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Editorial: A Brief Panorama of Artificial Intelligence in Mexico

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Abstract. Artificial Intelligence (AI) allows that computer-based systems learn from experience and perform a task similar to how humans would. Currently, Mexico is considered one of the Latin American countries with significant progress in adopting technologies related to AI. In this paper, we present a summary of what is happening in Mexico regarding AI. First, we introduce the concept of AI. Second, we present a timeline and speak about the Mexican society of AI and the related conferences and journals. Then, we present the academic programs and the challenges of AI. Finally, we present the conclusions.

Keywords: Artificial Intelligence, SMIA, COMIA, MICAI, CINIAI, Komputer Sapiens.

1 Introduction

Sixty-six years have passed since, in 1955, John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon published the proposal for the summer research project on Artificial Intelligence (AI) at Dartmouth College (Hanover, New Hampshire, USA). The proposal established that for two months, ten men conduct studies related to AI based on the conjecture that every aspect of learning can, in principle, be so precisely described that a machine can be made to simulate it. The proposal for the research project was the first time that the term AI was used [1]. AI deals with some of the phenomena surrounding computers; therefore, it is a part of computer science [2]. Artificial Intelligence is the science and engineering in charge of studying computational models that can perform typical human beings' activities based on two primary characteristics: reasoning and behavior [3].

Since its invention, AI has been consolidating, and today it is a reality in schools, companies, and many real-life situations. There are several examples of the use of IA in our daily life, such as i) AI has been adopted in education institutions to innovate the teaching-learning processes [4]; ii) AI systems have been used to learn the moods and the behavior of people, and with this knowledge, artificial agents are built to serve as therapists [5]; iii) A procedure that autonomously adjusts the equipment settings to keep patients in a hospital intensive care unit in optimal conditions [6]; iv) The use of AI to speed up the creation of COVID-19 vaccines [7]; v) Law enforcement based on AI data analysis and interpretation [8]; vi) The use of intelligent manufacturing system comprising autonomous intelligent sensing, interconnection, collaboration, learning, analysis, cognition, decision-making, and control [9].

Particularly in Mexico, AI has gained attention in the last two decades (2000-2020). Mexico stands out in areas such as Evolutionary Computation, whose prominent leader is Carlos Coello [10]; Robotics and Bayesian Learning lead by Enrique Succar [11] and Eduardo Morales [12]; Artificial Neural Networks represented by Humberto Sossa [13]; Natural Language Processing, where the leading researchers are Grigory Sidorov [14] and Alexander Gelbukh [15]; Robotics and Autonomous Cars by the professor Raúl Rojas [16]; Fuzzy Logic, where the leaders are Oscar Castillo [17] and Patricia Mellin [18]; Pattern Recognition, represented by Ernesto Bribiesca [19]; Computer Vision, led by José Luis Marroquin [20]; Applications of AI to Health by Jesús Favela [21]; Data Mining where many contributions have been presented by Adolfo Guzmán [22], Logics led by Raúl Monroy [23], among others.

In June 2018, the report "*Towards an AI strategy in Mexico: Harnessing the AI revolution*" was published in Mexico. The report summarizes the experience in formulating public policy on AI, estimates the impact of this technology on the Mexican labor market, and describes the opportunities and challenges perceived by 68 specialists in the field [24]. To face the report recommendations, in 2018, the national survey of AI was applied in Mexico to obtain an idea of the perception of the Mexican society regarding the AI concept. In the survey participated more than 20 states from the Mexican republic. As a result, AI main terms were detected, including robots, science, rules, imitators, mind, and computers [25].

In 2021, the National Autonomous University of Mexico (UNAM) director, Enrique Graue, pointed out that the proliferation and diversification of computer technology applications are growing so fast that it is estimated that by 2030 AI will contribute 14 percent of the Gross Domestic Product [26].

Because of the importance of AI in Mexico, we present a brief history of the main events between 1956-2021. We also explain about the Mexican Society of Artificial Intelligence, the related conferences, and the journals. Then, we present the academic programs and the main AI challenges in Mexico. Finally, we present the conclusions of this report.

2 A Brief History of Artificial Intelligence in Mexico

Following a timeline of the main events that occurred in Mexico regarding AI is presented.

1956: Artificial Intelligence term is coined.

1958: The first computer was installed in the Sciences Faculty of UNAM.

1962: The Centro Nacional de Cálculo (CENAC) is created by Instituto Politécnico Nacional (IPN).

1973: The first book related to AI entitled "Introducción a la Informática" was published [27].

