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FAAI:

The Future is in Applied Artificial Intelligence
Erasmus+ project 2022-1-PL01-KA220-HED-000088359

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Research 8: Collecting real cases of AAI: the state-of-the-art analysis for WP2





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Date

31.03.2023

Places of the development of the result

University of Bielsko-Biala, Bielsko-Biala, Poland

University of Library Studies and Information Technologies, Sofia, Bulgaria

University of Nis, Serbia

University of Ss. Cyril and Methodius in Trnava, Slovakia

University of Montenegro, Montenegro

Summary: Project FAAI:2022-1-PL01-KA220-HED-000088359 "Future is in Applied Artificial Intelligence" (FAAI) under the Erasmus+ program started in September 2022. This project aims to bring together universities and business, and provide innovative solutions to develop artificial intelligence experts.

The project unites 5 partners from Central European and Eastern European universities: Poland, Slovakia, Serbia, Bulgaria and Montenegro.

In fulfillment of the goals set in the project, a case study with real application of AAI was conducted at stage WP2. The survey was conducted by the participants of this project.

Keywords: research, Artificial Intelligence, Applied Artificial Intelligence, real cases

1. Introduction

This research explores practical solutions implemented using applied artificial intelligence. The research was done by preparing an online survey containing a total of 7 questions, open and closed. The questionnaires were developed in the AdminProject environment and provided to the participants of this project by each of the partner universities.

The survey was conducted in the period from February 1, 2023, to March 5, 2023.

The purpose of the study is to find real working applications of applied artificial intelligence projects, describe their application in what field, and record the name of the projects found to describe their activity.

Survey data were processed using IBM SPSS Statistics 19. During this time, no events were reported that could affect the result

2. Collection and analysis of data

The data was collected by scientists from the five partner institutions. A total of 279 questionnaires were collected in the study, with 97 (53.41%) questionnaires received from Bulgarian researchers, 50 questionnaires (17.92%) from Polish researchers, 52 (18.64%) from Serbian researchers, 30(10.75%) from Slovak researchers and 50 (17.92%) by researchers from Montenegro.

A total of 279 questionnaires were collected by 32 researchers.

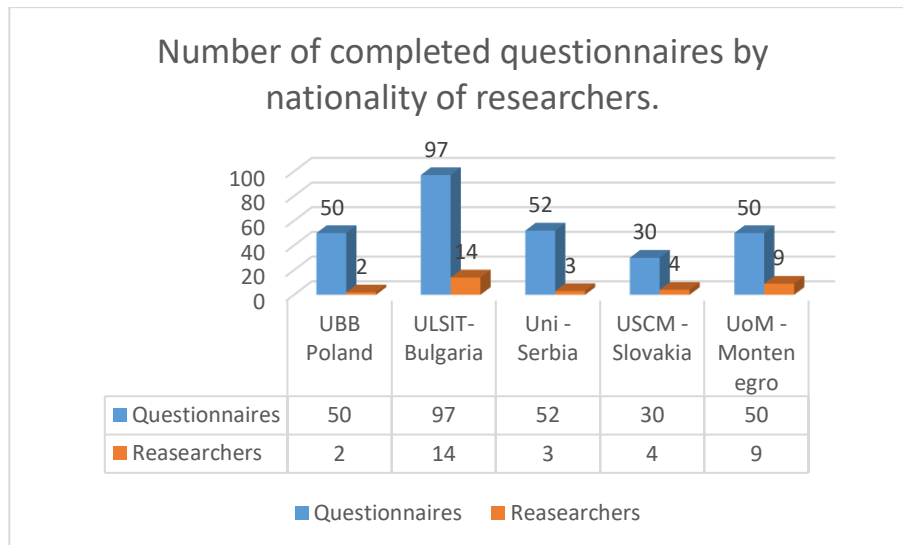


Fig.1 Distribution of surveys by nationality of scientists - researchers

3. Results

3.1. What is the country of real case

The first question the survey asks is which is a country of a real case of AAI. Out of a total of 279 completed questionnaires, as many as 27 (9.68%) real cases do not have a completed answer for a country. The remaining 252 questionnaires have data for this value.

