

3. Implementation of marketing information systems in agricultural activities of enterprises

3.1.1 Research of cloud services and machine learning algorithms in marketing information systems

In modern conditions of global transformation, the role of managing marketing activities of agricultural enterprises is growing. An important element of effective business is understanding and using the concept of marketing in the management of agricultural enterprises. The quality of marketing activities in management is decisive, since it determines the highly profitable rhythmic activity of the enterprise.

Marketing information is usually used exclusively in the commercial sphere. At the same time, in modern conditions there is an urgent need for its use in the activities of almost all functional divisions of the enterprise, which sets the task of quantitative and qualitative development of marketing information systems. At the same time, the marketing orientation of the enterprise requires both organizational and informational unification of various fields of activity around the interests of the consumer, the development of new techniques and methods for obtaining and analyzing marketing information.

Studies of agricultural enterprises in Ukraine confirm that the introduction of marketing, although becoming more widespread, is not yet fully using all existing forms of marketing management. This would ensure the competitiveness of agricultural enterprises, adaptation to constant changes in the external environment and market conditions.

Today, information flows of data, which are the basis for making economic decisions in enterprises, are not sufficiently adapted to the unstable marketing situation and aggressive market environment.

The long-term success of any agricultural enterprise depends not only on the financial results of its activities at a particular point in time, but also on the proper organization of the marketing strategy and the flexibility of the management system,

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because in market conditions, the company's management needs market reviews, research of purchasing power, sales, forecast calculations of the effectiveness of product advertising.

Management that does not keep pace with dynamic changes within the enterprise and the external environment can lead to the death of the enterprise, and makes it incapable of adaptation and further development, and marketing is an integral part of the enterprise.

In the practice of domestic agricultural enterprises there are a number of disadvantages that reduce the effectiveness of marketing activities. These include: the chaotic use of individual marketing elements and the lack of a well-developed sales funnel, the reduction of marketing functions only to stimulate the sale of goods, food, focus on the short term, lack of flexibility and ignorance of consumer demand.

To solve these problems, it is necessary to develop measures to promote products through the formation of a sales support system, and the development of agri-food market infrastructure, which would cover different geographical and Internet communication levels. In these conditions, the role of marketing activities of agricultural enterprises and the need to develop recommendations for the organization and development of marketing tools in agro-industrial production at the enterprise level are growing.

The issues of effective functioning of enterprises, during the global financial crises, which spread to the domestic market, are of particular relevance. Under these conditions, business leaders should pay special attention to marketing as an indispensable and universal market tool, since the crisis in the economy should be considered as new opportunities for redistributing markets, an opportunity to gain other market positions.

Marketing information provides an opportunity to reduce uncertainty in the process of making management decisions and, as a result, reducing the risk of making erroneous decisions. However, the lack of necessary information or its late receipt, the use of inaccurate, outdated, biased data, errors in the interpretation of data can cause non-achievement of marketing goals of the enterprise and significant losses.

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Therefore, issues related to the collection, systematization, processing and analysis of information with the subsequent communication of results to decision-makers are of particular importance. The solution of these issues is possible only with the application of special procedures and methods, as well as the introduction of modern information technologies. In this regard, the extremely relevant task of managing marketing activities of the enterprise is the creation and effective functioning of the marketing information system (Fig. 1).

