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# Publicaciones de alto impacto

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Publicaciones de

# Alto impacto

El Departamento de Ingeniería Industrial considera de vital importancia compartir con el público los resultados de investigación de excelencia alcanzados por nuestros docentes. Estos logros representan un motivo de gran satisfacción para nuestra comunidad académica. En esta décima edición, se presentan las publicaciones correspondientes al año 2023, las cuales reflejan la amplitud, relevancia e impacto de la Ingeniería Industrial. Para su inclusión en esta revista, es necesario que dichas publicaciones cumplan con los rigurosos criterios establecidos por Minciencias para ser reconocidas como de "alto impacto" en la producción académica y que se resumen a continuación:

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# “Majority networks and local consensus algorithm”

1 de febrero de 2023



**Pablo Medina**

Eric Goles

Julio Santiváñez

**scientific** reports

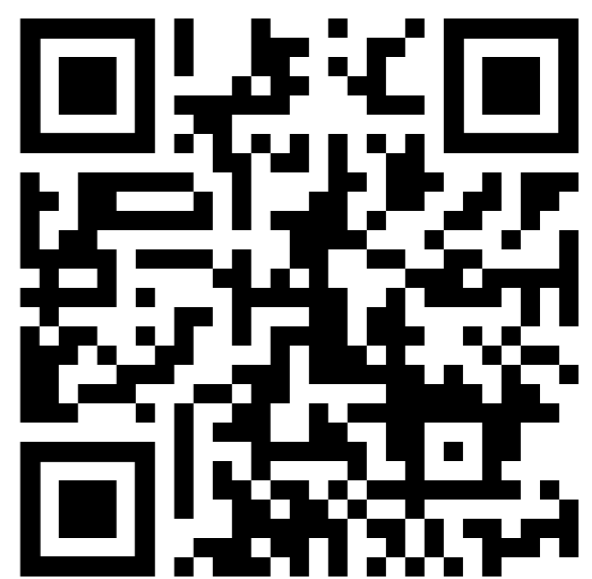
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# OPEN Majority networks and local consensus algorithm

Eric Goles<sup>1,4</sup>, Pablo Medina<sup>2,3,4</sup> & Julio Santiváñez<sup>1,4</sup>✉

In this paper, we study consensus behavior based on the local application of the majority consensus algorithm (a generalization of the majority rule) over four-connected bi-dimensional networks. In this context, we characterize theoretically every four-neighbor network in its capacity to reach consensus (every individual at the same opinion) for any initial configuration of binary opinions. Theoretically, we determine all regular grids with four neighbors in which consensus is reached and in which ones not. In addition, in those instances in which consensus is not reached, we characterize statistically the proportion of configurations that reach spurious fixed points from an ensemble of random initial configurations. Using numerical simulations, we also analyze two observables of the system to characterize the algorithm: (1) the quality of the achieved consensus, that is if it respects the initial majority of the network; and (2) the consensus time, measured as the average amount of steps to reach convergence.

Several new technological and social collective phenomena have emerged as a consequence of many interacting elements' dynamics. An example of this is *consensus*, a phenomenon in which the macroscopic state of the whole system is produced when all elements of the system exhibit the same microscopic state, which may explain the emergence of the leading majority over a population of individuals. In this sense, blockchain-based applications<sup>1–4</sup>, dynamics of opinion formation<sup>5–12</sup>, physiological and ecological systems<sup>13–15</sup>, gene networks<sup>16–18</sup>, and transportation<sup>19–21</sup>, among others, are examples of the landscape of systems in which these majority dynamics emerge.

Even though there are various approaches to modeling these dynamics in the literature, the most common mechanisms are related to considering the local majority. Henceforth, there are two possible opinions (or states) that every individual (represented by an agent or a node in a network or cellular automata model) may assume, namely +1 and –1 in a mathematical formulation; in a resemblance to the Ising spin model of Statistical Mechanics to study magnetism<sup>22</sup>. Then, every individual interacts locally with individuals in his/her neighborhood, assuming the most common opinion in this set, and in case of a tie, the individual keeps his/her status unchanged. This procedure is carried out by selecting one individual randomly and repeating until dynamics reach an asymptotic state. Two of the most interesting asymptotic states are those in which the whole population assumes the same state, namely the states +1\* (all individuals have +1 state) and –1\* (all individuals have –1 state), in our notation. We denote any of these situations as *consensus*. In addition, other fixed points different from the consensus ones may emerge, namely for this work *spurious points*, in which the two opinions appear once the asymptotic state is reached.

Beyond different variations of the evolution rules and other algorithmic details, in a nutshell, the body of research that considers the majority rule algorithm may be divided roughly into two wide categories: one in which agent connections are changing as the system evolves<sup>23–25</sup>, and the other that considers static networks, in which vertex's neighborhoods remain invariant in time<sup>6,7,26</sup>. In a physical interpretation, the first category represents the interaction of particles in a “gas”, where individuals are colliding with others varying their interactions as the system evolves. This model has been studied experimentally in NKN's white paper<sup>25</sup>, in which every individual interacts only with a fixed number of individuals chosen randomly in each simulation step. The recurrent evolution of the system under this rule guarantees the capacity to achieve consensus. As for the second category, it may be thought of as a “crystal model”, where particles interact in a fixed network, so with fixed vicinity. This approach may be interpreted as automata networks with the local majority function<sup>27–30</sup>. Research of these models has provided a variety of important results attained to complex topologies (i.e., Erdos–Renyi graphs, Watts–Strogatz graphs, Barabasi–Albert graphs, cellular automata), which show how consensus dynamics appear in every type of

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# “A Drought Index as a Way to Improve Hedging Effectiveness for Copula Insurance Models”

10 de febrero de 2023



**Adriana Lourdes Abrego Pérez**  
**Carlos Felipe Valencia Arboleda**

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## A Drought Index as a Way to Improve Hedging Effectiveness For Copula Insurance Models

### Abstract

Copula methods for the yield-index relationship estimation are current ways of overcoming the drawbacks of OLS-based index insurance models. This paper examines the risk-reducing effectiveness of two weather-related index insurance models. We compare a bivariate copula taking into account five weather regions that represent regular, excessive, and extreme weather conditions and a simple piecewise linear model. The study aims to demonstrate how a copula structure with dynamic quantiles for drought, flood, and regular crop conditions can outperform current copula and linear index insurance models. Our model is designed to achieve higher hedging effectiveness and lower basis risk values; thus, it is able to derive index insurance contracts that have more affordable fair premiums. Using monthly coffee yield data (2007–2020), climatic water balance, and precipitation indices derived from satellite data, we were able to compare a linear payoff model structure. Next, a bivariate copula approach with four key dynamic quantiles on its structure to capture regular, low, and high climatic conditions was used. For both methods, we measured the marginal expected shortfalls and calculated their hedging effectiveness. Results showed that for the region under study, the bivariate copula approach reached unprecedented hedging effectiveness rates compared to typical copula index insurance models with a single quantile. Compared to linear structures, it doubles rate effectiveness and lowered the fair premiums by one third. This model represents a novel way to model regions that have extreme volatile weather conditions.

**Keywords:** Index Insurance, bivariate copula, quantile regression, SPEI, hedging effectiveness.

This preprint research paper has not been peer reviewed. Electronic copy available at: <https://ssrn.com/abstract=4353828>



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# “Forecasting Agricultural Financial Weather Risk using PCA and SSA in an index insurance model in low-income economies”

13 de febrero de 2023



**Adriana Abrego Pérez**

Natalia Pacheco Carvajal

María Camila Díaz Jiménez



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## Article

# Forecasting Agricultural Financial Weather Risk Using PCA and SSA in an Index Insurance Model in Low-Income Economies

Adriana L. Abrego-Perez <sup>\*</sup>, Natalia Pacheco-Carvajal  and Maria C. Diaz-Jimenez 

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**Abstract:** This article presents a novel methodology to assess the financial risk to crops in highly weather-volatile regions. We use data-driven methodologies that use singular value decomposition techniques in a low-income economy. The risk measure is first derived by applying data-driven frameworks, a Principal Component Analysis (PCA), and Singular Spectrum Analysis (SSA) to productive coffee crops in Colombia (163 weather stations) during 2010–2019. The objective is to understand the future implications that index insurance tools will have on strategic economic crops in the country. The first stage includes the identification of the PCA components at the country level. The risk measure, payouts-in-exceedance ratio, or POER, is derived from an analysis of the most volatile-weather-producing regions. It is obtained from a linear index insurance model applied to the extracted singular-decomposed tendencies through SSA on first-component data. The financial risk measure due to weather volatilities serves to predict the future implications of the payouts-in-exceedance in both seasons—wet and dry. The results show that the first PCA component contributes to forty percent of the total variance. The seasonal forecast analysis for the next 24 months shows increasing additional payouts (PO), especially during the wet season. This is caused by the increasing average precipitation tendency component with POERs of 18 and 60 percent in the first and second years. The findings provide important insights into designing agricultural hedging insurance instruments in low-income economies that are reliant on the export of strategic crops, as is the case of Colombian coffee.

**Keywords:** index insurance; coffee production; low-income economies; Principal Component Analysis (PCA); Singular Spectrum Analysis (SSA); payouts in exceedance (PoE); financial risk measure; Colombia



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## 1. Introduction

Low-income economies are severely affected by climate change, limiting sustainable development [1]. These effects are strengthened in regions with underdeveloped financial services [2,3]. Unusual weather events lead to disruptions in worldwide food security [4]. According to recent studies, the effects of climate change, such as droughts and extreme heat conditions, have reduced the yield of staple crops worldwide by approximately 10% [5,6].

