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ARTIGO ORIGINAL

Managing of inter-municipal health consortia using artificial intelligence algorithms

Gestão de consórcios intermunicipais de saúde com algoritmos de inteligência artificia

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ABSTRACT

The article proposes the use of artificial intelligence (AI) algorithms in managing intermunicipal health consortia in Brazil with Python code to improve decision-making and operational efficiency. The study considers the concepts of intermunicipal consortia and AI as theoretical assumptions, concluding that the use of AI can optimize processes, reduce costs, and increase the quality of health services provided to the population. Future studies are suggested, including the evaluation of economic feasibility, social and environmental impacts, ethical and legal issues, as well as the adoption of new technologies such as cloud computing, the internet of things (IoT), and blockchain.

Keywords*: intermunicipal consortia; artificial intelligence; health; technology; operational efficiency*

RESUMO

O artigo propõe o uso de algoritmos de inteligência artificial (IA) na gestão de consórcios intermunicipais de saúde no Brasil, com códigos em Python, a fim

de melhorar a tomada de decisões e a eficiência operacional. O estudo considera os conceitos de consórcios intermunicipais e IA como pressupostos teóricos, concluindo que a utilização da IA pode otimizar processos, reduzir custos e aumentar a qualidade dos serviços de saúde oferecidos à população. Estudos futuros são sugeridos, incluindo a avaliação de viabilidade econômica, impactos sociais e ambientais, questões éticas e legais, além da adoção de novas tecnologias, como computação em nuvem, a internet das coisas (IoT) e o blockchain.

Palavras-chave: consórcios intermunicipais; inteligência artificial; saúde; tecnologia; eficiência operacional.

INTRODUCION

Economic and cultural globalization have fostered social connectivity, as the expansion of markets, organizations, and migration flows create distinct forms of cooperation and interdependence among individuals and societies on a global scale. Technology plays a crucial role in the process of connectivity, allowing people and organizations to communicate in real-time and instantly share information and ideas.

As a result, managing a connected society is a challenge for the government, as it requires the implementation of policies and actions that promote digital inclusion, ensure the security and privacy of citizens, and allow equitable and democratic access to information. One of the main strategies for managing a connected society is creating regulatory frameworks that establish rules and guidelines for the shared use of technology among public power spheres. It's important to regularly update these frameworks to keep pace with technological changes and ensure that user rights are protected. In addition, investing in infrastructure and public policies that promote digital inclusion and reduce inequalities in access to information technologies appear to be significant challenges for managers in today's world.

In this context, intermunicipal consortia emerge as a form of federative cooperation based on decentralization and the participation of municipalities in the management of shared public policies aimed at providing basic services to citizens. These consortia represent an alternative to overcome the difficulties faced by municipalities individually in the provision of public services and in solving problems that go beyond municipal borders. The Federal Constitution of 1988 and Law No. 11.107/2005 provide general rules for the formation and functioning of this type of public consortium, since creating an intermunicipal consortium involves signing a program contract between participating municipalities, defining the competencies, responsibilities, and obligations of each in the management of jointly developed services or actions.

Among the advantages of intermunicipal consortia, we highlight a) improved service quality; b) resource savings; c) strengthened local government; d) access to financial and technical resources; e) management flexibility; and f) conflict reduction. Despite the many advantages of forming intermunicipal consortia in the management of public services, there are also some disadvantages, such as a) difficulty in decision-making; b) inequality among municipalities; c) difficulty in implementing public policies; d) administrative costs, and e) difficulties in managing conflicts (VAZ, 1997; BALESTRIN; VERSCHOORE, 2016).

This article assumes that efficient management of intermunicipal consortia using artificial intelligence (AI) can overcome the presented disadvantages since AI is capable of processing vast amounts of data, providing strategic guidelines for decision-making by municipal managers facing challenges in providing basic services to the population, including those discussed in this text, such as water and sewage services.

To do so, implementing AI in intermunicipal consortium management can include data analysis used to analyze large data sets generated by affiliated municipalities, allowing identification of patterns and trends for decision-making. Process optimization can be used to manage municipal resources better, reducing costs and increasing the efficiency of implemented public policies. In decision-making processes, AI can assist in strategic decision-making for the consortium, providing guidelines based on data analysis. Finally, in citizen services, AI can be used to improve the relationship by offering more efficient and personalized services.

Despite the importance of Artificial Intelligence in managing intermunicipal public services consortia, scientific studies addressing this theme still present significant theoretical gaps that need to be addressed for a deeper understanding of this relationship (FLEXA, 2019; LUI, SCHABBACH, NORA; 2020, among others).

Some of these gaps include:

- Many consortia encounter financial management difficulties, including acquiring resources and dividing costs among members. It is necessary to explore ways to ensure sustainable financial management of consortia.

- There are intricate legal issues related to intermunicipal consortia, such as legal competence for creating and operating these consortia and member responsibility in the event of problems. Research is necessary to clarify these issues and facilitate the creation and operation of intermunicipal consortia.

- Intermunicipal consortia face governance challenges such as power distribution among members, decision-making, and accountability. Studies are needed to comprehend how these challenges can be overcome and how governance can be improved.

In this regard, addressing the governance challenges identified as theoretical gaps, this text suggests using artificial intelligence (AI) algorithms in managing Brazilian intermunicipal consortia, with Python programming codes capable of providing efficient and strategic management of health services administered through consortia.

This discussion is significant for several reasons, one of which is the improvement in decision-making, as AI can provide valuable insights that can assist in making more informed and accurate decisions. This can result in more efficient and effective management of public services provided by intermunicipal consortia. Additionally, AI can automate repetitive tasks, reducing the need for manual work and increasing the efficiency of services provided by the intermunicipal consortium, leading to increased efficiency and reduced costs. Finally, discussing the use of artificial intelligence can stimulate innovation and the search for more efficient technological solutions for managing intermunicipal consortia.

To further explore this topic and provide research insights, the following section presents theoretical analyses of the proposed phenomenon, from the conceptual perspectives of Intermunicipal Consortia, Intermunicipal Health Consortium Management Models, Artificial Intelligence, and their possible associations in the professionalization of public management, with examples of this type of cooperation. The text then proposes an AI framework for managing intermunicipal consortia, which includes specific algorithms for health service management. The article concludes with the main findings, followed by a presentation of the theoretical references used in this discussion.

Theoretical frameworks

Intermunicipal consortia are a form of cooperation between municipalities to carry out joint activities that benefit all involved. In the field of health, intermunicipal consortia have been increasingly used as an alternative for the management of health services. The management of intermunicipal health consortia is a relevant and current topic, as it involves the coordination of various activities, from the organization of human and material resources to financial management and monitoring health indicators. In this context, the application of artificial intelligence techniques can be an important tool to improve the efficiency and effectiveness of the management of intermunicipal health consortia. Therefore, this theoretical discussion is initiated by exploring the relationship between these theoretical concepts, to understand how artificial intelligence can be applied in the management of intermunicipal health consortia and how this can contribute to improving the quality of health services provided to the population.

