Período

2020/01/01 - 2020/12/31

Publicaciones de alto impacto

Departamento de Ingeniería Industrial

Número 7

Universidad de los Andes

Universidad de los Andes | Vigilada Mineducación
Reconocimiento como Universidad: Decreto 1297 del 30 de mayo de 1964.
Reconocimiento personería jurídica: Resolución 28 del 23 de febrero de 1949 Minjusticia.

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Publicaciones de Alto Impacto

Para el Departamento de Ingeniería Industrial es estratégico divulgar y compartir los resultados de investigación del más alto nivel realizados por nuestros profesores. Estos resultados son un motivo de especialorgullo para nuestroDepartamento. La presente edición no. 7 cubre las publicaciones realizadas en el año 2020 y refleja la diversidad, el alcance, el impacto y las posibilidades de la ingeniería industrial. Para que estas publicaciones se incluyan en esta revista se requiereque cumplan con los criterios que Minciencias establece para la producción académica reconocida como “de alto impacto” y que se resumen a continuación:

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desarrollo tecnológico o de innovación y de reconocimiento de investigadores del sistema nacional de ciencia, tecnología e innovación vigente.

Contenido

Productos Reconocidos

15.Guerra, A.M.; **Montes, F.; Useche, A.F; Jaramillo, A.M.**; González, S.; Meisel, J.D.; Obando, C.; Cardozo, V.; Hunter, R. & Sarmiento, O.L.(2020). "Effects of a Physical Activity Program Potentiated with ICTs on the Formation and Dissolution of Friendship Networks of Children in a Middle-Income Country". International Journal of Environmental Research and Public Healths. Published: 11 August 2020. Available at: https://doi.org/10.3390/ijerph17165796..... ***Pag 29-30***

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Time Estimation and Hotspot Detection in the Evacuation of a Complex of Buildings: A Mesoscopic Approach and Case Study

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Time Estimation and Hotspot Detection in the Evacuation of a Complex of Buildings: A Mesoscopic Approach and Case Study

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***Abstract*—Evacuation drills are critical to ensure safety and to evaluate emergency preparedness. However, drills are overly expensive in terms of the involved resources. Before conducting drills, it is possible to test the infrastructure under stress using computer simulation (combined with optimization) to identify critical points (hotspots) that could improve the flow dynamics during a real evacuation or emergency. This article proposes a mesoscopic (optimization–simulation) framework that models the evacuation dynamics from a strategic perspective considering the infrastructure of the evacuated area and the effect of congestion on the evacuation times. The mesoscopic framework iteratively interweaves two models: (i) a macroscopic network-oriented optimization model that finds flows of evacuees toward the safe zones, and (ii) a microscopic discrete-event simulation model that evaluates the effect of congestion. To illustrate the applicability of the proposed framework, the article presents a case study that recreates a real evacuation drill that took place in a university campus. The results of the case study support infrastructure investment decisions that enhance the evacuation dynamics.**

***Index Terms*—Congestion, discrete-event simulation, evacuation, network optimization, simulation optimization.**

I. Introduction

ON FEBRUARY 2 of 2016, the smoke of an escaped wildfire in the Eastern Hills of Bogotá (Colombia) triggered a yellow alert in the historic city center [1]. Fig. 1 shows the smoke over the historic city center the day of the fire. On a city with over 8 million inhabitants, the result was a massive evacuation of approximately 300 000 people from several government facilities, office buildings, and education institutions in the historic city center, located at the base of the surrounding hills in the Andes mountain range [2]. One of the facilities evacuated on the day of the fire was Universidad de los Andes (Uniandes), which holds up to 23 000 people among students, faculty, and staff, and over 82 newly built and renovated old structures that spread over 154 160 square meters [3].

Fig. 2 shows a 3-D view of Uniandes' campus (buildings in blue and red; safe zone in gray). Pedestrian evacuation flows in the campus are somewhat challenging due to: (i) a topography with varying slopes, (ii) a narrow pedestrian network, (iii) the complexity of connections between old and new buildings, and (iv) the location of the meeting points along public spaces [5]. On the day of the fire, the evacuation times were severely affected by these factors. Moreover, although campus and building administrators often conduct evacuation drills for emergency preparedness due to metropolitan regulations [6], on the day of the fire, severe congestions delayed the evacuation for several hours [7]. Thus, campus administrators identified the need for a tool to help them understand the effect of the currently built environment on the safety of students, faculty, and staff during an emergency. Moreover, they needed to prioritize infrastructure interventions supported with evidence.

Evacuation managers could use planning tools to help them estimate times and identify critical points when an emergency unfolds. On the one hand, these tools must consider infrastructure and built environment aspects; and on the other, human and social behavior. Campus administrators pay special attention to the former, as controlled infrastructure interventions may improve or worsen the flow of evacuees, having a direct effect on the formation of congestion hotspots, and ultimately on the evacuation times. Understanding evacuation dynamics from a strategic perspective through modeling and data-driven what-if analyses before a critical event happens can help administrators to gain insight, prioritize possible infrastructure adequacy interventions, and, at the end, save lives.

This article presents a mesoscopic framework to model evacuations from a strategic perspective considering the underlying infrastructure of the evacuated area (i.e., the connection of multiple buildings, intersecting corridors, and meeting points with different capacities over a complex topography with changes in slope) and the effect of *congestion* on the egress times of a moving crowd. The proposed computational framework is composed of two models that iteratively communicate and exchange information: (i) a network-oriented optimization model that finds flows of evacuees toward the safe zones; and (ii) a discrete-event simulation (DES) model that evaluates the effect of congestion in the evacuation flows. Although simplified and

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Urban Transformations and Health: Methods for TrUST—a Natural Experiment Evaluating the Impacts of a Mass Transit Cable Car in Bogotá, Colombia

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Urban Transformations and Health: Methods for TrUST—a Natural Experiment Evaluating the Impacts of a Mass Transit Cable Car in Bogotá, Colombia

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Background: Cable cars provide urban mobility benefits for vulnerable populations. However, no evaluation has assessed cable cars' impact from a health perspective. TransMiCable in Bogotá, Colombia, provides a unique opportunity to (1) assess the effects of its implementation on the environmental and social determinants of health (microenvironment pollution, transport accessibility, physical environment, employment, social capital, and leisure time), physical activity, and health outcomes (health-related quality of life, respiratory diseases, and homicides); and (2) use citizen science methods to identify, prioritize, and communicate the most salient negative and positive features impacting health and quality of life in TransMiCable's area, as well as facilitate a consensus and advocacy-building change process among community members, policymakers, and academic researchers.

Methods: TrUST (In Spanish: Transformaciones Urbanas y Salud: el caso de TransMiCable en Bogotá) is a quasi-experimental study using a mixed-methods approach. The intervention group includes adults from Ciudad Bolívar, the area of influence of TransMiCable. The control group includes adults from San Cristóbal, an area of future expansion for TransMiCable. A conceptual framework was developed through group-model building. Outcomes related to environmental and social determinants of

Benchmarking seeding strategies for spreading processes in social networks: an interplay between influencers, topologies and sizes

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Benchmarking seeding strategies for spreading processes in social networks: an interplay between influencers, topologies and sizes

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The explosion of network science has permitted an understanding of how the structure of social networks affects the dynamics of social contagion. In community-based interventions with spill-over effects, identifying influential spreaders may be harnessed to increase the spreading efficiency of social contagion, in terms of time needed to spread all the largest connected component of the network. Several strategies have been proved to be efficient using only data and simulation-based models in specific network topologies without a consensus of an overall result. Hence, the purpose of this paper is to benchmark the spreading efficiency of seeding strategies related to network structural properties and sizes. We simulate spreading processes on empirical and simulated social networks within a wide range of densities, clustering coefficients, and sizes. We also propose three new decentralized seeding strategies that are structurally different from well-known strategies: community hubs, ambassadors, and random hubs. We observe that the efficiency ranking of strategies varies with the network structure. In general, for sparse networks with community structure, decentralized influencers are suitable for increasing the spreading efficiency. By contrast, when the networks are denser, centralized influencers outperform. These results provide a framework for selecting efficient strategies according to different contexts in which social networks emerge.

