

Studies in Systems, Decision and Control 563

Aleksander Śładkowski *Editor*


# Using Artificial Intelligence to Solve Transportation Problems

 Springer

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# Using Artificial Intelligence to Solve Transportation Problems

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# Preface

The author of this text had to participate in conferences several times, when famous scientists argued with great enthusiasm on the topic of what logistics is. Despite the fact that logistics tasks were posed, for example, to military leaders of the ancient world in order to ensure the supply of their armies, the concept of logistics as a science arose quite recently. Moreover, many question whether logistics is a separate scientific field or not.

Even though computers are relatively new and were originally intended to make computing easier for engineers and scientists, the concept of artificial intelligence has only come into everyday use in recent years. Of course, many science fiction novels and stories have been written where machines or creatures armed with artificial intelligence appear. Among the most famous authors who devoted some part of their work to this topic are Karel Capek, Isaac Asimov, Stanislav Lem and many others. There were also numerous science fiction films, which, for their part, supported the interest of young researchers in order to devote their work to this scientific direction.

These days, artificial intelligence is moving from science fiction works into everyday life. And the question immediately arises, what is artificial intelligence? This term, which appeared in the 50s of the last century, was understood as the process of modeling human intelligence using computer technology. And just as in the case of logistics, different authors give different definitions to this concept. For example, on the website<sup>1</sup> the authors provide the following definition: “Artificial intelligence (AI) is the theory and development of computer systems capable of performing tasks that historically required human intelligence, such as recognizing speech, making decisions and identifying patterns. AI is an umbrella term that encompasses a wide variety of technologies, including machine learning, deep learning and natural language processing (NLP)”. But then these authors themselves understand that they will be criticized for a very expanded understanding of artificial

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<sup>1</sup> Coursera (2024) What Is Artificial Intelligence? Definition, Uses, and Types. <https://www.coursera.org/articles/what-is-artificial-intelligence>.

intelligence, calling such computer assistance to a person, despite the fact that the system can be self-learning, is only the first step in creating AI, calling genuine AI “general artificial intelligence” (GAI).

Thus, we see an example of a double interpretation of this concept: expanded and narrowed. N. Laskowski and L. Tucci in their article<sup>2</sup> also give an expansive definition: “Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems”. Next, they try to explain the differences in the concepts of AI, machine learning and deep learning. At the same time, these authors note that in many companies that deal with the development of software and computer systems, these concepts are identified.

Based on the above definitions and understanding that it is difficult to find a general approach to this issue, we will further rely on an expanded interpretation of the concept of AI. Thus, if we further consider the use of AI to solve problems in the transport industry, we should understand that the level of AI development can be different: from fully autonomous vehicles to the use of AI as an assistant in solving logistics problems.

It should be noted that vehicle operation, production, recycling, transport infrastructure and many other aspects currently require AI. The idea of this monothematic monograph was to offer readers a description of the different approaches that exist in different countries, with different levels of economic development or well-being of the population. Various chapters of this book were written by leading scientists from Greece, Bulgaria, Hungary, Kazakhstan, Lithuania, Ukraine, China and Poland. The monograph examines various problems in the transport industry that find their solutions using AI.

The first chapter, which was written by Greek colleagues, discusses the possibilities of using AI to analyze the behavior of drivers in difficult road situations, to find out the causes of certain emergency situations. It is quite obvious that such an analysis is always carried out. Previously, the main factor was the subjective opinion and experience of the expert who analyzed each specific situation. AI puts in the hands of an expert an important tool that can answer not only the question of whether the driver is acting correctly in a critical situation, but also the question of whether everything is in order with the vehicle being used. Perhaps some design changes should be introduced to ensure passenger safety. Obviously, modern cars have some devices that allow them to react to a critical situation created while driving. But whether emergency braking is correct or not, for example, in a given situation. The further you go, the more information the on-board computer must process in order to make the right decision. At the same time, in certain situations, prompting the driver to make the right decision, and in other situations, replacing it.

The next few chapters are devoted to the problems of using AI in railway transport. The second chapter examines various aspects based on the experience and new developments of Ukrainian scientists. While writing this introduction, tragic information appeared that in the Czech Republic, at the Pardubice station, a train accident

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<sup>2</sup> Laskowski N, Tucci L (2024) What is artificial intelligence (AI)? Everything you need to know. <https://www.techtarget.com/searchenterpriseai/definition/AI-Artificial-Intelligence>.

occurred during which, as a result of a collision between passenger and freight trains, 4 people were killed and more than 20 people were injured<sup>3</sup>. The cause of the accident was the driver's lack of response to a prohibitory traffic light signal. If the proposals of the authors of the chapter under consideration had been implemented, this tragic situation could have been avoided. Unfortunately, this case is not an isolated one. Despite the important technical and organizational measures that are being implemented in many countries around the world, such accidents are not uncommon. This information is presented here only because this accident was recent and to some extent is typical. In the event of this emergency situation, the decision to stop the train could be made not only by the on-board computer of the locomotive, but also by the dispatcher who served this electrified section of the track. The accident occurred at 11 pm, when, apparently, the attention of those involved in the event was weakened due to fatigue or other reasons. The authors of the chapter consider the problems of traffic safety using AI in a comprehensive manner. It is claimed that thanks to the ability to automatically train security systems (neural networks), and it is possible to achieve a level of 98% efficiency in detecting threats. Another aspect covered in this chapter is the management of railway energy systems. Thanks to the use of AI, it is possible to optimize the operation of such systems, which will significantly save energy resources.