Agriculture in Colombia is one of the most significant socioeconomic sectors, contributing to 7.4% of the GDP [7]. Some of Colombia's main agricultural products are coffee, corn, potatoes, and palm oil, among others. According to the National Agricultural Survey, ENA 2019, the total production recorded was estimated at more than 63 million tons, 67% of which corresponds to the agro-industrial product group [8]. The export of high-value crops such as coffee accounts for a sizeable portion of the GDP total. In 2020, coffee was the third most exported product in Colombia, with a value of \$2.54 billion (about \$8 per person in the US), and was ranked as the fourth largest coffee-exporting country in the world [9]. Nevertheless, according to the World Bank [10], Colombia is highly exposed to hydrometeorological events, known as El Niño and La Niña. These weather events result



# “The Environmental Kuznets Curve hypothesis for Colombia: impact of economic development on greenhouse gas emissions and ecological footprint”

17 de febrero de 2023



**Carlos F. Valencia**

Jorge A. Acevedo-Ramos

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## Article

# The Environmental Kuznets Curve Hypothesis for Colombia: Impact of Economic Development on Greenhouse Gas Emissions and Ecological Footprint

Jorge A. Acevedo-Ramos , Carlos F. Valencia \*  and Carlos D. Valencia 

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**Abstract:** Climate change has become a significant concern for developing countries given the risk that it poses to energy and food independence, and to general productivity. Despite having an energy system with low carbon intensity when compared to other Latin American countries, Colombia is already facing climate change impacts and requires urgent efforts to mitigate them. As a developing country, the challenge is bigger as policies for economic growth should be in line with the global commitment of reducing greenhouse gas emissions. With the aim of contributing to the design of climate policies by using data driven methodologies and scientific evidence, this study assesses the impact of economic development on the environment by examining the validity of the environmental Kuznets curve hypothesis for Colombia. Statistically validated and stable autoregressive distributed lag models are estimated for three different environmental indicators: carbon dioxide emissions, methane emissions, and the ecological footprint. Moreover, the effects of other variables such as urbanization, foreign direct investment, the value added by the agricultural and industrial sectors, and energy use are analyzed with dynamic simulations. To the best of our knowledge, there are no reports of EKC estimation using these variables in statistically validated models for Colombia; thus, this paper adds to the scientific evidence of the EKC hypothesis in developing countries. Empirical evidence supports a long-run equilibrium relationship among investigated variables and the existence of an inverted U-shaped EKC relationship between gross domestic product (GDP) and methane emissions, and GDP and the ecological footprint. The results of this paper show that shifting to renewable energy sources and leveraging the use of cleaner technologies in agricultural and industrial sectors are key factors for economic growth without harming the environment, which has important scientific value because of its evidence-based approach for public policy making in developing countries, particularly Colombia.

**Keywords:** carbon dioxide emissions; ecological footprint; economic growth; EKC hypothesis; environmental degradation; ARDL; methane emissions



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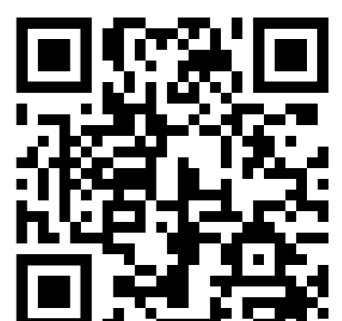


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## 1. Introduction

Climate change mitigation has become a significant concern for both developed and developing countries. The increase in environmental degradation, greenhouse gas (GHG) emissions, and global warming is mainly a result of human activities, and the potential consequences are so dreadful that researchers, leaders, and politicians around the world have begun to prioritize efforts with regard to investigating climate change causes and designing appropriate policies to mitigate its impacts. As international cooperation and global solutions are required, world leaders from almost 200 countries met in November 2021 at the United Nations Climate Change Conference (COP26) and made enhanced commitments to accelerate actions towards the goals of the Paris Agreement, such as limiting the rise of mean global temperature to 1.5 °C.

Reaching global net-zero carbon dioxide (CO<sub>2</sub>) emissions, phasing down coal power, halting and reversing deforestation, switching to electric vehicles, and reducing methane



# “Decision Support for Agri-Food Supply Chains in the E-Commerce Era: The Inbound Inventory Routing Problem with Perishable Products”

23 de febrero de 2023



**Camilo Hernando Gómez Castro**

**David Álvarez Martínez**

Daniel Hernando Cuéllar Usaquén

Marlin Ulmer



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# Decision Support for Agri-Food Supply Chains in the E-Commerce Era: The Inbound Inventory Routing Problem with Perishable Products

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**Abstract.** We consider an integrated planning problem that combines purchasing, inventory, and inbound transportation decisions in an agri-food supply chain where several suppliers (farmers) offer a subset of products with different selling prices and available quantities. We provide a mixed-integer programming formulation of the problem and a matheuristic decomposition that divides the problem into two stages. First, the purchasing and inventory problem is solved. Second, the capacitated vehicle routing problem is solved using a split CVRP procedure. Computational experiments on a set of generated test instances show that the matheuristic can solve instances of large size within reasonably short computational times, providing better solutions than its MIP counterpart. In future work, it is proposed to develop heuristic approaches to validate the performance of the presented matheuristic and to try other routing cost approximations.

**Keywords:** Agri-food supply chain · Inbound transportation · Inventory routing problem · Perishable products

## 1 Introduction

The spread of online shopping through e-commerce platforms has disrupted not only traditional business models but also the supply chains that support them, with a growth of 7 to 10% in European countries in recent years [1]. Consumers now can access a global supply of products that can be delivered to any location within short times. In turn, producers (even small ones) can access competitive markets that were previously attainable only for large corporations with expensive infrastructure for distribution and marketing. These technology-based trade relationships have increased democratization in access to markets and provided efficiencies and convenience for both consumers and producers.

The agriculture sector has especially benefited from these technology-based business models, as small farmers can move away from intermediaries which

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# “Production planning decisions in the broiler chicken supply chain with growth uncertainty”

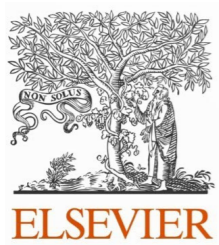
02 de marzo de 2023



**Andrés Leonardo Medaglia González**

Alfaima Lucía Solano Blanco

Jaime Esteban González Jurado



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## Production planning decisions in the broiler chicken supply chain with growth uncertainty

Alfaima L. Solano-Blanco<sup>a</sup>, Jaime E. González<sup>b</sup>, Andrés L. Medaglia<sup>a,\*</sup>

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### ARTICLE INFO

#### Keywords:

Poultry supply chain  
Two-stage stochastic programming  
Lot sizing decisions  
Growth uncertainty

### ABSTRACT

Broiler chickens are specially raised for meat production and their supply chain is composed of breeders, hatcheries, feed mills, farms, slaughterhouses, wholesalers, and retailers. The coordination between supply chain players has great potential to streamline production and increase competitiveness in the market. A critical element in the decision-making process of this agri-system is the weight gain of broiler chickens. Variability in chicken growth patterns can affect production plans in practice. The most efficient weight estimation models require sensors in real-time, which are not available in many companies. Thus, some small farms require a simpler approach to adjust production planning based on the uncertainty of chickens' weight while they transition to new technologies. This research proposes an optimization-based methodology for the integration of farms and slaughterhouses to plan production under chicken growth uncertainty. The methodology includes two models: (i) a two-stage stochastic model that supports lot-sizing and inventory management decisions while considering scenarios of chicken growth uncertainty; and (ii) a mixed-integer linear programming model that supports lot allocation. We present the results of implementing the methodology in a poultry company in Santa Marta (Colombia), where we improved costs by 8.6% while meeting tactical, biological, and biosecurity constraints.

### 1. Introduction

Broiler chickens are especially raised for meat production. In the meat sector, broiler chicken is the second most produced and consumed meat after pork. In 2022, the global production increased by 9% with respect to 2018 for a total of 100 thousand tons [1]. Broiler chickens are considered a cheap source of protein and their consumption is increasing all over the world, especially in emerging economies. Thus, the efficient production of broiler chicken meat is critical for food security and it is closely linked to the sustainable development goal #2 (zero hunger) of the United Nations [2].

The broiler chicken supply chain is mainly composed of breeders, hatcheries, farms, slaughterhouses, wholesalers, and retailers. Fig. 1 shows the broiler chicken supply chain and the inputs and outputs of each echelon. Breeders produce eggs which are an input for hatcheries. Hatcheries produce day-old chickens which are sent to farms. Farms buy feed from feed mills and fatten chickens up until they reach the desired weight to send them to slaughterhouses. Slaughterhouses produce chicken meat products which are commercialized at the wholesale and retail levels.

Production lines in slaughterhouses benefit from a homogeneous size and weight of birds, as it avoids making frequent adjustment setups in the machinery. Markets such as the restaurant industry perceive value on the homogeneity of chicken products. This requirement flows upstream to the farms which control the weight gain of birds along their lives. At the end, farms prefer to send chicken lots to slaughterhouses whose weights deviate the least from the target market weight.

Broiler chicken growth is influenced by factors like the dietary composition of feed and the feed intake [3]. In turn, the feed intake can be influenced by weather, stocking density, and water consumption, among other factors, that may or may not be controlled depending on the infrastructure of the farm [4]. Such is the complexity that the most efficient weight estimation models require sensors in real time [5], which are not available in many companies, specially those located in low- or middle-income countries. Thus, some farms require a simpler approach to adjust production planning based on uncertainty of chickens' weight while they transition to these technologies.