A detailed list of real cases of AAI can be seen in Table 1. The data are graphically presented in Fig.2.

Table 1. Full list of real cases of AAI by country

Countries	Real cases of AAI
Bulgaria	50
Serbia	41
N/A	27
USA	27
Slovakia	16
EU countries	15
Poland	12
Italy	10
Czech	10
Montenegro	9

Germany	10
Collaborative (EU and No-EU countries)	10
Greece	7
France	6
China	5
United Kingdom	3
Spain	3
Austria	2
Switzerland	2
Sweden	2
Chile	1
Rumania	1
Russia	1
Norway	1
Japan	1
Korea	1
Malaysia	1
Croatia	1
Finland	1
Hungary	1
Iran	1
Ireland	1
Total:	279

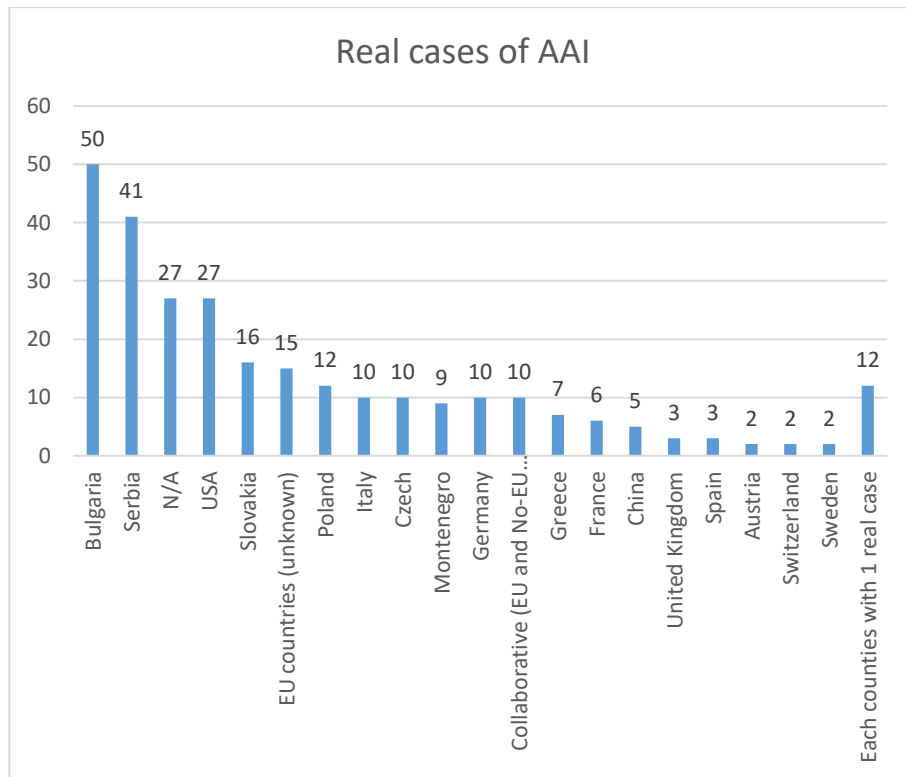


Fig.2. Full list of real cases of AAI by country

Data description:

The data from Table 1 show that the most real cases with the application of AAI were found in the territory of Bulgaria and Serbia, with 50 and 41 real cases, respectively. The USA follows with 27 cases, Slovakia with 16 cases, and Poland with 12 cases. Italy and the Czech Republic with 10 cases each. Along with them, many applied cases from the USA (27) and the EU (15) were considered.

For 27 (9.68%) real cases, there is no specific country to which they can be assigned. The research notes 10 jointly developed real-life cases involving both EU and non-EU member states.

Discussion:

The data in Table 1 show that the use of real cases using AAI is practiced worldwide. Most of the described real cases are observed in the project countries, as the researchers have better knowledge of their own countries. There are also a large number of described real cases in the USA and under the general term European Union, as they have well-developed economies and IT industries.

If these same data (Table 1) are considered as real cases with the application of AAI in European Union member countries and others, it can again be seen that the use of solutions with the application of artificial intelligence is proportional. The data are shown in Table 2 and visualized in Fig.3.