Information, behaviors, diseases, emotions, and even the adoption of technological innovations spread through social networks[1–5]. Recently, the explosion of network science across disciplines has produced many important advances in understanding how the structure of social networks affects the dynamics of social contagion. Specifically, the study of social networks has provided an opportunity to potentiate interventions with spill-over effects aimed to increase population well-being. For example, several studies have examined the spreading processes efficiency related to the topological properties of networks[4,6–8]. Other studies have analyzed the role of homophily in spreading processes[9–11], while others have focused on identifying influential spreaders in networks and how they may be harnessed to increase the efficiency of public health and poverty reduction interventions[12–15].

A key point for designing interventions with spill-over effects is to allocate resources for the intervention targeting in a wisely way. Thus, it is crucial to have an appropriate methodological framework for selecting seednodes with the best spreading ability. Several complex networks studies have proposed selecting seednodes by ranking network nodes based on centrality measures[12,15–28]. Particularly, nodes with high degree, closeness, and betweenness coefficients have been identified as influential or high-risk individuals during a spreading process[16,23,29]. Furthermore, there are random-walk based seeding strategies, such as Page-Rank, that have been shown more efficient than centrality-based strategies for infecting some networks but less efficient in other ones[19,24,25]. Also, Kitsak *et al.* have proposed that targeting the core of the network by using a K-shell decomposition method is

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Colombian Higher Education Institutions Evaluation

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Colombian higher education institutions evaluation

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ABSTRACT

Over the last twenty years, access to higher education has grown extraordinarily in Latin America. Higher education systems have been challenged to improve their efficiency while strengthening quality assurance processes. In Colombia, the government and the researchers developed models to assess the performance of Higher Education Institutions (HEIs). Nevertheless, the current scholarship does not have a model that allows the system to measure multiple efficiencies in a diverse environment. In this study, we address the challenge of evaluating the efficiency of HEIs taking into account different goals of the Colombian education system. To this aim, we extend a cross-efficiency data envelopment analysis (DEA) approach to evaluate the efficiency of Colombian HEIs in the presence of flexible measures. While some HEIs are efficient in terms of teaching or employment, others are efficient in terms of research. Therefore, the model suggests broader policies to achieve the efficiency of the institutions under multiple goals.

1. Introduction

Over the last twenty years, the rising demand for participating in higher education has presented an extraordinary growth in Latin America. The gross enrollment rates for the 18–24 years old population doubled from 21% to 43% between the years 2000 and 2013 [1]. This trend has challenged the higher education systems to design access and quality strategies for attending to the increasing demand while strengthening quality assurance processes.

Among Latin American countries, Colombia has presented the highest growth in its enrollment rate increasing from 31.6% (1.3 million students) in 2007 to 51.2% (2.3 million students) in 2016 [2]. In Colombia, the higher education institutions (HEIs) play a key role in the country's development and economic growth through the production of human capital and knowledge. The rapid growth in enrollments has led to the challenge of maintaining and improving teaching, research and extension missions of HEIs. The government has responded to this rapid growth by offering funding opportunities to facilitate access, and fostering development plans for strengthening quality assurance processes [3]. Consequently, HEIs have been able to enhance their capacity and invest in their quality assurance processes, as well as increase their interaction with firms, government, and communities through the extension of their teaching and research services for a sustainable development at both regional and national levels. Nevertheless, there is still a low ratio of accredited HEIs: 17.4% in 2016 [2].

In this challenging yet inspiring path, the major challenge faced by Colombia's higher education system is limited resources. The financial gap has been increasing due to payroll costs, especially in the public HEIs [4]. In the value chain of higher education, students, teachers, learning environments, and financial funds are the resources used in the processes of student learning, professional development, and research-related activities. Owing to these processes, trained professionals, developments in the skills of the professors, and research-relevant products are obtained. Higher education fulfills the function of creating citizens and generating positive drivers for society. With the aim of enhancing the performance of HEIs, the government faces the critical decision of how to assign resources to enable maximum outcomes. In this decision-making process, for the case of Colombia, the efficiency of the transformation processes in the value chain of higher education remains unexplored at the national level.

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A systematic review of empirical and simulation studies evaluating the health impact of transportation interventions

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A systematic review of empirical and simulation studies evaluating the health impact of transportation interventions

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ABSTRACT

Urban transportation is an important determinant of health and environmental outcomes, and therefore essential to achieving the United Nation's Sustainable Development Goals. To better understand the health impacts of transportation initiatives, we conducted a systematic review of longitudinal health evaluations involving: a) bus rapid transit (BRT); b) bicycle lanes; c) Open Streets programs; and d) aerial trams/cable cars. We also synthesized systems-based simulation studies of the health-related consequences of walking, bicycling, aerial tram, bus and BRT use.

Two reviewers screened 3302 unique titles and abstracts identified through a systematic search of MEDLINE (Ovid), Scopus, TRID and LILACS databases. We included 39 studies: 29 longitudinal evaluations and 10 simulation studies. Five studies focused on low- and middle-income contexts. Of the 29 evaluation studies, 19 focused on single component bicycle lane interventions; the rest evaluated multi-component interventions involving: bicycle lanes (n = 5), aerial trams (n = 1), and combined bicycle lane/BRT systems (n = 4). Bicycle lanes and BRT systems appeared effective at increasing bicycle and BRT mode share, active transport duration, and number of trips using these modes. Of the 10 simulation studies, there were 9 agent-based models and one system dynamics model. Five studies focused on bus/BRT expansions and incentives, three on interventions for active travel, and the rest investigated combinations of public transport and active travel policies. Synergistic effects were observed when multiple policies were implemented, with several studies showing that sizable interventions are required to significantly shift travel mode choices.

Our review indicates that bicycle lanes and BRT systems represent promising initiatives for promoting population health. There is also evidence to suggest that synergistic effects might be achieved through the combined implementation of multiple transportation policies. However, more rigorous evaluation and simulation studies focusing on low- and middle-income countries, aerial trams and Open Streets programs, and a more diverse set of health and health equity outcomes is required.

1. Introduction

Over the course of the last two centuries, the proportion of the world's population residing in cities has increased more than 10 fold, with more than half of all people living in urban areas (United Nations, 2014). According to the United Nations (United Nations, 2018), especially rapid rates of urbanization are projected to occur in low- and middle-income countries. While the dense intersection of social,

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Using a system dynamics model to study the obesity transition by socioeconomic status in Colombia at the country, regional and department levels

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Using a system dynamics model to study the obesity transition by socioeconomic status in Colombia at the country, regional and department levels

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ABSTRACT

Objective We study the obesity transition by socioeconomic status (SES), gender and age within the Colombian urban population at the country, regional and department levels.

Design The study is informed by cross-sectional data from the 2005 and 2010 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 at the country, regional and department levels from 2005 to 2030.

Participants The sample size of the 2005 ENSIN comprised 8515 children younger than 5 years, 32 009 children and adolescents aged 5–17 years and 48 056 adults aged 18–64 years. In 2010, the corresponding numbers were 11 368, 32 524 and 64 425, respectively.

Primary and secondary outcome measure The obesity prevalence ratio and prevalence rates for each BMI category.

Results The results show, at the country level, transitions from overweight to obesity were projected to increase sharply among lower SES adults, particularly among women, suggesting that these groups will undergo an obesity transition by 2030. The model projections also indicate that the regions of Colombia are in different stages of the obesity transition. In the case of women, five out of the six regions were expected to undergo an obesity transition by SES over time. For men, only one region was expected to undergo an obesity transition. However, at the department level, trends in the burden of obesity varied.

Conclusions We evidence that the Colombian population could be experiencing an obesity transition where the increase in the GDP could be related to shifts in the burden of obesity from higher to lower SES, especially in women. These patterns support the need for policy planning that considers SES and gender, at the national and subnational levels, as important determinants of overweight and obesity among adults in Colombia.