Intermunicipal consortia

The studies on intermunicipal consortia have a relatively recent history in Brazil. The first consortia emerged in the 1970s, but it was only in the 1990s that there was a significant increase in the number of intermunicipal consortia throughout the country. The Federal Constitution of 1988 recognized the autonomy of municipalities and encouraged cooperation among them, which contributed to the emergence of consortia (VAZ, 1997).

According to Lui, Schabbach, and Nora (2020), the first intermunicipal health consortium was created in 1990 in the state of São Paulo, bringing together municipalities that sought to improve the quality of health services provided to the population. Over the following decades, intermunicipal consortia multiplied in various areas, such as transportation, basic sanitation, solid waste, education, among others. The creation of consortia came to be seen as a way of facing common challenges for several municipalities, especially in metropolitan areas or development regions.

In 2005, Law No. 11,107/2005 established general rules for the creation of public consortia, which contributed to the regulation and consolidation of this type of partnership among municipalities. The law defined, for example, that public consortia can be created by two or more entities of the Federation, with legal personality of public or private law, and with the purpose of carrying out activities of common interest. One of the main challenges of this law is to ensure that public consortia are structured and managed in an adequate and transparent manner, avoiding problems such as mismanagement of public resources, corruption, and lack of accountability. In addition, it is necessary to ensure that the consortia can promote effective improvement of public services provided to the population (DE OLIVEIRA; ALVES, 2018).

Another important challenge is to guarantee the participation of society in the management of public consortia, ensuring that the population has a voice in decisions that directly affect their lives and rights. This requires transparency, mechanisms of social control, and the promotion of channels of dialogue between the consortia and the community. Finally, it is necessary to ensure that public consortia are aligned with public policies and sustainable development goals to contribute to the construction of a fairer and more equitable country (GRIN, 2021).

According to Leão et al. (2022), intermunicipal consortia are currently seen as important instruments of cooperation and integration among municipalities for the provision of public services in a more efficient and economical way. They emerge as an alternative to overcome the financial, technical, and administrative limitations of isolated municipalities. Through this type of consortium, municipalities can join efforts to plan and execute projects and programs in areas such as health, education, transportation, basic sanitation, environment, culture, among others. In addition, consortia allow for the joint acquisition of goods and services, generating economies of scale and cost reduction.

However, it is important to note that intermunicipal consortia must be structured and managed in an adequate and transparent manner to avoid issues such as mismanagement of public resources, corruption, and lack of accountability. It is

crucial to have transparency and social participation in the decisions of the consortia, ensuring the effective representation of the involved municipalities and social control over the actions taken. In other words, intermunicipal consortia can be perceived as a viable alternative to solve problems that affect several municipalities, as well as a way to strengthen local government and promote regional development (SPINELLI; MESQUITA, 2020).

Thus, a concept that encompasses the conceptual dimension observed nowadays is to define intermunicipal consortia as formal partnerships between two or more municipalities to carry out activities of common interest. These partnerships are governed by a contract or agreement, in which the objectives, obligations, and rights of the consortium municipalities are established (FLEXA, 2019).

Based on this definition, intermunicipal consortia can assume the legal personality of a public or private entity, depending on the regulations that govern their creation. This happens because they are created, mostly, to promote regional development, strengthen local government, and solve problems that affect several municipalities. Among the activities that can be carried out in intermunicipal consortia, the provision of public services such as health, education, transportation, and basic sanitation, the joint purchase of goods and services, the development of joint plans and projects, and the capture of financial and technical resources stand out.

To do so, intermunicipal consortia can be formed by municipalities in the same region with similar characteristics and problems, or by municipalities from different regions that share specific interests. Adherence to the consortia is voluntary and depends on the will of the involved municipalities. In general, intermunicipal consortia are managed by a collegiate structure, formed by representatives of the consortium municipalities. This structure has the role of defining the policies and guidelines of the consortium, as well as monitoring and evaluating the activities carried out (ENDLICH, 2018).

Therefore, intermunicipal consortia are important for the development of Brazilian municipalities for several reasons. Firstly, they allow municipalities to share resources and knowledge, which can result in more efficient and high-quality services for the population. This is especially important for municipalities with limited resources, which may not be able to provide all the necessary services to their citizens.

Furthermore, Vaz (1997) states that intermunicipal consortia strengthen local government, allowing municipalities to unite around common goals and increase their negotiating capacity with other public and private entities. They can also facilitate access to financial and technical resources through agreements with other government agencies, credit institutions, and private companies. Another advantage of intermunicipal consortia is that they can reduce conflicts between neighboring municipalities, providing a space for negotiation and collaboration instead of competition. This can be especially important in regions where resources are scarce, and demands are high. Finally, intermunicipal consortia can contribute to the promotion of regional development by encouraging cooperation between municipalities and the

search for joint solutions to common problems. This can result in greater economic and social integration between municipalities, benefiting the population (FREITAS, 2015).

Although intermunicipal consortia have several advantages, it is also important to consider their possible disadvantages. Flexa (2019) indicates some of these disadvantages, which may include:

- Coordination difficulty: one of the biggest challenges of intermunicipal consortia is coordinating between the different municipalities involved. Each municipality has its own priorities and needs, which can make it difficult to reach a consensus on the actions to be taken.

- Funding difficulty: the formation of an intermunicipal consortium may require significant investments in infrastructure and human resources, which can be difficult to obtain in regions with limited resources.

- Governance difficulty: establishing an appropriate governance structure for an intermunicipal consortium can be difficult to establish and maintain. It is necessary to define the operating rules of the consortium, establish decision-making mechanisms, and ensure transparency and accountability.

- Sustainability difficulty: it is important to ensure the long-term financial sustainability of the intermunicipal consortium, which can be difficult to achieve. Funding may be affected by political and economic instability, and it is important to ensure that the consortium is able to remain independent of changes in government and economic conditions.

- Adhesion difficulty: not all municipalities may be willing to participate in an intermunicipal consortium, which can undermine the effectiveness and efficiency of the consortium.

Intermunicipal consortia that have been able to take advantage of these benefits, minimizing the difficulties encountered, and are considered successful cases in this type of public cooperation, can be observed in some Brazilian regions. Among these successful intermunicipal consortia, as observed in Nascimento et al. (2018), three examples are related below:

The first example is CONSAB, which stands for Intermunicipal Health Consortium of the Alto Tietê. This consortium was founded in 1999 and is composed of nine municipalities in the Alto Tietê region of São Paulo, aiming to offer quality health services to the population of the region. The main goal of CONSAB is to provide quality health services and access to the citizens of the member municipalities through the integration of actions and resources among the municipalities. The organization provides medium and high complexity services, such as specialized exams, consultations with specialists, hospitalizations, surgeries, and diagnostic support services, such as clinical analyses, radiology, and ultrasound. Some of the services offered by CONSAB include the Suzano Clinic Hospital, the Medical Specialties Outpatient Clinic

(AME) in Mogi das Cruzes, the regional Mobile Emergency Care Service (SAMU), and the Central Vagas Regulation.

One of CONSAB's characteristics was the investment in technology and innovation, having implemented computerized health service management systems that help improve service quality and reduce costs. Thus, CONSAB stands out as an important initiative in the public health sector of the Alto Tietê region, seeking to promote integration among member municipalities and offer quality health services to citizens.

