ARTIFICIAL INTELLIGENCE IN ENTERPRISE RESOURCE PLANNING SYSTEMS

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Abstract. The article presents a study of the implementation of Artificial Intelligence (AI) in Enterprise Resource Planning (ERP) systems. In recent years, with the digitization of manufacturing and the globalization of the economy, the implementation of ERP systems has become a necessary condition for the effective functioning of the industry. Developers of ERP systems are using AI as a tool for functionality optimization. SAP Business Technology Platform (SAP BTP) is a modern cloud platform based on intelligent business management, a next-generation ERP system that helps achieve business results through integration and embedded tools with AI. The embedded applications with AI elements in SAP BTP are investigated. The main functionalities with built-in AI in modern ERP systems are presented.

Keywords: Artificial Intelligence (AI), Enterprise Resource Planning (ERP) systems, SAP BTP.

1. INTRODUCTION

In the more than three decades since the advent of integrated Enterprise Resource Planning (ERP) systems, the needs of companies for management solutions have evolved steadily, primarily for two reasons – the need to run businesses more efficiently and the revolutionary development of information technology. ERP systems are increasingly at the center of modernization projects for business organizations. In this context of development, intelligent functionalities are increasingly being added to ERP systems using various forms of Artificial Intelligence (AI) [1].

In this article, based on a study of the cloud-based systems available with access to research and training from leading ERP vendor SAP, we will look at the main directions of applying AI to ERP systems.

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A pioneer in offering cloud services with integrated AI tools as business management platforms is SAP Business Technology Platform (SAP BTP).

2. INTELLIGENCE AND ARTIFICIAL INTELLIGENCE

Intelligence is the quality of humans and some living beings to analyze data and information with their skills such as analytical thinking, logical reasoning, statistical knowledge and as a result generate solutions to problems in different situations. The basic elements of intellect are perception, reasoning, linguistic intelligence, learning and problem-solving skills.

Artificial intelligence is the science and technology of simulating human intelligence. Artificial intelligence was developed for machines and robots that, by analyzing data sets, acquire problem-solving abilities like those of humans and living objects. Artificial intelligence is a concept that originates from human intelligence. A machine that copies human intelligence and performs a task like a human is called a machine with elements of artificial intelligence. This is accomplished by the development of complex software systems that perform certain tasks like the human brain. These systems collect and analyze data using predefined algorithms, generate useful information from that data, and then use that information to make a final decision and fix the problem with a flexible approach and adaptive solutions.

The foundation of artificial intelligence is the strong development of mathematical and algorithmic methods and the revolution in information technology and computing.

On the other hand, the development of artificial intelligence also stimulates the development of human intelligence since it is a prerequisite for new research. The entry of new technologies into our daily lives directly affect the functioning of all spheres in society. This is especially true for the effective management of business processes in the face of globalization, highly competitive environments and global crises.

3. DIRECTIONS FOR THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE AND ERP SYSTEMS

Artificial intelligence is developing in five main interrelated directions [2]:
• Machine learning (ML);
• Neural Networks (NN) – NN AI;
• Deep Learning (DL);

- Natural Language Processing (NLP);
- Robotics.

The name Machine Learning was introduced in 1959 by scientist Arthur Samuel. It generally means generating knowledge from experience; the artificial system learns from examples and can generalize them after completing the learning stage. For this purpose, algorithms in machine learning build a model based on training data. This means that not only are examples remembered, but patterns of behaviour are recognized in the training data. In this way, the system can also estimate unknown patterns of behaviour.

Machine learning consists of discovering knowledge in databases and retrieving data and, respectively, information on demand. Obviously, machine learning is related to the operation of databases and algorithms for intelligent data analysis. In ERP systems, ML finds application mainly in financial modules.

The neural network in AI (Neural Networks) is an information processing model inspired by the study of bioelectric networks in the human and animal brain, formed by neurons and the connections between them – synapses. The mathematical analogue of a biological neural network is a set of interconnected simple computational elements (neurons). Each neuron receives signals from the others (in the form of numbers), sums them up as the sum passes through an activation function, and so determines its activation (degree of excitation), which is transmitted over the output connections to the other neurons. A neural network consists of interconnected layers of neurons and connections between them. In ERP systems, it finds application in scheduling and production modules, e.g. for controlling robotic production lines.

