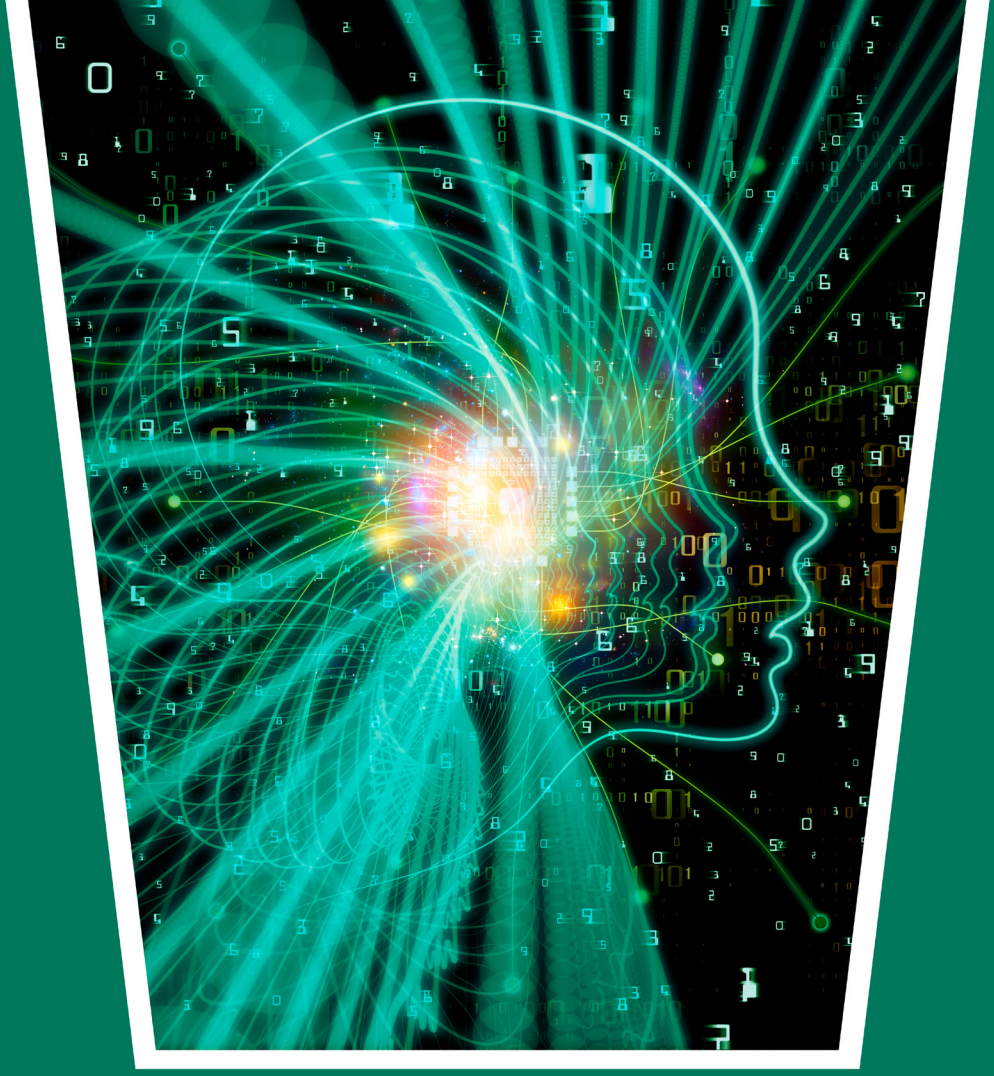

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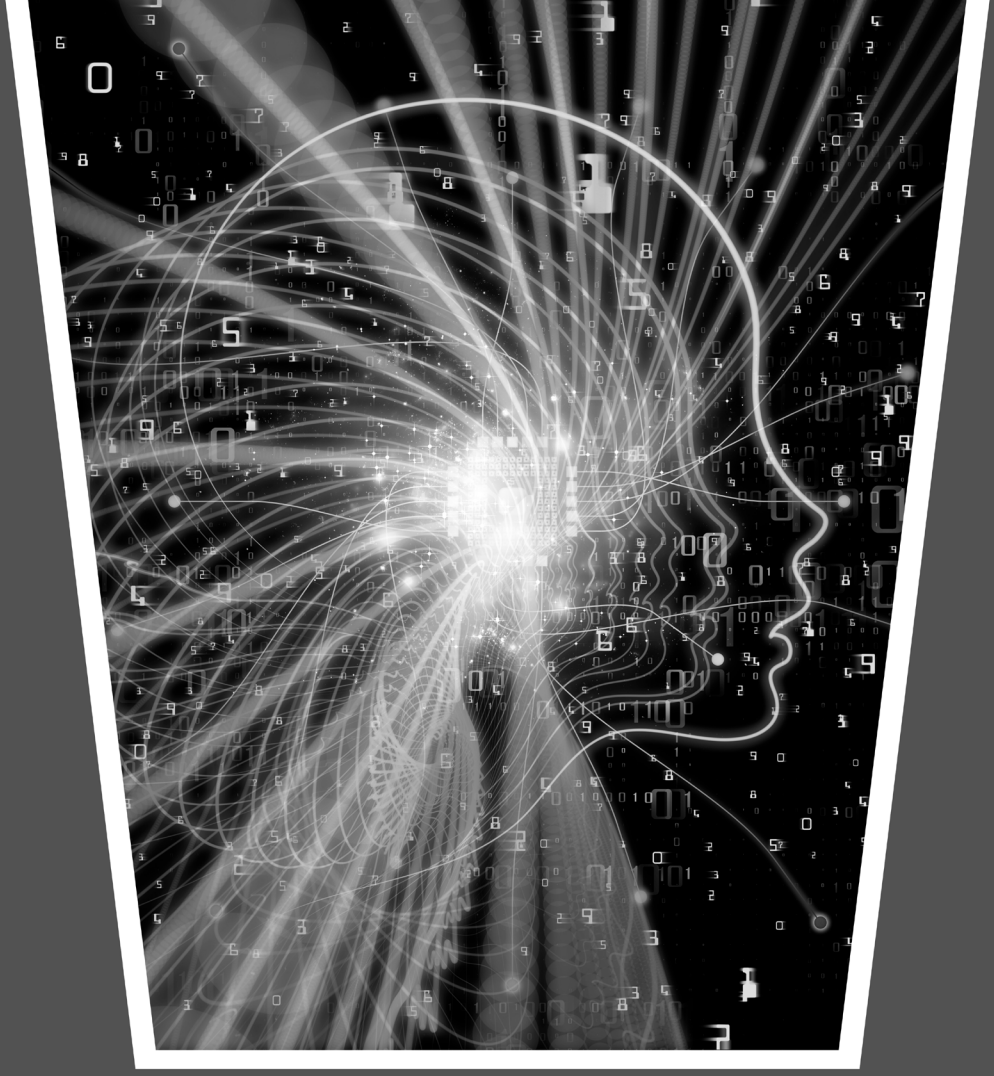

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APRESENTAÇÃO

A ciência tenta obter conhecimento sobre a estrutura fundamental do mundo utilizando observações sistemáticas e experimentais. A engenharia explora o campo do desconhecido procurando sistematicamente por novas soluções para problemas práticos. O GPS, a Internet, antibióticos, dentre outros, surgiram em meio às dificuldades das guerras. O Brasil, apesar de não estar envolvido em nenhuma, vive outras batalhas diárias.

No primeiro volume deste livro trouxemos um pouco da produção científica de um grupo de pesquisadores da região de Campinas e neste novo volume, não diferente, apresentamos mais engenharia e ciência aos serviços da sociedade e da indústria. Entretanto, desta vez a produção ocorreu durante um dos eventos de mudança mais rápida observada na sociedade recente: a quarentena imposta pela pandemia de COVID-19.