Strengths and limitations of this study

- To our knowledge, this is the first system dynamics (SD) model to explore the obesity transition by age, gender and socioeconomic status (SES) at the national and subnational level.
- The SD model has the capacity to incorporate a real-world ageing population structure from an upper middle-income country to dynamically explore the relationship between gross domestic product (GDP), and overweight and obesity prevalence, by gender and SES.
- Our study focuses only on GDP per capita as the main indicator of economic development at the country, region and department levels. This is the only indicator we had with available data across all time points and at both the national and subnational levels.
- Transference rates (TRs) between body mass index (BMI) categories were estimated using two data points, and we assumed no variation in mortality rates across BMI categories because these data were not available.
- Our model assumes that the estimated TRs between BMI categories do not change over time.

INTRODUCTION

Obesity has become a global epidemic with at least 2.8 million deaths each year attributable to overweight and obesity.[1] Obesity and overweight are associated with a range of non-communicable diseases (NCDs) including cardiovascular diseases, cancer, diabetes and chronic respiratory diseases. These NCDs are the leading global cause of death (70% of deaths worldwide),[2] especially in low-income and middle-income countries (LMICs).[3]

Studies of socioeconomic status (SES) and obesity have shown that LMICs are facing an obesity transition, which sees the burden of obesity shift towards the lowest SES group, particularly in women, as the economic development level of a country increases.[4–7] Growing evidence suggests that several countries in Latin America and the Caribbean are experiencing an important and rapid obesity transition[8 9] (eg, Chile,[10] Brazil,[11 12] Colombia,[13–15] Mexico[16] and Argentina[17]). These findings have been

Level of traffic stress-based classification: A clustering approach for Bogotá, Colombia

13/06/2020

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Level of traffic stress-based classification: A clustering approach for Bogotá, Colombia

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ABSTRACT

The Level of Traffic Stress (LTS) is an indicator that quantifies the stress experienced by a cyclist on the segments of a road network. We propose an LTS-based classification with two components: a clustering component and an interpretative component. Our methodology is comprised of four steps: (i) compilation of a set of variables for road segments, (ii) generation of clusters of segments within a subset of the road network, (iii) classification of all segments of the road network into these clusters using a predictive model, and (iv) assignment of an LTS category to each cluster. At the core of the methodology, we couple a classifier (unsupervised clustering algorithm) with a predictive model (multinomial logistic regression) to make our approach scalable to massive data sets. Our methodology is a useful tool for policy-making, as it identifies suitable areas for interventions; and can estimate their impact on the LTS classification, according to probable changes to the input variables (e.g., traffic density). We applied our methodology on the road network of Bogotá, Colombia, a city with a history of implementing innovative policies to promote biking. To classify road segments, we combined government data with open-access repositories using geographic information systems (GIS). Comparing our LTS classification with city reports, we found that the number of bicyclists' fatal and non-fatal collisions per kilometer is positively correlated with higher LTS. Finally, to support policy making, we developed a web-enabled dashboard to visualize and analyze the LTS classification and its underlying variables.

1. Introduction

The Level of Traffic Stress (LTS) is an indicator that classifies the components of a road network according to the stress experienced by cyclists (P. G. Furth, Mekuria, & Nixon, 2016; Mekuria, Furth, & Nixon, 2012). The original LTS indicator classifies

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Consequences of climate drivers on burned grassland area in Xilingol, China

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Consequences of climate drivers on burned grassland area in Xilingol, China☆

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ABSTRACT

The potential links between climate change and grassland fires have received considerable attention, but few studies have examined the potential effects of climate variability on burned grassland area within the extensive grassland steppes of Eurasia. We used a novel econometric approach, dynamic simulated autoregressive distributed lag (ARDL) modeling, to explore the relationship among average monthly wind speed, sunlight, maximum temperature, mean temperature, relative humidity, and precipitation on burned grassland area in Xilingol, a large grassland-dominated landscape of Inner Mongolia in northern China. We provide a detailed explanation of this methodology and its potential usefulness to fire ecologists. Dynamic ARDL modeling indicated that burned grassland area was associated with both short-term fluctuations in climate and long-term climate trends. Our long-term analysis demonstrates that burned grassland area was most sensitive to wind speed and temperature. A 1% increase in wind speed was associated with an 86% increase in burned grassland area while a 1% increase in maximum temperature was associated with a 55% increase in burned grassland area. Under future climate change scenarios, our model predicts that by the year 2050 increases in average monthly wind speed, maximum temperature, and mean temperature will play a critical role in increasing the area of grassland burned relative to the baseline period of 2001–2018. Dynamic simulated ARDL methodology provides insights into the variability of area burned across Inner Mongolia grassland in the context of anthropogenic climate change, as well as the potential for broader applicability to predict changes in burned area with future climate scenarios across a range of grass-dominated ecosystems.

Introduction

Mongolia contains one of the world's most extensive contiguous grasslands (Ren et al. 2019; Wang et al. 2019). These grasslands have ecological, cultural, and carbon cycling significance at regional and global scales (Piao et al. 2009; Lu et al. 2019). Approximately 80% of Inner Mongolia—that portion of the Mongolian steppe found in China—is covered by arid and semiarid grasslands, which provide some of the last remaining refuges for a range of wild ungulates and traditional pastoral practices (Gao et al. 2016; Liu et al. 2017). These steppe landscapes are vulnerable to degradation and have been in declining ecological health for more than 60 yr (Schaffrath and Bernhofer 2013; Chen et al. 2015; Godde et al. 2019). An estimated 90% of existing grasslands are degraded due to aridification, shrub encroachment, and physical damage due to overgrazing and other land use practices (Schaffrath and Bernhofer 2013; Wu et al. 2014; Chen et al. 2015; Fan et al. 2019). Liu et al. (2013) suggest that Mongolian steppes are highly susceptible to species loss due to limited natural functional redundancy across species.

The Mongolian steppe is an important subregion of the more widespread Eurasian Steppe characterized by long, cold winters and short summers with high temperatures; most precipitation is received in summer and the short transitional periods on either side of summer, although rainfall can be variable (50-400 mm across the regions) (Schaffrath and Bernhofer 2013). Average

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Pricing rainfall derivatives in the equatorial Pacific

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Pricing rainfall derivatives in the equatorial Pacific

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Abstract

Purpose – In the equatorial Pacific, rainfall is affected by global climate phenomena, such as El Niño Southern Oscillation (ENSO). However, current publicly available methodologies for valuing weather derivatives do not account for the influence of ENSO. The purpose of this paper is to develop a complete framework suitable for valuing rainfall derivatives in the equatorial Pacific.

Design/methodology/approach – In this paper, we implement a Markov chain for the occurrence of rain and a gamma model for the conditional quantities using vector generalized linear models (VGLM). The ENSO forecast probabilities reported by the International Research Institute for Climate and Society (IRI) are included as independent variables using different alternatives. We then employ the Esscher transform to price rainfall derivatives.

Findings – The methodology is applied and calibrated using the historical rainfall data collected at the El Dorado airport weather station in Bogotá. All the estimated coefficients turn out to be significant. The results prove more accurate than those of Markovian gamma models based on purely statistical descriptions of the daily rainfall probabilities.

Originality/value – This procedure introduces the novelty of incorporating variables related to the climatic phenomena, which are the forecast probabilities regularly published for the occurrence of El Niño and La Niña.

Keywords Weather derivatives, Rainfall, ENSO, Esscher transform

Paper type Research paper

1. Introduction

Weather derivatives are financial instruments that hedge the risk associated with unexpected or adverse weather conditions (Jewson and Brix, 2005; Alexandridis and Zapranis, 2013). Their payoffs depend on the values of underlying weather variables, such as rainfall, temperature, wind, solar irradiance, snowfall and humidity (Cao and Wei, 2004). Organizations and individuals have used weather derivatives as part of risk management strategies to cover non-catastrophic weather events (Alexandridis and Zapranis, 2013). The Chicago Mercantile Exchange (CME) estimated that nearly 30% of the US economy and 70% of US companies are exposed to weather risk (CME, 2005). However, pricing these financial instruments is difficult, because the data collection accuracy can be affected by extreme weather or systematic errors; besides, the historical record is short and the statistical properties can be complex (Xu *et al.*, 2008; Dischel, 2000; Little *et al.*, 2009; Cabrera *et al.*, 2013).