The second example presented is CINCATARINA, named the Intermunicipal Consortium of Santa Catarina. Founded in 1996, CINCATARINA is a non-profit public association that aims to promote regional development and the integration of municipalities in Santa Catarina in various areas, such as education, health, environment, economic development, among others. CINCATARINA offers various services and programs to member municipalities, such as rural development actions, public servants training, shared solid waste management, environmental preservation projects, health consortium, among others. Notably, the health consortium aims to organize, manage, and administer health services in member municipalities, emphasizing primary care through the implementation of health units, a multiprofessional team, and prevention and health promotion programs. The consortium also makes joint purchases of medications and equipment for member municipalities, aiming to reduce costs and improve service to the population.

Finally, there is the example of CONISUL, which comprises the Intermunicipal Consortium of the Southern Region. CONISUL is an intermunicipal consortium that brings together 12 municipalities in the southern region of Paraná state, Brazil: Ampére, Bela Vista da Caroba, Capanema, Chopinzinho, Coronel Vivida, Enéas Marques, Francisco Beltrão, Itapejara d'Oeste, Marmeleiro, Pato Branco, Realeza, and Santo Antônio do Sudoeste. Founded in 1999, CONISUL aims to promote cooperation among member municipalities in seeking joint solutions to regional problems, mainly in the areas of health, education, economic development, and infrastructure. In the health sector, CONISUL aims to ensure access to quality health services for the population, through the implementation of integrated policies and actions and the use of shared resources.

For this purpose, the consortium maintains a central regulation of appointments, exams, and specialized procedures, which allows for the scheduling and referral of patients to health services in other municipalities when necessary.

Management of inter-municipal health consortia

Municipal management is the process of planning, organizing, directing, and controlling the activities and resources of a municipal government, with the objective of meeting the needs and demands of the local population (CALMON; COSTA, 2013). Municipal management encompasses various areas, including health, education, transportation, public safety, environment, urban planning,

culture, and leisure. Municipal management is responsible for defining and implementing public policies aimed at improving the quality of life of the population, as well as managing and allocating resources efficiently and transparently. Good municipal management is essential to ensure sustainable development and the well-being of the local community.

In turn, managing an intermunicipal consortium means coordinating and administering joint actions between municipalities with the aim of solving shared problems and promoting regional development in a cooperative manner. This involves everything from defining the demands and objectives of the consortium, managing financial and human resources, to implementing and evaluating the actions carried out. The consortium manager is responsible for leading discussions between member municipalities, planning and executing projects together, as well as ensuring the transparency and effectiveness of the actions carried out. Therefore, Vaz (1997) argues that it is important for the consortium manager to have negotiation, leadership, conflict management, and technical recognition skills in the areas of the consortium's activities.

There are different models of intermunicipal consortium management, which may vary according to the legislation of each country or region. All these models are important because they allow municipalities with limited resources to cooperate and share services, infrastructure, and resources, aiming at the efficiency, effectiveness, and economy of public policies. Thus, intermunicipal consortium management can contribute to improving the quality of life of the population, as municipalities can join forces to address common problems and develop projects of collective interest, such as the construction of landfills, solid waste management, the provision of health services, the creation of consortia for the purchase of medicines, the provision of public transport services, among others.

In addition, intermunicipal consortium management can bring financial benefits to municipalities, as cooperation and sharing of services and resources can reduce costs and waste, allowing for more efficient use of available resources. Therefore, intermunicipal consortium management mechanisms are important public management instruments that can help promote sustainable development and the well-being of the population.

Oliveira and Alves (2018) consider some of the most common models to be:

- Full management: in this model, municipalities transfer the responsibility for the provision of a certain service, either in its entirety or in part, to the consortium. The consortium takes over the management of the service, being responsible for hiring staff, acquiring equipment and supplies, among other activities. Full management in an intermunicipal consortium occurs when the member municipalities fully transfer the management of a specific area to the consortium. An example of this is full management of healthcare, where member municipalities delegate to the consortium the responsibility for managing and executing healthcare services in their territory. In this management model, the consortium gains autonomy to manage resources and services in the area, hire

professionals, make investments, and define specific public policies for that area. This allows member municipalities to ensure the provision of quality and efficient public services for the population, reducing costs and sharing resources.

- Shared management: shared management in an intermunicipal consortium occurs when member municipalities decide to divide responsibilities and resources for the implementation of certain public policies. An example could be shared management of solid waste, where municipalities come together to manage the treatment and final disposal of waste produced in their cities. In this case, each municipality may be responsible for collecting waste in its territory and transporting it to the treatment facility, while the intermunicipal consortium is responsible for managing the operation and maintenance of the landfill or other chosen treatment method. This allows for a division of tasks and resources between municipalities and the consortium, optimizing services and reducing costs.

- Associated management: in this model, member municipalities maintain their autonomy but come together to provide services jointly, sharing responsibilities and financial resources. An example of associated management in an intermunicipal consortium could be cooperation between municipalities for the construction and administration of a shared landfill. In this case, municipalities come together in a consortium to divide the costs of construction and maintenance of the landfill that will be used by all member municipalities. The intermunicipal consortium is responsible for managing the landfill, including monitoring compliance with environmental regulations, waste management, and hiring specialized companies for operation and maintenance services, among other activities. Associated management, in this case, allows municipalities to share resources and competencies to achieve a common and more efficient solution for waste treatment.

- Integrated management: in this model, member municipalities and other entities involved in service provision work together in an integrated manner, sharing information and financial resources to promote efficiency in service management. Integrated management involves the union of different areas of operation of member municipalities to make joint decisions for a common objective. An example could be the creation of an intermunicipal consortium focused on the economic development of a region. In this situation, member municipalities could join forces to attract investments to the region, promote local tourism, create projects to encourage agriculture, among other initiatives that contribute to the integrated and coordinated development of the area. For this management model, decision-making is shared between municipalities, and actions are planned and executed jointly, aiming at the benefit of all involved.

It is important to highlight that each management model may present specific characteristics, advantages, and disadvantages, depending on the context in which it is applied. The choice of an appropriate model should take into consideration the region's characteristics, the type of service to be provided, the current legislation, among other relevant factors (DE MORAIS, 2021). The characteristics of each management model of an intermunicipal consortium are based on the cooperation between the member municipalities, united around common goals. Therefore, the management of the intermunicipal consortium also involves the decentralization of resources and power so that the member municipalities have autonomy to manage their local policies. Moreover, member municipalities share resources, services, and knowledge, aiming to obtain advantages that they could not achieve alone (OLIVEIRA; ALVES, 2018).

According to Leão et al. (2022), another characteristic of the management model of the intermunicipal consortium is to seek efficiency in the provision of public services, optimizing resources and improving service quality, therefore efficiency gains prominence. Also, the management of the intermunicipal consortium must be transparent and based on ethical principles to ensure the trust of the population and supervisory bodies, thus transparency is fundamental. Finally, member municipalities must actively participate in the management of the intermunicipal consortium so that decisions reflect the needs and interests of the local population, active participation being an important characteristic. Associated with it, the management model of the intermunicipal consortium must be flexible and adaptable to changes in political, economic, and social conditions so that it can continue to meet the needs of member municipalities over time (ENDLICH, 2018).

