

# Optimization Workshop 2024

## November 19<sup>th</sup>, 2024

### Auditório Fernão – ICMC/USP

**9:00 am - Opening section**

**9:30 am - "Personnel rostering: open problems in practice and theory"**

**Speaker: Greet Vanden Berghe - KU Leuven - Gent**

**Chair: Franklina Toledo**

**Abstract:** Personnel rostering represents a fascinating combinatorial optimisation problem due to its relevance in practice and its computational difficulty. The personnel rostering problem has yielded ample practice-oriented combinatorial optimisation approaches. Despite the vast amount of academic research results, it remains hard for novice developers to profit from general insights or re-usable models and algorithms. This 'cold start' issue can be partially explained by complicated regulations typical for personnel environments with 24/7 duties which are different in almost every organisation. The very same issue also persists due to the lack of a theoretical framework for nurse rostering. This talk will focus on the challenging interplay between important practical and theoretical nurse rostering contributions.

**10:30 am - Break for a cup of coffee**

**11:00 am – A MILP model for the product-to-shelf allocation problem in supermarkets**

**Speaker: Aline Leão - State University of Londrina, Paraná**

**Chair: Marina Andretta**

**Abstract:** The product-to-shelf allocation problem consists of determining the space that each type of product will occupy on shelves in order to maximize the profit in retail stores. Studies have shown that sales are extensively influenced by the space available for the products, the location of the products on the shelves, and the product assortment, among others. In this talk, we present a mixed integer linear programming model and a warm start heuristic that integrate the strategic and the tactical levels from a two-dimensional perspective following the category management applied in Brazilian supermarkets. The strategic level considers the space allocated to the products and the type of shelves, defining the height of the shelves and the length of the modules. The tactical level considers the horizontal and vertical location and the number of facings of the products. Computational results show that the proposed method provides good results for real instances.

**11:30 am - "Model and algorithms to solve the multi-service and multi-period IoT-Fog-Cloud allocation problem"**

**Speaker: Mayron Moreira - Federal University of Lavras, Minas Gerais**

**Chair: Maristela Santos**

**Abstract:** The Internet of Things (IoT) and Fog Computing (FC) technologies, when integrated, enable the development of smart urban systems and efficient processing of large volumes of data. This study presents a mathematical model and algorithms for integrating these technologies and allocating resources to serve multiple network services in Smart Cities environments. In this context, multi-period service provision is justified in planning and scheduling the response to IoT sensor demands, minimising fog and cloud nodes activation costs. The computational results show the limitations of an exact approach to solve the problem, and show future avenues concerning solution methods improvement based on heuristics.

**12:00 pm – Lunch Break**

**2:00 pm – "Supply chains and the social-ecological crisis: looking back and beyond"**

**Speaker: Vinícius Picanço Rodrigues – INSPER, São Paulo**

**Chair: Franklina Toledo**

**Abstract:** In this talk, I will explore various epistemological perspectives on supply chain operations and the impact of interconnected social-ecological crises on production and consumption systems. I will particularly emphasise how complex systems approaches can—and should—address the global social and environmental challenges ahead. Finally, I will briefly present examples of past and recent research projects I have been involved in to encourage future collaborations among us.

**3:00 pm – Session A**

**Chair: Aline Leão**

**"The Stochastic Production and Procurement Lot-Sizing Problem with Perishable Items"**

**Speaker: Caio Paziani Tomazella – UFSCar/USP**

**Abstract** This presentation addresses a production and procurement lot-sizing problem with uncertain demand and perishable products. The problem is modeled using two-stage stochastic programming, in which some decisions, mainly those related to procurement, need to be made before demand realisation, while others can be made after, such as production quantities and inventory management. This semi-flexible production setting is found in some practical applications, especially in the food industry. We present two formulations for this problem, based on the deterministic formulations for lot-sizing problems with perishability, and discuss how their optimal recourse policy considers planned inventory losses in their solutions. In this context, we propose an alternative recourse to prevent these losses and discuss its practical implications in terms of costs and inventory management.

**Logic-based Benders Decomposition for the integrated vehicle routing and three-dimensional packing problems.**

**Speaker: Douglas Nogueira do Nascimento**

**Abstract:** This work studies the integration of the Vehicle Routing Problem (VRP) with the Container Loading Problem (CLP), which is of great practical relevance, as the efficiency in load allocation directly impacts the effectiveness of delivery routes. By solving the problem in an integrated way, we aim to use the space available for delivery (packing) better and reduce greenhouse gas emissions in the planning. The proposed strategy solution is an exact method using the Logic-based Benders Decomposition (LBBD) that formulates the problems separately so that the CLP is treated as a subproblem of the VRP, checking the feasibility of packing all boxes ordered by the customers visited for each vehicle in the fleet. Unlike the original Benders Decomposition, which can only be applied when the subproblem is a linear programming problem, the logic-based variation allows the resolution of any optimization problem, even involving binary and/or integer variables. Preliminary computational experiments with instances from the literature have been performed, and the results were promising.

**Formulations and exact methods for the green split delivery vehicle routing problem under commodity constraints**

**Speaker: Kamyla Maria Ferreira**

**Abstract:** This work addresses the Green Commodity Constrained Split Delivery Vehicle Routing Problem (GC-SDVRP), which aims to design efficient and environmentally friendly delivery routes to reduce CO<sub>2</sub> emissions in multi-commodity transportation. In the GC-SDVRP, various commodities are available at the depot, and each customer has specific demands. Multiple vehicles can visit each customer as long as each vehicle delivers only one commodity. A branch-and-cut approach is introduced based on a relaxed formulation, along with adaptations of two formulations from the literature. Computational experiments indicate that this approach surpasses existing methods and show that minimizing emissions does not always reduce travel costs, with the latter being more challenging to optimize computationally.

**4:30 pm – Closing section and Coffee Break**