

**Title:**

Artificial Intelligence in Railway Transport: Taxonomy, Regulations, and Applications

**Authors:**

Nikola Bešinović<sup>1</sup>, Lorenzo De Donato<sup>2</sup>, Francesco Flammini<sup>3,4</sup>, Rob M. P. Goverde<sup>1</sup>, Zhiyuan Lin<sup>5</sup>, Ronghui Liu<sup>5</sup>, Stefano Marrone<sup>2</sup>, Roberto Nardone<sup>6</sup>, Tianli Tang<sup>7</sup>, Valeria Vittorini<sup>2</sup>

<sup>1</sup> Department of Transport and Planning, Delft University of Technology, Delft, The Netherlands

<sup>2</sup> Department of Electrical Engineering and Information Technology, University of Naples Federico II, Naples, Italy

<sup>3</sup> School of Innovation, Design and Engineering, Mälardalen University, Västerås, Sweden

<sup>4</sup> Department of Computer Science and Media Technology, Linnaeus University, Vaxjo, Sweden

<sup>5</sup> Institute for Transport Studies, University of Leeds, Leeds, United Kingdom

<sup>6</sup> Department of Engineering, University of Naples "Parthenope", Naples, Italy

<sup>7</sup> Jiangsu Key Laboratory of Urban ITS, Jiangsu Province Collaborative Innovation Center of Modern Urban Traffic Technologies, School of Transportation, Southeast University, Nanjing, China

**Abstract:**

Artificial Intelligence (AI) is becoming pervasive in most engineering domains, and railway transport is no exception. However, due to the plethora of different new terms and meanings associated with them, there is a risk that railway practitioners, as several other categories, will get lost in those ambiguities and fuzzy boundaries, and hence fail to catch the real opportunities and potential of machine learning, artificial vision, and big data analytics, just to name a few of the most promising approaches connected to AI. The scope of this paper is to introduce the basic concepts and possible applications of AI to railway academics and practitioners. To that aim, this paper presents a structured taxonomy to guide researchers and practitioners to understand AI techniques, research fields, disciplines, and applications, both in general terms and in close connection with railway applications such as autonomous driving, maintenance, and traffic management. The important aspects of ethics and explainability of AI in railways are also introduced. The connection between AI concepts and railway subdomains has been supported by relevant research addressing existing and planned applications in order to provide some pointers to promising directions.

**Fundings and Disclaimer:**

This research has received funding from the Shift2Rail Joint Undertaking (JU) under grant agreement No 881782 RAILS (Roadmaps for Artificial Intelligence (A.I.) integration in the rail Sector). The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Shift2Rail JU members other than the Union.

The information and views set out in this document are those of the author(s) and do not necessarily reflect the official opinion of Shift2Rail Joint Undertaking. The JU does not guarantee the accuracy of the data included in this document. Neither the JU nor any person acting on the JU's behalf may be held responsible for the use which may be made of the information contained therein.

**Publication Notes:**

This Journal Article is available at: <https://doi.org/10.1109/TITS.2021.3131637>