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› FEMM-Antrag (https://fww.ovgu.de/fww_media/femm/FEMM.pdf)

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23013 **Rosario Paradiso, Roberto Roberti, Marlin Ulmer**

› Dynamic Time Window Assignment for Next-Day Service Routing
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_13.pdf)

Abstract:

We consider a problem where customers dynamically request next-day home service, e.g., repair instalment. Unlike attended home delivery, customers cannot select a time window (TW), but the servic provider assigns a next-day TW to each new customer if the customer can feasibly be inserted in th service route of the next day without violating the TWs of the existing customers. Otherwise, the custom service is postponed to another day (which is outside of the scope of this work). For fast service ar efficient operations, the provider aims to serve many customers the next day. Thus, TWs have to b assigned to keep the flexibility of the fleet for future requests. For such anticipatory assignments, w propose a stochastic lookahead method that samples a set of future request scenarios, solves th corresponding team orienteering problems with TWs, and uses the solutions to evaluate current TW assignment decisions. For real-time solutions of the TOP, we propose to approximate its optimal solutic value with a tight upper bound. The bound is obtained by solving the linear relaxation of a set packir reformulation via column generation. We test our algorithm on Iowa City data and compare it to sever benchmark policies. The results show that our method increases customer service significantly and th our relaxation is essential for effective decisions. We further show that our policy does not lead observable discrimination against inconveniently located customers.

JEL:

Keywords: next-day service, dynamic TW assignment, stochastic lookahead, approximate dynamic programming, column generation

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23012 **Simona Mancini, Marlin W. Ulmer, Margaretha Gansterer**

› Dynamic Assignment of Delivery Order Bundles to In-Store Customers
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_12.pdf)

Abstract:

Many larger grocery stores offer home delivery services. However, the delivery cost is usually high ar such services are rarely profitable. One way of reducing cost is by outsourcing some orders to in-sto customers for a compensation. While initially single orders were dynamically assigned to customer companies started exploring the assignment of order bundles instead to reduce per-order compensatic and exploit consolidation potential. We investigate the value of dynamic assignment of bundles in th work. To this end, we consider a setting where all orders are known and, over time, unknown in-sto customers enter the system for a short time and offer transportation of bundles of orders f compensation. The store decides dynamically which bundle to assign to which in-store customer (if any At the end of the time horizon, the remaining orders are delivered by a dedicated fleet of store employee The goal of the store is to minimize the compensation prices together with the delivery cost. We propos a threshold based policy tuned by a stochastic lookahead procedure. Popularity and compensation pric thresholds are determined a priori by solving a set of perfect information scenarios. In every stat

bundles are only assigned if they are popular enough and the compensation is comparably low. Th thresholds are adapted over time to account for the decrease in assignment opportunities. We show th effectiveness of our policy in a comprehensive computational study and highlight the value of bund assignments compared to assigning individual orders. We further show that our strategy not only reduce the compensation paid to in-store customers but also the final routing cost.

JEL:

Keywords: Crowdsourcing, Order bundling, Sequential decision making, Approximate dynamic programming

23011 **Thomas Horstmannshoff, Jan Fabian Ehmke, Marlin Ulmer**

› Dynamic learning-based Search for Multi-criteria Itinerary Planning
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_11.pdf)

Abstract:

Travelers expect integrated and multimodal itinerary planning while addressing their individu expectations. Besides common preferences such as travel time and price, further criteria such as walkir and waiting times are of importance as well. The competing features of these preferences yield a varie of Pareto-optimal itineraries. Finding the set of Pareto-optimal multimodal travel itineraries in efficient ru time remains a challenge in case multiple traveler preferences are considered. In this work, we present sampling framework to approximate the set of Pareto-optimal travel itineraries that scales well in terms considered preferences. In particular, we guide the search process dynamically to uncertain areas of th complex multimodal solution space. To this end, we learn the structure of the Pareto front during th search with Gaussian Process Regression (GPR). The GPR sampling framework is evaluated integratir an extensive amount of real-world data on mobility services. We analyze long-distance trips betwee major cities in Germany. Furthermore, we take up to five traveler preferences into account. We observ that the framework performs well, revealing origin and destination specifics of Pareto fronts of multimod travel itineraries.

