Publicaciones de alto impacto

Departamento de Ingeniería Industrial

Número 4

Publicaciones

Departamento de Ingeniería Industrial

Edición 4

Universidad de los Andes

Productos Reconocidos

Ordenado por fecha de aparición en línea:

• Cabrales, S.; Bautista, R.; Benavides, J. (2017). A Model to Assess the Impact of Employment Policy and Subsidized Domestic Fuel Prices on National Oil Companies. Energy Economics. 68, 566 – 578. Doi: https://doi.org/10.1016/j.eneco.2017.10.038

• Montes, F.; Jimenez, R.C.; Onnela, J.P. (2017). Connected but Segregated: Social Networks in Rural Villages. Journal of Complex Networks. 00, 1-13. Doi: https://doi.org/10.1093/comnet/cnx054

• Franco, C.; Hougaard, J.L.; Nielsen, K. (2018). Learning Preferences and Attitudes by Multi-criteria Overlap Dominance and Relevance Functions. Applied Soft Computing. 67, 641-651. Doi: https://doi.org/10.1016/j.asoc.2017.07.031

• Pillac, V.; Guéret, C.; Medaglia, A.L. (2018). A Fast Reoptimization Approach for the Dynamic Technician Routing and Scheduling Problem. In Recent Developments in Metaheuristics. Amodeo, L., Talbi, E.G., Yalaoui, F. (eds). Operations Research/Computer Science Interfaces Series. Springer. 62. Doi: https://doi.org/10.1007/978-3-319-58253-5_20

• Pinzon-Salcedo, L.A.; Torres-Cuello, M.A. (2018). Community Operational Research: Developing a Systemic Peace Education Programme Involving Urban and Rural Communities in Colombia. European Journal of Operational Research. 268 (3), 946-959. Doi: https://doi.org/10.1016/j.ejor.2017.11.040

• Estévez-Mujica C.P.; Acero, A.; Jiménez-Leal W.; García-Díaz, C. (2018). The influence of homophilous çinteractions on diversity effects in group problem solving. Nonlinear Dynamics, Psychology and Life Sciences. 22(1), 77-102. PMID: 29223199

• Meisel, J.D.; Sarmiento, O.L.; Olaya, C.; Lemoine, P.D., Valdivia, J.A.; Zarama, R. (2018). Towards a Novel Model for Studying the Nutritional Stage Dynamics of the Colombian Population by Age and Socioeconomic Status. PLoS One. 13 (2): e0191929, 1-22. Doi: https://doi.org/10.1371/journal.pone.0191929

• Sarmiento, C.; Valencia, C.; Akhavan-Tabatabaei, R. (2018). Copula Autoregressive Methodology for the Simulation of Wind Speed and Direction Time Series. Journal of Wind Engineering and Industrial Aerodynamics. 174, 188-199. Doi: https://doi.org/10.1016/j.jweia.2018.01.009

• Olaya, C.; Gomez-Quintero, J.; Navarrete, A. (2018). Crime and Punishment as a Social System: The Case of Prison Overcrowding. Kybernetes. 47 (2), 369-391. Doi: https://doi.org/10.1108/K-05-2017-0190

Productos Reconocidos

Ordenado por fecha de aparición en línea:

- Camacho, G.A.; Alvarez, D.; Cuellar, D. (2018) Heuristic Approach for the Multiple Bin-size Bin Packing Problem. IEEE Latin America Transactions. 16 (2), 620-626. Doi: 10.1109/TLA.2018.8327421

- Bonet, N.; Garcés, K. Casallas, R.; Correal, M.E.; Wei, R. (2018). Influence of programming style in transformation bad smells: mining of ETL repositories. Computer Science Education. 28 (1), 87-108. Doi: https://doi.org/10.1080/08993408.2018.1472950

- Abolghasem, S.; Solano, F.; Bedoya, C.D.; Navas, L.P.; Ríos. A.P.; Pinzón. E.A.; Medaglia, A.L.; Sarmiento, O.L. (2018). A Robust DEA-centric Location-based Decision Support System for Expanding Recreovía Hubs in the City of Bogotá (Colombia). International Transactions in Operational Research. 00, 1-31. Doi: https://doi.org/10.1111/itor.12573

- Pérez, F.; Torres, F.; Mendoza, D. (2019). Stocking and Price-reduction Decisions for Non-instantaneous Deteriorating Items under Time Value of Money. International Journal of Industrial Engineering Computations. 10(1), 89-110. Doi: 10.5267/j.ijiec.2018.3.001

- Pérez, F.; Torres, F. (2019). An Integrated Production-inventory Model for Deteriorating Items to Evaluate JIT Purchasing Alliances. International Journal of Industrial Engineering Computations. 10(1), 51-66. Doi: 10.5267/j.ijiec.2018.5.001

A Model to Assess the Impact of Employment Policy and Subsidized Domestic Fuel Prices on National Oil Companies

Sergio Cabrales;
Rafael Bautista;
Juan Benavides

Energy Economics

03

CrossMark

A model to assess the impact of employment policy and subsidized domestic fuel prices on national oil companies

Sergio Cabrales [a,*], Rafael Bautista [b], Juan Benavides [c]

[a] Department of Industrial Engineer, Universidad de Los Andes, Bogotá, Colombia
[b] School of Management, Universidad de Los Andes, Bogotá, Colombia
[c] Fundación para la Educación Superior y el Desarrollo (Fedesarrollo), Bogotá, Colombia

