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Artículos científicos

Artificial intelligence applied in the aerospace industry and the generation of information

Inteligencia artificial aplicada en la industria aeroespacial y la generación de información

Inteligência artificial aplicada à indústria aeroespacial e à geração de informações

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Abstract

The rise of technologies and the use of artificial intelligence (AI) have given airlines new ways to obtain benefits derived from the data collection of terabytes by aircraft flights. The objective of this research is to analyze the impact that AI has in the aerospace industry and to measure the amount of information (terabytes) that a commercial airplane can collect during its flight, as well as to account for the impact that the COVID-19 pandemic had on the reduction of these flights. The methodology to be used is through a multiple econometric regression with dummy variables to capture the effect of the pandemic, where the preliminary results show a tendency with respect to the number of flights made in Mexico City (discounting the pandemic effect), and therefore an increase in the amount of data that an aircraft can collect.

Keywords: Aerospace industry, artificial intelligence, technology, flights.

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Resumen

El auge de las tecnologías y el uso de la inteligencia artificial (IA) han generado a las líneas aéreas nuevas formas de obtener beneficios derivado de la recopilación de terabytes de datos recopilados por sus aeronaves durante los vuelos. El objetivo de esta investigación es analizar la injerencia que tiene la IA en la industria aeroespacial y medir la cantidad de información (terabytes) que puede recoger un avión comercial durante su vuelo, así como contabilizar el impacto que tuvo la pandemia COVID-19 en la disminución de estos vuelos. La metodología que se usa es mediante una regresión econométrica múltiple con variables dummy para capturar el efecto de la pandemia, donde los resultados preliminares arrojan una taza de crecimiento constante respecto de la cantidad de vuelos realizados en la ciudad de México, (descontado el efecto pandemia) y por ende un aumento en la cantidad de datos que un avión puede recopilar.

Palabras clave: Industria aeroespacial, inteligencia artificial, tecnología, vuelos.

Resumo

O avanço da tecnologia e o uso da inteligência artificial (IA) geraram novas maneiras para as companhias aéreas lucrarem com os terabytes de dados coletados por suas aeronaves durante os voos. O objetivo desta pesquisa é analisar a influência da IA na indústria aeroespacial e mensurar a quantidade de informações (terabytes) que uma aeronave comercial pode coletar durante um voo, bem como quantificar o impacto da pandemia de COVID-19 na redução desses voos. A metodologia utilizada é a regressão econométrica múltipla com variáveis dummy para capturar o efeito da pandemia. Os resultados preliminares mostram uma taxa de crescimento constante no número de voos na Cidade do México (desconsiderando o efeito da pandemia) e, portanto, um aumento na quantidade de dados que uma aeronave pode coletar.

Palavras-chave: Indústria aeroespacial, inteligência artificial, tecnologia, voos.

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Introduction

The aerospace industry it is classified into military, commercial aviation, and space, while artificial intelligence (AI) by its nature is divided into computer vision, natural language, virtual assistant, robotic process automation, and advanced machine learning (Schiliro, 2020). AI is the simulation of methods, techniques, and knowledge trying to replicate a human intelligence by machines, specifically computer systems, then AI is defined as the intelligence exhibited by an artificial entity to solve complex problems (Strong, 2016).

AI has different areas, especially in the fields of medicine, robotics, financial markets, in the aerospace industry, applied from aircraft manufacturing, fleet management, airport operations and defense applications.

The objective of this research is to analyze the impact that the use of AI has had on commercial aviation and airport operations, by measuring the amount of data that a commercial airplane can collect during its flight to increase security of these aircraft, taking as a sample the Mexico City airport.

The scope of AI in the area of airport operations includes aircraft management, use of big data for better decision-making, automated logistics through manned and unmanned aerial flights by commercial airlines this area of knowledge currently denotes a growth in the integration of AI technologies, an example of this is the incorporation of artificial intelligence hardware and software to improve the safety and effectiveness of operations in airline fleets, and thus be able to optimize flight efficiency.

Therefore, in the future, it would be expected that airplanes, when integrated with AI, would have more secure communications networks and improve decision-making processes for pilots, seeking to make air navigation operations more efficient.

Use of AI in the aerospace manufacturing industry

The manufacturing industry is the main engine of a country's economy, currently manufacturing processes are incorporating technological systems, generating more efficient manufacturing models.

The foregoing denotes a change in the life cycle of manufacturing production, mainly in the aerospace industry that incorporates the integration and optimization of various technological aspects, which facilitates the production of aerospace equipment, providing

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greater efficiency and quality in final products, improving competitiveness in the market of this group of companies.

AI is properly applied in the manufacturing field through the intelligent manufacturing system, characterized by autonomous intelligent detection, interconnection, collaboration, learning, analysis, cognition and execution of information throughout the production system. The smart manufacturing technology system mainly consists of general technology, basic platform technology, smart manufacturing platform technology, ubiquitous network technology, product life cycle smart manufacturing technology, and supporting technology (Li et al, 2017).

