



Optimal Trajectory Generation using Transformers

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Highlights

- Reframe optimal trajectory generation problem as sequence modelling problem.
- Based on Decision Transformer framework developed by Chen et.al.[1]
- Can generate effective warm-start trajectories for convex optimization.

Problem Setup

- 2D, Double integrator dynamics
- Cost function

Single Agent system

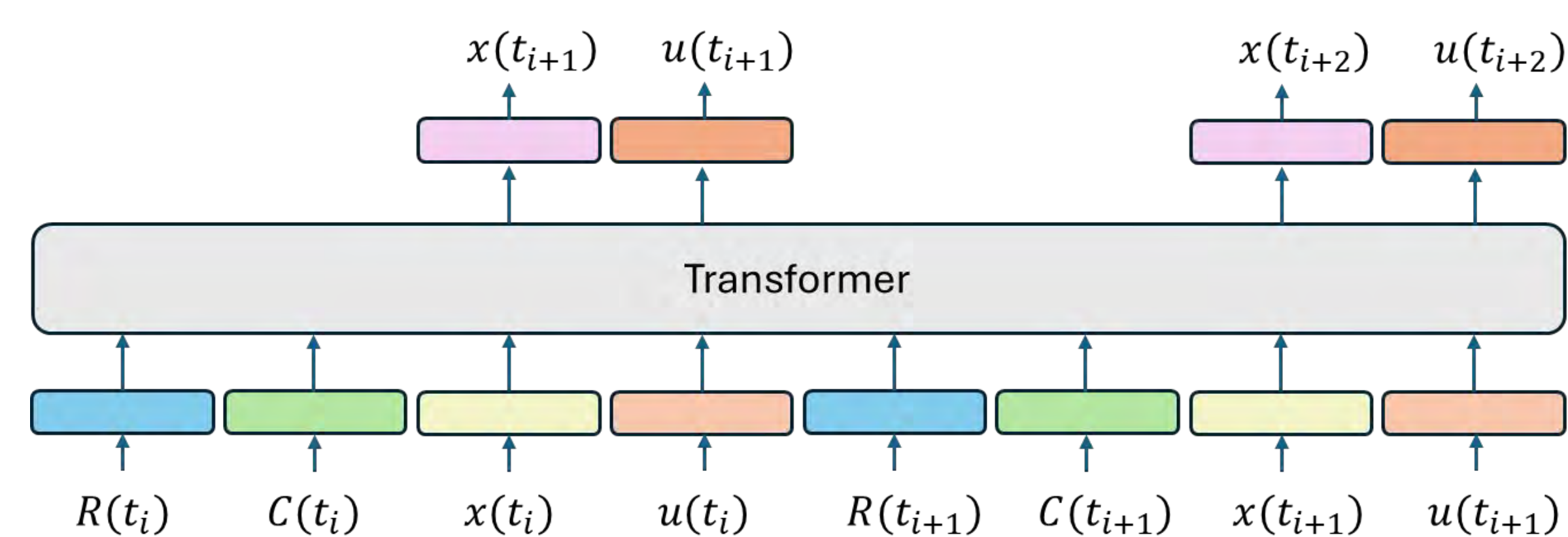
$$J = \sum_{t=0}^{T-1} (x_t^T Q x_t + u_t^T R u_t)$$