JEL:

Keywords: Routing, Multi-Criteria Decision Support, Multimodal Mobility, Gaussian Process Regression

23010 **Thomas Spengler, Tobias Volkmer and Sebastian Herzog**

› Artificial Intelligence and Fuzzy Logic in modern Human Resource Management
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_10.pdf)

Abstract:

The corporate environment is always characterized by a high degree of volatility, uncertainty, complexi and ambiguity. These aspects influence Human Resource Management (HRM) just like other areas of th company. In the context of decision problems, especially in HRM, it is not always possible to specify the considered variables precisely. A suitable instrument to deal with such fuzzy conditions is Fuzzy Log (FL). This paper aims to give insights into this field and its possible applications in HRM. For this purpos selected theoretical foundations from the areas of HRM, FL and Artificial Intelligence (AI) are presente first. Based on this, situations in HRM are shown in which it can be useful to include FL in decisic calculations. These concern e.g. problems of personnel allocation or considerations on the segmentatic of labor forces. The paper is aimed at both practitioners and scholars.

JEL: A20, A22, A23, C60, C61, C63, J21, J23, M12, M21, M51

Keywords: Artificial Intelligence, Data Mining, Demography Sensitive Personnel Policy, Dig-itization, Fuzzy Expert Systems, Fuzzy Logic, Fuzzy Scenarios, Human Resource Manage-ment, Leadership Styles, (Meta-)Heuristics, Simulation

23009 **Kim Michelle Siegling, Thomas Spengler and Sebastian Herzog**

› Personnel Planning and Leadership as Central Personnel Economic Instruments
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_09.pdf)

Abstract:

Economic activity always involves the allocation of scarce goods to competing uses. Among these scarc goods is also the personnel of the enterprise. Personnel economics therefore also has to make suc allocation decisions with respect to the availability of personnel and with respect to the functionality personnel. For this purpose, two sets of instruments are used, namely personnel planning and leadershi This article is dedicated to a selection of such in-struments. Beyond selected relevant basics of personn planning and leadership, this article introduces hierarchical personnel planning and the conception fuzzy rule systems for the selection of appropriate leadership styles.

JEL: A20, A22, A23, C60, M12, M21, M50, M51

Keywords: (fuzzy) linear programming, fuzzy logic, (hierarchical) personnel planning, leader-ship, leadership styles, leadership style choice models, management by … concepts, productiv-ity factors, rule based systems

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23008 **Dmitri Bershadskyy, Laslo Dinges, Marc-André Fiedler, Ayoub Al-Hamadi, Nina Ostermaier, Joachim Weimann**

› Experimental economics for machine learning - a methodological contribution (https://fww.ovgu.de/fww_media/femm/femm_2023/2023_08.pdf)

Abstract:

In this paper, we investigate how technology has contributed to experimental economics in the past ar illustrate how experimental economics can contribute to technological progress in the future. We argu that with machine learning (ML) a new technology is at hand, where for the first time experiment economics can contribute to enabling substantial improvement of technology. At the same time, M opens up new questions for experimental research because it can generate observations that we previously impossible. To demonstrate this, we focus on algorithms trained to detect lies. Such algorithm are of high relevance for research in economics as they deal with the ability to retrieve otherwise priva information. We deduce that most of the commonly applied data sets for the training of lie detectic algorithms could be improved by applying the toolbox of experimental economics. To illustrate this, w replicate the “lies in disguise-experiment” (Fischbacher & Föllmi-Heusi, 2013) with a modificatic regarding monitoring. The modified setup guarantees a certain level of privacy from the experimenter y allows to record the subjects as they lie to the camera. Our results indicate the same lying behavior as the original experiment despite monitoring. Yet, our experiment allows for an individual- level analysis ar provides a video data set that can be used for lie detection algorithms.

JEL: C90, C91, O30

Keywords: lying behavior, lie detection, experiment, technology, machine learning

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23007 **Kim Michelle Siegling, Thomas Spengler and Sebastian Herzog**

› Rule-based systems for leadership style selection (https://fww.ovgu.de/fww_media/femm/femm_2023/2023_07.pd

Abstract:

In personnel economics, the choice of a leadership style is about the question of how a supervisor shou lead his or her employees in such a way that operational goals are achieved. In this paper, we assum that such leadership decisions are made according to the situation. Thus, the optimal or at least permissible leadership style has to be selected from a set of several possible leadership styles. For th choice a wide range of models has been developed in the scientific literature, from which we want to pic out and focus on the so-called normative decision model by Vroom & Yetton (Vroom/Yetton 1973). Whi the original model is based on univocal rules, in this paper we develop a fuzzy rule system.

