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Publicaciones de *alto impacto*

Para el Departamento de Ingeniería Industrial es estratégico divulgar y compartir con el público general los resultados de investigación del más alto nivel realizados por nuestros profesores. Estos resultados son un motivo de especial orgullo para nuestro Departamento. La presente edición no. 9 cubre las publicaciones realizadas en el año 2022 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 requiere que 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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Publicaciones

- Cuéllar, D.; Palacio, A.; Ospina, E.; Botero, M. & Álvarez-Martínez, D. (2022). Modeling and solving the endpoint cutting problem. International Transactions in Operational Research (ISSN 0969-6016). https://doi.org/10.1111/itor.13091. Publicado: 1/01/2022

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Modeling and solving the endpoint cutting problem

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Modeling and solving the endpoint cutting problem

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Abstract

The material cutting process consists of two NP-hard problems: first, it is necessary to find the optimal cutting pattern to minimize the waste area. Second, it is necessary to find the cutting sequence over the plate to extract the pieces in the shortest possible time. The structure of the cutting path problem can vary according to the technology used in the process. In industries where material can be considered a commodity, the cutting path is decisive due to the need to operate economically and efficiently. These types of minimization demand exact models that use nonconventional formulation techniques in search of computational efficiency and for heuristic processes to be specialized so that a good solution is guaranteed. In this paper, three different approaches were proposed. First, a novel and accurate formulation was presented based on a network flow structure. Second, a reactive GRASP algorithm with solution filtering was designed, using seven operators executed under two randomly selected local search philosophies. Finally, four warm-start variants were designed hybridizing the GRASP algorithm subprocedures with the exact model. The approaches are compared through benchmarking; for this, a set ofinstances composed of cutting patterns taken from the solution of classical instances of the two-dimensional cutting problem was created and made available. The obtained results show that all three approaches solve the problem successfully. Additionally, the computing time is analyzed, illustrating the pros and cons of each approach. Given the cutting path, including the quality of the pieces is left as a future work proposal.

Keywords: endpoint cutting problem; GRASP; mixed-integer programming model; warm-start

1. Introduction

The material cutting process is a decisive stage in the production chain of multiple industries worldwide, highlighting the metal-mechanical, textile, glass, and wood industries, and having in common

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Exact bidirectional algorithm for the least expected travel-time path problem on stochastic and time-dependent networks

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ABSTRACT

The Least Expected Travel-time Path on Stochastic and Time-Dependent networks (LETP-STD) is the problem of finding, for a given departure time, the path between an origin and a destination that guarantees the minimum expected travel time. The difficulty in solving this problem arises from the nonlinear objective function and the fact that Bellman's principle of optimality does not hold. To tackle the LETP-STD, we propose an extension of the pulse algorithm, an exact method based on a recursive search that combines various pruning strategies to avoid complete exploration of the solution space. To accelerate our solution approach, we adapt several strategies that have proved their effectiveness in the deterministic context to the time-dependent stochastic domain, including a bidirectional adjustable search, an effective preprocessing method to remove nodes that are not part of the optimal solution, a lower bound on the objective function, and an upper-bound update procedure that joins the most promising paths. Finally, we derive the theoretical and empirical time complexity expressions of the algorithm. Experiments over a set of real-world transportation networks reveal that the algorithm compares favorably against the state-of-the-art methods.

1. Introduction

Finding the shortest paths on networks has drawn the attention of many researchers in the fields of operations research, transportation engineering, and computer science due to its extensive set of practical and theoretical applications. Several efficient solutions have been proposed when arc weights, representing distance, travel time, or cost, are defined as deterministic variables (Dijkstra et al. , 1959 ; Ahuja et al. , 1993). However, real-world applications inherit both uncertainty and dynamism. In particular, transportation networks can be heavily affected by random events such as weather, collisions, vehicle breakdowns, and natural disasters. Also, in the context of urban transportation, dynamism is an important factor in light of the systematic variability in the transportation demand, traffic flow, and mean travel times as a function of the time of day (e.g., peak vs. off-peak hours). Consequently, Stochastic and Time-Dependent (STD) networks, where arc travel times are considered as time-dependent random variables, provide a more coherent and precise representation of real-world transportation networks. On the one hand, uncertainty captures the random variations of the arcs' travel times, and on the other hand, dynamism considers their fluctuations along the time of day. As a result, STD models have become a strong modeling tool to represent transportation networks. Although deterministic shortest path algorithms have been demonstrated to be very effective, they may lead to suboptimal solutions in time-dependent stochastic contexts, leading to poor decision-making in real-world applications. Due to the high complexity and computational cost demanded to solve dynamic stochastic problems on large-size instances, there is a need for highly efficient algorithms that solve shortest path problems on STD networks.

In the context of STD networks, there are two predominant routing problems: time-adaptive strategies and a priori paths. In a strategy, the traveler makes en-route decisions regarding the next arc to use upon arrival to a node, meaning that the traveler adopts a policy for its route. More precisely, a strategy is a function that maps every feasible node and departure time combination to an arc. On the contrary, a path is an a priori route choice (i.e., ordered sequence of nonrepeating nodes) in which – regardless of the revealed information or actual traffic conditions – the traveler is not allowed to react or deviate from the selected path. Time-adaptive strategies lead to better solutions than a priori paths as they use unveiled information in the decision-making process (Gao, 2005 ; Hall , 1986).

Two main objectives have been studied on the stream of research of STD networks: the expected travel time and travel time reliability. The expected utility is the most straightforward metric to evaluate the performance of paths. Alternatively, and as a response to account for

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A hybrid matheuristic approach for the vehicle routing problem with three-dimensional loading constraints.

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A hybrid matheuristic approach for the vehicle routing problem with three-dimensional loading constraints

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This paper proposes a matheuristic algorithm based on a column generation structure for the capacitated vehicle routing problem with three-dimensional loading constraints (3L–CVRP). In the column generation approach, the master problem is responsible for managing the selection of best-set routes. In contrast, the slave problem is responsible for solving a shorter restricted route problem (CSP, Constrained Shortest Path) for generating columns (feasible routes). The CSP is not necessarily solved to optimality. In addition, a greedy randomized adaptive search procedure (GRASP) algorithm is used to verify the packing constraints. The master problem begins with a set of feasible routes obtained through a multi-start randomized constructive algorithm (MSRCA) heuristic for the multi-container loading problem (3D–BPP, three-dimensional bin packing problem). The MSRCA consists of finding valid routes considering the customers' best packing (packing first-route second). The efficiency of the proposed approach has been validated by a set of benchmark instances from the literature. The results show the efficiency of the proposed approach and conclude that the slave problem is too complex and computationally expensive to solve through a MIP.

1. Introduction

The integrated vehicle routing and packing problem, considering three-dimensional loading constraints (3L–CVRP), is categorized as an NP-hard problem because it is a generalization of two well-known problems: the vehicle routing problem and the packing problem (Garey & Johnson, 1979). Commonly, routing and packing problems consider general two-dimensional space constraints because they could be applied for several real-life cases. In this case, the pallet construction is set with a fixed maximum height, and there is no possibility of stacking products. However, the packing problem in many logistic contexts is usually a three-dimensional case. An influential research field is the decision-making process for routing decisions considering packing aspects for a set of customers. Both decisions are classic, complex, well-known combinatorial problems. The combined problem of routing and packaging has increased the attention of industry and practitioners of applied science. The main aim of this paper is to merge the container loading problem (CLP) with the conventional vehicle routing problem (VRP) by using three-dimensional (3D) constraints. The CLP seeks to identify the optimal place for shipping boxes to a set of customers. The CLP's key goal is to optimize the used space and inventory distribution without relocation aspects when a customer is visited by a vehicle on a given route. In addition, the VRP aims to minimize the distance traveled by the vehicles (Bernal et al., 2018; Linfati & Escobar, 2018). The capacitated vehicle routing problem with three-dimensional loading constraints (3L–CVRP) occurs when the VRP and CLP are combined. The 3L–CVRP considers the combination of two well-known NP-hard problems: the capacitated vehicle routing problem (CVRP) and the three-dimensional loading problem (3L).