1986: The Mexican Society of Artificial Intelligence (SMIA) was created.

1989: UNAM was the first Mexican institution to have access to the Internet.

1991: The Laboratorio Nacional de Informática Avanzada, A.C. (LANIA) was founded, and the first supercomputer was installed.

1994: The Centro de Investigación en Inteligencia Artificial (CIIA) from Universidad Veracruzana was created. Also, the First Master on Artificial Intelligence was proposed.

1995: The Sociedad Mexicana de Ciencia de la Computación (SMCC) was founded.

1996: Adolfo Guzmán receives the National Sciences Award.

1997: Marvin Minsky offers a conference in the International Conference on Computation (CIC). Paul Werbos and Lotfi Zadeh give a speech in The Second Joint Mexico-US International Workshop on Neural Networks and Neuro control.

2000: First Mexican International Conference on Artificial Intelligence (MICAI).

2003: The International Joint Conference of Artificial Intelligence (IJCAI) was held in Acapulco, Guerrero, Mexico.

2005: John McCarthy participates in a conference in MICAI.

2006: Bernard Widrow participates in the First International Conference on Neural Networks and Associative Memories (NNAM).

2007: Universidad Panamericana created the first AI engineering.

2008: First number of *Komputer Sapiens*.

2009: First Congreso Mexicano de Inteligencia Artificial (COMIA).

2012: First Doctoral Program in AI by Universidad Veracruzana.

2015: Academia Mexicana de Ciencias de la Computación (AMEXCOMP) was founded.

2016: Yann LeCun received an Honoris Causa Doctorate from Centro de Investigación en Computación (CIC) and Raúl Rojas from Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE).

2017: The patrimonial cathedras “Humberto Sossa” and “Raúl Rojas” were established in Universidad Autónoma de Ciudad Juárez (UACJ).

2018: Mexico was the first Latin American country to launch a national AI strategy.

2019: The patrimonial cathedra "Humberto Sossa" was established by Universidad del Valle de Atemajac (UNIVA).

2020: IPN creates an AI engineering, and the first of the Simposio Nacional de Inteligencia Artificial e Industria 4.0 (SINIAI) was realized.

2021: UNAM and Huawei create the laboratory for AI development, and the first CINIAI will be held in November.

3 Mexican Society of Artificial Intelligence

The Mexican Society of Artificial Intelligence (SMIA in Spanish) was created in 1986. The mission of SMIA is to promote the cultivation and application of AI in Mexico. The society offers professionals and academics an organizational and management framework that allows sharing and disseminating research projects, teaching, and discipline divulgation. In addition, through the national chapters, the society groups undergraduates, or graduate students whose interests are focused on cultivating any area of AI [28]. The society's work is coordinated by the board of directors, whose members are elected every two years. The logo of SMIA is shown in Figure 1.



Fig. 1. SMIA logo [27].

The first president of the society was Prof. José Negrete Martínez, and since then, great personalities have served as presidents including Raúl Monroy, Humberto Sossa, Christian Lemaitre, Enrique Succar, Alvaro de Albornoz, Ángel Kuri, to mention a few. The current director of the society is Prof. Felix Castro. In 2015, the SMIA Fellow Program was established to reward Mexican researchers who have made significant contributions to AI progress in Mexico. The Mexican professors who have received the award include José Negrete, Alexander Gelbukh, Oscar Castillo, Patricia Melin, Grigori Sidorov, Enrique Succar, Humberto Sossa, and Adolfo Guzmán.

To broadcast the production of the society members, SMIA organizes three conferences in the year, namely the Mexican International Conference on Artificial Intelligence (MICA), Mexican Congress on Artificial Intelligence (COMIA), and the International Conference on Artificial Intelligence and Industry 4.0 (CINIAI). Moreover, SMIA has one divulgation magazine called *Komputer Sapiens*.

3.1 Mexican International Conference on Artificial Intelligence

Springer editorial characterized MICA as a high-level peer-reviewed premier conference covering all areas of AI [29]. MICA arises by the union of the National Meeting on AI and the International AI Symposium. The first edition was held in 2000 in

Acapulco, Guerrero, Mexico. The first proceedings were published in Lecture Notes in Artificial Intelligence (LNAI) and edited by Osvaldo Kairo, Enrique Succar, and Francisco Cantu. Initially, MICAI was held every two years (Merida, 2002, and CDMX, 2004, CDMX) until, in 2005, it was decided to do it annually.