Table 2. Distribution of the described real cases according to the country's membership of the European Union

Countries	Real cases of AAI
EU countries	147
no EU countries	95
N/A	27
Collaborative (EU and No-EU countries)	10
Total:	279

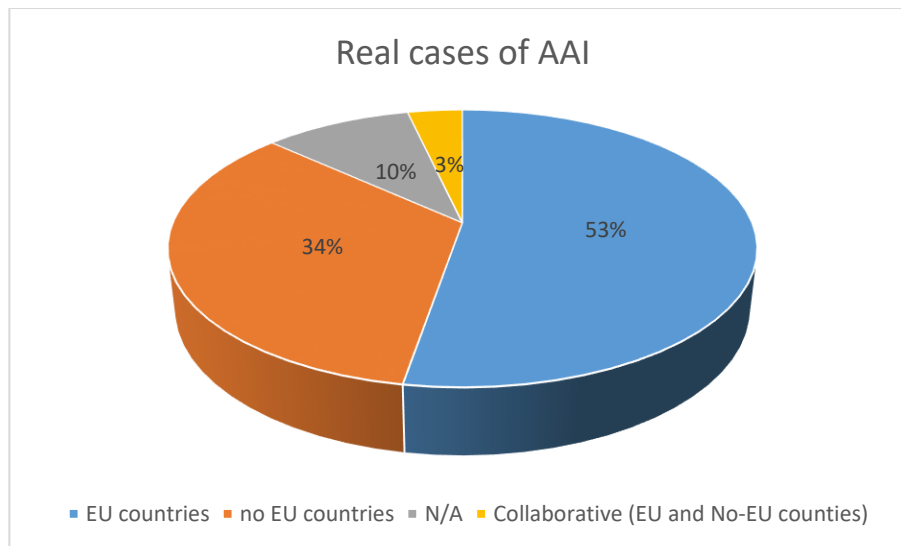


Fig.3. Distribution of the described real cases according to the country's membership of the European Union

Main conclusions:

- Countries use a lot of solutions using artificial intelligence
- the use of solutions with the application of artificial intelligence is proportional both for EU member states and for other countries.

3.2. Title of the real case of AAI

The study carried out collected a description of 279 different real cases of application of artificial intelligence. An appendix (Annex 1) has been prepared for this report, in which all the titles (and URLs) of the found projects, which were described in the completed surveys, are described. The study contains 279 different titles related to different spheres of human life.

3.3. Application area of ML/AI

В приложение 1 към настоящия отчет са описани всичките 279 заглавия на реални случаи с прилагане на изкуствен интелект, който бяха описани в попълнените анкети. За всеки един от тези проекти е посочена сферата на приложение на ML/AI. Според определената сфера на прилагане на ML/AI бяха оформени 31 групи. В таблица 3 могат да се видят в какви среди се прилагат намерените реални случаи на прилагане на изкуствен интелект.

Table 3. Distribution of real cases by Application area of ML/AI

Application area of ML/AI	Real cases
Health care	47
Ecology	26
Cybersecurity	24
Manufacturing	20
Data processing	14
Robotics	13
Finance	11
Energetics	10
Smart grid	10
Agriculture	8
Recommender systems	8
Photo and video	7
Automotive	6
Business Intelligence	6
Chatbots	6
Culture	6
Face and body recognition	6
Ocean energy	6
Text recognition	6
Education	5
Video processing	5
Voice recognition	5
Geo location	4
Object detection	4
Road traffic	4
Search and recommendation	3
Transport	3
Aviation and ocean transport	2

Library	2
Army	1
Social network analytics	1

Data description:

The data from table 3 show that the largest number of projects are in the field of health care - as many as 47 projects (16.85%). They are followed by Ecology with 26 real cases (9.32%), Cyber Security with 24 cases (8.6%), Manufacturing with 20 real cases (7.17%). Other fields of application are Data processing – 14 (5.02%), Robotics – 13 real cases (4.66%), Finance – 11 real cases (3.94%).

The spheres in which less than 5 real cases are described are united in "Other" and represent a total of 9 spheres with a total of 24 described real cases. This includes Geolocation, Object Detection, Road Traffic, Search and Recommendations, Transportation, Air and Sea Transportation, Library, Army, and Social Network Analysis.