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Smart Pooling: AI-powered COVID-19 informative group testing.

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Scientific Reports

Smart Pooling: AI-powered COVID-19 Informative Group Testing

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ABSTRACT

Massive molecular testing for COVID-19 has been pointed out as fundamental to moderate the spread of the pandemic. Pooling methods can enhance testing efficiency, but they are viable only at low incidences of the disease. We propose Smart Pooling, a machine learning method that uses clinical and sociodemographic data from patients to increase the efficiency ofinformed Dorfman testing for COVID-19 by arranging samples into all-negative pools. To do this, we ran an automated method to train numerous machine learning models on a retrospective dataset from more than 8,000 patients tested for SARS-CoV-2 from April to July 2020 in Bogotá, Colombia. We estimated the efficiency gains of using the predictor to support Dorfman testing by simulating the outcome of tests. We also computed the attainable efficiency gains of non-adaptive pooling schemes mathematically. Moreover, we measured the false-negative error rates in detecting the ORF1ab and N genes of the virus in RT-qPCR dilutions. Finally, we presented the efficiency gains of using our proposed pooling scheme on proof-of-concept pooled tests. We believe Smart Pooling will be efficient for optimizing massive testing of SARS-CoV-2.

Introduction

COVID-19 is an acute respiratory illness caused by the novel coronavirus SARS-CoV-2[1,2]. It has rapidly spread to most countries, causing182 million confirmed infections and over3.9 million deaths as of June 29th 2021[3]. In order to contain the ongoing pandemic, countries have rushed to implement massive testing to control the spread of the disease by identifying and isolating carriers. Massive testing is a fundamental strategy to curb the disease,[4] mainly due to its asymptomatic transmission[5]. Large-scale testing is costly and requires scarce reagents. As there is a global need to make testing more accessible to larger populations, strategies to increase the number of people that can be tested with the same amount of test kits are urgent.

Dorfman proposed pooling methods[6] to diagnose syphilis among the US military during World War II by combining samples from multiple soldiers in a single test tube. Different pooling strategies, such as Dorfman's two-stage pooling[6,7] and matrix pooling[8], offer higher efficiency gains for different combinations of test sensitivity and disease prevalence.

Existing works have demonstrated that using prior information to exclude samples likely to be positive from pools can increase testing efficiency. In informative group testing, as stated by Bilder et al., the different probabilities ofindividuals testing positively are exploited by grouping their samples into pools that are more likely to be all negative.[9] McMahan et al. proposed to threshold individuals as "high" or "low risk" and to use risk-specific algorithms while simultaneously identifying pool sizes to minimize the expected number of tests.[10] Taylor et al.[11] used a complementary microscopic examination of samples in the grouped detection of malaria and Lewis et al.[12] used clinical information in patients' forms in the grouped

Multistage reliability-based expansion planning of ac distribution networks using a mixed-integer linear programming model

22 de enero de 2022

Alejandra Tabares
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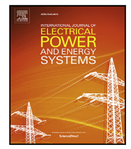

Multistage reliability-based expansion planning of ac distribution networks using a mixed-integer linear programming model

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ABSTRACT

A new mathematical model for the multistage distribution network expansion planning problem considering reliability is proposed in this paper. Decisions related to substation and branch expansion are driven by the minimization of the total cost, which comprises investment and operating costs including the impact of reliability. The proposed model features two main novelties. First, a set of novel algebraic expressions is devised for a standard reliability index, namely the expected energy not supplied. As a result, the dependence of reliability on network topology is explicitly and effectively cast in the mathematical formulation of the planning problem at hand. In addition, the effect of the network is characterized by a computationally efficient piecewise linear representation of the ac power flow model that takes into account both real and reactive power. The resulting optimization problem is formulated as an instance of mixed-integer linear programming, which provides a suitable framework for the attainment of high-quality solutions with acceptable computational effort using efficient off-the-shelf software with well-known convergence properties. The effectiveness of the proposed planning methodology is empirically demonstrated by providing cheaper expansion plans that enhance system reliability and by achieving better computational results as compared with state-of-the-art models.

1. Introduction

Due to the capital intensive nature of the transmission and generation systems and the catastrophic social and environmental consequences of their inadequacy, the assessment of reliability has usually focused on such infrastructures. Nonetheless, the analysis of customer interruption occurrences indicates that service unavailability is mostly related to faults at the distribution system level [1,2]. System-wide reliability can thus be greatly enhanced by adequately planning distribution network investment decisions. To that end, reliability-based distribution planning models should minimize the duration and frequency of customer interruptions through the improvement of standard reliability assessment indices [2–5]. This paper addresses the incorporation of reliability into multistage distribution network expansion planning.

Existing techniques for reliability assessment can be categorized in two groups, namely simulation-based methods and non-simulation-based approaches. In the former, reliability indices are obtained via examining network operation for every component outage, Monte Carlo simulation being typically adopted [6]. To that end, a power flow is run to determine the impact of every interruption, which is computationally demanding. Moreover, simulation-based methods cannot be directly integrated into the optimization models used for distribution operation and planning, thereby requiring the application ofinexact solution techniques wherein reliability assessment is decoupled from the optimization process. Relevant examples are [7–11].

Non-simulation-based methods usually derive the impact range of interruptions through topological analysis [4], or by formulating an interruption incidence matrix based on topological information from distribution networks [12]. Both approaches involve the characterization of the network topology, which, within the context of the optimization problems related to operation and planning, is a priori unknown, hence being represented by decision variables. As a result of this topological dependence, the use of non-simulation-based methods for the evaluation of reliability indices within such optimization problems drastically increases their mathematical complexity.

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College integration and social class

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College integration and social class

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Abstract
What is the impact of social class on college integration? Higher education institutions are becoming more diverse, yet the integration of underprivileged students remains a chal lenge. Using a social network approach, we analyze the general integration of low soeio economic status (SES) students, as well as how segregated by class these friends are. The object of analysis is the extreme case of an elite university that, based on a government loan program (Ser Pilo Paga), opened its doors to many low-SES students in a very unequal country, Colombia. Using a mixed methods perspective, including a survey, 61 in depth interviews, and ethnographic observation, we analyze friendship networks and their mean ings, barriers, and facilitators. Contrary to the literature, we find that low-SES students had, on average, the same number of connections and were no more isolated than students from upper social classes. Also, low-SES students' networks were not more segregated, even if relations with the upper classes were less likely and required more relational work than with middle or lower class friends. This high level of social integration stemmed from the intense relational work that low-SES students engage in, so as to fit in. Middle class friends act as a catalyst that can enable cross-class friendships.

