured by the total number of DE iterations) is allocated iteratively according to the obtained evaluations of candidate curves. Each time the computing budget is allocated only to the selected ‘good’ curves.

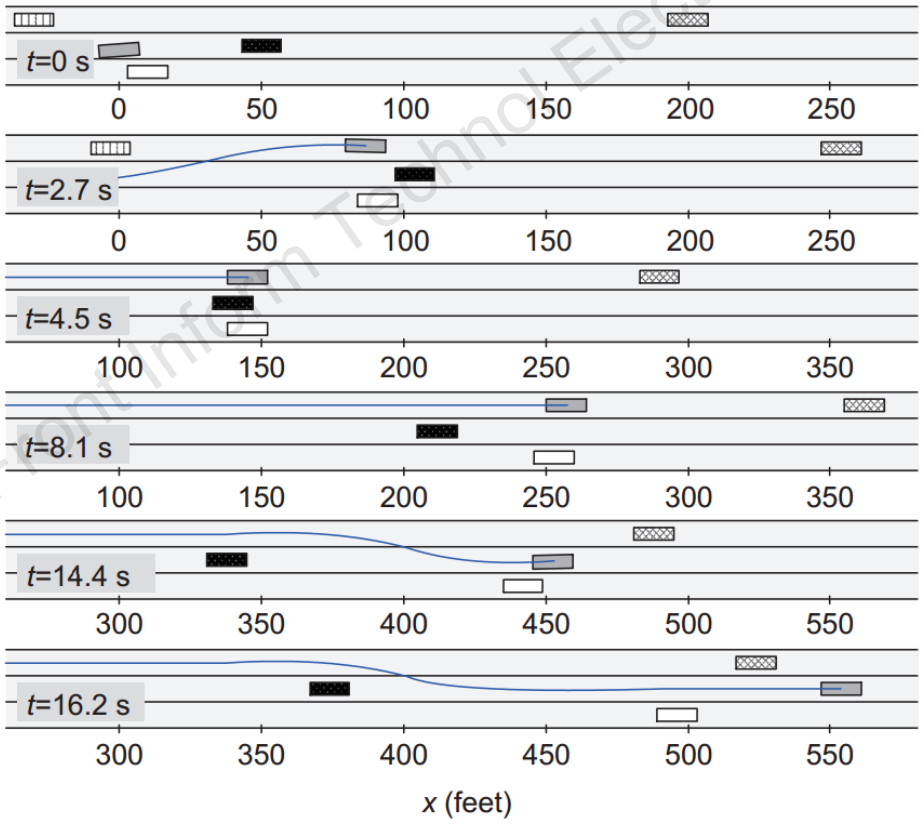
Method

- Framework of IOODE



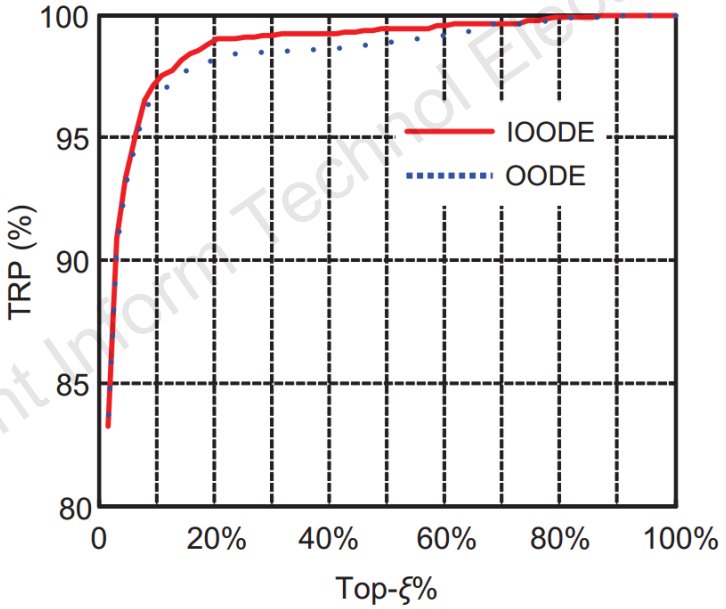
Major results

- IOODE is performed in a rolling horizon framework with a replanning cycle T_0=0.3 s.



Major results

- Top rank percentage (TRP) vs. ξ% using IOODE and OODE to select the best curve from candidates



- We see no significant difference between the solution quality of IOODE and OODE, but the average planning speed of IOODE is about 20% faster than that of OODE.

Conclusions

- We have proposed IOODE by introducing intelligent computing budget allocation into OODE. When selecting the best curve based on curve evaluation, IOODE iteratively allocates the computing budget to promising designs, which effectively reduces the computing cost.
- The framework of computing budget allocation shown here can be applied to other candidate-curve-based planning methods. The key is to build an evaluation model whose accuracy depends on the computing cost and a selection model which selects good designs from candidates based on biased evaluations.