According to the Weather Risk Management Association (WRMA), approximately 53% of the over-the-counter (OTC) weather derivatives transactions are based on temperature, and 23% are based on rainfall (WRMA, 2011). The considerable gap between the uses of temperature and rainfall derivatives makes it difficult to estimate the value of the underlying asset (Cabrera *et al.*, 2013). In contrast to the daily average temperature and daily wind speed, the daily rainfall is a binary event that cannot be modeled using geometric Brownian motion (GBM) or a mean-reverting (MR) stochastic process using seasonality for the mean and variance (Wilks, 2011; Benth and Benth, 2013; Alexandridis and Zapranis, 2013).

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An exact bidirectional pulse algorithm for the constrained shortest path

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SPECIAL ISSUE ARTICLE

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An exact bidirectional pulse algorithm for the constrained shortest path

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Abstract

A constrained shortest path is a minimum-cost sequence of arcs on a directed network that satisfies knapsack-type constraints on the resource consumption over the arcs. We propose an exact method based on a recursive depth-first search procedure known as the pulse algorithm (PA). One of the key contributions of the proposal lies in a bidirectional search strategy leveraged on parallelism. In addition, we developed a pulse-based heuristic that quickly finds near-optimal solutions and shows great potential for column generation (CG) schemes. We present computational experiments over large real-road networks with up to 6 million nodes and 15 million arcs. We illustrate the use of the bidirectional PA in a CG scheme to solve a multi-activity shift scheduling problem, where the pricing problem is modeled as a constrained-shortest path with multiple resource constraints.

KEYWORDS
bidirectional search, constrained shortest path, large-scale networks

1 | INTRODUCTION

Let $\mathcal{G} = (\mathcal{N}, \mathcal{A})$ be a directed graph defined by a set of nodes $\mathcal{N} = \{v_1, \ldots, v_n\}$ and a set of directed arcs $\mathcal{A} = \{(i,j) \mid v_i \in \mathcal{N}, v_j \in \mathcal{N}, i \neq j\}$. Each arc $(i,j) \in \mathcal{A}$ has a corresponding nonnegative cost c_{ij} and a nonnegative resource consumption vector $\mathbf{t}_{ij} \in \mathbb{R}^m$. The constrained shortest path problem (CSP) consists on finding a path $\mathcal{P}$ between a start node $v_s \in \mathcal{N}$ and an end node $v_e \in \mathcal{N}$ that minimizes the total cost, without exceeding a maximum resource consumption vector $\mathbf{T} \in \mathbb{R}^m$. Unless stated otherwise, for simplicity in the exposition, we assume throughout the paper that $m = 1$, thus the resource consumption t_{ij} and resource limit T are scalars. The CSP is known to be NP-hard even for the case of one resource [14].

The CSP naturally arises in a wide range of transportation and logistics applications. Zabarankin et al. [32] model an aircraft's flight trajectory problem in which the goal is to minimize exposure to radars while satisfying technical constraints such as trajectory length. Cabral et al. [5] model a telecommunication network design in which the goal is to find a set of edges that allow for minimum cost paths between communicating pairs of nodes while satisfying a constraint on the path length (in the case of a single pair of communicating nodes, the problem reduces to the CSP). In addition, the CSP is often used as an *auxiliary problem* in column generation (CG) schemes. CG is a technique that solves linear programs with a large number of decision variables. Instead of considering all the variables at once, CG starts with a modestly sized subset of variables and incorporates candidate variables in an iterative fashion. At every iteration of a CG scheme, the goal is to either prove optimality or choose a promising decision variable to enter the basis. This goal is accomplished by solving an optimization problem, known as the auxiliary problem [7]. Examples of problems in which variants of the CSP appear as an auxiliary problem in a CG scheme include planning and routing [6], flight planning [15], crew pairing [18], shift scheduling [26], and tail assignment in aircraft scheduling [16], among others.

There is significant literature addressing the CSP through different solution strategies including dynamic programming-based (DP) labeling algorithms [10,34], Lagrangian relaxation [27], and path ranking approaches [17,29,30,33],

Building a Methodological Foundation for Impactful Urban Planetary Health Science

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BRIEF REPORT

Building a Methodological Foundation for Impactful Urban Planetary Health Science

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Abstract Anthropogenic environmental change will heavily impact cities, yet associated health risks will depend significantly on decisions made by urban leaders across a wide range of non-health sectors, including transport, energy, housing, basic urban services, and others. A subset of planetary health researchers focus on understanding the urban health impacts of global environmental change, and how these vary globally and within cities. Such researchers increasingly adopt collaborative transdisciplinary approaches to engage policy-makers, private citizens, and other actors in identifying and evaluating potential policy solutions that will reduce environmental impacts in ways that simultaneously promote health, equity, and/or local economies—in other words, maximising 'co-benefits'. This report presents observations from a participatory

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Bicycle safety in Bogotá: A seven-year analysis of bicyclists' collisions and fatalities.

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Bicycle safety in Bogotá: A seven-year analysis of bicyclists' collisions and fatalities

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Latin America

ABSTRACT

Road safety research in low- and middle-income countries is limited, even though ninety percent of global road traffic fatalities are concentrated in these locations. In Colombia, road traffic injuries are the second leading source of mortality by external causes and constitute a significant public health concern in the city of Bogotá. Bogotá is among the top 10 most bike-friendly cities in the world. However, bicyclists are one of the most vulnerable road-users in the city. Therefore, assessing the pattern of mortality and understanding the variables affecting the outcome of bicyclists' collisions in Bogotá is crucial to guide policies aimed at improving safety conditions. This study aims to determine the spatiotemporal trends in fatal and nonfatal collision rates and to identify the individual and contextual factors associated with fatal outcomes. We use confidence intervals, geostatistics, and generalized additive mixed models (GAMM) corrected for spatial correlation. The collisions' records were taken from Bogotá's Secretariat of Mobility, complemented with records provided by non-governmental organizations (NGO). Our findings indicate that from 2011 to 2017, the fatal bicycling collision rates per million kilometers traveled have decreased by 50 % for females and 54 % for males. Additionally, we identified high-risk areas located in the west, southwest, and southeast of the city, where the rate of occurrence of fatal events is higher than what occurs in other parts of the city. Finally, our results show associated risk factors that differ by sex. Overall, we find that fatal collisions are positively associated with factors including collisions with large vehicles, the absence of dedicated infrastructure, steep terrain, and nighttime occurrence. Our findings support policy-making and planning efforts to monitor, prioritize, and implement targeted interventions aimed at improving bicycling safety conditions while accounting for gender differences.

1. Introduction

Bicycling provides substantial benefits to the health and wellbeing of the population and is relevant for the development of a healthy and sustainable environment (Deenihan and Caulfield, 2014; Oja et al., 2011). Among children and adolescents, bicycling can prevent obesity and improves cardiorespiratory fitness (Oja et al., 2011; Sarmiento et al., 2015). Among adults, bicycling is associated with risk reduction for all-cause and cancer mortality; with risk reduction for cardiovascular, diabetes, cancer, and obesity morbidity (Celis-Morales et al., 2017); and with improvement in mental health (Mueller et al., 2015). Hence, bicycling may result in reductions in health care costs (Ding et al., 2016; Elvik, 2000) and increases in the gross domestic product (Fishman et al., 2015). Furthermore, increasing bicycling for commuting and recreation can mitigate greenhouse gas emissions, improve air quality, and can also reduce noise and vehicular congestion (Gössling et al., 2019; Krizec, 2007; Macmillan et al., 2014; Rabl and de Nazelle, 2012).

Despite the benefits of bicycling, research has shown that concerns related to traffic safety constitute a significant adoption barrier for bicycling (DiGioia et al., 2017). A significant percentage of the population across cities and countries are interested in bicycling but remain

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Improving harvesting operations in an oil palm plantation.