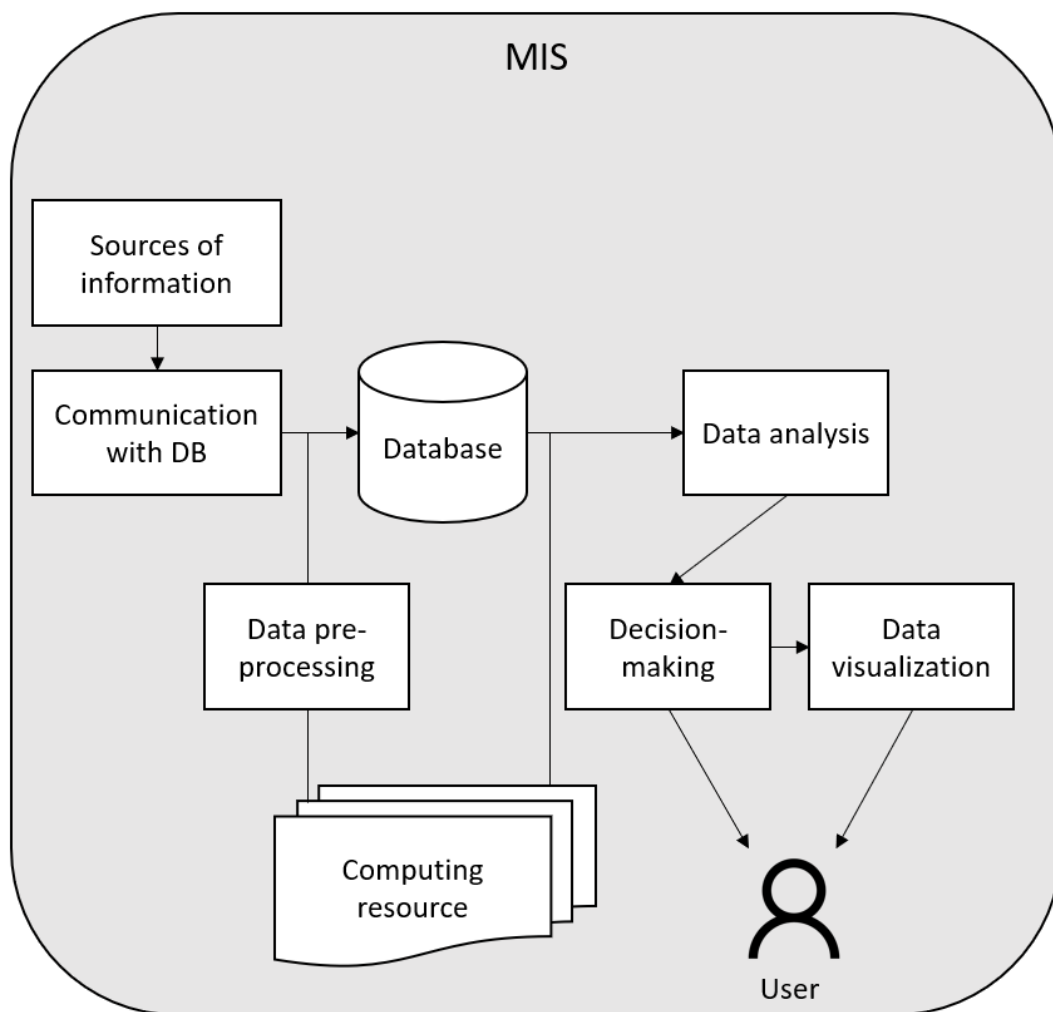


Figure 1. An example of the MIS

For a comparative analysis of modern information systems, which provide modules responsible for the implementation and support of marketing activities, it should be

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noted the feasibility and effectiveness of ERP systems that provide informatization of almost all business processes of an industrial enterprise.

It is the ERP system that is recommended to be implemented as a key component of information support for marketing activities. However, given the power of modern algorithms for processing large amounts of data, it will also be advisable to investigate the correlation on the data diluted by new sources (Fig. 2). Modern pattern recognition algorithms will reveal complex relationships between data, predict customer behavior and optimize marketing decisions.