O ano de 2020 será lembrado por todos como o ano mais atípico das nossas vidas. O distanciamento social afastou pesquisadores do contato diário com colegas e de seus materiais de trabalho. Pesquisar de casa parecia impossível. Vimos ao longo de 2020 que nossos alunos conseguiam fazer pesquisa nas empresas que trabalhavam. Que, com os devidos cuidados, poderíamos usar os laboratórios. Que a internet aproximou os distantes grupos de pesquisa. Que ciência se faz com pessoas dedicadas e apaixonadas pelo trabalho.

Pesquisamos. E este livro é a amálgama do árduo trabalho de produzir ciência e tecnologia em 2020. É a flor do mandacaru: aos olhos de quem vê, surgiu no ambiente aparentemente improvável e inóspito. O ano que passou fortaleceu nosso grupo de pesquisa e parcerias foram criadas e/ou fortalecidas. Reforçamos, porém, que este livro está mais para um *tweet* diante do livro que foi 2020. Um ano longo, com muito aprendizado, muitas quebras de paradigmas e que de certa maneira, parece ainda insistir em estar entre nós. Este livro foi um recorte das nossas vidas acadêmicas, uma lembrança que será registrada nos anais da academia, mas com significado muito particular para cada um dos autores que aqui depositaram as lembranças do que melhor fizeram neste período.

