

## FEMM - Working Paper Series - 2016

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16006

André Scholz

› An Exact Solution Approach to the Single-Picker Routing Problem in Warehouses with an Arbitrary Block Layout

Abstract:

The Single-Picker Routing Problem (SPRP) arises in warehouses when items have to be retrieved from their storage locations in order to satisfy a given demand. It deals with the determination of the sequence according to which the respective locations have to be visited. The storage locations in the warehouse are typically arranged in a specific way and constitute a so-called block layout. Using this structure, Scholz et al. (2016) proposed a model to the SPRP in a single-block layout whose size (in terms of number of variables and constraints) is independent of the number of locations to be visited. They briefly described how the model can be extended to deal with multiple blocks, but also stated that its size will drastically increase. In this paper, the extension of this formulation is considered and different scenarios are pointed out which can be used to significantly decrease the size of the model. By means of numerical experiments, it is demonstrated that the size of the formulation can be decreased by up to 60%, resulting in a reduction of computing time by up to 99.5%. Furthermore, it is shown that computing times do not increase with an increasing number of blocks, which is a major advantage of the model as no efficient solution approach to the SPRP is available able to deal with more than two blocks.

JEL:

Keywords:

Traveling Salesman, Order Picking, Picker Routing

16005

André Scholz/Daniel Schubert/Gerhard Wäscher

› Order picking with multiple pickers and due dates Simultaneous solution of order batching, batch assignment and sequencing, and picker routing problems

Abstract:

In manual picker-to-parts order picking systems of the kind considered in this article, human operators (order pickers) walk or ride through the warehouse, retrieving items from their storage location in order to satisfy a given demand specified by customer orders. Each customer order is characterized by a certain due date until which all requested items included in the order are to be retrieved and brought to the depot. For the actual picking process, customer orders may be grouped (batched) into more substantial picking orders (batches). The items of a picking order are then collected on a picker tour through the warehouse. Thus, the picking process of each customer order in the batch is only completed when the picker returns to the depot after the last item of the batch has been picked. Whether and to which extent due dates are violated (tardiness) depends on how the customer orders are batched, how the batches are assigned to order pickers, how the assigned batches are sequenced and how the pickers are routed through the warehouse. Existing literature has only treated special aspects of this problem (i.e. the batching problem or the routing problem) so far. In this paper, for the first time, an approach is proposed which considers all aspects simultaneously. A mathematical model of the problem is introduced that allows for solving small problem instances in reasonable computing times. For larger instances, a variable neighborhood descent (VND) algorithm is presented which includes various neighborhood structures regarding the batching and sequencing problem. Furthermore, two sophisticated routing algorithms are integrated into the VND algorithm. By means of numerical experiments, it is shown that this algorithm provides solutions of excellent quality.

JEL:

Keywords:	Order Picking, Order Batching, Batch Sequencing, Picker Routing, Traveling Salesman, Variable Neighborhood Descent
16004	Henriette Koch/Tino Henke/Gerhard Wäscher › A Genetic Algorithm for the Multi-Compartment Vehicle Routing Problem with Flexible Compartment Sizes
Abstract:	<p>In this paper, a genetic algorithm for the multi-compartment vehicle routing problem with continuously flexible compartment sizes is proposed. In this problem, supplies of several product types have to be collected from customer locations and transported to a depot at minimal cost. In order to avoid mixing of different product types which are transported in the same vehicle, the vehicle's capacity can be separate into a limited number of compartments. The size of each compartment can be selected arbitrarily within the limits of the vehicle's capacity, and in each compartment one or several supplies of the same product type can be transported.</p> <p>For solving this problem, a genetic algorithm is presented. The performance of the proposed algorithm is evaluated by means of extensive numerical experiments. Furthermore, the economic benefits of using continuously flexible compartments are investigated.</p>
JEL:	
Keywords:	vehicle routing, multiple compartments, genetic algorithm, heuristics
16003	Daniel Baumgarten/Michael Kvasnicka › Temporary Agency Work and the Great Recession
Abstract:	<p>We investigate with German data how the use of temporary agency work has helped establishments to manage the economic and financial crisis in 2008/09. We examine the (regular) workforce development, use of short-time work, and business performance of establishments that made differential use of temporary agency work prior to the crisis. Overall, our results suggest that establishments with a greater use of temporary agency work coped better with the sharp decline in demand and made less frequent use of government-sponsored short-time work schemes.</p>
JEL:	E32, J23, L23, J68
Keywords:	labour demand, employment adjustment, economic crisis, temporary agency work, short-time work, establishment data
16002	Yann Ruberg/André Scholz › A Mathematical Programming Formulation for the Single-Picker Routing Problem in a Multi-Block Layout
Abstract:	<p>The Single-Picker Routing Problem (SPRP) arises in warehouses when items have to be retrieved from their storage locations in order to satisfy a given demand. It deals with the determination of the sequence according to which the requested items have to be picked in the picking area of the warehouse and the identification of the corresponding paths to be travelled by human operators (order pickers). The picking area typically possesses a block layout, i.e. the items are located in parallel picking aisles, and the order pickers can only change over to another picking aisle at certain positions by means of so-called cross aisles. Using this special structure, Scholz et al. (2016) developed a model formulation whose size is independent of the number of locations to be visited. They presented the model for a single-block layout and briefly described how it can be extended to the case of multiple blocks. However, by extending this formulation, the number of variables and constraints is multiplied by the number of blocks and, therefore, the model is not suitable for solving the SPRP in warehouses composed of several blocks. In this paper, the extension to multiple blocks is considered and it is pointed out how to drastically reduce the size of the formulation. Depending on the storage locations of the requested items, the number of variables can be decreased by up to 96%.</p>
JEL:	

Keywords: Traveling Salesman, Order Picking, Picker Routing

16001 Dirk Bethmann/Michael Kvasnicka  
› International Tax Evasion, State Purchases of Confidential Bank Data and Voluntary Disclosures

**Abstract:** International tax evasion is a major source of discontent for tax authorities. State purchases of bank data on suspected tax evaders from international tax havens constitute one tool to combat such tax evasion. Increasing the risks of detection, such purchases may spur voluntary disclosures for fear of facing charges for tax fraud. Tax authorities in Germany have made repeated use of this tool in recent years, above all in North-Rhine Westphalia, Germany's most populous federal state. Using self-compiled data for North-Rhine Westphalia on the timing and content of data acquisitions and on monthly voluntary disclosures of international tax evasion involving Swiss banks, we study the effects that such acquisitions had on the evolution of voluntary disclosures over time. Our results show that purchases of data on potential tax evaders had a positive and sizeable effect on voluntary disclosures. Various robustness checks and additional explorations corroborate this conclusion.

JEL: H2, H3, H26

Keywords: Tax Evasion, Tax Havens, Whistle-blowers, Tax Data, Voluntary Disclosures

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