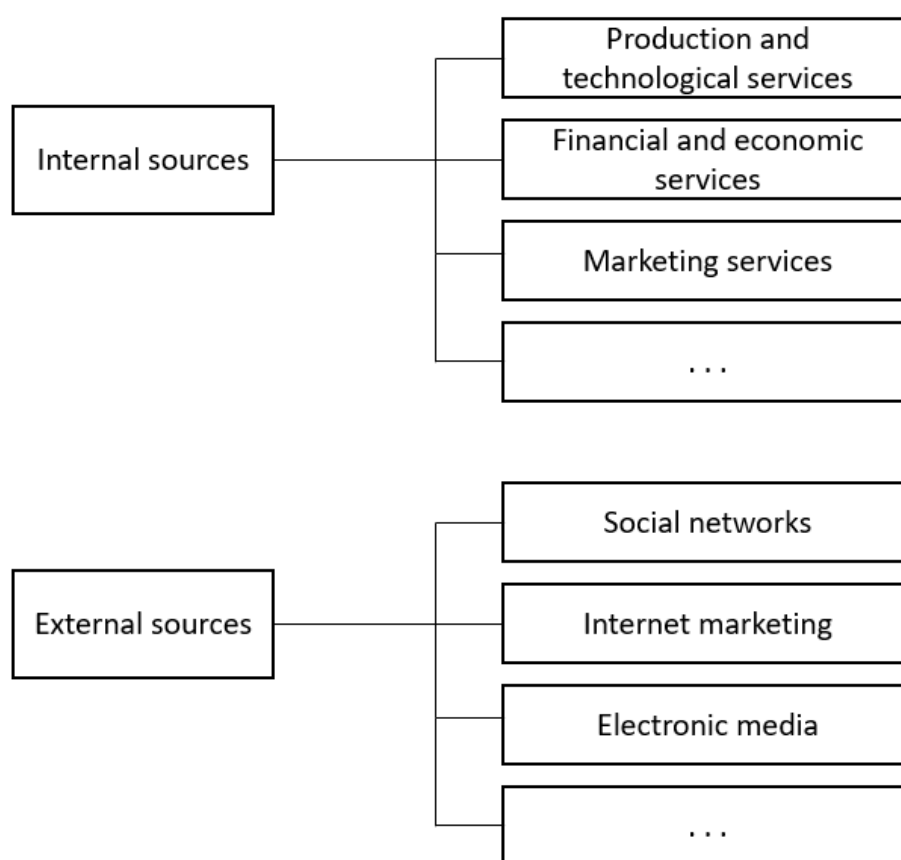


Figure 2. Internal and external sources of information

Therefore, as part of a comparative analysis of modern marketing information systems, it is worth considering a combined approach that uses both ERP systems and Big Data algorithms. This will allow, on the one hand, to ensure the management of all business processes, and on the other - to effectively analyze and use large amounts of data, which is an integral part of modern marketing.

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Given this, we can say that the optimal variant of the marketing information system can be built on the basis of an ERP-system with additional modules for processing big data. This will maximize the benefits of both approaches.

On the one hand, ERP will automate marketing processes, organize information, improve interaction between different departments of the enterprise. On the other hand, Big Data tools will allow analyzing large amounts of unstructured data from different sources, identifying complex patterns and trends that may affect the marketing strategy.

In today's world, information is the most valuable global resource. The economic potential of society is mainly determined by the volume of information resources and the level of development of information infrastructure. Today, the Internet is one of the largest sources of information on Earth.

The annual growth of users on the Internet means an increase in the amount of information about customers and enterprises. It is very appropriate to have additional tools for collecting data from the Internet in real time, as an additional source of information for processing and further use for business optimization.

One of the main disadvantages of using marketing information systems is the large initial time spent on deploying and configuring an information system. Today, it is appropriate to use cloud platforms with a set of services for storing, processing and visualizing data (Fig. 3). The implementation of the marketing information system infrastructure on the cloud platform makes it possible to quickly deploy the system to new enterprises, establish communication between enterprises if necessary, and have no restrictions on the amount of input data using serverless resources for computing.

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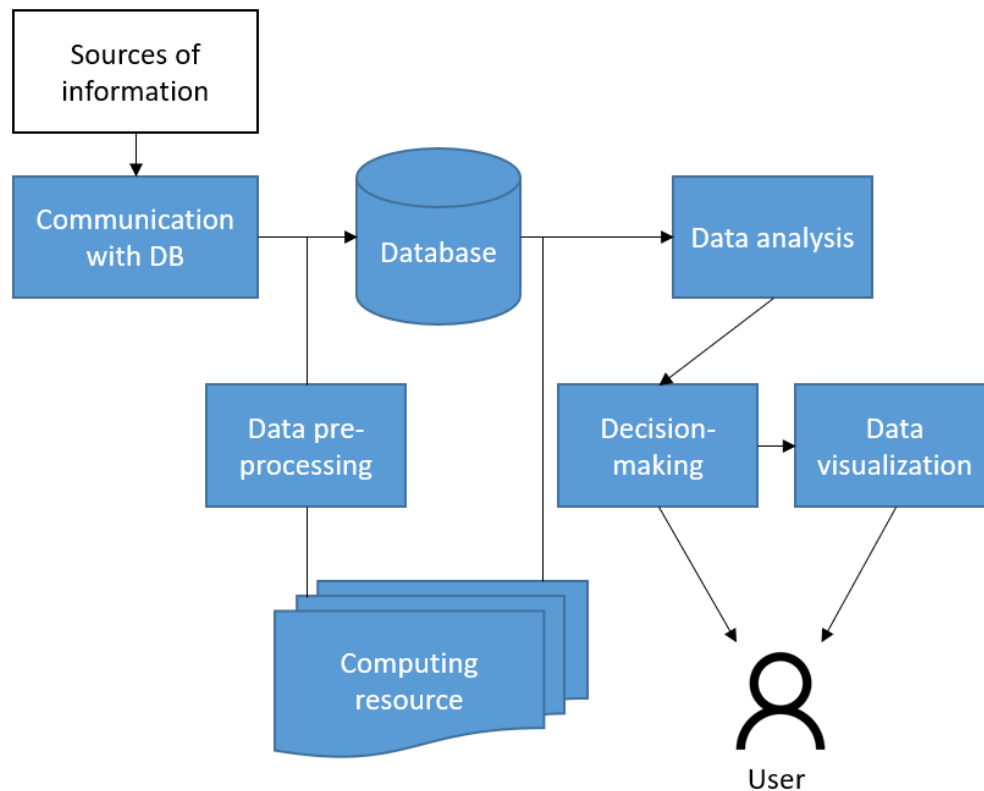