O ano que se adentra rapidamente traz a esperança de renovação, de mudanças não mais tão bruscas e de um ano que se inicia em regime laminar. E nesta correnteza que é a vida, celebramos neste volume trabalhos que envolvem inteligência artificial aplicada (inclusive para a COVID-19), aplicação ou desenvolvimento de materiais, melhorias de processos industriais e da gestão de linhas de produção, geração de energia, dentre outros temas.

Finalmente, agradecemos a Editora Atena por abraçar esta iniciativa, abrindo as portas para a divulgação do conhecimento para a comunidade científica e a sociedade.

Filipe Alves Coelho

Monica Tais Siqueira D'Amelio

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SUMÁRIO

CAPÍTULO 2

THE IMPACT OF COMPUTATIONAL INTELLIGENCE FOR COVID-19 AS A TECHNOLOGICAL RESOURCE TO SUPPORT THE GLOBAL PANDEMIC

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ABSTRACT: Computational Intelligence is a great ally in the fight against time to combat the Covid-19 pandemic, helping from the effectiveness of research aimed at repositioning and discovering drugs (searching for molecules like drugs against the disease) to studies in image recognition, or still processing natural language on technical/scientific bases generating new insights in a collection of academic literature on COVID-19. Computational Intelligence and in the face of this global pandemic context, is seeking to identify ways to characterize, assist, and optimize through effective solutions useful in facing Covid-19 using Artificial Intelligence (AI) models. Considering that AI technologies and tools play a key role in all aspects of the COVID-19 pandemic response, from better understanding the virus and accelerating medical research on drugs and treatments, detecting and diagnosing the virus and predicting its evolution, assist in preventing or reducing the spread of the virus through monitoring and tracking, or even responding to the resulting health crisis through personalized information and monitoring and improving early warning tools, among other possibilities. This chapter is motivated to provide a scientific major contribution related to the discussion and overview of Computational Intelligence, their applications, and influence with respect to COVID-19 in the current era, as well as categorizing and synthesizing the technology's

potential as a technological resource to support the global pandemic.
KEYWORDS: Information Science, Health Informatics, Technology in Healthcare Management, Computational Intelligence, COVID-19.

1 | INTRODUCTION

The pandemic caused by the new coronavirus created a phenomenon in the scientific milieu that seems paradoxical amid the imperative need imposed by governments of several countries of social distance, to increase the initiatives of collaborative projects, especially in the field of Artificial Intelligence (AI). United in the virtual space, scientists from all over the world use computational intelligence instruments applied to predict the evolution of COVID-19, which are dedicated to the development of AI algorithms in universities, research centers, and companies have directed time and knowledge in the search for solutions to the crisis (VAISHYA *et al.*, 2020).

As the new coronavirus continues to spread throughout the world, a series of graphs showing the evolution of COVID-19 and curves that illustrate what may happen in the future has been observed, which poses a series of additional challenges for scientists of computing. In this sense, as a note if the possibility of extracting useful knowledge from this gigantic amount of information circulating on the internet about the pandemic. Through artificial intelligence techniques applied to data mining and using artificial intelligence to analyze events extracted from journalistic texts, such as information about what happened, how, when, where, and who is involved, taking advantage of the technological resources available today, we can perceive several perspectives within the same theme (SCHULLER *et al.*, 2020, LI *et al.*, 2020).

Based on this, it is possible to incorporate into the existing forecasting models, information from the knowledge of specialists in the identification of the pathology in order to enable a more accurate forecast of the pandemic contamination curve, which can be adjusted considering events on this subject (ALLAM; DEY; JONES, 2020).

When one observes the future evolution of the disease contamination curve and only takes into account data on contagions that occurred in the past, a limited view of the problem is obtained. Since the information that circulates on the web can also function as digital sensors that help in understanding the reality faced. In this sense, through the use of computational intelligence resources, it is possible to enrich this view. Adding to the forecast information extracted from reliable sources, increasing the scientific look to build predictive models closer to reality. Such a reality is possible due to the fact that computers are able to process a large amount of information and find patterns in what happened in the past and that can be repeated in the future (ALLAM; DEY; JONES, 2020).