Keywords College integration · Friendship networks · Inter-class relations · Segregation · Social class · Ser Pilo Paga · Colombia

Introduction

Higher education institutions are becoming more diverse across the globe, partly due to massification and partly due to deliberate attempts to include minorities, particularly in elite institutions which have remained the least diverse. Looking at diversity beyond enroll ment (Park et al., 2019) is crucial in terms of understanding its consequences and improv ing its outcomes for both institutions and individuals. Lower-class students tend to be less socially integrated in college than middle-class students (Rubin 2012). Lower levels of integration, in turn, have a negative effect on their persistence, performance, and subjective well-being (Ostrove & Long, 2007; Robbins et al., 2004; Rubin et al., 2016). This study addresses the question of the extent to which low socioeconomic status (SES) students in

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Predicting subgrain size and dislocation density in machining-induced surface microstructure of nickel using supervised model-based learning

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Full length article

Predicting subgrain size and dislocation density in machining-induced surface microstructure of nickel using supervised model-based learning

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ABSTRACT

Microstructure transformations during severe shear deformation induced by large strain machining experiments are examined on high-purity (99.99%) nickel plastically deformed to strain (1–5) and strain-rate (10^2–$10^4/s$). Deformation conditions are created using plane strain machining (PSM). They are characterized via in-situ techniques, which are then juxtaposed with orientation imaging microscopy (OIM) via electron backscattered diffraction (EBSD), and the dislocation densities are quantified using the broadening of X-ray diffraction peaks of crystallographic planes. We parameterize the variation of microstructure response by measuring the subgrain size as a function of seven variables involved in the cutting process: cutting speed, rake angle, temperature, strain, strain-rate, Zenner-Holloman parameter, and a dependent rate parameter (R). This parametrization was based on supervised model-based learning. One of them used Principal Component Analysis (PCA) within a linear regression, which produces good predictions. We use the PCA model in addition to a FEM simulation of the PSM to predict the subsurface subgrain size. Furthermore, the Principle of Similitude (PS) is incorporated for predicting the dislocation densities in both the deformed chip and the machined subsurface. The proposed framework (FEM simulation-PCA model-PS relation) is shown to offer opportunities for creating multifunctional surface microstructure in an array of machining manufacturing processes.

1. Introduction

Plastic deformation plays an essential role in determining the microstructural characteristics of metals by changing their mechanical properties [1]. As an essential mechanical property, the improved strength of metallic materials through Severe Plastic Deformation (SPD) has recently been the focus of research. SPD is based on applying high deformation strains, typically including low levels of strain-rates accompanying modest temperature rises, which results in the generation of ultrafine-grained (UFG) or nanostructured materials [2–4]. This microstructural refinement occurs in SPD-based processes, resulting from the accumulation of dislocations into grain and subgrain boundaries [5]. Contradictory to thermally activated phenomena such as migration of vacancies and dynamic recovery that lead to the dislocations' annihilation. Temperature rises and strain-rate escalation during SPD lead to increasing dislocation densities, thus boosting the mechanical strength of the materials [6,7]. Hence in SPD, the deformation strain, the strain-rate, and the coupled temperature rise are critical in the manifestation of microstructural response, leading to a transformation in a suite of materials properties such as strength, corrosion resistance, electrochemical, and biological responses [8,9], among others.

Evolutionary trajectories of microstructure during plastic deformation are relatively well examined at low strain-rates ($<10^2/s$) and a moderate range of deformation strain (1). These operation ranges are handled within the Hopkinson bar testing equipment, which imposes high levels of strain-rate ($>10^3/s$) and a relatively lower range of strains (<1). Another case of microstructural transformation by deformation includes hot torsion experiments or rolling, which involve modest ranges of strain-rate ($<10^2/s$) and relatively higher deformation strains (>4) [10,11]. Unfortunately, these studies exclude the peculiar niche of high strain, i.e., 1, and high strain-rates, i.e., $>10^2/s$. This combination of ranges leads to thermomechanical conditions, which are difficult to emulate using traditional mechanical testing. However, these conditions can be achieved using machining manufacturing processes.

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Stochastic cost-benefit analysis to assess new infrastructure to improve the reliability of the natural gas supply

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Stochastic cost-bene fit analysis to assess new infrastructure to improve the reliability of the natural gas supply

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The reliability of a natural gas system involves the capacity of the supply, transportation, storage and distribution system to provide service without short-term interruptions in the event of contingencies. Typically, increasing the gas supply reliability implies diversi fication of gas sources, transportation redundancies or larger gas storage capabilities. In addition, the combined operative uncertainty of the transportation pipeline and gas supply are not considered when assessing the impact of new infrastructure seeking to increase the gas supply reliability. To overcome these de ficiencies, we propose: (i) a stochastic cost-bene fit analysis; (ii) a pipeline contingency model using topographical, societal (violence) and pipeline information; and (iii) a supply contingency model of scheduled and unscheduled maintenance. Moreover, we consider both the gas supply and transportation uncertainties using a Monte Carlo simulation and an optimization model; furthermore, the expected cost-bene fit is estimated. Our methodology is applied and calibrated to the Colombian natural gas system to estimate the expected cost-bene fit of a new pipeline: Jobo - Medellín. The results show that the expected bene fit-cost ratio (BCR) of this pipeline is 2.02 and that the probability of having an economic bene fit greater than the cost is equal to 99.0%.

1. Introduction

In the last 46 years, natural gas has increased its participation in the total primary energy supply (TPES) from 16% in 1971 to over 22% in 2017 [1]. This source of energy has a relatively high calori fic value, and its combustion emits fewer pollutants than other fossil fuels [2]. Among all fossil fuels, natural gas represents 28% of the world energy consumption, with an average annual growth of 3% since 2000 [3]. This increase in consumption has caused several important economic and social activities to depend on a constant natural gas supply. As a consequence of this dependency, interruptions of the natural gas supply generate catastrophic consequences. For instance, in the 1970s, the severe winter of 1976 e 1977 led to rationing in the supply of natural gas in signi ficant areas of the west-central region of the United States [4]. In the winter of 2006, Russia stopped the supply of natural gas due to its political and commercial disputes with Ukraine, affecting a signi ficant number of member countries of the European Union [5]. Similar political and economical disputes occurred in 2007 between Belarus and Russia, and in 2009 again between Ukraine and Russia. In the last decade, several unexpected natural gas supply interruptions have occurred, with severe consequences [6]. Therefore, there is an increasing importance of understanding the behaviour of the reliability of the natural gas system to exogenous and endogenous factors, as well as, the creation of policies to minimize the risk of service interruptions [7,8].

The reliability of natural gas systems involves the capacity of the supply, transportation, storage, and distribution system to provide service without short-term interruptions in the event of contingency or failure in the systems infrastructure. Typically, increasing the gas supply reliability implies diversi fication of natural gas sources, transportation redundancies or larger gas storage [9,10].

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Stochastic multi-objective optimal energy management of grid-connected unbalanced microgrids with renewable energy generation and plug-in electric vehicles

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Stochastic multi-objective optimal energy management of grid-connected unbalanced microgrids with renewable energy generation and plug-in electric vehicles

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abstract

Microgrids (MGs) contribute to the integration of renewable energy-based distributed generation (DG) units and electric vehicles (EVs) in a smart, secure, sustainable, and economic fashion. However, the unbalanced nature of MGs along with the probabilistic nature of renewable energy, electricity prices, and EV demand complicate the energy management process. To overcome that challenge, a stochastic multi-objective optimization model for grid-connected unbalanced MGs is proposed here to minimize the total operational cost and the voltage deviation. The epsilon-constraint method and fuzzy satisfying approach are used to solve the multi-objective optimization problem and to obtain compromise solutions. Uncertainties are considered by employing the roulette wheel mechanism for generating scenarios regarding renewable energy generations, EV charging demands, electric loads, and electricity prices. In addition, to avoid adopting infeasible and impractical solutions, a three-phase power flow is integrated in the proposed model. The proposed method is assessed in a modified IEEE 34-bus test system consisting of EVs, battery systems, wind turbine units, photovoltaic units, and diesel generators. The results show the effectiveness and benefits of the proposed model for handling uncertainties while minimizing both operational cost and voltage deviation index and providing more realistic and reliable solutions that can be applied by MG operators.