ARTICLE INFO

ABSTRACT

National oil companies (NOCs) control international oil markets. Nevertheless, by the end of the 2000s, their share of the industry's total revenues was only 35% while controlling more than 70% of the oil reserves and 65% of the gas reserves. Conventional financial theory prescribes that the proper management of an enterprise should seek the maximization of the NOCs' profits. However, maximization of profits is not their only objective. Their targets often include non-commercial objectives, such as domestic fuel subsidies and employment. This paper develops a model to assess the impact of domestic fuel subsidies and employment on NOCs' performance, which clarifies the trade-offs among non-commercial objectives and NOCs' market value, production, and reinvestment. The model is applied and calibrated to the Colombian NOC to find the financial and operative effects of these non-commercial objectives for different scenarios.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

National oil companies (NOCs), that have the government as their major ownership, control most of the international oil reserves. In the early 1970s, NOCs controlled slightly more than 10% of the world's oil and gas reserves (Leis et al., 2012). By the end of 2000s, NOCs controlled 73% of oil reserves and 65% of gas reserves (Victor et al., 2011). The nature of the NOC's ownership alters its objectives, and directly influence the public policies and incentives faced by company's managers (Vickers and Yarrow, 1988).

Despite the importance of the effects of ownership, research on oil and gas companies is limited. In fact, the literature has compared the technical efficiency between NOCs and IOCs. Al-Obaidan and Scully (1992) state that NOCs generate between 61% and 65% of the IOCs' revenues with the same inputs. Victor (2007) finds that

revenues from their main commercial objective are generated with more efficiency by IOCs than NOCs. This author attributes these inefficiencies to several factors, in particular, employment policy and subsidies for delivered products, among others. Wolf and Pollitt (2008) estimate a 3.6% increase in return on sales, a 35% drop in employment and an average of 15% increase in total production when an NOC becomes an IOC. Wolf (2009) finds that IOCs encourage superior performance compared to NOCs in terms of output efficiency and profitability. Eller et al. (2011) find that NOCs are less efficient than IOCs, which can be mainly explained by the differences in the firms' objectives. Likewise, Shleifer and Vishny (1994), Hartley and Medlock (2008), Eller et al. (2011) and Hartley et al. (2012) find empirical evidence that non-commercial objectives, such as domestic fuel subsidies and employment – which represent high levels of employment, unprofitable projects, or non-necessary expenditures – are major sources of reduced economic efficiency for many NOCs.

NOCs' commercial objective is very much like those of international oil companies (IOCs), seeking to generate wealth for their owners – the citizens. Nevertheless, governments include non-commercial

---

* Corresponding author.
  E-mail address: s-cabral@uniandes.edu.co (S. Cabrales).

Connected but Segregated: Social Networks in Rural Villages

Felipe Montes;
Roberto C Jimenez;
Jukka-Pekka Onnela.

Connected but segregated: social networks in rural villages

FELIPE MONTES[†] AND ROBERTO C. JIMENEZ

Department of Industrial Engineering, Universidad de los Andes, Carrera 1E # 19A-40, Bogotá, Colombia
[†]Corresponding author. Email: fel-mont@uniandes.edu.co

AND

JUKKA-PEKKA ONNELA[†]

Department of Biostatistics, Harvard T.H. Chan School of Public Health, 677 Huntington Ave, Boston, MA 02115, USA
[†]Corresponding author. Email: onnela@hsph.harvard.edu

Edited by: Neil Johnson

There is an increased appreciation for, and utilization of, social networks to disseminate various kinds of interventions in a target population. Homophily, the tendency of people to establish relations with those they perceive to be most like themselves, can create within-group cohesion but at the same time can also lead to societal segregation. In public health, social segregation can form barriers to the spread of health interventions from one group to another. We analysed the structure of social networks in 75 villages in Karnataka, India, both at the level of individuals and network communities. We found all villages to be strongly segregated at the community level, especially along the lines of caste and sex, whereas other socioeconomic variables, such as age and education, were only weakly associated with these groups in the network. While the studied networks are densely connected, our results indicate that the villages are highly segregated.

Keywords: homophily; assortativity; community structure.

1. Introduction

The study of social network structure has enabled the identification of social relations as conduits for the spread of health-related behaviours in both randomized and observational studies [1–3]. Several studies have now demonstrated the utility of social networks for identifying initial spreaders within networks and how they may be harnessed to increase the efficiency of public health and development interventions [4–7]. It has been shown that the community structure of networks, where a community refers to a set of densely interconnected nodes, is important for targeting public health interventions, especially interventions that may have spillover effects, that is, when the effect of an intervention may spread from one person to another [8, 9]. An additional consideration is the role of homophily, the tendency for individuals to be connected to others like them, which can result in overly optimistic estimates of the effectiveness of different seeding strategies of interventions if not properly taken into account [10]. Karnataka is a southern state of India with approximately 55 million inhabitants, and it agglomerates individuals from heterogeneous castes under a common language and religion. Prior research has studied the Karnataka networks at the household level with the goal of identifying injection

Learning Preferences and Attitudes by Multi-criteria Overlap Dominance and Relevance Functions

Camilo Franco;
Jens Leth Hougaard;
Kurt Nielsen.