In the case of COVID-19, news can be collected that specifically refer to the disease or coronavirus, as long as it comes from reliable sources, and make a pre-processing, using various techniques, such as natural language processing, performing a kind of translation of the human language to a language that machines can understand, and so the texts become a set of signs (LI *et al.*, 2020).

Artificial intelligence in the health field can work associated with the tabulation of

data mining, or text mining. This technique consists in its combination with machine learning algorithms, in order to assist the health specialist in critical moments that require quick decisions when there is a deficiency of the resources presented, for example, low-resolution images (FRANÇA *et al.*, 2020).

These computational intelligence resources are already being used to predict the spread of the disease, support in diagnosis and treatment, development of new drugs and vaccines, management of beds and hospital supplies, and identification of clusters of people. This process occurs in the same way that in the economy, analyzes are carried out that take into account the impacts of social isolation and even fight against false news using AI as a tool (ALLAM; DEY; JONES, 2020; LI *et al.*, 2020).

Therefore, this chapter has the mission and objective of providing an updated overview of computational intelligence for COVID-19, addressing its evolution and fundamental concepts, addressing its success, with a concise bibliographic basis, categorizing and synthesizing the potential of technology for this aspect.

2 | METHODOLOGY

This study was developed based on the data collection of **21** scientific articles present in bases such as Scielo, Google Scholar, and PubMed, with the scientific work dated from 2016 to 2020.

3 | THE IMPORTANCE OF COMPUTATIONAL INTELLIGENCE

Computational Intelligence is related to the use of computational devices to understand human (or animal) intelligence, referring to a set of bioinspired computational methods capable of dealing with complex real-world problems. This differs from AI in that it is based on models inspired by nature, such as Artificial Neural Networks, Genetic Algorithms or even Swarm Intelligence, Ant Colonies, Particle Swarm Algorithms (PSO), Self-Organizing Maps (SOM), Multi-Layer Perceptrons (MLP), Radio Basis Function Net (RBF), or Negative Selection Algorithms, Clonal Expansion, among others. In other words, it is a technology capable of building adaptive control models, in which cognition and evolutionism combine, directing the execution of tasks in dynamically changing environments (MONTEIRO *et al.*, 2020).

The modern web is a powerful sensor that allows you to understand in real-time what is happening in the world, thanks to access to reliable and secure sources of information from around the world, in several languages. Also considering that through this information from the web it is possible to measure temperature, humidity, the amount of rain, speed, and wind direction in a single location. In this way, the data captured by sensors (temperature variation, humidity, rain, and wind, among other aspects) are related to the AI models that predict the weather over time (FRANÇA *et al.*, 2020).

It is possible to apply this technological premise in the case of COVID-19, creating a kind of platform that monitors the global media from almost every corner of all countries in printed, broadcast, and web formats, in more than languages, comprehensively.

In this sense, Computational Intelligence is a branch of AI, related to Bioinspired Computing, Natural Computing and Soft Computing, allowing to study specialist systems, neural networks, genetic algorithms, fuzzy logic, hybrid systems, among others, each having its application including inference human (related to the conclusions that the human being draws, based on the knowledge he has), a theory of evolution, neurons, a study of language processing and even combinations of techniques (CHEN; LI, 2018; KRUSE *et al.*, 2016).

Computational Intelligence considers the study of imprecise or imprecise solutions, given the characteristics of neural networks that seek to represent and recognize predetermined patterns, or even the fuzzy logic trying to simulate decision making when it finds an environment that it cannot control, full of uncertainties and inaccurate readings of the real situation (CHEN; LI, 2018; KRUSE *et al.*, 2016).

From this, it is possible through a neural network to process and analyze the characteristics extracted from the collected data and to give a different weight to each one (between its connections through layers), according to the greater or lesser frequency in which the given characteristic appears in the dataset. Finding patterns in a gigantic amount of texts, information, and data resulting in valuable knowledge (LEVINE, 2018).

Also related to the potential of an AI tool for data and text mining, enabling the generation and study of the contagion curve adapted to Brazilian conditions, obtaining data that can be incorporated into existing forecast models, and even allowing early warning of the pandemic, especially to hospitals, agencies and healthcare companies. This complementary knowledge and daily dissemination data from Covid-19 around the world extracted from the web, or Data Repository from reputable educational institutions around the world, i.e., sources with reliable data, about the epidemic regarding “when it happened”, “what happened”, and “where it happened” support experts in evaluating initiatives to combat the pandemic (DAGNINO *et al.*, 2020).