Integrated livestock system models represent whole livestock farms. These models are complex and the interactions among their key components justifies the use of simulation and optimization [6]. Meat supply

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2214-7160/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



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# “Analyzing Sustainable Practices in Engineering Projects: A Systemic Approach”

30 de marzo de 2023



**Catalina Ramírez**

Andrés Acero



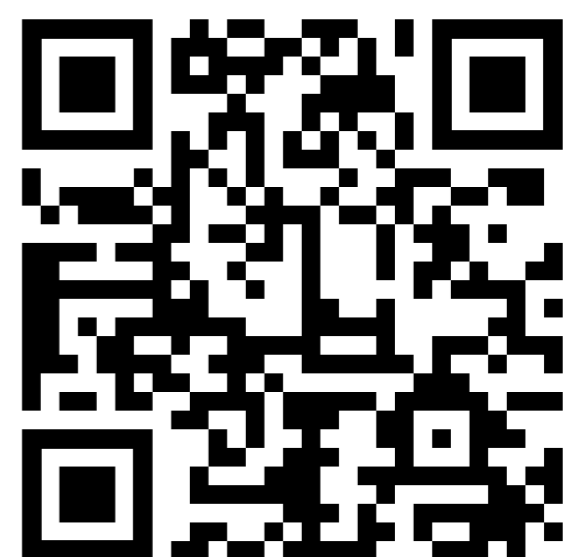
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Article

# Analyzing Sustainable Practices in Engineering Projects: A Systemic Approach

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**Abstract:** The work of an engineer involves the conceptualization, design, and implementation of new and improved artifacts. However, what sets engineering apart from other professions is the direct responsibility of engineers to think critically and design innovative solutions to solve complex problems in social systems. Unfortunately, the solutions often do not consider the dynamics of the environment or the cultures that will receive them, leading to obsolescence due to the lack of technical knowledge of maintenance and repair. This exacerbates the disruptive power of technology in culture and society, leading to a gap in engineering education that needs to be addressed. Critical theories attempt to reformulate the teaching and practice of engineering in social-environmental contexts of vulnerability, utilizing systemic models to anticipate solutions based on possible scenarios. However, these theories do not consider the mental models of professional engineers, relying mostly on educational studies. To address this gap, this article explores a novel approach to the problem of sustainability mindset in engineering by understanding the characteristics and structures of engineering systems of practice and conveying it through causal loop diagrams. The results identify causal loops that reinforce or affect the application of sustainable practices, which can be used as leverage points within the systems of practice structure to improve the performance and interest of engineering students in sustainable development endeavors and promote more professionals working with a sustainable mindset.

**Keywords:** systems dynamics; sustainable mindset; systemic models; professional practice



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## 1. Introduction

The idea of society's well-being and development is not new. For more than 90 years, concern for social problems has been a recurring topic within research, and some of the existing approaches have focused on measuring and creating standards [1]. For example, gross domestic product (GDP), implemented in 1934, or the Multidisciplinary Poverty Index (MPI), established ten years ago, are some of the indicators that exist to measure the well-being of a society [2]. These measurements are used widely as the main driver of comparing countries, regions, and social groups. Furthermore, government and multilateral agencies define policies based on these measures to increase people's well-being. These tools, unfortunately, do not provide a holistic vision for the creation of opportunities for communities and people in vulnerable conditions. For example, with the end of the armed conflict and the signing of peace agreements, a mix of opportunities and challenges has become evident in most of the territories of rural Colombia, and these challenges, if well managed, can help in the elimination of the systemic barriers to having well-being in these areas of the country. However, if Colombia wants to continue moving towards a more just and sustainable society, then the GDP or MPI does not reflect the structural changes required to reduce inequality and unsatisfied basic needs [3].



# “Nature vs. Nurture in Science: The Effect of Researchers Segregation on Papers’ Citation Histories”

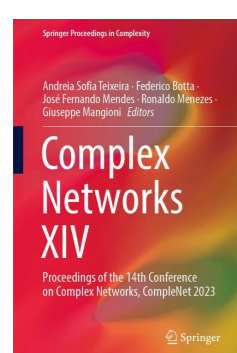
30 de marzo de 2023



**Felipe Montes**

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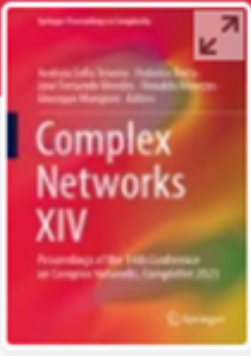
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# Nature vs. Nurture in Science: The Effect of Researchers Segregation on Papers' Citation Histories

[Ana Maria Jaramillo](#) , [Felipe Montes](#) & [Ronaldo Menezes](#)

Conference paper | First Online: 30 March 2023

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## Abstract

Academia is a competitive world where researchers are judged by their productivity, and their strategies to get visibility and success (i.e., number of citations) vary. In addition to conducting rigorous research, there are social strategies that influence authors' and their papers' level of citations. The author's position in the co-authorship network affects the success of their papers. Hence, we want to understand if the authors' segregation in the co-authorship network relates to citations gained by a paper over time. We address this question by examining the patterns in Computer Science from 1975 to 2015 (and citations until 2020) from the Semantic Scholar Open Research Corpus. Specifically, we identify communities in the co-authorship network and classify them into segregation categories and core positions. Then, we compare the citation histories of papers written in those communities. We examine papers written solely by members of the same community (internal) and different communities (external), resulting in the following five categories: internal highly-segregated, internal non-segregated, external highly-segregated, external non-segregated, and external mixed. Our results show that from 1998 to 2010, internal highly-segregated papers gained fewer citations than internal non-segregated and external mixed papers. Also, from 2010 to 2015, external mixed papers gained more citations than internal non-segregated papers and even more citations than internal highly-segregated papers. We also found that in the network nucleus (from core decomposition), there is little difference in the citations of internal non- and highly-segregated papers. In contrast, in the network's periphery, internal non-segregated papers tend to gain more citations than internal highly-segregated papers since 2005. From this work, we conclude that papers written by a more diverse set of authors (measured by their network connectivity) receive more citations over time and that to compensate for the lack of diversity, their authors should be in central positions of the co-authorship network. Hence, this work could incentivise diverse co-authorships and strengthen researchers' cohesion to increase their papers' success.



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# “Towards disaster risk mitigation on large-scale school intervention programs”

31 de marzo de 2023

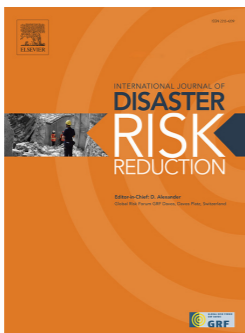


**Andrés Leonardo Medaglia González**

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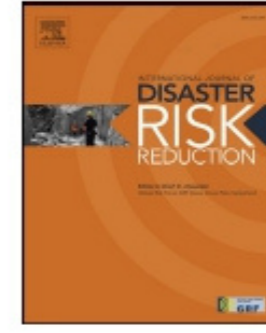
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## Towards disaster risk mitigation on large-scale school intervention programs

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### ARTICLE INFO

#### Keywords:

Disaster mitigation  
Disaster preparedness  
School infrastructure  
Clustering analysis  
Unsupervised machine learning  
Machine learning  
Education

### ABSTRACT

Education infrastructure is one of the main barriers on school quality in Low- and Middle-Income Countries (L&MICs), since it is insufficient and unevenly distributed. Improving the school infrastructure is needed to provide a high-quality education environment. Although research on how to improve the infrastructure is available, there is still a lack of a consistent and systematic approach to develop large-scale interventions at the national or regional level. To fill this gap, we propose a data-driven methodology with the purpose of developing a prioritization of interventions to carry out a seismic disaster risk reduction program. The method starts by identifying groups of similar buildings using clustering analysis, starting with a seismic taxonomy as descriptor (i.e., model input). Then, domain experts analyze the suggested clusters to design scalable interventions for the representative building of each cluster. The proposed data-driven methodology requires experts' criteria in each step to validate the results and make them applicable, but significantly reduces the bias by automating the decision-making process. We use as case study the Dominican Republic public school infrastructure and present the results of the application of the proposed method. The method presented herein is extensible to other infrastructure portfolios, as well as to other types of hazards.

### 1. Introduction

Several barriers affect the education quality in Low- and Middle-Income Countries (L&MICs). The Non-Governmental Organization *Educate a Child* considers school infrastructure as one of nine barriers for high quality education [1]. Likewise, the World Bank argues that quality education should be achieved through five pillars, being one of them, school infrastructure [2]. The critical role that infrastructure plays in education quality has become evident with the COVID-19 pandemic [2]. This crisis has also shown that there is a need for strong institutions in countries to address school infrastructure challenges at a large scale, in a well-structured and systematic way [2]. One of the greatest challenges related to school infrastructure is the safety against natural hazards, and in particular against earthquakes. This criticality is due to the vulnerability of the occupants and the fact that the effect of earthquakes cannot be mitigated through early warning. Therefore, the focus is on how to improve seismic safety in school infrastructure.

Multilateral agencies have been promoting large-scale school infrastructure safety improvement programs at different levels. For

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# “The Role of Data-Driven Methodologies in Weather Index Insurance”

11 de abril de 2023



**Adriana Abrego Pérez**

**Carlos F. Valencia Arboleda**

Natalia Pacheco-Carvajal; Luis F. Hernandez-Rojas;  
Fernando E. Lozano Martinez; Maria C. Diaz Jimenez;  
Juan J. García-Cardenas



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Article

# The Role of Data-Driven Methodologies in Weather Index Insurance

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**Abstract:** There are several index insurance methodologies. Most of them rely on linear piece-wise methods. Recently, there has been studies promoting the potential of data-driven methodologies in construction index insurance models due to their ability to capture intricate non-linear structures. However, these types of frameworks have mainly been implemented in high-income countries due to the large amounts of data and high-frequency requirements. This paper adapts a data-driven methodology based on high-frequency satellite-based climate indices to explain flood risk and agricultural losses in the Antioquia area (Colombia). We used flood records as a proxy of crop losses, while satellite data comprises run-off, soil moisture, and precipitation variables. We analyse the period between 3 June 2000 and 31 December 2021. We used a logistic regression model as a reference point to assess the performance of a deep neural network. The results show that a neural network performs better than traditional logistic regression models for the available loss event data on the selected performance metrics. Additionally, we obtained a utility measure to derive the costs associated for both parts involved including the policyholder and the insurance provider. When using neural networks, costs associated with the policyholder are lower for the majority of the range of cut-off values. This approach contributes to the future construction of weather insurance indexes for the region where a decrease in the base risk would be expected, thus, resulting in a reduction in insurance costs.