On the basis of the data from table 3, a cross-analysis was made, which tries to track the distribution of the described real cases with the application of ML/AI in relation to their belonging to the European Union. The data are placed in Table 4 and visualized in Fig. 5.

Table 4. Cross-analysis of the found real projects using ML/AI according to their belonging to the European Union

Сфери на приложение на проектите с ML/AI	Страни				Total
	Colaborative	EU	N/A	NoEU	
Agriculture	0	3	1	4	8
Army	0	0	0	1	1
Automotive	0	3	0	3	6
Aviation and ocean transport	0	2	0	0	2
Business Intelligence	0	2	1	3	6
Chatbots	0	4	0	2	6
Culture	1	2	0	3	6
Cybersecurity	1	22	0	1	24
Data processing	1	5	0	8	14
Ecology	0	7	14	5	26
Education	0	3	1	1	5
Energetics	0	10	0	0	10
Face and body recognition	0	5	0	1	6

Finance	1	7	2	1	11
Geo location	0	2	1	1	4
Health care	0	30	0	17	47
Library	0	1	0	1	2
Manufacturing	0	10	0	10	20
Object detection	0	3	0	1	4
Ocean energy	0	0	6	0	6
Photo and video	0	4	0	3	7
Recommender systems	0	5	1	2	8
Road traffic	1	3	0	0	4
Robotics	0	7	0	6	13
Search and recommendation	0	1	0	2	3
Smart grid	4	1	0	5	10
Social network analytics	0	0	0	1	1
Text recognition	0	2	0	4	6
Transport	0	3	0	0	3
Video processing	1	0	0	4	5
Voice recognition	0	0	0	5	5
Total	10	147	27	95	279