Multi-agent system

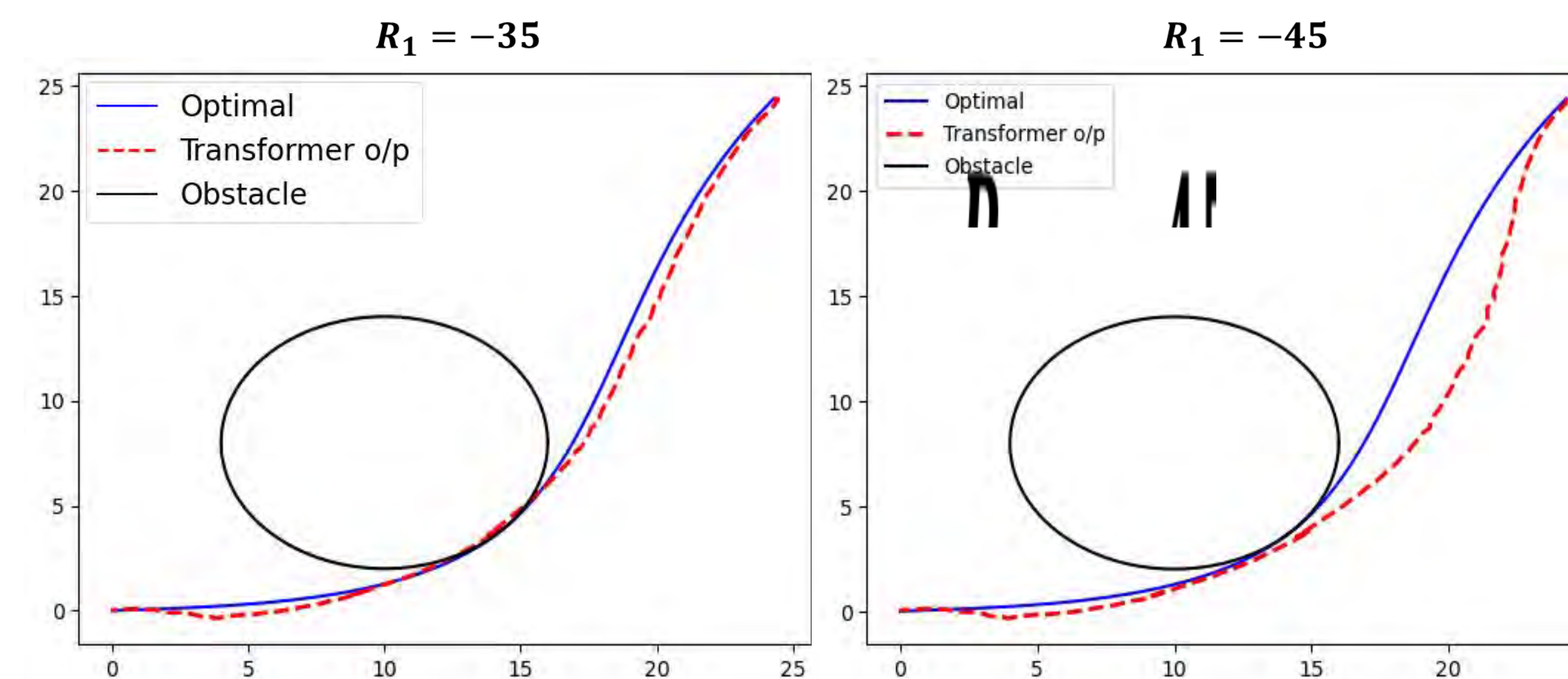
$$J = \sum_{n=1}^{N_{agents}} \sum_{t=0}^{T-1} (u_t^T R u_t)$$

Methodology and Parameters

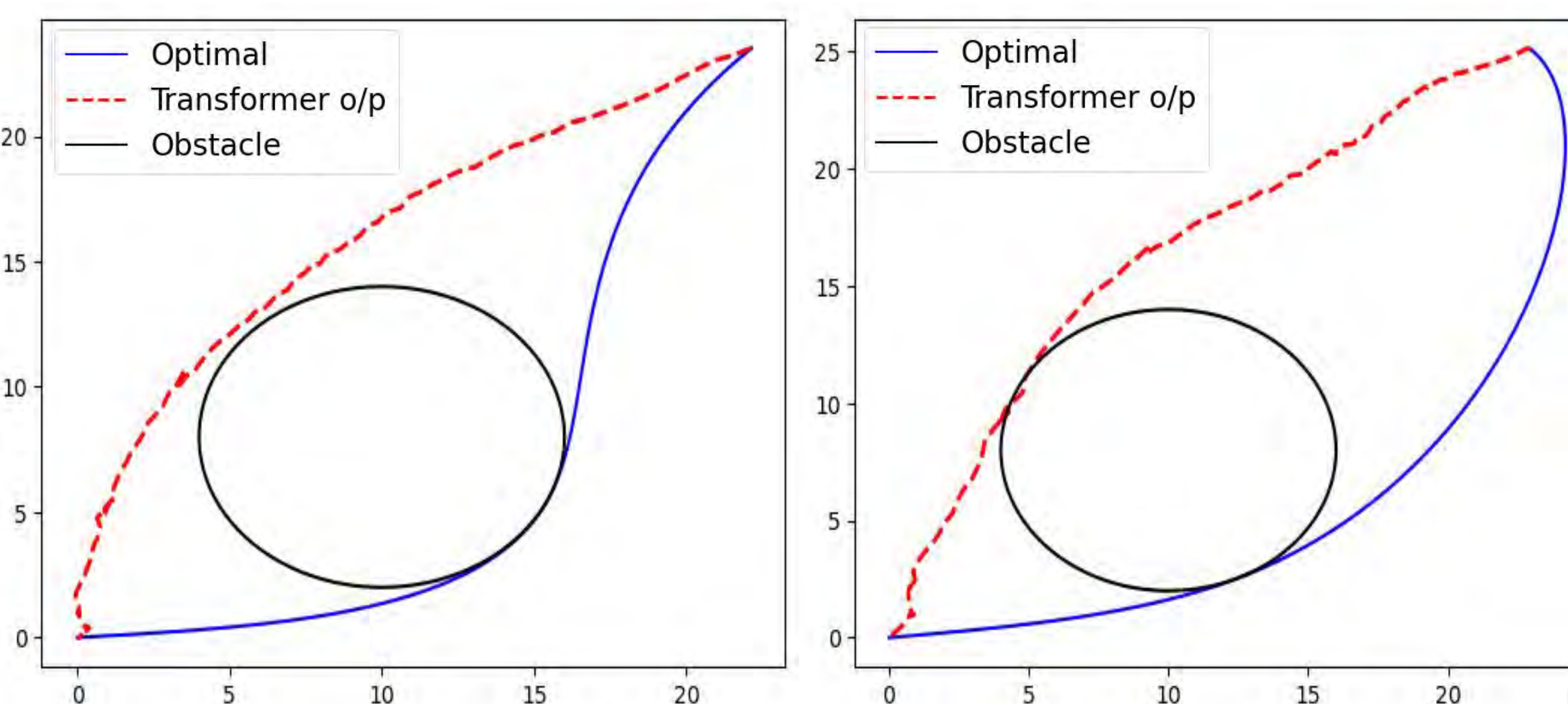
- Transformer architecture[2]