4 I TECHNOLOGIES EMPLOYED

4.1 Natural Language Processing

The techniques of Natural Language Processing (PLN) related to the study of the interaction between machines and human language, combined with machine learning techniques allowing AI to extract data and information that are inserted in scientific articles, journalistic texts, tweets, social media post, or other documents related to COVID-19. Making it possible to develop a database made available in order to help doctors and researchers to find scientific production related to pandemics. Or the tool can also be used with the objective of investigating and analyzing the public at events related to coronavirus and COVID-19, focusing on feelings and emotions related to social isolation and quarantine (OYEBODE, 2020).

Or even by means of chatbot derived from algorithms capable of recognizing voice patterns, it is possible to avoid the initial contact with the health professional, avoiding the spread of the virus, and carrying out a screening enabling subsequent safe referral to a health professional. The PLN technique allows the prevention of contagion and even allows

action in initiatives through telemedicine (ALAG, 2020).

4.2 Computer vision

Computer vision is the technology-centered on analysis of exams and diagnostics processed by a digital image, allowing the availability of image banks for training, involving AI techniques of image processing and machine learning, allowing the creation of data repositories about the coronavirus with visual information, powered by hospital labs and educational institutions around the world (CHEN; LI, 2018).

Through this technology, it is possible to develop an algorithm for detecting pneumonia in lung images, and even creating a dataset that allows the identification of diseases in lung scans. In terms of prevention, computer vision technology made it possible to predict the virus's migration elsewhere, even before the outbreak was communicated to other countries. For that, algorithms with PLN have used that identified different patterns, representing possible epidemic outbreaks in those determining regions (KRUSE *et al.*, 2016).

4.3 Machine Learning

Through the use of Machine Learning algorithms capable of generating, tracking, and optimizing computationally with a high probability of success, making it possible to generate millions of possibilities of therapeutic antibodies with a focus on trying to find treatments for Covid-19 more quickly (LI *et al.*, 2020).

With these algorithms, it is possible to digitally identify antibodies that can fight the virus in less time, since this type of antibody discovery in a laboratory can take years. The technology brings a significant reduction in the time and cost required to identify promising antibody candidates, given the reduced likelihood of failure to discover new drugs in the laboratory. Pondering the average prospect of years and millions of dollars to discover and optimize these antibodies in a laboratory, considering that it is best to fail the computer as much as possible to reduce the possibility of failure in the laboratory (KANNAN *et al.*, 2020).

Considering that in the face of the pandemic scenario, the search for new molecules in medicines is strategic, and subject to safe and reliable evaluation in a digital environment, it is possible to achieve clinical tests, with human patients, in a short period of time, compared to the process normal drug discovery. Also listing the promotion of therapy, diagnostics, and vaccines as soon as possible (RANDHAWA *et al.*, 2020).

4.4 Deep Learning

The application of Deep Learning techniques using convolutional neural network architectures allows the resolution of the problem of classification of x-ray images of people with pneumonia, helping in the pre-diagnosis of COVID-19, which can become a possible method of screening patients. However, it is worth mentioning that it is necessary to have a good data set, with many samples, border cases, metadata, and different images, so that Deep Learning models generalize this database, so that it has characteristics to make accurate predictions in relation to data new and unknown (LIANG *et al.*, 2020).

Through this type of technique, it is possible to predict the risk of patients having an aggravated health condition, allowing healthcare professionals to calculate the probability of

the infected patients' health condition getting worse in a matter of days, using variables such as age, comorbidities, and others. Or, used together with Machine Learning techniques, it is possible to develop a tool to make predictions about the spread of COVID-19 (LIANG *et al.*, 2020).

5 | COMPUTATIONAL INTELLIGENCE TOOLS USED TO COMBAT THE PANDEMIC

The study by Seyed Mohammad Ayyoubzadeh and collators aimed to predict the incidence of COVID-19 in Iran. To do this, the data were obtained from the Google Trends website. Subsequently, linear regression models and long-term memory (LSTM) were used in order to estimate the number of positive COVID-19 cases. All models were evaluated by means of 10-fold cross-validation and the Root Mean Square Error (RMSE) was used as a parameter for performance analysis. As a result, the model developed showed the ability to predict incidence with an RMSE of 7,562 (SD 6.492). This result considered the use of incidence data on the previous day, frequency of washing, and hand disinfection (AYYOUBZADEH *et al.*, 2020).