JEL: A20, A22, A23, C60, M12, M21, M51

Keywords: leadership, leadership styles, rule-based systems, fuzzy logic

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23006 **Florentin D. Hildebrandt, Alexander Bode, Marlin W. Ulmer, Dirk C. Mattfeld**

› Reinforcement Learning Variants for Stochastic Dynamic Combinatorial Optimization Problems in Transportation (https://fww.ovgu.de/fww_media/femm/femm_2023/2023_06.pdf)

Abstract: With rising customer expectations and increasing computational potential, many transportation service face real-time decision making in stochastic and dynamic environments. They often need to find ar adapt complex plans that are effective now but also flexible with respect to future development Mathematically, these three challenges of searching the large and complex decision space for effectiv and flexible decisions are reflected in the three parts of the famous Bellman Equation, namely the rewa function (effective), the value function (flexible), and the decision space (search). In the transportatic literature, reinforcement learning (RL) has shown potential to quickly evaluate the reward- and valu function of the Bellman Equation for a limited number of decisions but struggles to search a comple constrained decision space immanent in most transportation problems. The question of how to combir the thorough search of the complex decision space with RL-evaluation techniques is still open.W propose three RL-based solutions, each inspired by one component of the Bellman Equation, to searc for and evaluate decisions in an integrated manner. The first and second method learn to dynamical manipulate the reward function and decision space to encourage effective and flexible and prohib inflexible decisions, respectively. The third method models the Bellman Equation as a mixedinteger line programming formulation in which the value function is given by a neural network approximator. W compare our proposed solution methods in a structured analysis for carefully designed problem classe based on longhaul, medium-haul, and short-haul transportation logistics. We demonstrate the over effectiveness of our methods compared to prominent benchmark methods and highlight how the method performances depend not only on the problem classes but also on the instances' parameterizations.

JEL:

Keywords: stochastic dynamic transportation problems, sequential decision processes, mixed integer linear programming, reinforcement learning, approximate dynamic programming

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23005 **Thomas Spengler, Sebastian Herzog**

› Defuzzification in Scenario Management – A theoretical and practical Guide
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_05.pdf)

Abstract: It is virtually a truism that companies should respond to situations of high complexity, dynamics and contingency with strategic management measures. Not least in turbulent VUCA-type environments, the company is well advised to use alternative scenarios for environmental forecasting. The so-called scenario technique is used for this purpose. Human modes of thought, judgment and action are often ambiguous and rarely univocal. Here, so-called expert (control) systems based on fuzzy control offer valuable help. Their core is rule inference resulting in fuzzy rule output. In many cases, however, managers are interested in receiving concrete recommendations for action that are as unambiguous as possible. To do so, they need to defuzzify the fuzzy output set. In this paper, we consider selected defuzzification procedures in the area of scenario management.

JEL: A20, A22, A23, C60, M20, M21

Keywords: scenario management, defuzzification, fuzzy logic

23004 **Daniel Cuellar-Usaquén, Marlin W. Ulmer, Camilo Gomez, David Álvarez-Martínez**

› Adaptive stochastic lookahead policies for dynamic multi-period purchasing and inventory routing
(https://fww.ovgu.de/fww_media/femm/femm_2023/2023_04.pdf)

Abstract: We present a problem motivated by discussions with Colombian e-commerce platforms for agri-food products. In regular time intervals (periods), the platforms collect groceries from local farmers and stores them at a warehouse to distribute them to local customers. The supply quantities and prices per farmer and the cumulated customer demand can change from period to period. Thus, there is value in purchasing more than needed in one period to exploit cheap prices and consolidation opportunities, to hedge against future uncertainty, and to save routing cost in future periods. A careful balance between to much and not enough inventory needs to be found, especially, since inventory perishes over time. The resulting optimization problem is a stochastic dynamic multi-period routing problem with inventory and

purchasing decisions. The decision space of the problem is vast as it combines purchasing, inventory, ar routing decisions. Further, the value of a decisions is unknown since it depends on future developments and decisions. We propose solving the problem with a stochastic lookahead method. In every state, the method samples a set of future realizations and solves the resulting two-stage stochastic program. To cope with the complex decision space in first and second stage, we propose a “soft” decomposition wher the inventory and purchasing decision are fully considered, but the routing decisions are simplified and their cost is approximated via a cost function approximation. As the routing cost also depends on future decisions, the approximated cost are learned iteratively via repeated simulation and adaption of the lookahead. We show that our method outperforms a large number of benchmark policies for a variety of instances. We further analyze the functionality of our method and investigate variation in the problem dimensions in a comprehensive analysis.