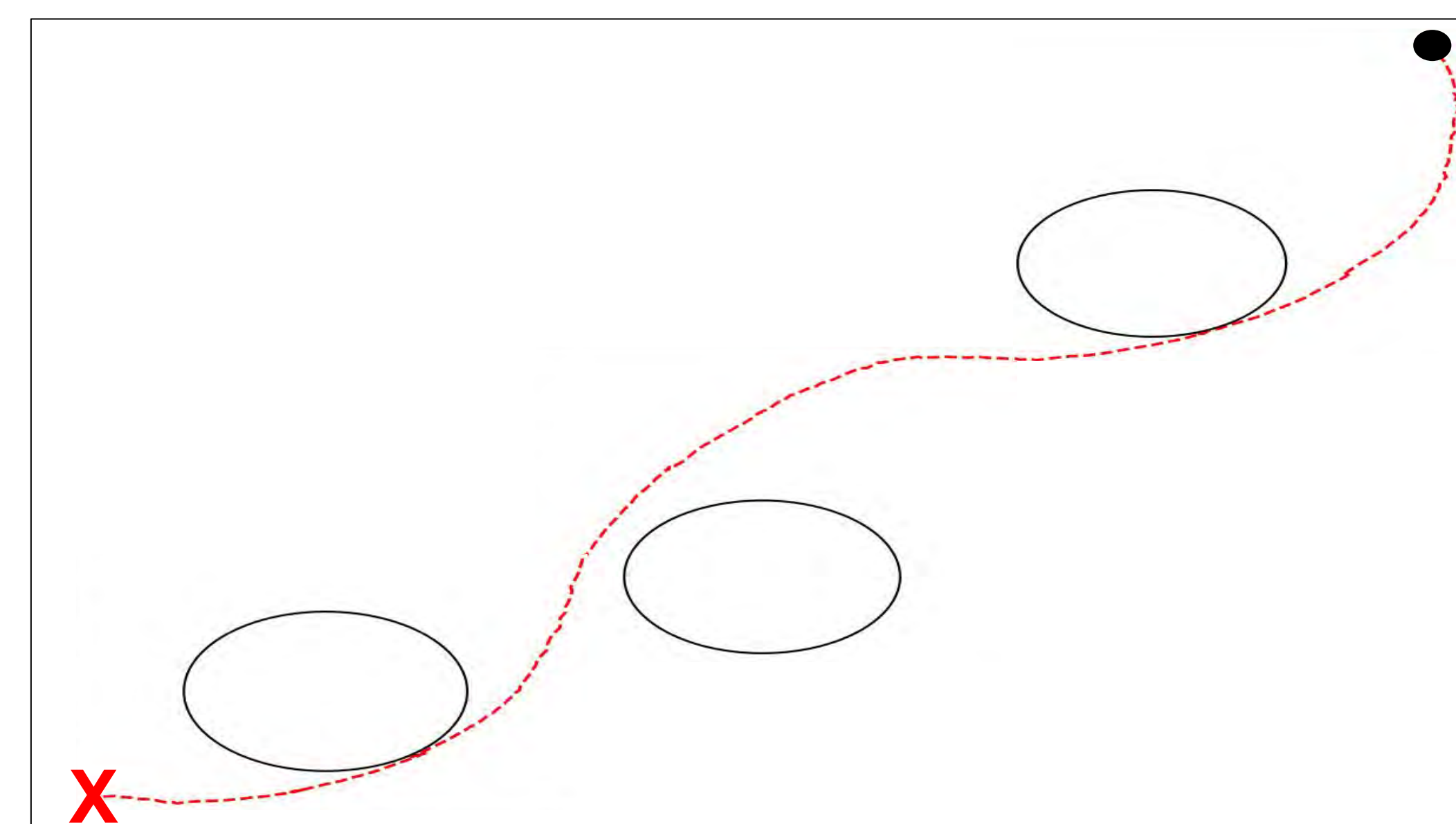
Results and capabilities



- When a higher cost is desired, trajectory takes a longer, sub-optimal