In addition, the study has that artificial intelligence can be seen as a strong ally in combat the disease, not only in terms of data prediction but also as an aid in choosing medical drugs. It is important to note that, until now, a WHO (World Health Organization) has not approved any pharmaceutical protocol as being the most ideal and effective against the virus. Currently, the reuse/repositioning of medicines has been studied, in order to use drugs already known to treat emerging diseases such as COVID-19. This is because reusing drugs can dramatically reduce development times and costs. Artificial intelligence (AI) and related areas are compatible with high-tech applications to suggest new therapeutic techniques with low error rates (ZHOU, YADI *et al.*, 2020)

Studies have pointed out the great need for the development and use of "emergency ML (Machine Learning)" in order to increase clinical decisions, based on vital signs collected in real-time, results of laboratory tests, use of medicines by the patient, and comorbidities. In this way, the use of forecasting tools shows how base models can be implemented during a COVID-19 pandemic to guide hospitals and health administrators to make decisions. In this period when there is an overcrowding of beds, it is essential to consider the tiredness of health professionals who may make erroneous decisions based on their physical, mental, and psychological tiredness. The use of machine learning eliminates variables of human nature and tends to make more accurate decisions (ZHOU *et al.*, 2020).

Through AI it is possible to identify symptoms, seeking new solutions to diagnose and treat Covid-19. Through AI solutions, it is possible, through chatbot and voice assistant, to clarify doubts about the symptoms of the disease on a smartphone, guiding the population in relation to Covid-19, avoiding an overload of emergency rooms. Through these chatbots, which are programmed algorithms, simulating a human conversation in a chat, it is possible to make repetitive tasks such as frequently asked questions, it is possible to interact with the user by text message (MINER; LARANJO; KOCABALLI, 2020).

Artificial intelligence can also be used to predict the occurrence of deaths, seeing that this type of technological solution applied to Covid-19 (based on machine learning)

aims to anticipate the risk of a person dying, based on information about their condition clinical data, and data such as age and pre-existing diseases. By analyzing hundreds of cases of patients who have already died from the disease, the tool is able to establish comparison standards and determine which conditions can put a person at greater risk of succumbing to the disease (WANG *et al.*, 2020).

6 | DISCUSSION

Considering all the improvements that the systems based on artificial intelligence are necessary before supplying the system with a volume of data, that is, the more information feeds the system, the greater the ability to define standards, resulting in quality even more determinant for the effectiveness of the tool. Considering that it is possible to have reliable data for these algorithms, it will be possible to conclude a viable tool to support clinical decisions during this wave of the pandemic, or even other possible ones in the future.

Or in which it is possible to perceive that AI solutions through the use of algorithms study the protein structures of Sars-CoV-2 from the amino acid sequence, generating fundamental knowledge to understand the behavior of the virus in the human organism and what actions can be done to fight it. In this sense, artificial intelligence has great potential in the implementation of new techniques of bioinformatics, medical informatics, evidence-based medicine, industry 4.0, and health 4.0.

However, to reach this point it is necessary to remodel the medical areas, with total digitalization and safe storage of all data generated by patients. It is necessary to consider that these data come from human beings, so the whole process of collecting, storing, manipulating, and transmitting them, respect the ethical standards of each country.

Currently, artificial intelligence tools linked to the geolocation of cell phones of the population have been employed with ferocious metrics of adherence to quarantine, social isolation, and social distance. This type of analysis of information is not individualized, as individualization can be interpreted as a violation of probity and the like. The geolocation of smartphones is released through a cooperation agreement with telephone operators that monitor the displacement of the population in real-time. This information is presented, in general, in the form of a “heat map” indicating the points of greater or lesser population concentration by location, at different times of the day, not identifying the user individually. It is admitted that much still needs to be discussed about user security and privacy protocols, but this methodology can be seen as an attempt to flatten the contagion curve of the virus.

Thus, the AI tools, in addition to alerting to agglomerations dangerous to contagion, allow the monitoring of the flow of people in basic health units and hospitals, even those who die. Enabling technology to assist the government with the necessary knowledge where the highest concentrations of cases of the disease are found.

Evaluating the algorithm based on AI tools can help doctors look at the situation from different angles, helping them to make a more just and effective decision, easing the burden of resolution. However, it is important to emphasize that these instruments serve to support medical decision-making, and not to replace the medical clinical judgment made by the qualified professional.