Deep Learning is a form of learning based on the use of neural networks to elaborate models of control systems behaviour. The term deep comes from the fact that artificial neural networks consist of visible and hidden layers. A deep learning neural network has multiple layers and a sophisticated algorithm to analyze data, detect features and patterns in the data. The types of layers are input, hidden and output. The data processed by hidden layers are invisible and can be significant in amount depending on the input layers. The input layers receive the data and then process it and transfer it to the hidden layers. The output layer represents the layer of classified predictive data in the neural network. Deep learning is used in the financial modules of ERP and in customer and supplier relationships, for example for predictive analytics and chatbots in customer service.

Natural Language Processing is a subfield of the science of artificial intelligence and computational linguistics. It deals with the automatic generation

and recognition of natural human languages. Language generation systems convert information from computer databases into human language, and automatic natural language understanding systems convert language entries into a formal representation accessible for processing by computer programs. In the former case, we are talking about document management systems and the goal is for the information system to read the contents of documents. The technology can then extract information and ideas from the documents as well as categorize and organize the documents themselves. In the second case, we are talking about speech recognition and natural language generation. We can say that NLP is a key factor in the development of E-Commerce functionalities of ERP business management systems.

Robotics is the science and technology that consists of the artificial recreation of automatic machines capable of performing activities that a human could perform, so it is closely related to artificial intelligence. A robot can be a physical object, but increasingly the term is also used for specialized applications in information systems. Robots in all their forms are the basis for intensifying not only production processes but also data processing.

4. APPLICATION OF AI IN ERP SYSTEMS

Enterprise resource planning systems have become a crucial part of any business organization and the need for intelligent ERP systems has been increasing over the last decade, becoming a key factor in the success of any organization. The requirements for deep process management from these systems are increasing and artificial intelligence is now entering management systems in almost all functionalities. Artificial Intelligence as an integrated part of the ERP system is impacting the very essence of day-to-day operations. Solutions with integrated artificial intelligence are increasingly taking over the routine tasks of data entry, analysis, control, and decision making that are currently performed by humans. Consequently, the development of new technology is also driven by the growing need to reduce the operational costs of businesses by supporting employee workflows, thereby increasing the efficiency of the organization. The development of artificial intelligence is, in other words, a development that ERP developers, integrators and implementers need to follow if they want to remain efficient and competitive in the market [3].

Let us look at some of the areas where artificial intelligence is changing the way ERP systems function.

4.1. Sales and marketing

Currently, sales management, computerization and automation systems are all about tracking, reporting and productivity for sales teams. The next wave will be about smarter individual interaction by using data to determine which content, which solutions (solutions in text?) and which sales are more likely to drive results. AI can be introduced early in the process by mining volumes of data from outside the organization, e.g., social networks and public platforms, to help reps build comprehensive profiles of their counterparts to realize their goals [4].

Artificial Intelligence, mainly NLP and ML, is a basic factor in the development of e-commerce and the demand is increasing day by day. The growth of AI application in e-business in two years exceeds 600% [5].

AI solutions, stepping on ML and DL, can learn from customer service history, allowing chatbots to respond to customer queries more cost-effectively, quickly and consistently. The quality of customer service can also be improved by integrating real-time data from different customer-facing departments, providing a 360-degree view of the customer – enquiries, requests, payments, volumes, development forecasts. Based on the huge market and customer data sets, dedicated sales robots can successfully replace sales staff, solving the problem of subjective decision making, not always to the company's advantage.

4.2. Warehouse management

AI and machine learning can test hundreds of demand forecasting models and capabilities with a new level of precision, while automatically adapting to different variables such as: new product introductions, supply chain disruptions, or sudden changes in demand. With AI, each individual product can be tracked from the moment it is manufactured to the moment it is shipped to the end customer. Artificial intelligence helps in optimizing warehouse space, organizing shipment.

Huge commercial companies also use non-standard solutions for warehouse inventory. One of the largest retailers, Walmart, has reduced physical inventory from a month to 24 hours by using drones that fly through the warehouse, scanning merchandise labels and packaging and checking for lost items [6].