07

Learning preferences and attitudes by multi-criteria overlap dominance and relevance functions

Camilo Franco*, Jens Leth Hougaard, Kurt Nielsen

IFRO, Faculty of Science, University of Copenhagen, Denmark

ARTICLE INFO

ABSTRACT

This paper proposes an interval-valued multi-criteria method for learning preferences and attitudes, identifying priorities with maximal robustness for decision support. The method is based on the notion of weighted overlap dominance, formalized by means of aggregation operators and interval-valued fuzzy sets. The procedure handles uncertainty by estimating the likelihood of dominance among pairs of alternatives, inducing an attitude-based system of dominance and indifference relations. This system allows conflicting situations of indifference/dependency to arise, which need to be resolved for properly identifying preferences under any attitude. In order to do so, relevance functions are examined over the whole system of relations, obtaining a weak preference order together with its associated attitude and robustness index. As a result, the proposed method allows learning preferences and attitudes, identifying the solutions with maximal robustness for intelligent decision support.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

Modern information technology allows collecting large amounts of data under natural conditions of uncertainty. The ability to make use of these raw data by (data-driven) decision systems is becoming a major competitive driver for everyone alike. Hence, aided by proper analytical tools and expert knowledge, decision systems can harness the raw input, reasoning with uncertain information for the identification of sound and satisfactory solutions. In that way, Decision Makers (DMs) can obtain automatic decision support on complex problems relying on different criteria, containing very detailed information that has to be smartly handled for inferring reliable conclusions.

Motivating the setting for imprecise multi-criteria decision problems, consider e.g. the assessment and selection of candidate sites for green energy production, where different locations have to be evaluated by public authorities (DMs) to decide where to build new facilities. Here, important aspects to take into account include, among others (see e.g. [7]), spatial and geographical information, regarding e.g. the means to connect biomass sources with the industrial facilities, as well as connecting those facilities with the electricity/energy grid. Being there very detailed data on the location of sites, facilities and the grid, there is also *imprecision* or lack of knowledge about the exact valuation of the variables under study, such as the *distance* separating each candidate site from a given biomass source.

Consider the road distance from the biomass source to the site, where a *degree of proximity* between them has to be maximized together with the other (desirable) attributes. Dealing with geographical information, it is observed that candidate sites are not just one point in the map, but a whole area where a new facility can be built. Hence, the distance cannot be determined exactly with respect to a precise point, but to the area representing the candidate site. In this way, a basic representation of the imprecision associated to the measurement of distances, consists in the valuation of some lower and upper bounds (e.g. taking the minimum and the maximum distance between the biomass source and the perimeter of the candidate site), such that the degree of proximity is estimated for each site by a suitable choice of its characteristic function. But notice that, even considering the oversimplified scenario where sites are represented by a unique point, such that the available data contains a unique value regarding distance, there could also be some disagreement about the specific function to be used to model and estimate such a proximity degree.

In either scenario, one referring to uncertainty of data measurement/estimation and the other to the multiplicity of modeling

* Corresponding author. Present address: Department of Industrial Engineering, Faculty of Engineering, Andes University, Bogotá, Colombia.

E-mail addresses: cf@ifro.ku.dk (C. Franco), jlh@ifro.ku.dk (J.L. Hougaard), kun@ifro.ku.dk (K. Nielsen).

A Fast Reoptimization Approach for the Dynamic Technician Routing and Scheduling Problem

Victor Pillac;
Christelle Guéret;
Andrés Medaglia.

Chapter 20
A Fast Reoptimization Approach for the Dynamic Technician Routing and Scheduling Problem

V. Pillac, C. Guéret, and A.L. Medaglia

Abstract The Technician Routing and Scheduling Problem (TRSP) consists in routing staff to serve requests for service, taking into account time windows, skills, tools, and spare parts. Typical applications include maintenance operations and staff routing in telecoms, public utilities, and in the health care industry. In this paper we tackle the Dynamic TRSP (D-TRSP) in which new requests appear over time. We propose a fast reoptimization approach based on a parallel Adaptive Large Neighborhood Search (RpALNS) able to achieve state-of-the-art results on the Dynamic Vehicle Routing Problem with Time Windows. In addition, we solve a set of randomly generated D-TRSP instances and discuss the potential gains with respect to a heuristic modeling a human dispatcher solution.

Keywords Dynamic Vehicle Routing • Technician Routing and Scheduling • Parallel Adaptive Large Neighborhood Search

V. Pillac
Ecole des Mines de Nantes, IRCCyN UMR 6597, Nantes, France
Centro para la Optimizacion y Probabilidad Aplicada (COPA), Universidad de los Andes, Bogota, Colombia
e-mail: victor.pillac@gmail.com

C. Guéret (✉)
LARIS, Université d'Angers, Angers, France
e-mail: christelle.gueret@univ-angers.fr

A.L. Medaglia
Centro para la Optimizacion y Probabilidad Aplicada (COPA), Universidad de los Andes, Bogota, Colombia
e-mail: amedagli@uniandes.edu.co

Community Operational Research: Developing a Systemic Peace Education Programme Involving Urban and Rural Communities in Colombia

Luis Pinzon Salcedo;
María Alejandra Torres Cuello.

Community Operational Research: Developing a systemic peace education programme involving urban and rural communities in Colombia

Luis Arturo Pinzon-Salcedo*, Maria Alejandra Torres-Cuello

Universidad de los Andes, Engineering School, Cra 1a Este No.19A-40, Universidad de los Andes, Bogota, Colombia

ABSTRACT

This paper describes a Community Operational Research inquiry in which members of diverse local and marginalised communities, working with external researchers, created a peace programme that was implemented in more than four hundred and fifty local schools. It has disseminated a culture of peace in a social context characterised by high levels of violence. Diverse systemic problem structuring methods were used throughout the development of the programme. The creative design of methods guided the research and contributed to develop an evolving, participative multimethodology that mixes methods and tools from the qualitative/quantitative spectrum, including interactive planning, critical systems heuristics, soft systems methodology, statistics, and methods from the conflict resolution field. The peace programme was initially designed using a synergy of problem structuring methods, and several tools and methods were used thereafter to improve the programme as its contexts evolved. Community operational research and systems thinking have had an impact on the programme since its initial stages, and have contributed to modify it based on well-grounded quantitative and qualitative information. This programme has reached more than a million people in Colombian society, and has been internationally recognised as one of the most innovative and impacting experiences for Latin American social development. It has created a culture of peace in hundreds of schools, having transformative effects on the individuals as well as on their social relations. Moreover, the impact of the programme has transcended the schools' boundaries and has spread to wider circles of society.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

This paper presents a Community Operational Research (COR) application: the development of peace education –in the form of the Hermes Programme. This programme is an example of what has been called conflict resolution education (Harris, 2004), and was originally developed by a group of researchers in 2003. Its initial development, and improvements through the participation of the affected communities, can help us to realise some insights into the application of COR ideas.