1. Introduction

1.1. Background

The transition from carbon-based fuel systems to renewable energy ones will drive changes in behaviour across different actors including society, industries, engineers, and policymakers [1]. These changes in public attitude and expectations encourage most governments to take political actions to support this transition. As a result, the Paris Agreement was signed in 2015, which is expected to have significant positive effects on the acceleration of decarbonisation of transportation sectors as well as the increase in renewable energy generation globally [2]. Renewable energy-based distributed generation such as photovoltaic (PV) units and wind turbine (WT) units, as well as plug-in electric vehicles (EVs), can play a key role during the renewable energy transition. However, indiscriminate operation or integration of renewable energy-based distributed generation (DG) and plug-in EVs can lead to unfavourable deviations on voltage profiles of distribution networks, while the utility must ensure high-quality services for every consumer [3,4]. In this regard, microgrids (MGs) can facilitate the integration and exploitation of DG units and EVs.

In general, due to widespread acceptance, researchers usually cite the United States Department of Energy's definition for a MG [5], which corresponds to a set ofloads and distributed energy resources (DERs). According to this definition, MGs should have

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Mixture modeling segmentation and singular spectrum analysis to model and forecast an asymmetric condor-like option index insurance for Colombian coffee crops

22 de febrero de 2022

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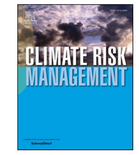

Mixture modeling segmentation and singular spectrum analysis to model and forecast an asymmetric condor-like option index insurance for Colombian coffee crops

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ABSTRACT

Weather-related hazards generate unfortunate risks, especially for low-income economies, such as populations dependent on agriculture. Index insurance offers structural advantages compared with conventional insurance, including moral hazard, adverse selection, and systemic risk. It also represents a promising financial tool because of its potential to provide timely economic relief after an unusual weather event by indemnifying policyholders based on the observed value of a particular index directly related to weather parameters. Because of these advantages, this type of insurance can potentially be extended to more crop-productive regions. This study examines the possible spread of weather index insurance programs for Arabica Coffee in Colombia in the short and medium terms in aggregated regions, according to the wet and dry crop seasons. Using a short historical precipitation data from 2010 to 2019 for 163 productive zones in 11 departments located at altitudes of 990–1,890 m, we use an unsupervised technique to first cluster the observations through mixture modeling. Then, we extract through singular spectrum analysis, the signal components of precipitation of each cluster and seasons to propose a simple index insurance model which determines the immediate payoff disbursals. We particularly identify the behavior of the tendency and seasonal payoffs. Finally, we forecast the tendency components in each cluster and season to derive a ratio of future payoffs in exceedance. This ratio serves as a measure of financial risk as it represents future additional payments that are expected to be disbursed due to the tendency component. The results have important implications for designing agricultural hedging instruments for coffee producers at an individual scale or as reinsurance instruments.

1. Introduction

Climate change creates severe problems in low-income economies, thus limiting sustainable development (Jensen, 2017). These

Abbreviations: EM, Expectation Maximization Algorithm; FNCC, National Federation of Coffee Growers of Colombia; GDP, Gross domestic product; GMM, Gaussian Mixture Model; IR, Indemnity Ratio; MI, Maximum Indemnity; NDVI, Normalized difference vegetation index; NEC, Normalized Entropy Criterion; PO, Payoff; PoE, Payoff-Exceedance or POs-Exceedance; POER, Payoff-Exceedance Ratio or PoE Ratio; PTPM, Monthly-accumulated precipitation values in mm; SSA, Singular Spectrum Analysis; SVD, Singular value decomposition.

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Exploring the mechanistic pathways of how social network influences social norms in adolescent smoking prevention interventions

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Research Square

Exploring the mechanistic pathways of how social network influences social norms in adolescent smoking prevention interventions

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Research Article

Keywords: Smoking susceptibility, social norms, social network analysis, friendship network, adolescents, social influence.

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A Clustering Approach for the Optimal Siting of Recharging Stations in the Electric Vehicle Routing Problem with Time Windows

24 de marzo de 2022

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Article

A Clustering Approach for the Optimal Siting of Recharging Stations in the Electric Vehicle Routing Problem with Time Windows

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Abstract: Transportation has been incorporating electric vehicles (EVs) progressively. EVs do not produce air or noise pollution, and they have high energy efficiency and low maintenance costs. In this context, the development of efficient techniques to overcome the vehicle routing problem becomes crucial with the proliferation of EVs. The vehicle routing problem concerns the freight capacity and battery autonomy limitations in different delivery-service scenarios, and the challenge of best locating recharging stations. This work proposes a mixed-integer linear programming model to solve the electric location routing problem with time windows (E-LRPTW) considering the state of charge, freight and battery capacities, and customer time windows in the decision model. A clustering strategy based on the k-means algorithm is proposed to divide the set of vertices (EVs) into small areas and define potential sites for recharging stations, while reducing the number of binary variables. The proposed model for E-LRPTW was implemented in Python and solved using mathematical modeling language AMPL together with CPLEX. Performed tests on instances with 5 and 10 clients showed a large reduction in the time required to find the solution (by about 60 times in one instance). It is concluded that the strategy of dividing customers by sectors has the potential to be applied and generate solutions for larger geographical areas and numbers of recharging stations, and determine recharging station locations as part of planning decisions in more realistic scenarios.

Keywords: charging stations; electric vehicles; k-means algorithm; location routing problem with time windows; mixed-integer linear programming; vehicle routing

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1. Introduction

The transport sector is one of the principal sources of environmental pollutants, producing 20% of the gas emissions that accelerate climate change, according to reports presented by the European Union in 2014 [1]. Since then, merchandise distribution companies and civil society have defined strategies to mitigate these effects [2]. In recent years, researchers have been seeking strategies for logistical operations to balance the assistance quality, operating cost, and environmental impact. The target is to reduce emissions of polluting gases via logistical route planning for each vehicle according to its freight [3].

The vehicle routing problem (VRP) is one of the most studied combinatorial optimization problems in the specialized literature. Its classification is NP-hard, where researchers look for reasonable quality solutions through algorithms to solve it in a limited time [4]. It serves customers to minimize the overall distance traveled by conventional vehicle fleets. The complexity of this problem depends on the different variants of the characteristics or

A participative system methodology to model pest dynamics in an agricultural setting

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A participative system methodology to model pest dynamics in an agricultural setting

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Abstract

Purpose – This study aims to identify the most relevant causal factors and the feedback loops of the dynamics between Tuta absoluta incidence in tomato crops and farmers' reactions to the problem. The authors seek to develop a conceptual model based on farmers' know-how to address crop damage by T. absoluta at a local and regional levels in order to determine how to confront this problem in the tomato-growing region of Colombia.

Design/methodology/approach – Community-Based System Dynamics (CBSD) is a participatory research methodology in which a group of stakeholders identifies relevant variables and the cause-effect relations among them which are then arranged into a causal loop diagram. The authors implemented this methodology in a workshop, focused on the farmers' insights related to the pest situation at the local and regional level, to achieve a causal loop diagram that explained pest dynamics and their potential management.

Findings – The relevant factors for the presence of T. absoluta, seen in the causal loop diagram, vary regionally and locally. At the local level, the pest impacts tomato production, farmers' well-being and their cash flow, while at the regional level, it affects market dynamics and environment and promotes regional coordination among farmers. Farmers propose product innocuity as a key regional objective. They also proposed establishing a planting calendar and census of greenhouses to control the pest throughout the region and the tomato supply.