Figure 3. Services that can be in the cloud

One of the biggest benefits of using cloud services is reducing enterprise hardware and software costs. Instead of investing a significant amount of money in acquiring and maintaining their own infrastructure, companies can use cloud services where hardware and software reside on the cloud service provider's servers. This allows management and marketing departments to focus on their core tasks instead of wasting time and resources on technical support.

Also, cloud services provide an opportunity to scale their needs for computing resources depending on changes in demand and data volume. With cloud services, enterprises can easily increase or decrease data storage, computing power, and other resources depending on their needs. This is especially useful in marketing, where fluidity in demand and data volumes is an integral part of the job.

One of the important aspects for marketing information systems is data security. Cloud service providers, such as Google, usually invest significant effort in ensuring the security of their systems and customer data. They use encryption, authentication mechanisms, and other measures to prevent unauthorized access to data. Using cloud

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services can help businesses maintain the privacy of their data and protect it from loss or damage.

With cloud services, data can be accessed from anywhere and on any device that has an internet connection. This facilitates interaction with MIS for different departments of enterprises and external partners. Although, in some situations there may be restrictions on access to the Internet, which may complicate the receipt of data from cloud services. For example, when working in certain geographic areas or remote locations where Internet connection may be unreliable or limited.

However, some cloud services offer the ability to work offline. This means that users can continue working on reports or other data even without access to the Internet. The changes will be synchronized with the cloud as soon as the connection is restored. In the case when the Internet connection is limited or absent, the option of physical transport of data carriers can be taken into account. This may include the use of portable data drives such as USB drives, external hard drives, or SSDs.

Marketing information systems are designed to help businesses make informed decisions about manufacturing, marketing, and distribution. MIS can include a number of different tools such as market research, customer surveys, and sales data analysis. There are fairly standard and effective tools for visualization and data processing. However, decision-making models must evolve given the increasing scale of data on a daily basis. There are a large number of examples when a computer, using a new machine learning algorithm, was able to process and provide useful information that the human eye could not catch. Therefore, it is advisable to explore modern decision-making models and implement them to optimize marketing results (Fig. 4).

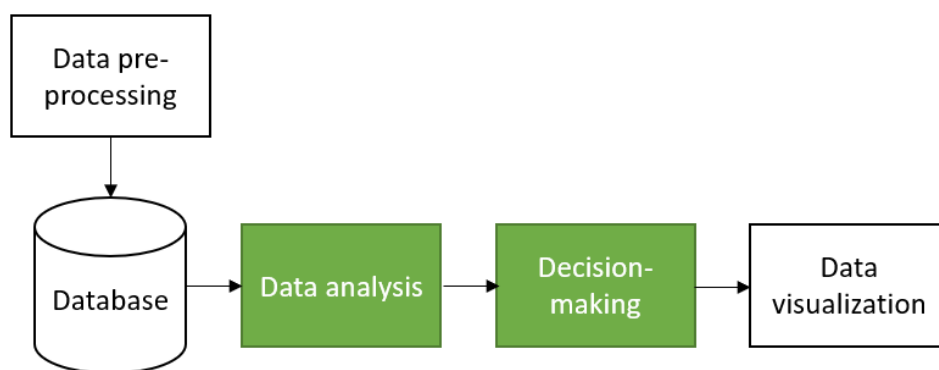


Figure 4. Stages of effective application of machine learning

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The following areas can be identified where machine learning can be particularly useful in MIS for agriculture. One area is yield forecasting with the generation of appropriate reports for enterprises. By analyzing historical data on weather conditions, soil quality, and other environmental factors, machine learning algorithms can make accurate predictions about potential yields. This information can be used to help businesses make planting, fertilizing and irrigation decisions, ensuring that they maximize yields and minimize losses.