4.3. Financial management and controlling

Information robots, bots, can automate repetitive accounting functions, including categorizing information from invoices into different accounts, for example, distinguishing between a monthly phone bill and a phone purchase. AI

can complete accounting transactions and automate the generation of monthly, quarterly and annual statements, even comparing account balances between different independent systems and checking statements and reports for accuracy. Using machine learning, bots can even learn from different human experiences and ways of working to make better judgments and adapt to the behavior patterns of different accounting professionals.

The cost of production can be predicted in real time by processing data on resources used – materials, energy, labor, equipment in production and, accordingly, the cost of goods can be managed by changing the cost norms without human intervention in the process.

4.4. Human resource management

Human Capital Management (HCM) is the part of ERP systems that is responsible for effective personnel management, but not only. The search and talent acquisition software can scan, read and evaluate applications and quickly eliminate about 75% of them from the recruitment process. AI systems can successfully plan, organize, and coordinate training programs for all staff members.

4.5. Planning and production

In Production Planning (PP) in ERP, experience-based learning methods are currently more used, but the future lies more in the use of neural networks of a different kind [7]. AI is also fundamentally changing manufacturing – Manufacturing Execution Systems (MES) or Manufacturing Application Processes (MAP) systems.

New technologies, prerequisites for the emergence of the fourth industrial revolution (Industry 4.0), such as artificial intelligence, machine learning, automation and robotics, ERP systems, Predictive Analytics (BI) and the Internet of Things (IoT), are at the heart of the digitalization and optimization of manufacturing processes.

Based on the collection of a huge amount of operational data about manufacturing processes is possible [7]:
• Online tracking of key KPIs, such as cost of production, cost price, scrap rate and quality of production.
• Troubleshoot production bottlenecks.
• Online correction of equipment inefficiencies.
• Forecasting potential supply chain disruptions.

According to research by the McKinsey Global Institute [8], new technologies in manufacturing are expected to create about $3.7 trillion in value by 2025, with artificial intelligence alone potentially generating $1.2 to $2 trillion in value from manufacturing and supply chain management. AI is making inroads into all sectors of manufacturing: forecasting, robotic factories also known as Smart Factories, quality control, intra-factory transport using autonomous vehicles. Thanks to machine learning algorithms, ERP systems with integrated AI tools can learn, adapt and improve continuously.

Companies using AI in manufacturing have realized cost savings and revenue growth according to a statistical study conducted in 2021. 16% of the companies surveyed saw a 10–19% reduction in costs, while 18% reported a 6–10% reduction.

4.6. Information security

With today's proliferation of information access devices and ever-evolving cyberattacks, machine learning ML and AI can be used to automate threat detection as it responds more effectively than traditional human- or software-driven approaches. AI provides much-needed threat analysis and identification to reduce the risk of a breach and improve security posture. In security, AI can identify and prioritize risk, immediately spot malware on a network, guide incident response, and identify potential breaches before they start.

At the same time, securing cybersecurity poses a serious challenge to businesses for the following reasons:

- Organizations use hundreds and thousands of devices in their daily operations. They are increasingly difficult to administer.
- Datasets have long exceeded the volume that can be managed by a human.
- ERPs are becoming increasingly open and use huge data sets from public networks and platforms that are difficult to track and filter.
- The proliferation of networks and the deployment of ERP systems on the Internet open a huge front for potential hackers to attack.
- A major shortage of qualified security professionals. Hiring administrators with no experience and no background check often leads to a breach from within.
- Due to the immense tension in the workplace, employees themselves are often the cause of a security breach. It is a practice for salespeople to open all e-mails with a subject containing the word offer, and for accountants to open an invoice without checking the sender of the mail. This is the most common cause of security breaches now.