Research limitations/implications – First, the synthesized model could not be validated with the farmers due to the COVID 19 epidemic. However, the authors held sessions with experts to analyze each result. Second, decision-makers from the local government did not participate in the workshop. Nevertheless, the approach of the workshop was aimed at understanding the mental models of the farmers since they are the ones who decide

The authors acknowledge the contribution of Diego Avendaño, Lorena Carmona and Diego Sanchez from AGROSAVIA [1] in the workshop's conceptualization and development and the 12 farmers that participated. This study was funded by Corporación Colombiana de Investigación Agropecuaria – AGROSAVIA and Universidad de Los Andes [Grant No. 1000940 to DR and FM]. Research support was provided by government funds assigned to AGROSAVIA. The authors assume full responsibility for the interpretation of results and ideas presented in this manuscript, which do not necessarily reflect the official opinions of these organizations.

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The Role of Citizen Science in Promoting Health Equity

1 de abril de 2022

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Annual review of public health

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ANNUAL REVIEWS

Annual Review of Public Health

The Role of Citizen Science in Promoting Health Equity

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Keywords

citizen science, health equity, participatory research, environmental health, community, physical activity, healthy eating

Abstract

While there are many definitions of citizen science, the term usually refers to the participation of the general public in the scientific process in collaboration with professional scientists. Citizen scientists have been engaged to promote health equity, especially in the areas of environmental contaminant exposures, physical activity, and healthy eating. Citizen scientists commonly come from communities experiencing health inequities and have collected data using a range of strategies and technologies, such as air sensors, water quality kits, and mobile applications. On the basis of our review, and to advance the field of citizen science to address health equity, we recommend (a) expanding the focus on topics important for health equity, (b) increasing the diversity of people serving as citizen scientists, (c) increasing the integration of citizen scientists in additional research phases, (d) continuing to leverage emerging technologies that enable citizen scientists to collect data relevant for health equity, and (e) strengthening the rigor of methods to evaluate impacts on health equity.

Do jaguars of the Amazon rainforest have a systemic perspective?

15 de mayo de 2022

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RESEARCH PAPER

SYSTEMS and BEHAVIORAL RESEARCH SCIENCE WILEY

Do jaguars of the Amazon rainforest have a systemic perspective?

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Abstract
In a jungle environment where jaguars are considered human, systems thinking has evolved in unexpected ways. Although systems thinking is commonly seen as a product of the Western world, other cultures have developed their own versions with unique characteristics. In this article, we explore Amazonian systems thinking, which has similarities to modern Western systems thinking, as well as differences that may inspire the evolution of systems approaches worldwide. We will discuss the contributions of Amazonian systems thinking particularly to find answers to the planet's ecological and sustainability problems, such as climate change and mass extinction of species, among others. We will present the systems thinking that emerged in some Amazonian communities, how it relates to mainstream Western systems thinking, and focus on some unique aspects of Amazonian systems thinking. This paper is based on the ethnographic work of Gerardo Reichel-Dolmatoff and other anthropologists who have studied Amazonian communities for decades.

KEYWORDS
Amazon rainforest, boundary critique, ecology, sustainability, systems thinking

1 | INTRODUCTION

When people are confronted with distinct contexts and problems, they may conceive different systems thinking approaches to cope with their environments and life challenges. The development of systems thinking is not culture-free, and therefore, different cultures produce diverse systems approaches.

In recent decades, non-Western systems concepts have been introduced into the systems thinking arena and comparisons between systems thinking and non-Western ideas have been made (e.g. see Hammond, 2003; Jackson, 2019; Macy, 1991; Shen & Midgley, 2007a; Zhu, 2000, 2010). In other cases, ancient knowledge has been used to support new systems thinking developments (e.g. Nakamori et al., 2011; Shen & Midgley, 2007b).

As with any other perspective, systemic perspectives are grounded in ideas, points of view, ethical conceptions and other elements that are embedded in cultures. This paper introduces an Amerindian systemic perspective based on ideas that differ from those which prevail in mainstream systems thinking, and that grew completely apart from current Western systems thinking. It was anthropologist Gerardo Reichel-Dolmatoff (1976) who, after visiting remote Amazonian regions, claimed that some Amerindians had developed a systemic perspective. He noted that according to the Tukano's perspective, the energy of the sun was part of a large circuit that involved the entire cosmos (see also Castaño-Uribe, 2019).

Our Voice in a Rural Community: Empowering Colombian Rural Adolescents to Advocate for Community Well-being through Citizen Scienc

17 de mayo de 2022

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Our Voice in a Rural Community: Empowering Colombian Rural Adolescents to Advocate for Community Well-being through Citizen Science

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Research Article

Keywords: Citizen science, rural, well-being, healthy lifestyles, built environment, participatory research, community, under-resourced, Latin America, low-income

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Pipeline Two-Phase Flow Pressure Drop Algorithm for Multiple Inclinations

19 de mayo de 2022

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Pipeline Two-Phase Flow Pressure Drop Algorithm for Multiple Inclinations

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Abstract: A Generalized Additive Model (GAM) is proposed to predict the pressure drop in a gas–liquid two-phase flow at horizontal, vertical, and inclined pipes based on 21 different dimensionless numbers. It is fitted from 4605 points, considering a fluid pattern classification as Annular, Bubbly, Intermittent, and Segregated. The GAM non-parametric method reached high prediction capacity and allowed a great degree ofinterpretability (i.e., it helped to visualize and test statistical inference), considering that each predictor's marginal effects could be described, unlike in other Machine Learning (ML) methods. The prediction capacity of the GAM model for the pressure gradient obtained an adjusted R^2 and a mean relative error of 99.1% and 12.93%, respectively. This capacity is maintained even when ignoring Bubbly flow in the training sample. A regularization technique to filter some variables was used, but most of the predictors must maintain the model's high predictive ability. For example, dimensionless numbers such as the Reynolds, Froude, and Weber numbers show p-values ofless than 0.01% to explain the pressure gradient in the different flow patterns. The model performs adequately on 500 randomly sampled data points not used to fit the model with an error lower than 15%. The variable importance for the model and the relationship with the pressure gradient is evaluated based on the obtained splines and p-values.

Keywords: pressure gradient; gas–liquid two-phase flow; flow patterns; Generalized Additive Model; dimensionless numbers

check for updates

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1. Introduction

Transporting fluids in the Oil and Gas Industry, for instance, from the well to the processing plant (upstream sector), represents a challenge. This challenge requires a complex configuration of pipes that contain multiphase mixtures of gases and liquids at different inclinations and operating conditions. The design of this two-phase configuration includes essential parameters for operators such as pressure gradient or void fraction, which are avoided in single-phase flows, in which reliable methods to calculate frictional pressure drop are available (e.g., the Moody chart or Colebrook-White equation). For two-phase flow, there are complex dynamics between the gas and liquid within the pipe that makes these predictions much more challenging [1].

Several approaches estimate or predict the frictional pressure drop in two-phase flows based on empirical correlations such as the ones proposed by Hagedorn and Brown [2] or Beggs and Brill [3]. These correlations depend strongly on the data used and the conditions under which they were built; therefore, their application range is restricted. For example,

Voyage Viewer: Empowering human mobility at a global scale

2 de junio de 2022

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Serena Chan
Alice Yu
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EuroVis Workshop on Visual Analytics

Voyage Viewer: A Multivariate Visualisation Tool for Migration Analysis

ISABELLA LOAIZA, GERMÁN SÁNCHEZ, SERENA CHAN, FELIPE MONTES JIMÉNEZ, MOHSEN BAHRAMI, AND ALEX PENTLAND

Introduction

THE STUDY OF displaced populations is often hampered by missing, scattered, and incomplete data, making it more difficult for researchers, NGOs, policy-makers, and migrants to understand the process of migration and make informed decisions. Some even argue that our knowledge about how to harness data to maximise the benefits and minimise the costs of migration is still at a global shortage (Bilsborrow, 2016). Indeed, some authors declare the need for radical innovation in how we visualise, model, and study human mobility as a multidimensional process that involves space, time, and context (Dodge, 2021).