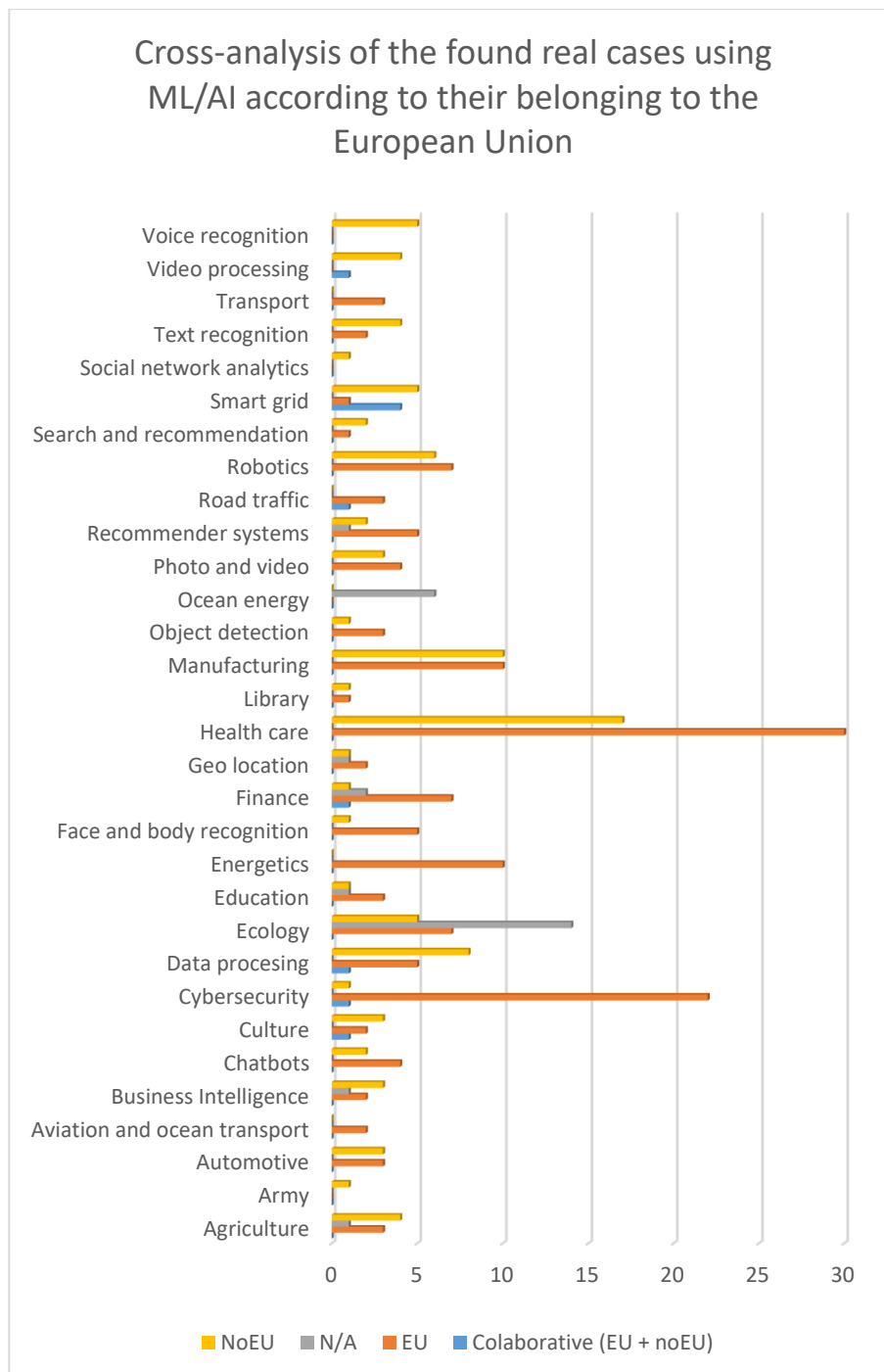


Fig.5. Cross-analysis of the found real projects using ML/AI according to their belonging to the European Union

Discussion:

The data from Table 4 and Figure 5 shows that the largest number of projects are still implemented in the healthcare field - in 30 European countries and 17 countries outside the European Union. There are no projects in collaboration implemented in this area.

The next most important are the implemented projects in the field of cyber security - here already the projects within the European Union are significantly more than those outside it. As many as 22 real cases of the use of artificial intelligence were found on the territory of the European Union and only 2 outside it or in an alliance with it.

In the field of Ecology, leading cases were implemented without established nationality - 14 projects. In this category, there are 7 described projects of countries of the European Union and 5 projects of countries outside it.

In the field of Manufacturing, data were reported for 10 projects using artificial intelligence in EU member countries and another 10 projects in non-member countries.

In the field of Energetics, only 10 real cases of application of artificial intelligence were found, and only in EU member states.

In the field of Robotics, a total of 13 cases of the use of artificial intelligence are described, 7 of them are in the territory of the EU, and the remaining 6 are in countries - which are not members of the EU.

Main conclusions:

- Health care is the leading topic for the development of real cases using artificial intelligence.
- Cyber security is of higher importance for EU member states.
- Energy is important for EU member states.
- Implementation of artificial intelligence projects is equally important both for the EU member states and for the rest of the countries.

3.3.1. Real cases with application area of ML/AI in a Health care

Описаните в проучването 47 реални случая с използване на изкуствен интелект разглеждат различни теми в сферата на медицината. Едни от тях са:

- Using artificial intelligence to find new uses for existing medications
- Finding new uses for existing medications
- Wearable sensor-based human activity recognition with transformer model
- Supporting the medical processes, simplifying and shortening the waiting period for medical advice with robotic thoracic surgery.
- Tool to detect stillbirths
- System for Early Neurological Deviation Detection in small children
- A device, which helps adults and children with neurodegenerative diseases to exercise continuously during post-rehabilitation at home, with a simple interactive sensor device for physical therapy.
- A solution for personalized and contextualized remote monitoring ideal for chronic illness management, long-term care, and fitness activities alike.
- Cyberlegs as a means to enhance/restore the mobility of transfemoral amputees and to enable them to perform locomotion tasks such as ground-level walking, walking up

and down slopes, climbing/descending stairs, standing up, sitting down and turning in scenarios of real life.

- Body parts recognition in healthcare - a solution that allows doctors to visualize all anatomical structures of the patient during surgery.