27/06/2020

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S.I.: AGRICULTURE ANALYTICS, BIGDATA AND SUSTAINABLE DEVELOPMENT

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Improving harvesting operations in an oil palm plantation

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Abstract
Oil palm agricultural systems involve large extensions of land that demand careful planning of the harvesting operations. The plantation manager is in charge of synchronizing resources (i.e., crews and a complex cableway network) to harvest at the right time to maximize palm oil yield in latter stages of the value chain. In particular, in this type of crop it is ideal to visit each palm every eight to twelve days to avoid loose fruit picking, overripeness, or rotten fruit harvesting. To optimize harvest operations, we propose an end-to-end analytics solution involving data treatment, descriptive (simulation), and prescriptive models (optimization) in this agricultural system. At the core of our approach lies a set of interconnected models that use optimization, heuristic techniques, and simulation. These models cover strategic (harvest cycle), tactical (resource allocation), and operational (transport allocation) decisions. We present a case study of a 2000-ha plantation located in the Colombian Orinoquia. The results show a strong potential for improving yield by reducing the harvest cycle length from 19.6 to 8.3 days.

Keywords Column generation · Scheduling · Discrete event simulation · Agricultural systems · Operations research in agriculture

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An exact optimization approach to the principal-agent problem in infrastructure projects via PPPs.

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An exact optimization approach to the principal-agent problem in infrastructure projects via PPPs

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ABSTRACT

PPPs are a compelling mechanism for infrastructure procurement but are vulnerable to the principal-agent problem due to the divergence in the parties' utility functions. This research considers PPPs in infrastructure maintenance problems, in which the *principal* pursues high performance levels, whereas the *agent* pursues cost-efficiency. This paper proposes an optimization model that describes infrastructure performance as a result of deterioration and maintenance processes, and computes the associated benefits and costs for the principal and the agent, combining game theoretical notions with life-cycle analysis. Illustrative examples show how the organizational conditions surrounding PPPs shape the parties' decisions and outcomes by running the model under different scenarios. For instance, the model can anticipate the agent's optimal reaction to specific contractual conditions; i.e., what maintenance plan can be expected from a contractor depending on whether certain performance-related constraints or incentives are in place. Finally, the model can find the optimal maintenance plan for one party conditioned on respecting the other party's optimum within a specified tolerance. This allows to explore a variety of middle-ground solutions and choose an alternative in which one party's gain exceeds the other's loss, providing evidence for incentive design. This research provides a quantitative tool to support decisions and policy on PPPs by integrating physical, financial, and organizational aspects of infrastructure management.

KEYWORDS
Infrastructure maintenance; exact optimization; public-private partnerships; principal-agent problem

Introduction

Public Private Partnerships (PPPs) have been widely discussed and implemented worldwide as a means to leverage the development of public projects with the participation of private companies, with infrastructure projects being a typical case in which PPPs show interesting potential. PPPs, however, have been criticized, among other issues, because of the potential conflicts of interest that may arise when business-oriented actors get involved in the public realm. For instance, while the highest system performance is desirable from a public perspective, financial pressure may drive private companies in a different direction, which is of particular concern in contexts where institutions are weak, and corporations have disproportionate influence on policy and regulation (Percoco 2014; Liu et al. 2016). There is, thus, a challenge in developing analysis tools that help determine the conditions under which PPPs may be adequate, relying on comprehensive technical evidence, and aside from ideological controversies.

Infrastructure management problems are complex, as they integrate a variety of phenomena and fields of knowledge. Broadly, these include the behavior of physical components (e.g., roads, bridges, buildings); the analysis of societal costs and benefits associated to infrastructure systems; and the analysis of coupled decision-making processes between involved actors, considering the influence of the legal and organizational framework (e.g., through regulation and/or incentives). The analysis of complex infrastructure management problems should, thus, respond to a thorough yet tractable integration of these aspects, which poses a challenging problem in mathematical and computational modeling.

This research proposes a methodological framework that integrates technical, financial, and organizational aspects of PPPs into exact optimization models that allow to analyze the interactions and decision strategies of governments and companies in the context of infrastructure management projects. We analyze decisions for involved actors adopting the notion of agency problem, in which a principal (in this case the government) hires an agent (in this case a private company) to perform a task. The problem arises as the agent may take advantage of information asymmetries to pursue its individual benefit to the detriment of the task. The proposed methodology integrates these key aspects of infrastructure management into a model that enables quantitative analysis of PPPs.

Figure 1 provides an overview of the optimization model that supports the proposed methodology. Its purpose is to describe a system's physical performance through its life cycle as a function of deterioration and maintenance, which in turn determine outcomes for the parties in a PPP. The left-hand side of the figure describes the model in terms of its objective function (maximization of utility from the perspective of either the principal or the agent) and four blocks of constraints. The right-hand side illustrates the phenomena or aspects related to each of the blocks. The first block of constraints models the system's performance using deterioration functions as an input parameter. The second block translates the performance (often related to continuous physical variables) to a set of discrete service levels, which

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Effects of a Physical Activity Program Potentiated with ICTs on the Formation and Dissolution of Friendship Networks of Children in a Middle-Income Country.

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Article

Effects of a Physical Activity Program Potentiated with ICTs on the Formation and Dissolution of Friendship Networks of Children in a Middle-Income Country

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Abstract: This paper assesses the potential cohesion effect of a physical activity (PA) school-based intervention potentiated using text messages (SMS) through analyzing longitudinally the friendship network structure and the mechanisms of the formation and dissolution of friendships. Three schools (n = 125 participants) in Bogotá, Colombia, were randomly assigned into three groups: Modulo Activo Recreo Activo (MARA) + SMS (networks 1 and 2), MARA (networks 3 and 4), and control (no intervention: networks 5–7). We collected socio-economic, health-related, network structure, and intervention satisfaction variables in the baseline and after 10 weeks on July–November 2013. For each classroom network, we conducted four models using a temporal and static network approach to assess (1) temporal social network changes, (2) friendship homophily, (3) friendship formation and dissolution mechanisms, and (4) effect of SMS on the networks' cohesion. We found that (1) social cohesion emerged in the four intervened networks that were measured over time with transitivity and homophily driven by clustering, (2) the intervention affected the mechanisms of friendship formation and dissolution, and (3) MARA + SMS on average created more social cohesion and 3.8 more friendships than the program alone. Potentially, school-based interventions with information and communication technologies (ICT) such as MARA + SMS could encourage social cohesion among children. The particular characteristics of each school network need to be considered when developing school-based interventions.

Keywords: physical activity; technology; QAP logistic regression; STERGM; friendship ties; social network analysis; eHealth; mobile phone interventions

MECHANISMS Study: Using Game Theory to Assess the Effects of Social Norms and Social Networks on Adolescent Smoking in Schools—Study Protocol.

04/08/2020

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MECHANISMS Study: Using Game Theory to Assess the Effects of Social Norms and Social Networks on Adolescent Smoking in Schools—Study Protocol

Ruth F. Hunter[1], Felipe Montes[2], Jennifer M. Murray[1], Sharon C. Sanchez-Franco[3], Shannon C. Montgomery[1], Joaquín Jaramillo[3], Christopher Tate[1], Rajnish Kumar[4], Laura Dunne[5], Abhijit Ramalingam[6], Erik O. Kimbrough[7], Erin Krupka[8], Huiyu Zhou[9], Laurence Moore[10], Linda Bauld[11], Blanca Llorente[12], Olga L. Sarmiento[3] and Frank Kee[1]*

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This proof of concept study harnesses novel transdisciplinary insights to contrast two school-based smoking prevention interventions among adolescents in the UK and Colombia. We compare schools in these locations because smoking rates and norms are different, in order to better understand social norms based mechanisms of action related to smoking. We aim to: (1) improve the measurement of social norms for smoking behaviors in adolescents and reveal how they spread in schools; (2) to better characterize the mechanisms of action of smoking prevention interventions in schools, learning lessons for future intervention research. The *A Stop Smoking in Schools Trial* (ASSIST) intervention harnesses peer influence, while the Dead Cool intervention uses classroom pedagogy. Both interventions were originally developed in the UK but culturally adapted for a Colombian setting. In a before and after design, we will obtain psychosocial, friendship, and behavioral data (e.g., attitudes and intentions toward smoking and vaping) from ∼300 students in three schools for each intervention in the UK and the same number in Colombia (i.e., ∼1,200 participants in total). Pre-intervention, participants take part in a Rule Following task, and in Coordination Games that allow us to assess their judgments about the social appropriateness of a range of smoking-related and unrelated behaviors, and elicit individual sensitivity to social norms. After the interventions, these behavioral economic experiments are repeated, so we can assess how social norms related to smoking have changed, how sensitivity to classroom and school year

Social cohesion emerging from a community-based physical activity program: A temporal network analysis.