The shortcomings with migration data are partly due to the traditional survey methods used to collect information about migrants. Surveys are time and resource intensive, they are challenging to scale, and the data collected by different actors is not easy to combine or compare. Recent advances in computational methods, together with the availability of new large-scale datasets, provide governments and NGOs with an effective alternative to analyse, synthesise, and map the mechanics of migrants, refugees, and displaced populations. Smartphone traces and data from social media platforms like Facebook and Twitter are already being used to study migration in cities (Spyratos *et al*., 2019; Palotti *et al*., 2020; Hawelka *et al*., 2014). Despite these efforts, the study of global human mobility remains fragmented across borderlines and limited to snapshots of a migrant's journey, unable to provide a complete picture of the migration process.

An essential step in creating a more cohesive understanding of human migration at a planetary scale is to develop tools that gather the multitude of data available into easily digestible visual representations. This chapter introduces Voyage Viewer, an

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Nontrivial and anomalous transport on weighted complex networks

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Communications in Nonlinear Science and Numerical Simulation

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Nontrivial and Anomalous Transport on Weighted Complex Networks

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(Dated: July 26, 2022)

Transport on weighted graphs is a general framework to study a variety of physical and social phenomena, serving to characterize the transport efficiency or propagation of quantities or packages on different weighted complex networks. Packages that start at a particular node propagate through the weighted network and produce a distribution of arrival times or travel costs at other nodes, depending on the network topology characterized by the probability weights of the directed links in the network and the possibly nonuniform cost function of each directed link. We present a mathematical formulation in terms of the moments of the distribution function of travel-times (or cost), which completely characterizes the distribution function theoretically. Interestingly, this approach is equivalent to finding the propagator (Green's function) in quantum mechanics, as it provides full information about how packages propagate along the network. Our formulation does not depend on the usual assumptions of symmetric connectivity, symmetric weights, or spectral analysis. This approach allows obtaining exact expressions of the mean travel-time (or cost) and its fluctuations for any connected binary or weighted graphs. We contrast our theoretical results with Monte Carlo simulations on Erdos–Renyi , Watts–Strogatz , and Barabasi–Albert topologies considering binary and weighted cases, which confirm our analytical predictions. Our approach also allows retrieving the information of the probability weights among nodes theoretically once the mean travel time is known without considering any assumptions of the connectivity of the network. Hence, such analysis could be useful for Epidemiology or Public Health purposes to ascertain information that is typically difficult to obtain.

I. INTRODUCTION

The transport or propagation of certain quantities over a complex network is becoming a hot research topic in both the natural and social sciences as many systems can be described and analyzed using this particular framework.

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Examples include packet transport in the internet [1, 2], epidemic spreading [3, 4] enhanced by the global flow of air travel passengers [5, 6]; sequences of seismic events [7–11], symbol sequences in texts [12–14], armed conflicts [15, 16]; migrations [17]; brain dynamics [18, 19]; and city traffic flows [20, 21]. Conceptually, all of them may be modelled as transport of certain quantities over weighted-networks, in which specific probabilities represented by weighted and directed links connect a set of nodes. The transport in all of these systems displays inherent non-

Cross-sector co-creation of a community-based physical activity program for breast cancer survivors in Colombia

19 de julio de 2022

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Cross-sector co-creation of a community-based physical activity program for breast cancer survivors in Colombia

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Summary

Benefits of physical activity (PA) in breast cancer survivors (BCS) are well established. However, programs to promote PA among BCS tailored to real-world contexts within low- to middle-income countries are limited. Cross-sector co-creation can be key to effective and scalable programs for BCS in these countries. This study aimed to evaluate the networking process to engage multisector stakeholders in the co-creation of a PA program for Colombian BCS called *My Body*. We employed a mixed-methods design including semistructured interviews, workshops and a social network analysis of centrality measures to assess stakeholders' engagement, resources and skills enabling the collaborative work, challenges, outcomes and lessons learned. The descriptive analysis and the centrality measures of the network revealed that 19 cross-sector stakeholders engaged in the *My Body* collaborative network. Through ongoing communication and cooperation, *My Body* built relationships between the academic lead institutions (local and international), and local and national public, private and academic institutions working in public health, sports and recreation, social sciences and engineering fields. The outcomes included the co-creation of the community-based PA program for BCS, its implementation through cross-sector synergies, increased relationships and communications among stakeholders, and successful dissemination of evidence and project results to the collaboration partners and other relevant stakeholders and community members. The mixed-methods assessment enabled understanding of ways to advance cross-sector co-creation of health promotion programs. The findings can help to enable continued development of sustainable cross-sector co-creation processes aimed at advancing PA promotion.

Lay summary

Collaborative work among stakeholders and researchers from different governmental sectors and disciplinary fields can be key to design and implement effective and scalable programs to promote physical activity (PA) among breast cancer survivors (BCS). This might be particularly critical in low- to middle-income countries where the implementation of evidence-based health-promoting programs tailored to real-world contexts are limited. This study aimed to evaluate the networking process to engage multisector stakeholders in the co-creation of a PA program for Colombian BCS. We employed qualitative methods and social network analyses to assess stakeholders' engagement, resources and skills enabling the collaborative work, challenges, outcomes and lessons learned. The co-creation of the program improved synergies between research, policy and practice. Communication through several channels including e-mail and workshops was the key resource to advance the collaborative work. Stakeholders

Pedestrian evacuation planning: Unveiling evacuation routes via column generation

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Pedestrian evacuation planning: Unveiling evacuation routes via column generation

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ABSTRACT

Evacuation drills are critical to evaluate emergency preparedness and infrastructure capacity. Before conducting drills, it is necessary to design the evacuation routes that people are likely to follow in a real evacuation. In this paper, we present a path-oriented optimization model for evacuation planning. To solve this model, we propose a column-oriented approach in which a master problem assigns people to evacuation paths, while an auxiliary problem generates feasible evacuation paths. To recreate possible evacuation drills, we embed the column generation method in an optimization-based simulation procedure that mimics the evacuation dynamics and unveils critical evacuation routes that are likely to become congested. To illustrate the applicability of our method, we recreated a real evacuation drill conducted in a university campus. Our results support evacuation planners that often make infrastructure decisions with the goal of enhancing evacuation dynamics with the commendable goal of saving lives.

1. Introduction

On February 2nd of 2016, the smoke of an escaped wildfire in the eastern hills of Bogotá (Colombia) triggered a yellow alert in the historic city center (Navarro and Rodriguez, 2016). The result was a massive evacuation of approximately 300,000 people from several government facilities, office buildings, and education institutions (Alcaldía Local de La Candelaria, 2013). One of the affected institutions was Universidad de los Andes (Uniandes), whose main campus can hold up to 23,000 people among students, faculty, and staff (Universidad de los Andes, 2017). Since this campus is located in the historic city center, newly-built and adapted old structures create a contrasting network of buildings with narrow connections between them that preserve the historic architecture. Furthermore, due to its location at the foot of a hill in the Andes mountain range, inclined corridors, stairs, and staged terraces predominate in the campus' landscape, connecting the buildings together at many different levels and heights to overcome the steep changes of slope. Fig. 1 presents a 3D view of Uniandes' campus that clearly displays its complex topography with varying slopes, as well as its urban integration with the historic city center. Additionally, because of its location at the base of the hill, the designated safe areas and meeting points during an evacuation (depicted in green) are located at different heights.