The Hermes Programme is an initiative developed by the Bogota Chamber of Commerce (BCC), a group of researchers in the University of los Andes, and members of several local communities in Colombia. The idea of conceiving a peace programme emerged while considering the particular context of Colombia. The country experienced a low-intensity war for more than five

decades, encompassing various illegal armed groups and leaving more than 7 million displaced persons, plus around 8200,000 victims (Colombian Victims Unit, 2016).

The initial part of this paper describes the planning phase of the research inquiry, including the details of its theoretical underpinnings and the role of those who were involved. Later on, two intervention phases will be described. Finally, the theoretical contribution and the conclusions of the case study will be presented.

2. Theoretical and methodological considerations

Midgley and Ochoa-Arias (2004) argue that COR practitioners have two common concerns: a desire to contribute to positive changes in communities and an interest in the development of methodologies, methods, and techniques. More recently, Midgley, Johnson, and Chichirau (2018) have claimed that the main concern of COR practice is the 'meaningful engagement of communities'. Additionally, they argue that the birth of COR was the result of an OR crisis that took place in the 1970s and 1980s that led the UK Operational Research Society to look for new areas of application

* Corresponding author.
E-mail addresses: lpinzon@uniandes.edu.co (L.A. Pinzon-Salcedo), ma.torres133@uniandes.edu.co (M.A. Torres-Cuello).

The Influence of Homophilous Interactions on Diversity Effects in Group Problem Solving

Claudia Estévez;
Andrés Acero;
William Jiménez;
César García.

The Influence of Homophilous Interactions on Diversity Effects in Group Problem-Solving

Claudia P. Estévez-Mujica,[1] **Andrés Acero, William Jiménez-Leal,** and **César García-Díaz,** *Universidad de los Andes, Bogotá, Colombia*

Abstract: Increasingly diversity researchers call for further studies of group micro-processes and dynamics to understand the paradoxical effects of diversity on group performance. In this study, based on analyses of in-group, networked, homophilous interactions, we aim to explain further the effects of diversity on group performance in a parallel problem-solving task, both experimentally and computationally. We developed a "whodunit" problem-solving experiment with 116 participants assigned to different-sized groups. Experimental results show that low diversity and high homophily levels are associated with lower performance while the effects of group size are not significant. To investigate this further, we developed an agent-based computational model (ABM), through which we inspected (a) the effect of different homophily and diversity strengths on performance, and (b) the robustness of such effects across group size variations. Overall, modeling results were consistent with our experimental findings, and revealed that the strength of homophily can drive diversity towards a positive or negative impact on performance. We also observed that increasing group size has a very marginal effect. Our work contributes to a better understanding of the implications of diversity in-group problem-solving by providing an integration of both experimental and computational perspectives in the analysis of group processes.

Key Words: agent-based modeling, diversity, group performance, homophily, problem-solving

INTRODUCTION

Given that teams are the most common structural units for organizations to set up and manage resources (Gerard, 1995), research on team formation, group dynamics, and their outcomes has drawn the attention of hundreds of scholars (Kozlowski & Bell, 2013). Since teams seem to have the potential to successfully accomplish complex tasks (Jackson, 1992; Salas, Cooke, & Rosen, 2008), a large part of this research has focused on understanding the determinants of performance (for review see Kozlowski &

---

[1] Correspondence address: Claudia P. Estévez-Mujica, Carrera 1 No. 18A-10 Piso 2, Bloque G-GB, Department of Psychology, Universidad de los Andes, Bogotá, Colombia. E-mail: cp.estevez68@uniandes.edu.co
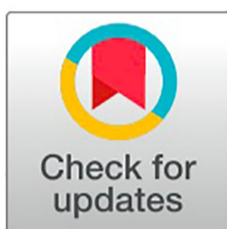
Towards a Novel Model for Studying the Nutritional Stage Dynamics of the Colombian Population by Age and Socioeconomic Status

Jose D. Meisel;
Olga L. Sarmiento;
Camilo Olaya;
Pablo D. Lemoine;
Juan A. Valdivia;
Roberto Zarama.