7 | CONCLUSIONS

In the modern contemporary world, algorithms are capable of managing a huge number of data including geolocation and the use of card purchases, or determining the path of an infected person and, thus, breaking the chain of contagion. That is, these algorithms are fed by this data produced by AI solutions applied to data mining, generating complementary knowledge to the existing models.

Still pondering that AI has played a significant role in medicine and health, gaining prominence in the wide media related to support initiatives using this technology in the fight against the pandemic. Assessing that from the moment that the pandemic COVID-10 began to spread around the globe, some initiatives gained notoriety, presenting data that could be used by AI algorithms.

These algorithms fed with information about what happened (how, when, where, and with whom) have been enough to make good advances in relation to collecting data on the COVID-19 incorporating existing prediction models. As the pandemic contamination curve, fed with information combined with official infection data resulting in a contamination model for the next few days, which changes as new events emerge

Through computational intelligence it is possible to add the events, collecting and presenting updated data of the pandemic around the world so that it can be processed by other solutions using AI. Allowing the prediction of more cases or even more infections, given that still with little data available concerning each country, it is possible to statistically validate the technology that has been allowing this predictive analysis over the past months.

Still pondering about the AI paradigm break related to the factor that technology started to learn based on examples and feedbacks, and no longer because of the explicit need for programming. Since it is used in the fields of health, it can operate in association with the tabulation of data mining, collecting and presenting updated data on the pandemic around the world so that it can be processed by other solutions using AI, or even text mining.

In this sense, this technology used in public health can help to improve the understanding of COVID-19, serving as a decision support tool to mitigate pandemics. Informing the public and even assisting in the formulation of policies in order to guide a response to the fight against the pandemic, improving care and saving lives.

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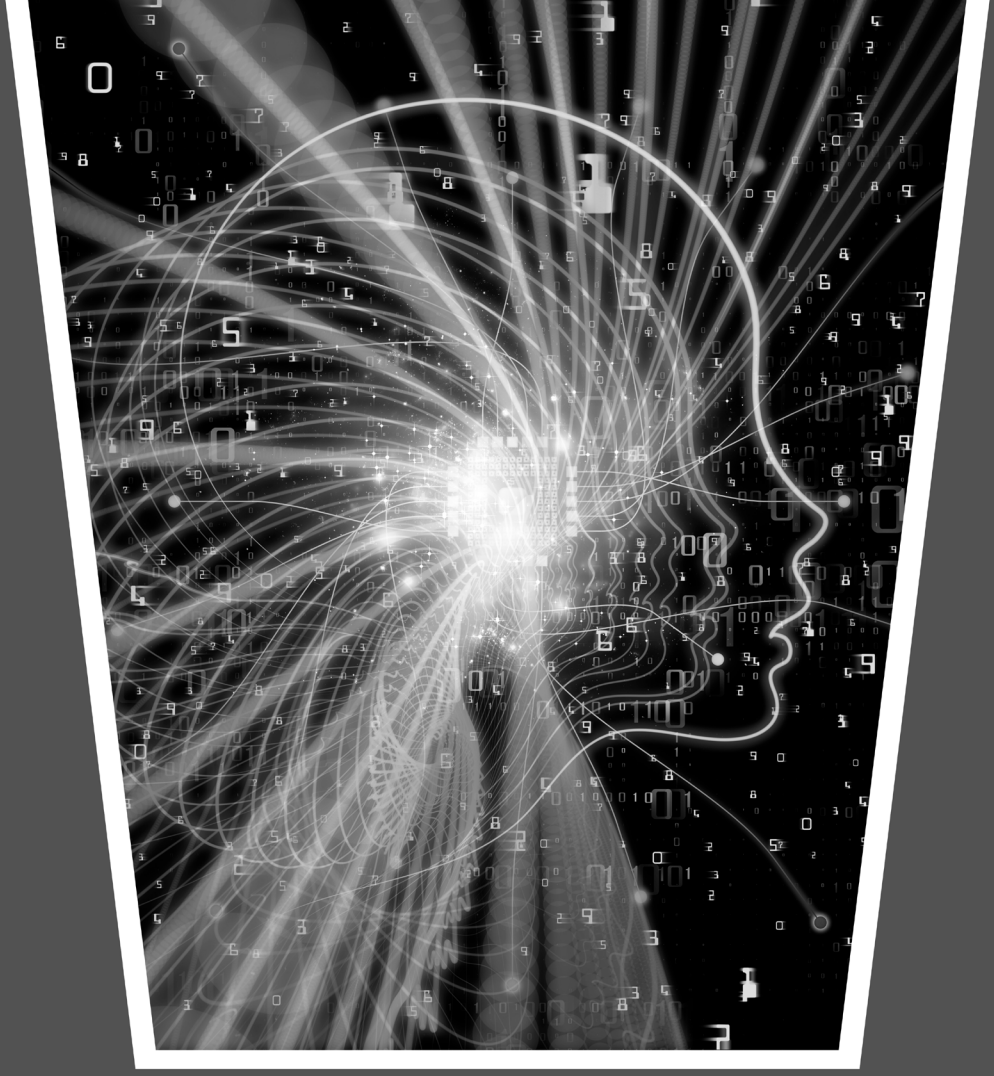