Until today, 19 editions of the conference have been held, and MICAI has become the main forum to present the most significant advances of AI in Mexico and worldwide. Almost all the papers presented in MICAI were published in Springer LNAI, while IEEE published the rest. Moreover, in almost all editions, the best papers were invited to present extended versions to special issues of journals included in the Institute for Scientific Information (ISI) - Journal Citation Reports (JCR). The most recent edition of MICAI was held virtually in CDMX in 2020 and organized by Universidad Panamericana. The proceedings included 77 papers carefully selected from a set of 186 submissions that represents an acceptance rate of 41.3%. The logo of the MICAI conference is shown in Figure 2.

3.2 Mexican Congress on Artificial Intelligence

COMIA is a scientific forum for the Spanish presentation and publication of research work derived from dissertations or projects completed or in process. The congress covers all the topics related to AI, either research or applied. The first COMIA was realized in 2009 in Atizapán de Zaragoza, Estado de México, and since then it is yearly organized [30]. All the papers accepted are published in the Mexican journal named Research in Computing Science.

Due to the pandemic, in 2020, for the first time, COMIA was virtually realized in conjunction by SMIA and UACJ. This edition established a record of attendees and papers received. A total of 124 papers were presented, and 43,250 people participated in the activities. The most recent COMIA was held on May 2021 in Sonora, Mexico. The logo of COMIA is shown in Figure 3.

3.3 International Conference on Artificial Intelligence and Industry 4.0

In November 2021, the first edition of CINIAI will be organized by UNIVA in conjunction with SMIA and SMCC as an effort to recognize AI as a detonator of industry 4.0. The conference aims to establish the basis that contributes to the relationship between the academy, government, industry, and society to consolidate industry 4.0 [31]. It is essential to highlight that the conference is part of the cathedra "Humberto Sossa." All the accepted papers will be published in Research in Computing Science Journal. The logo of CINIAI is shown in Figure 3.

CINIAI is the result of the internationalization of the SINIAI conference virtually held in 2020. A total of 30 high-quality papers were published in the journal Research in Computing Science.



Fig. 2. MICAI logo [29].



Fig. 3. COMIA logo [30].



Fig. 4. CINIAI logo [31].

3.4 Komputer Sapiens

Komputer Sapiens is a journal from SMIA for the scientific dissemination in the Spanish language on topics related to AI. The magazine is aimed at decision-makers and a broad audience of readers of various profiles, such as students, professors, and researchers. Today, CONACYT included Komputer Sapiens in the index of Mexican journals for scientific and technological dissemination. The current editor-in-chief is Prof. Karina Mariela Figueroa Mora.

The first volume of Komputer Sapiens was published in October 2008, and since then, it has tried to publish at least two volumes per year up to the present. One of the authors of this editorial had the pleasure of publishing, in the first issue, an article about neuro symbolic hybrid systems [32]. The first cover of the magazine is shown in Figure 5.



Fig. 5. Cover of the first issue of Komputer Sapiens journal [30].

4 Academic Programs

There are only two universities, one public and one private, that offer Engineering on AI in Mexico. Moreover, only two institutions offer the Master on AI, and one institution offers the Doctoral program. Following, we offer a brief description of the five academic programs on AI.

4.1 Graduate

Instituto Politécnico Nacional (IPN) was the first public institution that offers an AI engineering. This engineering aims to train experts to be capable of developing intelligent systems using methodologies in the different stages of development and applying algorithms in areas such as Machine Learning, Automatic Natural Language Processing, Computer Vision, and Bio-inspired models to meet the needs of different sectors of society through the generation of innovative processes and solutions. The engineering has a duration of 8 semesters and includes subjects such as Big Data, Data Mining, Natural Language Applications, Multiagent Systems, and cloud computing. Currently, the engineering is offered in three locations, 1) Escuela Superior de Cómputo (ESCOM) in CDMX, Mexico, 2) Unidad Profesional Interdisciplinaria de Ingeniería Campus Coahuila (UPIIC) in Coahuila, Mexico, 3) Unidad Profesional Interdisciplinaria de Ingeniería Campus Tlaxcala (UPIIT) in Tlaxcala, Mexico.

Universidad Panamerica is a private university that offered AI engineering. This engineering aims to study the most advanced topics related to computer science and their interaction with the real-life utilizing Augmented Reality, Wearable Computing, Controlled Drones, Machine Learning, Smartphones, and Big Data. The Engineering is offered in Campus Aguascalientes, Mexico, and has a duration of 8 semesters. The engineering includes Optimization and Metaheuristics, Microcontrollers, Software Architecture, Intelligent Agents, Development of Applications for Smartphones, and Natural Language Processing. Furthermore, a graduate of this engineering can obtain a Master in Engineering if he/she takes a specialty in Software Quality.