Towards a novel model for studying the nutritional stage dynamics of the Colombian population by age and socioeconomic status

Jose D. Meisel[1,2,3]*, **Olga L. Sarmiento**[3,4], **Camilo Olaya**[1,3], **Pablo D. Lemoine**[1,3,5], **Juan A. Valdivia**[3,6,7], **Roberto Zarama**[1,3]

1 Department of Industrial Engineering, Faculty of Engineering, Universidad de los Andes, Bogotá, Colombia, **2** Facultad de Ingeniería, Universidad de Ibagué, Ibagué, Colombia, **3** CeiBA Complex Systems Research Center, Bogotá, Colombia, **4** Department of Public Health, School of Medicine, Universidad de los Andes, Bogotá, Colombia, **5** Centro Nacional de Consultoría, Bogotá, Colombia, **6** Departamento de Física, Facultad de Ciencias, Universidad de Chile, Santiago, Chile, **7** Centro para el Desarrollo de la Nanociencia y la Nanotecnología, CEDENNA, Santiago, Chile

* jd.meisel28@uniandes.edu.co

Abstract

Low-and middle-income countries (LMICs) are experiencing a nutritional transition in which the burden of obesity tends to shift towards the lower-socioeconomic status (SES) group. We propose a system dynamics (SD) model for assessing the nutritional stage dynamics of the Colombian urban population by age and SES projected to 2030. This SD model captures the ageing population according to body mass index (BMI) categories and SES. In this model, the transference rates (TRs) between BMI categories by age and SES are estimated using a heuristic based on data obtained from national surveys. The simulation results show that the Colombian population, particularly those aged 20 to 39 years with a lower SES, is moving towards the overweight and obese categories. The TRs for overweight and obese categories in the lower SES group (the mean TR from *not overweight* to *overweight* = 0.0215 (per year) and mean TR from *overweight* to *obese* = 0.0098 (per year)) are increasing more rapidly than the those in the middle (the mean TR from *not overweight* to *overweight* = 0.0162 (per year) and mean TR from *overweight* to *obese* = 0.0065 (per year)) and higher SES groups (the mean TR from *not overweight* to *overweight* = 0.0166 and mean TR from *overweight* to *obese* = 0.0054 (per year)). Additionally, from 2005 to 2010, individuals aged 20 to 39 years had the highest TRs towards the overweight and obese categories (from 0.026 to 0.036 per year and from 0.0064 to 0.012 per year, respectively). The TRs also indicated that children aged 0 to 14 years are moving from the obese to overweight and from the overweight to not overweight categories. These TRs show that the Colombian population is experiencing an SES-related nutritional transition that is affecting the lower SES population. The proposed model could be implemented to assess the nutritional transitions experienced in other LMICs.

Copula Autoregressive Methodology for the Simulation of Wind Speed and Direction Time Series

Carlos Sarmiento;
Carlos Valencia;
Raha Akhavan-Tabatabaei.

Copula autoregressive methodology for the simulation of wind speed and direction time series[☆,☆☆]

Carlos Sarmiento[a,**], Carlos Valencia[a,*], Raha Akhavan-Tabatabaei[b]

[a]University of los Andes, Department of Industrial Engineering
Cra 1 Este No 19A-40, Bogota, Colombia, South America
[b]School of Management, Sabanci University
Orta Mahalle, Tuzla 34956 ,Istanbul, Turkey

Abstract

In this paper we present a methodology for synthetic generation of wind speed and direction bivariate time series based on copula functions to represent the temporal and cross-dependence structure. We explore the advantages of using this nonlinear time series method over more traditional approaches that use a transformation to normal distributions as an intermediate step. The use of copulas gives some flexibility to represent the serial variability of the real data on the simulation, besides allowing more control on the desired properties of the data. Empirical Bernstein copulas were used to consider the circular nature of wind direction. Experimental analysis and real data application prove the usability and convenience of the proposed methodology.

Keywords: Copula autoregressive, Time series generation, Wind direction, Wind simulation, Wind speed

1. Introduction

Synthetic generation of wind speed and direction time series is a fundamental tool in many engineering and environmental applications. These streams of simulated data have been successfully used in areas such as electricity generation (wind power), air quality, fatigue analysis and wildfire risk management. For example, for the estimation of wind energy output, a correct representation of wind speed (and sometimes direction) in terms of time and space is crucial for the evaluation of power systems viability (Costa

Crime and Punishment as a Social System: The Case of Prison Overcrowding

Camilo Olaya;
Juliana Gómez Quintero;
Andrea Catalina Navarrete.

Crime and punishment as a social system: the case of prison overcrowding

Camilo Olaya

Department of Industrial Engineering, Faculty of Engineering,
Universidad de los Andes, Bogota, Colombia, and

Juliana Gomez-Quintero and Andrea Catalina Navarrete
Universidad Sergio Arboleda, Bogota, Colombia

Abstract

Purpose – This paper presents an actor-based conceptualization of the increasing oscillatory pattern of prison overcrowding in Colombia. The research proposes a dynamic hypothesis that explains that unintended behavioural pattern as a result of delayed balance feedback loops shaped by decision-making processes of actors that intend to control crime. This system matches a well-known systemic archetype that explains those persistent oscillations. The paper also introduces a simulation model for testing that dynamic hypothesis and for delivering concrete courses of action. This work illustrates the relevance for policymakers to understand the dynamic complexity of social systems as the outcome of the agency of actors who take action to defend their own interests. Such actions ultimately form a complex web of interactions that drive the performance of such systems with unintended consequences. In particular, the construction of explicit models provides better chances of devising policies that consider the system-level implications of those interactions.

Design/methodology/approach – This work uses system dynamics modelling. First, the paper presents a conceptual model anchored in operational thinking, which refers to the identification of actors and decisions, and the manner in which those decisions ultimately build the respective social system in which the oscillatory pattern emerges. Second, it identifies key feedback structures that result from those chains of decisions. Finally, the paper introduces a simulation model for suggesting policy implications for decisionmakers.