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Social cohesion emerging from a community-based physical activity program: A temporal network analysis

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Abstract

Community-based physical activity programs, such as the Recreovía, are effective in promoting healthy behaviors in Latin America. To understand Recreovías' challenges and scalability, we characterized its social network longitudinally while studying its participants' social cohesion and interactions. First, we constructed the Main network of the program's Facebook profile in 2013 to determine the main stakeholders and communities of participants. Second, we studied the Temporal network growth of the Facebook profiles of three Recreovía locations from 2008 to 2016. We implemented a Time Windows in Networks algorithm to determine observation periods and a scaling model of cities' growth to measure social cohesion over time. Our results show physical activity instructors as the main stakeholders (20.84% nodes of the network). As emerging cohesion, we found: (1) incremental growth of Facebook users (43–272 nodes), friendships (55–2565 edges), clustering coefficient (0.19–0.21), and density (0.04–0.07); (2) no preferential attachment behavior; and (3) a social cohesion super-linear growth with 1.73 new friendships per joined user. Our results underscore the physical activity instructors' influence and the emergent cohesion in innovation periods as a co-benefit of the program. This analysis associates the social and healthy behavior dimensions of a program occurring in natural environments under a systemic approach.

Keywords: social network analysis; temporal networks; community-based interventions; socially transmitted conditions; physical activity

1. Introduction

In low- and middle-income countries, non-communicable diseases cause 48% of annual deaths, which are mainly attributed to health-related behaviors (Allen et al., 2017; Riley et al., 2017). The World Health Organization promotes physical activity as an effective behavior to prevent non-communicable diseases (Basu & Dutta, 2008), recently reframed as socially transmitted conditions (Allen & Feigl, 2017).

Integrated planning decisions in the broiler chicken supply chain.

12/08/2020

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INTERNATIONAL TRANSACTIONS IN OPERATIONAL RESEARCH

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

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Fifteen-Year Follow-Up of Stapedotomy Patients: Audiological Outcomes and Associated Factors in a Middle Income Country.

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Fifteen-Year Follow-Up of Stapedotomy Patients: Audiological Outcomes and Associated Factors in a Middle Income Country

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Keywords
Stapedotomy · Long-term hearing outcomes · Preoperative air-bone gap · Long-term bone conduction deterioration

Abstract
Objective: To evaluate the short-term (postoperative), medium-term (5 years), and long-term (10 and 15 years) audiometric results of patients who underwent stapedotomy and to determine specific factors associated with better postoperative outcomes. ***Methods:*** This study is a retrospective case review of 486 ears with surgically confirmed stapes fixation who underwent microscopic small fenestra stapedotomy. Preoperative, postoperative, and medium- and long-term air conduction (AC), bone conduction (BC), and air-bone gap (ABG) were assessed. Postoperative factors associated with better postoperative outcomes were evaluated. ***Results:*** At 10- and 15-year follow-ups, ABG, AC, and BC were significantly deteriorated but clinically preserved in comparison with postoperative results. According to a multiple quantile regression, younger age was associated with better postoperative results at 0.25 kHz ($p = 0.003$) and 4 kHz ($p = 0.028$) and a smaller preoperative ABG was associated with better audiometric results at 0.25 kHz ($p = 0.048$), 0.5 kHz ($p = 0.001$), and 4 kHz ($p = 0.001$). In addition, younger age ($p = 0.001$ for AC and $p < 0.001$ for BC) and preoperative AC PTA ($p < 0.001$ for AC) were significantly associated with better postoperative AC and BC PTA. ***Conclusions:*** Stapedotomy surgery provides short-, medium-, and long-term hearing benefits in our studied cohort. ABG, AC, and BC thresholds obtained after the surgery are clinically preserved in 5-, 10-, and 15-year follow-ups, with an age-expected BC deterioration. Smaller preoperative ABG and younger age were positive predictors for better postoperative ABG. Future research should address long-term subjective and quality of life outcomes.

Introduction

Otosclerosis is a temporal bone disease that affects the otic capsule, producing fixation of the stapes and therefore conductive hearing loss. Its prevalence has been estimated to be around 0.3% [Declau et al., 2001] in Western countries, but its etiology and pathophysiologic mechanisms still remain unknown. The mainstay of treatment is the surgical improvement of the hearing loss by either

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Package Cargo: A decision support tool for the container loading problem with stability.

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PackageCargo: A decision support tool for the container loading problem with stability

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ABSTRACT

This article presents PackageCargo. A modular open-source application developed using the Unity game engine to calculate, visualize, and save efficient packing patterns to instances of the Container Loading Problem (CLP). The packing patterns are obtained through approximate optimization algorithms (metaheuristics). Additionally, the proposed tool allows us to estimate cargo stability metrics through the implementation of mathematical models and verify the results of said models using a simulation environment built with the PhysX library. The goal of this application was to create a usable decision support system suitable for industrial purposes as well as a platform for academic research. It is offering a modifiable framework that can adapt to the necessities of its users, saving them software development time while continuing to extend PackageCargo through community contributions. The resulting application was compared with commercial software solutions. Furthermore, each module was tested using the most successful approaches found in literature as benchmarks. The packing module was compared against the top-performing algorithm published to date, obtaining similar results in similar computational times. The simulation module for cargo stability was benchmarked against high-performance simulation software, validating its accuracy and performance. Accordingly, PackageCargo was found to have a competitive feature set useful in both academic and commercial settings. As future work, it is proposed to combine the different modules to solve more sophisticated variants of the CLP, like the container loading problem constrained to weight distribution profiles.

Code metadata

Current code version	v1.0.1
Permanent link to code/repository used for this code version	https://github.com/ElsevierSoftwareX/SOFTX_2020_198
Code Ocean compute capsule	
Legal Code License	GPL 3.0
Code versioning system used	git
Software code languages, tools, and services used	C++, C#, MySQL, Unity, PhysX
Compilation requirements, operating environments & dependencies	Unity Editor 5.6.6 or higher
If available Link to developer documentation/manual	
Support email for questions	jc.martinez10@uniandes.edu.co

Software metadata

Current software version	1.0.1
Permanent link to executables of this version	For example: https://github.com/jcmartinez10/PackageCargo/releases/tag/v1.0.1-alpha
Legal Software License	GPL-3.0
Computing platforms/Operating Systems	Microsoft Windows, distributed/web based
Installation requirements & dependencies	Unity Editor 5.6.6 or higher
If available, link to user manual - if formally published include a reference to the publication in the reference list	https://github.com/jcmartinez10/PackageCargo/blob/master/README.md
Support email for questions	jc.martinez10@uniandes.edu.co

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Agent-Based Modeling for Urban Development Planning based on Human Needs. Conceptual Basis and Model Formulation.

08/10/2020

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Agent-Based Modeling for Urban Development Planning based on Human Needs. Conceptual Basis and Model Formulation

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ABSTRACT

A city comprises an ecological environment, a living and architectural space, the product of a history of human interactions that determines its morphology and destiny. Cities are complex systems that encompass elements of diverse types, such as natural objects, technical artifacts, human actors and social entities, including the rules or laws governing their behavior. Despite cities complexity, conventional urban policy models have focused on expanding and building places geared toward satisfying economic activities and markets. In this paper we propose an agent based model (ABM) for urban development planning based on the relationship between city inhabitants and the satisfaction of their basic needs with their physical environment. Our design recognizes human complexity within the urban contexts and establishes a new method for planning city development with the help of a tool geared toward simulating participation. This simulation platform makes it possible to consider the effects of human behavior as a determinant of the success or failure of urban interventions from the point of view of planning. The central elements of the simulation model are the relationship of each individual to the physical environment of the city and the satisfaction of their basic needs. This simulation platform can be used as a starting point on a collective and prospective vision of the city, grounded in the approach and experience of participatory modeling with multiple stakeholders.