JEL:

Keywords: Agri-Food Supply Chains, Dynamic Multi-period Vehicle Routing, Stochastic Dynamic Decision Making, Approximate Dynamic Programming, Two-Stage Stochastic Programming, Cost Function Approximation

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23003 **Hans-Peter Burghof, Horst Gischer**

› Competition, Resilience, and Stability – Implications for Institutional Protection Schemes and Systemic Risk in the European Banking Union (https://fww.ovgu.de/fww_media/femm/femm_2023/2023_03.pdf)

Abstract:

The finalization of the European Banking Union (EBU) requires the completion of the third pillar, the system of depositor protection. However, whereas the two first pillars, while set-ting common standards, allow for elements of decentralization and institutional diversity, some authors claim that the third pillar is only established with a single and joint deposit guarantee scheme (DSG) for all countries in the Monetary Union. Limits to joint liability, or alternative concepts like the existing institutional protection schemes (IPS in some member states, are seen as imperfections that can only be temporarily accepted for political reasons. According to this view, such elements of compromise and differentiation should be over-come.

In our paper, we argue that neither the DGS nor the IPS is always efficient. Choosing an IPS is a response to a special way to organize banking business. It contains no element of regulato-ry arbitrage, as it represents a cost-efficient mean to protect depositors in decentralized banking networks marked by larger number of regional banks and by a business model with a strong focus on long-term client relationships. Making decentralized banking and rela-tionship banking costlier through discriminating regulations (like the non-recognition of IPS) would thus have a negative impact on the common market, as it distorts the competition between different organizational concepts of banking.

JEL: G21, G28, L22, L51

Keywords: European Banking Union, banking industry, regulation, systems competition

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23002 **Shohre Zehtabian, Marlin W. Ulmer**

› Consistent Time Window Assignments for Stochastic Multi-Depot Multi-Commodity Pickup and Delivery (https://fww.ovgu.de/fww_media/femm/femm_2023/2023_02.pdf)

Abstract:

In this paper, we present the problem of assigning consistent time windows for the collection of multiple fresh products from local farmers and delivering them to distribution centers for consolidation and further distribution in a short agri-food supply chain with stochastic demand. We formulate the problem as a two stage stochastic program. In the first stage, the time windows are assigned from a set of discrete time windows to farmers and in the second stage, after the demand is realized, the collection routes are planned by solving yet a newly introduced multi-depot multi-commodity team orienteering problem with soft time windows. The objective is to minimize the overall travel time and the time window violations. To solve our problem, we design a (heuristic) progressive hedging algorithm to decompose the deterministic equivalent problem into subproblems for a sampled set of demand scenarios and guide the scenarios toward consensus time windows. Through numerical experiments, we show the value of considering

demand uncertainty over solving the deterministic expected value problem and the superiority of our approach over benchmarks when it comes to reducing the routing cost as well as the inconvenience for farmers.

JEL:

Keywords: Agri-food supply chains, Time window assignment, Consistency, Two-stage stochastic programming, Progressive hedging algorithm

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23001 **Marlin W. Ulmer, Justin C. Goodson, Barrett W. Thomas**

› Optimal Service Time Windows (https://fww.ovgu.de/fww_media/femm/femm_2023/2023_01.pdf)

Abstract:

Because customers must usually arrange their schedules to be present for home services, they desire a accurate estimate of when the service will take place. However, even when firms quote large service tim windows, they are often missed, leading to customer dissatisfaction. Wide time windows and frequent failures occur because time windows must be communicated to customers in the face of several uncertainties: future customer requests are unknown, final service plans are not yet determined, and when fulfillment is outsourced to a third party, the firm has limited control over routing procedures. Even when routing is performed in-house, time windows typically do not receive explicit consideration. In this paper, we show how companies can communicate reliable and narrow time windows to customers in the face of arrival time uncertainty. Under mild assumptions, our main result characterizes the optimal policy identifying structure that reduces a high-dimensional stochastic non-linear optimization problem to a root finding problem in one dimension. The result inspires a practice-ready heuristic for the more general cas Relative to the industry standard of communicating uniform time windows to all customers, and to other policies applied in practice, our method of quoting customer-specific time windows yields a substantial increase in customer convenience without sacrificing reliability of service, providing results that nearly achieve the lower bound on the optimal solution. Our results show that (i) time windows should be tailore to individual customers, (ii) time window sizes should be proportional to the service level, (iii) larger time windows should be assigned to earlier requests and smaller time windows to later requests, (iv) larger time windows should be assigned to customers further from the depot of operation and smaller time windows to closer customers, and (v) two time windows for one customer are helpful in some cases.

JEL:

Keywords: time windows, service routing, non-linear optimization

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