**Keywords:** index insurance; crop insurance; machine learning; neural networks; satellite data;

google  
earth engine



**Citation:** Hernández-Rojas, L.F.; Abrego-Perez, A.L.; Lozano Martínez, F.E.; Valencia-Arboleda, C.F.; Díaz-Jimenez, M.C.; Pacheco-Carvajal, N.; García-Cárdenas, J.J. The Role of Data-Driven Methodologies in Weather Index Insurance. *Appl. Sci.* **2023**, *13*, 4785. <https://doi.org/10.3390/app13084785>

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## 1. Introduction

Climate change has resulted in acute difficulties for low-income economies. Extreme weather events, such as droughts or heat waves, can cause crop failures and threaten the livelihoods of farmers and the food security of communities [1]. Mainly, these concerns can be severe due to underdeveloped financial services, where communities have access to limited financial services or even none at all [2]. Crop insurance is a tool that mitigates risk in farmers' investments and is a growing market that reached USD36.6 billion globally in 2021 [3]. Globally, traditional insurance is one of the most widely used forms of protection for farmers, and traditional insurance calculates the indemnity by assessing losses after the occurrence of a weather event. However, it has two main problems: adverse selection and moral hazard [4]. Adverse selection occurs when there is a lack of symmetry in the information prior to establishing a deal between a buyer and a seller. A moral hazard occurs when there are fraudulent behavioural changes that might occur which could likely increase the risk of loss when a person knows that insurance will provide coverage.



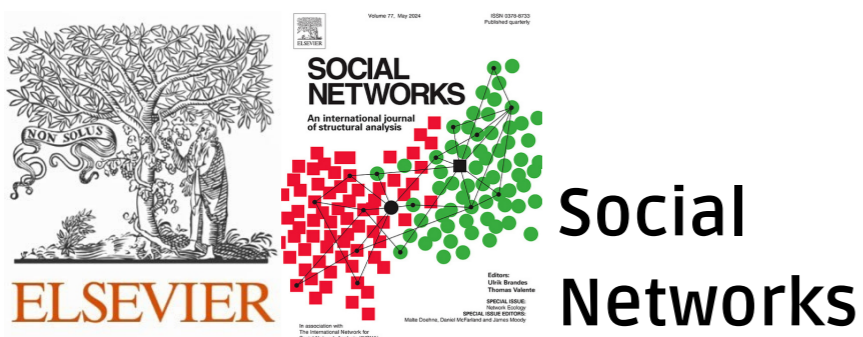
# “Emergence of social support networks among breast cancer survivors through a community-based physical activity program in Colombia”

1 de mayo de 2023



## Felipe Montes

Martha Blanco; Ana M. Guerra; María A. Rubio;  
Carolyn Finck; Abby C. King; Lisa G. Rosas;  
Olga L. Sarmiento



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# Emergence of social support networks among breast cancer survivors through a community-based physical activity program in Colombia

[Martha Blanco](#)<sup>a g</sup>, [Ana M. Guerra](#)<sup>a g</sup>, [Maria A. Rubio](#)<sup>b</sup>, [Carolyn Finck](#)<sup>c</sup>,  
[Abby C. King](#)<sup>d e</sup>, [Lisa G. Rosas](#)<sup>d f</sup>, [Olga L. Sarmiento](#)<sup>b</sup>, [Felipe Montes](#)<sup>a g</sup>  

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## Abstract

Physical activity (PA), social networks, and social support have been associated with decreased mortality and improved quality of life among breast cancer survivors (BCS). This study used social network analysis to understand the social co-benefits of a community-based PA program for BCS in Colombia. Two types of social support networks emerged from the program: friendship (the number of edges increased by 90%) and PA support (35% of participants practiced PA together after the program). Using egocentric and socio-centric analysis we show the presence of homophily for friendship and PA support relations and the BCS's roles in their networks.

## Introduction

The benefits of physical activity (PA) for breast cancer survivors (BCS) are well-documented (Battaglini, 2014). Growing evidence shows that higher PA levels after a breast cancer diagnosis are associated with lower risks of breast cancer-specific mortality and other causes of mortality, in addition to promoting quality of life (Department of Health & Human Services, 2018, Nelson et al., 2016, Covington et al., Jul. 2019). This is, in particular, a critical need in the Latin American and Caribbean region, where the



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## “Assessing cohesion and diversity in the collaboration network of the SALURBAL project”

10 de mayo de 2023



**Felipe Montes**

**Pablo Medina**

Sofia Baquero; Ivana Stankov; Olga L. Sarmiento  
S. Claire Slesinski; Francisco Diez-Canseco  
Maria F. Kroker-Lobos; Valeska Teixeira Caiaffa  
Alejandra Vives; Marcio Alazraqui;  
Tonatiuh Barrientos-Gutiérrez; Ana V. Diez Roux

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# Assessing cohesion and diversity in the collaboration network of the SALURBAL project

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**The SALURBAL (Urban Health in Latin America) Project is an interdisciplinary multinational network aimed at generating and disseminating actionable evidence on the drivers of health in cities of Latin America. We conducted a temporal multilayer network analysis where we measured cohesion over time using network structural properties and assessed diversity *within* and *between* different project activities according to participant attributes. Between 2017 and 2020 the SALURBAL network comprised 395 participants across 26 countries, 23 disciplines, and 181 institutions. While the cohesion of the SALURBAL network fluctuated over time, overall, an increase was observed from the first to the last time point of our analysis (clustering coefficient increased [0.83–0.91] and shortest path decreased [1.70–1.68]). SALURBAL also exhibited balanced overall diversity *within* project activities (0.5–0.6) by designing activities for different purposes such as capacity building, team-building, research, and dissemination. The network's growth was facilitated by the creation of new diverse collaborations across a range of activities over time, while maintaining the diversity of existing collaborations (0.69–0.75 between activity diversity depending on the attribute). The SALURBAL experience can serve as an example for multinational research projects aiming to build cohesive networks while leveraging heterogeneity in countries, disciplines, career stage, and across sectors.**

Over the past five decades, collaboration has played an increasingly important role in the production of knowledge and in scientific innovation<sup>1</sup>. Science to improve urban health is no exception, as multiple perspectives and disciplines are key to scientific understanding and to the identification of effective actions. Multidisciplinary and geographically diverse collaborative networks can strengthen urban health inquiry by bringing together diverse ideas, knowledge, experiences, and strategies to illuminate complex problems and their potential solutions. Diverse collaborative networks have been recognized as drivers of value creation, pushing the boundaries of innovative and impactful research<sup>2</sup>. These networks also provide access to resources, including physical facilities and diverse funding streams, and can also facilitate capacity-building and innovation by exposing researchers to a wide range of disciplines, tools, and data<sup>2,3</sup>.

Research networks have been more limited in low- and middle-income countries than in the Global North<sup>3</sup>. The paucity of research networks facilitating collaboration between diverse stakeholders across the countries of Latin America may impact the continent's progress towards meeting the United Nations Sustainable Development

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# “A decision-making framework for school infrastructure improvement programs”

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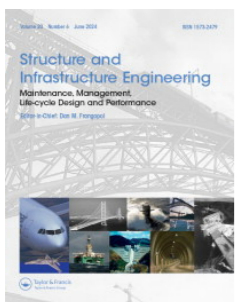


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## A decision-making framework for school infrastructure improvement programs

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### ABSTRACT

School infrastructure affects the quality of education and the performance of children and youth. Natural hazards such as earthquakes, hurricanes, floods, and landslides, threaten critical infrastructure such as school facilities. Additionally, problems related to the functionality of these facilities are common in the region, such as an inadequate number of classrooms, poor lighting, and insufficient ventilation, among others. At a national level, the decision-making process to prioritize schools' interventions becomes even more challenging due to limited resources and lack of information. Furthermore, there is a lack of a systematic approach to address the need of improving existing infrastructure taking into consideration limited resources. Considering this, a novel decision-making framework is proposed that prioritizes school infrastructure investment with limited budgets, using clustering procedures, a multi-criteria utility function, and an optimization component. This framework allows better public policy decisions and benefits students in terms of buildings quality with a multi-criteria perspective, improving both safety and functional conditions. The framework is illustrated with a case study applied to the public-school infrastructure in the Dominican Republic.

### ARTICLE HISTORY

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Budget allocation; clustering; decision-making; disaster risk reduction; multi-criteria; optimization; public-school infrastructure; school's functionality



## 1. Introduction


Quality education is a necessary condition to close inequality gaps, as it is stated in the Universal Declaration of Human Rights by The United Nations (1948). Quality education is also a priority of the Sustainable Development Goals (SDG), as the fourth goal states: *Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all* (The United Nations, 2020). Additionally, education contributes to many SDGs by reducing poverty, driving economic growth, and preventing inequality and injustice, among others (UNICEF, 2019). Although there are national and international efforts to improve education in low- and middle-income countries (L&MICs), more cooperative, structured, systematic, and coordinated efforts are required from governments and multilateral agencies to enhance quality education and reduce inequality gaps.

The United Nations showed that in L&MICs: 57 million primary-aged children remain out of school; one out of four girls do not have access to school; 50 percent of out-of-school children live in conflict-affected areas; 103 million adolescents (from which at least 60 percent are women) lack of necessary literacy skills; and six out of ten children and adolescents are not achieving a minimum level of proficiency in reading and

math (The United Nations, 2015). In addition, the education level and quality among countries have large differences, for example L&MICs have lower completion rates in all levels compared to high-income countries (UNESCO, 2020).