Automatic movement analytics in 3D for physiotherapy appliances

Automatic detection of focal cortical dysplasia's (FCD) on MRI pictures with Epilepsy Center

- "Intraoperative assistance with AI - minimally invasive surgery (MIS) is a combination of techniques and technologies in which the trauma caused by the surgery is reduced to a minimum. MIS procedures are increasingly being used with AI-enabled robotic assistance.

- A new artificial intelligence solution capable of analyzing biopsy slides in mere seconds could help pathologists diagnose cancer faster and more accurately.

- The system monitors the patient three lead heart signals and obtains a medical-grade ECG in just 30 seconds.

3.3.2. Real cases with application area of ML/AI in a Cybersecurity

The 24 real-life AI use cases described in the study address various cybersecurity topics. Some of them are:

- A theoretical and practical framework for applying process safety in a comprehensive model of smart enterprise management, covering the areas of health and safety, machine and machine systems safety, asset protection, and cyber security.

- A deep neural network for classifying normal passengers and potential attackers, and further develop an integrated DNN for identifying group attackers whose individual features are insufficient to reveal the abnormality.

- Advanced artificial intelligence (AI) system uses machine learning to automatically collect and extract data from entire user base — then trains every security module.

- Generating long-term crime forecasts for Dallas robberies in 200-by-200-foot grid cells that allow for spatially distinct associations of crime generators and demographic factors in the study area.

- Network-Intrusion-Detection

- Artificial Intelligence-based solutions for cybercrime and fraud prevention - security methods such as digital identity sensing technology that analyzes users' transactions and active traffic, web browsing habits, GUI interaction, device characteristics, and geolocation to ensure a match with the behavior of legitimate app users.

- Hierarchical Intrusion Detection

- Mapping the Risk Terrain for Crime Using Machine Learning

3.3.3. Real cases with application area of ML/AI in a Ecology

The 26 real cases of using artificial intelligence described in the study deal with various topics in the field of Ecology. Some of them are:

- AI-based networking platform, which helps in worldwide data collection, discovery, and safety of various plant species in real time.

- AI to help reduce flooding and river pollution across Yorkshire

- The Ocean Cleanup - a vision-based detection system that can identify and - categorize plastic detritus on the sea surface.

- Improving climate modelling and forecasting through leveraging artificial intelligence to combat climate change
- Climate study by collecting planetary data: AI-powered machines can analyze and monitor a huge amount of data from around the globe to measure and monitor forests.
- Regional flood susceptibility mapping
- Recording endangered species with AI
- Improving biodiversity protection through artificial intelligence
- Emission of CO₂
- Water quality control.
- AI to Combat Environmental Pollution

3.3.4. Real cases with application area of ML/AI in a Manufacturing

The 20 real use cases of artificial intelligence described in the study address various topics in the field of Manufacturing. Some of them are:

- An artificial intelligence system for predicting the success of new product development and selecting proper market-product strategy in the food industry
- detection and characterisation of surface damages (a dent, a crack, etc.) on mechanical parts using 2D/3D vision (3D scanner and/or 2D camera).
- Conformity control of complex aeronautical mechanical assemblies, such as aircraft engines, using deep NN on 3D point clouds, CAD models and based on 3D Deep Learning segmentation
- Visual mechanical assembly inspection based on point cloud data acquired via a 3D scanner and deep Siamese neural networks.
- AI system that can decide whether a product is defective or not, based on a product image.
- Visual AI monitoring of Olive Oil Production
- Decreasing the cost of the bread baking
- Product errors identification (dimensional, shape) by their digitization and processing using computational intelligence algorithms.
- A digitalization strategy for quality control in food industry based on Artificial Intelligence techniques

3.3.5. Real cases with application area of ML/AI in an Energetics

In the research, 10 real cases of using artificial intelligence are described, dealing with various topics in the field of Production. Some of them are:

- Solar Irradiance Forecasting with Transformer Model
- Artificial Intelligence for Sustainability in Energy Industry: A Contextual Topic Modeling and Content Analysis - to achieve sustainability in the energy sector.
- AI extend the life of an android phone battery.
- Reducing errors in forecasting faulty PV performance by stacking deep neural networks.
- AI can monitor and collect information in buildings and factories, about energy consumption in the form of numbers, text, images, and videos, and AI can manage energy usage, reducing it during peak hours.