Although Fig. 1 only depicts Uniandes' campus, its physical characteristics are shared by the other institutions located at the base of the eastern hills in the historic city center. Clearly, these physical characteristics only made more challenging the evacuation the day of the fire, delaying it for several hours due to multiple factors: the bottlenecks caused by narrow connections between old and new buildings, the steep changes in slope, the location of meeting points along public spaces at different heights, and the lack of information on suggested evacuation routes (Páez, 2016). Although the city mandates building administrators to conduct evacuation drills (Ministerio del Trabajo, 2015), many facilities did not have a detailed evacuation plan in place to guide people in case of a massive evacuation through the historic city center.

This story highlights the importance of having a detailed evacuation plan that suggests routes to evacuees in case of an emergency. To build such a plan, it is important to study beforehand the layout, topography, capacity, and integration of the infrastructure with its surroundings to anticipate bottlenecks and the possible flow of evacuees. With this understanding, administrators can design evacuation plans (and routes) based on insightful observation of the evacuation dynamics to help mitigate the impact of an emergency. Moreover, in the case of pedestrian evacuation over complex-topography areas, door-knocking agents and evacuation helpers must have special attention when guiding evacuees

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A bandwidth auction mechanism to enable affordable Internet access

9 de septiembre de 2022

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A bandwidth auction mechanism to enable affordable internet access

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Abstract
Although technological developments have provided momentum to extend the frontier of commercially feasible network deployments, the latest data from ITU regarding affordability of ICT services shows that the digital divide between the rich and poor is still an open issue. Therefore, an economic framework is needed to create conditions for affordable network services. In this paper, we propose a set-aside mechanism that can satisfy this need by reserving resources for targeted groups and resolving the practical problem of having greedy users that rationally compete for cheaper resources. In this mechanism, prices are tailored to users' budget capacities. Our simulation results indicate that it is possible to increase the resource allocation for delivering services to the poorest by inducing regular users to compete among themselves.

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Systems thinking concepts within a collaborative program evaluation methodology: The Hermes Program Evaluation

18 de septiembre de 2022

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Systems thinking concepts within a collaborative program evaluation methodology: The Hermes Program Evaluation

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Abstract
There has been a growing interest in introducing systems thinking ideas in the program evaluation field over the last decades. Most of these efforts have supported the practice of evaluation, rather than contributing to produce theoretical advancements in evaluation. This article illustrates how systems thinking concepts may enrich the program evaluation field both at theoretical and practical levels. In particular, it examines how critical systems thinking perspectives and concepts were introduced in evaluation by discussing the design of an evaluation of a peace-building program in Colombia. We describe theoretical contributions of systems thinking within a reframed evaluation methodology and illustrate its application in a practical evaluation. Finally, we discuss some advantages of using systems thinking in evaluation.

Keywords
boundary critique, collaborative evaluation, critical systems thinking, program evaluation, systems thinking

Introduction

In 2017, at the American Evaluation Association (AEA) Conference, Michael Quinn Patton (2017) and several other panelists addressed the need for developing critical evaluation

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Majority networks and consensus dynamics

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Majority networks and consensus dynamics

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ABSTRACT

Consensus is an emergent property of many complex systems, considering this as an absolute majority phenomenon. In this work we study consensus dynamics in grids (in silicon), where individuals (the vertices) with two possible opinions (binary states) interact with the eight nearest neighbors (Moore's neighborhood). Dynamics emerge once the majority rule drives the evolution of the system. In this work, we fully characterize the sub-neighborhoods on which the consensus may be reached or not. Given this, we study the quality of the consensus proposing two new measures, namely effectivenessand efficiency. We characterize attraction basins through the energy-like and magnetization-like functions similar to the Ising spin model.

1. Introduction

Given a binary set of opinions, $\{-1, +1\}$, the consensus problem consists of choosing, through a simple dynamic, an opinion in which the entire population agrees. This problem is very important in several domains, like social choices [1–4], voting decisions procedures, modelized as the density problem in Cellular Automata Theory [4–8], validate transactions in blockchain procedures in virtual currencies [9,10] or determine synchronization procedures in cellular automata [11,12].

Recently the use of cellular automata to determine consensus algorithms was studied from different points of view in the workshop about distributed consensus [13]. In the framework of cellular automata, in the present paper [14–16] we present a full characterization of the consensus dynamics for two opinions, $\{-1, +1\}$, based on the local majority rule in two-dimensional uniform grids. The local rule to update opinions is based on the majority, i.e., an individual takes the most represented opinion in its neighborhood, and in case of a tie it remains unchanged. The majority rule as well as its generalizations have been extensively studied [17–19]. We consider the following asynchronous dynamics: consider the classic two dimensional grid with the Moore's eight's neighbors (see Fig. 1) and a fixed value, k, $1 \leq k \leq 8$. Pick at random a site and updated it by the majority rule applied to k arbitrary neighbors in Moore's vicinity. Continue to do that for the same k, until to reach an attractor. In this context, we proved that for $1 \leq k \leq 5$, there is always consensus: each individual with the same opinion.

For $6 \leq k \leq 8$ other non-consensus, or spurious attractors appears. Our second result is slightly different, we study from the consensus point of view every non- equivalent regular grid with a local vicinity included in Moore's neighborhood with $2 \leq k \leq 8$ fixed sites. The local majority algorithm considered is always the asynchronous one but at each step one may compute the majority over the specific grid considered on an arbitrary subset of two or more individuals. In this context, we proved that for grids constructed with $k \leq 5$ neighbors there exists always specific grids where there is not consensus. Elsewhere, for every grid with $k \geq 6$ there is always consensus.

In this work, we also discuss the quality of the consensus. We propose two measures, efficiency, and effectivenessto characterize the quality. We also propose to characterize configurations with magnetization and energy, which allows estimating the size of the attraction basin. With this respect, we have developed works on cellular automata by taking into account the Ising model point of view, which considers the interactions ofindividuals with two different spins or states (± 1). For the sake of characterizing states, an interaction function (the energy) is proposed. This approach is important because it offers a solvable case ofinteractions, as well as a model to study attractors throw the energy. The resemblances of this physical model are considered in a social context like Schelling and Sakoda's segregation, in particular, the Schelling segregation model context [20–22]; and migrations [23].

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SIC: An intelligent packing system with industry-grade features

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SIC: An intelligent packing system with industry-grade features

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ABSTRACT

Optimal container loading provides efficiency, lower costs, and fundamental benefits for any supply chain. However, obtaining these benefits remains an unsolved problem for many companies. SIC (Sistema Inteligente de Cubicaje, Intelligent Packing System in English) has been developed with the user in mind, with extensive possibilities for creating, defining, saving, editing and exporting container loading instances by performing clear, precise and concise interactions. SIC is a consumer-grade open-source application developed using the Unity game engine that generates packing patterns from user-defined instances of the Container Loading Problem (CLP). SIC can create packing patterns for boxes and convex polyhedra employing optimization algorithms. SIC also intends to contribute to the development of new CPL algorithms since its modular structure allows the optimization engine to be easily changed, thus allowing the academic community interested in CPL to save time in creating software, focusing that time on conceiving better solution algorithms. The default optimization modules included in SIC for boxes and connected polyhedra have been tested against the best methods in the literature, showing similar results in run time and container usability. For the future of SIC, we intend to create a web application so that users can run it from any computer, allowing them to access their loads and load spaces. Additionally, it pretends to include more complex CPL constraints.