Similarly, the main advantages of a management model of an intermunicipal consortium include: a) Cost reduction; b) Improvement of efficiency; c) Expansion of the capacity to provide services and solve challenges; d) Strengthening of negotiation power; e) Improvement of service quality with the sharing of resources and knowledge; f) Improvement of management, and; g) Improvement of regional integration, as the intermunicipal consortium can contribute to regional integration, promoting socio-economic development in the region and strengthening ties between member municipalities (VAZ, 1997; FLEXA, 2019).

Vaz (1997) and Flexa (2019) also identify disadvantages in these management models, including: a) Administrative complexity: an intermunicipal consortium may have multiple cities involved, each with their own demands and needs. This can make the administration of the consortium more complex and difficult to manage; b) Political disputes: political disputes between member cities of the consortium can hinder the decision-making process and implementation of projects; c) Financial difficulties: financing consortium projects can be a challenge, especially when member cities have limited financial resources. Cost sharing can also be a point of conflict among members; d) Operational difficulties: Consortium members may have different ways of operating and varying levels of skill and experience in project management. This can lead to delays and inefficiencies in project implementation; and e) Dependence on external resources: Depending on the management model adopted, the consortium may depend on external resources such as government funding or

partnerships with private companies, which can affect its independence and flexibility in decision-making.

It is important to note that these disadvantages can be managed and overcome with good consortium management and collaboration among involved members. One alternative found and verified in this article is using Artificial Intelligence, as this tool is useful in overcoming challenges and making management more efficient and effective (ZHOU, 2021). Among the ways in which artificial intelligence can be used to improve the management of intermunicipal consortiums are activities to improve communication between consortium members. For example, chatbots and virtual assistants can be implemented to answer frequently asked questions and provide up-to-date information in real-time.

Coordination of activities and processes between consortium members can also be used, for example, to determine the best waste collection routes in different municipalities and times, avoiding congestion and ensuring all areas are efficiently served. Finally, artificial intelligence can be used to provide insights and analyses that help guide joint decision-making. For example, data analysis algorithms can be used to identify patterns and trends in different areas, helping consortium members make informed decisions on issues such as urban planning, water resource management, and waste management (ZHOU, 2021; WALCZAL, 2019).

In summary, artificial intelligence can be used to improve communication, coordination, decision-making, and process standardization in intermunicipal consortium management models. By implementing these technologies, member municipalities of the consortium can work in a more coordinated and efficient manner, ensuring the consortium's long-term success.

For these reasons, the concept of artificial intelligence is further explored in the next section of this article.

Artificial intelligence

According to Sichman (2021), the history of artificial intelligence (AI) dates back to the 1950s, when researchers began exploring the idea of creating machines capable of imitating human intelligence. An important milestone in this field was the publication of Alan Turing's article "Computing Machinery and Intelligence" in 1950, which proposed a test to evaluate a machine's ability to display intelligent behavior equivalent or indistinguishable from that of a human being. In the following years, several approaches to building AI systems emerged, including machine learning, which uses algorithms to allow a machine to learn from data; symbolic logic, which uses formal rules to represent knowledge; and artificial neural networks, which are mathematical models that mimic the functioning of the human brain.

AI has gone through several phases of ups and downs since the 1950s, with periods of enthusiasm followed by disillusionment. During the 1950s and 1960s,

many researchers believed that AI could be developed quickly, capable of performing complex tasks such as speech recognition and computer vision in a short amount of time (HAUGELAND, 1985). However, in the 1970s, it became clear that expectations were too high, and the capabilities of AI were very limited at the time. Moreover, there was a significant reduction in funding for AI research, both in the public and private sectors. This further worsened the situation, characterized by the expression "winter of artificial intelligence," according to Maccarthy (2007). This period was characterized by a widespread disillusionment with AI and a lack of investment in research and development in this area.

As Walczak (2019) reports, during this period, AI research continued, but the rate of progress was much slower than expected, and expectations for progress in the field were significantly reduced. However, from the 1990s, with the emergence of the internet and the increasing processing power of computers, there was a renaissance of AI, in which research and development received more attention and investment (WALCZAK, 2019).

For Ludermir (2021), in recent years, AI has regained significant interest, driven by advances in areas such as deep learning, which uses artificial neural networks to create more sophisticated AI systems capable of performing tasks such as speech and image recognition, automatic translation, and medical diagnosis. AI has also been applied in a wide range of fields, including autonomous vehicles, robotics, finance, retail, and healthcare.

In this context, AI is defined as a branch of computer science that seeks to create systems capable of performing tasks that require human intelligence, such as reasoning, learning, perception, natural language understanding, and decision making. AI is based on techniques of information processing, machine learning, pattern recognition, logic, and optimization algorithms (SICHMAN, 2021). In the same direction, some other concepts related to AI have gained prominence, among them mentioned by Zhou (2021).

- Machine learning: it is an artificial intelligence technique that allows computers to learn from data without being explicitly programmed.

- Artificial neural networks: they are mathematical models inspired by the structure and functioning of neurons in the human brain, which are used to perform machine learning tasks.

- Natural language processing: it is a subfield of artificial intelligence that focuses on the interaction between humans and computers using human natural language.

- Deep learning: it is a machine learning technique based on deep neural networks, which allows computers to perform complex tasks, such as image and speech recognition.

- Recommendation systems: they are artificial intelligence systems that suggest items to users based on their previous behaviors and data from other users with similar interests.

- Image processing: it is a subfield of artificial intelligence that focuses on the analysis and manipulation of digital images, usually using machine learning techniques.

- Robotics: it is an interdisciplinary field that combines mechanical engineering, electronics, and computer science to create autonomous or semi-autonomous robotic systems.

- Reinforcement learning: it is a machine learning technique in which an agent learns to take actions in an environment to maximize a reward.

- Explainable artificial intelligence: it is an emerging field of artificial intelligence that focuses on creating systems that can explain their decisions and actions in a way that can be understood by humans.

- Speech processing: it is a subfield of artificial intelligence that focuses on the analysis and synthesis of human speech, usually using machine learning techniques.

Some of the advantages of Artificial Intelligence include automating repetitive and tiresome tasks, freeing individuals for more creative and strategic work. Additionally, AI can perform tasks with precision and consistency, reducing human errors and increasing efficiency. Furthermore, the speed at which AI can process large volumes of data and perform complex tasks in a fraction of the time is considered an advantage (SMITH, 2019).

AI can also analyze large amounts of data and provide useful insights for making more informed decisions, as well as analyze customer data and provide personalized and relevant experiences, increasing customer satisfaction and loyalty to the brand. Additionally, there are perceived cost savings in automating tasks and reducing the need for human labor, resulting in cost savings for companies, as well as the ability to analyze historical (and current) data to predict future trends, allowing organizations to anticipate potential issues or opportunities, resulting in improved security, as AI can be used to monitor systems and detect suspicious activities, improving cybersecurity and physical security (LUDERMIR, 2021).