AI engineering for aerospace applications

AI made its first appearance in the aerospace industry during World War II, facing challenges in incorporating software and hardware into aircraft. Subsequently, the aerospace industry evolved to the point of having unmanned spacecraft and space exploration vehicles, including space robotics (Insaurralde, 2020).

Models and algorithms are fundamental techniques for AI, the most popular of which include support vectors, decision tree, trend prediction, neural networks, and machine learning (Li and Jiang, 2017).

The aerospace industry, due to its complexity, and which is classified as the industry of industries, is ideal for the adoption of AI; Currently, AI applications in this sector include aeronautical engine diagnostics, aircraft preliminary design, aircraft wear optimization, material alloys, etc. It is worth noting the work of Oroumieh et al (2013), in which they demonstrated that fuzzy logic and the neural network help to establish key parameters to reduce the aircraft design cycle time.

On the other hand, aerospace equipment manufacturers have been installing sensors in the manufacture of their engines and airframes in order to use it for the diagnosis and monitoring of component wear. That said, today's planes have thousands of sensors (the Airbus A350 has almost 250,000 of them, which generates around 2.5 TB of data per day (Airbus, 2020), where the key lies in filtering this data. and obtain practical information that is useful (Shukla, Fan, and Jennions. 2020).

Consequences of COVID-19 in the aerospace industry

The COVID-19 crisis has affected companies, technologies, and above all the global economy, and although to a lesser extent its impact is still ongoing; where the most affected industries were manufacturing, tourism and aviation, this was consequence of the closure of borders that limited trade, thus reducing the supply and demand of goods and services (Sharifi, Ahmadi and Ala. 2021).

During the COVID-19 pandemic, the aerospace industry experienced a contraction, where the flights of commercial airlines, and in general the activity of airport operations, were drastically reduced due to restrictions on national and international travel to reduce the spread of the virus. COVID-19. Therefore, the development of AI applications in the aerospace industry was affected by the decline that the airlines had in their income, since by not requiring new aircraft fleets, the assemblers had to stop their production, generating a vicious circle. in which there were no incentives to invest in technological development and the use of AI in this industry.

AI in the application of the aviation industry

There is a currently technological revolution, characterized by the rapid development of AI, where today, there are various types of technology that are a fundamental part of companies, AI is a necessary tool for the development of new technological options. in different industries, and in the case of the aeronautical industry, AI aims to revolutionize safety and efficiency in each of the operations, from air traffic management to the flight of unmanned aircraft.

AI is the ability of machines to imitate the cognitive functions of humans and having the ability to learn. And talking about AI in the aerospace industry is talking about 4 moments: in the first moment it is the most basic, it is the simple interaction of the pilot and the key systems, the second consists of the collection of big data, then it involves optimization of intercommunications, and the fourth stage corresponds to autonomous systems, that is, safe unmanned flights.

The collection of big data is a fundamental part of the aviation sector as one of the industries that generates and processes data the most. In an interview, Gutiérrez (2019), president of Airbus Spain, indicates that a modern aircraft collects 10 gigabytes of data for each hour of flight per aircraft, showing that if this amount is multiplied by the total number of aircraft flying in the world, it is possible to record approximately 400 terabytes of data per

hour, and that making a comparison with Facebook, it processes about 500 terabytes of data per day (Zamora, 2016).

Methodology

Empirical studies in economics are usually conducted using econometric techniques. These are made up of various elements, among which mathematical economics, probability and statistics stand out, as well as the analysis of economic databases to study and quantify economic phenomena through real data, thus providing indications on the relevance of economic theories.

In order to understand the behavior of the number of flights recorded by the Mexico City airport and the effects of the COVID-19 pandemic on them, the present study is based on multiple linear regression analysis, which is a statistical technique to test hypotheses and causal relationships between variables based on their analysis in time series, where each observation presents an attribute that allows its categorization; from which we can identify which independent variables Xi (causes) explain a dependent variable Y (effects), to predict their behavior based on growth rates. The ß coefficients will designate the increase or growth rate due to the increase in the corresponding explanatory variable. Therefore, these coefficients will indicate the weights corresponding to the measurement units of each variable Xi.

For the present investigation, variables such as the total number of flights departing and arriving at the Mexico City airport, the time itself denoted in months, and a binary qualitative variable of ones and zeros to capture the effect of COVID-19 will be analyzed. Then we will determine the increase in the number of flights, so our model is expressed in the next expression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u$$

Where:

Y = Number of flights entering and leaving the international airport of Mexico City.

X_1 = Time measured in months.

X_2 = Dummy quantitative variable, 1 for the duration of the pandemic and 0 for not.