1. Introduction

When examining the richness and complexity of human habitation in a city, questions regarding the way in which urban planning responds to its inhabitants' way of life immediately arise. Developing a city poses a series of implications concerning human actions, interests, relations and knowledge. Nevertheless, the predominant thinking in urban development is frequently focused on expanding and building places geared toward satisfying economic activities and the needs of the market. Addressing the complexity of human behavior in relation to the place people inhabits is a key challenge in planning city development.

A city comprises an ecological environment, a living and architectural space, the product of a history of human interactions that determines its morphology and destiny. It can be conceptually divided into five interrelated territorial dimensions and their connections with the needs of individuals: political/institutional, sociocultural, economic/productive, urban/regional and the natural base that supports all the others (Villegas-González et al., 2017).

From this perspective, sustainable territorial development should result in the synergy between all the dimensions over time and space and in the satisfaction of the basic needs of the city's inhabitants. Since our focus in the city is on its inhabitants and the relationship of development and planning models to their well-being, we conceive urban systems or cities as a sociotechnical systems (Kroes, 2009), comprised of elements of diverse types, such as natural objects, technical artifacts, human actors and social entities, including the rules or laws governing their behavior. Cities are complex, adaptive systems, with emergent properties that result from microlevel interactions and behaviors (Batty, 2005a). From this point of view, urban development planning is a complex task that requires understanding the city from a territorial perspective and its development as the synergy among all the dimensions that comprise it.

The study of urban phenomena requires thinking and acting in the integral field of knowledge, including fundamental elements such as the human experience of the environment. Many problems of the real world are often complex and are not solved within the narrow limits of an academic discipline (Phillips & Pugh, 2010). Addressing a problem of this nature requires an interdisciplinary approach that achieves a

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Cutting parameter optimization of Al-6063-O using numerical simulations and Particle Swarm Optimization.

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Cutting parameter optimization of Al-6063-O using numerical simulations and particle swarm optimization

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Abstract
Machining process simulations are commonly used by manufacturing industries to accurately predict machining force, time, and the performance of engineering components. Determination of optimal conditions of machining parameters is fundamental as it directly affects the material properties, surface finish quality, and the cutting tool life, among other objectives. In this work, we propose a multi-objective particle swarm optimization (PSO) algorithm, in order to determine the optimal machining parameters; i.e., rake angle (α), velocity (V), and cutting feed (f) using finite element (FE) simulation of orthogonal cutting. We evaluate the optimality of the problem for three objectives: (i) minimize the cutting force, (ii) maximize the microstructure refinement, and (iii) maximize material removal rate (MRR) in machining of Aluminum 6063. Minimum cutting force, higher refinement, and higher MRR are desirable in order to achieve enhanced cutting tool life, higher strength of the material, and higher machining performance, respectively. First, we develop the input-output relationships as well as the in-process parameter correlations using response surface methodology (RSM) and artificial neural network (ANN). Next, we use the particle swarm optimization technique combined with weight aggregation method to solve the multi-objective PSO (MOPSO) problem resulting in Pareto optimal solutions. Finally, we compare three machining conditions from the Pareto front in which one of the objective functions is optimized and the results show that a trade-off point can be drawn among the low cutting force, high microstructure refinement, and high MRR. A sample condition from the Pareto front is created experimentally resulting in good agreement with the model output. The optimization models can potentially enable the achievements of the desired objectives through the integration of the MOPSO algorithm with most of the available finite element simulations of machining.

Keywords Orthogonal cutting · Particle swarm optimization · FEM analysis · Microstructure · Material removal rate

1 Introduction

Emerging trajectories in the globally competitive environment of manufacturing demand simultaneously increase in productivity while enhancing surface quality as well as often difficult-to-realize material property combinations. Accordingly, a major challenge in metal cutting manufacturing processes is to minimize the manufacturing cost without sacrificing the quality or the enhanced material property of the engineering components. Consequently, the machine tools require optimization algorithms for an efficient selection of machining parameters such as the cutting speed, cutting feed, cutting angle, and depth of cut. In this context, the applications of optimization techniques in metal cutting manufacturing processes are substantial, enabling them to respond effectively to the arduous competitiveness and the increasing demand for high-quality products with enhanced properties in the market.

The challenge of selecting the optimal machining parameters in different metal cutting processes such as turning, milling, hard turning, and drilling has been studied in a diverse degree of generality by many researchers. In these machining-based processes, the most commonly used optimization principles are material removal rate (MRR), surface roughness, tool wear, cutting force, tool life, and power and energy consumption [1]. These often-conflicting objectives aim to achieve the maximum production rate, minimum operational cost, and maximum quality of

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Is a social network approach relevant to football results?

31/10/2020

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Is a social network approach relevant to football results?☆

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ABSTRACT

We study the relevance of considering social network analysis in determining soccer results. As a benchmark, we start using a simple regression model based on past performance to try to determine the main trends of a soccer match based on probabilities of winning, losing or tying, as home or visiting teams. The success of this simple model, based on historical performance, is improved by the addition of network descriptors of both teams in a game. Therefore, such network measures do offer additional useful information in determining match outcomes. We validate our approach using the data of the Spanish League (*La Liga*) 2012–2013. We observe that betweenness centrality seems to provide additional relevance information related to the performance of a team during the tournament.

1. Introduction

Social network analysis has been one of the most used tools to visualize and comprehend different relations among the parts that constitute a social system [1–4]. In recent years, because of the inherent nature of team sports, it has turned out to be an interesting field to apply this type of analysis. Perhaps the most relevant example, soccer, has been analyzed considering this approach, and because of the availability of data [5,6], different tools from physics to statistics have been used for mining information about the relevant variables that could determine the outcome of matches. Of course soccer is undoubtedly a hot spot of research because of scientific interest into social behavior, but also because it is the most popular sport around the world [7–10].

In soccer, a useful and simple network approach consists in representing the passing among players by a graph (a mathematical object represented by vertexes and edges). The players are represented as nodes and passes between players (from player i to player j) as a weighted and directed edges. The weights of the edges are represented by the proportion of the number of passes between two players. Several analysis and variations may be considered, for example, Gould and Gatrell [11] presented a first paper where the passing network in soccer was introduced. Duch et al. [12] use network analysis to study the team performance based on interactions among the members of the team. This methodology was developed in the context of soccer, which stress the importance of ref. [11] that generated a number of works in the field [5,13–16]. For example, in Cotta et al. [17], Narizuka et al. [18], it is shown that passing networks in soccer seem to exhibit a small world structure, which implies a high clustering coefficient and low number of average steps to reach a particular node from any other. Showing that a particular network that describes the interactions in a system has this structure is important because several physical, biological, and social systems share the same structure, and provides evidence of the connection/functionality among members of the system.

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Spatiotemporal correlation study of trac accidents with fatalities and injuries in Bogota (Colombia)

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Spatiotemporal correlation study of traffic accidents with fatalities and injuries in Bogota (Colombia)

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ABSTRACT

The planning and location of resources for urban traffic management generate complex decision problems, given the uncertainty of variables that explain traffic behavior, the lack of data, and the large number of factors to be considered when creating optimal policies. In particular, the attention given to traffic-related accidents by local authorities requires the modeling and forecasting of events that are spatial and temporally defined. In this study we use data from the traffic police department in Bogota (Colombia) about incidents with injuries or fatalities between 2014 and 2016. We locate each event in spatial coordinates and crossed the observations with exogenous variables (climate, seasonal events and road properties). We model the spatiotemporal stochastic process for accidents using a Log-Gaussian Cox model given its flexibility as it enables the use of fixed and random effects. The results of this study are summarized in three main contributions: (i) identification of principal factors that increase the risk of traffic accidents and fatalities; (ii) identification of critical zones in the city that require more attention; and (iii) a predictive tool to forecast accidents in the future, including the stochastic properties that can be used in a prescriptive model.

1. Introduction

Traffic injuries are one of the leading causes of death around the world, with an estimation of being the seventh cause of death by 2030 (WHO et al., 2014). This figure increases for low and middle-income countries with emerging economies where urbanization and motorization accompany rapid economic growth (WHO, 2015). Nowadays, a large proportion of these fatalities occurs inside urban and metropolitan areas where risk factors associated with congestion and high densities of vehicles and pedestrians coexist (Ewing et al., 2003; Dumbaugh and Rae, 2009; Kmet and Macarthur, 2006; Vorko-Jović et al., 2006; Archer and Vogel, 2000). Consequently, risk mitigation and attention to urban accidents involving motor-vehicles are a major concern for global public administration and urban planning.