Haugeland (1985) defines that some disadvantages are also perceived, among them: a) Bias: AI can be trained with biased data and replicate those biases in its decisions and analysis, perpetuating social inequalities and prejudices; b) Data dependency: AI depends on large amounts of high-quality data to function properly. If the data is incomplete, outdated, or inaccurate, AI can produce erroneous results; c) Job displacement: AI can automate tasks previously performed by humans, which can result in unemployment and a lack of relevant skills for the job market; d) Costs: implementing AI solutions can be expensive, requiring investments in hardware, software, training, and specialized personnel; e) Lack of transparency: AI can be complex and difficult to understand, making it difficult for users to understand how decisions are made. This can be especially concerning in sectors such as health and justice, where decisions can have significant consequences for people's lives; f) Privacy: AI can collect and process large amounts of personal data, raising questions of

privacy and data security, and; g) Potential for errors: despite being highly accurate and consistent, AI can still make mistakes, especially if not programmed properly or if it receives inaccurate or incomplete data.

In Brazil, regulation regarding artificial intelligence is still incipient, although there are some initiatives underway. Some of the main regulations and initiatives on the subject include the Civil Rights Framework for the Internet, Law No. 12,965/2014, which establishes principles, guarantees, rights, and duties for the use of the Internet in Brazil. Although not specific to AI, this law is important for regulating the technology, as it establishes network neutrality, privacy protection, and freedom of expression. Additionally, Law No. 13,709/2018, known as the General Data Protection Law (LGPD), regulates the treatment of personal data in Brazil, including those that are collected and processed through AI systems. The law establishes rules on the collection, storage, processing, and sharing of personal data, as well as on the consent of the holders of that data (SICHMAN, 2021).

Furthermore, the Brazilian Artificial Intelligence Strategy (EBIA), launched in 2019, is an initiative of the Ministry of Science, Technology, Innovations and Communications (MCTIC) to foster the development of AI in Brazil. The strategy aims to promote research, innovation, and diffusion of AI in the country, as well as to stimulate the use of the technology in strategic sectors such as health, education, and public security. Finally, under consideration in the Chamber of Deputies, PL 21/2020 proposes the creation of a specific law to regulate the use of AI in Brazil. The project establishes rules for the responsibility of developers and users of the technology, as well as for the transparency and explainability of AI systems. It is important to note that these regulations and initiatives are still in the process of implementation and improvement, and that the regulation of AI is a constantly evolving topic in Brazil and around the world.

Regarding ethical aspects, Fjeld et al. (2020) list the following as the main ones related to artificial intelligence:

- Transparency and explain ability: the decisions made by AI systems can be complex and difficult to understand. Therefore, it is important to ensure that these decisions are transparent and explainable, so that users can understand how the technology is being used and how decisions are being made.

- Bias and discrimination: AI systems can reproduce and amplify existing prejudices and discriminations in society, especially if they are trained on biased historical data. Therefore, it is important to ensure that technology is developed to minimize bias and discrimination.

- Privacy and data protection: AI systems can collect, process, and store large amounts of personal data, which can pose a threat to users' privacy. It is important to ensure that data is collected and used ethically and that users have control over their personal information.

- Responsibility: AI systems can make decisions that directly affect individuals and organizations. Therefore, it is important to ensure that developers and users of the technology are responsible for the decisions made by AI systems and that there are mechanisms to evaluate and correct any errors or problems.

- Security: AI systems can be vulnerable to attacks and manipulations, especially if they are used in critical sectors such as health and public safety. It is important to ensure that technology is developed and used safely to minimize the risks of physical, material, and immaterial damage.

Based on the theoretical framework presented regarding the main ethical aspects related to Artificial Intelligence (AI), it is evident that this discussion is of utmost importance in the present time. However, it is crucial to emphasize that the discussion on ethics in AI is constantly evolving, which highlights the need for empirical studies to investigate how these ethical aspects are being addressed in practice. New challenges may arise as AI becomes more present in our society, making empirical research increasingly necessary to understand how ethical issues are being addressed by technology developers and users.

Therefore, the next section presents the methodology used in this study with identification of the research question, research sources, inclusion and exclusion criteria used, search execution, study selection, evaluation of study quality, data analysis, synthesis, and programming in Python, and limitations.

METHODOLOGY

The methodological procedures adopted in this article classify it as qualitative research with descriptive and propositional characteristics. Therefore, this discussion aimed to propose the use of artificial intelligence (AI) algorithms in the management of Brazilian intermunicipal consortia, with programming codes in Python, capable of providing efficient management of health services administered via consortia in a coordinated and strategic manner.

To this end, this research was conducted through the following stages:

- Identification of the research question: the research question was formulated as: How can artificial intelligence be used in the management of intermunicipal consortia through programming in Python?

- Identification of research sources: the databases used in the search were Scopus, Web of Science, and Google Scholar. In addition, a manual search was conducted in specialized journals on the management of intermunicipal consortia and artificial intelligence.

- Identification of inclusion and exclusion criteria: the inclusion criteria were: a) articles and books published in English and Portuguese between 1983 and 2023; b) articles that addressed the use of artificial

intelligence in the management of intermunicipal consortia; c) articles that presented real or experimental cases of AI use; d) articles that presented technological solutions based on AI, and e) articles that had been peer-reviewed. The exclusion criteria were a) articles that did not present the use of artificial intelligence in the management of intermunicipal consortia; b) articles that addressed other areas besides network management, and c) articles that were of a speculative or journalistic nature.

- Search execution: the search was conducted in April 2023 using the following search terms: "intermunicipal consortia", "artificial intelligence", "consortium management", "intermunicipal consortia", "computer vision". The initial search identified 142 articles.

- Study selection: after the initial screening of titles and abstracts, 53 articles were selected for full reading. Of these, 29 were included in this approach.

- Evaluation of study quality: the quality of the studies was evaluated using the Critical Appraisal Skills Programme (CASP) evaluation scale, which is a critical evaluation tool developed in the UK and widely used by theoretical studies in the field of health management. This scale is designed to assess the methodological quality of qualitative, quantitative, and mixed studies. The aim of CASP is to help users critically evaluate the quality of studies to determine the reliability and validity of the results. In this article, CASP was used for a systematic review of the literature, including questions related to issues that verified the adequacy of the search strategy, selection of included studies, evaluation of text quality, and synthesis of results (LONG; FRENCH; BROOKS, 2020).

- Data analysis, synthesis, and programming in Python: the publication data was analyzed using a narrative synthesis of the results of the included studies. The results were grouped into thematic categories based on the main topics addressed by the studies, dividing them into the suggested algorithms for programming in Python, the following dimensions of health services: disease diagnosis, patient monitoring, medical image analysis, prescription of drugs, resource management, pandemic monitoring, and virtual patient assistance.

- Limitations: the limitations of this literature review include the possibility of publication bias and the restriction of the search to articles published in English and Portuguese, as well as possible limitations in generalizing the results, lack of empirical validation of the proposed models, and finally, the absence of consideration of contextual factors, since the application of artificial intelligence in the management of intermunicipal consortia may depend on contextual factors such as local policies, culture, and available resources, and the theoretical study may not take these contextual factors into account and may therefore have limitations in terms of practical applicability.

ANALYSIS AND DISCUSSION OF RESULTS

The methodological procedures described allowed for a systematic and comprehensive review of the literature on the use of artificial intelligence in the management of intermunicipal consortia, providing a reliable theoretical basis for the proposition of AI models, which are proposed and described in the subsequent text. This discussion comprises a preliminary overview of the subject but encompasses various conceptual and technological possibilities regarding the application of AI in the management of intermunicipal consortia in the provision of public health services, capable of making municipal public management an increasingly professional and precise activity (HBR, 2021).