3.3.6. Real cases with application area of ML/AI in a Robotics

In the research, 13 real cases of using artificial intelligence are described, dealing with various topics in the field of Production. Some of them are:

- Hybrid artificial intelligence solution, which it combines neural networks with a semantic approach. On the one hand, this makes it possible to carry out training starting from data; on the other hand, the system is able to accept and incorporate an a priori competence introduced by the user through abstract rules and to produce in turn abstract commands readable by a human being.
- Cloud-Based Robots and Intelligent Space Teleoperation Tools
- Delivery and Transportation Robot
- AI solution is capable of recognizing keywords (e.g., stop, go, left, right) in noisy conditions, being generally robust to noises and being thus useful in controlling equipment or machinery in loud environments.
- AI project, which explores the innovative use of robots and autonomous systems in construction, is a field where the incidence of such technologies is minor to non-existent.
- Humanoid robots, with communication through voice and tablets on their chest and characters that attract people and make them smile, are playing an active role in attracting and serving customers in commercial facilities. In addition, movements and conversations can be easily programmed, and programming dedicated educational tools has been adopted by many educational institutions.
- Robot assistant that is trained to understand maintenance tasks so that it can either proactively, or as a result of prompting, offer assistance to automation maintenance technicians performing routine and preventative maintenance.

3.3.7. Real cases with application area of ML/AI in a Finance

In the research, 11 real cases of using artificial intelligence are described, dealing with various topics in the field of Production. Some of them are:

- Automated accounting involves the use of software to automate important finance operations like accounts reconciliation, updating financial data, and preparing financial statements that can be completed without human interaction using accounting software.
- Water Leakage Detection - through the use of sound sensors that capture flow frequencies in pipes. This data can be read by an application that analyzes the recording through a database stored in the cloud, capable of differentiating sounds from pipes with normal flow and pipes with potential leakage.
- Traffic System Management - Traffic systems based in AI offer cities the power to improve the monitoring and data analysis of transit routes, traffic light control, and camera tracking. Video systems allow the recognition of different transport models, accident identification, and the distinction between vehicles and pedestrians, using that data to activate traffic flow control devices and analyze strategies for the future.
- The use of AI in the fight against financial crime.
- Retail pricing made simple.
- Optimization of Garbage Collection and Recycling

3.3.8. Others real cases with application area of ML/AI in a different theme

- License plate recognition
- Motorist's AI-based paperless car manuals
- Porsche Digital develops artificial intelligence for noise detection
- Detecting representative trajectories from global AIS datasets

- Artificial intelligence for ocean science data integration: current state, gaps, and way forward
- Coral Reef Monitoring, Reef Assessment Technologies, and Ecosystem-Based Management
- Public Transportation Optimization
- The AI-based cloud service creates both meshes and neural render models - Hyper-realistic, geometrically accurate, semantically rich digital twins using just a phone."
- AI technology to measure river levels with high accuracy.
- AAI is a powerful tool for analyzing and predicting ocean phenomena using large-scale data from observations and models.
- Artificial intelligence for ocean energy: AI can help to optimize the design, operation, and maintenance of ocean energy systems, such as wave energy converters (WECs), tidal turbines, offshore wind turbines, and floating solar panels.

4. Conclusions

The 279 real cases of artificial intelligence application described in the study cover multiple spheres of human life. Leading by number are real cases in mainly 7 spheres - 151 real cases in the spheres of health care, cyber security, ecology, production, energy, robotics and finance. The remaining 128 projects are distributed in other 24 spheres.

Artificial intelligence is entering various applications in both small and large countries. The examined real cases were mostly implemented independently in specific countries (242), and relatively few were implemented in cooperation (10).

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Annex 1. Title of the real case of AAI

	Title of the real case of AAI
1	Electricity 4.0 - cheaper, cleaner and more stable energy for Polish enterprises.
2	Face Detection
3	Zero-Shot Visual Concept Recognition
4	DVMS
5	Video Shot Detection
6	HosmartAI
7	Snow Water Equivalent (SWE) estimation
8	Thor X
9	Plant-O-Meter
10	Anari AI