Strategic policies oriented towards the mitigation of the incidence rate of accidents in the long and middle-terms are designed by the means of education, law enforcement and urban planning. These actions are aimed at the reduction of causal risk factors associated with vehicle-drivers and pedestrian behavior (e.g. driving speed and the use of seat belts), and also with the change of environmental variables (e.g. road conditions and traffic lights). On the other hand, more short-term operational decisions include the planning and location of resources for in situ attention of accidents and injured victims. For the latter group of tactical decisions, it is required to understand the spatial and temporal phenomenon that govern the occurrence of accidents. That is, in order to plan ahead on how and where to attend incidents, it is necessary to approximate the number of events per time period according to their spatial distribution.

The spatiotemporal distribution of traffic accidents in urban areas, however, is a complex stochastic process that depends on many environmental factors. There are two main mathematical modeling alternatives for these processes: mechanistic and statistical models. The mechanistic models attempt to explain the occurrence of traffic accidents as the result of interaction among vehicles and dynamic spatial and temporal factors explained through a series of equations that are solved analytically or by simulation (e.g. Krajzewicz et al., 2012; Vallati et al., 2016). Statistical models use data taken from previous accidents to estimate the underlying probabilistic process that produces spatiotemporal events. These statistical models may be divided according to three main objectives: (i) models oriented to the explanation of risk factors

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Using open access data to model a technician routing and scheduling problem in a congested urban setting.

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Using Open Access Data to Model a Technician Routing and Scheduling Problem in a Congested Urban Setting

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Abstract

This research aims at studying and improving the attended home services delivery in the city of Bogota (Colombia) by considering varying traffic patterns along the day. The goal is to improve routing decisions by adopting appropriate travel time functions between pairs of locations that are built upon the basis of freely available information gathered from collaborative consumption platforms. In first place, data collected from Uber Movement ® platform is used to identify the 1-hour consolidated traffic patterns based on coordinates and time of the day for all pairs of neighborhoods within the city. However, not all the information is available, as there might exist some journeys scarcely required by Uber users. To overcome this problem, a K-nearest neighbor regression is used to predict missing travel times when required and considering as an input the coordinates and the time of the day. Then, a piecewise linear function representing the travel time between pairs of locations is constructed by assuming that a breakpoint, or change in the travel time behavior, takes place at the middle point of each one-hour time frame. A set of piecewise linear functions is then obtained after solving a system of linear equations. Following, two different approaches are used to generate solutions for a technician routing and scheduling problem with hard time windows. The first consists in an approximation Integer Programming model that represents the problems using an acyclic directed graph. The second consist in a Memetic Algorithm that minimizes the number of vehicles and vehicles field time. Preliminary results show that both approaches present similar results and can be used in practical applications.

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Seasonal weather and climate predict area burned in grasslands of northeast China.

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Seasonal weather and climate predict area burned in grasslands of northeast China

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Grassland fire dynamics are subject to myriad climatic, biological, and anthropogenic drivers, thresholds, and feedbacks and therefore do not conform to assumptions of statistical stationarity. The presence of non-stationarity in time series data leads to ambiguous results that can misinform regional-level fire management strategies. This study employs non-stationarity in time series data among multiple variables and multiple intensities using dynamic simulations of autoregressive distributed lag models to elucidate key drivers of climate and ecological change on burned grasslands in Xilingol, China. We used unit root methods to select appropriate estimation methods for further analysis. Using the model estimations, we developed scenarios emulating the effects of instantaneous changes (i.e., shocks) of some significant variables on climate and ecological change. Changes in mean monthly wind speed and maximum temperature produce complex responses on area burned, directly, and through feedback relationships. Our framework addresses interactions among multiple drivers to explain fire and ecosystem responses in grasslands, and how these may be understood and prioritized in different empirical contexts needed to formulate effective fire management policies.

Human-populated grassland ecosystems are especially responsive to interrelated and dynamic physical, social, and biological forces. Climate, human-driven ignition and grazing dynamics, vegetation, and fuel characteristics, all interact to shape fire activity in grassland ecosystems[1–9]. Incidence and seasonality of grassland fire are both associated with natural climate variations and anthropogenic ignition patterns[3,9–12]. The potentially complex interactions among these drivers, along with anthropogenic climate change and the importance of grasslands ecosystems to sustaining regional livelihoods, add urgency to better understanding these relationships over multi-year periods.

Burned grassland extent is influenced by regional climate change through increasing temperature which reduces fuel moisture and, thereby, increases flammability[13–16], but climate change also alters productivity, biomass abundance, and carbon emissions[17,18], all factors which drive fuel accumulation dynamics[13,19,20]. Further, effects of changing climates on fire activity may only manifest once critical thresholds are crossed[21,22]. Such feedbacks and thresholds can mediate subsequent ecosystem responses to ecosystem drivers in the face of significant change in the annual extent of burned grassland incidence. Ongoing and coherent short-term change in climate across the Xilingol region provide a responsive example of potential direct anthropogenic and climatic drivers shifting critical ecosystem responses through measurable ecological traits via threshold or non-linear relationships[22].

To ensure the provision of critical ecosystem services and the viability of grassland- dependent enterprises, ecologists and policymakers need reliable models to better understand the short- and long-term impacts of dynamic climatic and anthropogenic ecosystem drivers[22,23]. Because ecological responses can be relatively insensitive to climate, at least until thresholds are crossed[22], ecological modeling using ordinary least square regression (OLS) has proven to be of little value to wildfire policymakers and managers[24]. Applicability of these models in grassland ecosystems have been limited by poor connectivity between climatic processes and ecological response

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A specialized genetic algorithm for the fuel consumption heterogeneous fleet vehicle routing problem with bidimensional packing constraints.

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A specialized genetic algorithm for the fuel consumption heterogeneous fleet vehicle routing problem with bidimensional packing constraints

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The vehicle routing problem combined with loading of goods, considering the reduction of fuel consumption, aims at finding the set of routes that will serve the demands of the customers, arguing that the fuel consumption is directly related to the weight of the load in the paths that compose the routes. This study integrates the Fuel Consumption Heterogeneous Vehicle Routing Problem with Two-Dimensional Loading Constraints (2L-FHFVRP). To reduce fuel consumption taking the associated environmental impact into account is a classical VRP variant that has gained increasing attention in the last decade. The objective of this problem is to design the delivery routes to satisfy the customers' demands with the lowest possible fuel consumption, which depends on the distances of the paths, the assigned vehicles, the loading/unloading pattern and the load weight. In the vehicle routing problem literature, the approximate algorithms have had great success, especially the evolutionary ones, which appear in previous works with quite a sophisticated structure, obtaining excellent results, but that are difficult to implement and adapt to other variants such as the one proposed here. In this study, we present a specialized genetic algorithm to solve the design of routes, keeping its main characteristic: the easy implementation. By contrast, the loading of goods restriction is validated by means of a GRASP algorithm, which has been widely employed for solving packing problems. With a view of confirming the performance of the proposed methodology, we provide a computational study that uses all the available benchmark instances, allowing to illustrate the savings achieved in fuel consumption. In addition, the methodology suggested can be adapted to the version of solely minimizing the total distance traveled for serving the customers (without the fuel consumption) and it is compared to the best works presented in the literature. The computational results show that the methodology manages to be adequately adapted to this version and it is capable of finding improved solutions for some benchmark instances. As for future work, we propose to adjust the methodology to consider the three-dimensional loading problem so that it adapts to more real-life conditions of the industry.

1. Introduction

The delivery of goods to geographically dispersed customers plays a crucial role in the management of distribution and logistics, since it stands for a significant proportion of the operating expenses of the companies, mainly because of the high consumption and cost of fuel required for the whole operation. The delivery problem which has attracted the greatest attention is known as the vehicle routing problem (VRP) and it describes the distribution of goods from a main depot to a set of

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