Therefore, a self-learning, AI-based cybersecurity management system should be able to solve many of these challenges. Automated learning technologies exist for a self-learning system to collect data continuously and independently from data-generating devices and information systems. Models are being created for functioning and responding to a potential attack. The result is new information security management capabilities including:

- IT Asset Inventory. Inventory of all devices, users, and applications with any access in organization provides opportunity for flexible maintenance and remote management.
- Predicting potential threat exposure. AI-based cybersecurity systems can provide up-to-date knowledge of global and industry-specific threats.
- Effectiveness of control mechanisms. AI helps identify the strengths and weaknesses of IT systems.
- Breakthrough risk forecast. By taking into account IT asset inventory, threat exposure, and the effectiveness of controls, AI-based systems can predict how and where a breach is most likely to occur so that resource and tool allocation can be planned toward protection weaknesses.
- Incident response. AI-powered systems can provide prioritization and response to security breach alerts, rapid incident response, and root-cause response to mitigate vulnerabilities and prevent future problems.
- Explainability. The key to using AI to improve information security in business management systems is the explainability of recommendations to employees at all levels and the analysis of their behaviour.

Most companies' information security platforms use AI-powered monitoring and analytics tools to provide real-time, risk-based predictions of vulnerability management and proactive control of security breaches.

5. SAP BUSINESS TECHNOLOGY PLATFORM

SAP is not only the most widely used ERP system, technology leader in the development of business management systems. It is evident that the demand for integrated information systems with built-in AI tools at an affordable price is a true megatrend. SAP recognized this potential several years ago and is now becoming a leading provider of enterprise AI systems for key business technologies. AI plays a key role in transforming SAP customers into intelligent enterprises. The main motivation for implementing AI is to support people – freeing them from mundane, repetitive tasks and thus providing them with more time to use human skills such as creativity and empathy.

SAP focuses on embedded AI services that are part of industry solutions and run in the background to support users. Users can use the built-in AI applications, but they can also develop their own, customized ones to embed in their platform.

More than a decade ago, the first version of SAP HANA was introduced, and a few years later, the cloud version of SAP HANA Cloud. In January 2021, a new platform, SAP BTP [9], was introduced to fully replace SAP Cloud Platform in March 2021. SAP BTP combines application development, data collection and analysis, process automation, and artificial intelligence into a single platform that encompasses solutions such as:

• SAP HANA;
• SAP Analytics Cloud;
• SAP Intelligent Enterprise Suite;
• Enterprise AI [10].

It is an intelligent business management platform that contains the core functionality of SAP S/4 NANA and helps drive business results through integration and extensibility. SAP S/4 HANA Cloud is a complete, modular, cloud ERP designed to meet every business need, with built-in AI tools and cloud data analytics. With SAP S/4HANA Cloud, business models can be introduced and expanded incrementally, running real-time business operations from anywhere in the world.

SAP BTP is available by creating an account for business users, for developers and for training purposes. The platform allows the creation of a temporary account valid for one year for training and development of new functionalities. It should be noted that the SAP Developers Insights Survey report from 2021 shows that over 5% of SAP BTP accounts were used for education or research purposes, highlighting the uniqueness of the features provided in the platform. The creation of such functionalities is the result of close collaboration between the business and teams to develop and deploy AI-enabled technologies and applications on the platform.

SAP BTP is a revolutionary step in the development of ERP systems. The SAP AI Factory collaboration model equips business process management applications with AI as if on an assembly line, i.e. a multiplicative approach to delivering AI solutions is applied. With this approach, SAP BTP delivers focused solutions, ready-to-run unified applications with AI and other services that customers can use simply and efficiently enough.

6. OVERVIEW OF SAP BTP INTEGRATED AI SERVICES

We can check which are the main directions for AI applications in SAP BTP directly from the Help & Support portal of the SAP, access to which is integrated in the user account.

This integration allows researchers, application developers and users to get the information they need directly from the platform, including access to multimedia content materials. Without logging out of your account, you can access short courses and sample solutions. For more information and even certification as a developer, you can also visit SAP's developer site or the specialized OpenSAP training and certification platform.

SAP AI Core is the runtime for SAP AI Business Services, but it also has many features of its own. These services can be used to train their own models or deploy already trained models. SAP AI Core is connected to the AI AIP (Application Programming Interface (API), which is a standardized interface for accessing all applications and models in SAP AI Core.

An AI API is an interface that allows developers to add AI features to their applications. These APIs can be used in a variety of business functions including facial recognition, spam filtering, location detection.