Several factors affect the quality of education and account for the existing gap between L&MICs and High-Income Countries (HICs). In particular, the Non-Governmental Organization (NGO) *Educate a Child* establishes the following list of barriers to better quality education: poverty; challenging geographies; conflict, insecurity, and instability; refugees; gender; infrastructure; human, material, and financial resources; teachers, contents, and academic procedures quality; and climate change (Educate a Child, 2020). Likewise, the World Bank argues that quality education should be achieved through five pillars: learners, teachers, learning resources, schools (infrastructure), and systems management (human resources and internal procedures) (The World Bank, 2020). Both sources acknowledge the critical role that infrastructure plays in the quality of education; the role has become evident with the COVID-19 crisis (The World Bank, 2020). Also, this situation differs considerably between Low-Income Countries (LICs) and Middle-Income Countries (MICs), since the latter usually have more technical and financial capacity than the former (Huss & Keudel, 2020). In MICs, in contrast to LICs,

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# “A Novel Decision-Making Framework for Waterflooding Optimization using Long and Short-Term Memory Models and Metaheuristics”

07 de junio de 2023



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## **A Novel Decision-Making Framework for Waterflooding Optimization using Long and Short-Term Memory Models and Metaheuristics**

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### **Abstract**

Meeting future energy demands in the low-carbon emissions paradigm requires improved decision-making processes. Waterflooding plays a vital role in obtaining increased oil recovery factors and minimizing undesirable water production. However, waterflooding optimization involves costly well control management optimization methods especially when numerical simulation is used. Alternatives such as data-driven proxy modeling can overcome the computation complexity drawbacks. In this paper, we develop a decision-making waterflooding framework, where an optimization component has embedded financial and machine learning models, to establish the wells operational plan obtaining the maximum profit and the best oilfield management.

In this work, we use a reduced-order predictive numerical model to generate synthetic data to train machine learning algorithms to be used in the optimization framework. We develop our methodology to find the optimal strategy to drive a waterflooding project using a black-oil reservoir model. We implement the proper orthogonal decomposition (POD)-based model reduction to evaluate the reservoir dynamics and calculate the historical fluid production based on an operational plan, reducing the time consumption and demand for computational resources. Based on these results, we train and test machine learning models to predict oil and water production rate for each well (output data) in which the operational wells' constraints change over time (input data), and select which of them has higher accuracy in the forecast. We evaluate the LSTM (long short-term memory) which are focusing in time series forecasting, using a multivariate model, analyzing Vanilla, Stacked and Bidirectional. Lastly, iteratively, the LSTM selected are embedded into a non-linear optimization component to define the best operational strategy in an oilfield with waterflooding, considering the reservoir's physics and a financial evaluation in a short- to mid-term planning horizon.

The proposed making decision framework is applied to a two-phase heterogeneous waterflooding reservoir with a 5-point inverted injection pattern. Then we conduct the comparison between the multivariate LSTM model tested, selecting for each producer well two LSTM models, one for oil and one for water production rate. These models were integrated in an optimization component, which use metaheuristics and



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# “Integrated planning decisions in the broiler chicken supply chain”

Julio de 2023



**Andrés Leonardo Medaglia González**

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## Integrated planning decisions in the broiler chicken supply chain

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### Abstract

In the poultry industry, the meat market requires a careful coordination of the broiler chicken supply chain comprising breeders, hatcheries, farms, slaughterhouses, wholesale, and retail vendors. Aside from the inherent challenges of coordinating a supply chain, animal husbandry systems face additional complex tasks. The lack of integrated decisions within the poultry chain could lead to a production plan that (a) does not comply with the biosecurity standards required in meat production for human consumption at the farms; (b) violates the production and inventory capacities at the slaughterhouses; and (c) does not meet the demand of customers. To streamline the supply chain, we propose a mixed-integer linear programming model that supports production planning and scheduling decisions in broiler chicken production facilities. In addition, we embedded the mixed-integer programming model in a rolling-horizon scheme to improve scalability and to avoid the myopic effect of time-indexed optimization models that put too much emphasis on a specific time period. We present the results of a case study in a poultry company in Santa Marta (Colombia), where we reach profit improvements that range from 7% to 57% with a reduction in inventory costs that range from 30% to 60%, while simultaneously meeting stringent technical, tactical, and biosecurity constraints.

**Keywords:** poultry supply chain; mixed-integer linear programming; production planning; lot-sizing decisions; decision support system; rolling horizon

\*Corresponding author.

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## “6D-ViCuT: Six degree-of-freedom visual cuboid tracking dataset for manual packing of cargo in warehouses”

13 de julio de 2023



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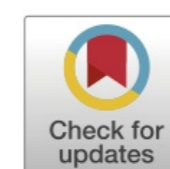
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## Data in Brief

journal homepage: [www.elsevier.com/locate/dib](http://www.elsevier.com/locate/dib)

## Data Article

## 6D-ViCuT: Six degree-of-freedom visual cuboid tracking dataset for manual packing of cargo in warehouses



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RGBD images

6D pose estimation

Visual tracking

Visual cuboid tracking

Visual box tracking

## ABSTRACT

Visual tracking of objects is a fundamental technology for industry 4.0, allowing the integration of digital content and real-world objects. The industrial operation known as manual cargo packing can benefit from the visual tracking of objects. No dataset exists to evaluate the visual tracking algorithms on manual packing scenarios. To close this gap, this article presents 6D-ViCuT, a dataset of images, and 6D pose ground truth of cuboids in a manual packing operation in intralogistics. The initial release of the dataset comprehends 28 sessions acquired in a space that rebuilds a manual packing zone: indoors, area of  $(6 \times 4 \times 2) \text{ m}^3$ , and warehouse illumination. The data acquisition experiment involves capturing images from fixed and mobile RGBD devices and a motion capture system while an operator performs a manual packing operation. Each session contains between 6 and 18 boxes from an available set of 10 types, with each type varying in height, width, depth, and texture. Each session had a duration in the range of 1 to 5 minutes. Each session exhibits operator speed and box type differences (box texture, size heterogeneity, occlusion).

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# “Adolescent Social Networks and Physical Intimate Partner Violence Among Colombian Rural Adolescents”

1 de agosto de 2023



## Felipe Montes

Ana Lucia Rodríguez de la Rosa; Dionne Stephens  
Olga L. Sarmiento; Eduardo L. De la Vega-Taboada  
Asia Eaton; Nadja Schreiber Compo  
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# Adolescent Social Networks and Physical Intimate Partner Violence Among Colombian Rural Adolescents

Ana Lucia Rodríguez de la Rosa , Dionne Stephens , Felipe Montes , Olga L. Sarmiento , Eduardo L. De la Vega-Taboada , Asia Eaton  ...show all

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## ABSTRACT

The current study analyzes individual and social network correlates of adolescent engagement in physical intimate partner violence (IPV) utilizing socio-centric data from a high-school population of 242 adolescents from rural Colombia. We studied self-reported victimization and perpetration for boys and girls. First, we used logistic regression to explore the relationship between adolescents' IPV engagement and school peers' IPV engagement, school violence victimization, and social network position, controlling for gender and age ( $N = 111$ ). Second, we used social network statistical methods to investigate if there were more friendships of similar IPV status to the adolescent than expected by chance in their social networks. Our results show that the proportion of friends perpetrating physical IPV increased the probability of adolescents' IPV perpetration. Contrarywise, the proportion of friends experiencing IPV victimization decreased with the adolescent's own victimization. Being a victim (a status significantly more common among boys) was also associated with reporting perpetration for both genders. Furthermore, our results contradicted the social network literature, as we found no preferential ties among perpetrators/victims (e.g. adolescents do not seem to befriend each other by IPV engagement). Our study is unique to the global adolescent IPV literature given the scarcity of research examining physical IPV among adolescents in the context of both girls and boys in the context of their school networks. We also add to the understanding of IPV in the case of the global majority of adolescents with the highest rates of IPV victimization (living in low and middle-income countries).

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“Boosting sustainable development goals: a hybrid metaheuristic approach for the heterogeneous vehicle routing problem with three-dimensional packing constraints and fuel consumption”

31 de agosto de 2023



**David Álvarez Martínez**

Juan Esteban Rojas-Saavedra

Johm Wilmer Escobar



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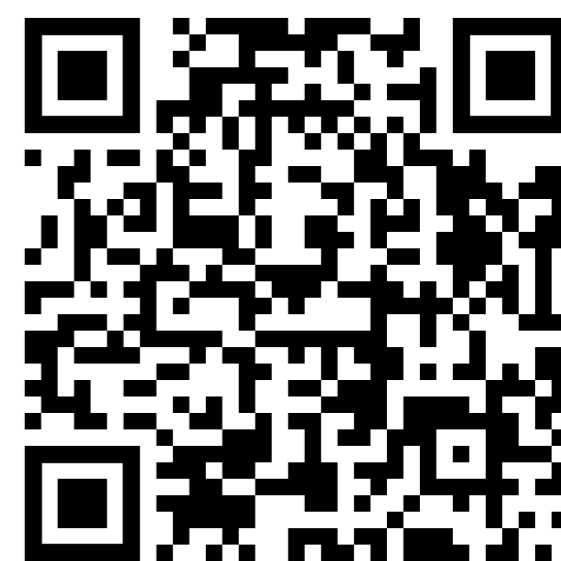
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# Boosting sustainable development goals: a hybrid metaheuristic approach for the heterogeneous vehicle routing problem with three-dimensional packing constraints and fuel consumption

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## Abstract

Due to rising carbon dioxide emissions and recent climate change events, there is an increasing focus on adopting Sustainable Road Freight Transportation to minimize fuel consumption. These issues are reflected in more recent research findings on adopting sustainable road transport methods in recent years, which positively affect the Sustainable Development Goals. This paper introduces the heterogeneous vehicle routing problem with three-dimensional packing constraints and environmental impact based on fuel consumption (3L-FHFVRP), an extension of the heterogeneous vehicle routing problem with 3D loading constraints (3L-HFVRP), considering fuel consumption as the objective function. We are given a set of requests and a heterogeneous fleet of vehicles. A set of minimum fuel consumption routes must be determined to transport each request from a loading site to the corresponding unloading site. In the 3L-FHFVRP, the customers' demand is represented by a set of 3D rectangular items (boxes), and a 3D loading space considers the vehicle's capacity. This study introduces the 3L-FHFVRP and its details, as well as a procedure for solving it has been proposed. We propose a variable neighborhood search metaheuristic algorithm to solve the problem, and we show that it is proper for some variants. The proposed method considers three-dimensional packing constraints, heterogeneous vehicle fleets, and environmental impacts based on fuel consumption. The split coding for the well-known CVRP guarantees capacity and packing constraints. A GRASP scheme is proposed to evaluate the packing constraints of the heterogeneous fleet. The optimization scheme includes the environmental impact as a fuel consumption factor directly affecting the cost function. The efficiency of the proposed approach was tested on a set of benchmarking instances for 3L-FHFVRP, 3L-HFVRP, 3L-CVRP, 2L-FHFVRP, and 2L-HFVRP. The proposed algorithm is compared with the best-known results of the literature showing that it outperforms some of the previously published results within short computing times. In future work, it is proposed to consider practical constraints such as limited vehicle fleet and time windows within the problem and to enhance the improvement operators by adding search aspects in granular space.