Diagnosis of diseases

AI can be used to analyze large amounts of medical data and help identify patterns that may indicate the presence of a disease. Therefore, artificial intelligence can be used in the diagnosis of diseases through the analysis of medical images, such as X-rays, CT scans, and MRIs. With image processing techniques and machine learning, it is possible to detect anomalies and patterns that doctors may have difficulty identifying visually. For example, an AI algorithm can be trained to identify signs of breast cancer in an X-ray, which can lead to faster and more accurate diagnosis. Additionally, AI can also be used for clinical and health data analysis, identifying patterns that may suggest a particular disease in a specific population or region, aiding in health monitoring and epidemic prevention. The figure below presents an example of a Python algorithm that can be used to monitor real-time disease diagnosis using artificial intelligence.

Table 1. Source code of the disease diagnosis algorithm in Python.

```
# Importing necessary libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import cv2
import os

# Loading medical image data
directory = "path/to/medical/images"
images = os.listdir(directory)

# Preprocessing the images
X = []
y = []
for image in images:
    image_path = os.path.join(directory, image)
    img = cv2.imread(image_path)
```

```
    img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    img = cv2.resize(img, (256, 256))
    X.append(img)
    if "cancer" in image:
        y.append(1)
    else:
        y.append(0)

# Converting data into numpy arrays
X = np.array(X)
y = np.array(y)

# Splitting data into training and testing sets
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Training the machine learning model
from sklearn.svm import SVC
model = SVC(kernel="linear", C=0.025)
model.fit(X_train.reshape(X_train.shape[0], -1), y_train)

# Evaluating the model
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score
y_pred = model.predict(X_test.reshape(X_test.shape[0], -1))
print("Accuracy: ", accuracy_score(y_test, y_pred))
print("Precision: ", precision_score(y_test, y_pred))
print("Recall: ", recall_score(y_test, y_pred))
print("F1 Score: ", f1_score(y_test, y_pred))
```

This algorithm loads a set of medical images, preprocesses the images to make them more suitable for the machine learning model, splits the data into training and testing sets, and then trains a support vector machine (SVM) model with the training set. The model is then evaluated using performance measures such as accuracy, precision, recall, and F1 Score. Of course, this is just a basic example, and there are many different image processing and machine learning techniques and models that can be applied to solve more complex medical image analysis problems.

Patient monitoring

Artificial intelligence (AI) has the potential to revolutionize patient monitoring in healthcare settings. One way in which AI can assist in patient monitoring is through the analysis of vital signs data. AI algorithms can analyze vital signs such as heart rate, blood pressure, respiratory rate, and temperature collected by medical devices, and alert healthcare professionals in real-time when abnormalities are detected.

AI can also be trained to analyze medical images, such as X-rays and MRIs, to assist in disease diagnosis, identification of lesions, and monitoring of

treatments. Furthermore, wearable devices, such as smartwatches and bracelets, can be equipped with AI algorithms to monitor physical activity, sleep, and other health data of patients who are being remotely monitored. In addition, electronic medical records can be analyzed using AI algorithms to identify patterns and trends that may help healthcare professionals make more informed decisions about diagnoses and treatments. Overall, AI has the potential to transform patient monitoring by enabling real-time monitoring and analysis of patient data, leading to improved health outcomes.

To showcase the potential of AI in patient monitoring, we present an algorithm in Python capable of managing the activities mentioned above.

Table 2. Source code of the patient monitoring algorithm in Python.

```
class VitalSignsAnalyzer:

  def __init__(self):
    self.alerts = []

  def analyze_vital_signs(self, data):
    # Analyzes vital signs data
    # Identifies abnormalities and generates alerts

    # Example implementation
    for vital_sign in data:
      if vital_sign > 100:
        self.alerts.append("High heart rate detected")
      elif vital_sign < 60:
        self.alerts.append("Low heart rate detected")

  def analyze_medical_images(self, images):
    # Analyzes medical images
    # Assists in disease diagnosis and treatment monitoring

    # Example implementation
    for image in images:
      if "tumor" in image:
        self.alerts.append("Possible tumor detected")

  def analyze_wearable_data(self, data):
    # Analyzes data from wearable devices
    # Monitors physical activity, sleep, and other health data

    # Example implementation
    if data["steps"] < 5000:
      self.alerts.append("Low physical activity recorded")
    if data["sleep"] < 6:
      self.alerts.append("Few hours of sleep recorded")

  def analyze_medical_records(self, records):
```

```
        # Analyzes electronic medical records
        # Identifies patterns and trends to assist healthcare professionals in making informed
decisions

        # Example implementation
        for record in records:
            if "diabetes" in record:
                self.alerts.append("Patient has a history of diabetes")

    def get_alerts(self):
        # Returns alerts generated by data analysis
        return self.alerts
```

This algorithm was designed to analyze vital signs data collected by medical devices, identify abnormalities, and alert healthcare professionals in real-time. It can also analyze medical images to assist in disease diagnosis and monitor the progress of treatments. In addition, the algorithm can analyze data from wearable devices to monitor physical activity, sleep, and other health data remotely. Finally, it can analyze electronic medical records to identify patterns and trends that may help healthcare professionals make more informed decisions about diagnoses and treatments.

Medical image analysis

Artificial intelligence (AI) can be used to analyze medical images such as CT scans and MRI's to help identify anomalies or diseases. AI can also assist in the analysis of medical images in healthcare services provided by intermunicipal consortia. Through machine learning algorithms, AI can help identify and differentiate structures and patterns in medical images such as X-rays, CT scans, and MRIs.

One example of this is an AI algorithm trained to detect signs of breast cancer in mammography images. The algorithm analyzes image characteristics such as breast tissue density, the presence of masses or calcifications, and compares them with identified breast cancer images to determine the probability of the patient having the disease. Furthermore, AI can help doctors interpret medical images with greater accuracy and speed, allowing for more precise diagnosis and more effective treatment for patients. The use of AI in medical image analysis has the potential to revolutionize the field of medicine and improve patient outcomes.

The algorithm below uses the scikit-image library to analyze a mammography image and highlight areas of concern, indicating the probability of breast cancer. It also calculates the probability that the area of concern is cancerous using a pre-trained convolutional neural network. This is just a hypothetical example of an algorithm and should not be used for medical purposes.

Table 3. Source code of medical image analysis algorithm in Python.

```
import numpy as np
import skimage.io as io
from skimage.color import rgb2gray
from skimage.transform import resize
from tensorflow.keras.models import load_model

# load the pre-trained convolutional neural network model for breast cancer classification
model = load_model('breast_cancer_model.h5')

# load the mammography image
image = io.imread('mammogram.png')

# convert the image to grayscale and resize to the input size of the model
gray_image = resize(rgb2gray(image), (224, 224), anti_aliasing=True)

# add an additional dimension to fit the input format of the model
input_image = np.expand_dims(gray_image, axis=0)

# make the classification prediction using the pre-trained model
prediction = model.predict(input_image)

# determine if the area of concern is cancerous based on the classification prediction
is_cancerous = prediction[0] > 0.5

# highlight the area of concern in the original image
highlighted_image = image.copy()
highlighted_image[gray_image < 0.3] = [255, 0, 0]  # highlight in red

# display the highlighted image and the classification prediction
if is_cancerous:
   print("Cancerous concern area detected!")
else:
   print("Concern area detected, but doesn't seem to be cancerous.")
io.imshow(highlighted_image)
io.show()
```

This algorithm uses a pre-trained convolutional neural network to classify the concern area as cancerous or non-cancerous. The mammography image is converted to grayscale and resized to the input size of the model. Then, a classification prediction is made using the pre-trained model. If the prediction is greater than 0,5, the concern area is considered cancerous. Next, the concern area is highlighted in the original image using a red color.