If necessary, enterprises can use computing resources to diagnose plant diseases. Models can be used to analyze images of plants and identify signs of disease or pests. This will help farmers identify problems early and take necessary measures.

Another area of application is personalized marketing. By analyzing large amounts of data about each consumer, algorithms can determine the personal preferences and interests of each customer. Based on this information, businesses can create personalized offers, recommendations, and special promotions, which significantly improves the effectiveness of marketing efforts.

Also, machine learning can be used to predict demand for goods and services. By analyzing historical data on sales, seasonality, marketing campaigns, and other factors, algorithms can make demand forecasts with high accuracy. This information allows businesses to plan production, inventory and marketing activities in order to meet consumer demand and avoid unnecessary costs.

Another area where machine learning can also be used is optimizing supply chain management. By analyzing data on delivery times, inventory levels in warehouses, and other factors that may be difficult to interpret in logistics, algorithms can identify opportunities to optimize supply chains and reduce costs. Enterprises will be able to make new logistics, warehousing and transportation decisions based on recommendations predicted by machine learning models.

One of the most significant areas that businesses may need is crime detection in e-commerce. Machine learning models can be used to detect fraudulent activity by analyzing transactional data and identifying unusual patterns aimed at causing harm to

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an enterprise. This allows businesses to prevent fraud, reduce financial losses, and ensure transaction security for their customers.

The datasets in each field have a different nature of origin, so the following machine learning methods can be used to investigate the results:

- Machine learning techniques such as linear regression, decision trees, random forest, gradient boosting, and neural networks can be used for the field of yield forecasting. These algorithms can analyze historical data on weather conditions, soil quality, fertilizer use, and other factors to make predictions about yields;
- To diagnose plant diseases, computer vision and image processing methods can be used. Deep learning models, such as convolutional neural networks, can be trained on images of plants with various diseases or pests. These models can then be used to analyze new images of plants and identify signs of disease or pests;
- For personalized marketing, you can use recommender system methods. For example, collaborative filtering algorithms can be used to determine similarities between consumers and recommendations to target consumers based on their preferences and interests;
- Various methods can be used to predict the demand for goods and services, such as time series, linear regressions, ensemble models (such as random forest or gradient boosting), and neural networks. These models can analyze historical data on sales, seasonality, marketing campaigns, and other factors to predict future demand;
- Optimization and clustering algorithms can be used to optimize supply chain management. For example, genetic algorithms or ant algorithm, using intelligent search, can be used to plan delivery routes, manage inventory and optimize schedules;
- Classification and clustering methods can be used to detect crime in e-commerce. Machine learning models, such as support vector method, naïve bayes, decision trees, or clustering algorithms, can be trained on data on previous fraudulent activity and normal consumer behavior. These models can then be used to identify unusual patterns that may indicate fraud and to take measures to prevent fraud.

Also, the methods can be combined and used together for a more accurate and comprehensive analysis of relevant data in agriculture.

To improve the economic stability of agricultural enterprises, today, it is necessary to carry out research and implement modern approaches to data storage and processing in a dynamic and aggressive market environment. With each passing day, machine learning is becoming an increasingly important tool in the agricultural industry. By analyzing large amounts of data and identifying patterns and trends, machine learning algorithms can help businesses make better decisions about manufacturing, marketing, and distribution. With the development of data-driven approaches, it is likely that machine learning will become even more important in the coming years, helping to ensure the continued prosperity of the agricultural industry and provide the necessary resources for people around the world.

3.1.2 Implementation of services based on neural networks to promote products of agricultural enterprises

Agricultural enterprises are constantly trying to increase sales of their goods to potential customers by various means. One of the most promising areas in marketing tools, which received a powerful impetus after the public release and the rapid growth in popularity of ChatGPT, is the use of services based on neural networks. Computer systems, called neural networks, are based on the structure and functioning of the human brain. They are designed to identify patterns, gain knowledge from experience, and make decisions based on complex inputs. Neural networks can help businesses in agricultural marketing by analyzing market patterns, forecasting demand, optimizing work with existing tools and directing advertising resources to more promising areas.

Figure 5 shows data from Google Trends over the past 5 years, which represent user interest in this topic in Ukraine. As interest grows, so does the number of entrepreneurs who are beginning to actively implement AI-based tools into their businesses.