Extended author information available on the last page of the article

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# “A Taxonomy of Uncertainty Events in Visual Analytics”

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## THEME ARTICLE: VISUALIZATION AND DECISION MAKING DESIGN UNDER UNCERTAINTY

# A Taxonomy of Uncertainty Events in Visual Analytics

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*Visual analytics (VA) has become a standard tool to process and analyze data visually to generate novel insights. Unfortunately, each component can introduce uncertainty in the visual analytics process. These uncertainty events can originate from many effects and need to be differentiated. In this work, we propose a taxonomy of potential uncertainty events in the visual analytics cycle. Here, we structure the taxonomy along the components included in the visual analytics cycle. Based on this taxonomy, we provide a list of dependencies between these events. At last, we show how to use our taxonomy by providing a real-world example.*

The increasing amount of data to be analyzed has led to a novel data processing concept, defined as Visual Analytics (VA). This paradigm is based on the idea that analytic reasoning should be supported by interactive visual interfaces that allow users to explore datasets according to their needs and perform decision-making tasks. Keim et al.<sup>1</sup> described VA as a connected process of four major components (*Dataset S*, *Hypothesis H*, *Visualization V*, and *Insight I*), as shown in Figure 1. These components are connected by functions that allow the user to transform and analyze the given input dataset while creating new insights. By now, VA is a standard tool to find novel insights in datasets and enable decision-making in many applications.

In real-world applications, datasets and processing algorithms used in VA are often affected by uncertainty originating from data incompleteness, unknown parameters, reconstruction artifacts, or the recognition process. Also, the user himself introduces uncertainty through his cognitive abilities and personal biases. As a result, each component in the VA cycle

can be affected by uncertainty, which has to be quantified, propagated, and communicated throughout a VA cycle. Sacha et al.<sup>2</sup> described the role of uncertainty in the VA process. Their main statement is that decision-makers cannot perform their tasks properly if uncertainty is not correctly communicated in a VA cycle. Keim et al.<sup>1</sup> proposed that the inclusion of uncertainty in VA is a major challenge. Maack et al.<sup>3</sup> provided a general description of an uncertainty-aware visual analytics (UAVA) cycle. They propose that for each component of the VA cycle, uncertainty quantification is required.

Still, a process of including various sources of uncertainty is not available, forming the motivation of the present work, as shown in the Related Work section. The Uncertainty Basics section starts with a short recap of what uncertainty is, including the definition and quantification of uncertainty. The following section on taxonomy provides the first taxonomy of uncertainties in the VA cycle based on these definitions. Here, uncertainties are differentiated by the VA cycle component. The type of each uncertainty component is determined and the quantifiability is discussed. As uncertainty events are not independent in each case, the section on dependencies provides a list of dependencies for the proposed sources of uncertainty. At last, we show how to utilize the provided taxonomy and list dependencies for real-world

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# “A Look at Power Issues in Collaborative Program Evaluations Under Michel Foucault’s Conception of Power-Knowledge”

1 de septiembre de 2023



**Luis Arturo Pinzón Salcedo**

María Alejandra Torres Cuello

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## Article

# A Look at Power Issues in Collaborative Program Evaluations Under Michel Foucault's Conception of Power-Knowledge

Maria Alejandra Torres-Cuello   
and Luis Arturo Pinzon-Salcedo 

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## Abstract

Power has always been an element of the program evaluation field, however, it has traditionally been attributed a negative connotation. With that in mind, power is seen as a force possessed to some extent by different stakeholders that can be imposed over others, and by which certain views, ideas, and decisions can be adopted. Given that program evaluation has a political character in which power is always present, we seek to explore a different notion of this concept. In this paper, we intend to take advantage of Michel Foucault's ideas to explore power in the program evaluation field. We illustrate the introduction of these concepts in collaborative evaluations and in doing so, we also explore power as well as power-knowledge relations, adopting a transformative perspective on power. The introduction of these concepts in collaborative evaluation is useful in illustrating how they can be used in non-collaborative evaluations.

## Keywords

power, power-knowledge, Foucault, collaborative evaluation

## Introduction

Evaluation spaces are not neutral, but shaped by power relations that surround and permeate them through time (Chouinard, 2014; Cornwall, 2002; Gaventa, 2006; Hampshire, Hills, & Iqbal, 2005; Rodriguez & Acree, 2020). Evaluation spaces are social areas of interaction where dominion, control, and power are exercised. Power relations not only determine the boundaries of these spaces, but define what can happen within them. They affect the type of actions and results that can take place in the evaluation. They influence “what” would be regarded as relevant during the evaluation (e.g., specific knowledge and data) and “who” can affect the evaluation and take decisions within it (Haugen & Chouinard, 2019). Moreover, power relations in domains outside the evaluation

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# “Bi-objective optimal design of desalination plants considering the uncertainty of renewable energy sources”

16 de septiembre de 2023

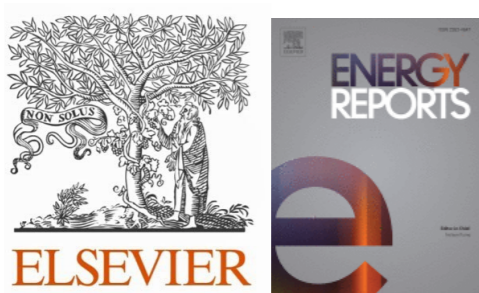


**Carlos Felipe Valencia**

**Sergio A. Cabrales**

Carlos Ramírez-Ruiz

Andrés Felipe Ramirez



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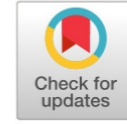
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## Energy Reports

journal homepage: [www.elsevier.com/locate/egy](http://www.elsevier.com/locate/egy)

Research paper

## Bi-objective optimal design of desalination plants considering the uncertainty of renewable energy sources

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## ABSTRACT

Desalination systems are commonly used in isolated areas to supply drinking water. However, they usually rely on fossil fuels, which emit greenhouse gases. Renewable energy sources can be used to power desalination systems, but they are intermittent. To address this, the power generation or the capacity of energy and/or water storage can be increased, but this increases the cost. In this paper, we present a bi-objective optimization methodology for designing a desalination system that is powered by renewable energy sources. The methodology aims to maximize reliability while minimizing the levelized cost of water (LCOW) by including the inherent uncertainty in renewable energy generation. We applied this methodology in the Guajira Peninsula, a region of Colombia with serious problems of drinking water scarcity, to evaluate photovoltaic (PV), wind, and PV/wind hybrid systems, determining the optimal combination of wind turbines, photovoltaic (PV) modules, desalination unit characteristics, water storage capacity, and batteries. We also introduced a new indicator, the Reliability - LCOW ratio (RLR), to assist in selecting the optimal configuration. Our results indicate that the renewable systems are feasible, achieving reliability levels between 92% and 95% and LCOW values between 0.82–0.84 USD/m<sup>3</sup>, when compared to fossil fuel configurations. Despite this, the PV-only system exhibited a significantly higher installed capacity when compared to wind and hybrid systems, while the latter two showed relatively similar characteristics. An analysis about the use of the water tank as a natural battery compared with electricity storage proved that the battery bank was more effective for the PV-only system, while the water tank was more suitable in systems where the use of wind power is predominant. Furthermore, an analysis of the direct CO<sub>2</sub> emissions of the fossil fuel configurations shows that the renewable solutions reduce emissions by over 150 tons-eq/y.

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## 1. Introduction

Access to drinking water is essential to ensure the health, quality of life and economic development for communities. However, water demand has been constantly increasing due to population growth, changing consumption patterns, the economic development, and other factors (WWAP/UN-Water, 2018). The global water demand is estimated at around 4600 km<sup>3</sup> per year and projected to increase by 20%–30% to between 5500 and 6000 km<sup>3</sup> per year by 2050 (Burek et al., 2016). This increase is causing an escalation in the number of regions that have already reached their capacity to sustainably deliver drinking water. This problem is worsened by global warming since an increase in the global average temperature implies a rise in the frequency and intensity

of droughts and greater desertification. Both of these weather extremes will lead to an increase in high-water stress areas (Shukla et al., 2019).

Currently, UNICEF and the World Health Organization (WHO) estimate that by 2030, only 81% of the world's population will have access to safe drinking water at home, leaving 1.6 billion people without it (WHO and UNICEF, 2021). The first areas to be affected by water scarcity are coastal, desert, and remote communities. More specifically, isolated communities may face additional challenges such as long distances from the electrical grid, a lack of fresh water sources, high supply costs, and significant variability in both water and electricity demand (Aberilla et al., 2020; Berrouet et al., 2020; Mohtar and Lawford, 2016). Therefore, alternative sources of water, such as seawater, groundwater, and rainwater, are becoming increasingly popular in these regions.