SAP AI Launchpad is the management platform. AI Launchpad is a SaaS multitenant in SAP BTP and is used to administer the operation of applications. The term software multitenancy refers to a software architecture where one copy of the software runs on a server and serves multiple users, in this case tenants of the service. A client, in turn, is a group of users who share common access with specific privileges to a particular application. With a multi-tenant architecture, the software application is designed to provide each tenant with a special partition of the model, including its data, configuration, user management, and tenant-specific features. It should be noted that an application can solve several tasks in real time.

AP Conversational AI is a chatbot application development service that is a common automation tool in e-commerce, connecting with consumers and providing information to customers. SAP BTP's built-in Robotic Process Automation (RPA) development applications are used to build chatbots. Robotic process automation is a software technology that simplifies the processes of building, deploying and managing software robots, i.e. bots. By following simple steps, different bots are quickly created using the models proposed in SAP Intelligent RPA (SAP iRPA).

The Business Entity Recognition (BER) service can detect specific entities in unstructured text. Within the service, four machine learning models are

implemented, each specialized in identifying different objects. This covers finding an address, a document title such as an invoice, or general terms in text. Using this service helps speed up the process of manually reviewing text data from an email or a business document. BER is a customizable service, meaning it can be optimized to recognize your own text data.

With the input data analysis and augmentation recommendation service using artificial intelligence Data Attribute Recommendation (DAR), data records can be classified, and missing pieces of data can be predicted. DAR is also a customizable service using standard or business specific document formats. DAR can supplement missing information autonomously by reading it from the customer's order history in the database. The accuracy of some of these services is close to 90% depending on the quality of the input data. As a result, manual processing or review is only necessary for a small number of orders. The same principle of operation applies to other business functions such as invoicing.

The Document Information Extraction (DOX) service extracts text from documents in structured data format. By combining Optical Character Recognition (OCR) with post-processing of the extracted text and data enrichment, DOX can significantly reduce the time required to process incoming documents. While business object recognition looks for specific objects in text, DOX extracts specific information from a file, including their position as coordinates in a document.

The Document Classification (DC) service classifies documents, e.g. files in different formats. A pre-trained model can be used that classifies documents into classes, e.g., invoices, purchase orders, delivery orders, or a custom model can be trained with its own classes.

The Personalized Recommendation (PR) service generates recommendations for users based on their browsing history and descriptions of their own items. A personalized recommendation model is created for each of the websites providing e-business features.

Service Ticket Intelligence (STI) classifies incoming service requests and routes them to the correct agent-service provider, while recommending agent decisions based on historical data. STI is designed to help accelerate the handling of a huge volume of messages and reduce customer service costs.

The SAP Data Intelligence (DI) service is specifically designed for data integration and data management. DI and SAP AI Core can complement each other but using ML for large datasets requires a lot of computing power.

AI tools are also used within SAP's HR software offering SAP Success-Factors, with employees receiving relevant training suggestions based on their business role and the courses they have already completed.

Intelligence in SAP Process Automation combines the features of SAP Workflow Management and SAP Intelligent RPA. SAP Process Automation is a powerful, intuitive environment for developing applications without writing programming code. This allows users who have little software development experience to design, modify, and improve their own workflows and business applications. In addition, built-in AI supports business processes, making them smarter and more efficient.

Among SAP's developments, there are applications aimed at environmental protection. For example, packaging and waste management applications. One solution to support the circular economy is SAP Returnable Packaging Management (RPM). SAP RPM focuses on the implementation of reusable packaging and shipping containers.

7. CONCLUSION

As a conclusion, we can note that AI enters the algorithms embedded in the various modules of ERP systems, sometimes fundamentally changing their functioning and becoming a tool for effective management of modern business.

Some of the applications listed are legacy applications from SAP HANA, some were implemented in SAP BTP just a few months ago – March and April 2022, and are intended to expand the application of the platform for integrated process management in business organizations, regardless of their size.

The provision of a temporary account valid for one year without limitation makes the platform attractive not only for business users. Learning the functionalities of the ERP system with integrated AI tools is also an engaging process for students, researchers, and implementers.

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