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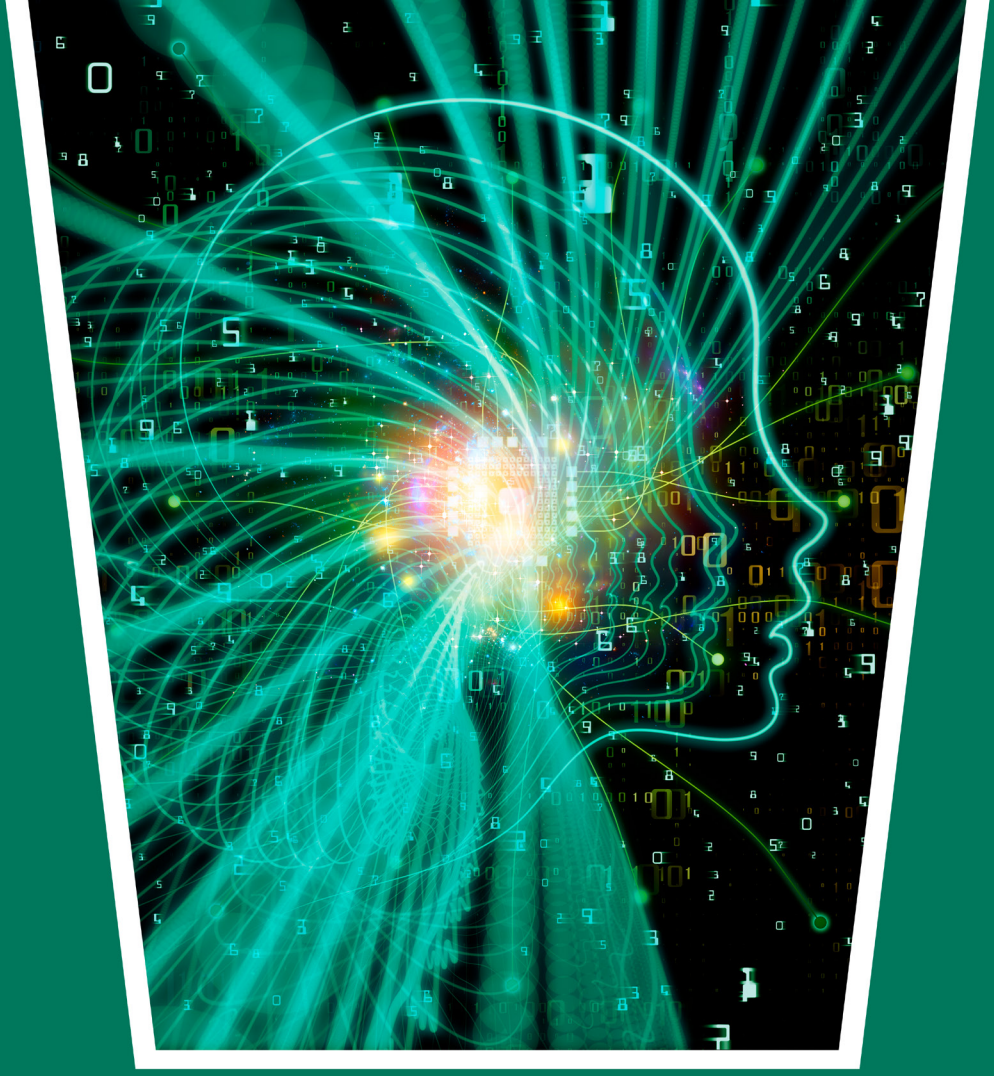

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