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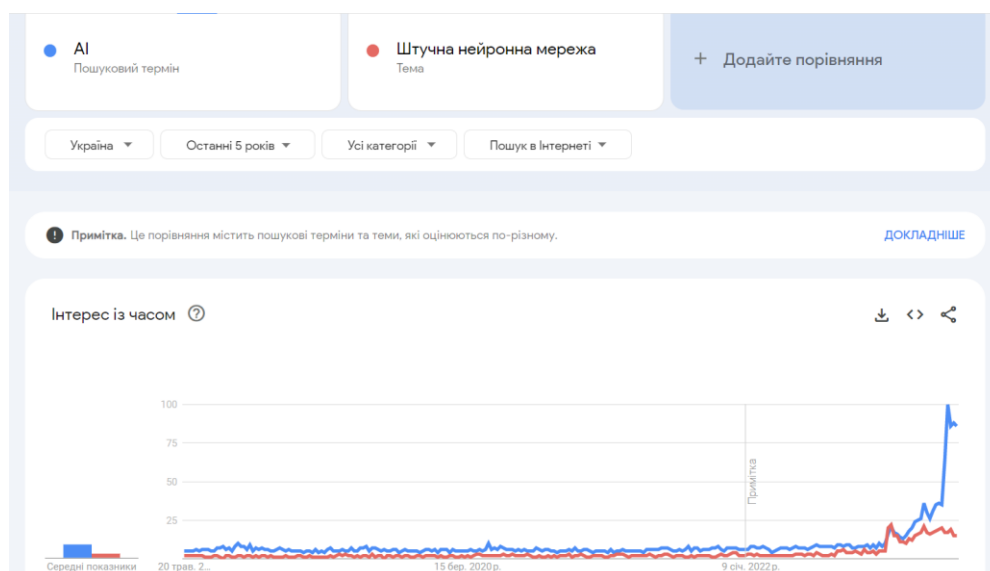


Figure 5. Data from Google Trends for the search term "AI" and the topic "Artificial neural network"

One example of neural network-based solutions are platforms that advise farmers and agribusinesses on how to improve their production and marketing strategies. They analyze data on weather conditions, soil characteristics, crop yields, and market demand using machine learning algorithms. The final data is used to support the production process, identify problems with plants or animals, predict crop and weather conditions.

Another popular example of the implementation of neural networks in the activities of companies are computer programs known as chatbots. They are designed to mimic human communication and can be used in agricultural marketing to provide customers with personalized guidance and assistance, based on their unique needs and interests. For example, a chatbot for a seed company can survey consumers about specific crops they want to grow, soil type, and weather in a region to provide them with individual recommendations on which seeds are best to buy and how best to grow them. At the moment, the creation of such bots does not require a large amount of resources and time, and the impact on the company's performance can be significant.

Although the application of neural network-based technologies in marketing is still in its early stages, there are already early encouraging results.

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However, like any new technologies, their implementation raises significant ethical and social problems that are gradually being addressed. For example, there are concerns about algorithmic bias and confidentiality of user data, or unethical raw data from generative neural networks.

In order to allay these fears, it is essential that agricultural businesses and service providers follow morally honest and open procedures when creating and implementing neural network-based services and technologies.

Neural networks can also be useful for predicting changes in the market. These systems can examine significant amounts of historical data on sales, demand, prices, and other relevant data based on forecasting models to predict future trends. This can help companies make informed choices on issues such as pricing, marketing strategy and production plans, and more.

Neural network-based services can be used to manage and optimize customer relationships (CRM), identifying critical information such as consumer preferences, purchase patterns, and reviews. Processing such data through machine learning can help businesses better understand their customers. Using this data, you can develop more successful marketing campaigns and sets of actions for customer service.

Automation of marketing processes is another area in which neural networks can be effectively applied. For example, AI-powered solutions can help create content for social media, automate emails, and even modify advertising campaigns based on user feedback data. Also, AI can be used to analyze information about certain products, brands or trends in agriculture using social media and other data sources that are abundant on the Internet and that are publicly available. This can help identify products that the business's target audience finds attractive and interesting, the challenges they face, and the expectations they have from agricultural products in the future.

Recently, more and more research is being devoted to studying how neural networks can be used to improve agricultural logistics. To find the best delivery routes, production plans, and optimize resource consumption, it is possible to process and evaluate data from satellites, drones, and the Internet of Things.