path to achieve higher cost.



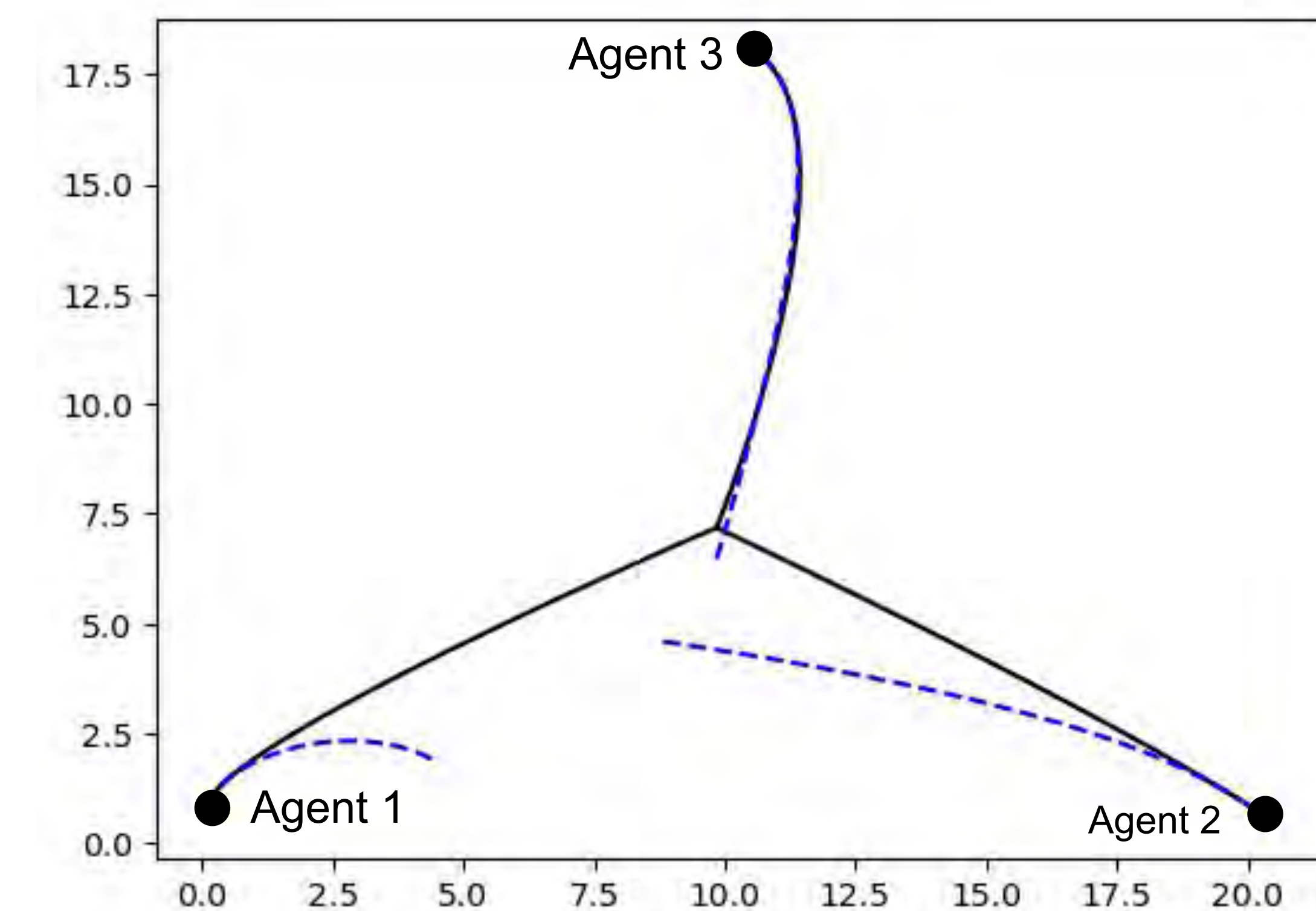
- Can find a shorter path independent of initial trajectory