Dealing with water shortages often necessitates the use of alternative water sources, such as saline or brackish water, which requires additional processes like desalination, especially in the areas mentioned above (Ghaffour et al., 2013). The most common

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“Sequential stochastic and bootstrap methods to generate synthetic solar irradiance time series of high temporal resolution based on historical observations”

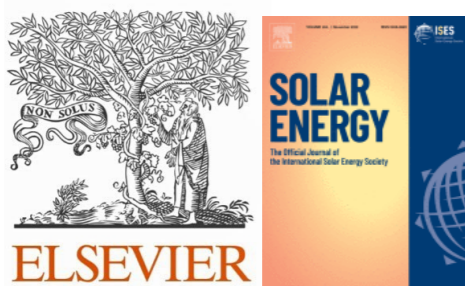
21 de septiembre de 2023



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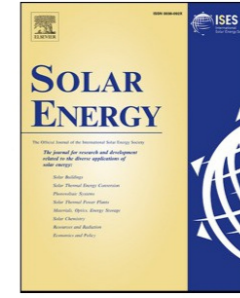


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## Solar Energy

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# Sequential stochastic and bootstrap methods to generate synthetic solar irradiance time series of high temporal resolution based on historical observations

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## ARTICLE INFO

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Sky condition

## ABSTRACT

Generating synthetic solar irradiance data through computational methods has become an attractive approach, especially when obtaining accurate measurements from historical observations or satellite-derived estimates is not feasible. Since solar photovoltaic energy production is influenced by variable weather conditions, having reliable solar irradiance data is crucial for evaluating the performance of photovoltaic systems accurately. In this paper, we propose two methods, namely stochastic method, and bootstrap method, to generate one-day synthetic solar irradiance data at a minimum 60-minute time resolution. Both techniques consider dynamic meteorological behavior and maintain the physical significance of the observed data, effectively capturing the intermittent nature of solar irradiance. Validations were performed for five sites with different climate conditions and significant geographical separation, and different time resolutions, through various metrics, including variability, statistical distribution, and energy production, which demonstrated mean average percentage errors as low as 2.1% for intraday irradiance fluctuations, statistical distribution goodness-of-fit up to 80%, and discrepancy for energy production close to 2.4%. results verify the applicability of the proposed methods regardless the time resolution, the location of the measured data and the procedure to record it (i.e., from ground weather stations or satellite-derived estimates). We also evaluated the computational performance of the proposed methods, synthetic, where the elapsed time to generate the synthetic data takes less than a minute to generate a hundred one-day solar irradiance time series. The novelty of the proposed methods is that it is only needed the information of a single month to generate representative synthetic solar irradiance one-day sequences generated for five climate conditions without the need of a training process (i.e., iterative adjustments of the parameters), being useful for pre-feasibility studies of the photovoltaic project and to train machine learning algorithms that deals with time series. To encourage the reproducibility of the research presented in this paper, the proposed methods to generate synthetic solar irradiance data are freely available in a well-documented GitHub repository from <https://github.com/salazarna/synthetic-irradiance-sequence>.

## 1. Introduction

### 1.1. Motivation

The energy industry is currently migrating from non-renewable fossil fuels towards cleaner energy sources that have minimum environmental impact both during their generation and use. This trend is reflected in the evolution of global energy consumption statistics where renewable energies, specifically photovoltaic (PV) solar energy, are experiencing

the highest growth rate of approximately 12% compared to traditional sources, according to the 2020 Annual Energy Outlook by the US Energy Information Administration. In addition, the International Renewable Energy Agency confirms the increasing popularity of solar PV energy as the most widely used renewable energy over the past 15 years, while also highlighting that solar projects are now providing some of the cheapest sources of electricity in history [24].

However, the main weakness of PV solar energy is its intermittent and stochastic nature due to variable weather conditions such as cloud

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# “Selection homophily and peer influence for adolescents’ smoking and vaping norms and outcomes in high and middle-income settings”

26 de septiembre de 2023



## Felipe Montes

Jennifer M Murray; Sharon C Sánchez-Franco;  
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Abhijit Ramalingam; Erin L. Krupka; Huiyu Zhou;  
Laurence Moore; Linda Bauld; Blanca Llorente;  
Frank Kee; Ruth F. Hunter.

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## ARTICLE


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OPEN

# Selection homophily and peer influence for adolescents' smoking and vaping norms and outcomes in high and middle-income settings

The MECHANISMS study investigates how social norms for adolescent smoking and vaping are transmitted through school friendship networks, and is the first study to use behavioral economics methodology to assess smoking-related social norms. Here, we investigate the effects of selection homophily (the tendency to form friendships with similar peers) and peer influence (a social process whereby an individual's behavior or attitudes are affected by peers acting as reference points for the individual) on experimentally measured smoking and vaping norms, and other smoking outcomes, in adolescents from high and middle-income settings. Full school year groups in six secondary schools in Northern Ireland (United Kingdom) and six secondary schools in Bogotá (Colombia) participated ( $n = 1344/1444$ , participation = 93.1%, target age 12–13 years). Over one semester, pupils received one previously tested school-based smoking prevention program (ASSIST or Dead Cool). Outcomes included experimentally measured smoking/vaping norms, self-report and objectively measured smoking behavior, and self-report smoking norms, intentions, susceptibility, attitudes, and psycho-social antecedents. We investigated selection homophily and peer influence using regressions and SIENA modeling. Regression results demonstrate lagged and contemporaneous selection homophily (odds ratios [ORs] = 0.87–1.26,  $p \leq 0.01$ ), and peer influence effects for various outcomes from average responses of friends, school classes, or school year groups (standardized coefficients [ $\beta$ s] = 0.07–0.55, ORs = 1.14–1.31,  $p \leq 0.01$ ). SIENA models showed that comparable proportions of smoking/vaping-based similarity between friends were due to selection homophily (32.8%) and peer influence (39.2%). A higher percentage of similarity between friends was due to selection homophily and/or peer influence for ASSIST schools compared to Dead Cool. Selection homophily was also more important in Bogotá, whilst peer influence was stronger in Northern Ireland. These findings support using social norms strategies in adolescent smoking prevention interventions. Future research should consider selection homophily and social influence jointly, and examine whether these findings translate to other high and low-middle-income settings with varying cultures and norms.

A full list of authors and their affiliations appears at the end of the paper.

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# “Understanding the dynamics of the obesity transition associated with physical activity, sedentary lifestyle, and consumption of ultra-processed foods in Colombia”

5 de octubre de 2023



## Felipe Montes

Jose D. Meisel; Valentina Esguerra; John K. Giraldo;  
Ivana Stankov; Carlos A. Meisel; Olga L. Sarmiento  
Juan A. Valdivia



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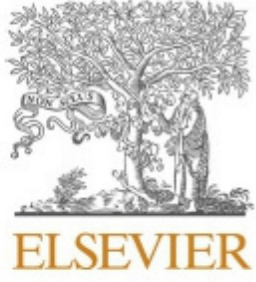
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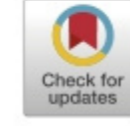




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## Understanding the dynamics of the obesity transition associated with physical activity, sedentary lifestyle, and consumption of ultra-processed foods in Colombia

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### ARTICLE INFO

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System dynamics model  
Complex system  
System science  
Physical activity  
Sedentary lifestyle  
Consumption of ultra-processed foods

### ABSTRACT

**Objective:** We investigate the obesity transition at the country- and regional-levels, by age, gender, and socio-economic status (SES) and its relationship to three health behavior attributes, including physical activity (PA), sedentary activities (ST), and consumption of ultra-processed foods (CUPF) within the urban population of Colombia, from 20,010 to 2050.

**Methods:** The study is informed by cross-sectional data from ENSIN survey. We used these data to develop a system dynamics model that simulates the dynamics of obesity by body mass index (BMI) categories, gender, and SES. This model also uses a conservative co-flow structure for three health-related behaviors (PA, ST, and CUPF).

**Results:** At the national level, our results indicate that the burden of obesity is shifting towards populations with lower SES as the gross domestic product (GDP) increases, particularly women aged 20–59 years with lower SES. Among this group of women, the highest burden of obesity is among those who do not meet the PA, ST and CUPF recommendations. At the regional level, our findings suggest that the regions are at different stages in the obesity transition.

**Conclusions:** The burden of obesity is shifting towards women with lower SES as GDP increases at the national level and across several regions. This obesity transition is paralleled by a high prevalence of women from low SES groups who do not meet the minimum recommendations for PA, CUPF, and ST. Our findings can be used by decision-makers to inform age- and SES- specific policies seeking to tackle the obesity.

### 1. Introduction

The rising prevalence of overweight and obesity, or high body mass index (BMI), has become an important focus of the World Health Organization (WHO). Overweight and obesity are the main risk factors for premature death and disability. Moreover, they are associated with chronic non-communicable diseases which account for 71% of all deaths

worldwide (Popkin and Reardon, 2018). The population with overweight or obesity has increased from 921 million in 1980 to 2.1 billion in 2013 worldwide (Ng et al., 2014). In 2018, the WHO also reported that worldwide, there are >380 million children and adolescents with overweight or obesity (World Health Organization, 2018). Similar patterns have also been observed in low-and middle-income countries (LMICs) (Jiwani et al., 2019). Notably, LMICs have been undergoing an

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# “Time-optimal trajectory planning for industrial robots with end-effector acceleration constraints”

17 de octubre de 2023



## David Álvarez Martínez

Samuel Romero

Ana María Montes

Carlos F. Rodríguez

Jorge S. Valero

# Time-optimal trajectory planning for industrial robots with end-effector acceleration constraints

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**Abstract**— The implementation of manipulator robots has become indispensable in various industries, enabling efficient performance of complex tasks. Swift and efficient movement of these robots is essential to maximize productivity. However, the grip limitations of the tool restrict rapid movement in scenarios where the manipulator's load varies. In this research, we propose a novel method for generating minimum-time trajectories while considering acceleration constraints on the tool. The algorithm incorporates two trajectory generation methods in the joint space: a simple polynomial approach and a composite approach. To validate the proposed method, we apply it to a UR10 robot model equipped with a vacuum gripper, specifically designed for handling boxes with diverse characteristics. By testing the algorithm on different trajectories, we successfully identify satisfactory solutions. The outcomes of this study significantly contribute to the advancement of manipulator robots by addressing the challenges posed by variable payload conditions. Our method enables efficient and rapid movement in real-world applications, enhancing overall productivity and expanding the scope of manipulator robot utilization.

