Optimization of a Conventional Tunneling Process Through Offline Reinforcement Learning

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Abstract. With emerging data-intensive technologies, industry automation has become promising in different fields, including the construction sector. Reinforcement learning has been applied to optimize conventional tunneling processes to minimize instabilities and excavation time. This study aims to take advantage of offline reinforcement learning through the soft actor-critic method, in which policies are evaluated and improved with offline datasets of the transitions occurring within the environment. The proposed method shows capabilities for encouraging exploration while generating actions, minimizing instabilities during the excavation, and allowing the transfer of this knowledge to different tunneling environments.

Keywords: Conventional tunneling · Offline reinforcement learning · Process optimization

1 Introduction

Over the past decade, digitalization in the construction industry has raised important attention due to its advantages demonstrated in different productive fields. In tunnel excavation projects, artificial intelligence (AI) techniques have been employed on tasks related to modeling, monitoring, and control of different operational variables, especially focused on tunnel boring machines (TBM) performance in which several sensors allow autonomous feedback [1]Conversely, conventional tunneling consisting of drill and blast sequences is more challenging to measure and, therefore, generates control strategies to optimize the excavation process.

The key to a smart process control strategy is its ability to adapt to changing conditions, in the tunneling case, the variant geology. The conventional tunneling methods allow the observation of these changes; however, technical and economic aspects heavily rely on the operators' experience [2]. Reinforcement learning (RL) is a machine learning (ML) focused on the control and objective optimization of a problem utilizing a closed loop of action and observations reinforced by rewards and has been widely utilized in in-game scenarios and real-world applications such as robotics [3]. Recent investigations

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