Findings – The increasing oscillatory pattern that prison overcrowding in Colombia has displayed over the last 20 years is the outcome of a wide variety of laws that increase sanctions on criminal conducts, a phenomenon known as "legislative inflation". Such reactions against crime are propelled and sustained by society and policymakers as the result of static and linear thinking that simply delivers "more punishment" of crime – harsher legislation and longer prison terms – which ultimately boosts long-term prison overcrowding and further cycles of crime control and overcrowding. Such actions create permanent negative feedback loops that involve various material and information delays, which – coupled with the reinforcing feedback loops – explain the previously mentioned behavioural pattern. Through a system dynamics simulation model, this paper tests and explains the proposed dynamic hypothesis and shows how policymakers can enhance and develop their dynamic understanding to explore and design effective policies intended to tackle prison overcrowding.

Practical implications – This paper presents a practical and concrete case that bridges the fields of criminal policy and prison management through systems thinking. It uses the case of prison overcrowding in Colombia to demonstrate the relevance of incorporating systemic thinking into the cognitive portfolio of policymakers if they aspire to improve complex systems.

Originality/value – Criminal policy and prison management are different fields that typically belong to different traditions (law and criminal psychology for the former, public administration for the latter). The work presented here bridges those perspectives under a single engineering and systemic perspective that answers questions in both fields and serves as a unifying framework for designing

Heuristic Approach for the Multiple Bin-size Bin Packing Problem

Guillermo Alberto Camacho;
Daniel Cuellar;
David Álvarez.

Heuristic Approach for the Multiple Bin-Size Bin Packing Problem

G. A. Camacho, D. Cuellar, and D. Álvarez

Abstract— **This article presents a heuristic to solve instances of the MBSBPP - Multiple Bin-Size Bin Packing Problem. The heuristic is validated by comparison with a commercial tool of high acceptance. A four-step methodology is used: (A) design of the optimization algorithm, (B) selection of test data, (C) calculation of the solution using the Cape Pack® and GrasPacking v1.0 optimization tools, (D) performance validation by comparison, with emphasis in the percentage of use and computational time. The performance of the proposed algorithm is evaluated in experimental cases and in instances associated with delivery orders of a logistic company. The results allow us to conclude that the proposed heuristic has a good performance and can overcome the commercial tool.**

Keywords— **Distributor's Pallet Packing Problem – DPPP, GRASP − Greedy Randomized Adaptive Search Procedure, Multiple Bin-Size Bin Packing Problem – MBSBPP.**

I. INTRODUCCIÓN

EL PROBLEMA de carga de contenedores consiste en cargar diferentes ítems rectangulares, en un número finito de contenedores, con el objetivo de minimizar el número de contenedores requeridos, cumpliendo un conjunto de restricciones propias del problema particular.

El problema general puede ser formulado a partir de la descripción de los objetos del sistema: C y P. $C = (L, W, H)$ es el objeto rectangular mayor con largo L, ancho W y alto H; el objeto rectangular mayor puede ser un contenedor, pero también puede ser el espacio de carga de un vehículo, una estiba que debe ser llenada sin sobrepasar una altura predefinida u otro tipo de contenedor. $P = \{P_1, P_2, \cdots, P_m\}$ representa un conjunto de ítems tridimensionales pequeños que deben ser empacados, con $P_i = (l_i, w_i, h_i)$; es decir, un objeto de longitud l_i, ancho w_i y alto h_i para $i = 1, 2, \cdots, m$. Además de los objetos, se considera la existencia de las funciones v y q que asignan a cada pieza P_i un valor o beneficio v_i y una demanda de ejemplares a empacar q_i, respectivamente. El propósito es empacar la lista P en el objeto C, cumpliendo un conjunto de restricciones propias del problema particular y teniendo como objetivo minimizar el número de contenedores requeridos. Una revisión de las restricciones es presentada en [1] y [2]. De acuerdo con las características de la carga, el contenedor y el objetivo del empaquetamiento, existen múltiples categorías del problema; en este trabajo nos concentramos en las categorías

denominadas: *Distributor's Pallet Packing Problem* – DPPP [3] y *Multiple Bin-Size Bin Packing Problem* – MBSBPP [4]. En el DPPP se busca empacar un conjunto heterogéneo de carga en el mínimo número de estibas idénticas. En el MBSPP se busca empacar un conjunto heterogéneo de carga en un grupo heterogéneo de contenedores, de tal forma que el valor de los contenedores utilizados sea minimizado. La selección de estas categorías obedece al requerimiento logístico de una empresa de carga localizada en la ciudad de Bogotá: empacar mercancía, primero en estibas y luego su respectiva carga en vehículos para el transporte. En la literatura se han reportado varias técnicas de solución para este tipo de problemas [5]–[7], y actualmente se cuenta con software comercial capaz de calcular soluciones [8]–[10].

En este artículo se presenta una heurística que resuelve los problemas DPPP y MSBSBPP de manera integrada. La heurística es una adaptación del algoritmo GRASP – *Greedy Randomized Adaptive Search Procedures* – [11] y su validación se alcanzó en cuatro etapas: (A) diseño de los algoritmos de optimización, (B) selección de datos de prueba, (C) cálculo de la solución utilizando las herramientas de optimización GrasPacking v1.0 que codifica un algoritmo GRASP y Cape Pack® que permite seleccionar entre algoritmos de construcción de columnas y capas [8], (D) validación de desempeño mediante comparación, haciendo énfasis en el porcentaje de utilización, estabilidad estática y tiempo computacional.

La organización del trabajo es la siguiente. En la sección II se presenta la descripción de los problemas de interés y sus restricciones. En la sección III se resume la metodología empleada para validar la propuesta denominada GrasPacking, el resumen incluye el algoritmo de optimización propuesto y el prototipo software construido para implementar la versión 1.0 del GrasPacking. En la sección IV se presenta el análisis comparativo de los resultados obtenidos para el caso de Laboratorio y el caso Industrial asociado con una empresa del sector logístico. Por último, en la sección V se presentan las conclusiones y recomendaciones para trabajos futuros.