The AI task, posed in the third chapter by Polish specialists, is to assess the prospects of railway lines for various purposes. This issue is very significant when planning investments in the development of the industry. Previously, such a task was considered exclusively by expert groups, where it was impossible to exclude subjective assessments. AI based on multifactor analysis makes it possible to develop proposals for the development of the railway network for individual regions or the state as a whole. It is obvious that the final decision on the development of a particular section of railways for passenger or freight traffic and, in some cases on its liquidation, will be made by specialists. However, the solutions proposed in the chapter can be an important tool in the hands of such expert commissions.

Container transportation for various cargoes is a progressive solution for the delivery of various goods. This is very significant nowadays due to the changing location of production facilities in different countries. In particular, the Southeast region has become such a global factory, from where various goods are delivered to Europe. Along with maritime transport corridors, there are a number of railway corridors. In this case, there are a number of barriers on the way of a container, for example, from China to Germany. In particular, this is a problem of different railway gauge widths. There are a number of technical solutions aimed at solving this problem, but the most common solution is to transship containers from one platform to another. There is also the problem of the last mile, when the container must be delivered to the end consumer. This is also where reloading from the railway

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<sup>3</sup> Alarabia News (06 June 2024: 02:53 AM GST) Four died, dozens injured in train crash in Czech's Pardubice. <https://english.alarabiya.net/News/world/2024/06/06/two-died-dozens-injured-in-train-crash-in-czech-s-pardubice>.



platform to the car trailer takes place. The chapter, written by the Hungarian authors, examines the use of AI to help operators speed up this reloading process.

The next chapter, which appeared on the basis of joint research by Kazakh and Polish scientists, also studies the problems of railway transportation. At the same time, the problems of long-term transportation planning on a national scale are considered using the example of Kazakhstan. Using AI to solve this problem can significantly speed up processes such as optimizing railway train routes, increasing the operational efficiency of transportation, reducing various types of costs and achieving a number of other advantages. It is obvious that such tasks are multifactorial. Solving them without the use of computer technology is almost impossible. At the same time, it is important to note the comprehensive nature of the research, which, despite a number of regional features, can be proposed for railways in other countries.

AI can provide significant assistance in planning the operation of urban transport. The city of Ruse (Bulgaria) was adopted by the authors as a specific testing ground for the implementation of new developments. The complexity of the transport system of this city lies in the fact that currently there are very heterogeneous means of public transport used here. Most of them are outdated buses with diesel engines. There is a fairly large trolleybus fleet. Recently, the number of buses with electric motors has been constantly increasing. Each type of transport requires its own route planning. This planning largely depends on the time of day or season of the year. At the same time, the quantitative composition of transport means is constantly changing, which is influenced by the need for periodic repairs or maintenance, the availability of charging stations, new investments and other factors. The developments brought to the attention of readers can be implemented in most cities that have similar problems.

Another field for AI implementation is warehousing. Modern warehouses are complex enterprises, equipped with various types of modern warehouse equipment, which allows for sorting, placement of goods, their packaging, labeling, control and many other technological operations. Chinese scientists have proposed a new development—a mobile logistics robot that can perform many technological operations in interaction with a general intelligent warehouse management system. This development included many innovative solutions, such as navigation positioning technology, path tracking technology, a new chassis design and several others. This development can be the basis for creating other specialized equipment for various types of warehouses.

The eighth chapter of the book was written jointly by Lithuanian and Ukrainian scientists. It should be noted that Ukraine is currently going through a very difficult moment in its history. A full-scale war taking place on its territory requires radical logistics solutions. The authors analyze the current situation with supply chains. As a result of this analysis, it is concluded that the introduction of special software based on AI can improve the quality of deliveries and speed up their implementation. This analysis was based on data from LLC Raben Ukraine.

In the last ninth chapter of the book, Polish authors were engaged in the introduction of AI technologies for the market of services of companies involved in the transportation of goods in European countries. It is known that Poland has been one

of the first places in the market for such services for many years. There are Internet services where logistics companies can offer both direct cargo transportation and related services: freight forwarding, insurance, customs clearance and a number of others. At the same time, assessing the cost of such services is key. This assessment depends on many factors: the urgency of delivery, the type and quantity of goods, the specific route and many others. Obviously, the current state of the market for such services is also taken into account. The proposed software, containing certain AI elements, is Open Source in nature and can be offered for implementation in various, not only European, countries.

In conclusion, I would like to wish readers interested in the use of AI technologies to solve problems facing the transport industry to receive new useful information. Such information can be useful for practical use in the field of development of transport systems, creation of transport infrastructure, logistics of cargo delivery, information support of transport processes and other applications. It is obvious that the readers of this book can and should be scientists, teachers and students. Despite the scientific nature of the book and its rather specialized focus, it can be recommended to a wider circle of readers interested in aspects of the practical application of computerization and the achievements of modern science in various countries.

Katowice, Poland  
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