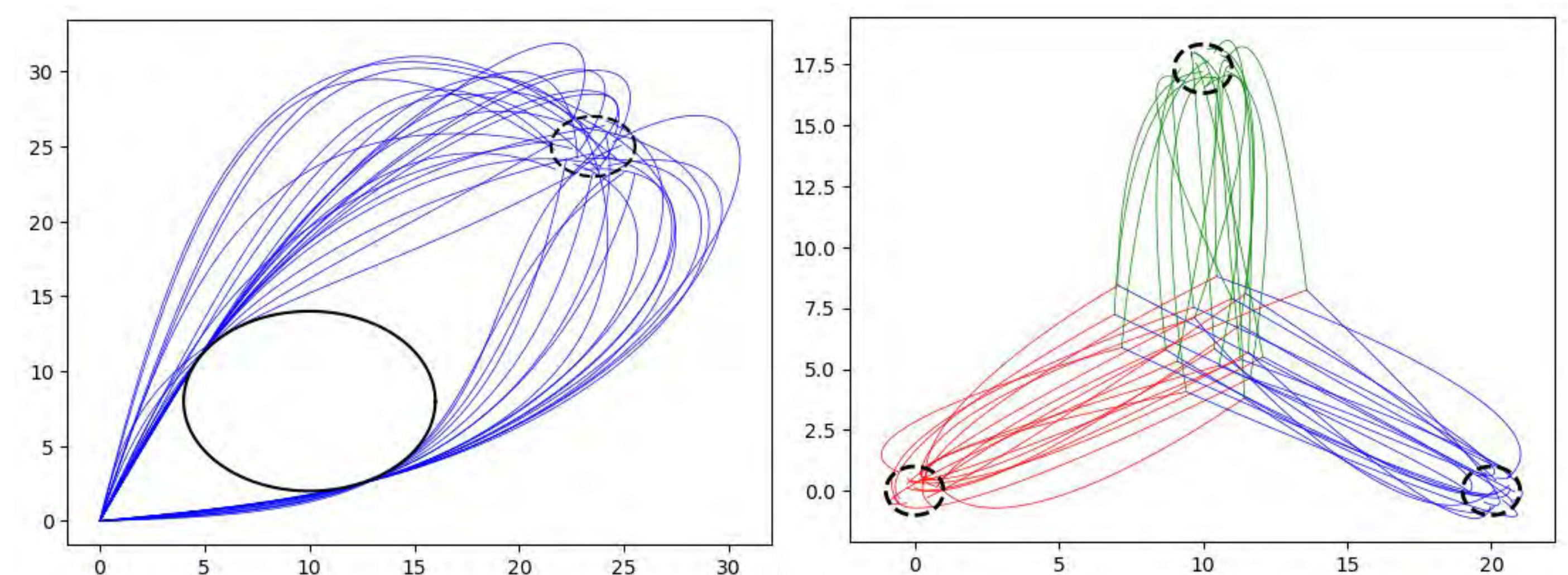
- It can patch several single obstacle avoidance trajectories to give a feasible trajectory with multiple obstacles.

Multi-agent system

- Optimal consensus for 3 agents
- Dynamics-in-loop



Training Data



Future Work and References

- Implementation on distributed multi-agent systems.
- Strict implementation of constraint satisfaction.

[1] Chen, L., Lu, K., Rajeswaran, A., Lee, K., Grover, A., Laskin, M., Abbeel, P., Srinivas, A., & Mordatch, I. (2021). Decision Transformer: Reinforcement learning via sequence modeling.

[2] Guffanti, T., Gammelli, D., D'Amico, S., & Pavone, M. (2024). Transformers for trajectory optimization with application to spacecraft rendezvous. IEEE Aerospace Conference.