Once the growth in the number of flights is projected, we will proceed to see the amount of information (terabytes) that a plane that departs or arrives at the international

airport of Mexico City can collect, under the premise that, for every hour An airplane flight collects approximately 10 gigabytes of data. Then we have that the shortest flight is from Mexico City to the Bajío airport in Guanajuato in 1:12 min, and the longest flight from Hong-Kong to Mexico City with approximately 15 hrs, and under the Assuming that the total number of flights is distributed as a normal with mean μ and variance σ2, then the average number of hours an airplane travels to or from Mexico City is 8 hrs.

Results

Table 1. Multiple regression model to determine the growth rate of the number of flights at the Mexico City international airport, discounting the effects of COVID-19.

Variable	Coefficient
Constant (C)	33,196.38***
Time (X_1)	35.4586***
COVID-19 (X_2)	-13,407.97***
R^2	0.52222

Own elaboration in E-views based on the AICM 2012-2022

Note: ***significant at 1%, **significant at 5%, *significant at 10%.

From the Table 1 the intercept (the point of origin), that is, the constant C, indicates the starting value, since this quantity is independent of the other variables, that is, when all the variables are worth 0, Y will be worth 33,196.38 flights, so the international airport of Mexico City begins with favorable conditions in terms of airport operations.

Analyzing the variable X1 in terms of economic analysis, we can infer that for each month that passes, the number of flights at the Mexico City airport increases by 35.4586.

Analyzing the variable X2 in terms of economic analysis, we can infer that this value determines captures the effects that the flights that were lost at the international airport of Mexico City had due to the pandemic, giving us to understand that COVID-19 brought the loss of 13,407.97 flights.

Also we can see that the value of the R-square = .52222, remembering that this value oscillates between 1 and 0, and being closer to 1 indicates a greater efficiency of adjustment of the model, so in general terms it can be inferred that the model fits to a good extent.

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Then, for each hour of flight of an airplane, it collects 10 gigabytes of data, and since an airplane that arrives or departs from Mexico City, makes 8 hours of flight, so it will give us a total of 80 gigabytes of data by plane, therefore, we will have the following data collection for subsequent years given the number of flights projected for the following years, remaining as follows:

Table 2. Terabytes generation per year in relation to flights made to or from Mexico City.

Year	Flights	Hrs per flight	Terabytes collected
2023	457,289	3,658,310	36,583
2024	462,395	3,699,158	36,992
2025	467,501	3,740,007	37,400
2026	472,607	3,780,855	37,809
2027	477,713	3,821,703	38,217
2028	482,819	3,862,552	38,626
2029	487,925	3,903,400	39,034
2030	493,031	3,944,248	39,442

Own elaboration with the projection made based on Table 1

From Table 2 affirms that on average per year the flights that arrive and depart from the international airport of Mexico City have a constant growing rate and that they can generate an average of about 38,013 Terabytes per year.

Discusion

Lara et al. (2017) said that the aerospace industry has experienced considerable growth, as has the development and application of autonomous systems, fostering significant advancements in their implementation and control systems. This aligns with the research presented, since further development of this industry will lead to greater technological innovation, increasing the autonomy capabilities of control systems to the point of achieving autonomous commercial flights. This is already a reality in ground transportation systems, as exemplified by Tesla's self-driving taxis.

Furthermore, Moreno et al. (2024) concludes that at a conceptual level, technologies associated with artificial intelligence and aerospace are considered to have high growth potential due to their dynamic scientific development.

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Conclusions

AI was created with the objective of reproducing human minds, that is, that machines can think and do things like a human with the advantages that their decisions are based on facts and not on emotions, and that in turn the AI has a greater speed in terms of the dissemination of knowledge.

The AI applied to the aerospace industry and mainly in commercial flights, as the results indicate in the case of Mexico City, the planes that take off and land at this airport, it is expected that by the year 2030 there will be 493,031 flights. and these can collect about 39,442 terabytes of information, now if we consider the set of all airports and the number of flights that cross the sky per day, the amount of information that can be collected is abysmal compared to technology companies, compared to the case of Facebook. Therefore, this research leads to the development of works that replicate the measurement of the amount of information that can be collected if each flight from each airport in the world is counted.

In conclusion, with the amount of information collected, safety can be increased, errors minimized, and waiting times between flights reduced; but for this to be possible, all the data collected through information and operational technologies must be integrated and managed in a way that is useful. Therefore, AI technology not only has the advantage of reducing costs by improving fleet availability (avoiding flight delays and cancellations), but also improves efficiency, and ensures safety.

Future lines of research

AI is a forefront topic that is still being understood due to its widespread use across all sectors, especially transportation. Future research could explore how, the more data collected and analyzed during air accidents, the more patterns can be found to prevent and detect future failures, as well as to identify the environmental conditions in which air accidents are most likely to occur.

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