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Although neural network-based services provide great potential for agricultural enterprises, their implementation and operation requires appropriate knowledge and skills, including skills in the correct use of software, understanding of data fundamentals and analytics, and the ability to interpret and act on the results provided by the system.

There are many varieties of neural networks, each of which has its own characteristics and can be used to perform different tasks. Below are some examples of types of neural networks that can be useful for agricultural enterprises to promote their products:

- Artificial neural networks (ANNs), which consist of a large number of artificial neurons or nodes, are the main type of neural network. Image classification, forecasting, recommender systems, and more are some of the many tasks they can perform.
- Convolutional neural networks (CNN) are excellent for image processing. For example, CNN can be used to analyze images from drones or satellites to identify plant diseases and pests and assess crop health.
- Recurrent neural networks (RNNs) - These neural networks can remember past data, making them especially useful for analyzing data sequences such as time series. PHN can be used to predict weather, yields, market prices, and other variables that change over time.
- Deep Learning Networks model high-level abstractions in data using complex methods and architectures. They can be used to perform much more complex tasks, such as speech recognition, text writing, or natural language processing, which can be useful for understanding analyzing customer reviews across a variety of online resources, analyzing trends in social networks, or automating customer service.

Generative AIs are a kind of machine learning algorithms used to create new data based on a specific set of input data. This type of AI is considered one of the most popular at the moment, because of its ease of use and very good results. Among the

popular, at the moment, services that use generative models of artificial intelligence are:

- ChatGPT is a large language model developed by OpenAI. It uses GPT (Generative Pretrained Transformer) architecture and uses a large amount of textual data obtained from the Internet to generate text, translate text and many other tasks. It is worth noting that the model does not have consciousness or its own ideas and instead simply creates answers based on the data it has learned. ChatGPT can be useful for optimizing the work of agricultural enterprises, for example, in tasks such as automating answers to common questions that may relate to agricultural topics, analyzing and processing text data such as yield reports, customer feedback, etc., translating text between different languages, which can be useful for international agricultural enterprises, planning and organizing, staff training. Although ChatGPT is a powerful tool, it depends on the quality of input data and requires human knowledge and expert judgment [28];

- DALL-E is a variant of the GPT-3 model developed by OpenAI that has been trained to create images based on text descriptions. Using a small amount of input data, the service can create unique images based on a text description, which can be used to create unique visual content for advertising and marketing campaigns that helps companies stand out in the market, and, for example, visualize educational materials [29];

- Bard is an experimental chatbot from Google that allows you to collaborate with generative artificial intelligence. In its capabilities, it is very similar to ChatGPT, but the main difference is that Bard has access to the latest information on the Internet and can easily access Google search to check his answers or research sources around the Internet [30];

- Midjourney is a generative artificial intelligence program and service created and hosted by the San Francisco-based independent research laboratory Midjourney, Inc. Midjourney creates images from text descriptions called "prompts", similar to DALL-E from OpenAI and Stable Diffusion [31];

- Stable Diffusion is a text-to-image deep learning model released in 2022. It is mainly used to create images on the axis of text prompts, similar to Midjourney and DALL-E [32].

All these services are growing in their capacity very quickly and the potential in various fields is very high. In addition, generative models can be used to create marketing content, which may include images, text, or video. For example, information about the interests and preferences of a particular user can be used by generative AI to create customized texts for advertisements, such as posts for social networks, or ad texts (titles, descriptions, etc.) for various tools.

Despite all the advantages of generative AI, it is important to remember about its potential problems, the main of which are copyright infringement, since the data on which the neural network learns is taken without taking into account this factor, and inaccuracies in the provided generation results, for example, images may not meet the user's expectations, and the response texts may have false information. ChatGPT states that "ChatGPT may provide inaccurate information about people, places, or facts," which should force users to verify the responses generated.

Different types of neural networks should be used separately or in combination to create powerful systems for data analysis, forecasting, optimization and automation of processes that are important for effective marketing and promotion of agricultural products.

In order to better understand the essence of using systems based on neural networks, it is necessary to understand several basic algorithms at a basic level:

- Classification: Attempts to determine which category an asset belongs to. For example, a classification algorithm can be used to assess whether a particular field is suitable for growing a particular crop.
- Clustering: the process of grouping different objects according to common and similar characteristics. This algorithm can be used in marketing, for example, to group customers by common characteristics, or buying behavior.