II. DESCRIPCIÓN DEL PROBLEMA

Este trabajo se concentra en resolver los problemas DPPP y MBSBPP de forma integrada. En la literatura ambos problemas han sido estudiados de forma separada, una revisión actualizada del problema DPPP, también conocido como *Pallet Loading Problem* es presentada en [12]. Por otro lado, el problema MBSBPP es casi siempre tratado como el problema de carga de mercancías (*Bin Packing Problem*), en

---

G. A Camacho, Universidad de La Salle, Bogotá, Colombia, gacamacho@unisalle.edu.co.

D. Cuellar, Universidad de Los Andes, Bogotá, Colombia, dh.cuellar@uniandes.edu.co.

D. Álvarez-Martínez, Universidad de Los Andes, Bogotá, Colombia, d.alvarezm@uniandes.edu.co.

Influence of programming style in transformation bad smells:
mining of ETL repositories

Nicolás Bonet;
Kelly Garcés;
Rubby Casallas,
María Elsa Correal;
Ran Wei.

Influence of programming style in transformation bad smells: mining of ETL Repositories

Nicolás Bonet, Kelly Garcés, Rubby Casallas[a], María Elsa Correal[b] and Ran Wei[c]

[a]Universidad de Los Andes, School of Engineering, Department of Systems and Computing Engineering
[b]Universidad de Los Andes, School of Engineering, Department of Industrial Engineering
[c]The University of York, Department of Computer Science

ABSTRACT
Bad smells affect maintainability and performance of model-to-model transformations. There are studies that define a set of transformation bad smells, and some of them propose techniques to recognize and —according to their complexity— fix them in a (semi)automated way. In academia it is necessary to make students aware of this subject and provide them with guidelines to improve the quality of their transformations. This paper presents the most common bad smells made by master students from Universidad de los Andes, and compares them with those from publicly available repositories of ETL transformations, with the purpose of knowing whether programming style affects the incidence of smells. Three concrete contributions are presented: i) two new bad smells that enrich the existing catalogs; ii) a process that includes the automated extraction of transformation metrics and bad smells metrics from the repositories, and a statistical analysis that helps in identifying the relation between such metrics; and iii) a tool that automatizes the process. From the statistical analysis, we conclude that, students must be encouraged and guided to develop maintainable declarative transformations. At this point, our tool has been proved to be very useful to help improve the quality of students transformations.

1. Introduction

Model-Driven Engineering (MDE) has gained some popularity in industry because companies and developers are beginning to adopt its features because of all the possibilities to make software less complex and easier to maintain. In this context, universities play a big role since they promote the use of MDE to students, who later become the companies' workforce. This promotion should include implementation best practices to get the best of MDE.

In the last ten years, the importance of measuring the quality of Model-to-Model (M2M) transformations was pointed out, since they are a key component in MDE. We have identified several studies (Kapová, Goldschmidt, Becker, & Henss, 2010; Rentschler, Noorshams, Happe, & Reussner, 2013; van Amstel, Lange, & van den

A Robust DEA-centric Location-based Decision Support System for Expanding Recreovía Hubs in the City of Bogotá (Colombia)

Sepideh Abolghasem;
Felipe Solano;
Claudia D. Bedoya;
Lina P. Navas;
Ana Paola Ríos;
Edwin A. Pinzón;
Andrés L. Medaglia;
Olga L. Sarmiento.

A robust DEA-centric location-based decision support system for expanding Recreovía hubs in the city of Bogotá (Colombia)

Sepideh Abolghasem[a], Felipe Solano[a], Claudia D. Bedoya[a,b], Lina P. Navas[a],
Ana Paola Ríos[c,e], Edwin A. Pinzón[d], Andrés L. Medaglia[a] and Olga L. Sarmiento[c]

[a]*Department of Industrial Engineering, Universidad de los Andes, Bogotá, Colombia*
[b]*Department of Systems and Computation Engineering, Universidad de los Andes, Bogotá, Colombia*
[c]*School of Medicine, Department of Public Health, Universidad de los Andes, Bogotá, Colombia*
[d]*District Institute of Sports and Recreation of Bogotá, Bogotá, Colombia*
[e]*School of Cardiorespiratory Therapy, Universidad Manuela Beltrán, Bogotá, Colombia*
E-mail: ag.sepideh10@uniandes.edu.co [Abolghasem]; f.solano1171@uniandes.edu.co [Solano];
cd.bedoya212@uniandes.edu.co [Bedoya]; lp.navas1582@uniandes.edu.co [Navas]; a-rios@uniandes.edu.co [Ríos];
edwin.pinzon@idrd.gov.co [Pinzón]; amedagli@uniandes.edu.co [Medaglia]; osarmien@uniandes.edu.co [Sarmiento]

Abstract

Multisectorial community programs to promote healthy living in public spaces are crucial for building a "culture of health" and could contribute to achieving the specific 2030 agendas of sustainable development goals, including reduction of inequalities; provision of inclusive, safe, resilient, and sustainable cities; and promotion of just, peaceful, and inclusive societies. In this context, the Recreovía program of Bogotá (Colombia) provides physical activity classes in parks mainly for vulnerable communities. We address the challenge of efficiently locating new Recreovía hubs through a novel robust data envelopment analysis (DEA) centric location-based decision support system (DSS) that helps the District Institute of Sports and Recreation of Bogotá (IDRD) to locate the best hubs to expand the Recreovía program throughout the city. The tool is applied to analyze different scenarios including one that was implemented in Bogotá and yielded an improvement of 28% in compound monthly growth rate of the average attendance to the hubs.