**Keywords**— *manipulator end-effector, optimization, pick and place task, robotics, trajectory planning.*

## I. INTRODUCTION

Manipulators are an essential tool in the automation and optimization of industry processes. Their ability to pick and place different types of products makes them an efficient and safe logistics solution. In terms of path planning for these activities, it has been widely studied. However, there is a lack of research in the existing literature regarding the transportation of objects with different weights and sizes that impose constraints on the robot's acceleration capacity. An example of a case where the load of manipulator robots varies is mixed palletizing in a supply chain. In this scenario, different items with varying shapes, sizes, and weights need to be efficiently placed on a pallet.

A brief literature review featured in this paper underscores several pertinent studies that have investigated the application of robotic manipulators for mixed palletizing tasks. Baldassarri et al. [1] present an architecture of a mobile robotic system for logistic applications, specifically from homogeneous pallet units extracted to build heterogeneous pallets, while Parisi et al. [2] used integer linear programming (ILP) to minimize the total distance traveled by the robot. During the palletizing. Lamon et al. [3] focus on a human-robot collaborative framework for mixed case palletizing, that uses visual perception algorithms for detection and localization, and high-level optimization of the combined effort. Chiba et al. [4] propose a method to improve the performance of a palletizing manipulator by optimizing the working environment under constraints such as manipulator

base position, pallet shape, position, trajectories, motion, and kinematics.

Trajectory planning is the process of generating a time sequence of the values reached by an interpolation function of the desired trajectory. This process involves finding a feasible trajectory that satisfies the kinematics, dynamics, and control performance constraints of the manipulator while minimizing distance or time, avoiding obstacles, or reducing energy consumption. Relevant sources such as Siciliano et al. [5] and Feng and Jia in [6] provide further insight into the definitions and concepts of trajectory planning robots.

Various authors have proposed solutions to the time optimization problem for pick and place applications. For instance, Fiorini and Shiller [7] presented a method for path planning in dynamic environments, avoiding static and moving obstacles. In contrast, Rajan [8] proposed a method that uses control theory to find the minimum time relative to a trajectory in configuration space. Similarly, [9] suggested a practical method for determining the minimum time of trajectories for industrial robots in joint space, using a genetic/interval hybrid algorithm. Other authors have also implemented new optimization strategies to find the minimum time trajectories subject to dynamic constraints [10]. In [11], Haddad et al. present several efficient schemes and algorithms for minimum-time trajectory planning for robots; Luan et al. [12] provide a maximum speed algorithm for serial palletizing robots, that can be easily implemented in real applications and Zhang et al. [13] propose to solve a convex optimization problem to generate a smooth minimum time trajectory. Similarly, Xu and Hong [14] propose a new optimal trajectory planning algorithm to improve efficiency and reduce the vibration of the Robot. Abu-Dakka et al. [15] expound a genetic algorithm procedure with parallel populations to obtain minimum time trajectories for manipulator robots.

Existing literature on trajectory optimization for palletizing applications has overlooked the impact of tool limitations in the end effector. In this research, we propose a novel approach that explicitly considers these constraints, improving trajectory computation accuracy and efficiency. This advancement fills a critical gap, with significant implications for precise and reliable palletizing operations in various industries.

This work presents a mathematical algorithm that optimizes the execution time of pick and place tasks, considering the limitations of the robot's capabilities, the effects of inertia on the end-effector when transporting boxes, and the unique characteristics of the boxes. This model comprises two trajectory planners, the criteria for deciding which one to implement include the execution time (associated with the computational cost of the tool) and the cumulative time for a set of trajectories.

## “Value-Based Smart Retrofitting of Maintenance in the Hydropower Plants of Celsia”

22 de noviembre de 2023



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## Value-based Smart Retrofitting of Maintenance in the Hydropower Plants of Celsia

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**Abstract:** Smart Retrofitting in maintenance indicates the development of maintenance services through the retrofitting of legacy devices with the functionalities of data collection, data communication and data processing. Many companies nowadays desire to retrofit their assets through the implementation of Prognostics and Health Management (PHM) services to assist in better predicting their future state and making timely and sound decisions. In this context, this work presents the PHM center developed by the company Celsia in the Alto Anchicayá hydropower plant and discusses the available approaches for estimating the value brought by PHM investments. Even if different works can be found in the literature with this purpose, only the economic feasibility of PHM implementations is generally considered. Whereas, in value-based decision-making different dimensions are embraced and not only the performance and cost ones. Therefore, the need of a value model to support decision-making concerning PHM implementations is presented and the potential of System Dynamics for this purpose is discussed.

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**Keywords:** Asset Management, Strategic Maintenance, Smart Retrofitting, Prognostics and Health Management, Predictive Maintenance, Hydropower Plant, Value-based Decision-Making, Decision-Making, System Dynamics, Value Model

### 1. INTRODUCTION

Due to the digital transformation of industrial plants boosted by industry 4.0, *Prognostics and Health Management* (PHM, also known as Predictive Maintenance) has emerged and is defined as a condition-driven preventive maintenance program. According to (Lee et al., 2017), three types of end results of a PHM approach are often distinguished: i) detection: used as a safety warning or last resort; ii) diagnosis: fault state determination and short-term (failure) behaviour forecast; iii) prognosis: long-term (failure) behaviour prediction.

*Hydropower* is one of the renewable energy sources with the highest conversion efficiency. Hydropower plants (HPPs) produces electricity from water potential energy by means of a hydro turbine that drives a generator. Typical average operations and maintenance costs for HPPs represents 2% of the investment cost (Taylor, 2010). Therefore, HPPs are often the cheapest means of generating electricity. Furthermore, HPPs are characterized with a very long lifespan.

*Maintenance of HPPs* is fundamental for their efficient operation and long life. Lack of effective maintenance processes can result in major losses such as electricity generation and revenues, whereas poor maintenance practices can also affect employees and public safety.

*Online monitoring of HPPs* is important for granting an uninterrupted generation. Monitoring of silt, vibration, discharge, level, energy generation, and tandem operation of HPPs to know the real-time condition of the plants is essential. Better monitoring and control strategies based on PHM policies can minimize unwanted breakdowns and improve the performance (Kumar & Saini, 2022).

Typically, two motivations can be discerned for implementing PHM policies (Tiddens et al., 2018): i) *top-down approach*: industrial practitioners look for the best maintenance policy for their high-impact assets, and PHM appears to be the most suitable one; ii) *bottom-up approach*: opportunities arise that make the application of PHM feasible. In the first case, the decision concerning the PHM implementation is driven from a strategic point of view, whereas in the second PHM is implemented and then its added value is quantified.

Furthermore, the implementation of PHM programs may require companies to either replace or upgrade their existing legacy devices to get access to industry 4.0 technologies. The second approach is defined as *Smart Retrofitting* (Sanchez-Londono et al., 2022): the development of maintenance services through the retrofitting of legacy devices with the functionalities of data collection, data communication and data processing.



# “A scaling investigation of urban form features in Latin America cities”

18 de diciembre de 2023



## Felipe Montes

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## A scaling investigation of urban form features in Latin America cities

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### Abstract

This paper examines scaling behaviors of urban landscape and street design metrics with respect to city population in Latin America. We used data from the SALURBAL project, which has compiled and harmonized data on health, social, and built environment for 371 Latin American cities above 100,000 inhabitants. These metrics included total urbanized area, effective mesh size, area in km<sup>2</sup> and number of streets. We obtained scaling relations by regressing log(metric) on log (city population). The results show an overall sub-linear scaling behavior of most variables, indicating a relatively lower value of each variable in larger cities. We also explored the potential influence of colonization on the current built environment, by analyzing cities colonized by Portuguese (Brazilian cities) or Spaniards (Other cities in Latin America) separately. We found that the scaling behaviors are similar for both sets of cities.

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**Data Availability:** "Availability of data and materials The code and implementation of scale analysis is available on Github. <https://github.com/sanchobuendia/Scaling-urban-form> The SALURBAL project welcomes queries from anyone interested in learning more about its dataset and potential access to data. To learn more about SALURBAL's dataset, visit <https://drexel.edu/lac/> and the data can be requested on the Salurbal website at the following address <https://drexel.edu/lac/about/contact/>."

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### Introduction

The growth of cities is characterized by many features that evolve over time [1], resulting from the action of many events and actors. Individual behaviors [2, 3], social institutions, economic interests, available technologies, and cultural tracts and values leave their signatures in each city. Despite the specificities of these actors in each city, such driving forces succeed in providing over time quite similar features across cities. For instance, cities are resilient, exhibit inequality patterns generated by intense competition for space, resources, and transportation [4–8], require the input of energy for their maintenance, and lack balance during their growth [9–12]. A series of prior studies have identified that many measurable features of cities, covering socio-economic, infrastructure, and health aspects, are found to depend on their size according to power-laws with respect to the city size [13–19]. Such simple mathematical laws express the presence of scaling behavior, a remarkable property of complex systems, which supports identifying and studying cities within such a general framework.

The identification of scaling behaviors has also received support from a robust theoretical framework that explains how scaling relations between social-economic indicators and city size emerge as a consequence of universal aspects of the drivers of city growth, which do not depend on particularities of the actors or their past history [1, 13–14, 18, 19]. The foundational assumptions of scaling theory include the importance of human interactions in physical space, the role of social networks in enhancing individual productivity and quality, the notion that all human activities generate costs and benefits, and the bounded nature of human effort. Moreover, scaling theory considers that the size of human settlements is both a consequence and a determinant of productivity, technological and cultural development, highlighting the importance of distributed knowledge and social networks in shaping economic and social outcomes. By recognizing the role of social networks in promoting knowledge sharing and innovation, it provides a better understanding of how to promote economic and social development in urban areas. In addition, a complementary





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