Code metadata

Current code version	v1.0.0
Permanent link to code/repository used for this code version	https://github.com/ElsevierSoftwareX/SOFTX-D-21-00216
Code Ocean compute capsule	
Legal Code License	GPL v3.0
Code versioning system used	git
Software code languages, tools, and services used	C++, C#, Unity
Compilation requirements, operating environments & dependencies	Unity Editor 2019.4.20f1 or higher
If available Link to developer documentation/manual	
Support email for questions	jc.pachon10@uniandes.edu.co

Software metadata

Current software version	1.0.0
Permanent link to executables of this version	https://github.com/jcpachon10/SICRepository/releases/tag/1.0.0
Legal Software License	GPL v3.0
Computing platforms/Operating Systems	Microsoft Windows, distributed/web based
Installation requirements & dependencies	Unity Editor 2019.4.20f1 or higher
If available, link to user manual - if formally published include a reference to the publication in the reference list	https://github.com/jcpachon10/SICRepository/blob/main/README.md
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Characterizing diffusion processes in city traffic

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Characterizing diffusion processes in city traffic

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ABSTRACT

Here we study the possibility of characterizing city transportation in analogy to diffusing particles. To recreate the dynamics of the vehicles in a city, we use a cellular automata model in a road network. The agents represent vehicles that follow consecutive routes between origin and destination, resembling the dynamics of taxis, deliveries, carpooling, and rideshare vehicles. We calculate the mean velocity and the diffusion coefficient through the statistical analysis of the parametric curves produced by car movements. We found that a power law relationship closely relates both quantities as in kinetic theory but with a different exponent than those found in Brownian motion theory. We close the paper by discussing the possibility of using the Diffusion coefficient to characterize the city, as it is traditionally done with the mean speed and the flux rate; and how to calculate this quantity in a smart city.

1. Introduction

The route to comprehend the complexity of city traffic requires developing analogies with other physical systems [1–4]. Those analogies allow us to understand better the collective process that arises in many aspects of the system and, more importantly, to find solutions to the big challenges that the current cities are and will be facing. Similarly, transport is a concept that widely appears in various contexts, ranging from the realm of kinetic theory [5] to the commute of the citizens; including communication [6], economy [7], and a plethora of other examples [8–11]. Transport is highly related to statistical mechanics in both natural and artificial systems. However, it is not so straightforward to relate concepts when considering the social aspect of human transport [12,13]. We do not move randomly; we commute with purposes. Even so, a city has emergent behaviors [14,15], such as traffic jam transitions [16–18], and chaos [19–22]. All of them are at the very core of thermodynamics.

Recently, it was shown by Bellocchi and Geroliminis [23] that reaction–diffusion–like dynamics could explain urban congestion propagation based on traffic data from a metropolis. The idea establishes a new analogy between kinetic theory and city traffic. In this work, we show that one can extend the analogy further. Although the drivers do not behave randomly, there are some random components to their dynamics. The taxis and rideshare drivers travel the city following deterministic routes. However, the concatenation of several routes is quasi-random as they take and drop passengers with unknown destinations. Henceforth, they should exhibit a diffusion-like process. If they do, Einstein's theory of Brownian motion states that the diffusion must be related to the mean speed [24]. Consequently, if we can identify the relationship, one could use the taxi or rideshare data to probe the city to estimate the mean velocity in the network and the flow rate. Those quantities are very important to city traffic, as they represent the efficiency of the transport in the city [2,25–27]. From another point of view, the diffusion coefficient could be a fundamental quantity on its own. It is related to the capacity of the network to deal with fluctuations in concentrations of cars, namely, congestion.

To explore this idea, we will use a city traffic model that we developed in Refs. [28–30]. The model consists of a network of roads, where roads contain vehicles that travel inside them. The cars cross from one street to another, following routes from an origin point to a destination. We have successfully used this model to study the impact of navigation strategies, traffic light periods, the impact of the willingness of the drivers to change the route, as well as jamming transitions inside the city, and how they relate to the previous points. The model with a few modifications is fit to explore the idea proposed above, as we can concatenate several trajectories to study diffusion. We study the effect of driving short or larger paths as a side point. Naturally, diffusion has to be written in terms of nodes and links in the complex networks context [31]. To simplify the discussion, we will consider a grid network, like many downtown areas oflarge cities such as

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Distribution-free chance-constrained load balance model for the operation planning of hydrothermal power systems coupled with multiple renewable energy sources

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Distribution-free chance-constrained load balance model for the operation planning of hydrothermal power systems coupled with multiple renewable energy sources

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ABSTRACT

We are interested in the potential risk of short-term load imbalance in hydro-thermal power systems under high integration of renewable energy sources, including wind, solar, and biomass. Toward this end, the short-term load balance across the system is formulated as a joint chance constraint. Due to non-convexity issues and the lack of information about the joint probability distribution of the renewable energy resources, we analyze a distribution-free robust relaxation and a *p*-efficiency approximation of the joint chance constraint. Our proposal is embedded within the widespread SDDP algorithm, and compared with the popular CVaR scheme on a simplified version of the Colombian power system.

1. Introduction

Bringing electricity from generating plants to end-users, be it households, commercial or institutional buildings, or workstations, requires upfront decisions and planning. Indeed, to meet the demand, decisions must be made about the quantity of electricity to produce based upon the available inputs, for instance in the case of hydropower, the levels of water in the reservoir. The utilization of stored water in reservoirs/dams is challenging, in part due to the hydrological cycle of water. Indeed, the stored water must be used in such a way to avoid shortages in periods of droughts and flooding in periods of runoff. Thus, appropriate management and planning strategies are needed to efficiently exploit the energy potential of water to produce electricity. What is more, decisions about water utilization must be made under stringent restrictions, including, for instance, the production capacity of the water turbines, legal requirements on the exploitation of rivers/lakes, and so on.

Depending on the planning horizon, hydropower system management problems are usually classified into short-, mid-, or long-term. Short-term problems are usually concerned with the allocation of the available water between turbines to produce electricity to meet daily, weekly or monthly demand [1], whereas mid-term problems often deal with the release, spillage, and storage of water for electricity production over a planning horizon of one to three years. Long-term problems typically span planning horizons of at least three years and may be used for different purposes, including expansion and investment strategies [2].

Optimization techniques are often used to find a strategic dispatch of power generation units to minimize production costs or maximize energy production, among others, over a finite planning horizon (e.g., [3–6]). Stochastic programming (SP) (e.g., [7,8]), and stochastic dynamic programming (SDP) (e.g.,[9–11]) are popular mathematical tools to tackle power system problems. For other approaches, please see [12,13]. Depending on the length of the planning horizon, and the size of the system, the operation planning problem may be intractable. This is exacerbated by the integration of renewable energy resources, due to their high uncertainty.

To tackle the potential dimensionality issue of the problem, low temporal resolutions are often used, by assuming low variability in the energy supply and demand. It is clear that this cannot hold for systems coupled with renewable energy sources. Indeed, the fluctuation of renewable energy entails the risk of potential load imbalance, which may result in wide voltage and frequency fluctuation [14]. As a result, appropriate tools are necessary for the reliability and proper operation of power systems under high penetration of renewables.

In SP, to account for uncertainty, the random variables (energy demand, water inflows, renewable resources, etc.) are discretized via a *scenario tree*, which may grow exponentially with the length of the planning horizon. In addition, it is also known that except for the first

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