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- **Q-Learning:** This is a type of computational reinforcement learning that allows agents to choose the best strategy for a finite state problem. Agricultural businesses can use this to train systems or agents that interact with customers or data.
- **Regression:** Used to predict a numeric value based on data. This can be used, for example, to predict prices and/or sales of products, based on historical data.
- **Dimensionality reduction:** An algorithm is used to reduce the number of input variables in a data set and maintain important information characteristics. This can help reduce the complexity of models and improve data processing efficiency.
- **RLHF (Reinforcement Learning with Human Feedback):** A machine learning algorithm that uses human feedback reinforcement to improve model learning. For example, marketing recommendation systems can use user feedback to teach them to recommend products that are more relevant or popular.

It is important to understand that each of these algorithms is used to solve certain types of problems and the choice of the best algorithm depends on the type of problem, available data and goals of the agricultural enterprise.

In order not to affect existing business processes that have passed the test of time, it is worth gradually introducing services based on neural networks for various parts of business activities, such as marketing, sales, customer service, supply chain management, human resources (HR) and much more. There are several stages that you need to go through for this:

1. **Assessing the needs of the company:** The first step is to determine the needs of the company. You need to know where your business can benefit from using neural networks.
2. **Choosing the right type of neural networks or their connections:** There are many types of neural networks, and each type is suitable for a specific type of task.
3. **Data collection and preparation:** data is needed to train the neural network. This can be images, text, or numeric data, depending on your tasks. In addition, you will need to clear this data from errors, remove unnecessary features, normalize and other procedures. Also, you can use existing data that may be publicly available.

4. Model learning: Neural network training means that it will learn to identify patterns in data. This may take some time and requires a lot of computing power.

5. Testing and implementation of the model: after training, it is necessary to test the model to make sure that it works properly. This may include testing on new data that the model has not seen before, and evaluating its effectiveness in real business tasks.

6. Continuous optimization: the neural network must be constantly monitored and optimized, even after its implementation. This can be done by researching how it works and collecting user feedback.

It is important to remember that although neural networks can bring significant benefits, they also require significant resources, such as time and money, therefore, before implementation, it is important to carefully study all the nuances and conduct a thorough analysis of the pros and risks.

Many well-known agricultural enterprises have already implemented services based on neural networks in their work and have obtained excellent results:

- Blue River Technology (purchased by John Deere): Blue River Technology uses neural networks and computer vision to distinguish weeds from plants in the field. With their See & Spray service, unwanted weeds are automatically detected and then spot-impacted spraying is applied to them. This helps to use pesticides more efficiently and reduce their use [33].

- Farmers Edge: Farmers Edge processes data from a variety of sources, such as weather data, monitoring stations, sensors, and satellite imagery. Neural networks and artificial intelligence are used for this. They provide farmers with knowledge about best treatment practices, seed placement, and plant protection doses, which increases yields and production efficiency [34].

- BASF: BASF uses machine learning and neural networks to create predictive models for agriculture. As an example, they created a model that predicts the risks of spreading diseases in crops, allowing farmers to protect crops in advance and reduce further losses [35].

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These companies achieved significant results after implementing services based on neural networks, and took a leading position in the agricultural market by improving efficiency, reducing costs, improving product quality and increasing yields.

Consequently, agricultural enterprises have gained new opportunities to increase productivity, efficiency and profitability through the use of services based on neural networks. AI and machine learning in agriculture allow optimizing crop cultivation, managing resources, forecasting weather and analyzing large amounts of data.

Services based on neural networks help predict demand for goods, create marketing strategies, optimize marketing processes, and identify market trends. They allow farmers and agribusinesses to more accurately determine the best and relevant production methods, make better use of resources, improve the quality of grown products and reduce the negative impact on the environment.

Companies engaged in precision farming, crop monitoring, supply chain management and predictive model development are successful examples of the use of neural networks in agriculture. They have already achieved significant benefits, including higher yields, lower costs, improved product quality and increased competitiveness in the market.

It is important to consider factors such as data privacy, ethical use, algorithmic bias, and the impact on people's work. These are all social and moral issues of using neural networks, which are now being solved by advanced scientists. The implementation of neural networks requires adherence to moral principles, the establishment of transparent procedures and a thorough risk analysis.

In general, agricultural enterprises that use services based on neural networks open up new opportunities for the development of the industry, improve production processes, increase efficiency and guarantee sustainable development of agriculture in the future.