4.2 Postgraduate

The Master on AI of the Universidad Autónoma de Queretaro was created in January 2016 to train human capital of high academic quality, with knowledge and skills to investigate, design, develop, manage, and supervise AI systems, based on innovative methods and technologies that provide solutions to industrial and health sector demands. The main research lines of the Master are Hardware and Software Development and Biomedical Engineering. The master's is recognized by the National Quality Postgraduate Program (PNPC) as a program of excellence. The program has a duration of four semesters.

The master in AI from Universidad Veracruzana was created in 1994. The program was formed by a collaboration of Universidad Veracruzana and the National Laboratory for Advanced Informatics (LANIA, A. C.). The aim is to provide the students with the theoretical/practical foundations to propose and develop solutions to complex problems in AI research, both basic and applied. The research lines are focused on Learning, Agents and Web Technologies, and Intelligent Robotics. The program has a duration of 4 semesters and is recognized by PNPC as a program of excellence.

The Doctoral Program on AI from Universidad Veracruzana is at the forefront of national and international research on AI. The aim is to provide the tools and knowledge for developing systems based on computer science and AI techniques. The doctorate has a duration of three years (six semesters) and is recognized by PNPIC as a program of excellence.

5 Challenges

Today, the AI community is looking to develop truly intelligent machines that can analyze and recognize patterns, efficiently apply common sense, and have emotions for decision-making. However, many technological challenges must be confronted to implement AI in daily life tasks.

The first one regards the data volume. AI requires thousands of more data than those required by the human brain to understand concepts and characteristics. In this sense, the field of Big Data can be a great ally to analyze, process, and interpret the large amount of information that is generated every day. Otherwise, it will be recommendable to develop AI algorithms that require less data.

On the other hand, it has been proven that AI is efficient in solving a single task such as voice or face recognition. However, AI is inefficient in realizing multiple tasks. Currently, there is no AI that can easily change from one task to other. Hence, it will be desirable to develop algorithms to perform multiple tasks as naturally is performed by human beings. In this regard, the so-called progressive neural networks are being tested as a mechanism to solve complex sequences of tasks.

Despite the great processing capacity of today's machines, AI is still limited by hardware. The robust infrastructure needed to experiment with AI is scarce and expensive. For example, today, a powerful Graphics Processing Unit (GPU) is needed to implement a convolutional neural network (CNN). Therefore, it will be recommendable to implement other computational paradigms such as quantum, neuromorphic, atomic, bacterial, and optic.

A non-technological challenge that must be confronted is the lack of investment destined for the advancement of AI. The little knowledge of the area generates that investors do not dare to risk their capital in AI projects. Moreover, it will be desirable to create public policies about the use of AI in Mexico.

The lack of talent is another of the non-technological challenge of AI in Mexico. It will be desirable to continue developing academic programs in AI. As was mentioned, Mexico have only a few programs related to AI. Better communication between the academy and industry is required to guide the subjects of the academic programs towards the solution of the real problems. Also, engineering such as Data Scientists, Intelligent Systems, and Big Data must be considered.

6 Conclusions

The world is experimenting with a new industrial revolution, and today, AI is strongly influencing jobs in all sectors. AI is changing how we learn, produce, consume, and work. However, there is still much work to do to adopt AI in Mexican daily life. In this paper, we have presented a brief panorama of AI in Mexico, beginning with a timeline and explaining the activities conducted by the SMIA. The efforts made by SMIA to disseminate AI among the academic and industrial community are significant but not sufficient. It is still necessary to invest more in projects and to open more academic programs. We have also discussed the Mexican academic programs, including graduate and postgraduate. In the end, we have explained the main challenges that Mexico must confront to insert AI into daily life.

The main finding of the 2018 Mexican AI survey [25] was that 93% of the respondents expressed interest in AI themes. Moreover, 80% of the respondents considered that AI would have a positive impact on daily life. However, not all the responses were favorable; 53% considered that AI could reduce employment because, with its implementation, some workers could be replaced. Indeed, AI is a technology that effectively solves several problems in almost every sector. However, care must be taken with the ethical implications of its use.

Due to the tremendous technological advances, it will be essential that Mexico continue applying AI in academics and almost all industries and affects every human life aspect. We consider that the countries that can insert AI more quickly into their daily life could have a competitive advantage that could turn them into economic power. We want to conclude with a reflection question: are you ready to use AI in your daily life?

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