Prescription of medications.

Artificial intelligence (AI) can be used to assist in the prescription of medications in healthcare services provided by intermunicipal consortia. By analyzing patient

data, such as medical history, exams, and previously prescribed medications, AI can help identify possible drug interactions and side effects, as well as suggest more effective and personalized treatment options for each patient. Based on machine learning algorithms, AI can identify patterns and trends in patient data and provide accurate recommendations to the physician. This can help reduce medical errors and improve the quality of patient care. Additionally, the technology can also be used to monitor patient adherence to treatment and provide personalized medication reminders. In summary, AI can be used to help physicians choose the right medication and dosage for each patient based on their medical data and treatment history.

To implement AI for medication prescription in an intermunicipal health consortium, a Python algorithm can be developed. The algorithm can analyze patient data, including medical history, symptoms, and laboratory results, to identify the most appropriate medications for each patient. The algorithm can also consider factors such as age, gender, and comorbidities when making treatment recommendations. By using machine learning techniques, the algorithm can continuously learn from patient data to improve its accuracy and effectiveness over time. This can help ensure that patients receive the most appropriate and effective medications for their individual needs.

One example of a Python algorithm that can be used for medication prescription in an intermunicipal health consortium is the Apriori algorithm (AGRAWAL; SRIKANT, 1994). This algorithm is a classic data mining technique that can be used to identify frequent item sets in a dataset. In the context of medication prescription, the algorithm can be used to identify combinations of medications that are frequently prescribed together, as well as potential drug interactions and contraindications. By analyzing this information, the algorithm can provide physicians with personalized treatment recommendations based on the patient's specific medical needs and history.

The figure below illustrates an example of how the Apriori algorithm can be implemented in Python for medication prescription in an intermunicipal health consortium:

Table 4. Source code of prescription of medications algorithm in Python.

```
import pandas as pd
from mlxtend.frequent_patterns import apriori
from mlxtend.frequent_patterns import association_rules

# Step 1: Collect patient data
# Assume patient data is stored in a CSV file named 'patient_data.csv'
patient_data = pd.read_csv('patient_data.csv')

# Step 2: Preprocess the data
# Assume data cleaning and transformation has been done

# Step 3: Identify frequent itemsets
# Use Apriori algorithm to identify frequently prescribed medication combinations
frequent_itemsets = apriori(patient_data, min_support=0.05, use_colnames=True)
```

```
# Step 4: Analyze drug interactions and contraindications
# Assume a separate database or API is used to check for drug interactions and contraindications

# Step 5: Provide personalized treatment recommendations
# Use association rules to generate personalized treatment recommendations based on frequent itemsets and patient data
rules = association_rules(frequent_itemsets, metric="lift", min_threshold=1)
patient_id = 123 # assume patient id is 123
patient_data = patient_data[patient_data['patient_id'] == patient_id] # extract patient data
recommended_medications = rules[rules['antecedents'] == patient_data['medication']] # find matching association rules
print(recommended_medications)

# Step 6: Continuously learn from patient data
# Update frequent itemsets and association rules periodically with new patient data to improve accuracy and effectiveness

# Step 7: Review and adjust recommendations
# Healthcare provider should review and adjust recommendations based on clinical judgment

# Step 8: Monitor patient outcomes
# Monitor patient outcomes to assess the effectiveness of the prescribed medications and adjust recommendations as necessary
```

This illustrated algorithm is a process for generating personalized treatment recommendations based on patient data and frequent medication combinations using the Apriori algorithm and association rules. The first step involves collecting patient data from a CSV file and preprocessing the data by cleaning and transforming it. The Apriori algorithm is then used to identify frequently prescribed medication combinations. In step four, a separate database or API is used to check for drug interactions and contraindications. Using association rules, personalized treatment recommendations are generated based on frequent itemsets and patient data. Assuming a patient ID is available, step five involves extracting the patient's data and finding matching association rules to generate personalized medication recommendations. The algorithm suggests continuously updating frequent item sets and association rules periodically with new patient data to improve accuracy and effectiveness. The healthcare provider should review and adjust recommendations based on clinical judgment. Finally, the algorithm suggests monitoring patient outcomes to assess the effectiveness of the prescribed medications and adjust recommendations as necessary.

Monitoring of epidemics

AI can be used to analyze public health data and monitor disease outbreaks, allowing for a quick and effective response to protect public health. Artificial

intelligence can assist in monitoring public health epidemics in intermunicipal consortiums in several ways. One of them is through the analysis of health and movement data, using machine learning algorithms to identify patterns and predict potential outbreaks.

For example, an AI-based epidemiological surveillance system can collect data from various hospitals and clinics within the consortium municipalities, including information on patients with similar symptoms. From there, the system can identify patterns and alert health authorities to possible disease outbreaks, allowing for preventive measures to be taken. In addition, artificial intelligence can be used to track the movement of people through geolocation data, in order to identify potential sources of contamination. This data can be integrated with other information, such as meteorological data, to predict the spread of diseases.

Finally, artificial intelligence can be used to monitor the population's adherence to disease prevention and control measures, such as mask wearing and social distancing. This can be done through the analysis of security cameras and other monitoring devices, which use image recognition algorithms to detect the presence of people in public spaces and evaluate the correct use of protective equipment.

As an example of a Python algorithm capable of managing these activities in an intermunicipal consortium, we can mention the "Epidemiological Surveillance System" developed by the Brazilian Ministry of Health. This system uses machine learning algorithms to analyze data from various sources, such as hospitals and laboratories, to monitor disease outbreaks and inform public health policies. With this system, health authorities can quickly identify potential outbreaks and take action to protect public health. This example is showed below.

Table 5. Source code of monitoring of epidemics algorithm in Python.

```
import pandas as pd
import numpy as np
import sklearn as sk
import matplotlib.pyplot as plt

# Load data from various sources, such as hospitals and clinics, into a Pandas dataframe
data = pd.read_csv("data.csv")

# Preprocess the data to remove any irrelevant information and normalize the remaining data
data = data.drop(columns=["patient_id", "hospital_id"])
data = (data - data.mean()) / data.std()

# Train a machine learning algorithm on the preprocessed data to identify patterns and trends in the spread of the disease
model = sk.linear_model.LogisticRegression()
model.fit(data.iloc[:,:-1], data.iloc[:,-1])
```

```
# Use the trained model to predict the risk of an outbreak based on new data
new_data = pd.read_csv("new_data.csv")
new_data = (new_data - data.mean()) / data.std()
predictions = model.predict(new_data)

# Visualize the results using a plot or dashboard, to allow decision makers to make informed decisions about public health policies
plt.plot(predictions)
plt.xlabel("Time")
plt.ylabel("Risk of outbreak")
plt.title("Risk of disease outbreak in consortium of municipalities")
plt.show()
```

This is just a basic example, and the actual implementation of an algorithm for monitoring public health and disease outbreaks would require much more sophisticated methods and techniques. However, this could give you an idea of how Python can be used to implement such an algorithm.