Keywords: location problems; data envelopment analysis (DEA); robust optimization; community programs; physical activity; decision support systems

1. Introduction

Public spaces are settings with great potential for promoting healthy living. Therefore, multisectorial community programs are crucial for building a "culture of health" and could contribute to achieving the specific 2030 agendas of sustainable development goals (SDG), including reducing inequalities;

Stocking and Price-reduction Decisions for Non-instantaneous Deteriorating Items under Time Value of Money

Freddy Pérez;
Fidel Torres;
Daniel Mendoza

Stocking and price-reduction decisions for non-instantaneous deteriorating items under time value of money

Freddy Andrés Pérez[a*], Fidel Torres[a] and Daniel Mendoza[b]

[a]Department of Industrial Engineering, Universidad de los Andes: Cra 1 N° 18A 12, Bogotá, 111711, Colombia
[b]Department of Industrial Engineering. Universidad del Atlántico: Cra 30 N° 8 49 Puerto Colombia Atlántico, Colombia

CHRONICLE	ABSTRACT
	Deteriorating inventory models are used as decision support tools for managers primarily, although not exclusively, in the retail trade. The mathematical modeling of deteriorating items allows managers to analyze their inventory management systems to identify areas that can be improved and to measure the corresponding potential benefits. This study develops an enhanced deteriorating inventory model for optimizing the inventory control strategy of companies operating in sectors with deteriorating products. In contrast with previous studies, our model holistically accounts for the overall financial effect of a company's policies on product price discounting and on inventory shortages while considering the time value of money (TVM). We aim to find the optimal replenishment strategy and the optimal price reductions that maximize the discounted profit function of this analytical model over a fixed planning horizon. To this end, we use an economic order quantity model to study the effects of the TVM and inflation. The model accounts for pre- and post-deterioration discounts on the selling price for non-instantaneous deteriorating products with the demand rate being a function of time, price-discounts and stock-keeping units. Shortages are allowed and partially backordered, depending on the waiting time until the next replenishment. Additionally, we consider the effect of discounts on the selling price when items have either an instant deterioration or a fixed lifetime. We propose five implementable solutions for obtaining the optimal values, and examine their performance. We present some numerical examples to illustrate the applicability of the models, and carry out a sensitivity analysis. The study reveals that accounting for TVM and inventory shortages is complex and time-consuming; nevertheless, we find that accounting for TVM and shortages can be valuable in terms of increasing the yields of companies. Finally, we provide some important managerial implications to support decision-making processes.

1. Introduction

Most deteriorating inventory models disregard the joint effects of price discounting, the time value of money (TVM), and the inventory policies regarding stockouts (out-of-stock events). However, such issues are important and should not be overlooked. In practice, businesses use methods such as the net present value, the internal rate of return, and the payback period to find a discount strategy that helps them to both meet their sales objectives and obtain the best profit possible for their market demand. For example, in supermarkets, manufacturers and the retailers frequently agree on increasing the shelf space allocation for a product or a product family because large-quantity displays can encourage consumption

An Integrated Production-inventory Model for Deteriorating Items to Evaluate JIT Purchasing Alliances

Freddy Pérez;
Fidel Torres.

An integrated production-inventory model for deteriorating items to evaluate JIT purchasing alliances

Freddy Pérez[a]* and Fidel Torres[a]

[a]*Department of Industrial Engineering, Universidad de los Andes: Cra 1 N° 18A 12, Bogotá, Colombia*

CHRONICLE	ABSTRACT
	The implementation of just-in-time (JIT) principles has been shown to be worthy of analysis due to its potential economic benefits. Yet, while several empirical studies have reported the success of adopting JIT management concepts, little work has been accomplished in offering analytical tools for assisting managers for implementing JIT strategy. This paper proposes a new inventory model to better embrace JIT purchasing. In pursuing this goal, we develop a deterministic single-setup multiple-delivery model for deteriorating items by considering the effect of the time value of money (TVM). We propose a solution procedure to determine the optimal decisions that maximize the discounted profit function of this analytical model, and compare it with some other alternatives. Here, we show the derivation of the mathematical model, the algorithm of the proposed solutions, and the application of the new approach through two numerical experiments. The study reveals that modeling the TVM effect complicates the determination of an optimal JIT inventory policy; nevertheless, we find that accounting for TVM can be decisive in terms of promoting and implementing JIT purchasing agreements.

1. Introduction

As indicated by Xu and Chen (2016), just-in-time (JIT) practices have been widely adopted in manufacturing businesses, and for both academics and practitioners, JIT production systems have been recognized as an effective strategy to enhance organizational competitiveness (Chen & Tan, 2013). In a JIT system, both a vendor and buyer work together in a mutually rewarding long-term partnership to achieve a cost-effective supply chain inventory system. Typically, this is mainly accomplished through the use of lower lot-size and frequent deliveries, and with the correct application of the JIT delivery concept (Matsui, 2007). An extensive literature of empirical studies is available highlighting many principles for adopting JIT, successfully. Readers are encouraged to consult Chen and Tan (2011), Chen and Tan (2013), Negrão et al. (2017), and the references cited therein.

Although, currently, organizations such as Dell, Walmart and many others have earned their success, at least in part, as a result of the JIT management strategy (Michelsen et al., 2014), the ultimate goals of a JIT system, zero-inventories and zero set-up times, are impossible to achieve even in the best JIT-lean applications (Ali et al., 2012; Darlington et al., 2016; Santos et al., 2006). Thus, in these contexts, a common question belonging to the field of inventory theory inexorably arises: what is the optimal