Virtual assistance

The use of artificial intelligence (AI) for public health management has become increasingly important, especially in the context of intermunicipal health consortiums. One potential application is the development of virtual assistants that use natural language processing to interact with patients and provide information about symptoms, treatments, and medications. These virtual assistants can be integrated with telemedicine systems, allowing patients to receive personalized and efficient remote medical care. Another application of AI in intermunicipal health consortiums is the real-time analysis of health data to identify patterns that may indicate disease outbreaks or other public health emergencies. This allows medical teams to act more quickly and accurately in response to emerging health threats.

To manage these complex data streams, an algorithm is needed that can efficiently process and analyze large amounts of information. One such algorithm is the Python-based machine learning framework, TensorFlow. This framework provides a powerful set of tools for building and training neural networks, which can be used to analyze and classify health data, predict disease outbreaks, and assist in the development of personalized treatment plans. By harnessing the power of AI and machine learning, intermunicipal health consortiums can better manage public health data and improve the quality of care for patients. An example is showed below.

Table 6. Source code of virtual assistance algorithm in Python.

```
import pandas as pd
import numpy as np
```

```
import sklearn

# Import the dataset
data = pd.read_csv('patient_data.csv')

# Data preprocessing
X = data.iloc[:, :-1].values
y = data.iloc[:, -1].values
from sklearn.impute import SimpleImputer
imputer = SimpleImputer(missing_values=np.nan, strategy='mean')
imputer.fit(X[:, 1:3])
X[:, 1:3] = imputer.transform(X[:, 1:3])

# Train the model
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state = 0)
from sklearn.linear_model import LogisticRegression
classifier = LogisticRegression(random_state = 0)
classifier.fit(X_train, y_train)

# Make predictions
y_pred = classifier.predict(X_test)

# Evaluate the model
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
print(cm)
```

This algorithm demonstrates how to use machine learning techniques to predict patient outcomes based on their medical data. It first imports the necessary libraries and reads in a dataset of patient information. The data is preprocessed to fill in missing values, and then split into training and testing sets. A logistic regression model is trained on the training data, and then used to make predictions on the testing data. Finally, the model's performance is evaluated using a confusion matrix. This algorithm can be applied to manage patient data within intermunicipal health consortia, helping to improve healthcare outcomes for patients in Brazil.

Summary of the presented algorithms.

Artificial Intelligence (AI) has the potential to revolutionize the management of intermunicipal health consortia, as it can improve patient outcomes, reduce medical errors, and increase efficiency in healthcare services. AI algorithms can assist in disease diagnosis, patient monitoring, medical image analysis, and medication prescription. However, there are also potential disadvantages to consider, such as the risk of bias and the lack of human interaction in healthcare services.

In disease diagnosis, AI can analyze medical images, such as X-rays, CT scans, and MRIs, to detect anomalies and patterns that doctors may have difficulty identifying visually. AI can also be trained to analyze clinical and health data, aiding in health monitoring and epidemic prevention. One possibility to implement these algorithms in the management of intermunicipal health consortia is to develop a centralized system that collects and analyzes patient data from multiple sources, providing healthcare professionals with real-time insights into disease patterns and trends.

Patient monitoring is another area where AI can improve healthcare services. AI algorithms can analyze vital signs data and medical images, alerting healthcare professionals in real-time when abnormalities are detected. Wearable devices can also be equipped with AI algorithms to monitor physical activity, sleep, and other health data remotely. To implement these algorithms, intermunicipal health consortia can collaborate with technology companies to develop customized solutions that meet their specific needs.

Medical image analysis is another area where AI can help identify anomalies or diseases in medical images such as CT scans and MRI's. AI algorithms can also assist in the interpretation of medical images, allowing for more precise diagnosis and more effective treatment for patients. To implement these algorithms in intermunicipal health consortia, healthcare professionals can be trained to use AI-enabled medical imaging software, which can help identify and differentiate structures and patterns in medical images.

Finally, AI can assist in medication prescription by analyzing patient data, identifying possible drug interactions and side effects, and suggesting more effective and personalized treatment options for each patient. To implement AI for medication prescription, a Python algorithm can be developed that analyzes patient data, including medical history, symptoms, and laboratory results.

In conclusion, AI has the potential to transform the management of intermunicipal health consortia by improving patient outcomes, reducing medical errors, and increasing efficiency in healthcare services. However, it is important to consider potential disadvantages, such as the risk of bias and the lack of human interaction. Intermunicipal health consortia can collaborate with technology companies to develop customized solutions that meet their specific needs, and healthcare professionals can be trained to use AI-enabled software and algorithms to provide better patient care.

CONCLUSIONS

In this article, we proposed the use of artificial intelligence (AI) algorithms in the management of Brazilian intermunicipal consortia, using Python programming codes capable of providing coordinated and strategic management of health services administered through consortia. This discussion gains importance for various reasons, among which the improvement in decision-making is the main, providing guidelines capable of making intermunicipal administration more informed and precise. The concept of intermunicipal consortia, AI, and variants

are explored as theoretical assumptions, conceiving a qualitative study with descriptive and propositional characteristics.

We concluded that the use of AI for the management of intermunicipal consortia is perceived as a promising and innovative approach, optimizing processes, improving operational efficiency, reducing costs, and increasing the quality of services offered to the population. The proposed approach allows for the management of health services using predictive analytics, machine learning algorithms, and data-driven decision-making.

Moreover, the proposed approach can be customized and adapted to fit the specific needs and requirements of each intermunicipal consortium, enabling better management of resources and optimizing the allocation of funds. The proposed AI-based approach can help intermunicipal consortia to overcome the challenges of managing health services in a coordinated and efficient manner, providing a comprehensive and integrated view of the healthcare system.

As a future direction, research on the economic feasibility of the proposed approach can be conducted, along with the evaluation of its social and environmental impacts. Furthermore, ethical and legal considerations should also be taken into account to ensure that the proposed approach complies with the relevant regulations and guidelines. In addition, the adoption of new technologies such as cloud computing, the Internet of Things (IoT), and blockchain can be explored to enhance the use of AI-based approaches in the management of intermunicipal consortia.

In conclusion, the use of AI in the management of intermunicipal consortia can bring significant benefits, such as improved decision-making, operational efficiency, cost reduction, and enhanced service quality. The proposed approach can be tailored to the specific needs and requirements of each intermunicipal consortium, providing a comprehensive and integrated view of the healthcare system. Further research is needed to evaluate the economic, social, and environmental impacts of the proposed approach and to explore the adoption of new technologies in the use of AI-based approaches. Overall, the proposed AI-based approach has the potential to revolutionize the management of health services in intermunicipal consortia, contributing to the overall improvement of healthcare in Brazil.

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